Small animal surgery

José Rodríguez

Basic surgical techniques

Advanced surgical techniques

Cardiorespiratory system

Circulatory system

Gastrointestinal system

Genitourinary system

Reproductive system

Endocrine system

Surgery atlas, a step-by-step guide

Surgical techniques

Bloodless surgery

SERVET

Small animal surgery

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Warning:

Veterinary science is constantly evolving, as are pharmacology and the other sciences. Inevitably, it is therefore the responsibility of the veterinary surgeon to determine and verify the dosage, the method of administration, the duration of treatment and any possible contraindications to the treatments given to each individual patient, based on his or her professional experience. Neither the publisher nor the author can be held liable for any damage or harm caused to people, animals or properties resulting from the correct or incorrect application of the information contained in this book.

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Reviewed by Steven C. Budsberg

Surgery atlas, a step-by-step guide

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Preface

"If you want different results, don't keep doing the same thing"
Albert Einstein (1879-1955)

Editorial Servet has the honor to present this eighth volume of its collection "Small animal surgery". This work represents the culmination of years of arduous work carried out by a team of specialists in small animal surgery and contains a selection of the main surgical procedures explained in the previous volumes of the collection with an added value: 53 high-quality, educational videos that will guide readers through the surgical procedure.

The book you have in your hands is dedicated, once again, to surgery, perhaps the most spectacular activity of a veterinary clinician: probably because it is a direct therapy, carried out by hand, and it confers a kind of magical power on the surgeon, aided by the fact that a disorder can often be solved very rapidly in the operating theatre.

The art of surgery is an "acid test" for the novice surgeon, with successes that can be spectacular and greatly add to the prestige of the surgeon, but failures that can be dramatic too. Either way, the mythical aura that surrounds both surgery and the surgeon force us to plan each surgical intervention in detail, in order to obtain the best results in the shortest time and with the least possible trauma. And that is precisely why the 53 videos added in this new work will be of great help for any surgeon. The subtitles explain step by step how the surgeon is performing the surgery and the image in motion guides the surgeon in a number of situations in the most visual and educational manner. We sincerely hope we will get the most of them. All this will not only be of benefit to the patient but will also ensure that the clinician enjoys being in the operating theatre, as surgery can and should be a pleasure.

This volume you have before you reflects the extensive surgical experience of all the collaborators and particularly that of Dr José Rodriguez and his knowledge to face the surgical challenges. Undoubtedly, the success of any surgical procedure depends on the skills and abilities of the surgeon and his or her team to identify and manage bleeding precisely, efficiently and effectively before, during and after procedure.

As in the previous books, we apologize for the quality of some of the visuals. Please, note that these were snapshots or videos taken during surgery, sometimes with sub-optimal framing, lighting and focus.

As always, the aim has been to contribute to the development of your daily clinical activities. Both the author and his collaborators would be satisfied if they were able to give you some ideas, and ever happier if they had been able to transmit their love of surgery.

We hope that images, videos, comments, recommendations and tips contained in this book will contribute to good planning for surgery on your patients. In any case, we thank you for your attention, and enjoy the operations you will perform.

Editorial Servet, Grupo Asís Biomedia.
September 2016, Zaragoza (Spain).

How to use this book

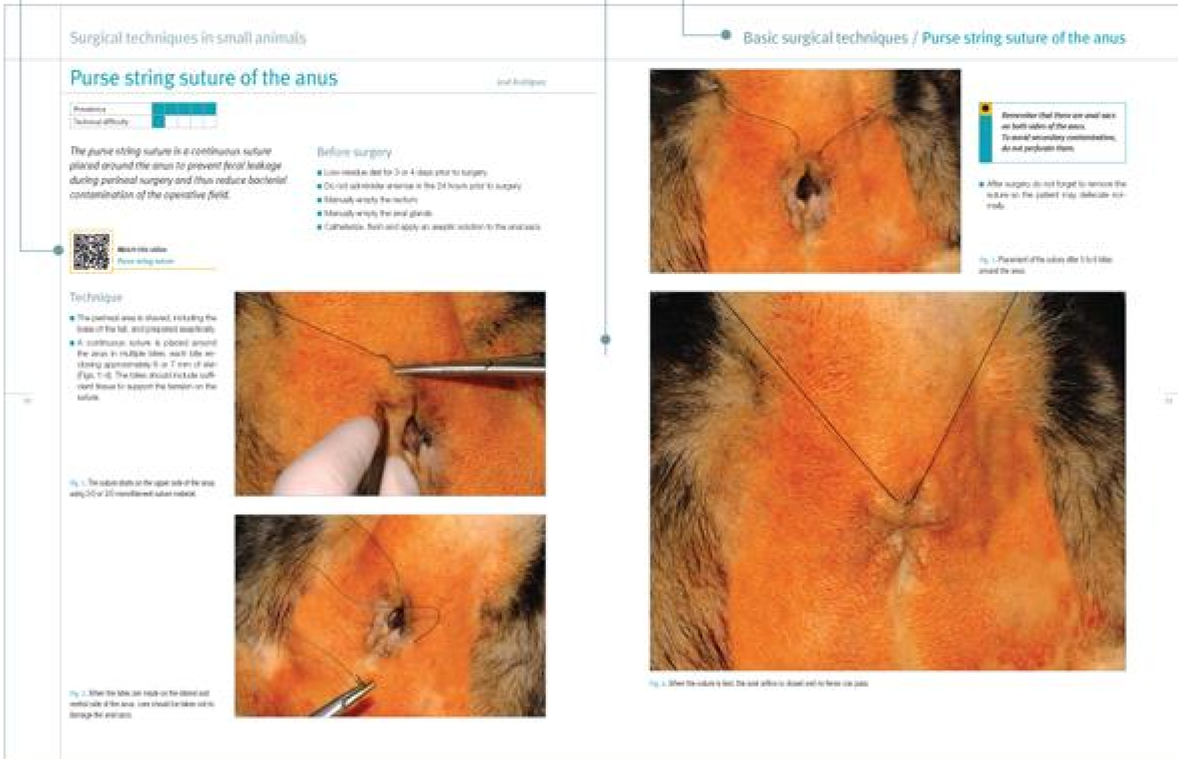
"Surgical techniques in small animals" is a selection of the main surgical procedures explained in the previous volumes.
The surgical techniques are classified according to degree of difficulty, basic and advanced. They are dedicated to different anatomical areas: cardiorespiratory system, circulatory system, gastrointestinal system, genitourinary system, reproductive system and endocrine system. This book also includes some techniques of bloodless surgery.
The book gives step-by-step, detailed explanations of surgical procedures aimed at resolving the most common disorders. But undoubtedly, the greatest asset of this book is that it is based on highquality videos, which accompany each of the surgical techniques.

Content

There are QR codes to watch the video of the surgical technique.

Procedures are illustrated, step by step, using excellent photographs.

Name of the chapter, topic or pathology in question.

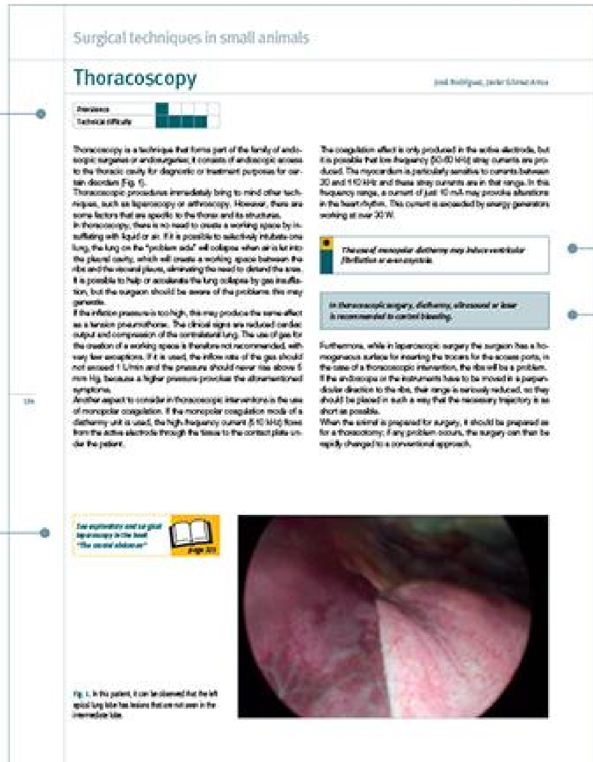


A box supplies information about the technical difficulty of the procedure and the prevalence of the described disorder (from 1 to 5).

These notes warns of risks in the procedure or a step that requires special attention.

The boxes highlight information of interest and useful tips.

References to other techniques or explanations appearing in other volumes of the Surgery collection for small animals.

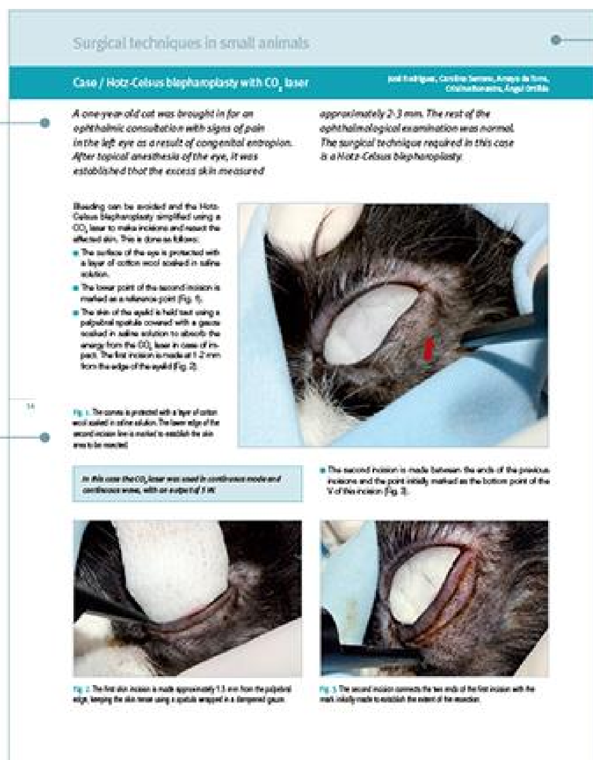

Surgical techniques in small animals

Thoracoscopy

The colored band denote a description of a clinical case study.

Introduction to the surgical technique.

The photo captions describe each step briefly but clearly.


Surgical techniques in small animals

Case / Hotz-Celsus blepharoplasty with CO_2 laser

A one-year old cat was brought in for an ophthalmic consultation with signs of pain in the left eye as a result of congenital entropion. After topical anesthesia of the eye, it was established that the excess skin measured approximately 2-3 mm. The rest of the ophthalmological examination was normal. The surgical technique required in this case is a Hotz-Celsus blepharoplasty.

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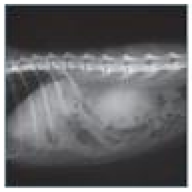
  

Basic surgical techniques

Renal biopsy

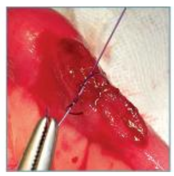
Wedge biopsy

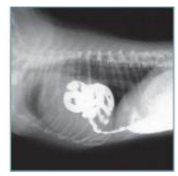
- ***Kidney biopsy***

Partial splenectomy

- ***Splenectomy***
- ***Splenectomy (vessel ligations)***
- ***Splenectomy (vessel sealants)***








Ovariohysterectomy

Ovariohysterectomy in the dog

- ***Ovariohysterectomy and pyometra***
- ***Laparoscopic ovariohysterectomy***

Pyometra / Cystic endometrial hyperplasia

- ***Ovariohysterectomy and pyometra***

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- ***Cystotomy (bladder stones)***

Bladder uroliths

- ***Bladder stones (surgical treatment)***

Case / Single urolith in a female dog

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- ***Ectopic testes (cryptorchidism/monorchidism)***

Case / Abdominal monorchid

Nephrectomy

- ***Nephrectomy (kidney stones)***

Gastrostomy. Midline laparotomy

- ***Foreign body (gastrotomy)***

Gastric dilatation-volvulus syndrome (GDV)

- ***Gastric dilatation volvulus syndrome***

Intestinal obstruction due to a non-linear foreign body

- ***Intestinal obstruction (enterotomy)***

Enterotomy

- ***Intestinal obstruction (enterotomy)***

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- ***Intestinal lesion (enterectomy)***

Intestinal intussusception

- ***Intestinal intussusception***

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- ***Megacolon (colectomy)***

Thoracocentesis

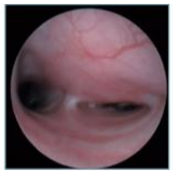
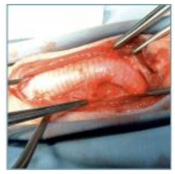
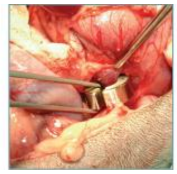
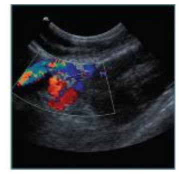
- ***Thoracic puncture***

Thoracotomy

- ***Intercostal thoracotomy***

Peritoneal-pericardial diaphragmatic hernia

- ***Diaphragmatic hernia***


Advanced surgical techniques

Exploratory laparoscopy and laparoscopic surgery

- ***Laparoscopic surgery***

Portosystemic shunt

Case 1 / Extrahepatic shunt. Cellophane tape banding (right-sided approach)

- ***Portosystemic shunt: occlusion with a cellophane strip***

Case 2 / Extrahepatic shunt. Ameroid constrictor (left-sided approach)

- ***Portosystemic shunt: placement of an ameroid ring***

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- ***Hepatic lobectomy***

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- ***Ureterocystostomy***

Case / Intramural ectopic ureter

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- ***Neo-ureterocystostomy***

Case / Extramural ectopic ureter

Esophageal hiatal hernia

- ***Hiatal hernia***

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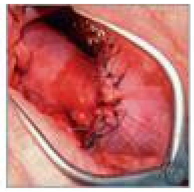
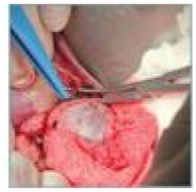
- ***Idiopathic megaesophagus (esophagus-diaphragmatic cardioplasty)***

Case / Megaesophagus

Adrenal gland surgery. Adrenalectomy

- ***Meticulous adrenalectomy***

Case / Adrenalectomy

Pheochromocytoma

- ***Pheochromocytoma***

Cardiac tamponade. Pericardiectomy

- ***Pericardiectomy***

Patent ductus arteriosus (PDA)

PDA. Conventional surgical treatment

- ***Patent ductus arteriosus***

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- ***Simple herniorraphy***

Case 2 / Mesh implant

- ***Mesh implant***

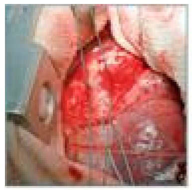
Case 3 / Deferensopexy

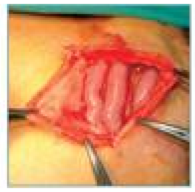
- ***Deferensopexy***

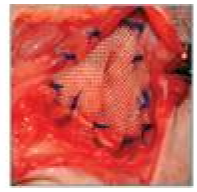
Perianal fistulas

Case / Radical surgical resection

- ***Perianal fistulas***







Surgical techniques

Basic surgical techniques

Excretory urography

Preventative hemostasis

Ophthalmic surgery. Entropion

Lumbosacral epidural anesthesia

Urethral catheterization

Cystocentesis

Percutaneous bladder catheterization

Purse string suture of the anus

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Thoracocentesis

Thoracotomy

Peritoneal-pericardial diaphragmatic hernia

Excretory urography

José Rodríguez

Prevalence	■■□□□
Technical difficulty	■□□□□

This technique consists of the administration of an intravenous injection of positive contrast medium that will progressively opacify the kidneys, ureters and urinary bladder, depending on the kidney's ability to concentrate and excrete the contrast.

The positive contrast medium for this technique must be iodinated. Usually, an ionic iodinated medium will suffice (e.g. sodium amidotrizoate), except in high risk patients, when a non-ionic iodinated contrast medium is recommended (iohexol or iopamidol).

> ***For excretory urography, an iodinated contrast medium should be used.***

The recommended dose of the contrast medium is 450-880 mg of the iodine compound/ kg body weight.

The patient should be prepared for this study. Solid food should be withheld for 24 hours before the study, because it is essential that the digestive tract is empty to optimize radiographic visualization of the kidneys and ureters. Rectal enemas 12 and 3 hours before the study are also recommended. The technique starts with catheterization of the cephalic or jugular vein, followed by a bolus injection of the contrast medium.

The sequential radiographic exposures should be taken at the following intervals:

- Immediately after injection of the contrast medium (VD projection).
- 15 seconds after injection (VD projection).
- 5 minutes after injection (VD, Lat and oblique projections).
- 15 minutes after injection (VD and Lat projection).
- 30 minutes after injection (VD and Lat projection).

Visualization of renal opacification after injection of the contrast medium depends on the functionality of the kidney: the poorer the function, the poorer the opacification. It may therefore be necessary to increase the dose of the contrast medium in patients that present some degree of renal insufficiency. Be careful, iodinated contrast agents can induce nephropathies.
Correctly performed excretory urography may be diagnostic for many disorders affecting the kidney and ureters (Figs. 1-8)

The degree of renal opacification during excretory urography depends on the functionality of the kidney.

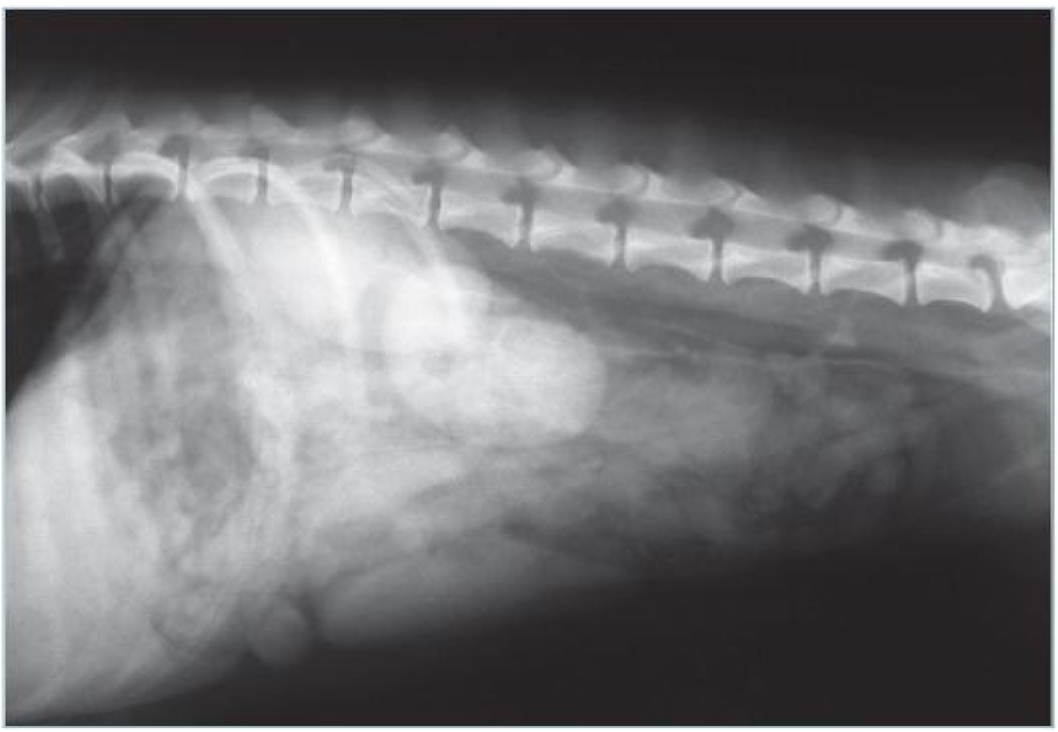

Fig. 1. Excretory urography 5 minutes after IV injection of the contrast medium. Lat projection.

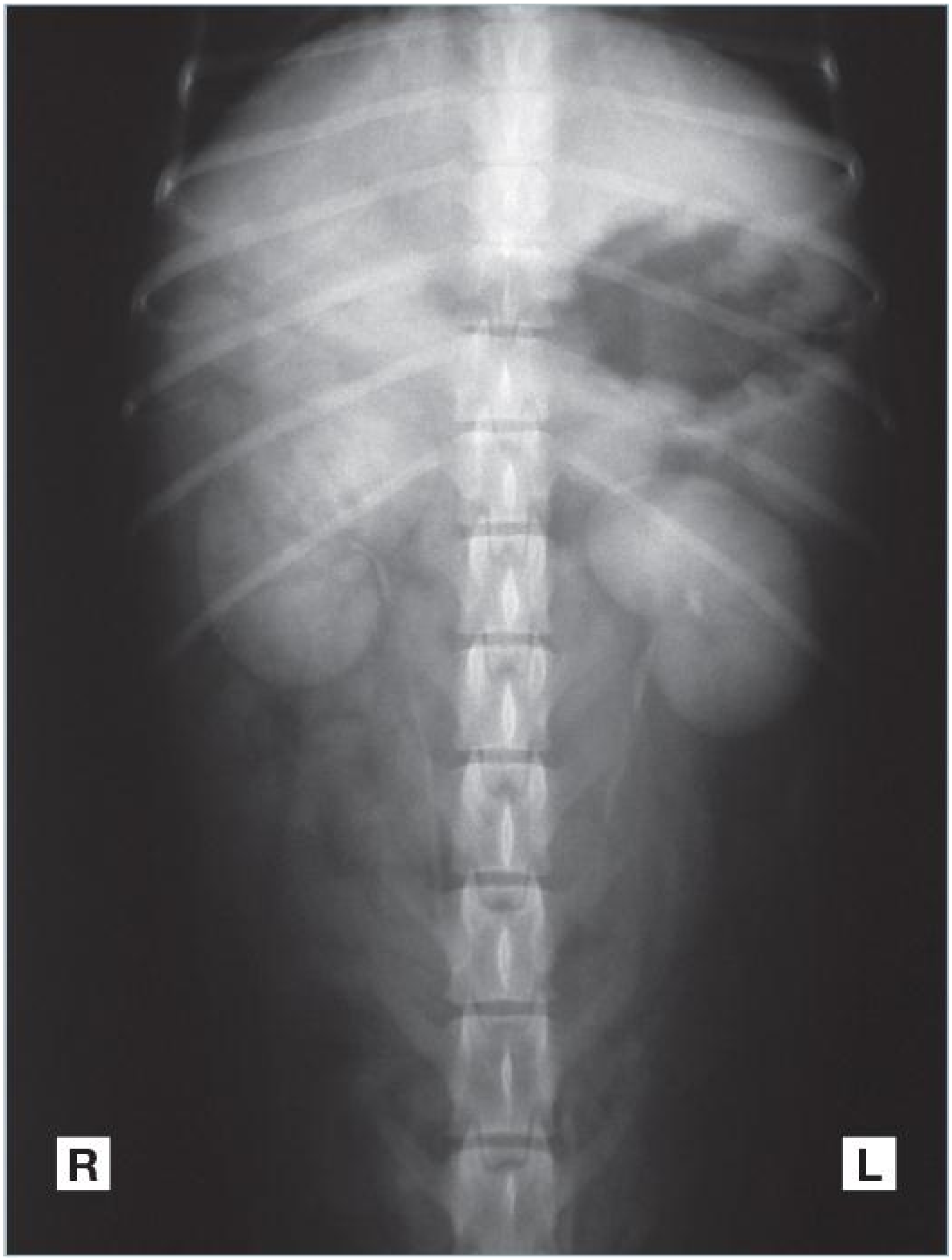

Fig. 2. Excretory urography 5 minutes after IV injection of the contrast medium. VD projection.

Fig. 3. Excretory urography 15 minutes after IV injection of the contrast medium. Lat projection. It can be seen that both ureters (u) terminate beyond the bladder trigone. In this case, excretory urography provided a definite radiographic diagnosis of ectopic ureters.

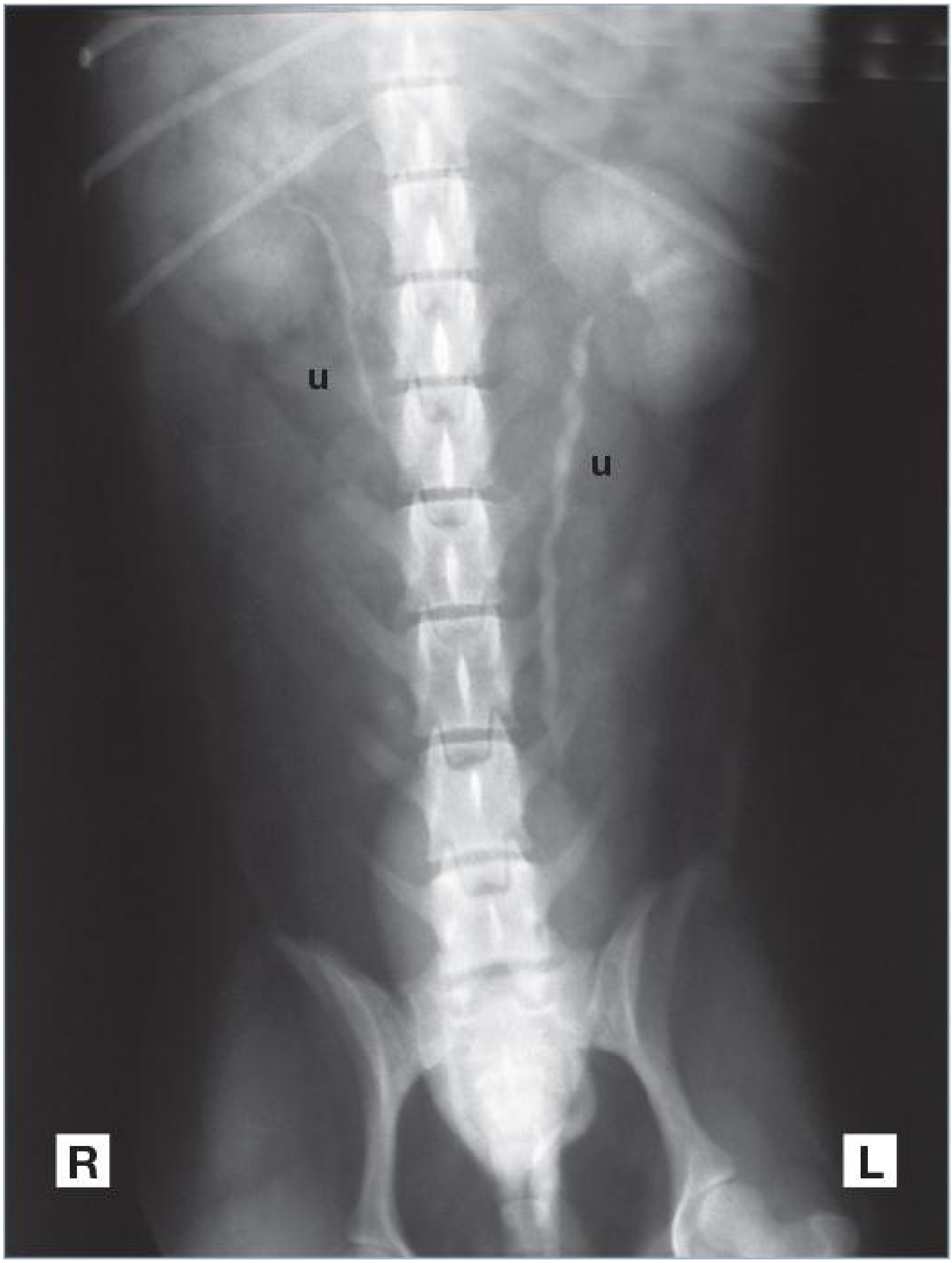

Fig. 4. Excretory urography 15 minutes after IV injection of the contrast medium. VD projection. It can be seen that both ureters (u) terminate beyond the bladder trigone. A diagnosis of ectopic ureters.

Fig. 5. Lat projection of the abdomen of a cat. The plain radiograph shows an abnormally large left kidney.


R
L

Fig. 6. The VD projection after IV injection of the contrast medium showed poor functionality of the left kidney. The diagnosis was renal lymphoma.

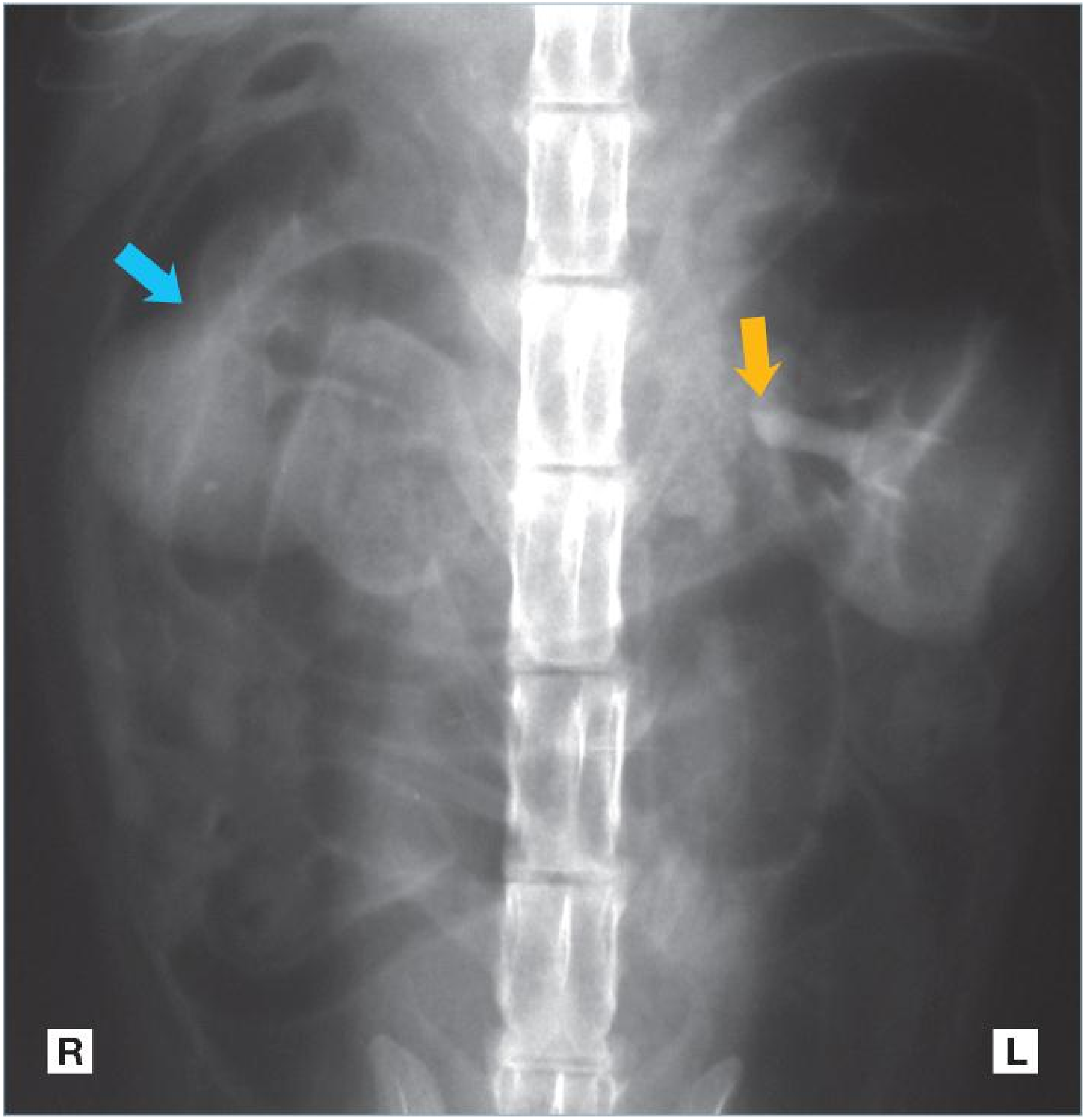

Fig. 7. VD projection of a cat 5 minutes after IV injection of an iodinated medium. The right kidney has an abnormal shape (blue arrow), compatible with a renal infarct, the left shows an obstruction of the ureteral flow (yellow arrow).

https://player.vimeo.com/video/180708205

Watch this video

Excretory urography

Fig. 8. VD projection of a dog minutes after IV injection of an iodinated medium. It shows that the renal pelvises and the ureters are extremely dilated.

Preventative

José Rodríguez, Jorge Llinás

hemostasis

Prevalence	■	■	■	■	■
Technical difficulty	■				

Preventative hemostasis limits bleeding from the tissues once they are affected and dissected during the procedures. It can be done temporarily in order to achieve an entirely bloodless operating field, for example, in the amputation of a finger, or it can be definitive, to prevent bleeding from a vessel that will be sectioned and not reconstructed, such as ovarian vessels during an ovariectomy.

Preventative hemostasis reduces the duration of the procedure.

This type of hemostasis can be achieved using chemical, thermal and mechanical methods, as can be seen in the following chapters.
On limbs, inflatable bands or an Esmarch bandage can be used externally for a certain amount of time to prevent irreversible ischemia of the tissue. Inside the organism, forcipressure or atraumatic clamps (vascular clamps) can be used, with a Rummel tourniquet to stop blood flow temporarily (Fig. 1).

Preventative hemostasis techniques for tissues and organs are based on the use of a range of instruments and materials to prevent bleeding from vessels before being sectioned (Figs. 2 and 3). These techniques include the use of clamps and *vascular clamps*, ligatures and sutures, vasoconstrictive drugs and high energy techniques used to induce blood coagulations before sectioning the tissue.

Preventative hemostasis can damage the blood vessels. Before completing the procedure it must be ensured that the tissue is not damaged and that there is limited chance of secondary hemorrhage.

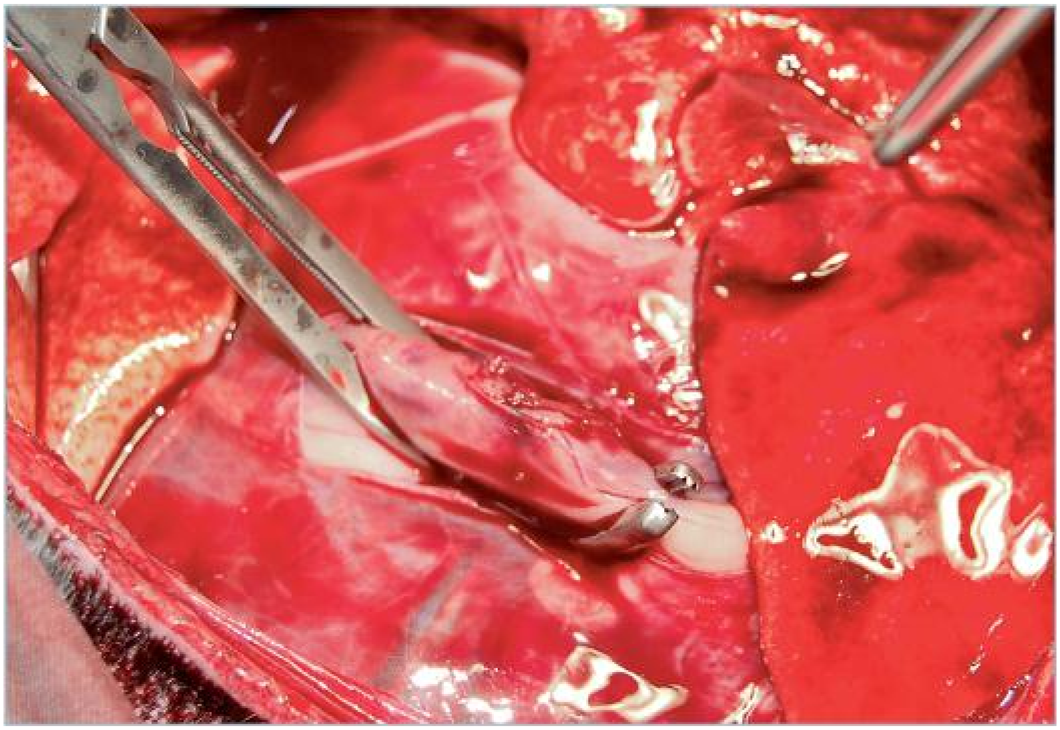

Fig. 1. Fitting of a Satinsky vascular clamp on the caudal vena cava to prevent bleeding during surgery.

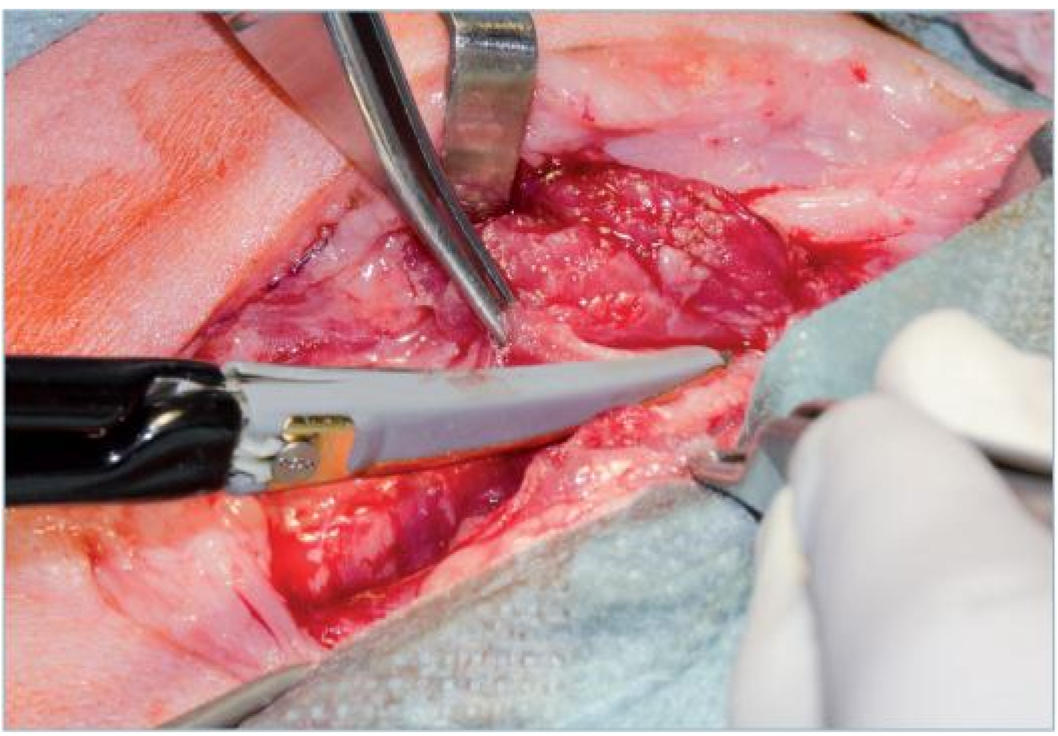

Fig. 2. The use of bipolar scissors when performing a lateral thoracotomy helps to coagulate the blood in the relevant vessels before sectioning, and

thus minimizing blood loss during the procedure.

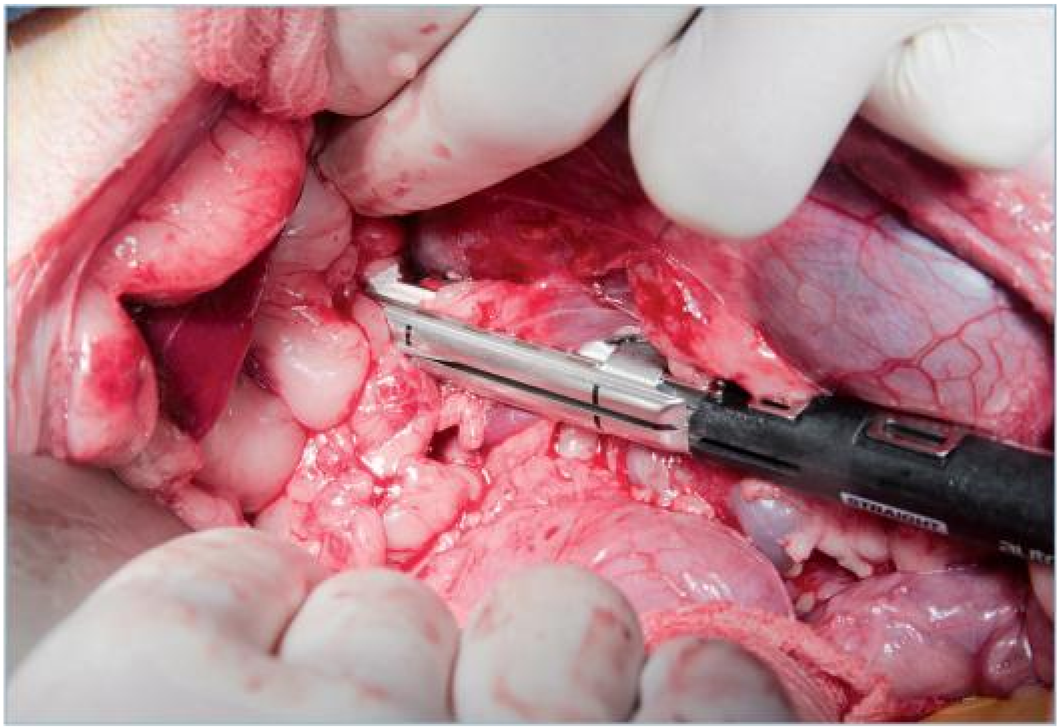

Fig. 3. Surgical staplers close blood vessels safely and permanently before sectioning. This case shows preventative hemostasis using stapling of the renal vessels before completing a nephrectomy.

Hydrodissection

José Rodríguez, Carolina Serrano, Amaya de Torre, Cristina Bonastre, Ángel Ortillés

The technique of hydrodissection used by the authors is based on the injection of saline solution into the tissue in question. This simplifies dissection, reduces surgical trauma and improves the view of the blood vessels, allowing selective hemostasis (Fig. 1).

Hydrodissection is used to separate tissues of different elasticity and consistency, minimizing blood loss.

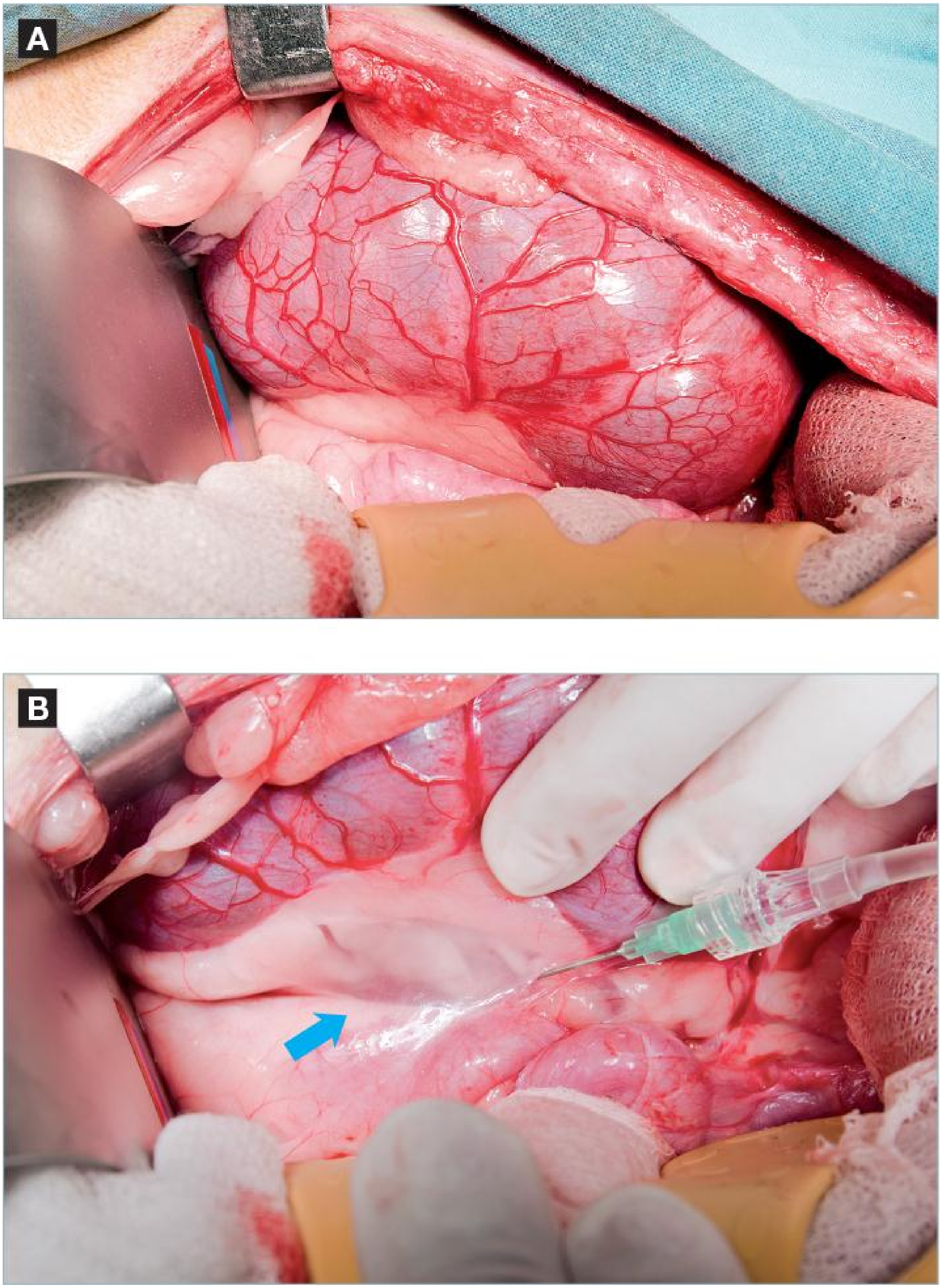
A
B

Fig. 1. This patient is undergoing a nephrectomy. In order to simplify the dissection of the renal hilum and identify the renal vessels more easily, saline solution is injected into the adipose tissue of the hilum.
As shown in the image below, the saline helps to identify blood vessels swiftly and precisely (renal vein marked by the arrow).

In delicate and elastic tissues low-pressure hydrodissection is used by injecting saline with a 20 ml syringe around the structure to be dissected. This is highly effective in low resistance tissues such as subcutaneous or fatty tissue and the retroperitoneal space (Figs. 2-4).

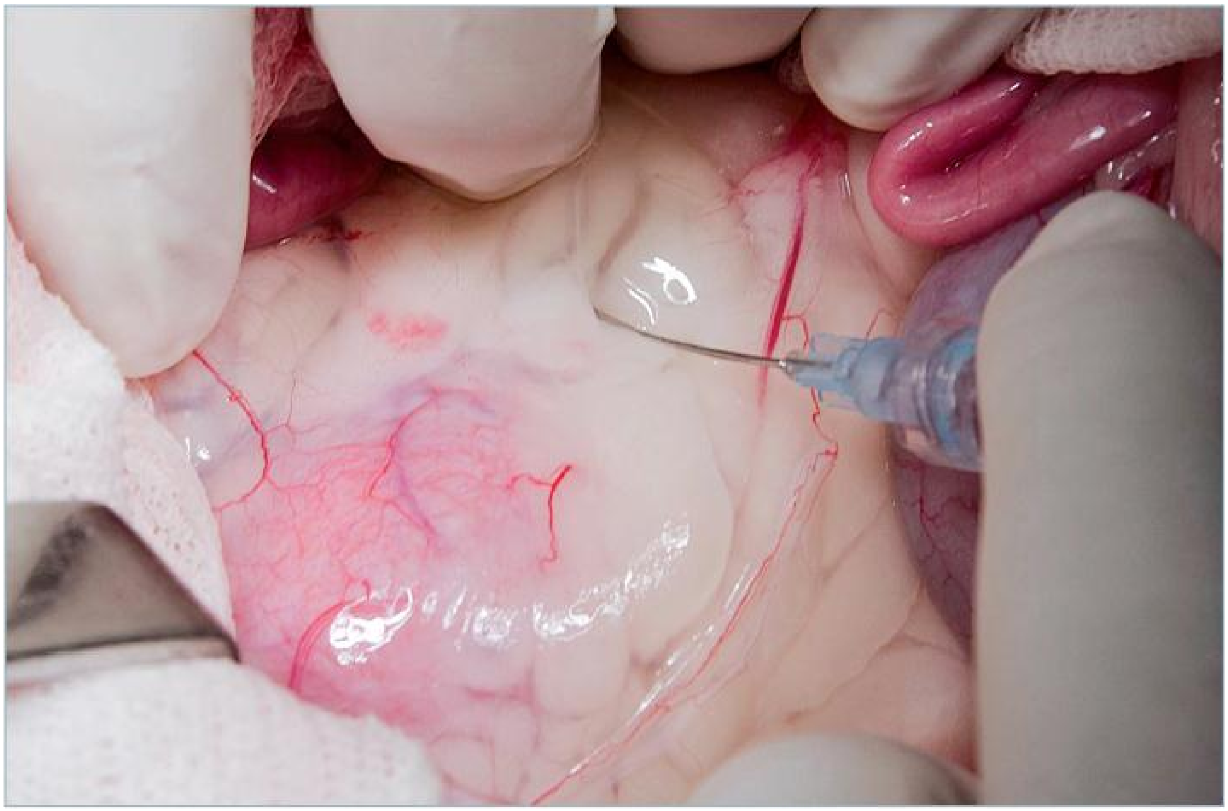

Fig. 2. The injection of saline into the perirenal tissue is simple and can be done easily with a 10 or 20 ml syringe.

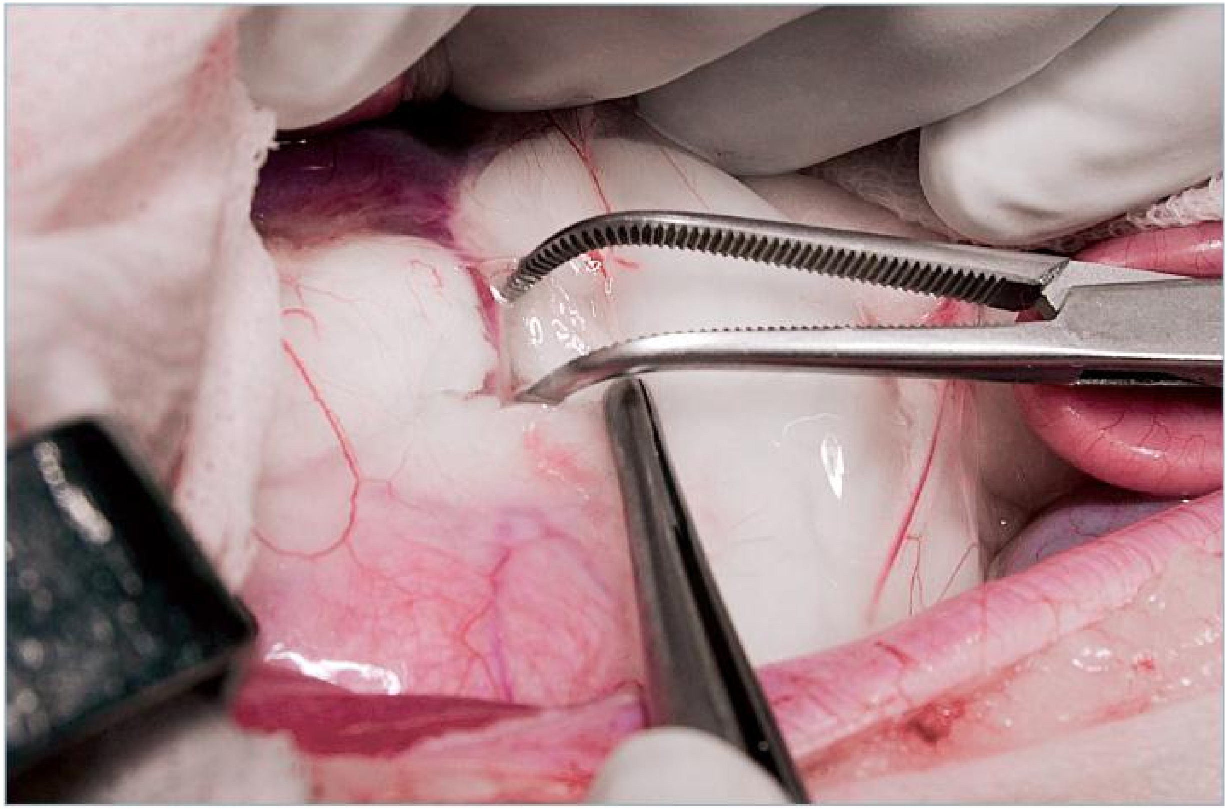

Fig. 3. The “edematization” of the adipose tissue of the renal hilum helps the surgeon to visualize and dissect the renal vessels more safely.

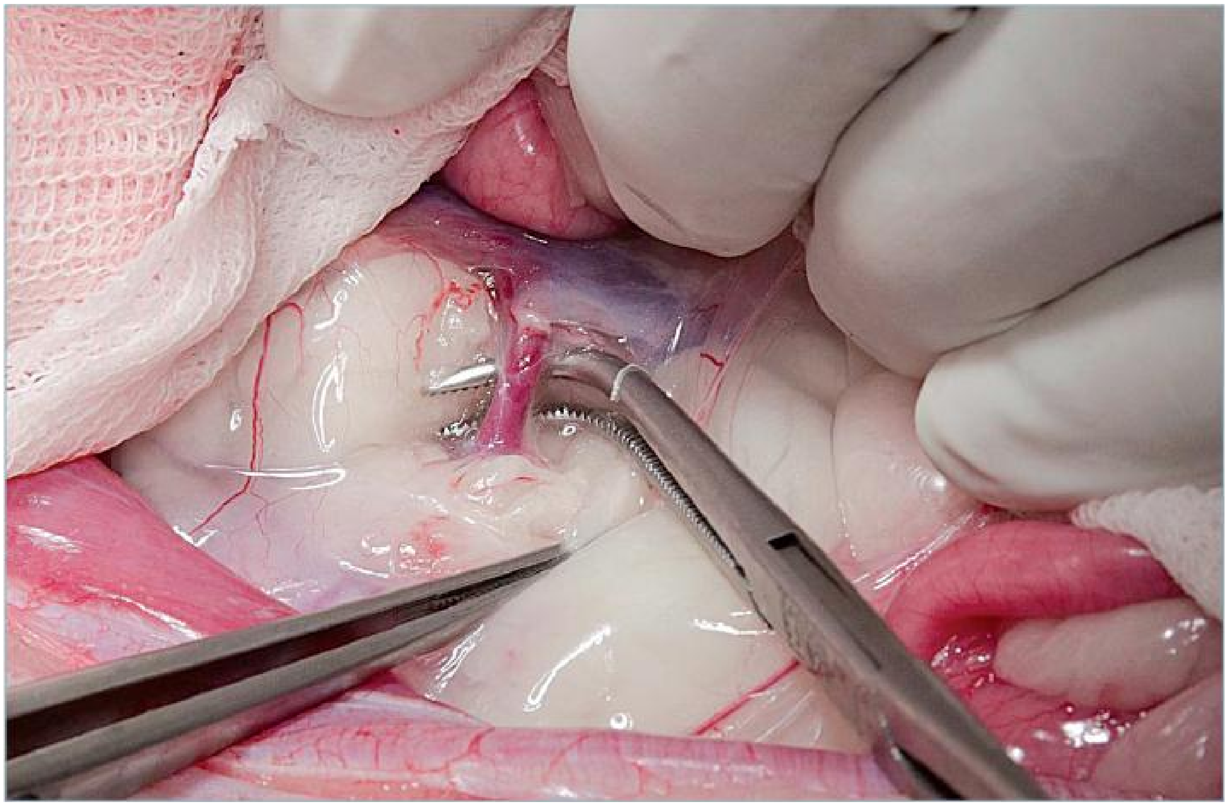

Fig. 4. Hydrodissection makes it easy to identify, dissect and occlude blood vessels before cutting.

In most cases, multiple infiltrations are necessary in order to separate tissue correctly (Fig. 5).

Cold hydrovasoconstrictive dissection

If hydrodissection is done using a solution of 1:200,000 or 1:400,000 epinephrine to saline, tissues can be separated along their natural planes and bleeding is reduced considerably thanks to the vasoconstriction caused by epinephrine, without any cardiovascular side effects (Fig. 6).

If a solution of epinephrine and lidocaine is added to the saline used, not only hydrodissection in achieved but also reduced bleeding.

Fig. 5. This case shows the hydrodissection of the tissue around the external ear canal prior to resection. Several punctures are required around the canal to allow the even distribution of the saline solution.

For a better vasoconstrictive effect, wait 5 to 10 minutes before starting surgery.

If a 20 ml syringe is to be used for the hydrodissection, take 0.1 ml of epinephrine (1 mg/ml) with an insulin syringe (4100) and add this amount to the 20 ml syringe preloaded with saline solution (1:200,000 dilution)*.


A
B

Fig. 6. Images taken before (A) and after (B) periocular injection of a saline and epinephrine solution (1:200,000). This reduces bleeding when approaching the subconjunctival and retrobulbar space, and notably simplifies the dissection of the muscles and tissues adhering to the eye.

Bleeding is minimal, without postoperative complications and with normal healing.

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Hydrodissection enucleation

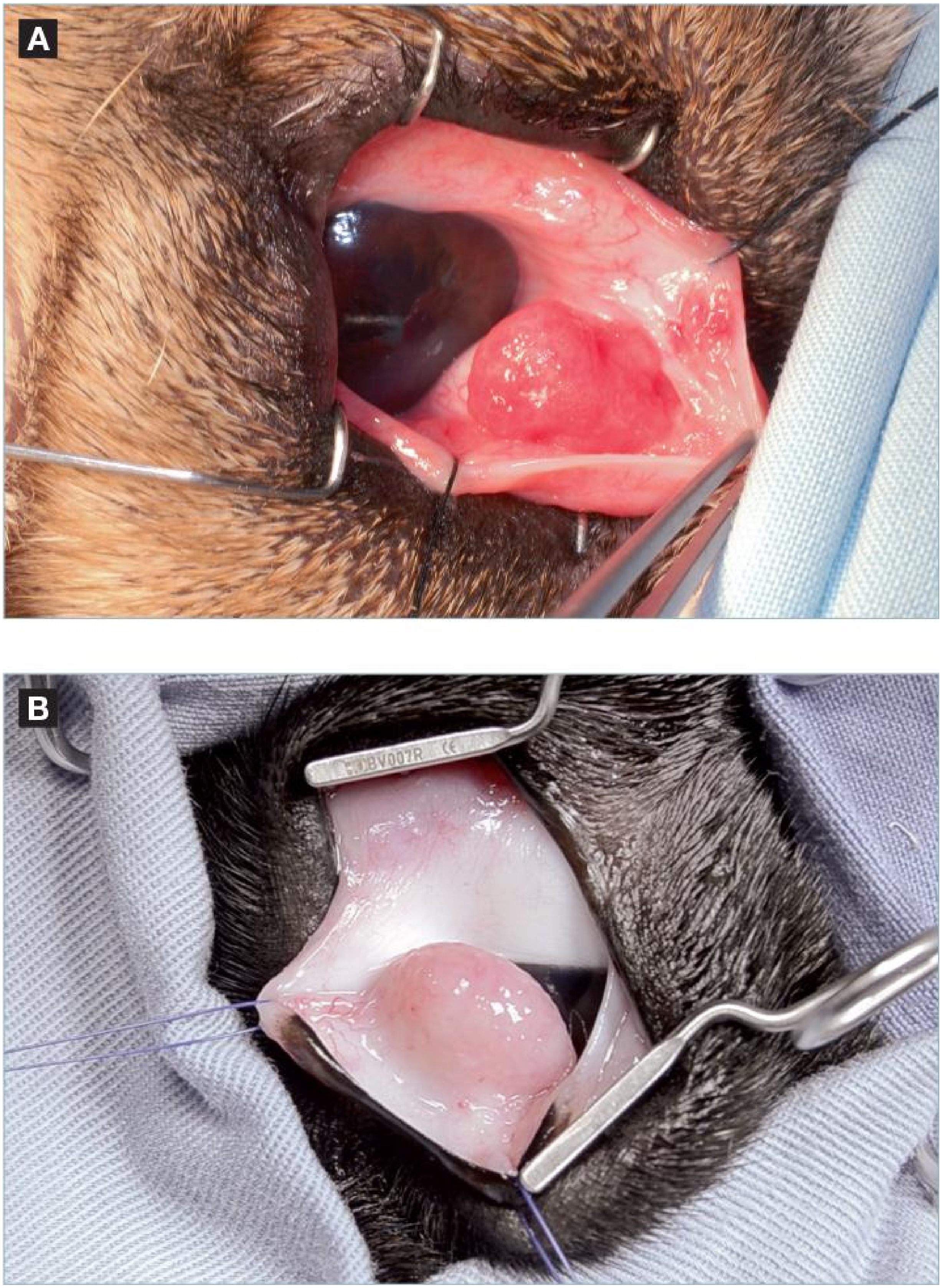
A
B
BV007R

Fig. 7. In superficial surgery, a solution containing a vasoconstrictive agent can be used to reduce intraoperative bleeding.
These images show two patients undergoing the repositioning of tear glands on the nictitating membrane. Condition of the tissue without using the vasoconstrictive solution (A). Effect of the administration of this solution over the surface of the eye; the operation is easier and faster due to vasoconstriction and reduced bleeding is achieved (B).

The dilution of epinephrine in saline solution at 1:200,000 can also be instilled over the tissue to reduce bleeding during superficial procedures. This reduces the application of other haemostatic techniques and the duration of the procedure (Fig. 7).

The amount of epinephrine injected into the patient must be controlled and any possible cardiac alterations (tachycardia, arrhythmia) or high blood pressure must be monitored.

Pressurized hydrodissection

When hydrodissection is to be used for fibrous and denser tissue, the saline must be injected at greater pressure in order to separate the tissue. In these cases, small 2 ml syringes are needed, which have been proven to provide a more forceful injection than other larger ones.
An excellent and cheap alternative, when considerable pressure is required to overcome tissue resistance, is the *syringe pressure gun* (Fig. 8). This system was designed by an Indian maxillofacial surgeon to facilitate the dissection of gingival tissue.
Another option when large quantities of liquid are in use is to use a pressure sleeve for fast fluid infusion, placed around a bag of lukewarm saline (Fig. 9). This system can create pressure of 33,330.6 -39,996.7 Pa (250 and 300 mmHg or 0.34-0.40 bar), sufficient to separate the tissue without trauma or damage to blood vessels.

Hydrodissection is a safe method of dissection, although it can have disadvantages:

- If high Prevalence equipment is being used, the efficacy of hemostasis via electrocoagulation or laser is lessened as the tissue is saturated with saline solution.
- If large amounts of saline are used, the patient may suffer hypothermia due to the cooling effect of this irrigation. This may be more severe if the saline is not warmed.
- If hydrodissection is performed using the epinephrine solution, cardiovascular alterations may occur if it passes into the circulation and concentrated solutions are being used. Necrosis may even occur in the surrounding tissue caused by ischemia due to intense vasoconstriction.

Fig. 8. Professional silicone application gun adapted to hold a 10-50 ml syringe.
With this application gun a pressure of 5,880,000 Pa (60 bar) can be achieved for hydrodissection of strongly adhered and fibrous tissue.

External hydrodissection

Hydrodissection using a high pressure stream of saline is becoming widespread in human surgery as a means of achieving atraumatic dissection of tissues with different elasticity and consistency, thus permitting the selective dissection of tissues with minimal blood loss.

Specific equipment is available to generate streams of saline at a pressure of between 294,000 and 5,880,000 Pa (30 and 60 bar), but these are possibly too expensive for veterinary surgeons.

With this type of dissection, the tissue surfaces can be defined more easily and anatomical structures can be separated more precisely.

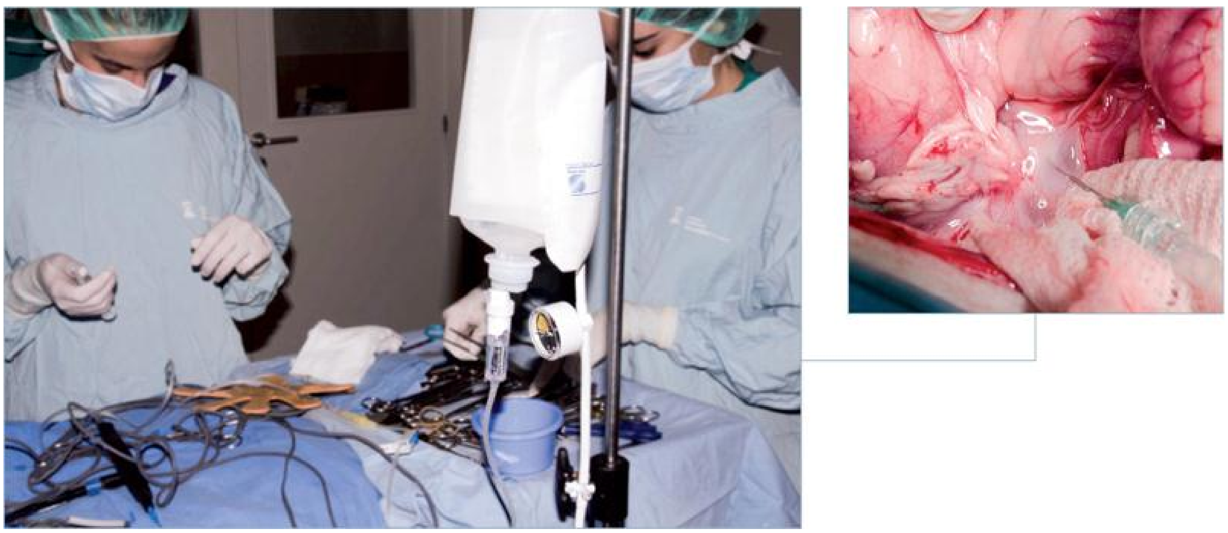

Fig. 9. Pneumatic perfusion system for injecting saline into tissue under pressure.
In this case, it is being used to separate and dissect adhesions created around the pancreas as the result of an ovariectomy performed several months earlier.

* Author's Note: regarding the epinephrine dilution, it is understood that a dilution of 1:200,000 is obtained by diluting a capsule of epinephrine (1 mg/ml) in 199 ml of saline solution.

Ophthalmic surgery. Entropion

José Rodríguez, Carolina Serrano, Amaya de Torre, Cristina Bonastre, Ángel Ortillés

Prevalence	■	■	■	■	□
Technical difficulty	■	■	□	□	□

Hotz-Celsus blepharoplasty

The Hotz-Celsus blepharoplasty is the technique of choice in cases of congenital entropion. It consists of the resection of a half-moon piece of skin in the inverted part of the eyelid, which is then sutured back into its normal position.

Entropion

Entropion is the folding or inversion of the eyelid into the eye, resulting in hairs touching, irritating and injuring the conjunctiva and cornea (Fig. 1). It can be caused by:

- Over-development of the palpebral skin.
- Sinking of the eyeball into the socket.
- Increased eyelid weight.
- Excessive skin laxity.
- Malformation of the palpebral fold.

The clinical signs observed are:

- The animal rubs at its face.
- Epiphora.
- Blepharospasm.
- Anophthalmia.
- Palpebral dermatitis due to continuous contact with tears.
- Redness of the eye due to hyperemia of the conjunctival vessels.
- Corneal injury and edema.
- Vascularization and corneal melanosis in chronic cases.

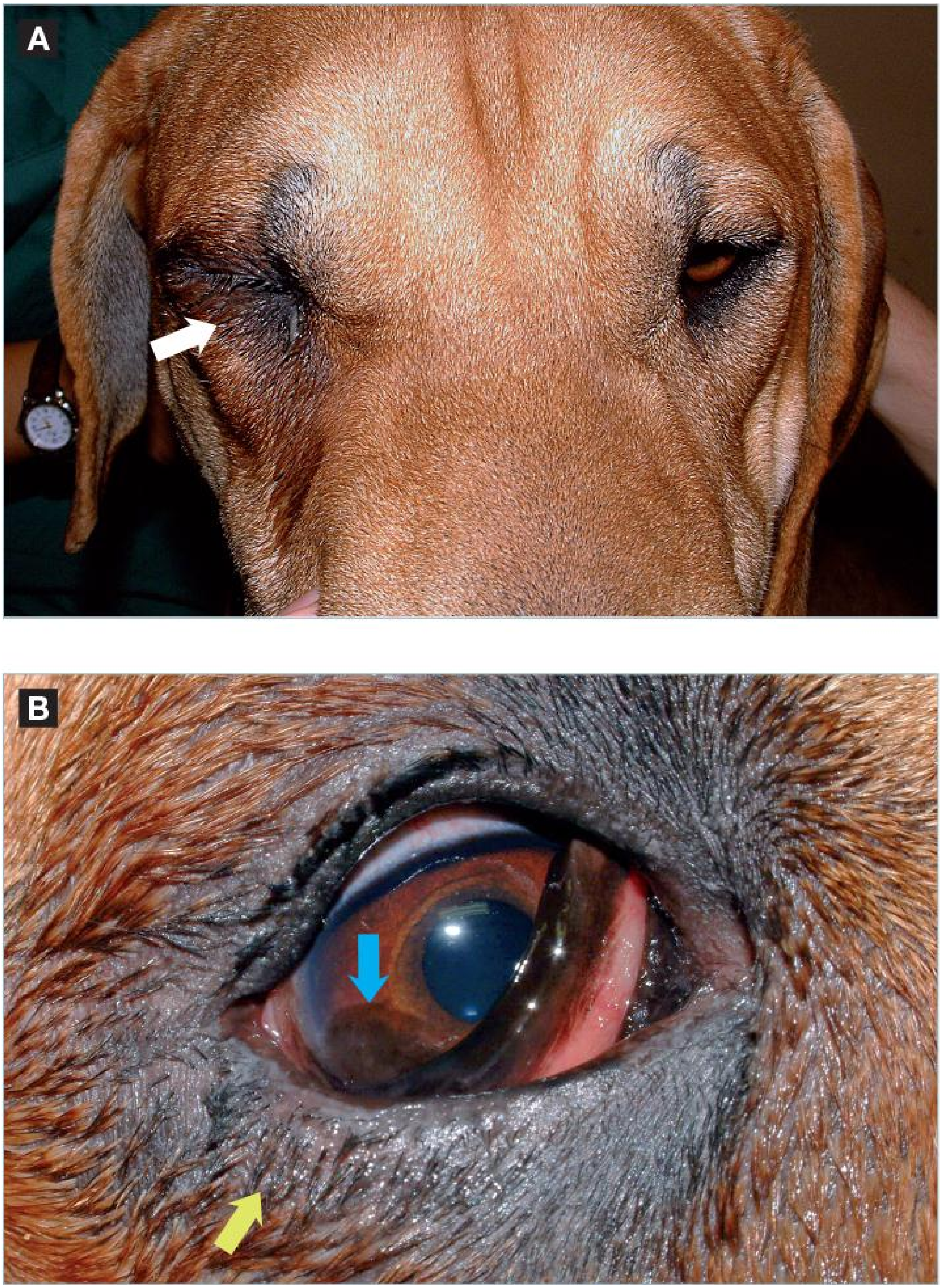
A
B

Fig. 1. Congenital entropion causes eye pain, blepharospasm and excess tear secretion (white arrow) (A), blepharitis (yellow arrow) and corneal injuries (blue arrow) (B).

After administering anesthetic drops to remove the blepharospasm, an assessment is made of the amount of skin invading the eye and the most affected palpebral area.

In order to resolve congenital entropion, the surgical technique of choice is an adapted Hotz-Celsus blepharoplasty (Figs. 2-6). This involves the resection of a crescent shape from the affected palpebral area to return the eyelid to its correct anatomical position (Fig. 2).

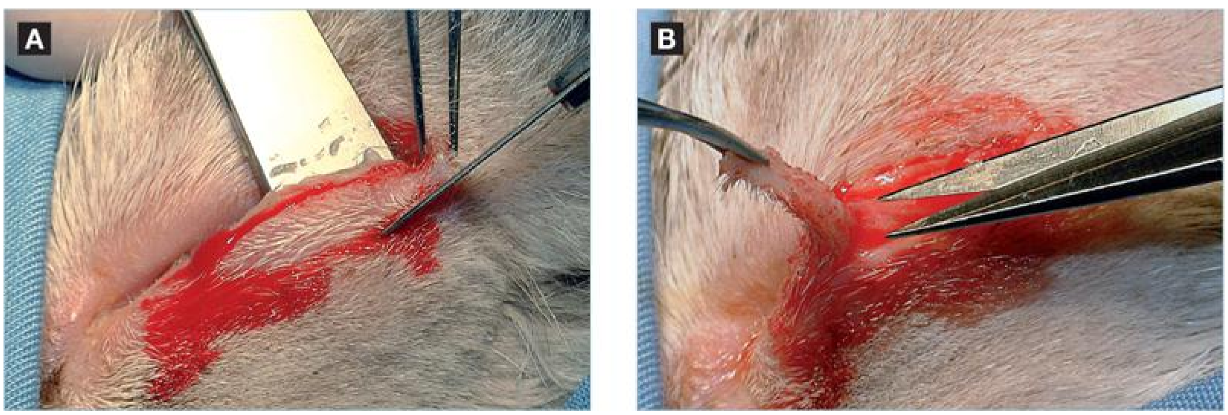

Fig. 2. The modified Hotz-Celsus blepharoplasty removes the section of skin causing the entropion. The first incision is made approximately 1-2 mm from the edge of the eyelid, and the second is made at a distance determined prior to the procedure, to remove excess skin and position the edge of the eyelid correctly.

The eyelids are highly vascularized, and this surgery causes considerable bleeding. Postoperative inflammation is very common.

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This procedure causes hemorrhage as the eyelids are highly vascularized. In this case, bleeding is controlled by compression using a gauze sponge. Palpebral sutures are made using simple stitches with fine multi-thread material (5/0 silk), taking care to keep the knots away from the edge of the eyelid in order to prevent the ends from injuring the eye (Fig. 3).

Fig. 3. When using simple stitches, the knots should be kept away from the eye; the tail ends should be left long to remain flexible and not injure the cornea should they touch it.

Case / Hotz-Celsus blepharoplasty with CO_2 laser

José Rodríguez, Carolina Serrano, Amaya de Torre, Cristina Bonastre, Ángel Ortillés

A one-year-old cat was brought in for an ophthalmic consultation with signs of pain in the left eye as a result of congenital entropion.
After topical anesthesia of the eye, it was established that the excess skin measured approximately 2-3 mm. The rest of the ophthalmological examination was normal.
The surgical technique required in this case is a Hotz-Celsus blepharoplasty.

Bleeding can be avoided and the Hotz-Celsus blepharoplasty simplified using a CO_2 laser to make incisions and resect the affected skin. This is done as follows:

- The surface of the eye is protected with a layer of cotton wool soaked in saline solution.
- The lower point of the second incision is marked as a reference point (Fig. 1).
- The skin of the eyelid is held taut using a palpebral spatula covered with a gauze soaked in saline solution to absorb the energy from the CO_2 laser in case of impact. The first incision is made at 1-2 mm from the edge of the eyelid (Fig. 2).

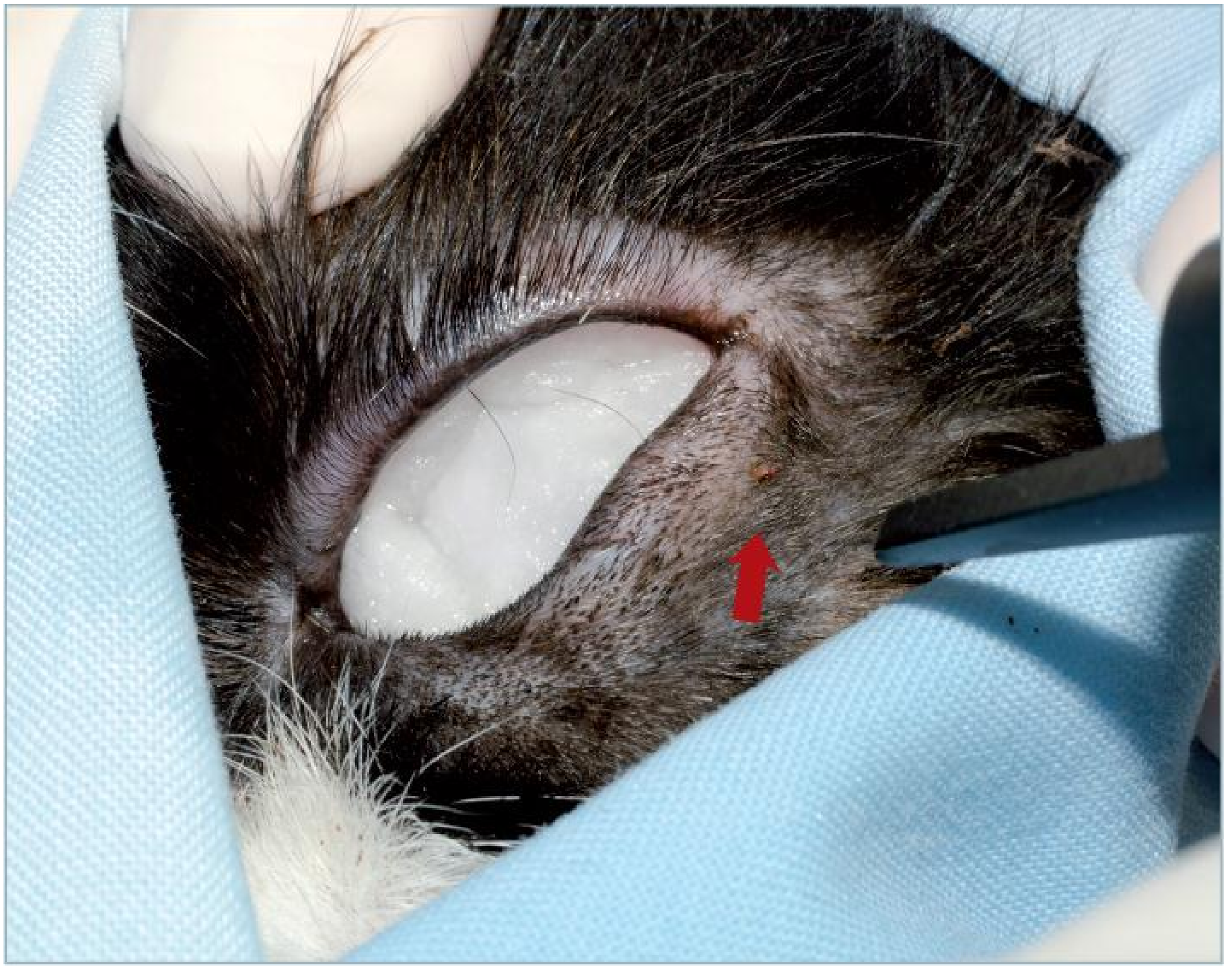

Fig. 1. The cornea is protected with a layer of cotton wool soaked in saline solution. The lower edge of the second incision line is marked to establish the skin area to be resected.

In this case the CO_2 laser was used in continuous mode and continuous wave, with an output of 5 W.

Fig. 2. The first skin incision is made approximately 1.5 mm from the palpebral edge, keeping the skin tense using a spatula wrapped in a dampened gauze.

- The second incision is made between the ends of the previous incisions and the point initially marked as the bottom point of the V of this incision (Fig. 3).

Fig. 3. The second incision connects the two ends of the first incision with the mark initially made to establish the extent of the resection.

- The skin marked by the previous incisions is also resected using a slanting laser beam to cause minimal damage to the orbicular muscle (Figs. 4 and 5).

Fig. 4. With the CO_2 laser the resection of the skin from the eyelid is bloodless.

Surgical laser hastens and simplifies palpebral surgery, as there is no intraoperative bleeding (Fig. 5).

Fig. 5. This image shows the immediate result of the skin resection using laser.

- In these cases the authors do not suture the palpebral incision, leaving it to heal by second intention (Fig. 6).

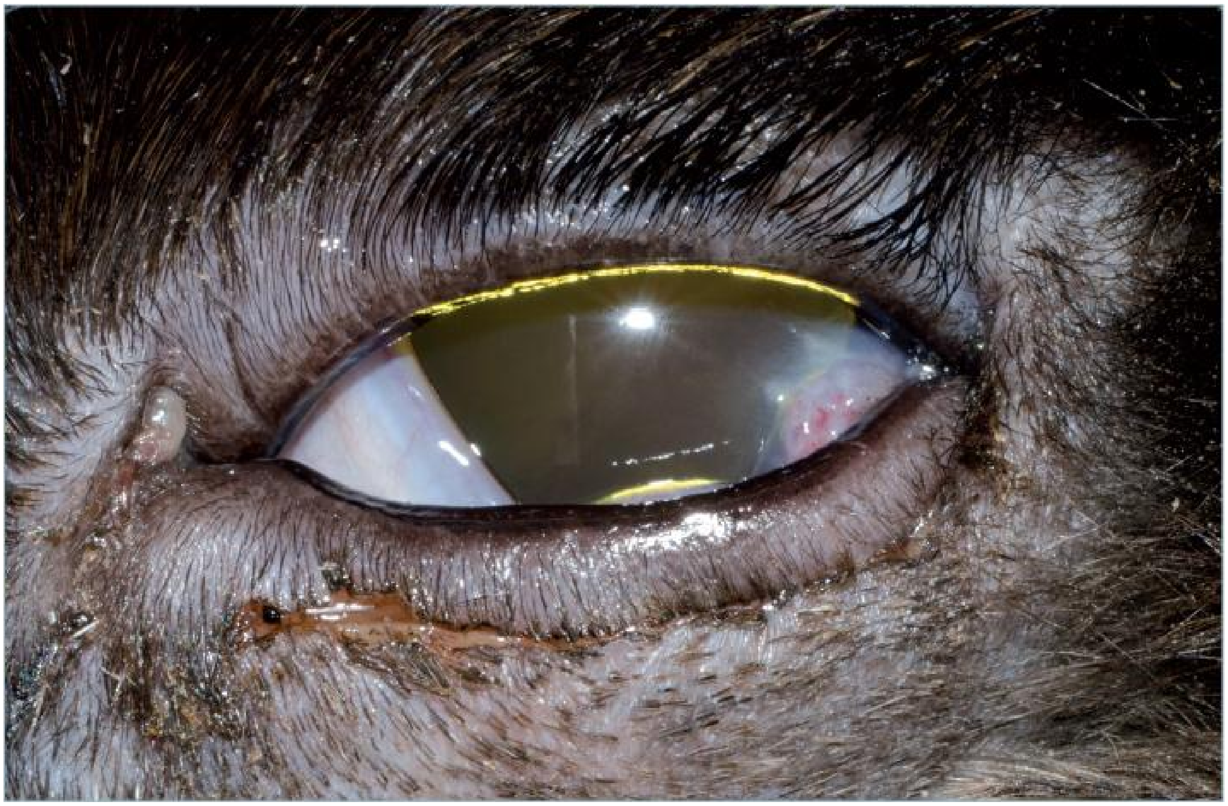

Fig. 6. Result of the above procedure in the immediate postoperative period.

After surgery an antibiotic and anti-inflammatory ointment should be applied three times a day for one week.
The final result is satisfactory as can been seen in other cases employing the same technique without sutures, such as a Shar Pei (Fig. 7) and a Pug (Fig. 8)

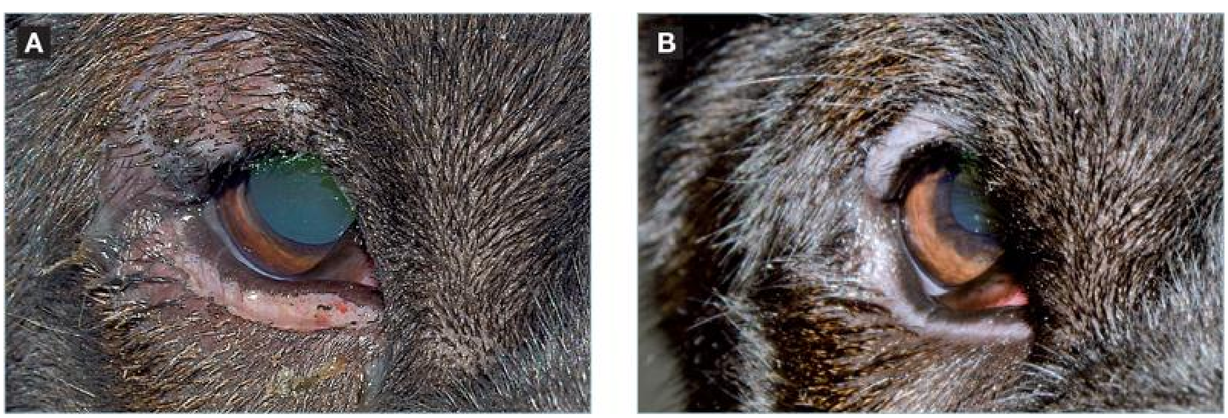

Fig. 7. Images of a Hotz-Celsus blepharoplasty performed using CO_2 laser on a Shar Pei, 24 hours (A) and 12 days after surgery (B).

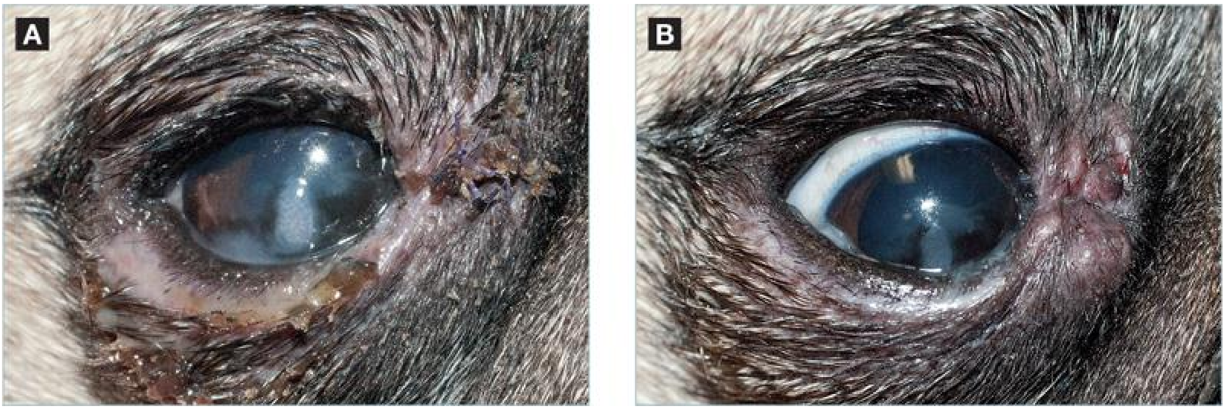

Fig. 8. Images of a Hotz-Celsus blepharoplasty performed using CO_2 laser and a medial canthoplasty in a Pug, 4 days (A) and 10 days (B) after surgery.

Lumbosacral epidural anesthesia

María José Martínez

Prevalence	■■■□□
Technical difficulty	■■■■□

Aim

To reduce the requirement for general anesthetics and to increase analgesia during surgical procedures on the hindquarters.
An appropriate drug is injected into the epidural space with a spinal needle inserted between the last lumbar and the first sacral vertebrae (Fig. 1).

> ***Do not use epidural anesthesia alone. If general anesthesia is not used, the patient should be deeply sedated.***

Required materials (Fig. 2)

- Electric clippers.
- Local antiseptics.
- Sterile surgical gloves.
- Disposable spinal needles.
- Small syringes to check the correct position of the needle (to identify the loss of resistance).
- Syringes of different sizes to administer the drug.

Patient size	Needle type	
	Length	Gauge
Small	2.5 cm	22G
Medium	3.8 cm	20G
Large	7.5 cm	18G

Drugs used

Anesthetic	Dose	Toxicity (IV)	Duration of the effect	Analgesic potency
Lidocaine 2 %	1 ml/ 4.5-6 kg	>10 mg/kg	60 minutes	
Mepivacaine 2 %		>30 mg/kg	2 hours	
Bupivacaine 0.5 %		>3 mg/kg	4-6 hours	

Local anesthetics may produce hypotension. Correct existing hypotension before administering epidural anesthesia.

Fig. 1 Radiograph to identify the position of the spinal needle. This is done if there is uncertainty about the location of the epidural space.

Fig. 2. Materials required for epidural anesthesia:

- Small low-resistance syringes to locate the epidural space.
- Spinal needles of varying thickness and length.

Landmarks

The iliac wings and the spinous processes of the 7th lumbar and the 1st sacral vertebrae (Fig. 3).

Fig. 3 Anatomical landmarks to locate the insertion point for the spinal needle into the vertebral channel:

- Iliac wings.
- Spinous process of L7.
- Spinous process of S1.

The thumb and middle finger of the non-dominant hand are used to palpate the iliac wings on both sides of the vertebral column. The spinous process of L7 is identified with the index finger of the same hand. The lumbosacral space (L7-S1), which feels like a depression, is located by caudal and cranial movement of the finger (Figs. 4 and 5).

Fig. 4 The thumb and middle finger are placed over the iliac wings and the index finger palpates the spinous process of L7.

Fig. 5 Next, the spinous process of S1 is palpated to identify the space where the spinal needle will be inserted.

Fig. 6 The patient is positioned in sternal recumbency with the hind legs pulled forwards to widen the lumbosacral space.

Technique

Patient positioning

After sedation the patient is positioned in one of the following ways, depending on the veterinarian's comfort or preference:

- On the sternum with the hind legs pulled forward (Fig. 6).
- In lateral recumbency with the hind legs pulled towards the head.

In both positions, expansion of the lumbosacral space will be achieved. After injecting the anesthetic, the patient is placed in ventral or dorsal recumbency to obtain a uniform distribution of the anesthetic on both sides of the spinal column. If the patient is placed in lateral recumbency, the anesthesia of nerve roots on the lower side will be increased.

Preparation of the area

- Shaving and aseptic preparation of the area.
- Use sterile gloves and meticulous aseptic technique to prevent infection.

Fig. 7 The area is prepared like any other surgical field: shaving, washing with antiseptic soap and the application of povidone-iodine.

Inserting the needle

With the dominant hand, the spinal needle is introduced perpendicularly into the space between the spinous processes of L7 and S1 (Figs. 8 and 9). It is inserted slowly until perforating the ligamentum flavum, indicated by a small characteristic “pop” and a loss of resistance (Fig. 10).

Fig. 8 The needle is inserted between the spinous processes of L7 and S1.

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Epidural anesthesia

Fig. 9 The needle should be introduced perpendicular to the skin.

Fig. 10 When the ligamentum flavum is perforated, a metallic “pop” and a loss of resistance to passage of the needle are noted.

Sometimes, particularly if the veterinarian is inexperienced, the needle may hit the body of L7 and has to be redirected in a caudal direction to reach the vertebral channel. Until sufficient experience has been gained, it is advisable to take a lateral X-ray of the area to determine the length of the needle required and the depth to which it has to be inserted to reach the vertebral canal.

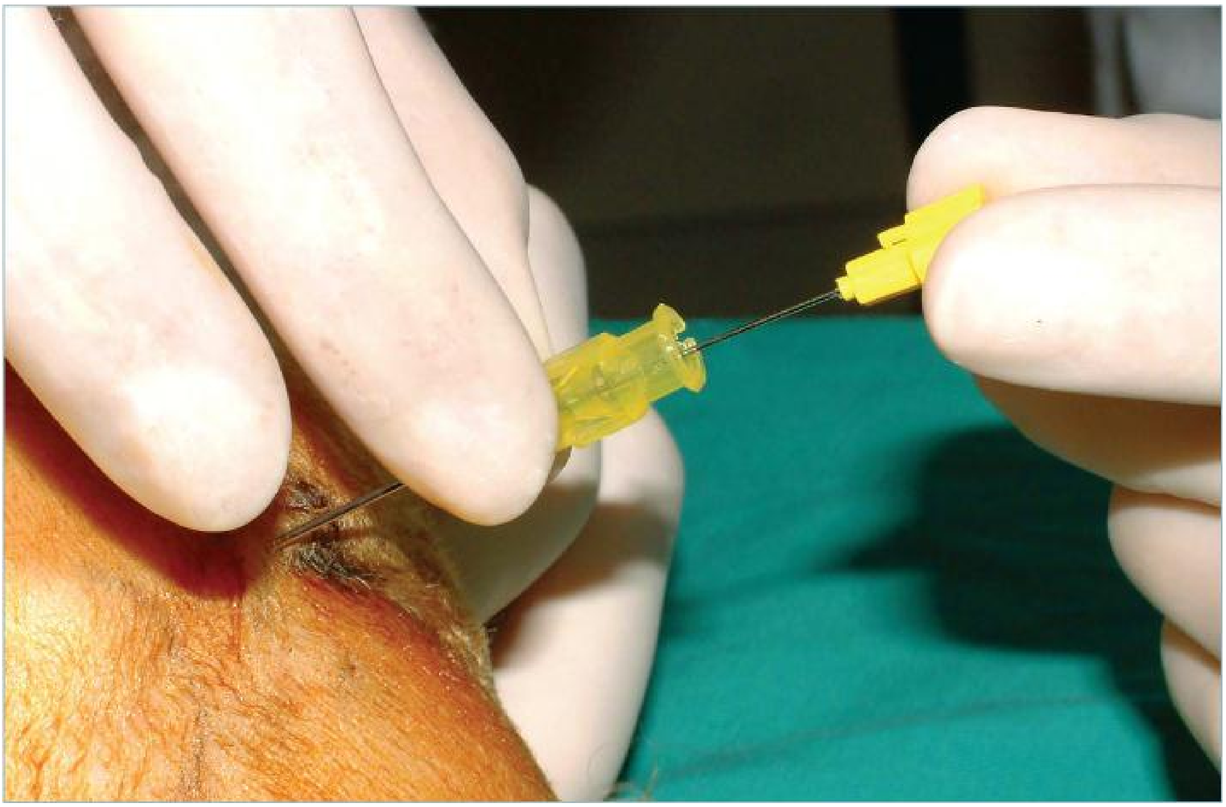

Fig. 11 Once the epidural space has been reached, the stylet of the spinal needle is withdrawn. If there is a need to reposition the needle, always replace the stylet to do so.

Fig. 12 Inspect the hub to ensure that no cerebrospinal fluid or blood comes out.

Next, the stylet is withdrawn from the spinal needle (Fig. 11) and the hub inspected for the presence of cerebrospinal fluid or blood (Fig. 12).

The presence of cerebrospinal fluid (Fig. 13) (resulting from a subarachnoid puncture) may be common in small and miniature breeds; if this happens, the needle should be redirected in a caudal direction or the dose of the anesthetic reduced to one third of the calculated dose. If the full calculated dose is injected, complete spinal anesthesia may ensue, with cardiovascular and respiratory depression or collapse.

If blood is observed, the ventral venous plexus that runs on the bottom of the vertebral canal has been punctured. In this case, the needle should be withdrawn and another attempt should be made to position it correctly.

If the tail moves, the nervous tissue may have been punctured. In this case, the location of the needle has to be modified slightly, but there is no need to withdraw it.

If the anesthetic is injected intravascularly, convulsions, cardiorespiratory depression and the absence of regional anesthesia

may result.

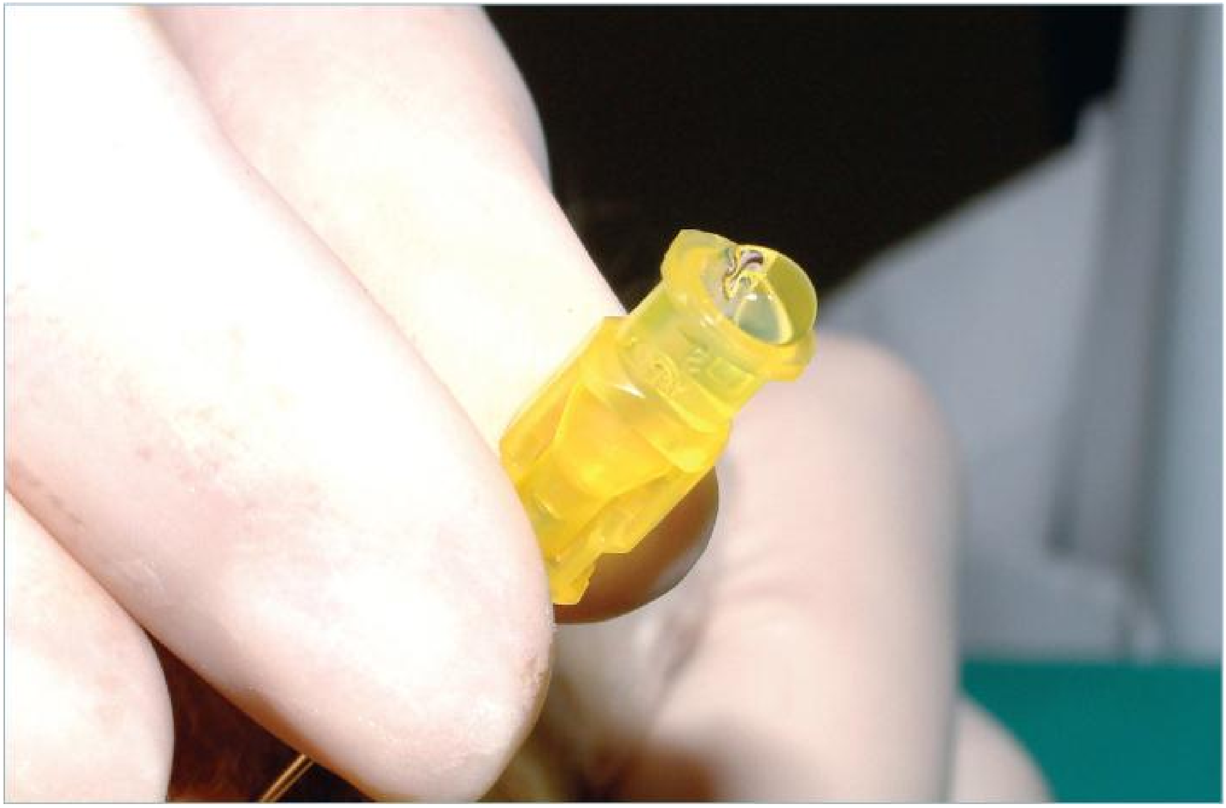

Fig. 13 If cerebrospinal fluid appears, the needle should be repositioned more caudally or the dose of the anesthetic should be reduced.

Checking the location

To check that the needle is correctly positioned in the epidural space, 0.5 ml sterile saline is injected and should enter without the slightest resistance. For this it is best to use special loss-of-resistance syringes (Fig. 14), or, in their absence, a glass syringe.

Fig. 14 To check that the needle is in the correct position, inject a small amount of sterile saline, which should enter easily without any resistance.

Administering the anesthetic

The anesthetic should be warmed to body temperature and injected slowly over 30-60 seconds. As in the previous test, this should not meet any resistance (Figs. 15 and 16).

A test dose of 0.5-1 ml lidocaine hydrochloride 2 % produces rapid dilatation of the external anal sphincter, which is further proof that the technique has been performed correctly.

Fig. 15 The anesthetic is introduced into the epidural space.


Injekt

Fig.16. The liquid should enter without meeting any resistance.

Adverse effects

- Subarachnoid or intravascular injection may produce paralysis of the respiratory muscles, hypotension, Horner's syndrome, and hypoglycemia due to sympathetic block, muscular contractions, convulsions and coma.
- If the injection technique is incorrect, anesthesia may be delayed or absent; paresis and/or sepsis may also ensue.

Use the correct technique. Choose an appropriate anesthetic and calculate the dose accurately. Ensure the correct positioning of the spinal needle. Use a test injection.

Contraindications

- Local anatomical anomalies.
- Local dermatitis (lumbar).
- Sepsis.
- Clotting disorders and hemorrhage.
- Uncorrected hypovolemia.
- Central or peripheral nerve disorders.
- Increased intracranial pressure.

The advantages of epidural anesthesia outweigh the possible risks.

Urethral catheterization

Manuel Alamán

Prevalence	■	■	■	■	■
Technical difficulty	■	□	□	□	□

Urethral catheterization is one of the most common procedures in clinical veterinary practice. Patients that present with urine retention, for whatever reason, must be catheterized to ensure urethral patency is maintained. It may also be necessary to catheterize the bladder to obtain a urine sample for analysis.

Fig. 1 Before urinary catheterization, the area should be prepared as aseptically as possible using a diluted povidone-iodine solution, introduced into the prepuce with a syringe.

Fig. 2 After introducing the antiseptic solution into the prepuce, the syringe is removed and the preputial orifice is compressed between thumb and index finger.

Fig. 3 The antiseptic solution stays in contact with the mucosa for a short while and is then released.

Fig. 4 Next, the penis is exteriorized. To do so, the prepuce is drawn back with one hand, while the other hand holds the base of the penis and pushes it in a cranial direction.

Fig. 5The catheter has to be sterile. To avoid contamination before catheterization, it is important that it only touches the penis.

Catheterization may introduce infection. It is important to perform this procedure in an aseptic manner.

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Urinary catheterization

Fig. 6 While keeping the penis exteriorized with one hand, the urinary orifice is identified and the tip of the catheter is inserted.

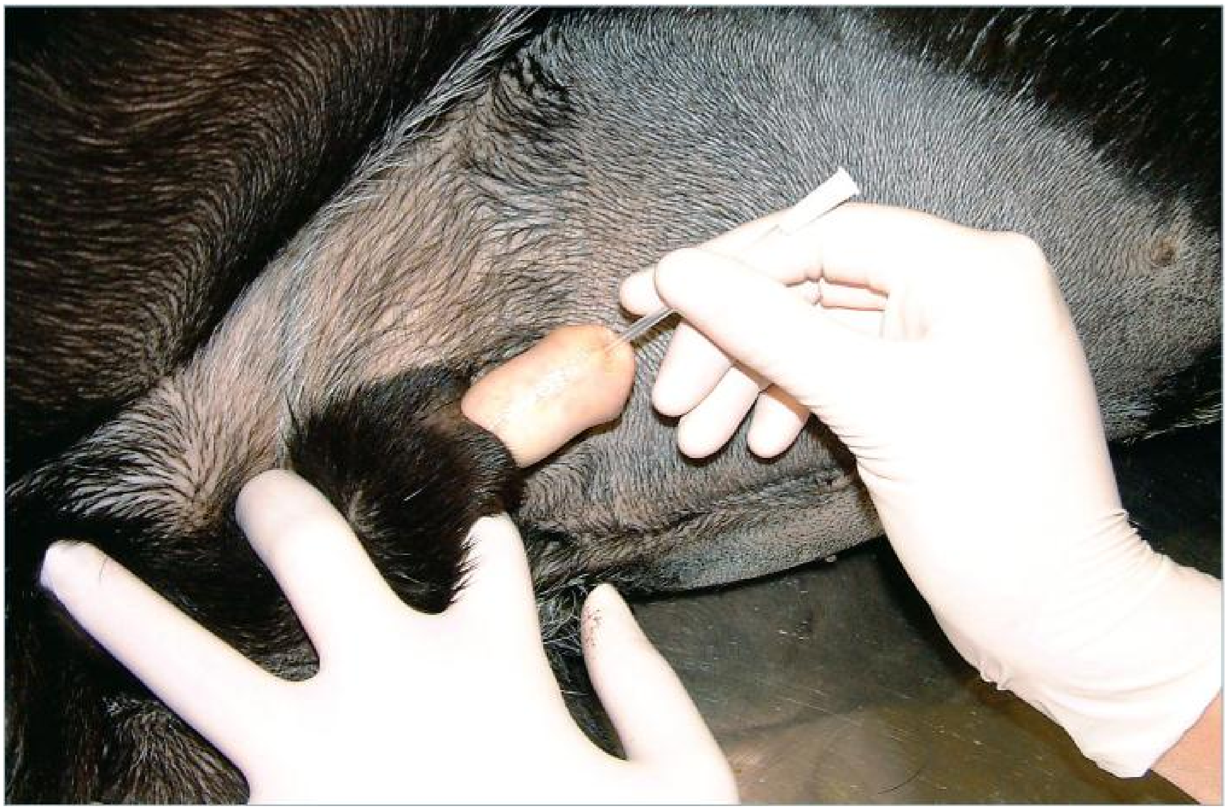

Fig. 7 The catheter is gently advanced until reaching the bladder. The use of a semi-rigid catheter facilitates this procedure, especially in cases with urethral obstruction.

Fig. 8 The bladder is emptied by connecting a sterile syringe to the end of the catheter.

Cystocentesis

José Rodríguez

Prevalence	■	■	■	■	■
Technical difficulty	■	□	□	□	□

Cystocentesis is used to obtain sterile urine samples directly from the bladder, avoiding contamination of the sample with bacteria or tissue from the urinary tract. It also reduces the risk of ascending urinary tract infection caused by catheterization. Another indication is decompression of the bladder in cases of urethral obstruction that cannot be resolved by retrograde catheterization.

Technique

- Shave and prepare the area aseptically.
- Locate and immobilize the bladder against the abdominal wall, taking care not to use excessive pressure (Fig. 1). When the bladder is overly compressed, there is a greater risk of urine leaking around the needle into the peritoneal cavity.
- The puncture is performed with a 22-21G 40 mm needle, in the midline in females and in a paramedian position in male dogs.
- The needle is inserted at an angle (45º) in the middle of the bladder, directed towards the trigone (Figs. 2 and 3).
- The syringe should be held in such a way that the plunger can be retracted without losing grip, drawing up the urine without interruption (Fig. 4).

Cystocentesis is a rapid and simple procedure that is better tolerated by queens and bitches than catheterization.

To facilitate cystocentesis it is recommended to insert the needle with the bevel facing upwards (Fig. 2).

Fig. 1 Stabilize the bladder to ensure correct needle placement. If the bladder is small, and in cats, it is better to immobilize it from the pelvic end.

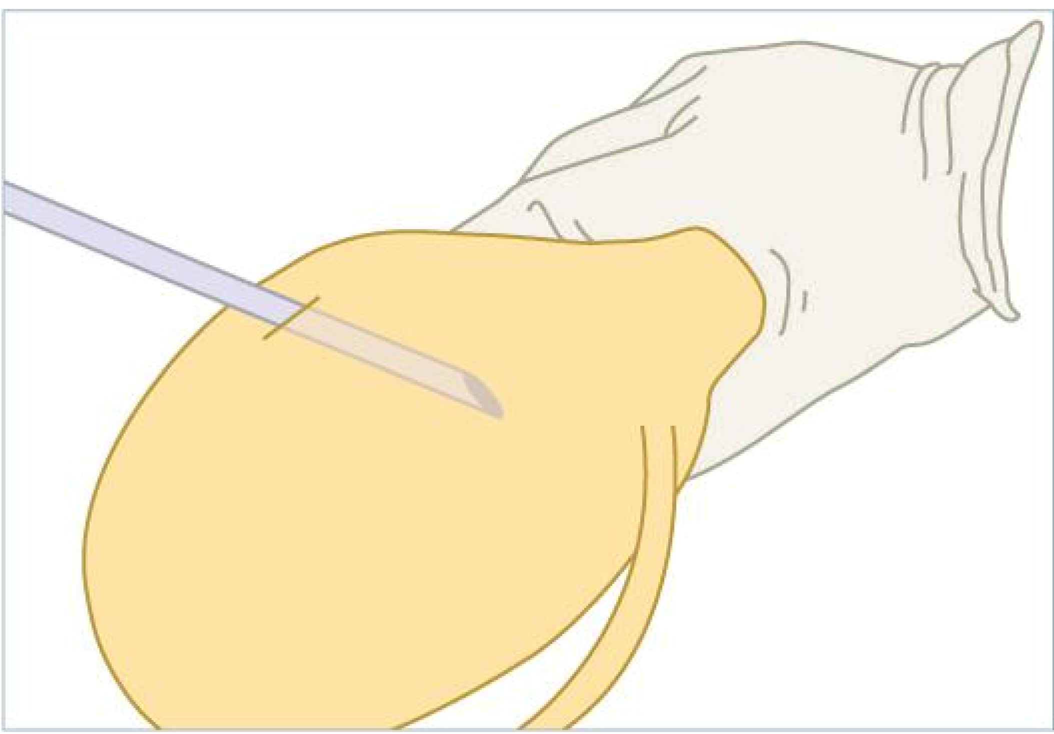

Fig. 2 Introducing the needle at an angle creates an oblique pathway in the bladder wall that helps closure of the puncture wound when the needle is

withdrawn, minimizing urine leaks into the abdominal cavity.

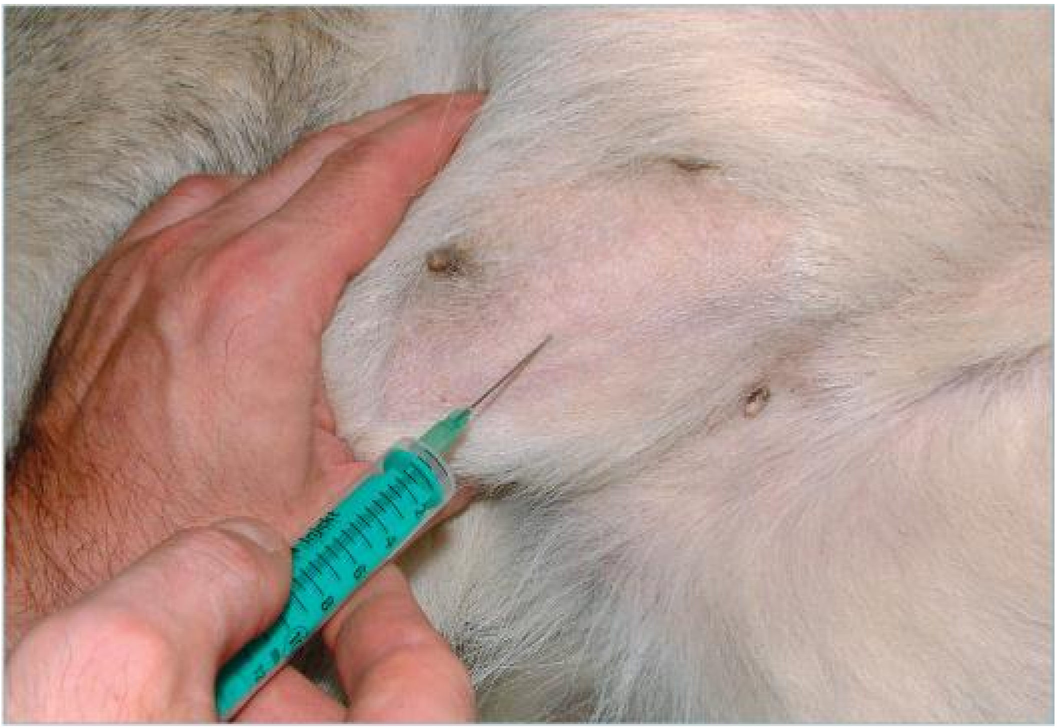

Fig. 3 The tip of the needle is directed towards the distal area of the bladder, the trigone, to ensure all urine can be completely drained, if needed, without having to insert the needle several times.

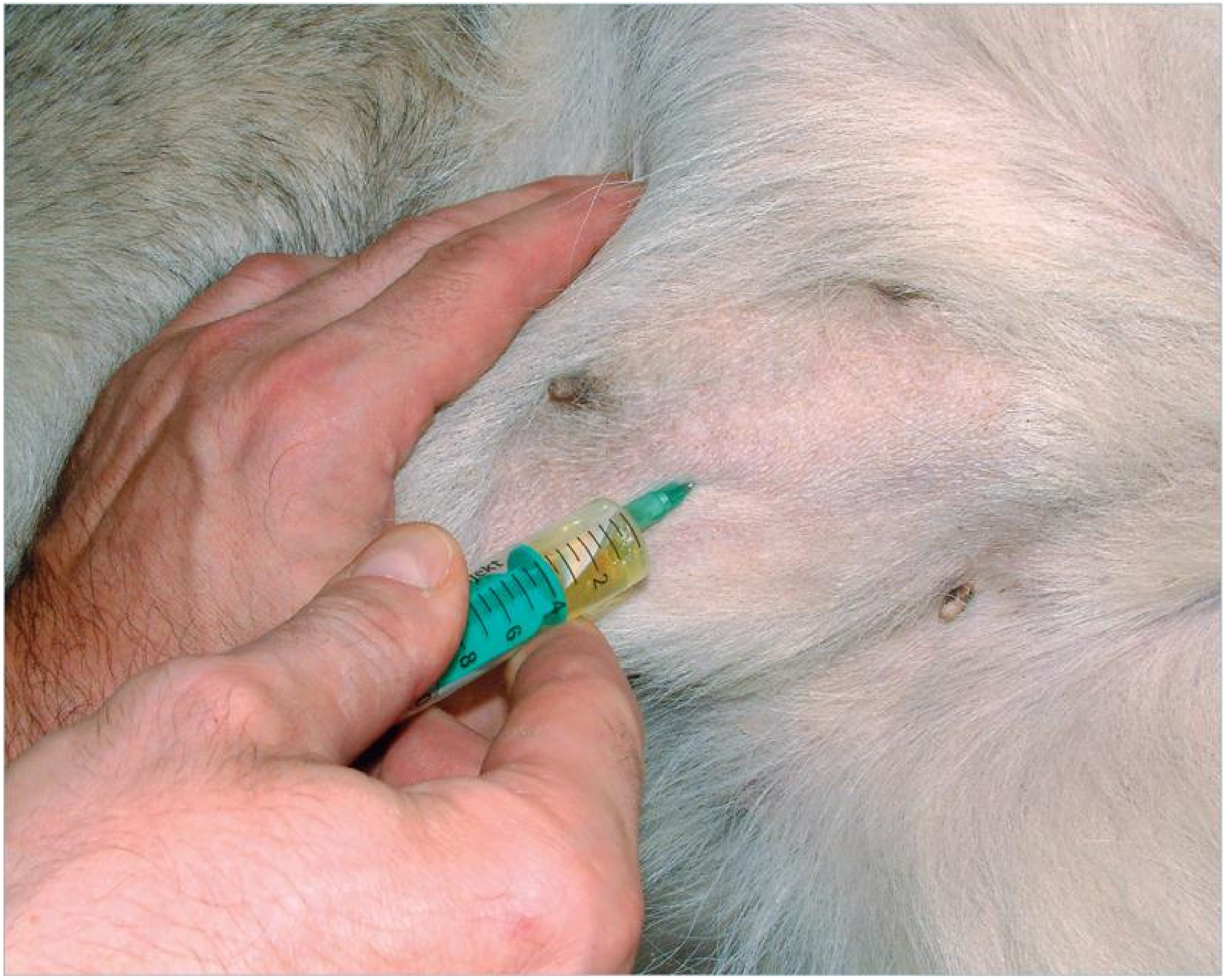

Fig. 4 Once the bladder has been punctured, urine should be extracted without sudden movements, to avoid damaging the mucosa and the bladder wall.

Cystocentesis is contraindicated if the bladder cannot be palpated, either because it is too small or because the patient is uncooperative. Do not perform a "blind" puncture.

If diuretics (furosemide) have been administered before cystocentesis, remember that this alters the specific gravity, the pH and the number of bacteria per ml.

Complications

- Generally, this technique does not lead to secondary complications.
- However, in patients that do not co-operate, or if the bladder is very small, bladder lesions, hemorrhage, peritonitis, urinary fistulas and adhesions may arise.

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Cystocentesis and percutaneous bladder catheterization

Percutaneous bladder catheterization

José Rodríguez

Prevalence	■	■	□	□	□
Technical difficulty	■	□	□	□	□

Placement of a bladder catheter through the abdominal wall is indicated in patients with urethral obstruction or lesions (uroliths, rupture, neoplasia) that make urethral catheterization impossible (Figs. 1 and 2).
A commercial set consisting of a trocar and cannula is introduced into the bladder, and a urinary catheter is introduced through the cannula (Figs. 3 and 4).

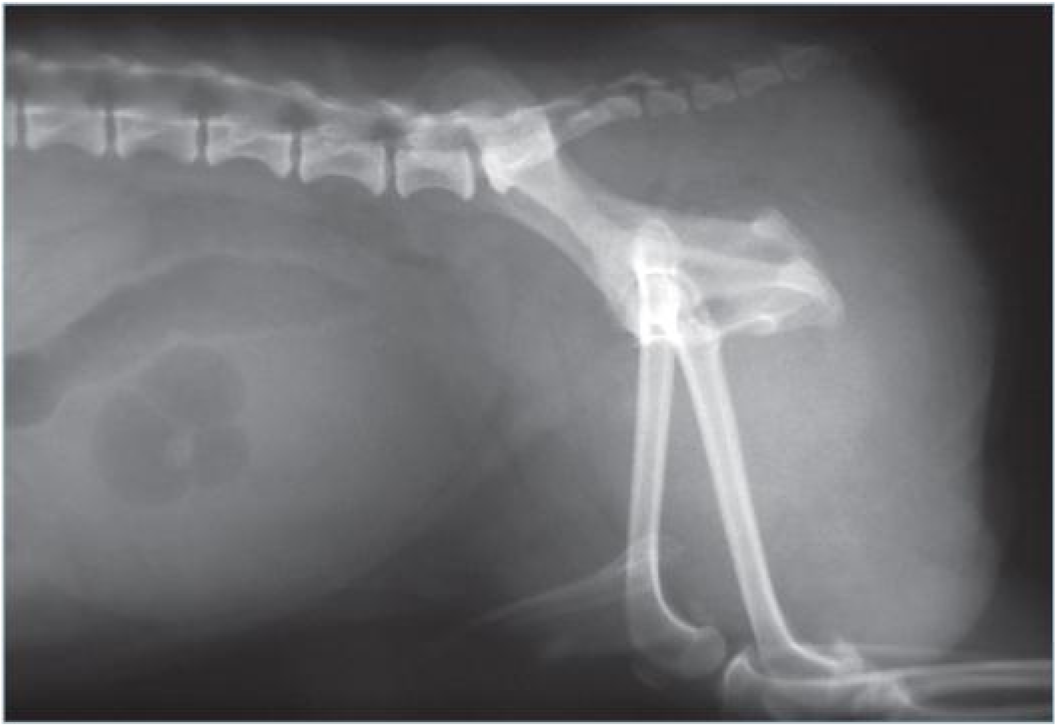

Fig. 1. This patient presented with urinary retention; catheterization was impossible because the catheter became lodged in the ischiatic area.

Fig. 2. As a urethral lesion was suspected, retrograde urethrography with an iodinated contrast medium was performed. On the radiograph, the contrast medium can be seen flowing out of the urethra into the pelvic cavity though a urethral rupture.

Fig. 3. Kit for percutaneous placement of a urinary catheter, consisting of a trocar, a cannula, a urinary catheter and a bag for urine recollection.

Fig. 4. Detail of the tip of the urinary catheter. When this is placed in the bladder, the loop will prevent it from slipping out.

Fig. 5. The bladder is immobilized with the non-dominant hand and the cannula is introduced through the midline.

Placement technique

The bladder is immobilized against the abdominal wall and the cannula and trocar are introduced together (Figs. 5 and 6).

Fig. 6. After introduction of the cannula and trocar into the bladder, urine will start to flow. The trocar is then withdrawn and the cannula is left in the bladder.

The trocar is then withdrawn and the urinary catheter is inserted into the bladder through the cannula (Fig. 7).

Fig. 7. The urinary catheter is inserted into the bladder through the cannula, always handling it through its plastic sleeve to avoid contamination.

To withdraw the cannula, its connector is split. Separating the two fragments, the cannula is split longitudinally in two halves that are easy to remove from the bladder (Figs. 8 and 9).

Fig. 8. The connector is easy to split and the two halves are separated.

Fig. 9. The cannula is withdrawn from the bladder by pulling out the two halves while the urinary catheter remains in place.

The bladder is emptied and samples for urinalysis and culture are collected (Fig. 10).

Fig. 10. The bladder is emptied and the catheter is connected to a closed urinary collection system to minimize the risk of ascending infection.

Finally, the catheter is fixed to the abdominal wall; the patient should be fitted with an Elizabethan collar to prevent its removal (Fig. 11).

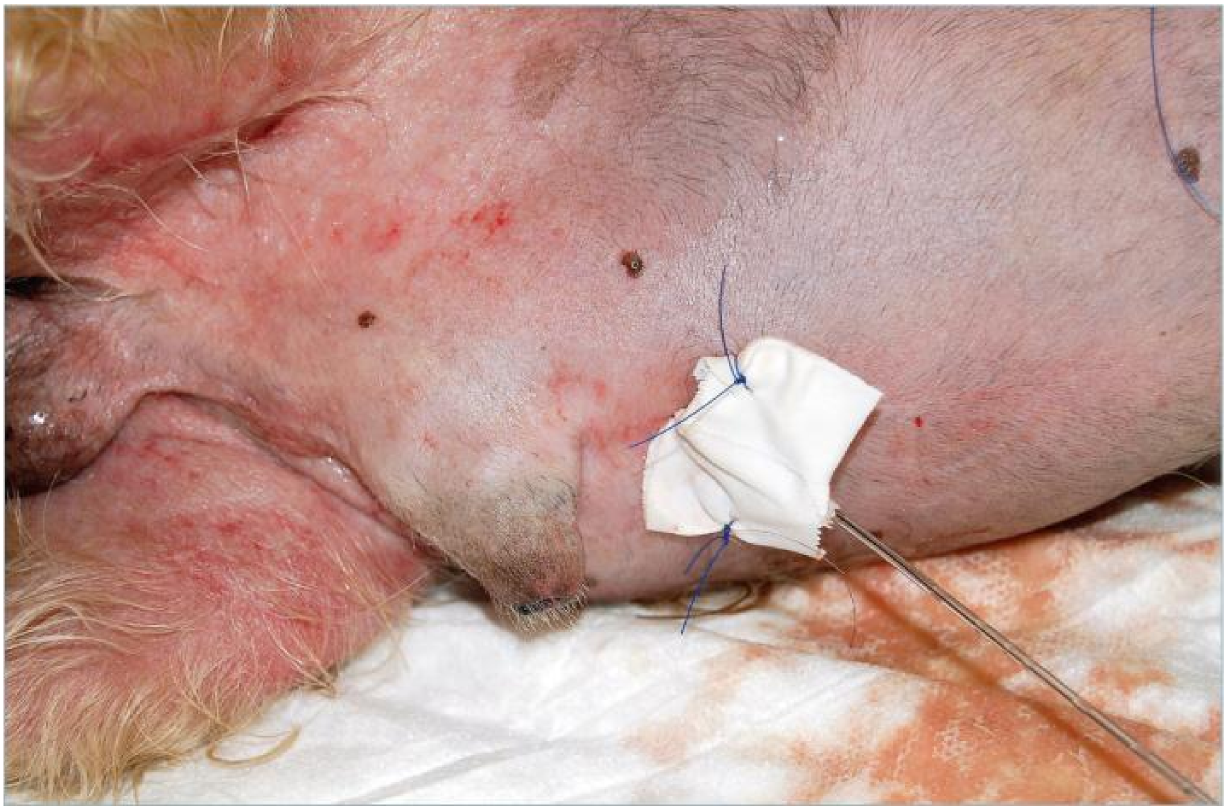

Fig. 11. The catheter should be secured to the skin to prevent it slipping out. In this case, it has been fixed with two sutures through a piece of surgical tape.

Aftercare

- After catheter placement, a full urinalysis is carried out, including culture and sensitivity testing.
- Fluid therapy is initiated to treat dehydration, uremia and electrolyte changes in the patient.
- The catheter should only remain for short periods of time in the bladder to avoid retrograde infection. Antibiotics are only indicated if there are signs of urinary or systemic infection.

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Cystocentesis and percutaneous bladder catheterization

Purse string suture of the anus

José Rodríguez

Prevalence	■■■■■
Technical difficulty	■□□□□

The purse string suture is a continuous suture placed around the anus to prevent fecal leakage during perineal surgery and thus reduce bacterial contamination of the operative field.

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Purse string suture

Before surgery

- Low-residue diet for 3 or 4 days prior to surgery.
- Do not administer enemas in the 24 hours prior to surgery.
- Manually empty the rectum.
- Manually empty the anal glands.
- Catheterize, flush and apply an aseptic solution to the anal sacs.

Technique

- The perineal area is shaved, including the base of the tail, and prepared aseptically.
- A continuous suture is placed around the anus in multiple bites, each bite enclosing approximately 6 or 7 mm of skin (Figs. 1-4). The bites should include sufficient tissue to support the tension on the suture.

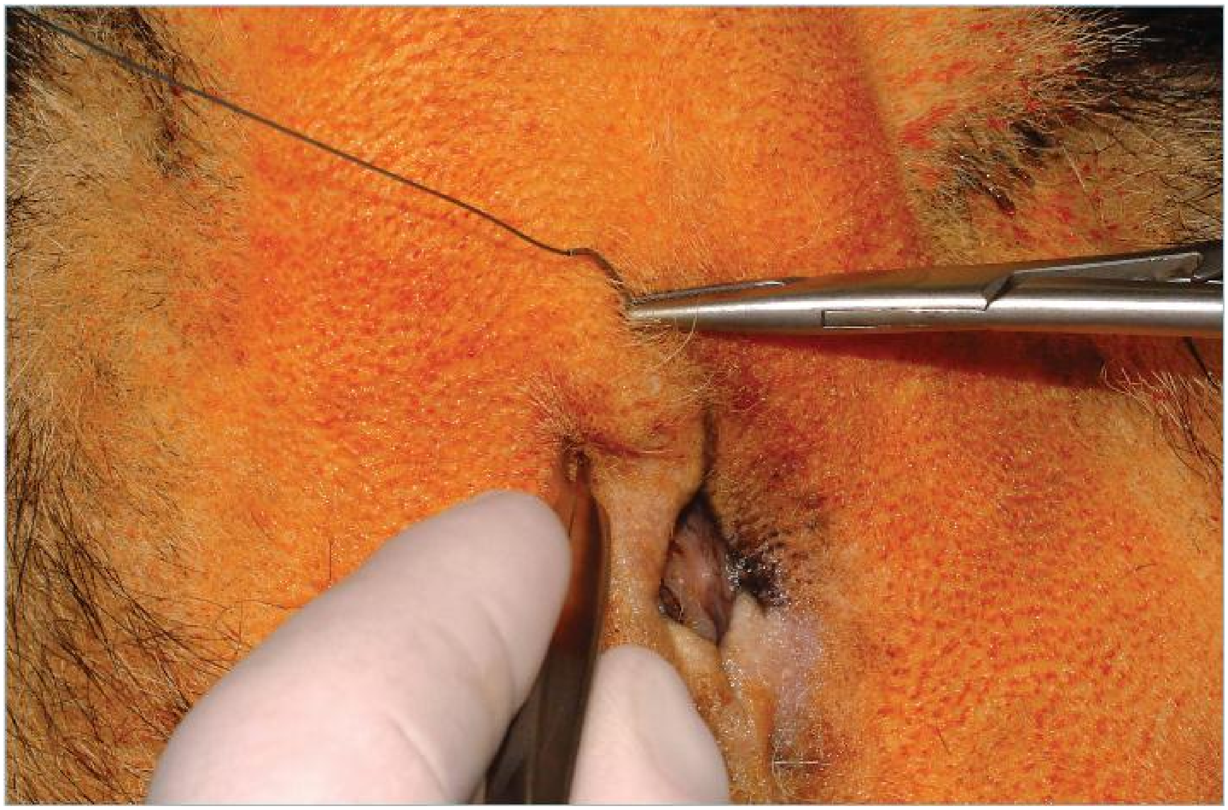

Fig. 1 The suture starts on the upper side of the anus, using 2/0 or 3/0 monofilament suture material.

Fig. 2 When the bites are made on the lateral and ventral side of the anus, care should be taken not to damage the anal sacs.

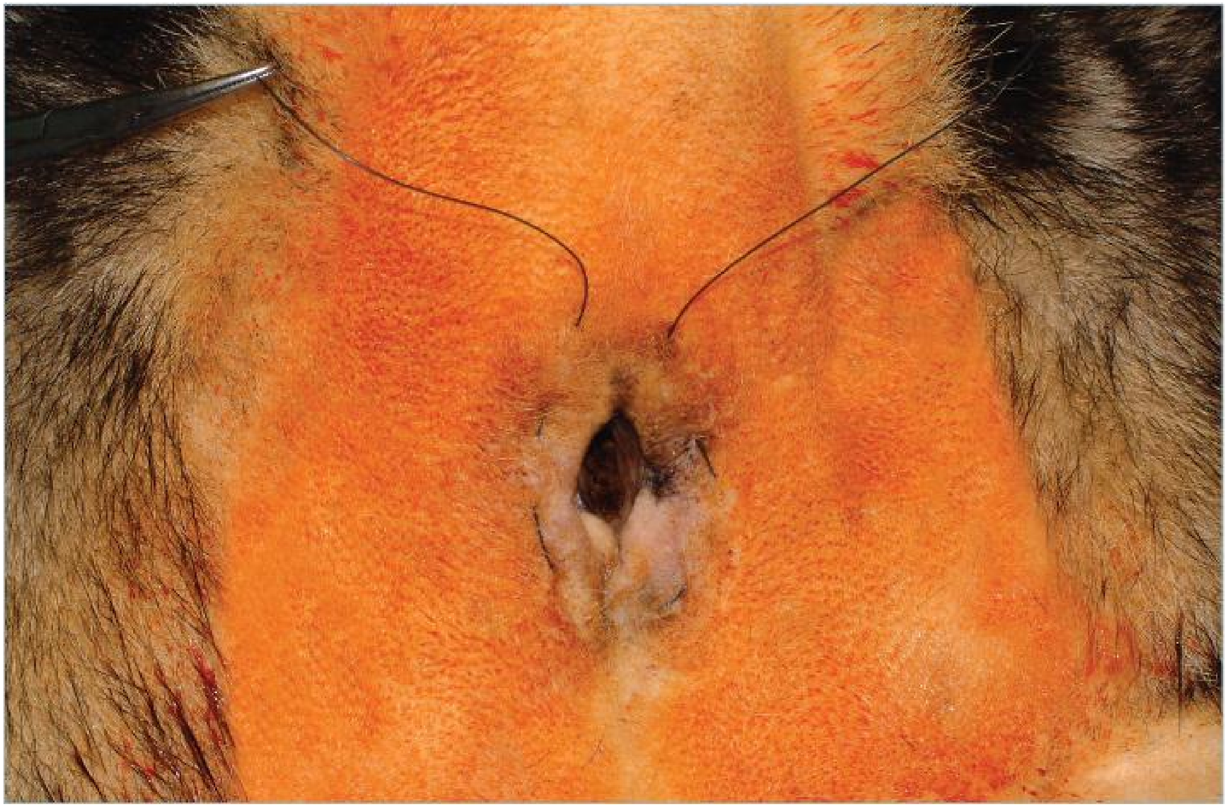

Fig. 3 Placement of the suture after 5 to 6 bites around the anus.

Remember that there are anal sacs on both sides of the anus. To avoid secondary contamination, do not perforate them.

- After surgery do not forget to remove the suture so the patient may defecate normally.

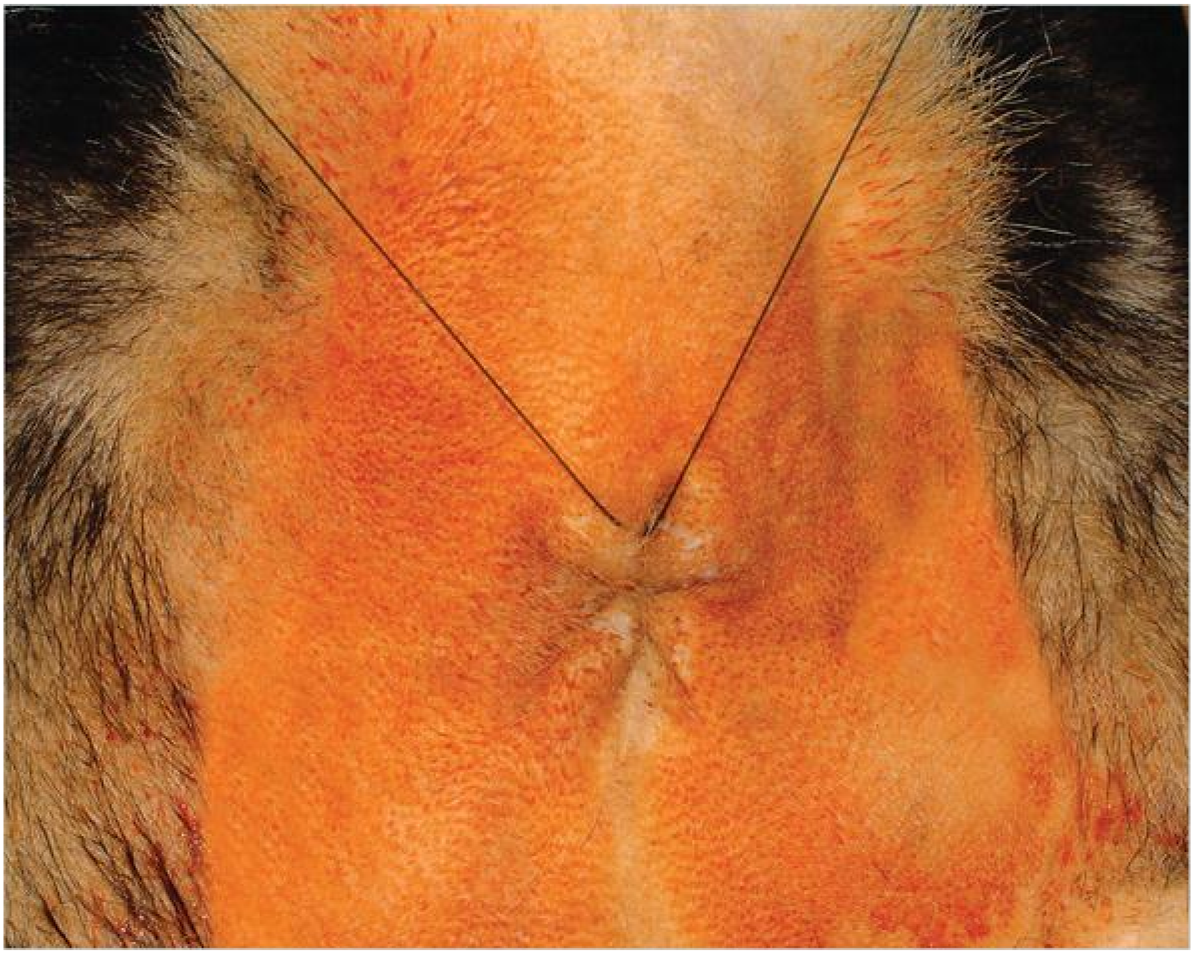

Fig. 4 When the suture is tied, the anal orifice is closed and no feces can pass.

Castration

Jaime Graus

Prevalence	■	■	■	■	■
Technical difficulty	■	■	□	□	□

Removal of the testes is probably the most common surgical intervention for a veterinarian. It has multiple indications ranging from population control to treatment of endocrinological, prostatic, neoplastic and behavioural disorders.

When castrating aggressive or difficult patients, it is advisable to close the incision with continuous sutures using absorbable suture material. This way there is no need to sedate the patient again to remove the stitches.

To prevent testicular stump haemorrhages in the abdomen, the stump should be held by forceps when sectioned until it can be confirmed that there is no bleeding.

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Canine orchidectomy

Castration may be prescrotal, scrotal or combined with scrotal ablation.
In the dog, prescrotal castration is most commonly performed and the testes are pushed cranially from the scrotum towards the prescrotal incision.
Castration with scrotal ablation is less common and is indicated in cases of scrotal trauma or when a perineal urethrostomy is necessary.
In the cat, scrotal castration is the technique of choice, either via a single incision in the scrotal midline or one in each scrotal sac.
Regardless of the chosen method, the procedure always includes an incision of the skin and the parietal tunica vaginalis. The testis is exteriorized through the incision and the tunica is separated from the tail of the epididymis by digital traction. Next, the structures of the spermatic cord are identified and the blood vessels and vas deferens are ligated separately using absorbable suture material.
Closure of the scrotal incision is optional. In the cat, it is usually left open. With prescrotal castration the skin is sutured using simple interrupted sutures. Alternatively, absorbable monofilament intradermal sutures can be used to avoid the need for suture removal.
The most common perioperative complications of castration are seromas, inflammation of the scrotal sac and haemorrhage. If the ligatures on the

pampiniform plexus are not placed securely enough or loosen, the risk of an undetected abdominal haemorrhage increases.

Case / Prescrotal castration in the dog

Technical difficulty	■	■	□	□	□

Fig. 1 For prescrotal castration, an extensive area around the scrotum is shaved and prepared aseptically.

Fig. 2 A single skin incision is made in the midline immediately cranial to the scrotal sac.

Fig. 3 The incision is extended by dissecting the subcutaneous tissue with scissors.

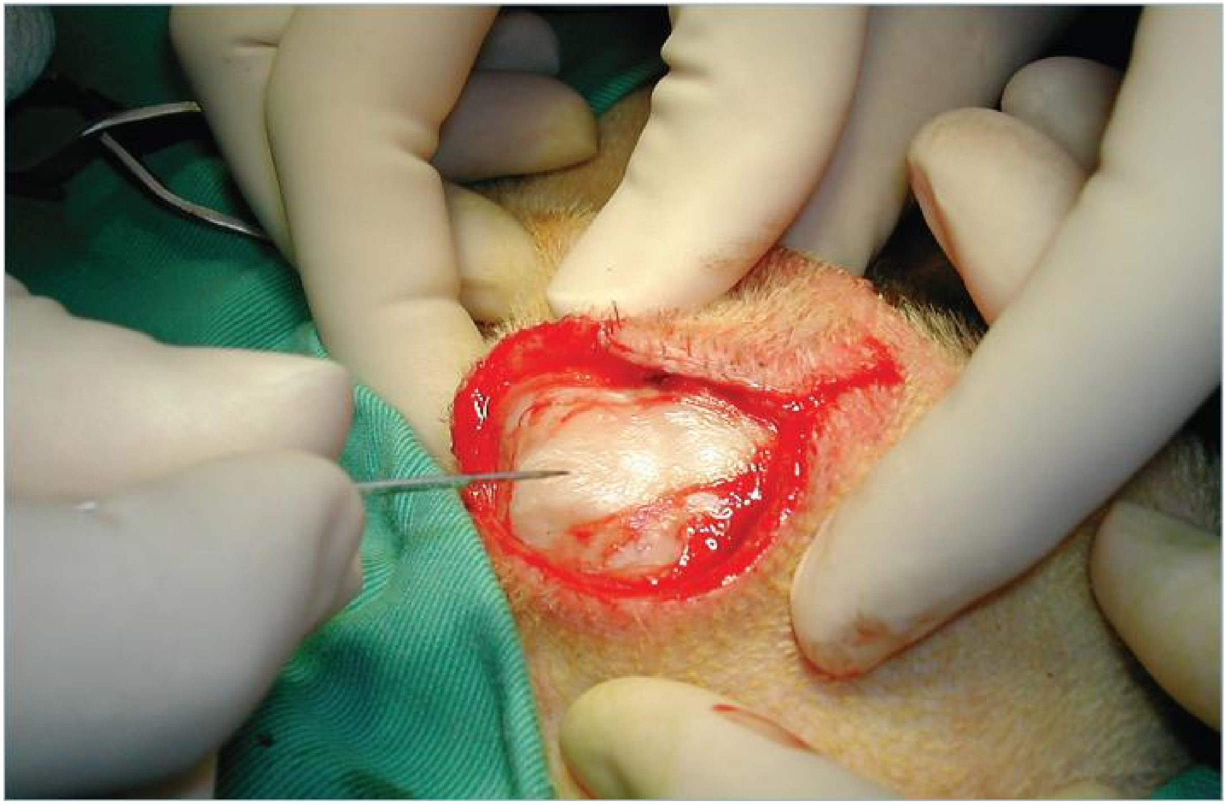

Fig. 4. The first testis is pushed towards the incision using gentle pressure until it can be visualized covered by the tunica vaginalis.

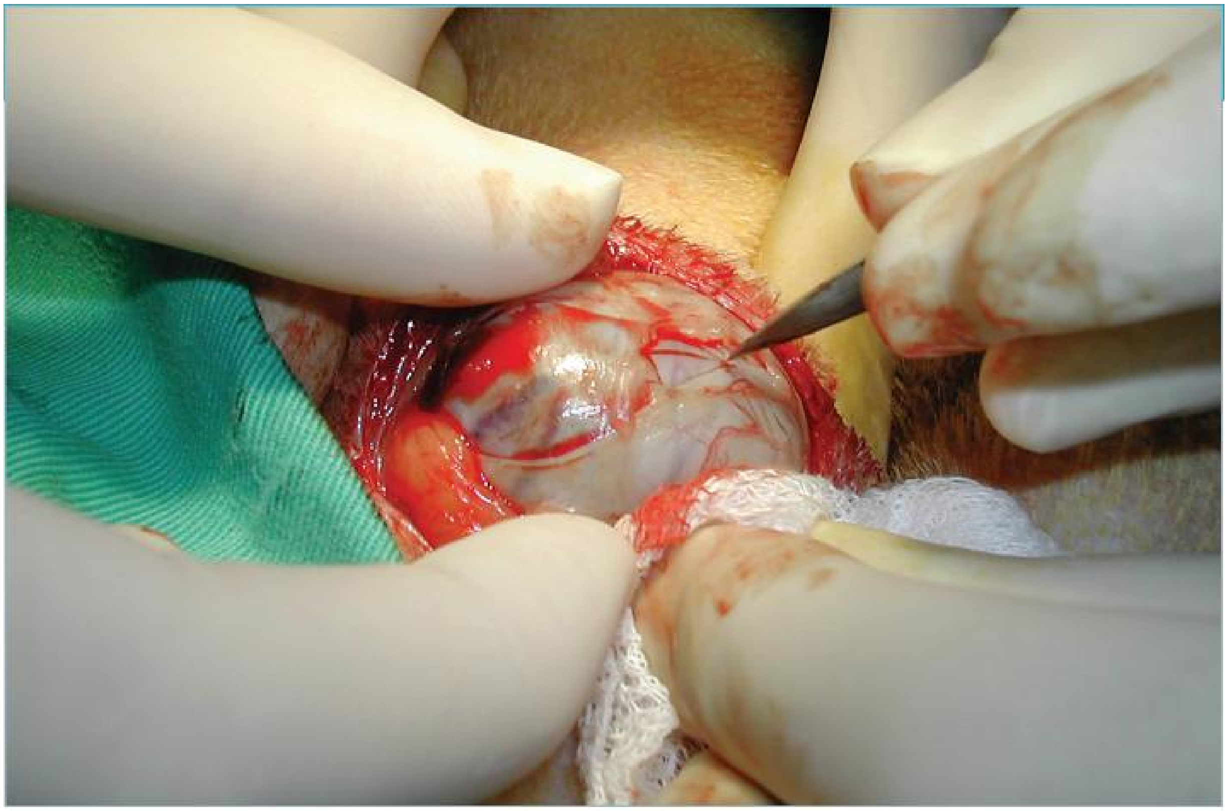

Fig. 5 Using a scalpel, the tunica vaginalis is incised, taking care not to damage the testicular parenchyma, as this results in hemorrhage.

Fig. 6 Once incised, the tunica vaginalis is still attached to the caudal pole of the testis, together with the insertion of the cremaster muscle. This attachment is broken by blunt dissection with the thumb and index finger of both hands. Using the fingers, rather than cutting minimizes bleeding.

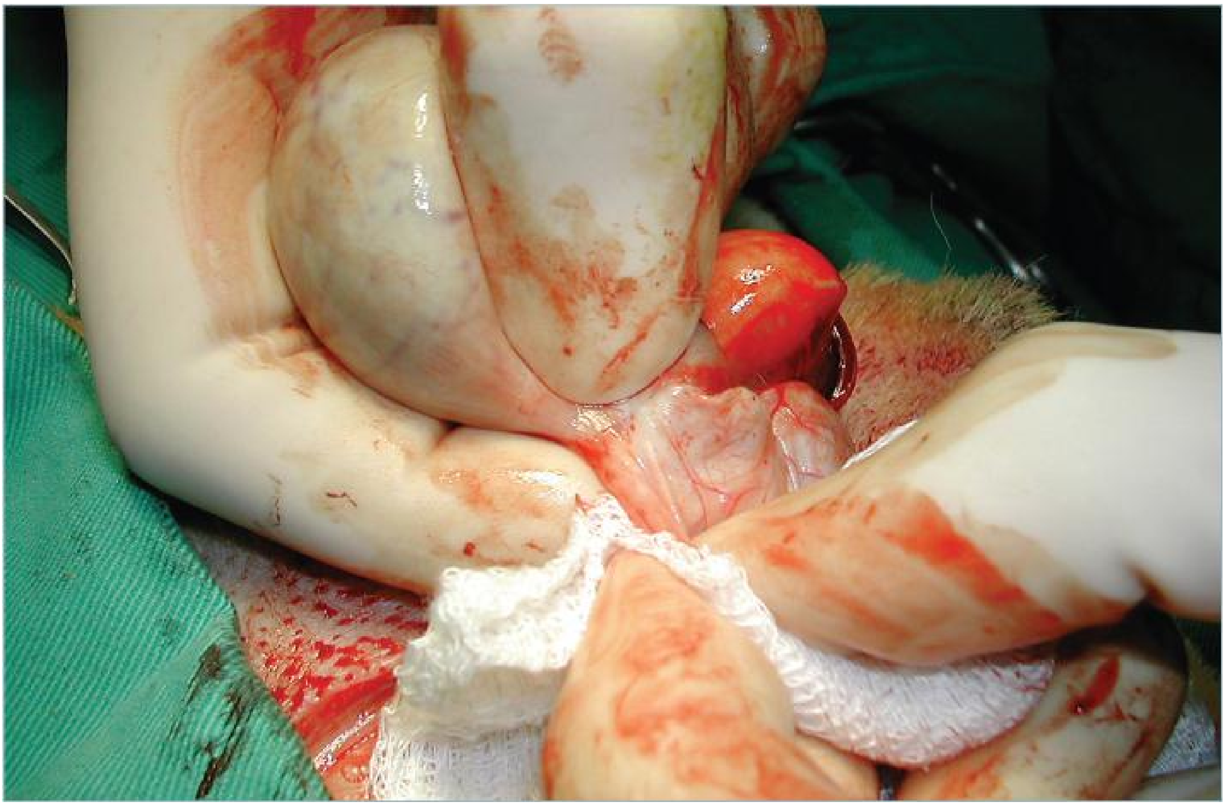

Fig. 7 A swab may be useful to detach the testis from the tunica vaginalis and insertion of the cremaster muscle.

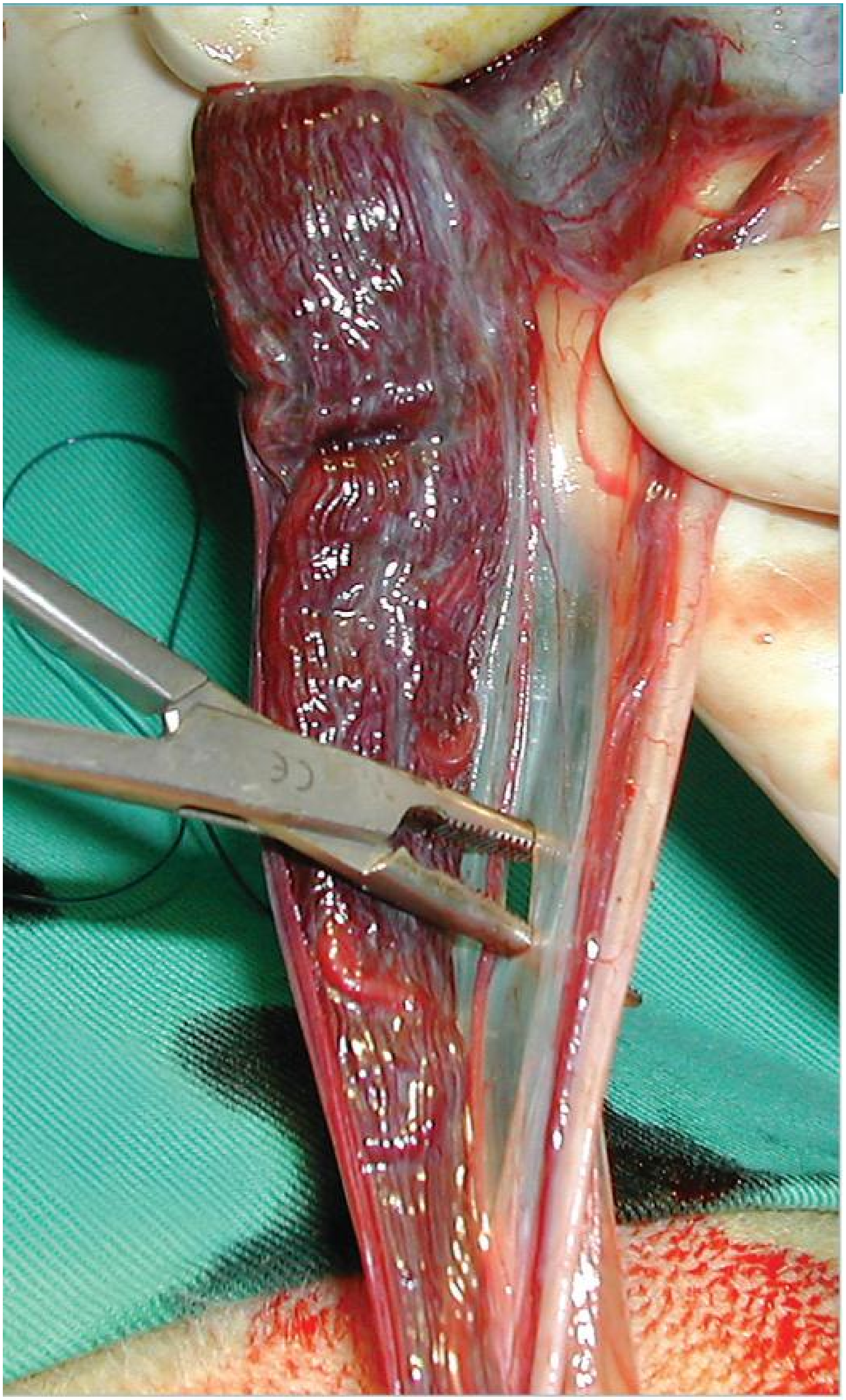

Fig. 8 In the spermatic cord, the pampiniform plexus and the vas deferens, with its own blood supply, can be identified individually. Both structures can be separated using forceps by blunt dissection of the membrane that joins them.

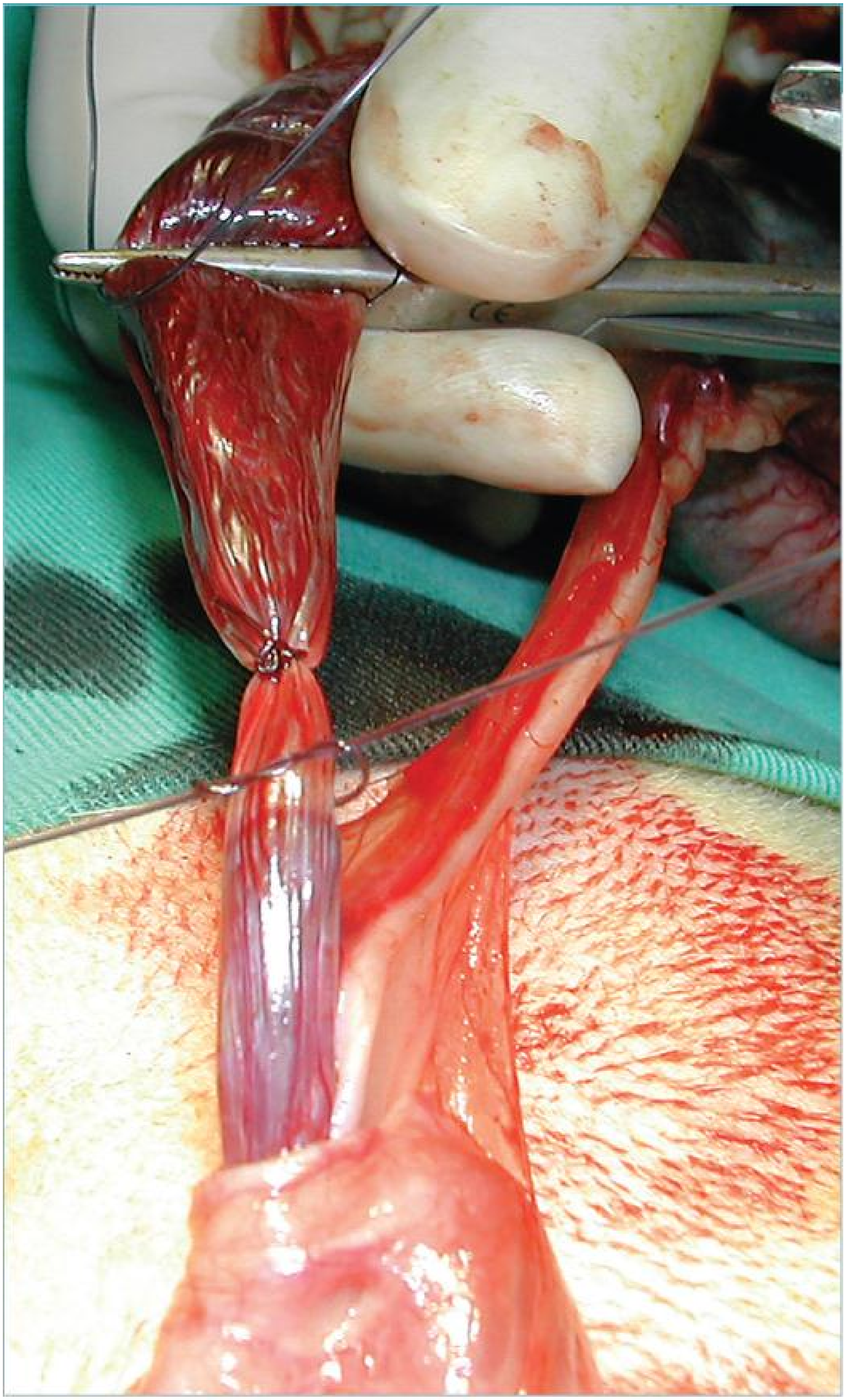

Fig. 9 Next, a double ligature is placed on the vascular structures of the spermatic cord, comprising the pampiniform plexus and the testicular artery which cannot be seen because it runs inside the plexus. An absorbable 2/0 or 0 monofilament suture material is used.

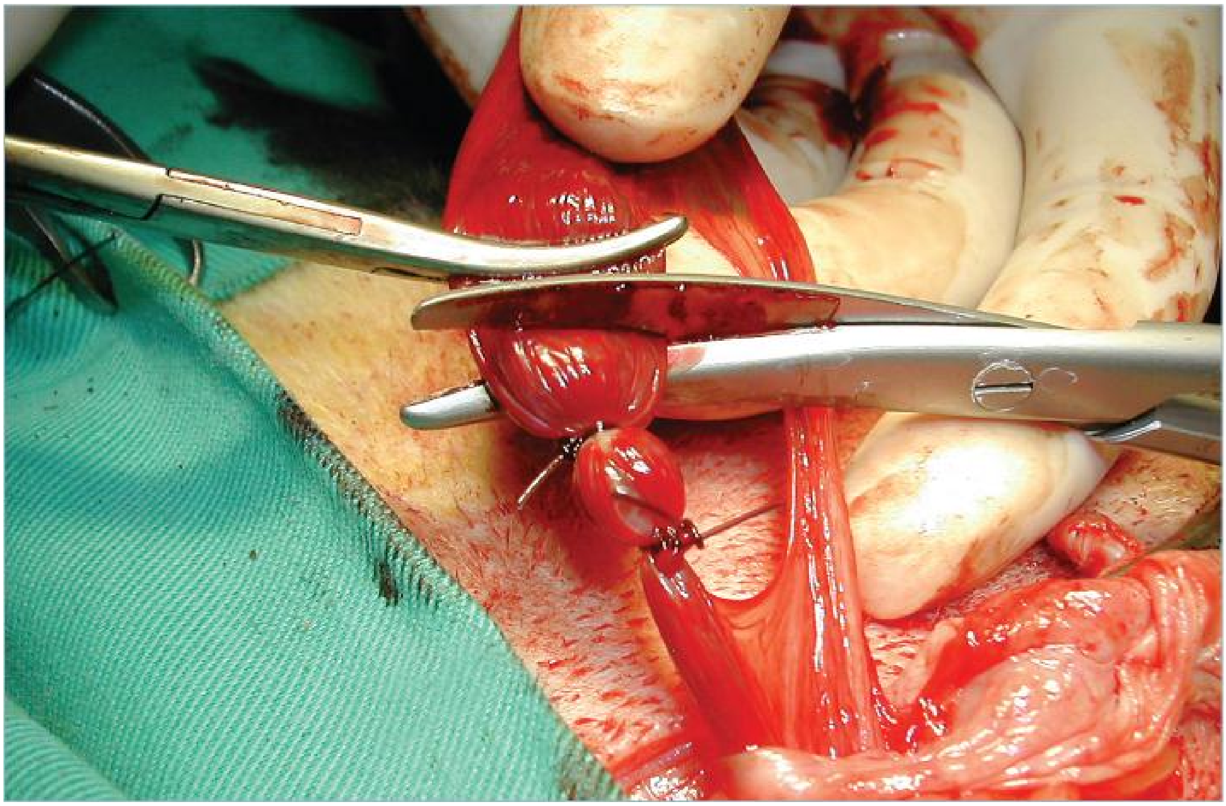

Fig. 10 The blood vessels are sectioned above the ligatures.

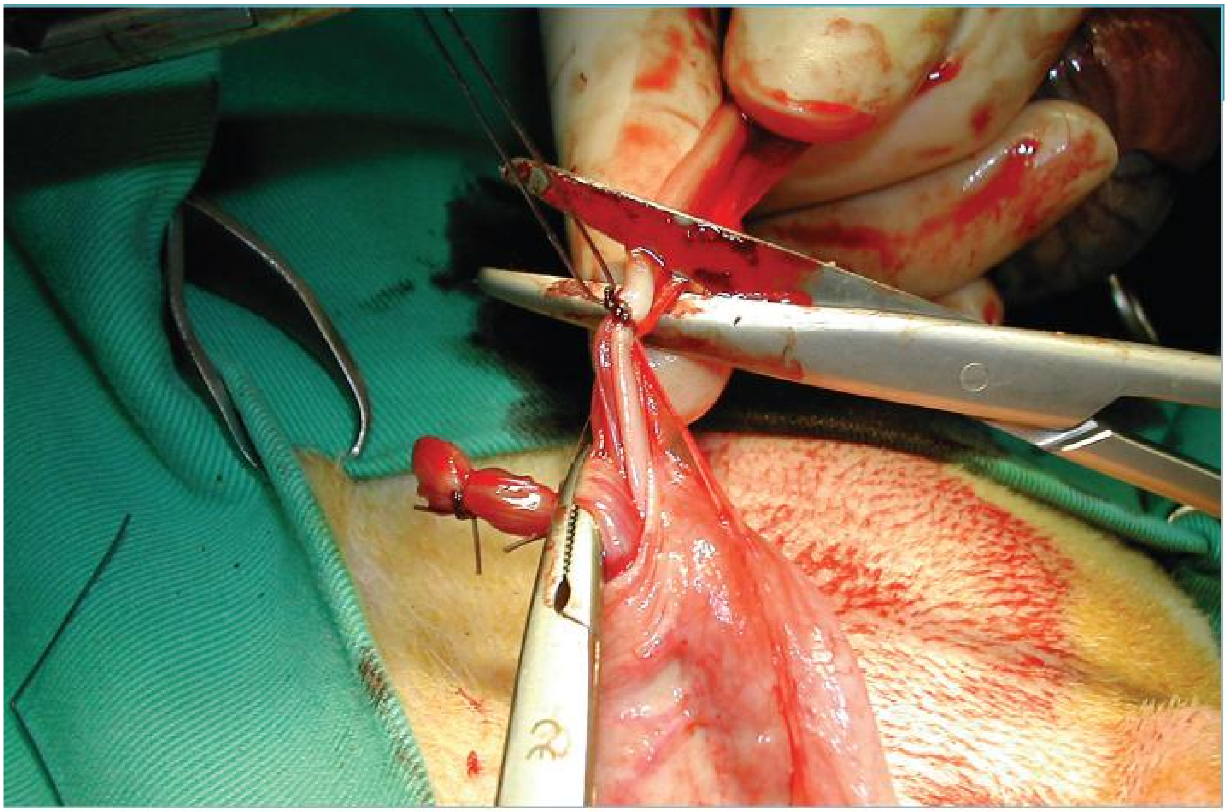

Fig. 11 The vas deferens and its blood supply are ligated together using the same material and are similarly sectioned.

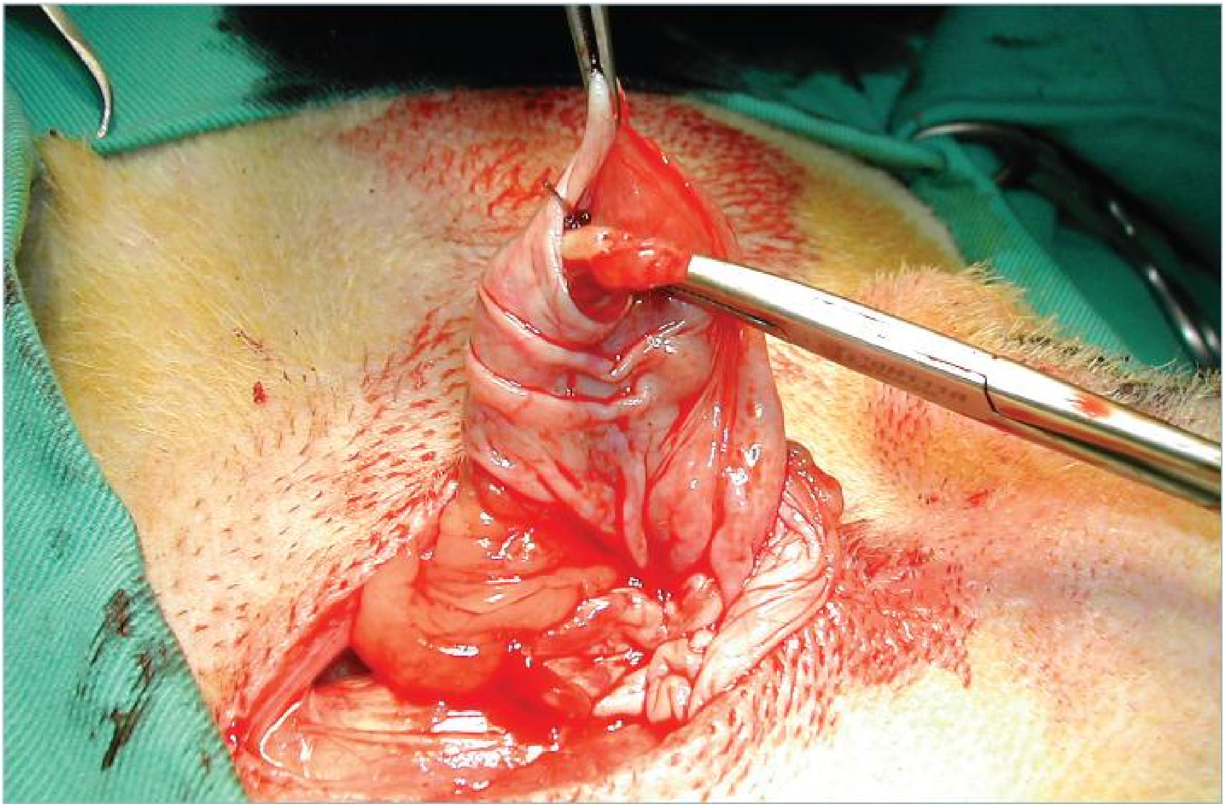

Fig. 12 Once it has been confirmed that there is no bleeding, the pedicles are pushed back into the tunica vaginalis towards the inguinal ring using forceps.

Fig. 13 The other testis is pushed towards the same incision and exteriorized, still covered by the tunica vaginalis; it is incised the same way as the first testis. Similarly, the components of the spermatic cord are separated, ligated and sectioned.

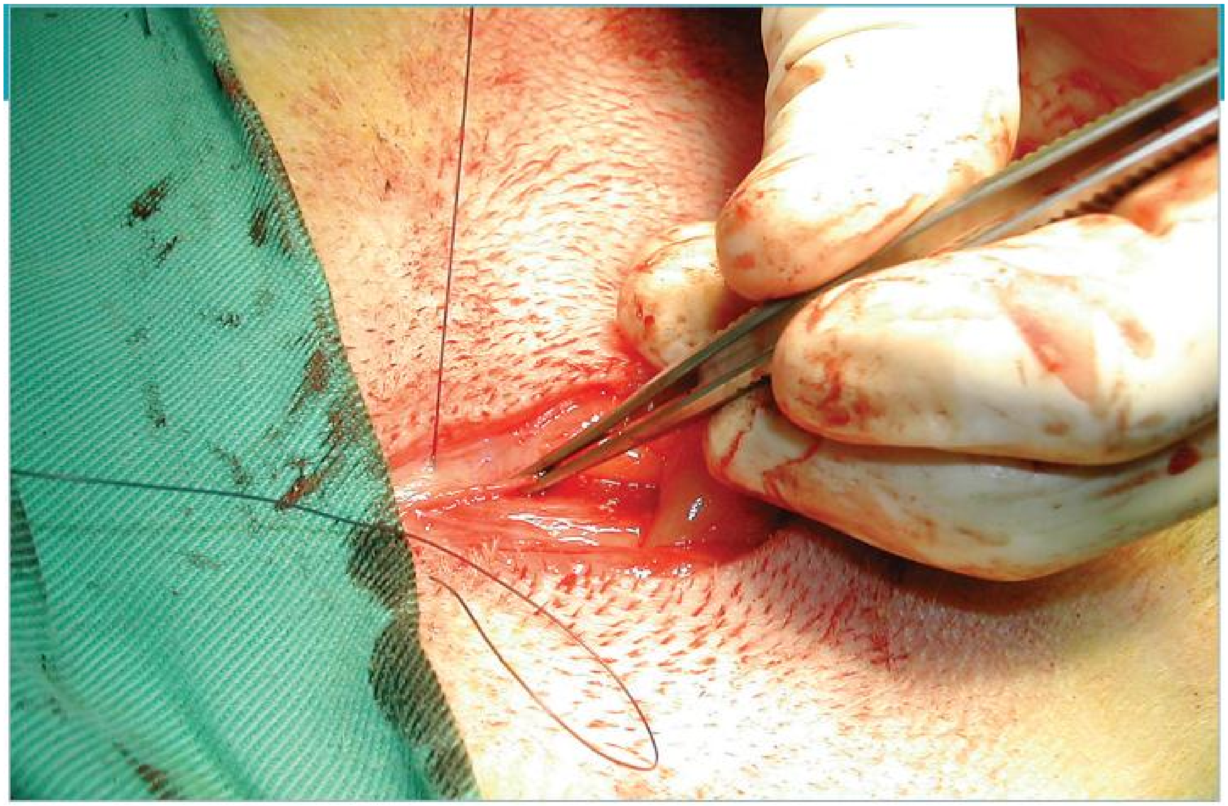

Fig. 14 The incision is closed in two layers, starting with the subcutaneous layer. A continuous suture in a 2/0 or 3/0 absorbable monofilament material is used.

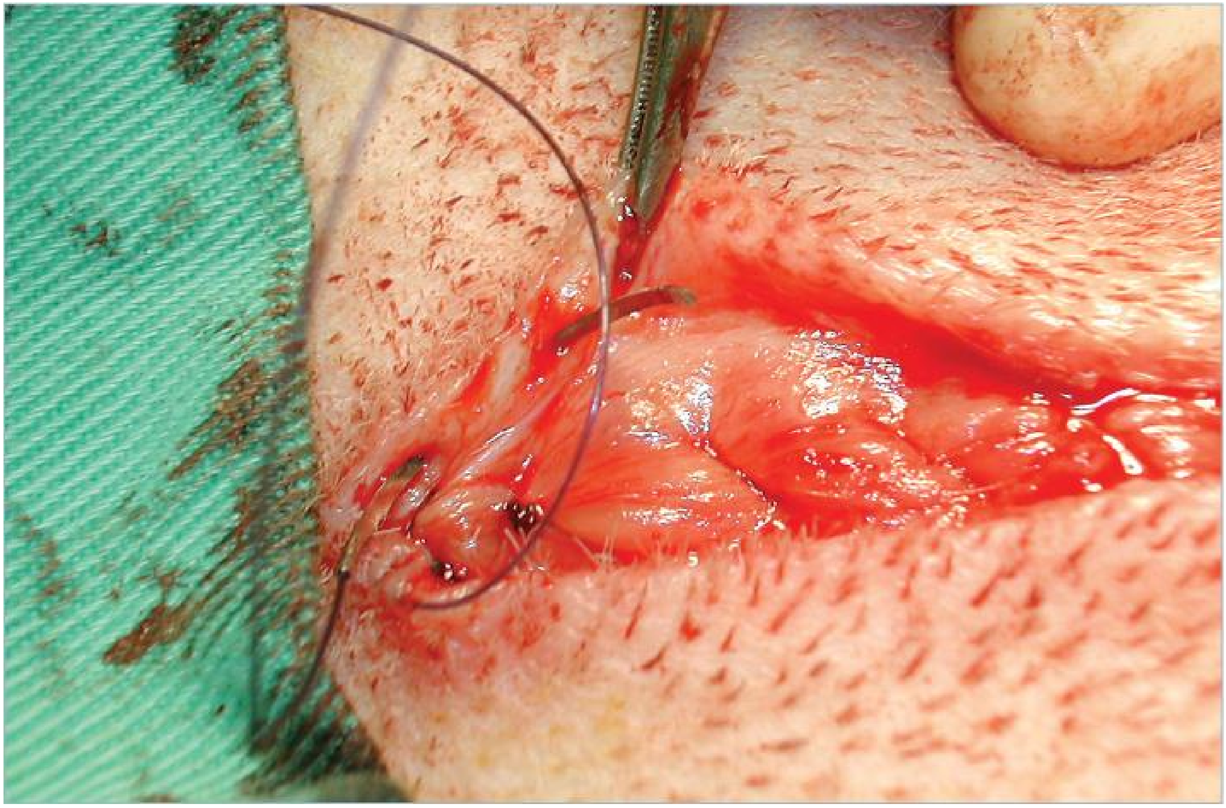

Fig. 15 Wound closure is finished with an intradermal suture in the same material.

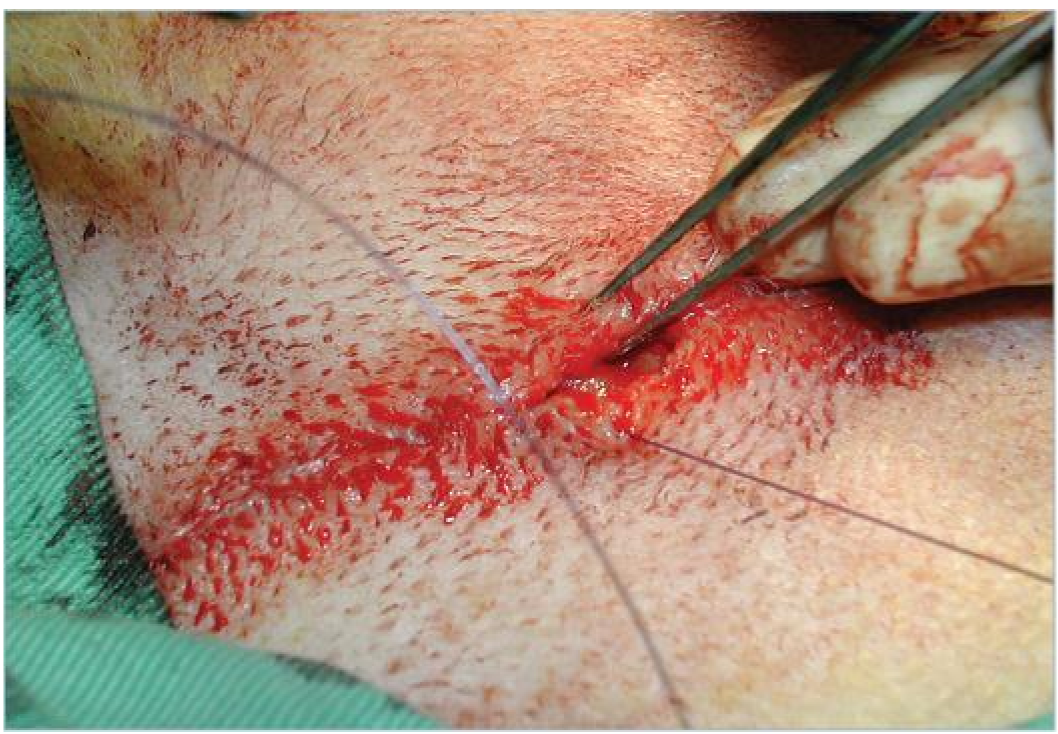

Fig. 16 The use of an intradermal suture avoids handling the patient again for suture removal.

Fig. 17 Final appearance of the surgical area. The empty scrotal sac and the scar of the surgical incision can be observed.

Anal neoplasia

José Rodríguez

Prevalence	■■■■□
Technical difficulty	■■■□□

Tumors located around the anus tend to be either adenomas and carcinomas of the perianal glands, or adenocarcinomas of the apo-crine glands located in the anal sacs.

Perianal adenomas are the most common neoplasms found in this area (80 %). They can also be found in other locations like the prepuce, the tail or the lumbosacral area.

They are hormone-dependent neoplasms and a large number of patients also have interstitial cell testicular tumors (Leydig cell tumor). Normally, they are small, smooth, multiple, well-defined and ulcerated tumors (Fig. 1). However, they can also be solitary and large (Fig. 2). Their growth is slow.

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Perianal neoplasia

> ✱
>
> ***Perianal adenomas are stimulated by an imbalance of the sex hormones. It is therefore recommended to castrate affected male dogs.***

Fig. 1. Circumanal tumors in an 8-year-old dog with a testicular Leydig cell tumor.

Fig. 2. Large perianal adenoma located between the anus and the base of the tail.

Carcinomas of the perianal glands cannot be differentiated macroscopically from adenomas.
Usually, they are solitary, ulcerated and locally invasive (Fig. 3). In addition, their growth is faster than that of adenomas.
These neoplasias are not hormone-dependent.
They mainly metastasize to the intrapelvic and sublumbar lymph nodes (Fig. 4).
Adenocarcinomas of the apocrine glands arise from the anal sacs.
They are usually unilateral and their growth is slow. Initially, they only affect the anal sacs but later can invade neighboring tissues.
They are highly malignant and metastasize to multiple organs. They also cause hypercalcemia, anorexia, vomiting, constipation, muscle weakness, polydipsia and polyuria.

The prognosis for patients with hypercalcemia is worse than those with normal calcium levels.

Fig. 3. Ulcerated and infected circumanal carcinomas. The smaller masses can be confused with perianal fistulas.

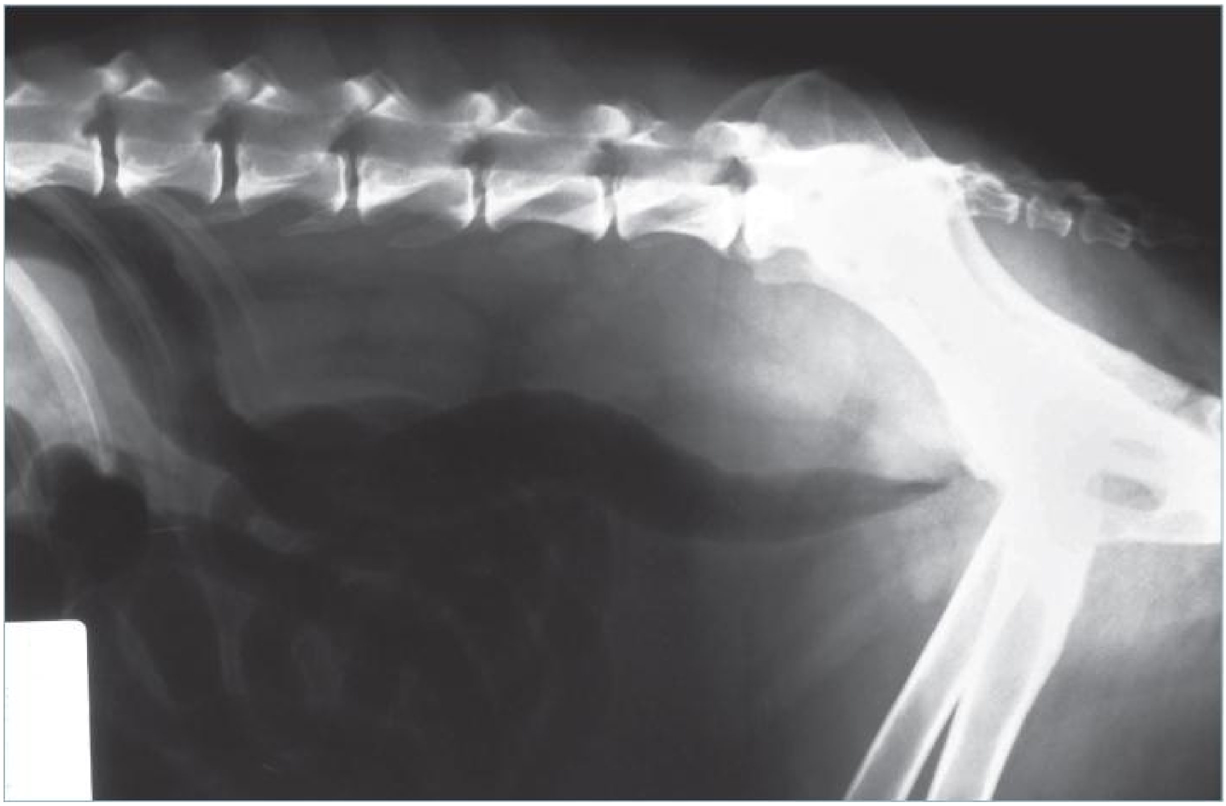


Fig. 4. In these patients, radiographic or ultrasound examinations should be carried out to detect any metastases.
This radiograph of the previous case shows metastasis in the sublumbar lymph nodes.

Case / Adenoma (small size)

Jaime Graus

Prevalence	■	■	■	■	□
Technical difficulty	■	□	□	□	□

This patient presents with various perianal neoplasias of different sizes, some of which are ulcerated (Fig. 1). During physical examination, the right testis was found to be much smaller than the left one. No metastases were detected and the blood tests were normal.

After preparation of the operative field, the patient is placed on the table in sternal recumbency, and a purse string suture is placed around the anus (Fig. 1).

Do not use enemas on the day of the operation, as this may contaminate the operative field with liquid feces.

Fig. 1. The operative field after shaving, disinfection and placement of a purse string suture to avoid fecal contamination.

Fig. 2. The skin around each of the neoplasms is incised with a scalpel, and the subcutaneous tissue is dissected. It is a simple technique as the tumors are normally not invasive.

Fig. 3. Adenomas of the perianal glands are easily dissected and the external anal sphincter rarely needs to be incised.

Avoid overusing monopolar coagulation as this may cause excessive fibrosis and iatrogenic anal stenosis.

Fig. 4. This area is well-vascularized so it is necessary to control bleeding during surgery by applying pressure with swabs. Only if the bleeding is intense should electrocautery, preferably using a bipolar coagulator, be performed.

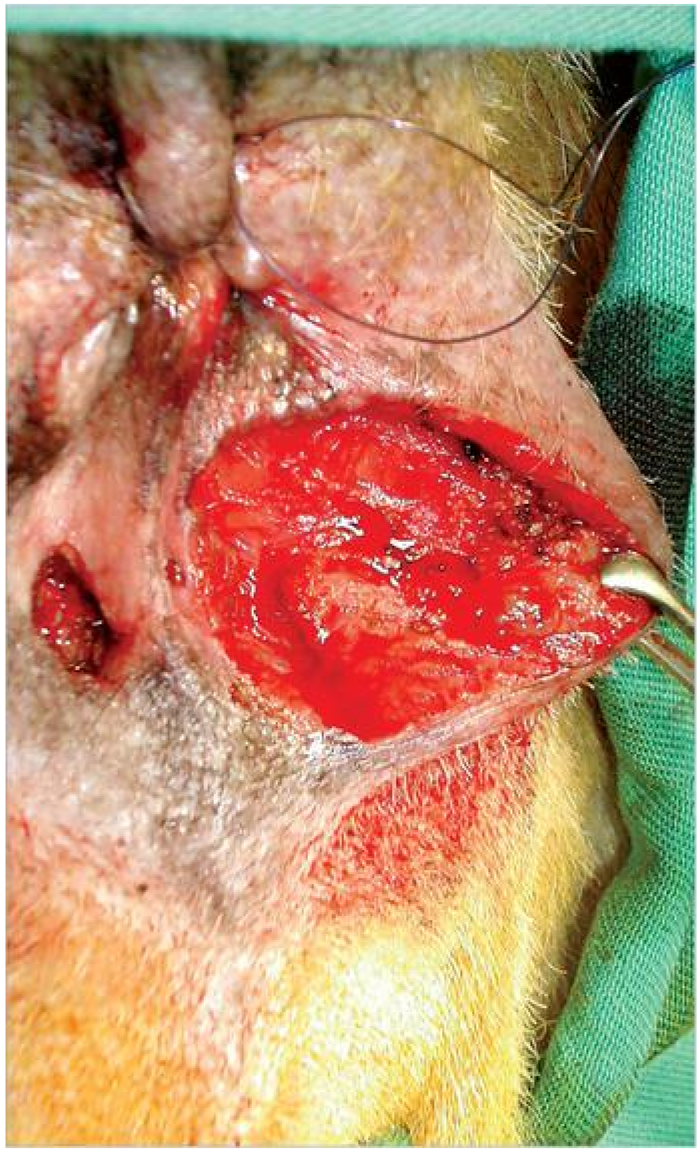


Fig. 5. After checking that there is no active bleeding in the bed of the resected area, the subcutaneous tissue should be closed using 3/0 absorbable suture material.

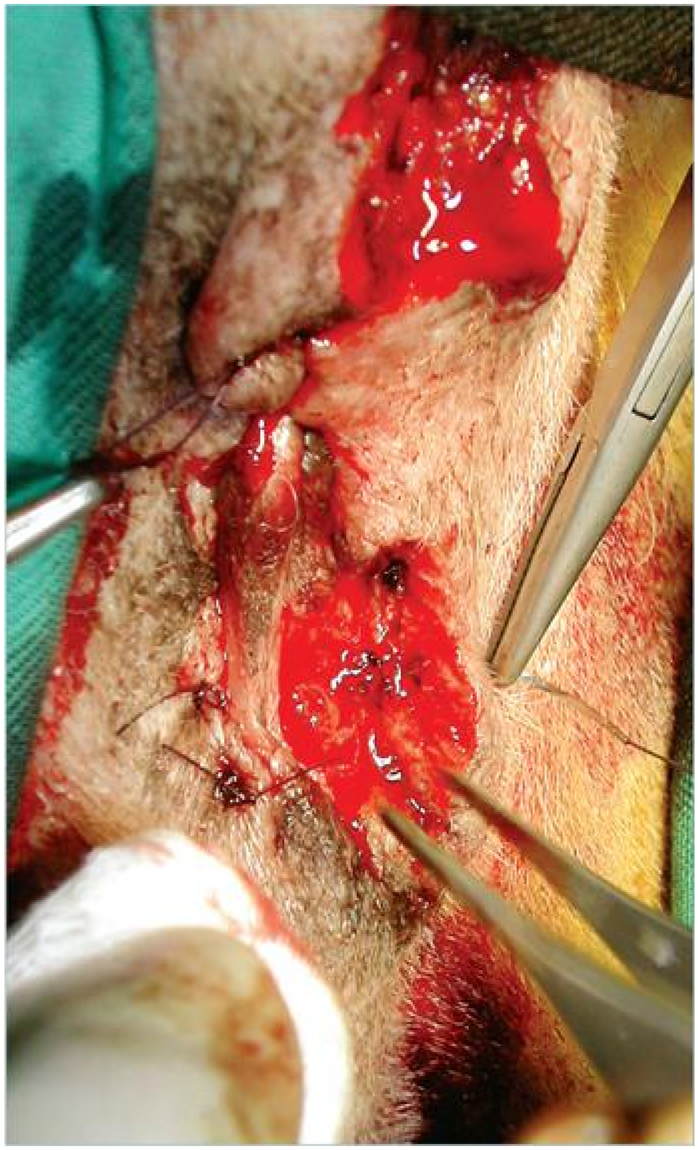


Fig. 6. The skin is closed with vertical mattress sutures using 3/0 non-absorbable monofilament material.

In order to reduce the risk of recurrence, bilateral castration is performed.

Fig. 7. The skin sutures near the anus should be perpendicular to the anus to avoid interfering with the lumen and function post-operatively.

Histopathological examination of this case confirmed the presence of a Leydig cell tumor in the right testis.

After surgery

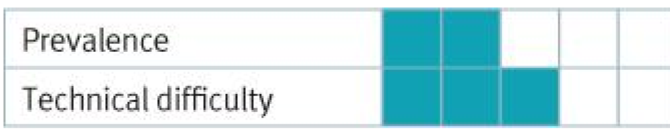
- Continue with antibiotic therapy for several days if contamination has taken place during surgery.
- Prescribe mild laxatives to avoid straining during defecation.

- Ensure the dog wears an Elizabethan collar, and observe strict hygiene in the area (wash the perianal area several times daily with water and soap, in particular after defecation).
- Regularly check the progress of wound healing.
- Recheck the patient 6 weeks later for possible recurrence.

Some authors recommend castration is carried out prior to the resection of the neoplasms in order to reduce the tumor size.

Closed sacculectomy

José Rodríguez



Sacculectomy (resection of the anal sacs) is performed in cases of recurrent anal sacculitis.

The patient documented on the following pages suffered from recurrent bilateral sacculitis and the owner elected surgery to solve the problem once and for all.

Anatomical reminder

The anal sac is located between the muscular fibers of the anal sphincter, near the rectum, with branches of the caudal rectal artery and vein medially, and in close proximity to the branches of the pudendal nerve that innervate the anus.

Before surgery

- Empty the rectum.
- Do not use laxatives in the 24 hours prior to surgery.

- Empty the anal sacs.
- Shave and prepare the surgical area aseptically.

Surgical technique

> ***In order to minimize postoperative complications with this technique, it should not be performed while the sacs are inflamed and infected.***
>
> ***Even if the problem is unilateral, removal of both anal sacs is recommended to prevent similar problems developing on the other side in the future.***

Fig. 1. Preparation of the operative field.

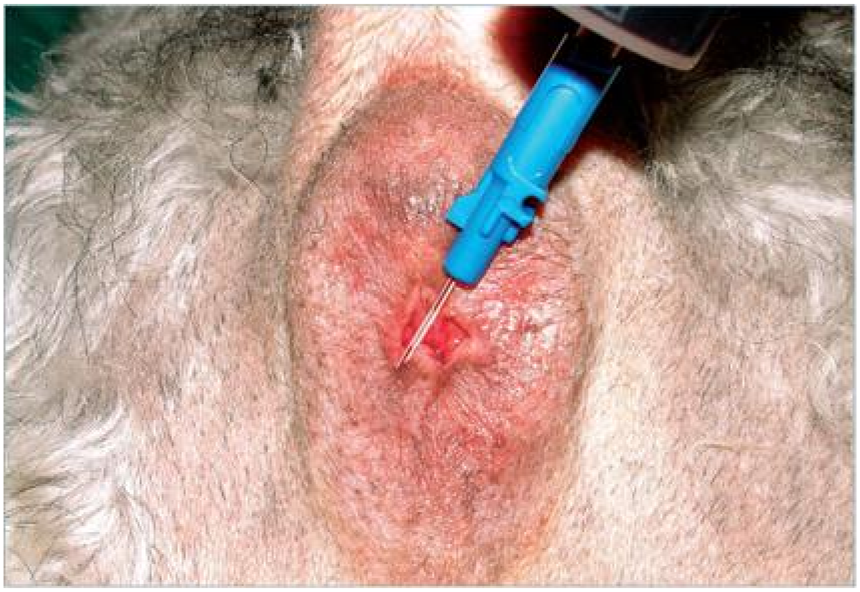


Fig. 2. After emptying the anal sacs, they should be flushed with an antiseptic solution (povidone iodine or chlorhexidine) to avoid secondary contamination in case the sac ruptures during dissection.

Fig. 3. A plug of gauze soaked in antiseptic is placed in the rectum to disinfect the area and to avoid the expulsion of feces during surgery. The patient is placed in sternal recumbency on the operating table.

During surgery

- Proceed in the least traumatic way and take extreme care, in particular in the deep areas, to avoid trauma to the vessels and nerves that supply and innervate the anus.
- Flush the tissues regularly with saline to stop them from drying out.

Fig. 4. The anal sacs are marked in green and the incision in red. In this case, haemostatic forceps have been introduced to demonstrate the left sac.

Fig. 5. The skin incision is parallel to the fibers of the anal sphincter. Hemostasis is achieved by clamping bleeding vessels with hemostats or by bipolar coagulation.

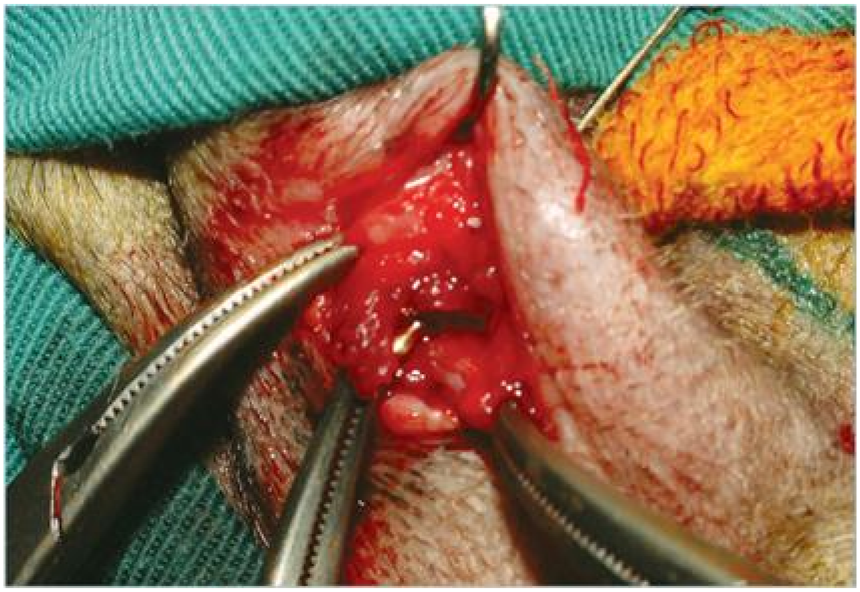


Fig. 6. During dissection of the anal sac, accidental rupture is possible. If the sac ruptures, great care should be taken to remove all tissue as any remaining sac tissue could produce recurring fistulas.

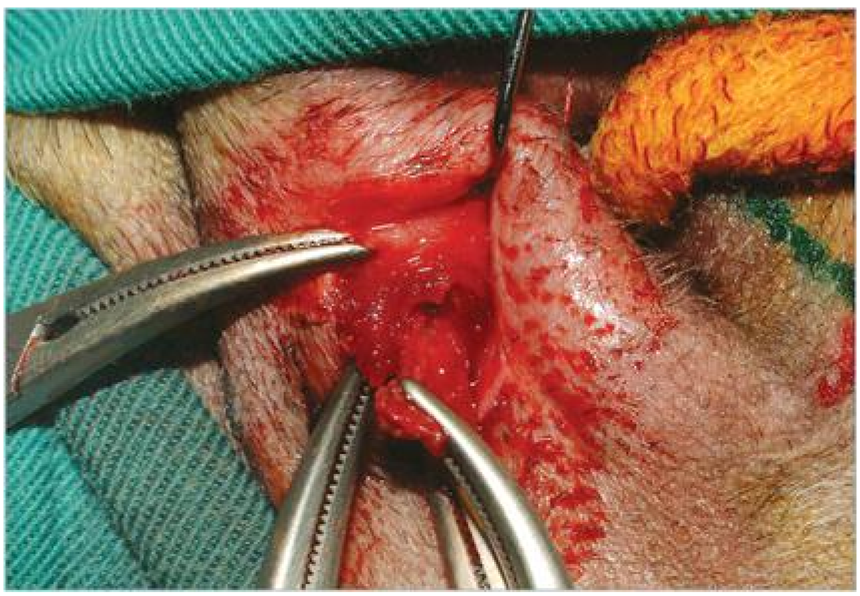


Fig. 7. Handle the anal sac gently and dissect it from the muscular fibers until it is only attached by its duct.

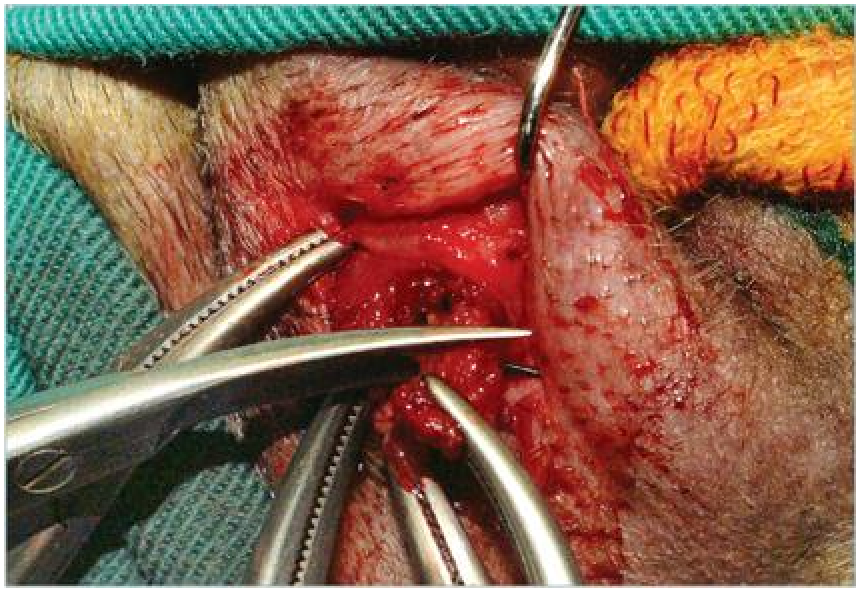


Fig. 8. Once the anal sac is isolated, its duct should be ligated with absorbable suture material as close as possible to the anal orifice. It is then transected with scissors and removed.

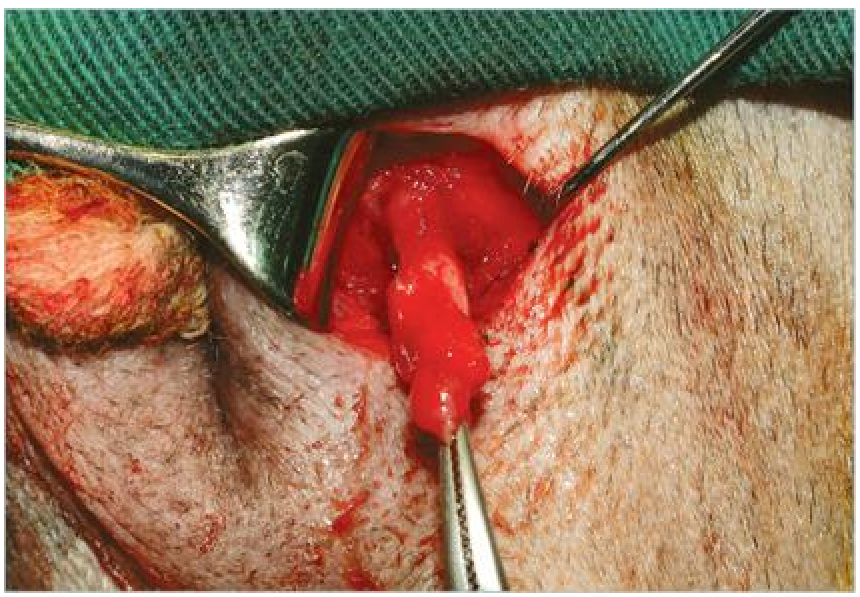


Fig. 9. Repeat the same steps on the other side. In this case, the right anal sac was less attached to the anal sphincter, and its resection was easier and quicker.

Fig. 10. The incisions are rinsed with saline and the sectioned muscles are closed with a continuous suture using absorbable 4/0 suture material.

Fig. 11. The skin wound is closed with vertical mattress sutures of monofilament non-absorbable 3/0 suture material.

After surgery

- Elizabethan collar to prevent the patient licking the area.

- Systemic antibiotic treatment for 3 or 4 days if there are no infectious complications.
- Regular cleaning of the area with soap and water.
- Prescribe medication that softens the stools to facilitate defecation.

*

Inform the owner that temporary fecal incontinence may occur (lasting less than a week).

Avoid monopolar coagulation, which can cause significant tissue damage and excessive scar fibrosis.

Inflammation and recurrent infections of the anal sacs lead to extensive fibrosis and adhesions within the fibers of the anal sphincter. This makes dissection more difficult and increases the risk of perforation.

Extreme care is required when dissecting the cranial part of the sac, since it should be remembered that this area contains vessels and nerves that are important for the correct functioning of the anus.

Laxatives	Dog	Cat
Lactulose	1 ml/4.5 kg/8 h PO	5 ml PO
Bisacodyl	5-20 mg PO 1 to 3 times daily	2.5-5 mg PO 1 to 3 times daily

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Bilateral sacculectomy

Fig. 12. If these steps and recommendations are followed, postoperative inflammation and infection, if any, will be minimal. On day 8, the sutures are removed and the treatment is complete.

> *Complications are common in the case of inexperienced or excessively aggressive surgeons.*

Complications

- **Fecal incontinence.** This is a relatively common complication due to excessive trauma of the anal sphincter. Normally, this only lasts a few days and is no cause for concern. If it persists, it is possible that there has been irreversible damage to the nerves (anal branch of the pudendal nerve), and a medical-nutritional or surgical treatment should be considered.
- **Tenesmus and dyschezia.** These two problems can occur in the initial postoperative period if there is local infection. If they appear in the medium-term, they can be due to stenosis of the anus as a result of excessive scar tissue formation. In the first case, correct antibiotic

treatment should be prescribed, while the second requires medical treatment facilitating faecal elimination or surgical resection of the scar tissue causing the signs.

- **Recurrence of the fistula.** This is associated with incomplete resection of the sac. Take care to place the ligature on the duct as close as possible to its exit, so that no sac or glandular tissue remains.
- **Local infection and appearance of fistulas.** If the duct is not liga-ted correctly, pathogens may pass from the anus into the subcutaneous tissue.

Vulval and vaginal neoplasia

José Rodríguez

Tumors of the vulva and vagina are the second most common in the bitch after mammary tumors. In the queen, they are very rare. Vulval and vaginal tumors are common in middle-aged and old dogs.
70-80 % of these tumors are benign.

> ***The majority of tumors in this area are benign and respond to surgery. However, they can be spectacular.***

Fibromas, lipomas and leiomyomas occur most commonly in this region. These three tumor types cannot be distinguished macroscopically. They are firm, rounded, often pedunculated masses with a smooth surface.

Fig. 1. Vaginal polyp.

Leiomyosarcoma is the most common malignant vaginal tumor, while **transmissible venereal tumor** has become rare in our environment but is still seen in rural areas where dogs run free. The latter, also called Sticker's lymphosarcoma, has an irregular, hemorrhagic, often ulcerated surface and can be solitary or multiple. It has a cauliflower form and is more or less pedunculated. Other malignant tumors include the **mast cell tumor** and **squamous cell carcinoma**. Metastasis of vaginal tumors is very rare.

On examination, it is common to find protrusion of tumor-like tissue through the vulva or a swelling of the perineal region. Hemorrhagic or purulent discharge may also be present.

Diagnosis is completed by rectal and vaginal palpation. Thoracic and abdominal radiographs will detect possible metastases. Special attention is required to detect invasion of the inguinal, iliac and sacral lymph nodes. For this reason, an abdominal ultrasound examination can be useful. Cytology will indicate the nature of the tumor, which will be confirmed by histopathology of the resected tissue.

A vaginal mass is most likely a tumor if the patient is an adult female dog. If the patient is young and in estrus, it is most likely vaginal hyperplasia.

The differential diagnoses include vaginal hyperplasia and uterine prolapse. The first is seen in young dogs, in association with estrus and originates from the vaginal floor, cranial to the urethral orifice. Uterine prolapse is linked to parturition and is more common in cats.

Treatment is mainly surgical; transmissible venereal tumors can also be treated with vincristine.

Fig. 2. Transmissible venereal tumor.

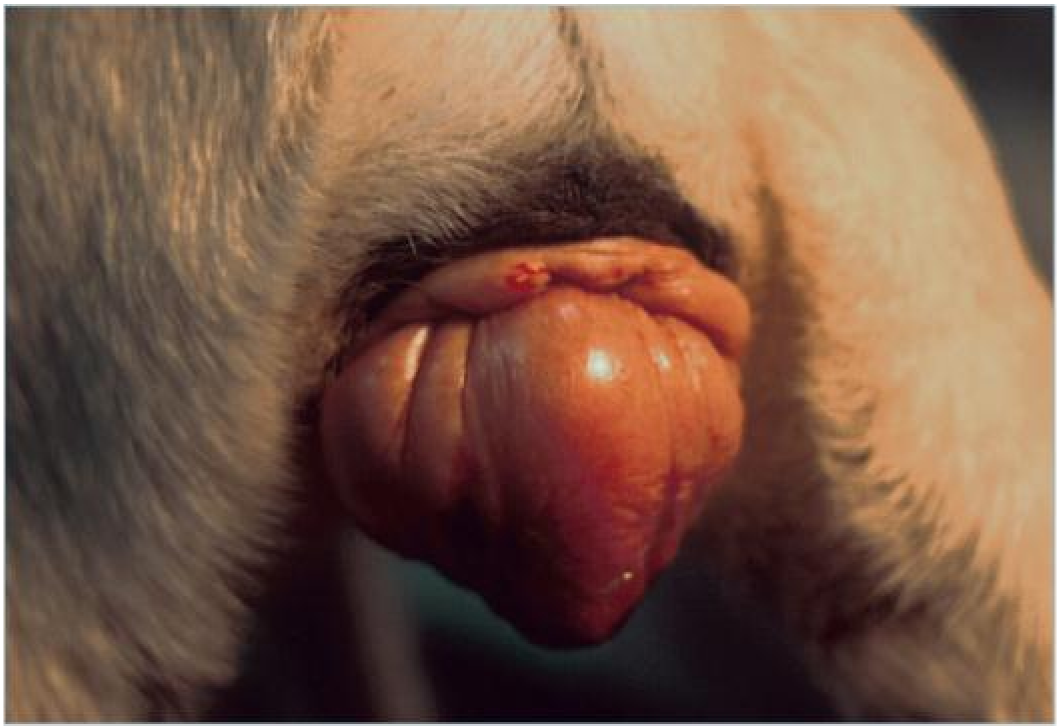

Fig. 3. Vaginal hyperplasia.

Case / Vaginal tumor

A small, 8-year-old Schnauzer, bitch presented on emergency following the sudden appearance of a mass in the vulvar area.
On examination, a congested, necrotic mass is found protruding through the vulva. It is assumed the tumor developed inside the vagina before protruding (Fig. 1).

Fig. 1. Caudal view of the patient, showing the mass.

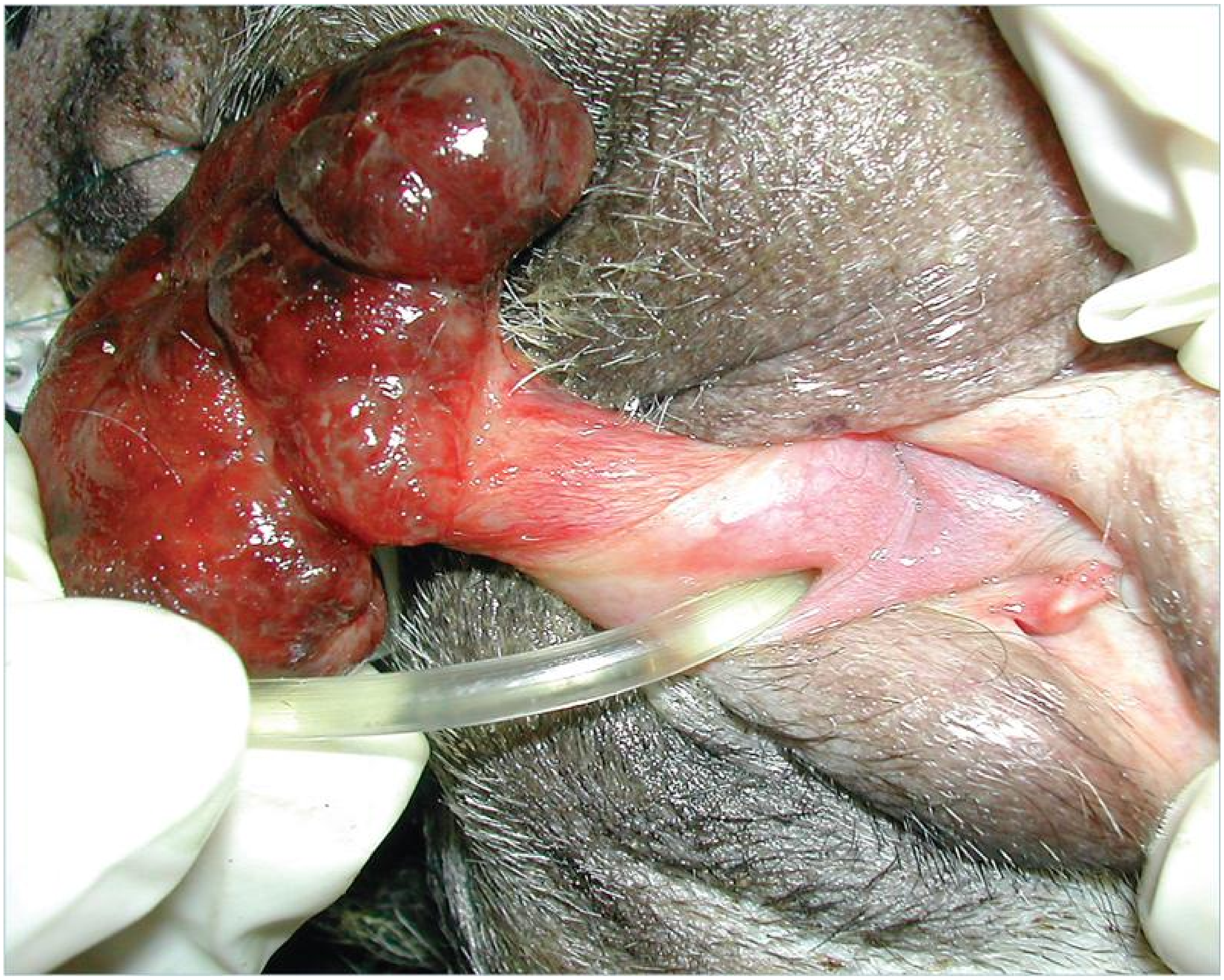

Fig. 2. Closer examination revealed that the tumor originated more caudally than is usual in these cases. Catheterization of the urethra revealed that the urinary orifice was included in the base of the long pedicle. Resection of the tumor was decided. Due to the accessibility of the tumor, it was not necessary to perform an episiotomy.

Fig. 3. During surgical procedures on the vagina, it is essential to keep the urethra catheterized at all times to confirm its location and avoid inadvertent damage. In this case, catheterization was particularly important in view of the inclusion of the orifice in the tumor pedicle. Before resecting the mass, a transfixating ligature is placed around the base of the pedicle using absorbable 2/0 monofilament material.

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Vaginal neoplasia

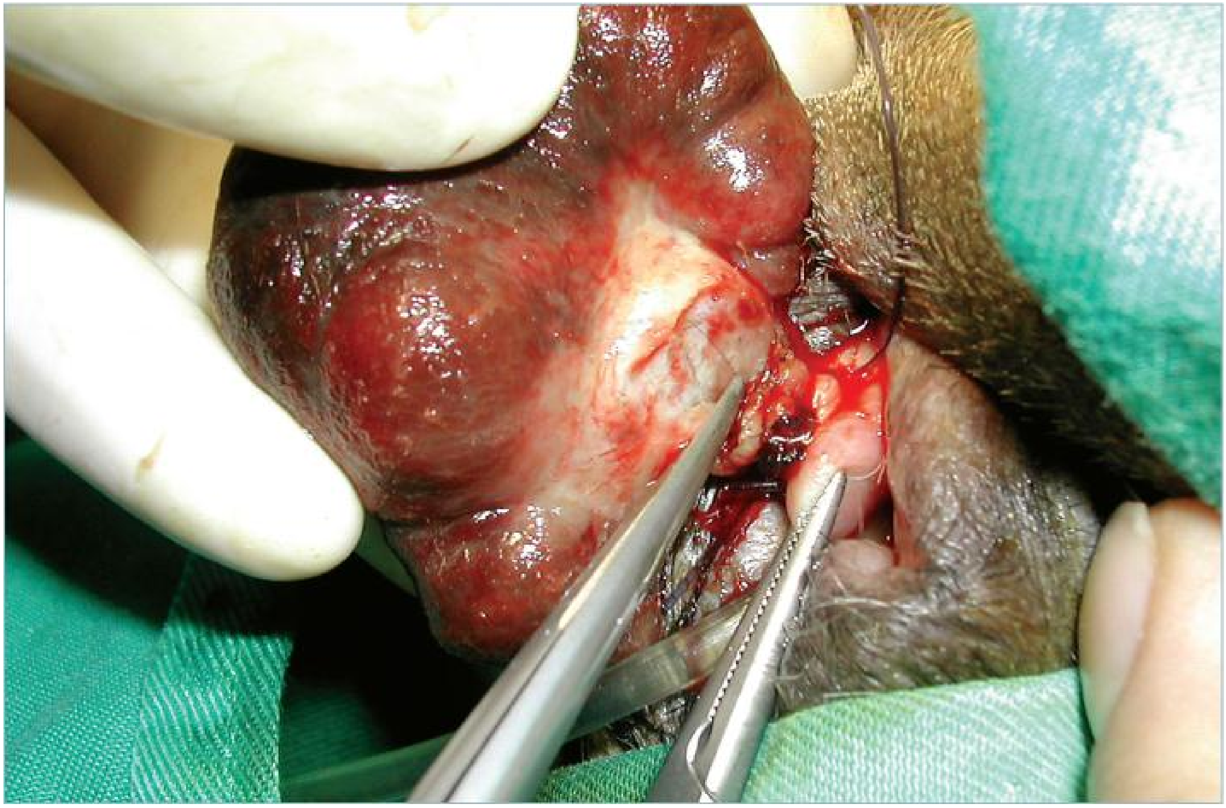

Fig. 4. The pedicle is cut distal to the ligature and the tissue is held with forceps to keep it in view. A second ligature is placed proximal to the first to ensure hemostasis.

For any vaginal procedure, it is essential to keep the urethra catheterized throughout surgery.

Fig. 5. Final appearance of the operative site.

Rectal prolapse. Colopexy

Prevalence	■	■			
Technical difficulty	■	■			

Rectal prolapse occurs in young animals with a parasite burden or diarhea (Fig. 1), and in adult animals with intestinal tenesmus (associated with polyps, Fig. 2). It can also be a post-operative complication of perineal herniorrhaphy (Fig. 3).

In a case of rectal prolapse in a puppy, think of intestinal parasites. In adult animals, consider differential diagnoses for

intestinal tenesmus.

Fig. 1. Prolapse of the rectal mucosa in a cat with diarrhea secondary to intestinal parasites.

Fig. 2. Rectal prolapse in an adult dog that had difficulty defecating for 4 days. A rectal tumor was diagnosed.

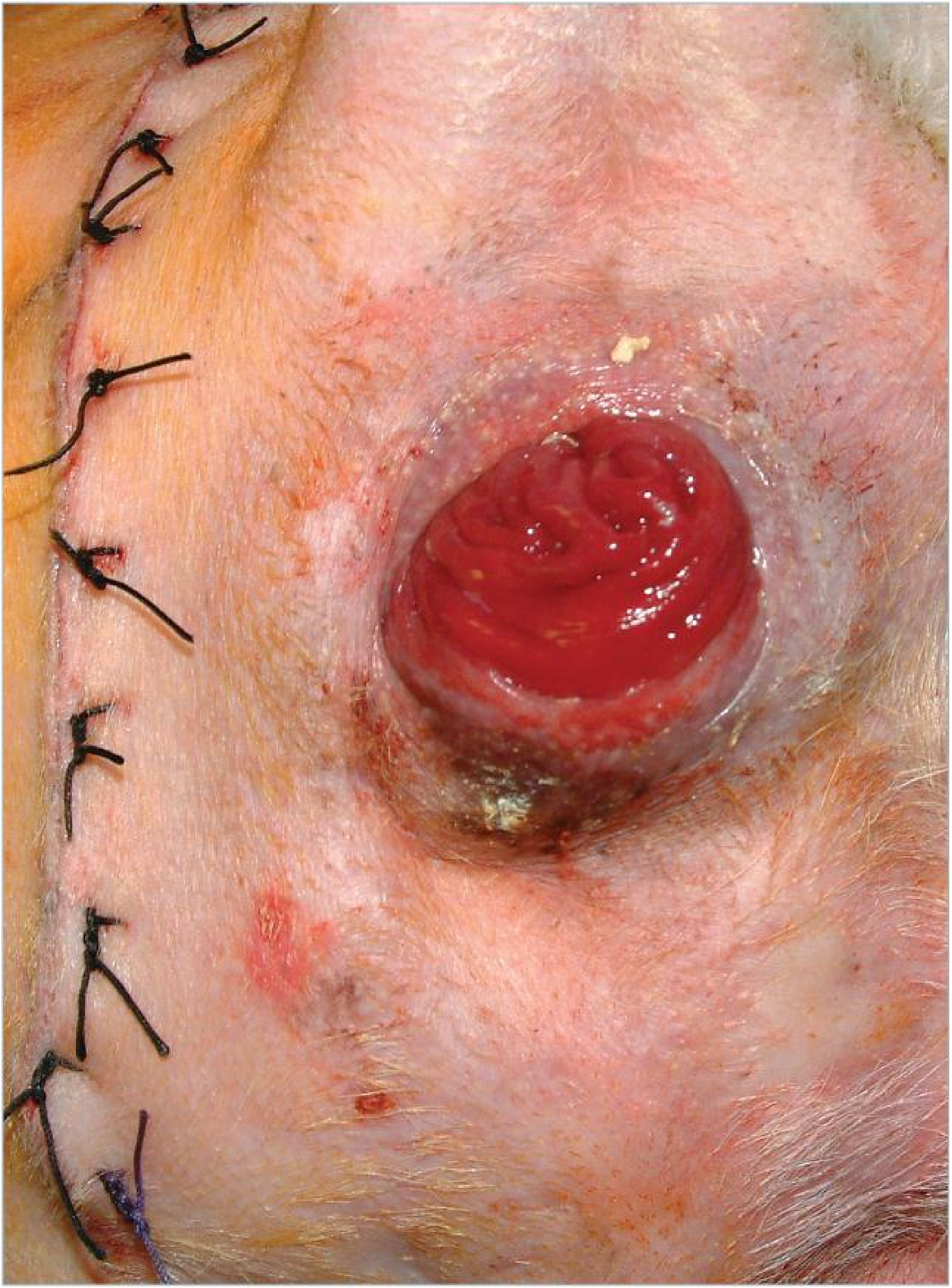

Fig. 3. After carrying out a perineal herniorrhaphy, a rectal prolapse can occur, particularly if the rectum is deviated.

Rectal prolapse can affect the mucosa only (Fig. 1) or the entire rectal wall (Fig. 4).

It is important to differentiate a “true” rectal prolapse from a prolapsed intestinal intussusception. To do so, insert a thermometer between the anus and the prolapsed mass; if the thermometer can be introduced easily, it is an intussusception (Fig. 5a), if it cannot, it is blocked by the mucosa of the prolapsed rectum (Fig. 5b).

Fig. 4. Complete rectal prolapse in a cat that suffered from intense tenesmus. This is a good candidate for manual reduction.

The everted tissue becomes inflamed due to vascular damage. Later, the tissue will become dessicated, and hemorrhagic and necrotic areas will appear (Figs. 6 and 7).

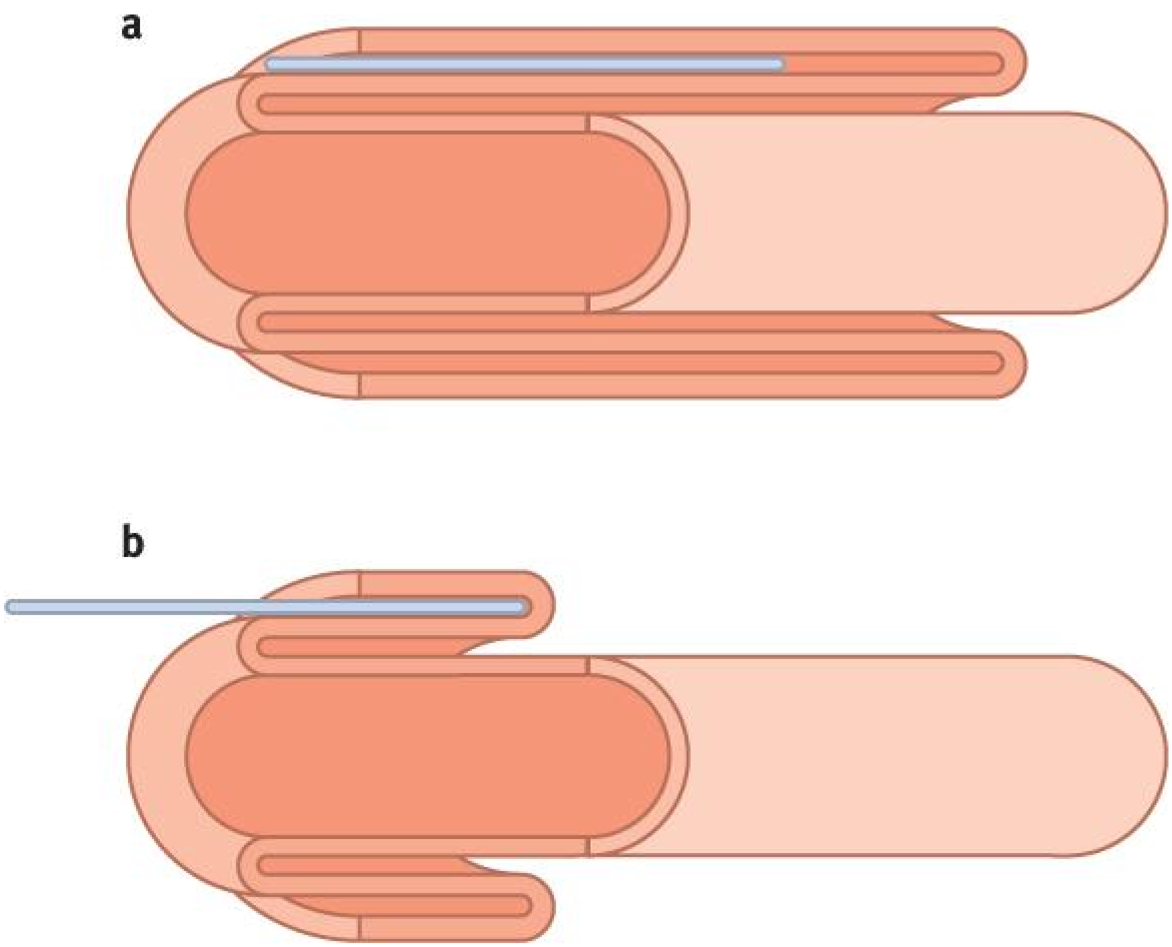

Fig. 5. a. Prolapse of an intestinal intussusception. b. Prolapsed rectum.

Fig. 6. Recurrent rectal prolapse in a German Shepherd puppy. The prolapsed tissue becomes congested and inflamed. In time, this problem becomes worse, making manual reduction more difficult.

Possible causes of a rectal prolapse		
Intestinal irritation	Tenesmus	Surgery
Parasites Enteritis/colitis Foreign bodies	Prostatic disease Rectal neoplasia Constipation Dystocia Urolithiasis	Perineal hernia Perianal surgery

Fig. 7. The rectal prolapse in this case has undergone necrosis in the lower part, and has become infested with fly eggs and larvae. In this patient, surgical resection is indicated.

Treatment

> ***Try to locate the origin of the problem and treat it.***

Manual reduction

Indicated when the prolapse is small or when the mucosa does not present any major lesions (Figs. 1-4).

- Apply gauze soaked in a hypertonic solution or sugar, for 30 minutes to reduce the rectal edema to a minimum.
- Manually compress the prolapsed mass towards the anus with moderate and continuous pressure.
- Place a purse string suture around the anus to avoid recurrence. In order to prevent complete closure of the anus, the suture should be tied after insertion of an object (approximate diameter 9 mm) in the anus.
- Prescribe laxatives (lactulose, approximately 0.3 ml/kg to effect) in order to facilitate fecal elimination.

Surgical treatment

- Amputation.

In cases of a severely traumatized prolapse or one that cannot be reduced.

- Colopexy.

In cases of repeated recurrence after manual reduction or amputation.

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Rectal prolapse: amputation

José Rodríguez, Jaime Graus

Laparotomy

Prevalence

Laparotomy, or celiotomy, is the surgical approach to the abdominal cavity in order to inspect, access and operate on the abdominal organs, either with a diagnostic or a therapeutic aim.

The laparotomy incision may be longer or shorter depending on the organ to be accessed, but the surgical technique is always the same, independent of the operation site, the species or the gender (except for a small variation in males on account of the presence of the penis).

Midline laparotomy is the preferred approach to the abdomen and is most commonly used in dogs and cats. It is a simple technique that provides good access to all abdominal organs.

A correct laparotomy procedure, including careful dissection of the area and perfect closure, is necessary to ensure the success of a surgical intervention. Any mistake may lead to disaster after a long and complicated operation.

Fig. 1. When clipping, care should be taken not to nick or burn the skin. All non-surgical lesions that might complicate the postoperative recovery of the patient should be avoided.

Patient preparation

It is important to take the necessary time to prepare the patient for surgery. First, the ventral area of the patient is clipped from 3-4 cm cranial to the xiphoid process to the perineal area, including the inside of the thighs and taking special care with the preputial area in male dogs. Care should be taken not to damage the skin during clipping; the blades of the clippers should be sharp to avoid clipper burns (Figs. 1 and 2).

> ***If possible, it is recommended that the patient's bladder is emptied before surgery, because a full bladder complicates abdominal surgery and is at increased risk of damage.***

Fig. 2. The entire ventral abdominal area should be clipped, especially in long-haired patients, to avoid secondary contamination during surgery.

If the animal has not urinated before surgery, it should be catheterized to empty the bladder. In male patients, the urethra is catheterized and the prepuce is covered by sterile drapes (Fig. 3).

The loose hair is vacuumed and the operating field is scrubbed two or three times with an antiseptic detergent to remove all dirt and reduce the microbial flora of the skin to a minimum.
The patient is placed in dorsal recumbency on the operating table, preferably on a warm cushioned surface to minimize hypothermia and injuries to the muscles or skin.

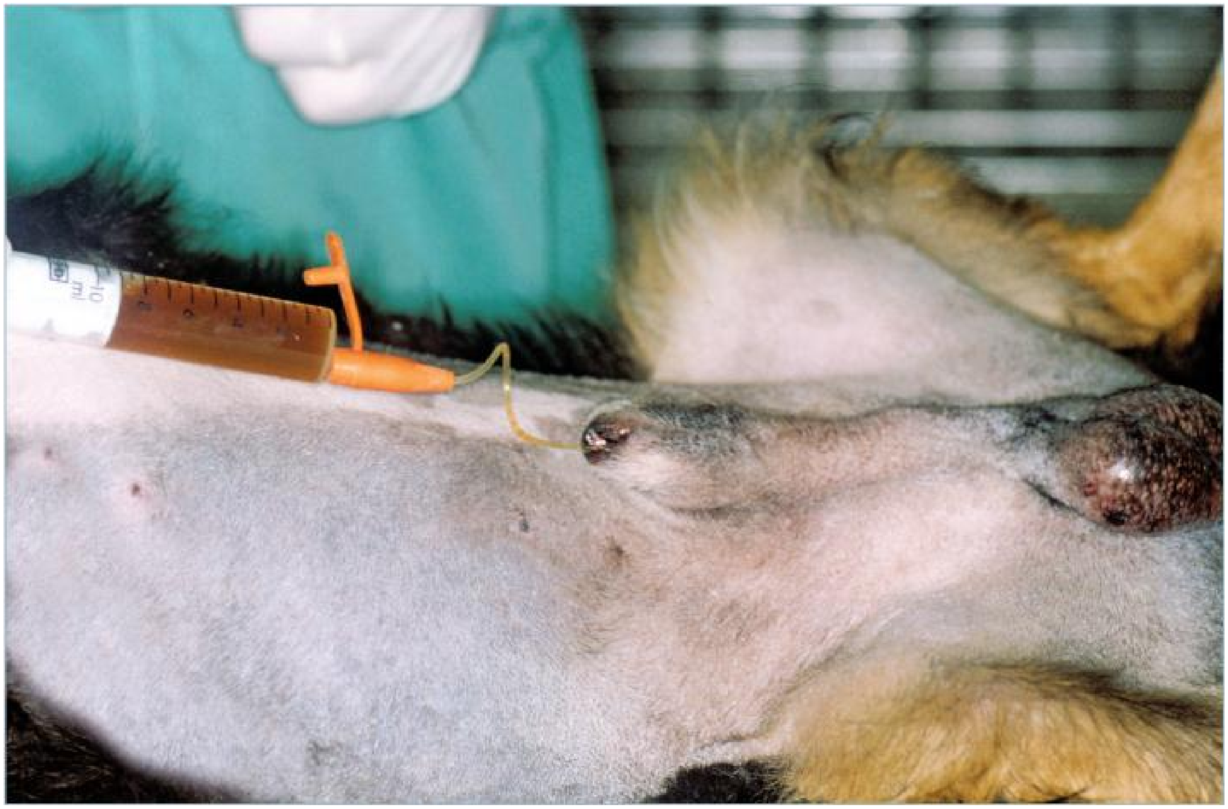

Fig. 3. Bladder catheterization is important to avoid an iatrogenic injury and also because its size may hamper the visualization and dissection of the other abdominal organs.

Next, an antiseptic solution (non-lathering) is applied to the operating field. A first strip is painted along the midline in a cranio-caudal direction, followed by parallel stripes from the center towards the edges (Fig. 4). This procedure is repeated two or three times.

Fig. 4. Aseptic preparation of the operating field starts in the midline with an iodine solution (1). Next, the antiseptic is applied in parallel stripes that start in the central area and are painted in alternate turns towards the edges.

Finally, the surgical drapes are placed according to the abdominal area that is to be incised (Fig. 5).

Fig. 5. In this case, a generous operating field has been prepared, because the laparotomy will start at the xiphoid process and end at the pubic symphysis.

Surgical technique

Technical difficulty ■■□□□

Good visualization of the operating field makes surgery easier, so a generous approach is recommended, but it should be remembered that an over-long incision may increase the risk of complications.

> ***An excessively long incision increases the loss of body fluids by evaporation and the risks of hypothermia and infection.***

Once the patient has been prepared and placed in dorsal recumbency, the limits of the laparotomy are identified, depending on the surgery that has been planned (Fig. 6).

The skin is incised with a scalpel. The blade should be perpendicular to the skin to obtain a straight (not oblique) incision. The pressure on the blade should be sufficient to reach the subcutaneous tissue but without cutting into the muscular layer (Fig. 7). In dogs, there is usually more fat and the skin is thicker, so it is more difficult to reach the muscle. In cats, and in pregnant females, in which the muscular wall has lost tension, more care should be taken with this first incision.

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Midline laparotomy

Fig. 6. The beginning and end of the line on the skin that will be incised with the scalpel are identified.

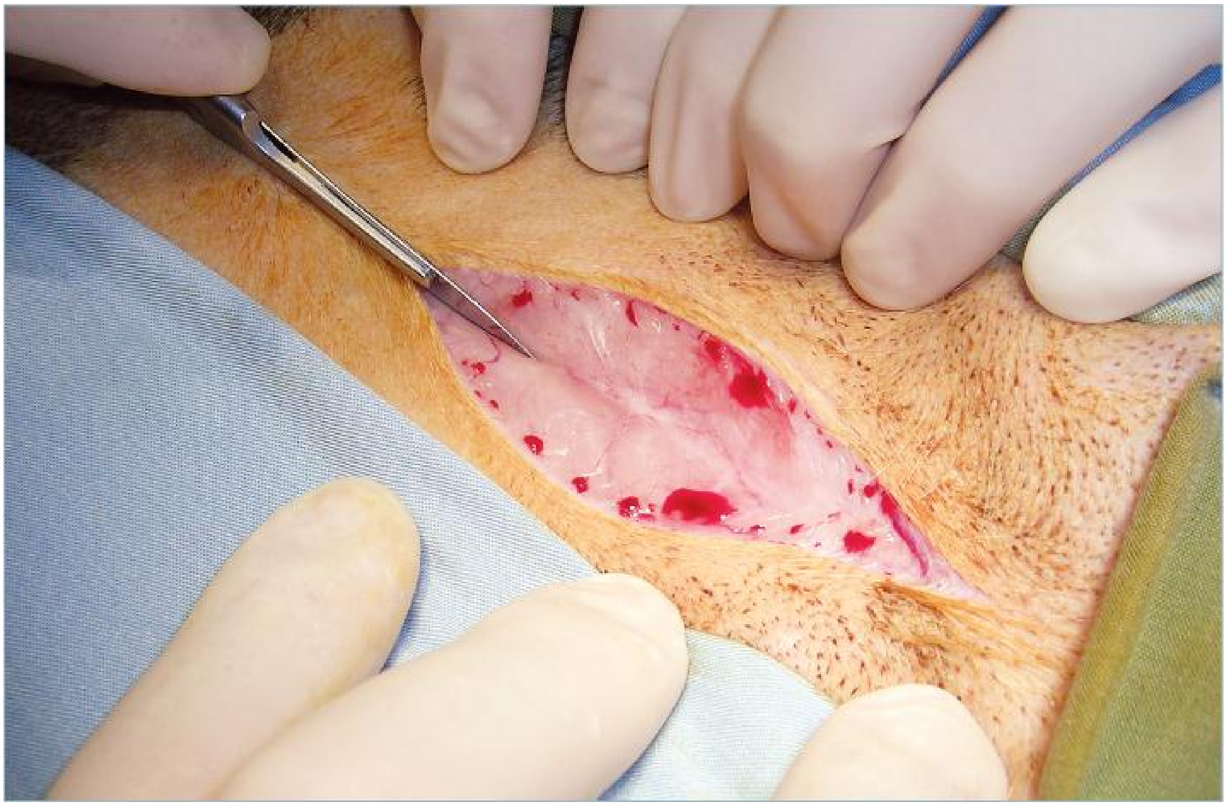

Fig. 7. The skin is cut until reaching the subcutaneous tissue. Keeping the area of the incision under tension, a firm straight incision can be made in one single movement.

In the preputial area of the male, the direction of the incision is deviated slightly, making a small curve to extend the skin incision parallel to the penis (Fig. 8). In principle, it does not matter if this deviation is made to the left or the right.

The vessels of the skin and subcutaneous tissue tend to bleed and hemostasis should be achieved by cauterization or hemostatic forceps. In males, the preputial vessels are encountered; these are branches of the caudal superficial epigastric artery that runs parallel to the penis and superficially in the subcutaneous tissues (Fig. 8). These vessels, depending on their size, should be cauterized or even ligated to prevent hemorrhage (Fig. 9). The subcutaneous tissue is dissected; its thickness will depend on the amount of subcutaneous fat.

Next, the linea alba is identified. This is a fibrous yellowish-white band where the abdominal muscles join in the ventral midline and through which the abdomen is entered. Dissection continues until the complete length of the linea alba that will be incised is clearly visible. The length depends on the operation that has been planned (Fig.10).

To open the abdominal cavity, a micro-laparotomy is performed at some point on the linea alba. Care should be taken not to damage any of the abdominal organs; the muscular wall on both sides of the chosen spot is tented with rat-toothed dissecting forceps to separate it from the abdominal contents and the linea alba is incised with a scalpel (Fig. 11).

Following this, a finger is introduced into the hole to check that there are no adhesions between the viscera and the wall, which is more likely when there have been previous surgical interventions (Fig. 12).

The linea alba may then be opened with scissors along the desired length. Again, care should be taken to avoid damage, so the fingers are placed under the abdominal wall to tense it and give extra protection to the internal abdominal structures (Fig. 13).

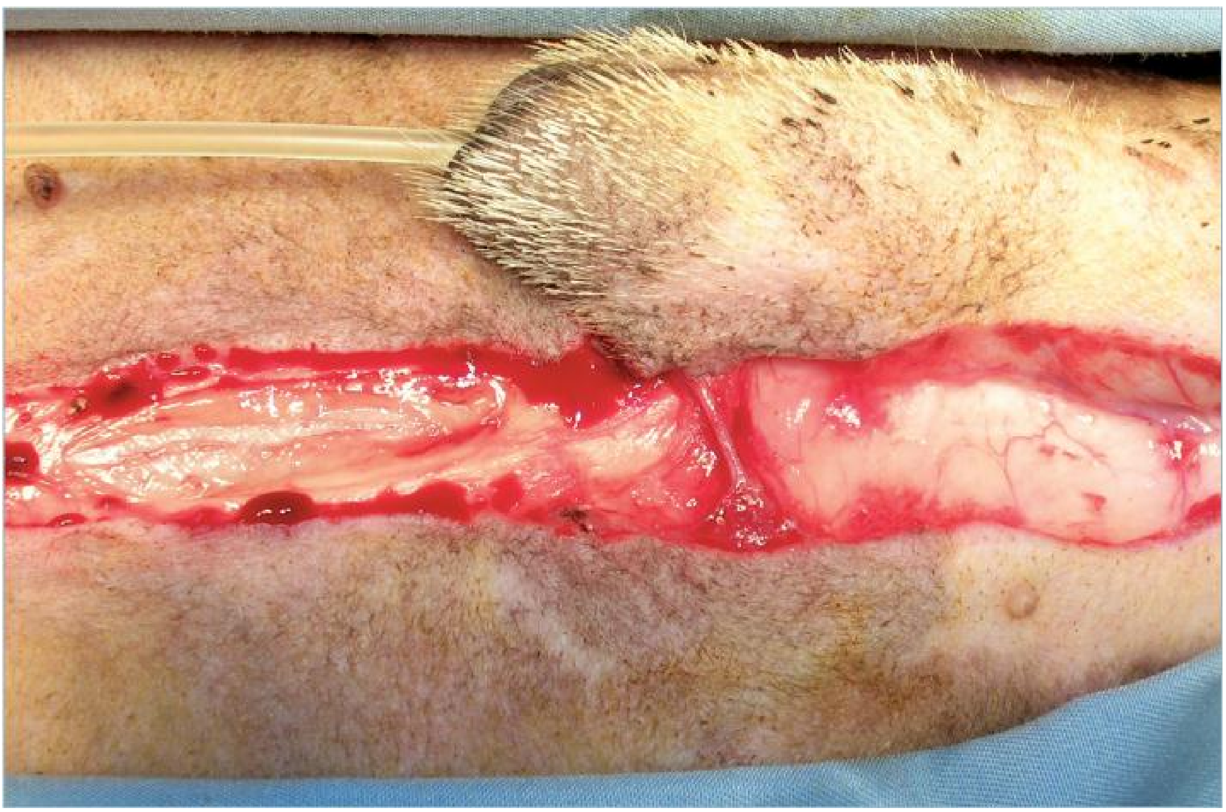

Fig. 8. In males, the penis may be drawn laterally, continuing a straight incision. This picture also clearly shows a vessel that runs towards the prepuce.

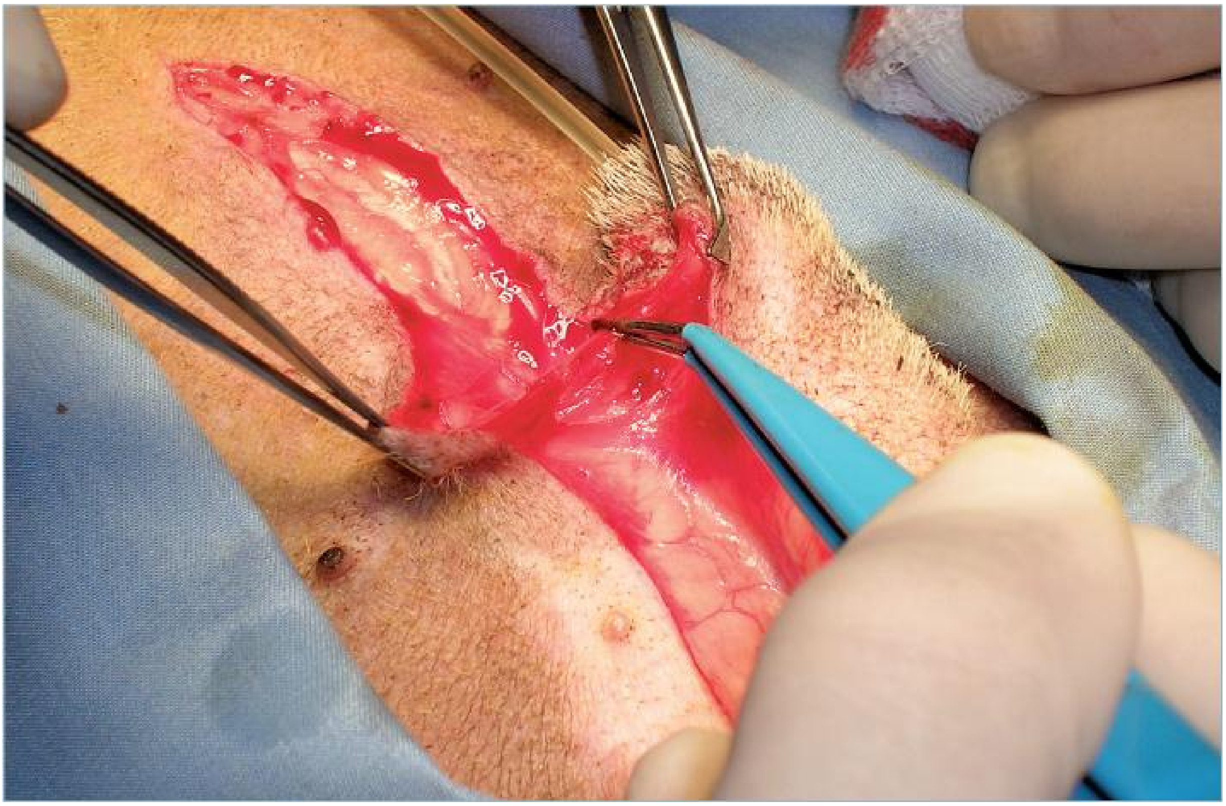

Fig. 9. Cauterization of the preputial vessels with a bipolar electric coagulator.

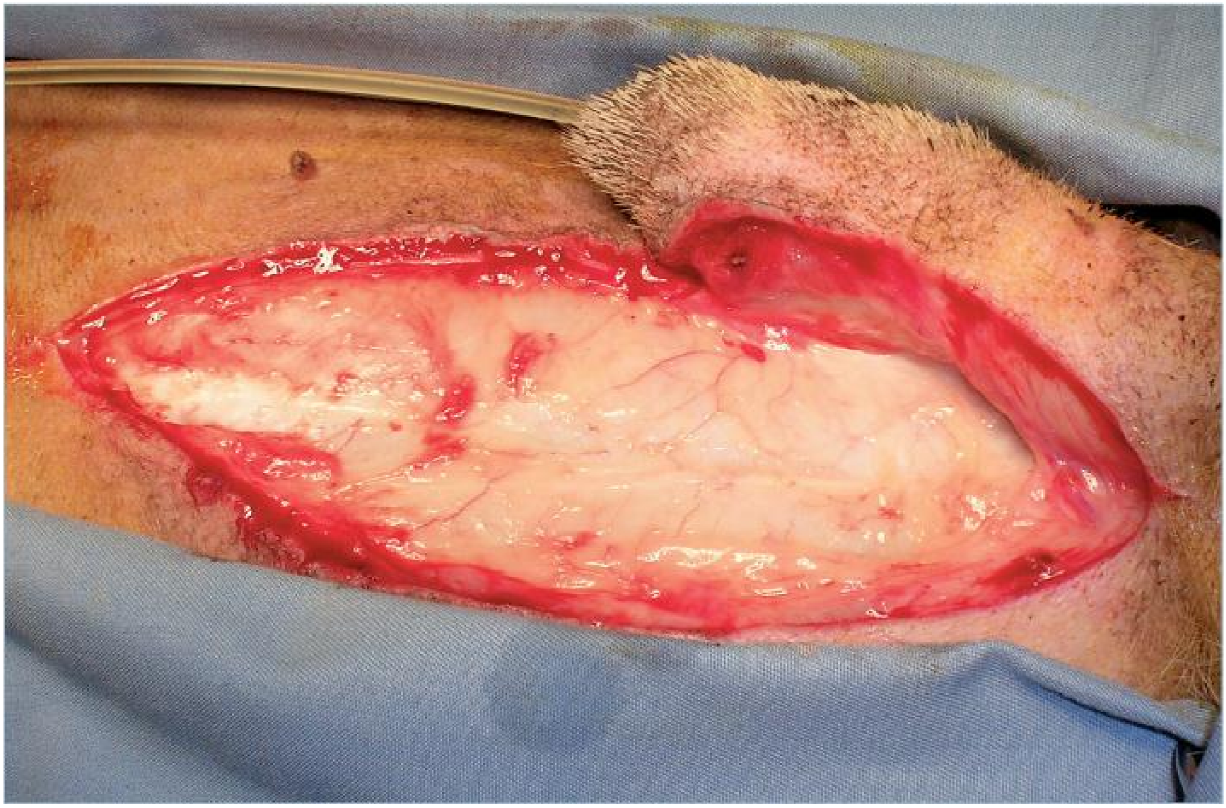

Fig. 10. After dissection of the subcutaneous adipose tissue, the linea alba is exposed. It is characterized by a more intense white color and by its position along the midline of the whole abdomen.

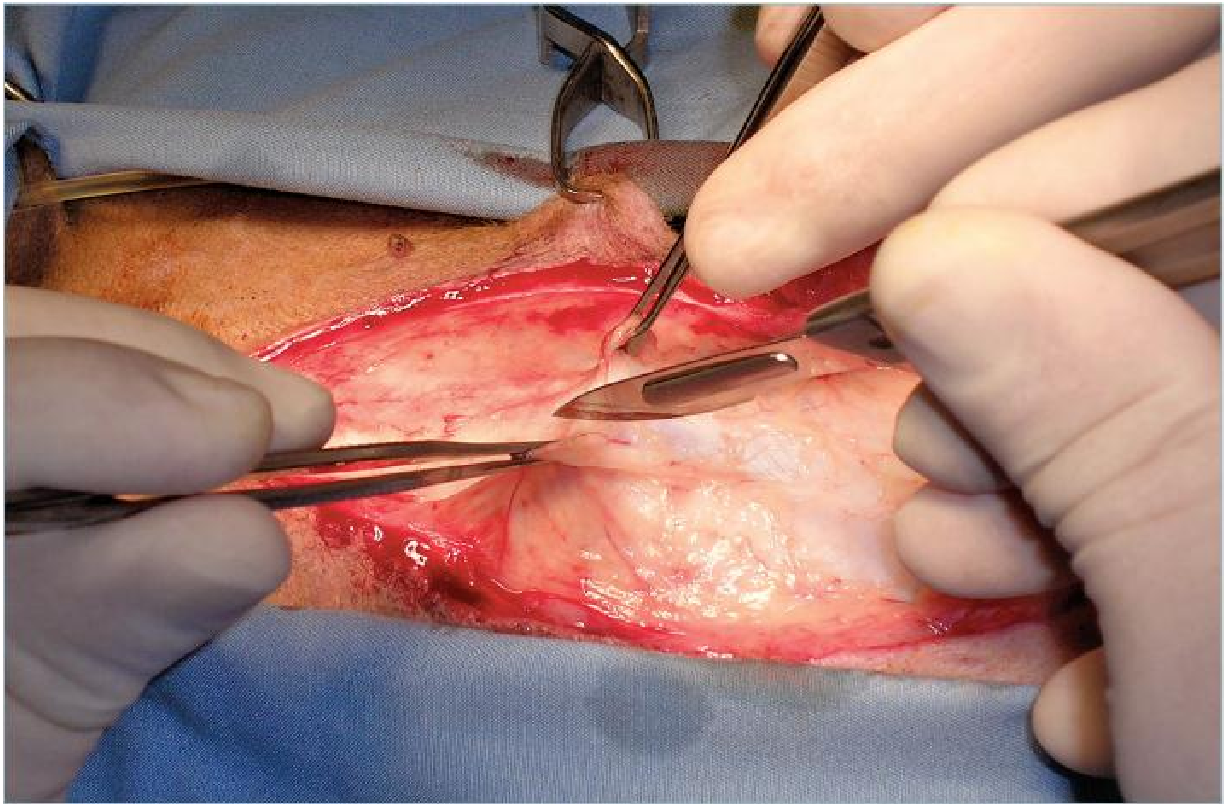

Fig. 11. With two Adson forceps, the aponeuroses on both sides of the linea alba are lifted to create space between the wall and the contents of the abdomen; next, the incision is made with a scalpel.

Fig. 12. An incision of about 3 cm is made and a finger is introduced into the abdomen to check that there are no adhesions between the viscera and the abdominal wall, which would increase the risk of damaging the viscera.

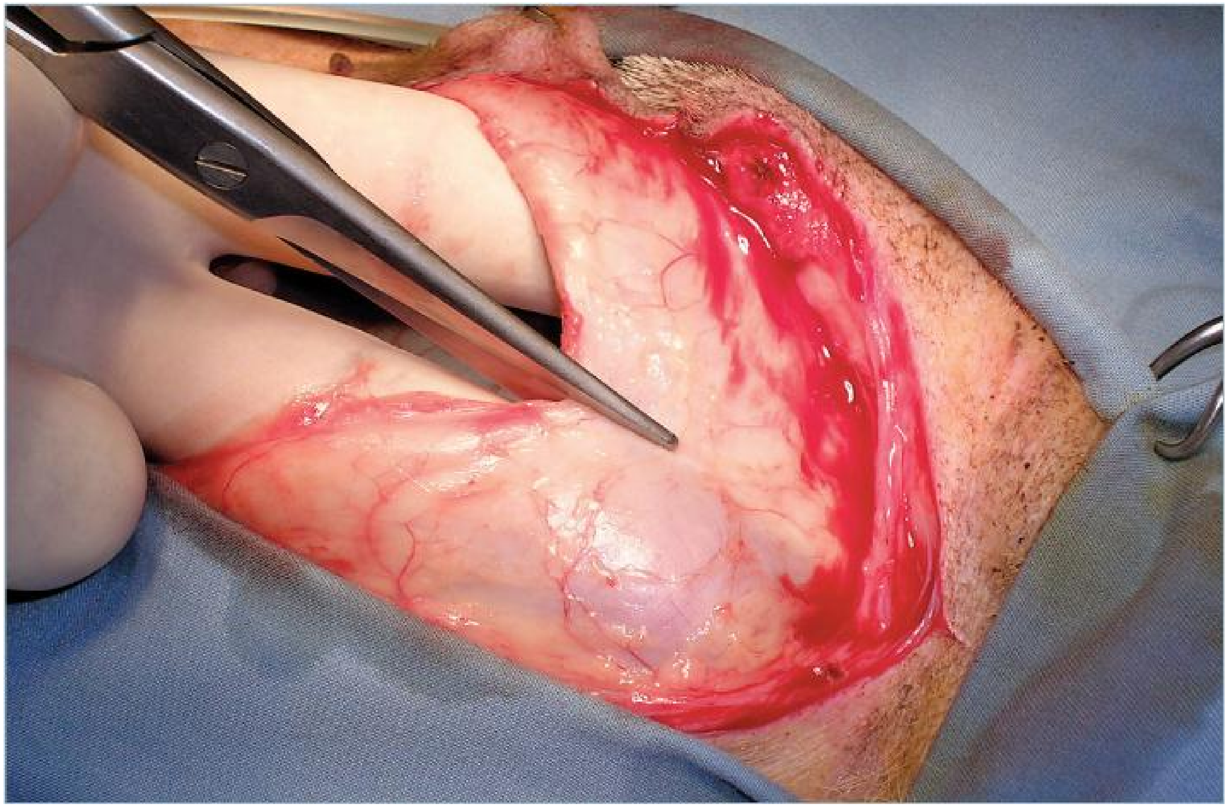

Fig. 13. The linea alba is cut with scissors. The fingers are placed between the contents and the abdominal wall to prevent damage to the internal organs.

Special care should be taken when the linea alba is incised entering the abdomen. Avoid damage to internal organs, especially those that may have experienced a physiological or pathological increase in size or a displacement from their normal anatomical position.

Ensure satisfactory hemostasis of the abdominal vessels that may have been cut during laparotomy. If this bleeding is not controlled, it may generate doubts as to the origin of any hemorrhage during surgery.
After performing the planned surgery, flushing the abdominal cavity with lukewarm sterile saline is recommended. The aim is to reduce the infection risk during the postoperative period, particularly if there may have been contact with microorganisms from the hollow organs, as in, for instance, enterotomy or pyometra (Fig. 14).

Try to keep the operating time to a minimum: the patient will recover faster and suffer fewer complications.

Following this, the laparotomy wound is closed. The choice of the suture material depends on the preference of the surgeon. Generally, synthetic absorbable mono- or multifilament material (polyglyconate or polyglycolic acid) gives good results; the size is adapted to the size of the patient. A successful closure depends more on a correct suture technique and good postoperative care than on the type of material.

The first suture is continuous; both the first and the last knot are very important, as the integrity of the suture depends on them. It is recommended that these knots are placed in tissue that has not been incised, that is: cranially and caudally to the incision (Fig. 15). It is not necessary to pull them very tight; use 4 or 5 throws on each knot and tighten them progressively.

In this suture, only the aponeuroses of the rectus abdominis muscles on both sides of the incision need to be included, starting with the caudal area of the abdomen in order to maintain good visibility of the abdominal organs as the suturing progresses (Fig. 16).

It is not necessary to take in the entire thickness of the muscle, as this will not increase the resistance of the suture, or include the parietal peritoneum, as this will increase the inflammatory reaction and the risk of adhesions.

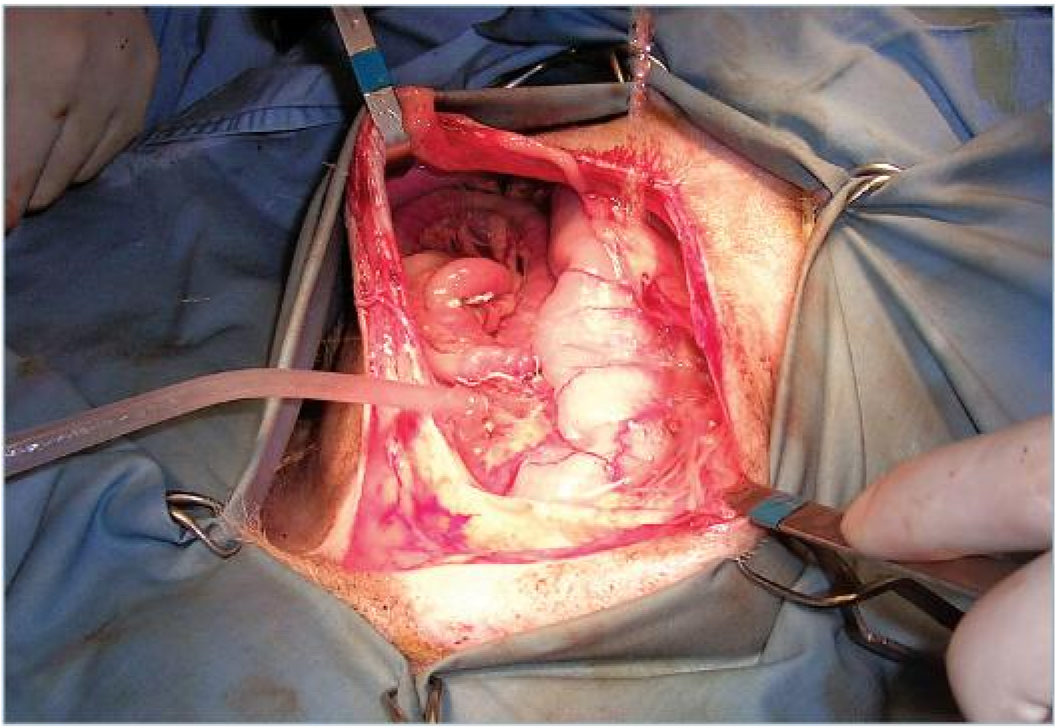

Fig. 14. After all surgical interventions, flushing of the peritoneal cavity with lukewarm saline is advised to help avoid postoperative infection.

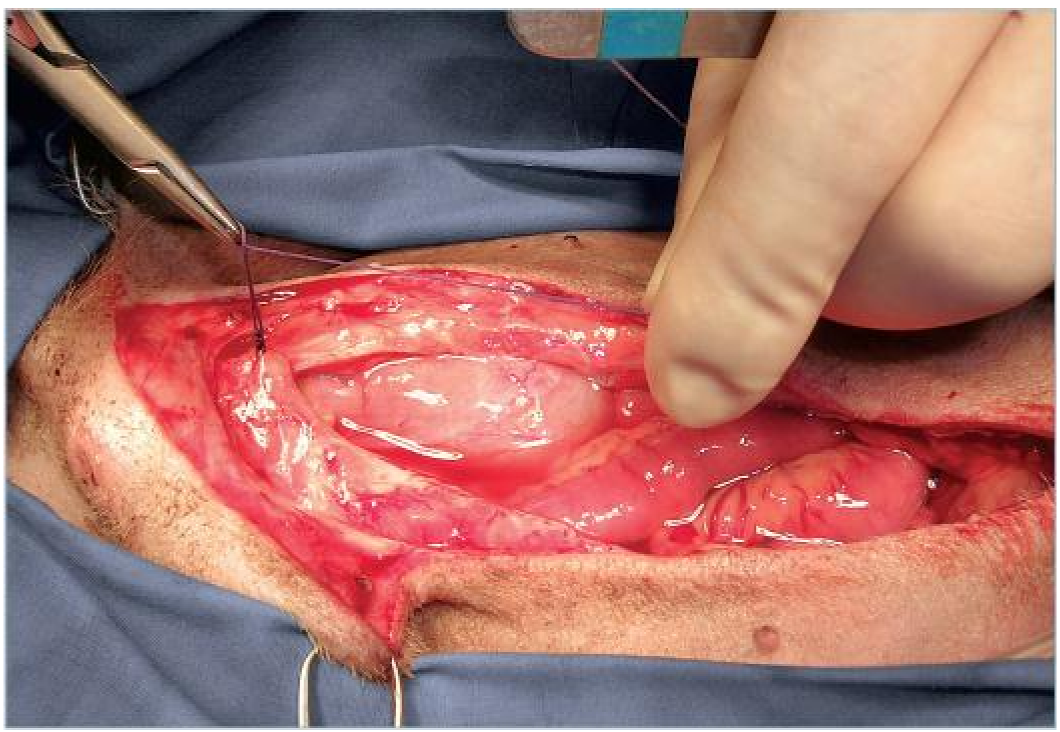

Fig. 15. The suture starts from the caudal end to maintain visibility of the abdomen during closure. The first knot is placed in undisturbed tissue for

more security.

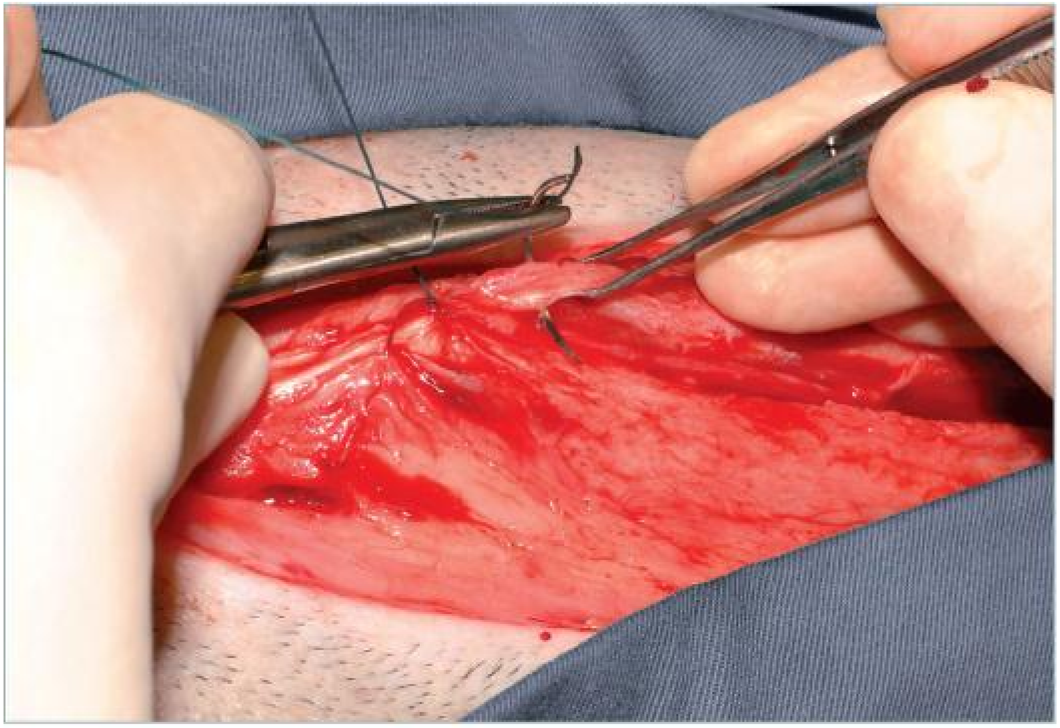

Fig. 16. Progressing in a cranial direction, a 0.5-1 cm wide strip of the fascia of the rectus abdominis muscle is included in approximately equidistant sutures.

Fig. 17. Final view of the first suture. Remember that it is essential not to include fat in the sutures.

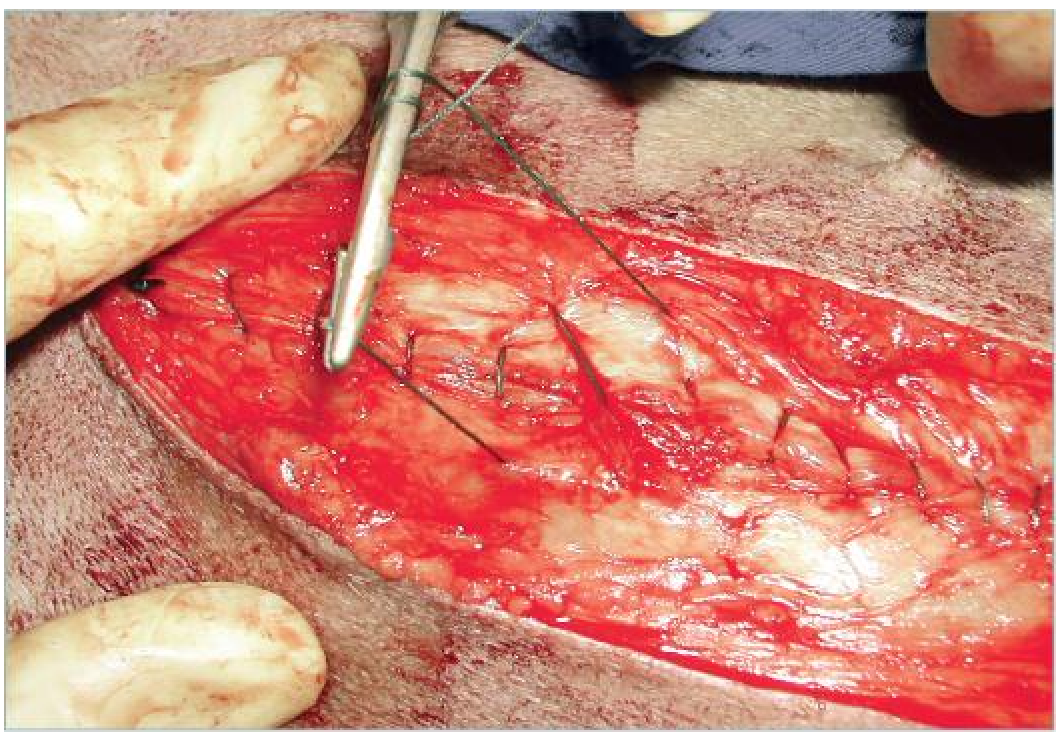

Fig. 18. Some cruciate sutures help to reinforce the continuous suture with which the abdominal cavity has been closed.

Avoid the inclusion of fat from the falciform ligament or the subcutaneous tissues in the knots or the sutures, as this may affect wound healing and cause eventration (Fig. 17).

The correct fixation of the suture material in the abdominal aponeuroses, without fat inclusion in any suture, and secure knots at the beginning and end of the suture line, are fundamental for the correct closure of any laparotomy.

To make the closure even more secure, a few cruciate sutures may be placed over the first suture, using the same material. The only precaution is to avoid cutting the continuous suture by keeping the needle away from it (Fig. 18).
As for suturing the subcutaneous tissue, opinions are divided and each surgeon should decide whether to suture or not. In male patients, some sutures should be placed to return the penis and prepuce to their normal anatomical position.

Finally, the skin is closed. There is no tension on this area, so any suture type will do. Non-absorbable monofilament material is recommended. Simple interrupted sutures, horizontal or vertical mattress sutures or an intradermal suture can all be used (Fig. 19).

Monofilament material reduces the risk of skin infection, because it does not possess the capillarity of the multifilament materials.

Finally, it should be remembered that the success of an operation does not only depend on the correct technique, but also on rigorous postoperative care, which in turn depends, to a large degree, on the owners and the care they are prepared to give. Stress the importance of postoperative care and their role in it.

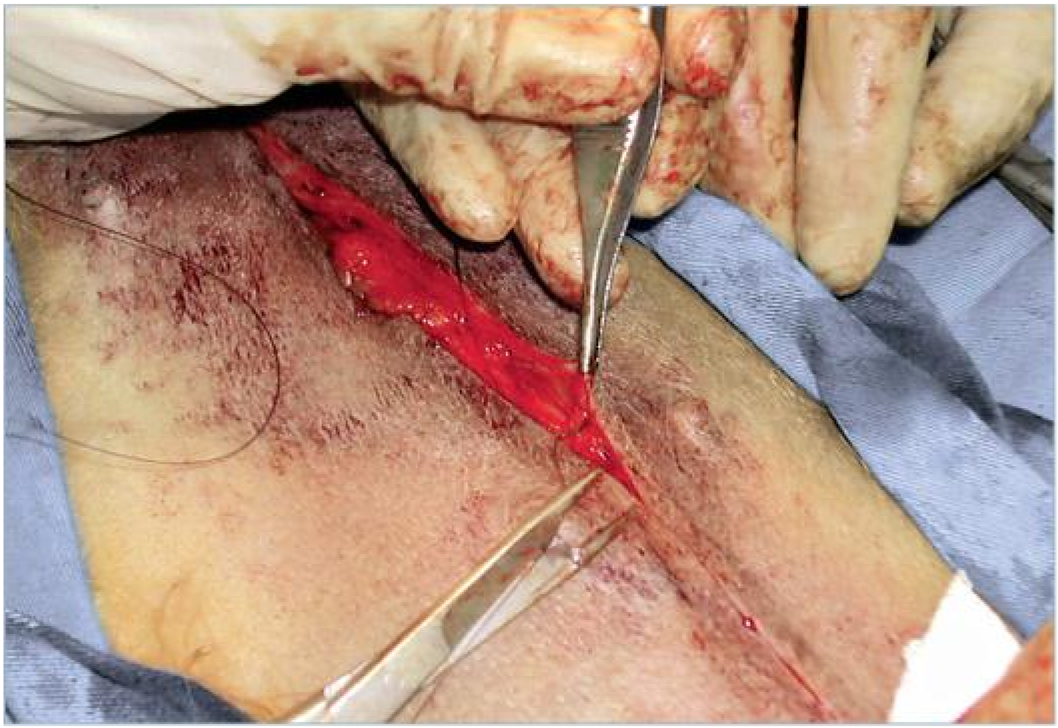

Fig. 19. The skin is closed according to the surgeon's preference. An intradermal suture is a good option, especially in patients that are difficult to handle.

Liver biopsy

José Rodríguez

The biopsy may be closed, either using ultrasound guidance or direct laparoscopic visualization, or open, by means of exploratory laparotomy or during abdominal surgery.

Before taking a biopsy, and in particular if closed, a blood clotting test should be performed; if this is not possible, it is advisable to check at least the buccal mucosa bleeding time.

Liver failure compromises the synthesis of clotting factors.

Percutaneous liver biopsy

Prevalence	■				
Technical difficulty	■				

Percutaneous biopsy may be carried out under sedation; general anesthesia is not necessary.

It is less invasive than the surgical biopsy, but is contraindicated in disorders such as:

- Abscesses.
- Cysts.
- Vascular tumors.
- Extensive abdominal adhesions.
- Septic peritonitis.
- Obstructive jaundice.
- Obesity.
- Severe blood clotting disorders.

A fine needle aspirate provides information on the cell type in the lesion, but not on the liver structure. As it is straightforward, this type of biopsy is useful for diffuse lesions like lymphosarcoma or fatty liver syndrome.
To obtain representative liver samples, Tru-Cut needles (Fig. 1) or automatic biopsy devices should be used.

Technique

- Guided by ultrasound, the liver area where the sample will be taken is located.
- The needle is introduced in the parenchyma (Fig. 2Aa).
- The inner needle is pushed in to capture the biopsy (Fig. 2B).
- The outer sheath is advanced, cutting the liver parenchyma, while leaving the needle in the same position (Fig. 2C).
- Sheath and needle are withdrawn together and the biopsy is placed in formaldehyde (Fig. 2D).

Fig. 1. Liver biopsy with a Tru-Cut needle. The system may be manual (A) or automatic (B).

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Watch this video

Liver biopsy

Surgical liver biopsy

Technical difficulty	■				

Surgical biopsy yields the most useful sample, giving a full view of the liver, its lesions and their extension. It permits biopsy of the most representative area and good visualization of any hemorrhage that may result, as well as providing an opportunity to remove the whole lesion.

General and anesthetic considerations

- There may be clotting disorders as a result of the reduced synthesis of clotting factors.
- Low albumin concentration (< 20 g/L) may delay wound healing.
- The capacity to metabolize drugs may be reduced.
- Acepromazine should be avoided in patients with hepatic diseases.
- Diazepam hardly affects the cardiovascular system and raises the threshold for convulsions. Use with caution in patients with low albumin levels.
- Use propofol at the lowest possible dose-response rate.
- Avoid ketamine in patients with severe liver damage and use with moderation in mild cases.
- Maintain anesthesia with isoflurane or sevoflurane.

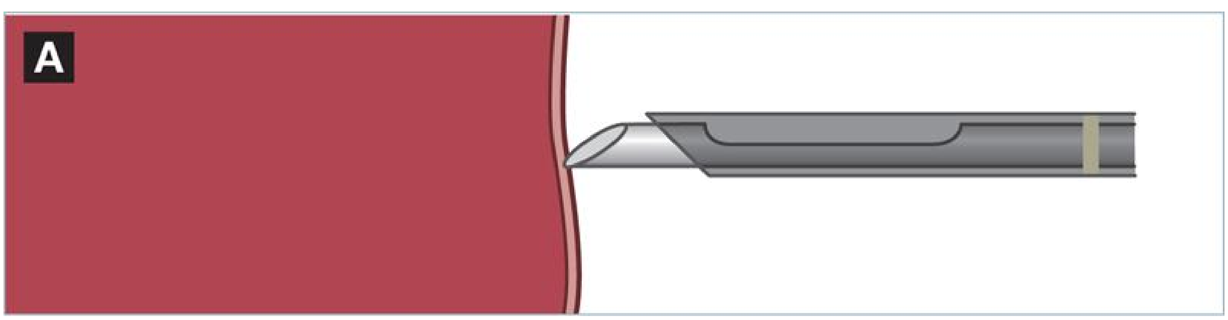

Fig. 2A. The biopsy needle is introduced in the liver parenchyma.

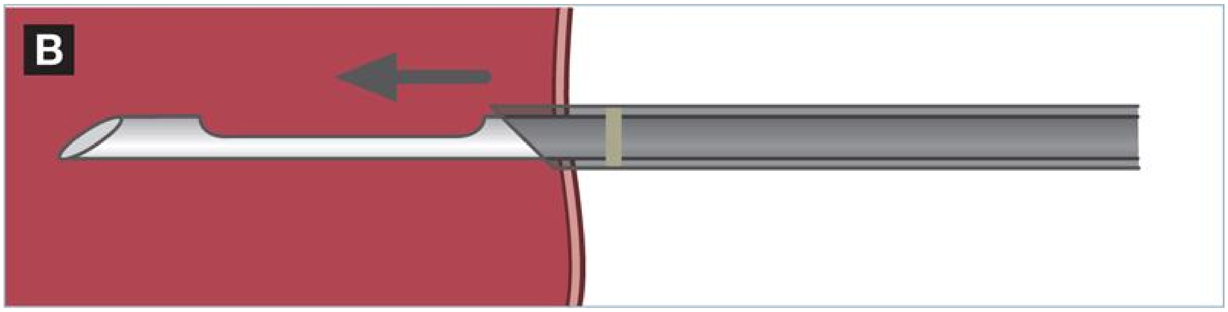

Fig. 2B. The needle is pushed into the biopsy area.

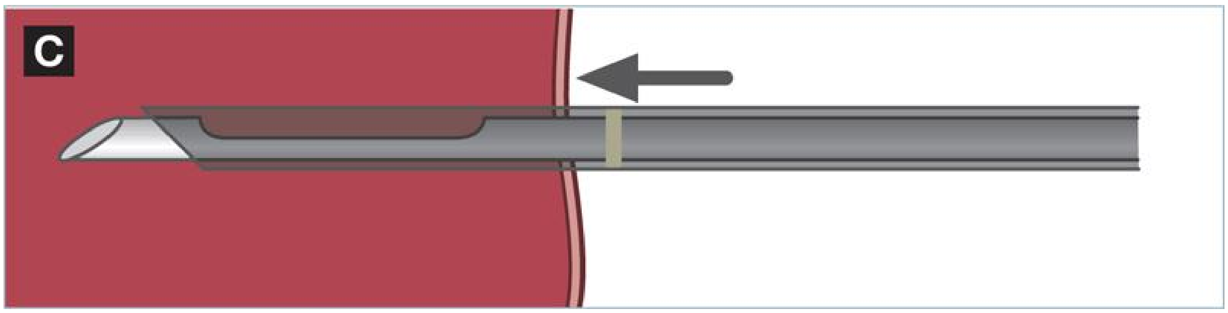

Fig. 2C. The outer sheath is advanced, cutting the tissue around the biopsy.

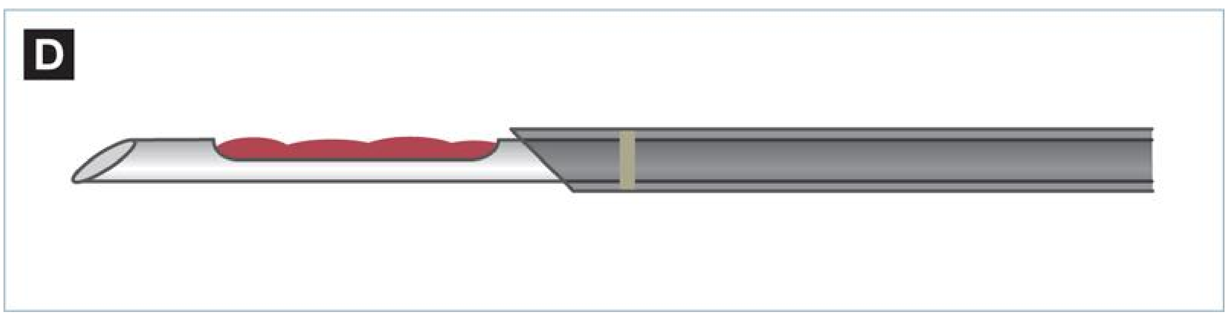

Fig. 2D. The device is withdrawn and the biopsy has been taken.

Laparoscopic biopsy

Laparoscopic biopsy permits direct observation of the liver, so that biopsies may be taken from diffuse or focal lesions, the biopsy site in the liver parenchyma can be monitored and any hemorrhage controlled (Fig. 3).

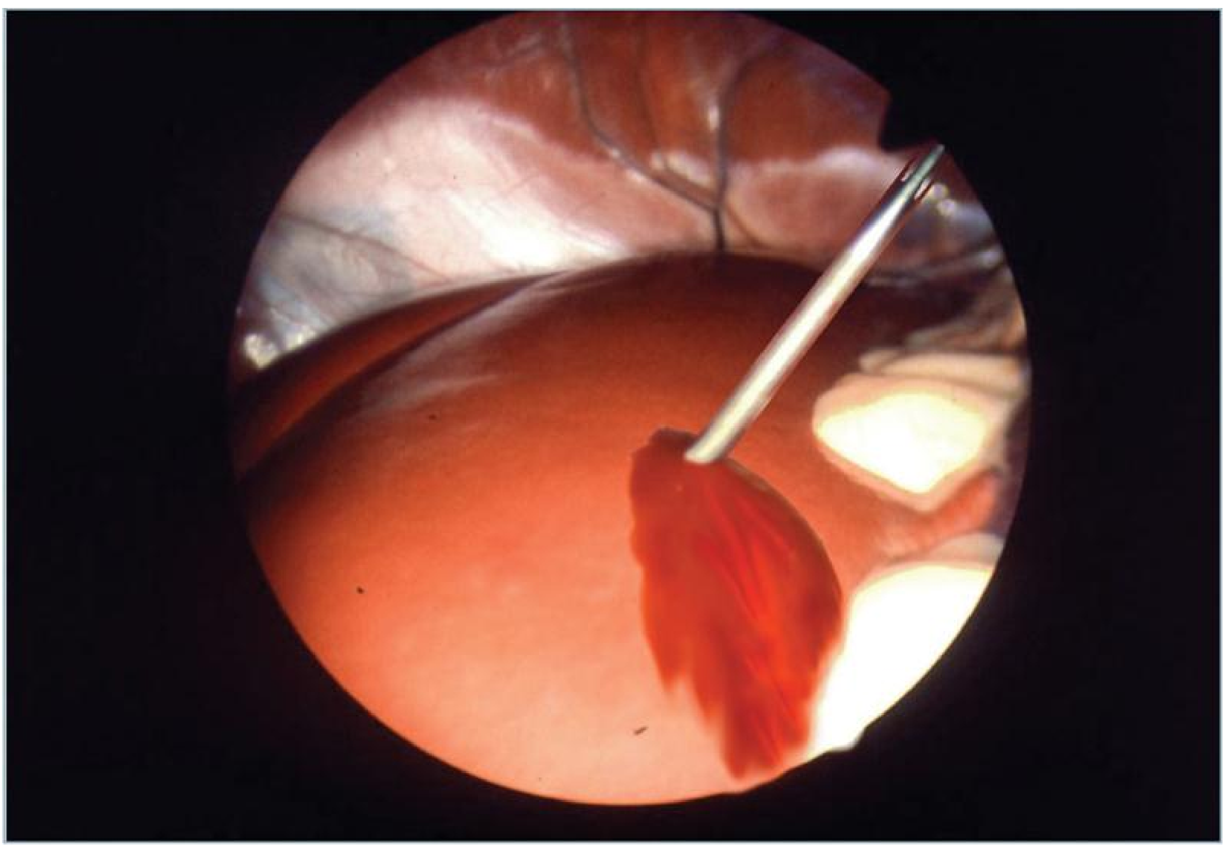

Fig. 3. Liver biopsy with a Tru-Cut needle under laparoscopy.

Biopsy by laparotomy

Histopathological analysis of a liver biopsy makes an exact diagnosis possible, for appropriate treatment and an accurate prognosis.

During exploratory laparotomy, liver samples should always be taken if liver damage is suspected even if the smallest alteration in the parenchyma is detected.

Open biopsy permits inspection and palpation of the entire liver and the biopsies may be taken from the most representative areas (Fig. 4).

With this technique, any hemorrhage following sampling can be identified and controlled.

If the lesion is generalized, the biopsy should be taken in the most accessible place, usually the peripheral areas (Figs. 5-7).

The liver lobe should be immobilized with the fingers, the most atraumatic instrument of all.

Liver tissue is very friable and tears easily; for this reason, the sutures should be placed with great care.

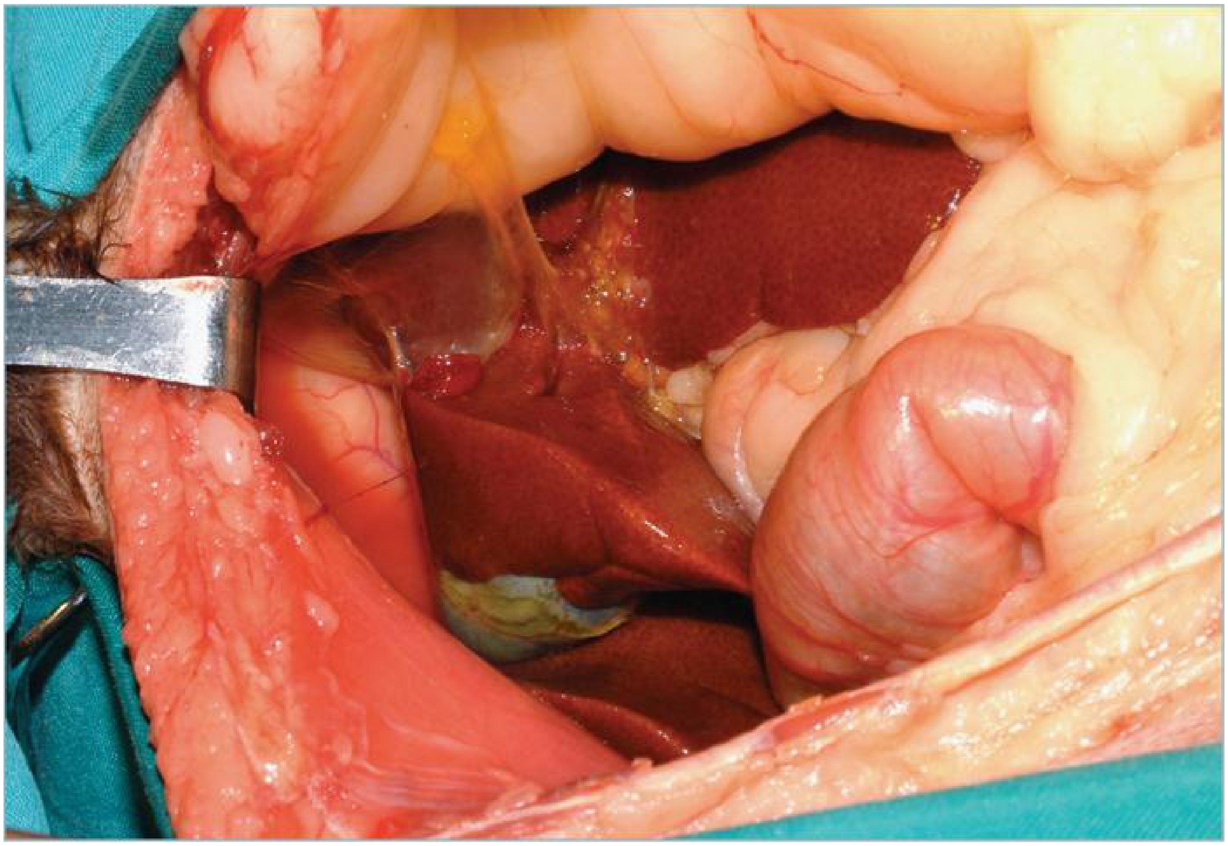

Fig. 4. Laparotomy in a patient that had marked icterus. The appearance of the liver could be checked and relevant biopsies obtained.

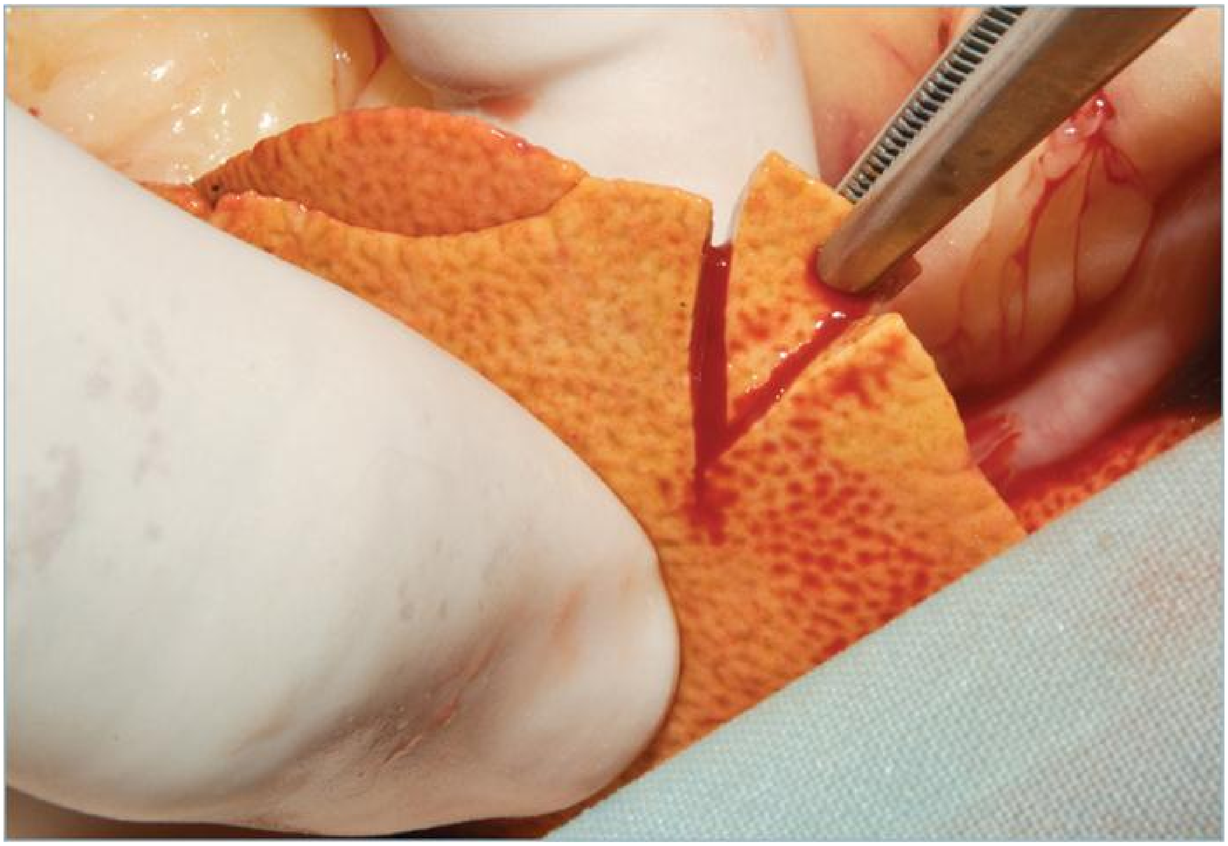

Fig. 5. Diffuse liver lesion. It looks like fatty liver syndrome. A wedge biopsy was taken from one of the borders. The liver lobe is immobilized and a wedge-shaped cut is made with a scalpel, as shown on the photograph.

Fig. 6. Cutting the liver parenchyma always causes bleeding. Monopolar coagulation should be avoided, because this produces a wide tissue lesion.

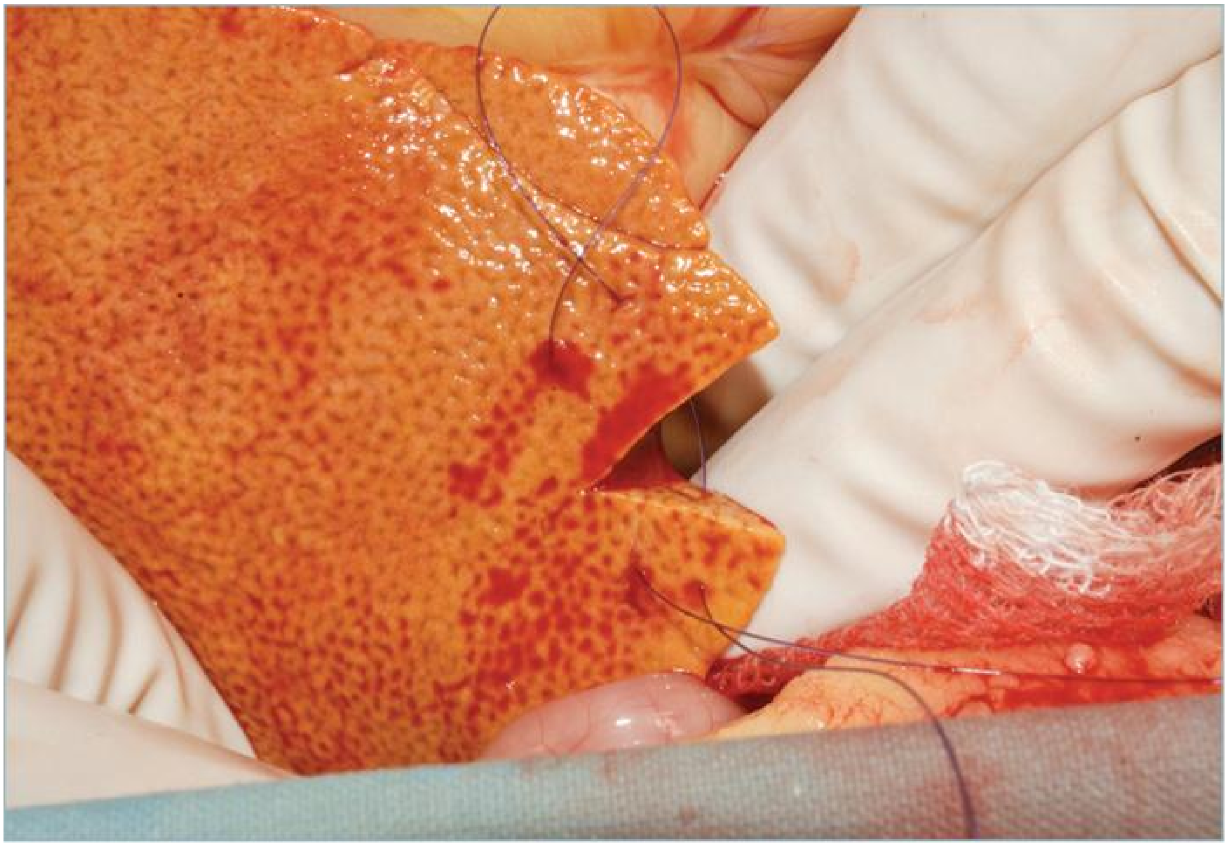

Fig. 7. To stem the hemorrhage, the edges of the cut are brought together with mattress sutures using monofilament absorbable material. The sutures should be placed very carefully and accurately so as not to tear the fragile liver parenchyma.

The suture material should be monofilament to avoid a "sawing" effect on the parenchyma. Preferably, use absorbable material to avoid local infection due to bacterial entrapment.

A cylindrical atraumatic needle should be used to pass through the liver parenchyma without cutting it.

If a focal lesion is found, the rest of the liver should be palpated thoroughly to identify further nodules or cavities.
The tissue samples should encompass part of the normal parenchyma (Figs. 8-11).

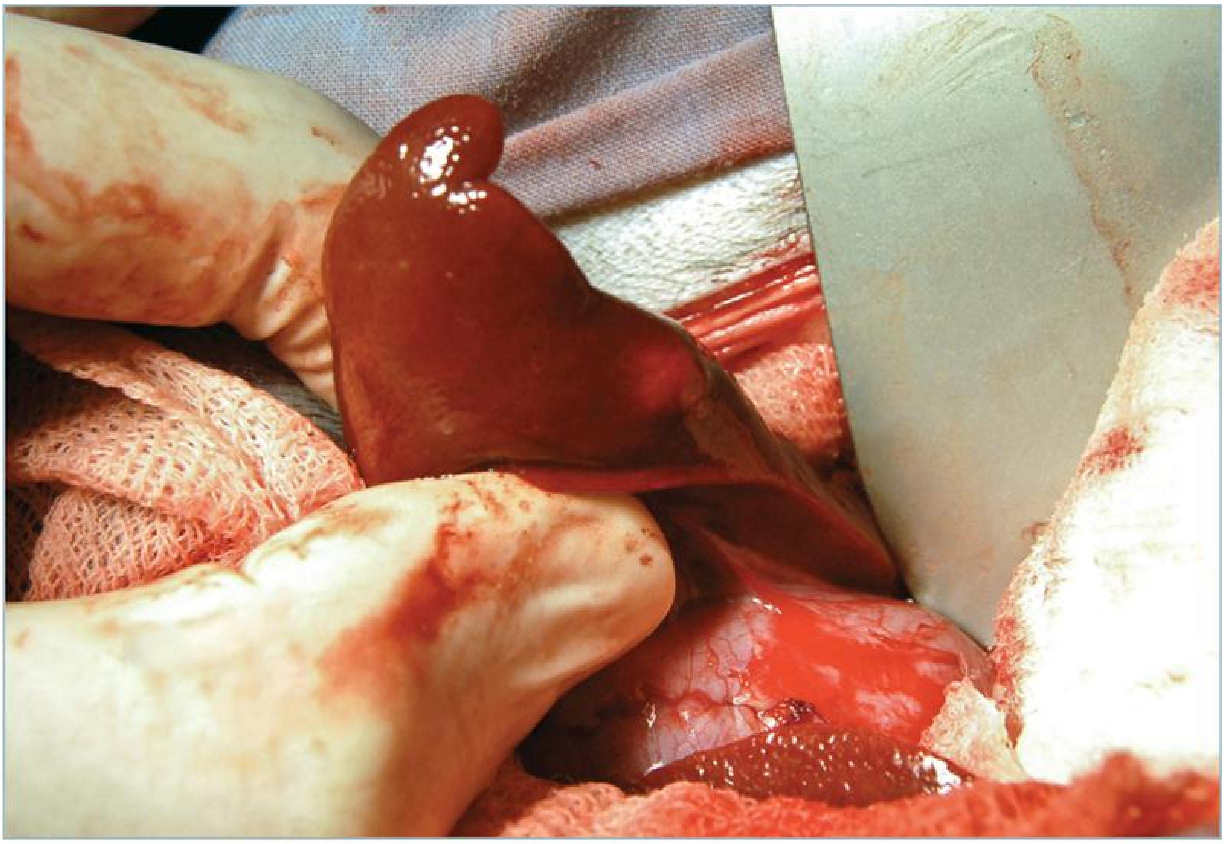

Fig. 8. In this case, a nodule was found in the quadrate lobe of the liver during an abdominal intervention. The patient did not present with signs of liver disease.

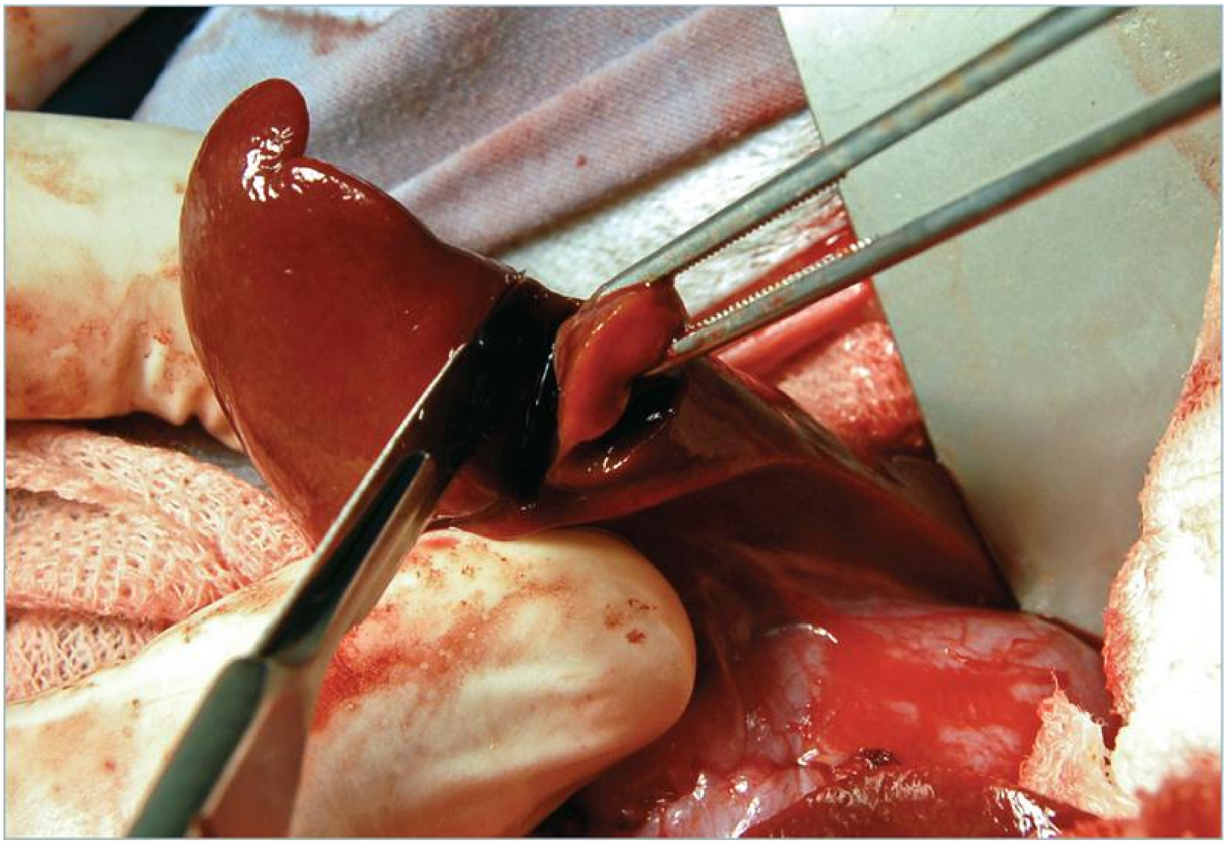

Fig. 9. After examination of the rest of the liver, a wedge biopsy is taken; it includes the nodule and a margin of normal liver parenchyma.

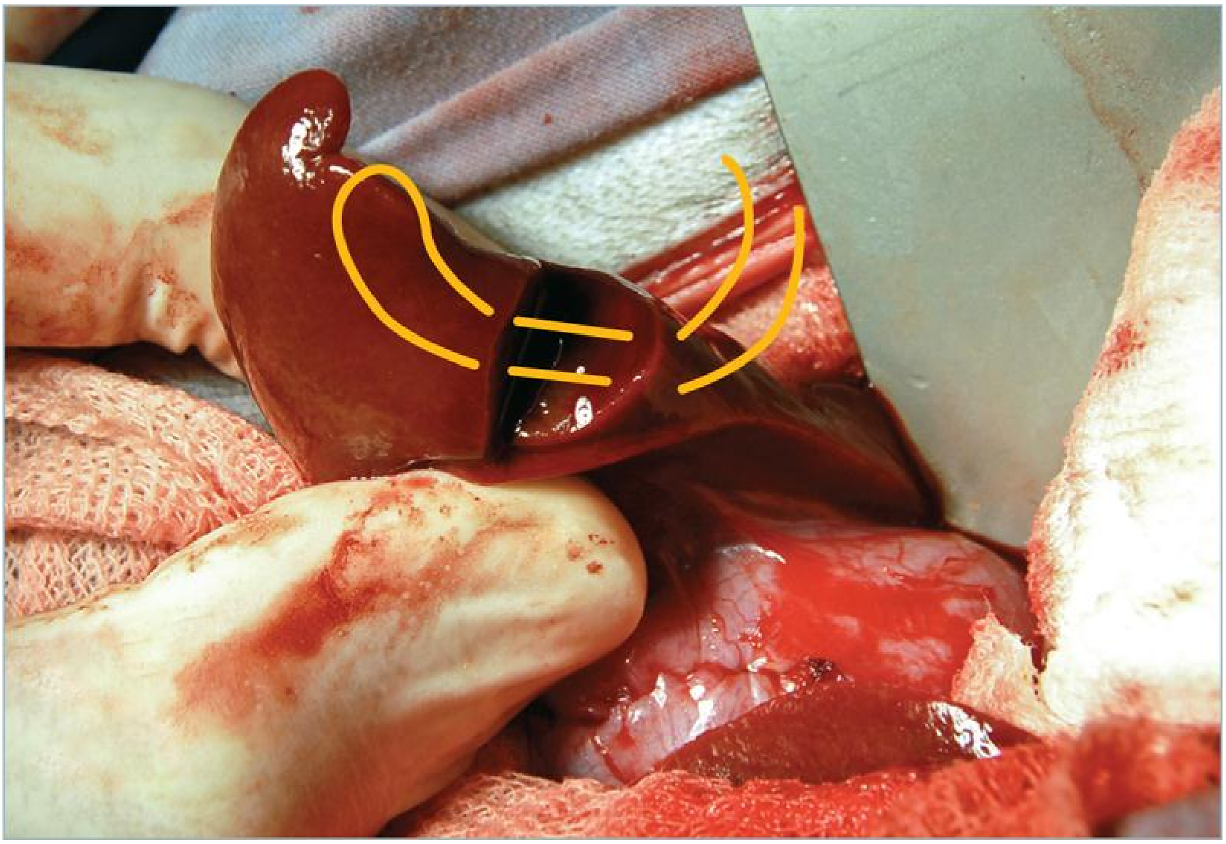

Fig. 10. Cutting the liver produces hemorrhage that is more or less profuse depending on the depth of the cut. To obtain effective hemostasis in the area, horizontal mattress sutures are placed.

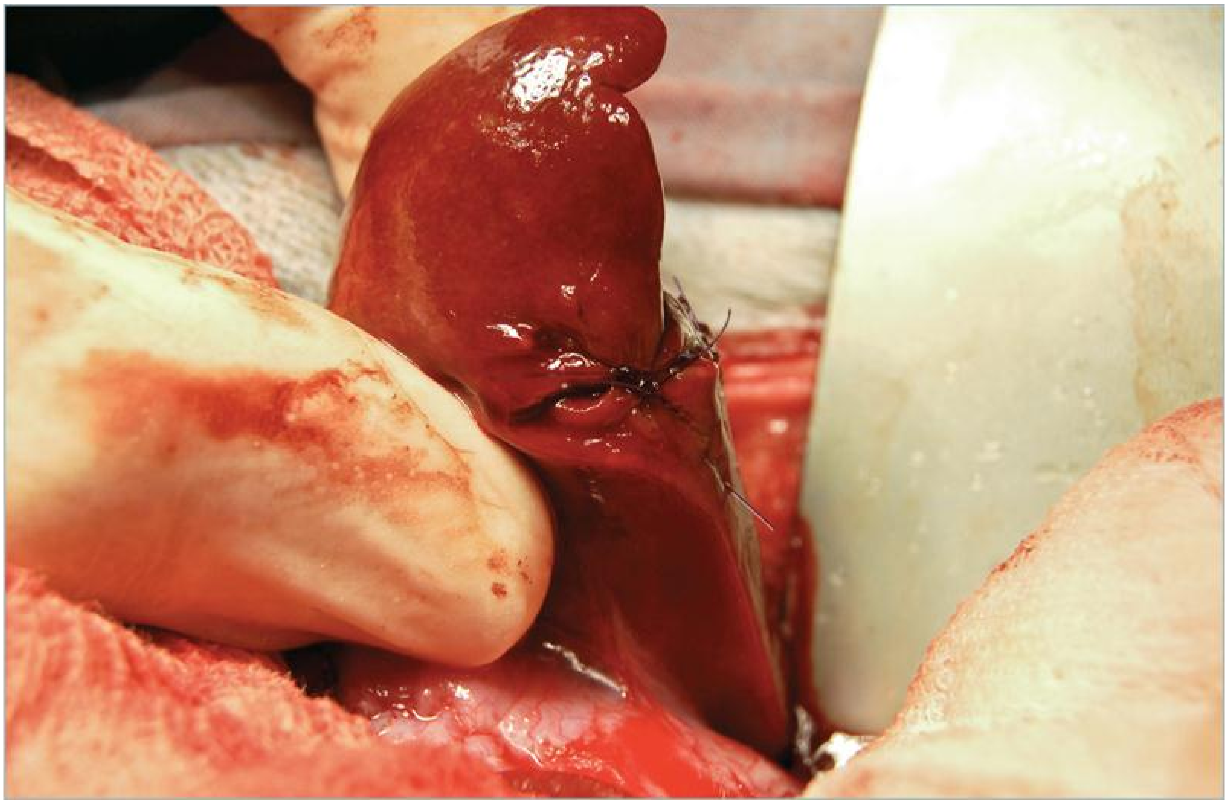

Fig. 11. In this case, three sutures with monofilament synthetic absorbable material were placed. The image shows there is no hemorrhage after the biopsy.

Liver biopsies are not very useful if the sample is fragmented or if it includes little liver tissue.

Before closing the laparotomy, check that the biopsy area is not bleeding anymore. The patient should be monitored for hemoperitoneum for the first few days after surgery.

Renal biopsy

José Rodríguez

Prevalence

Renal biopsy may be indicated in renal insufficiency, in particular if acute (Fig. 1).

Renal biopsy may be performed percutaneously guided by ultrasound, assisted by laparoscopy (Figs. 2 and 3) or by laparotomy.

Percutaneous biopsy is not recommended in cases of blood dyscrasias, clotting disorders, large renal cysts or perirenal abscesses.

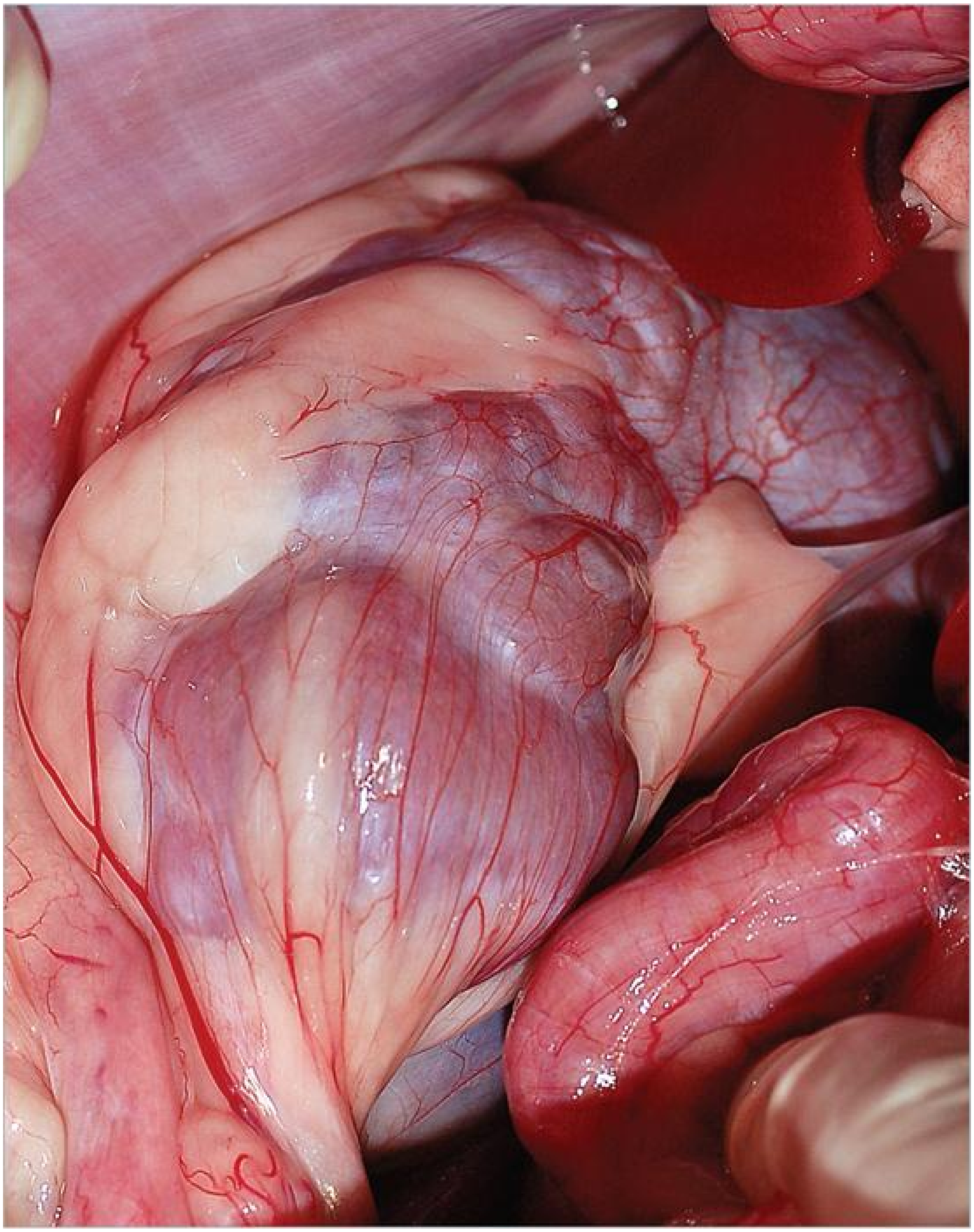

Fig. 1. Right kidney of a patient with renal insufficiency of unknown origin.

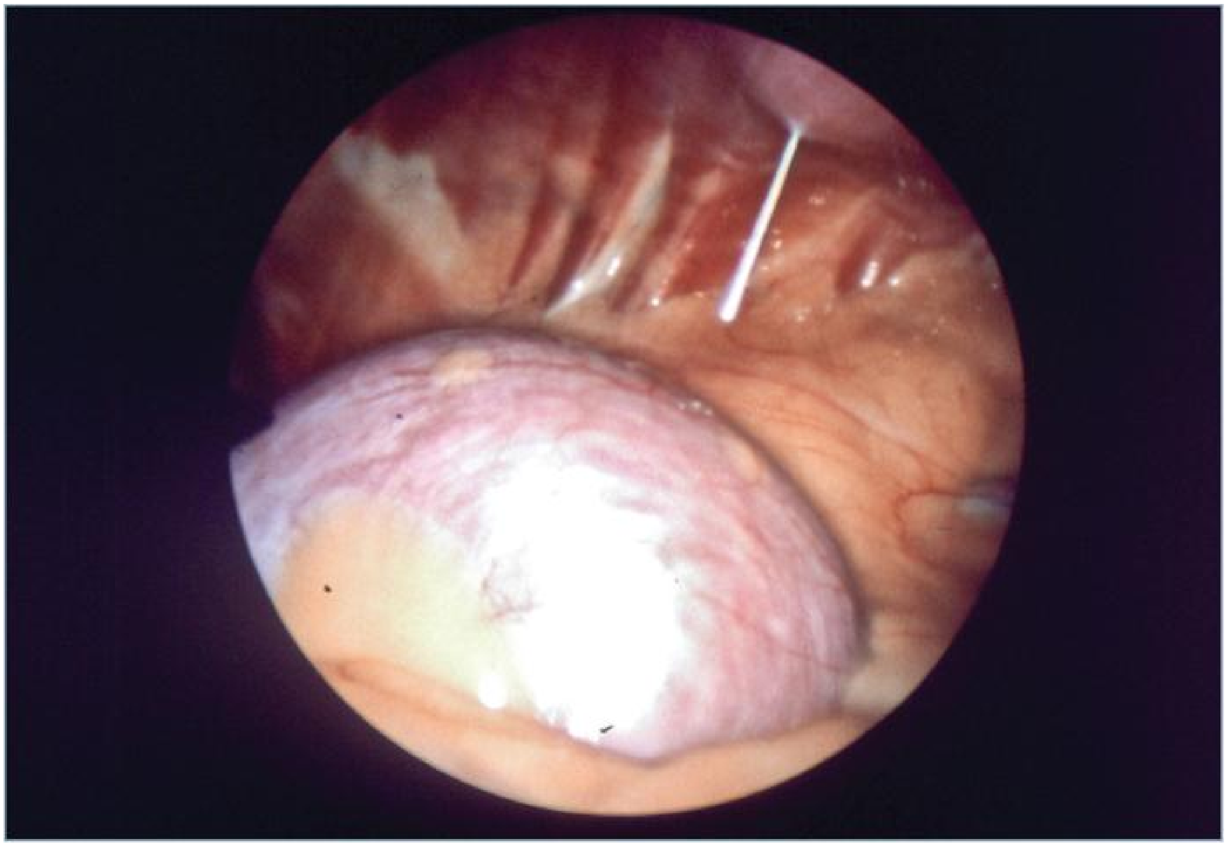

Fig. 2. Laparoscopy permits direct examination of the kidney and visual guidance of the biopsy needle to the most representative area of tissue.

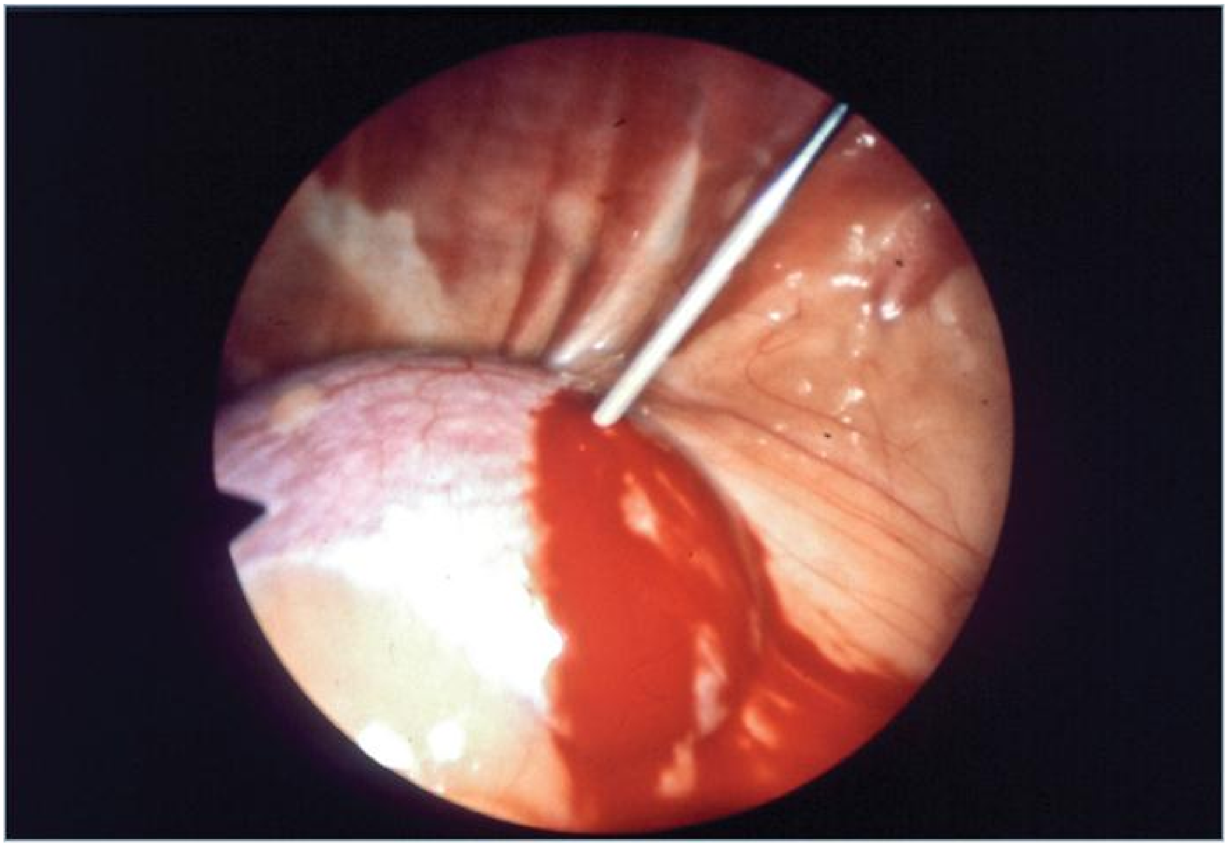

Fig. 3. Laparoscopy permits visualization of any renal damage and bleeding or incorrect needle orientation requiring attention.

Wedge biopsy

Technical difficulty	■				

Surgical biopsy is based on a wedge-shaped resection of the renal parenchyma.
For wedge biopsy, an incision is made in the renal parenchyma with a scalpel.
Then, a second incision is made at an angle to the first so that a wedge-shaped fragment of the kidney is obtained (Figs. 4-6).

> ***Wedge biopsies provide better and larger samples than those obtained by other techniques.***

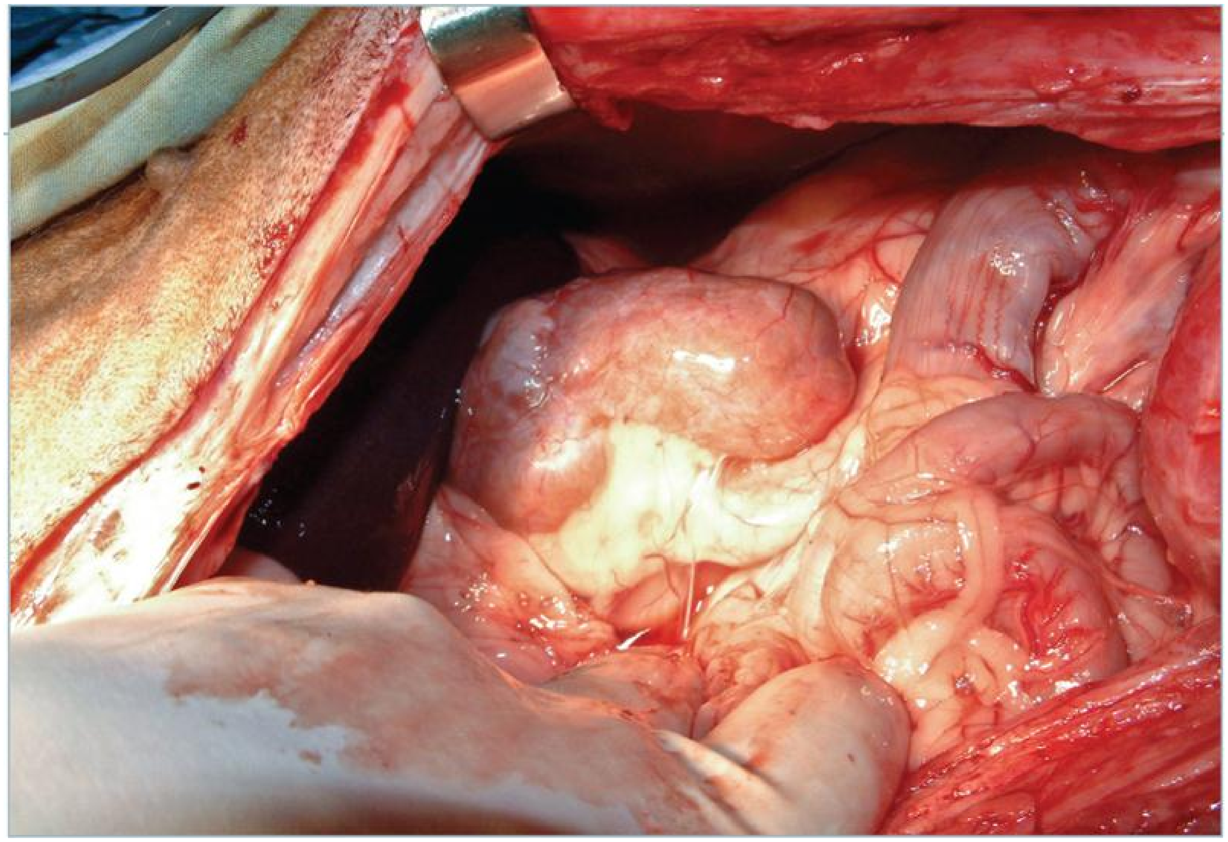

Fig. 4. The gastrointestinal tract is moved to the opposite side so that the renal area is adequately exposed.
In this case, a biopsy will be performed of the left kidney, which exhibits an abnormal structure.

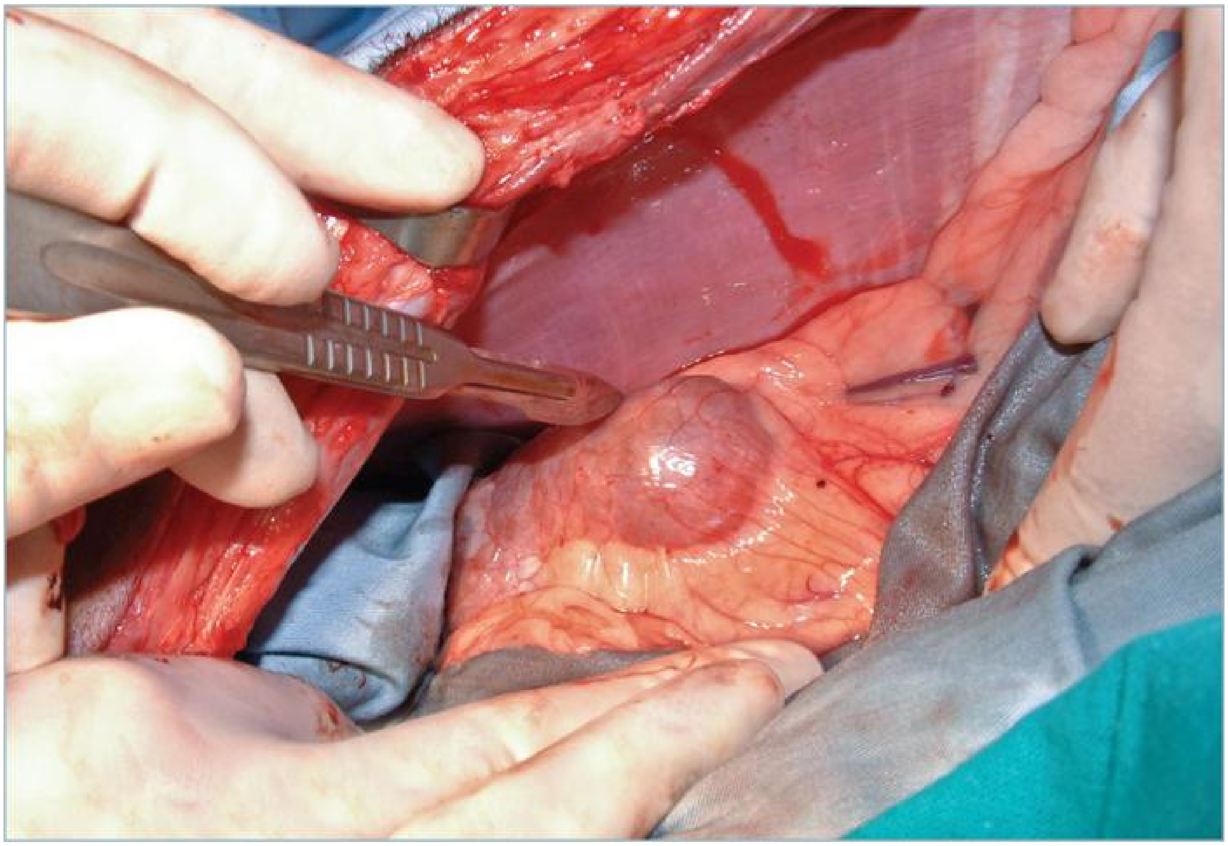

Fig. 5. Two converging incisions are made with a scalpel to obtain a wedge-shaped sample of the renal parenchyma.

✱

The incision is made perpendicularly to the convex border of the kidney.

To stop bleeding and to close the incision, several mattress sutures are placed using 3/0 or 4/0 synthetic absorbable material (Fig. 7).

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Kidney biopsy

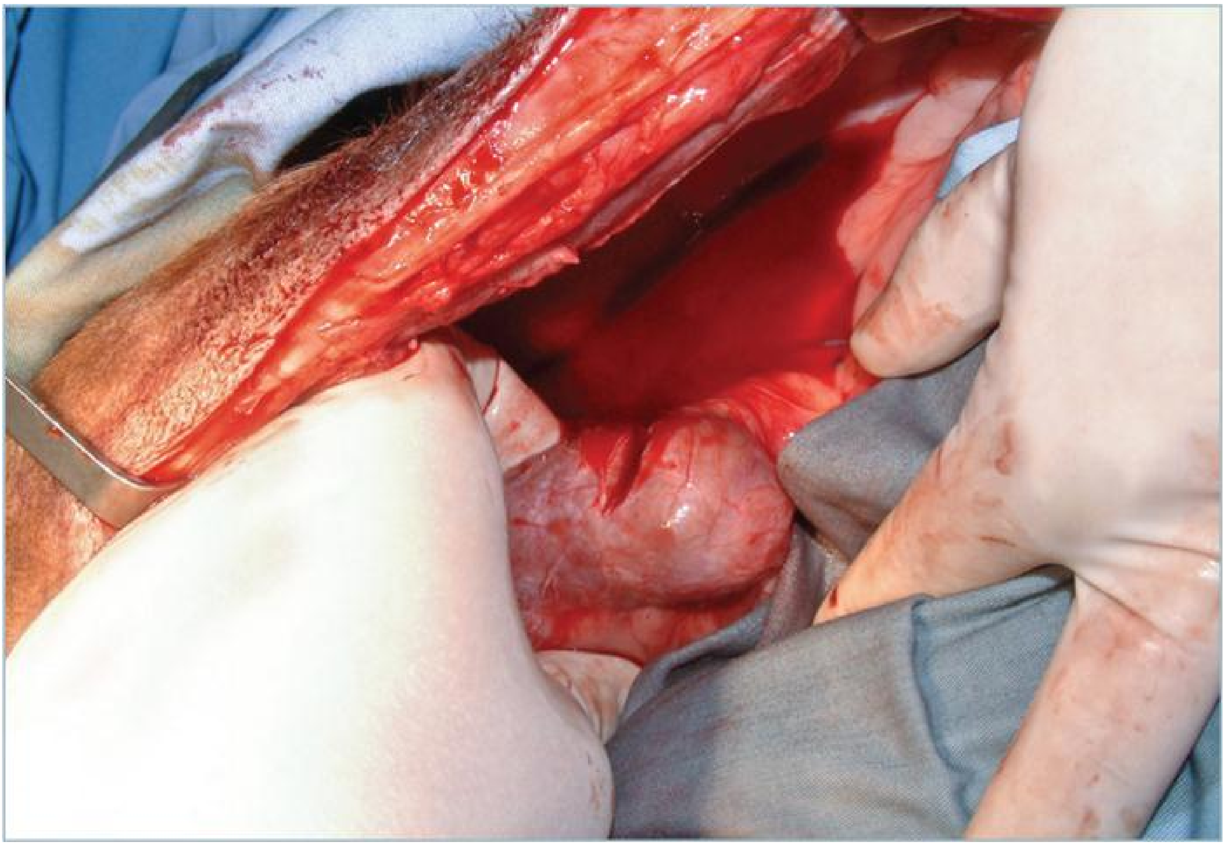

Fig. 6. Lesion created in the kidney after taking the biopsy. Bleeding is constant and relatively profuse.

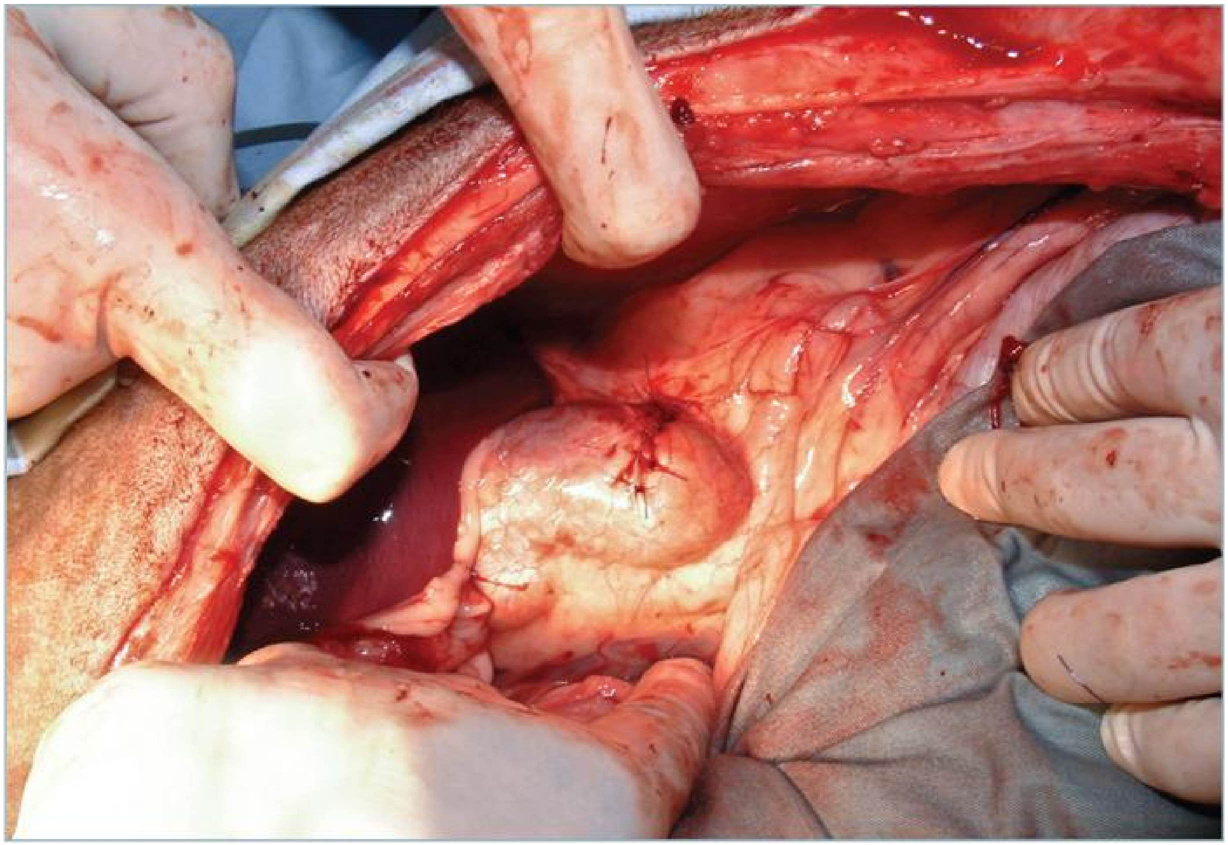

Fig. 7. Final result of the operation after placing several sutures to stop bleeding and to close the renal defect. Check that there is no bleeding from the incision.

Partial splenectomy

José Rodríguez

Prevalence	■				
Technical difficulty	■	■	■		

Partial splenectomy is indicated when taking biopsies in patients with irreparable focal lesions and for localized masses because it preserves the organ's functionality (Fig. 1).

Fig. 1. In this case, a nodule was identified at the ventral end of the spleen. A partial splenectomy will be performed.

A line is defined along which the cut will be made, and the vessels of the splenic hilus that supply this area are ligated and cut (Figs. 2 and 3).

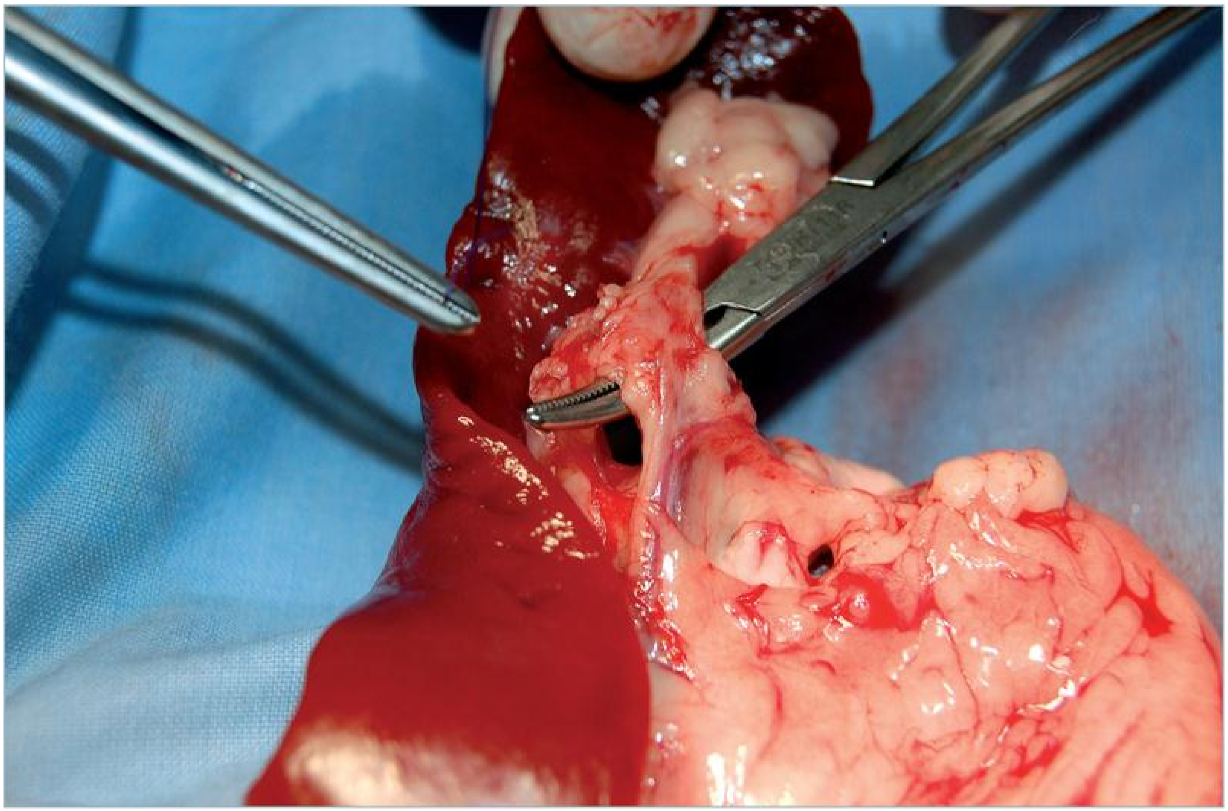

Fig. 2. Dissection and ligation (using monofilament absorbable material) of the hilar vessels that perfuse the part of the spleen that will be resected.

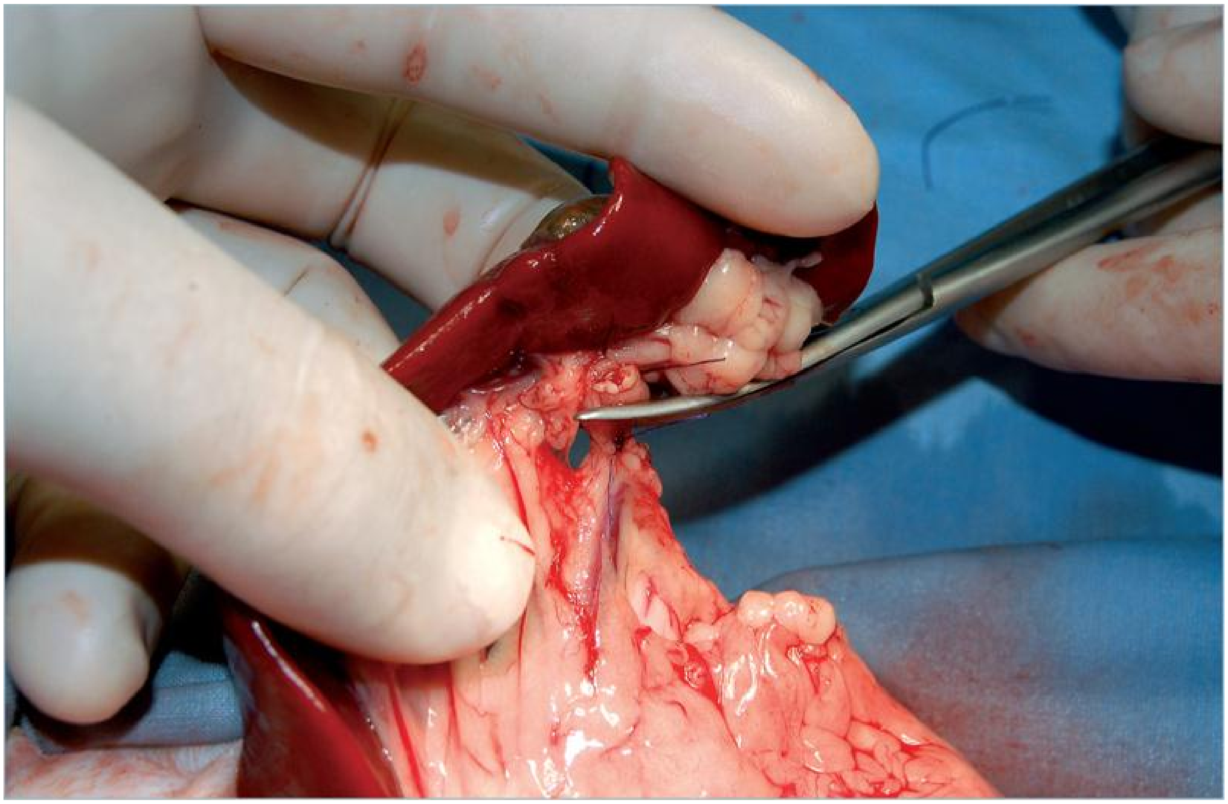

Fig. 3. Cutting the vascular branches that perfuse the affected area of the spleen.

Look for a well-perfused section of the spleen and cut the parenchyma at this level (Figs. 4 and 5).

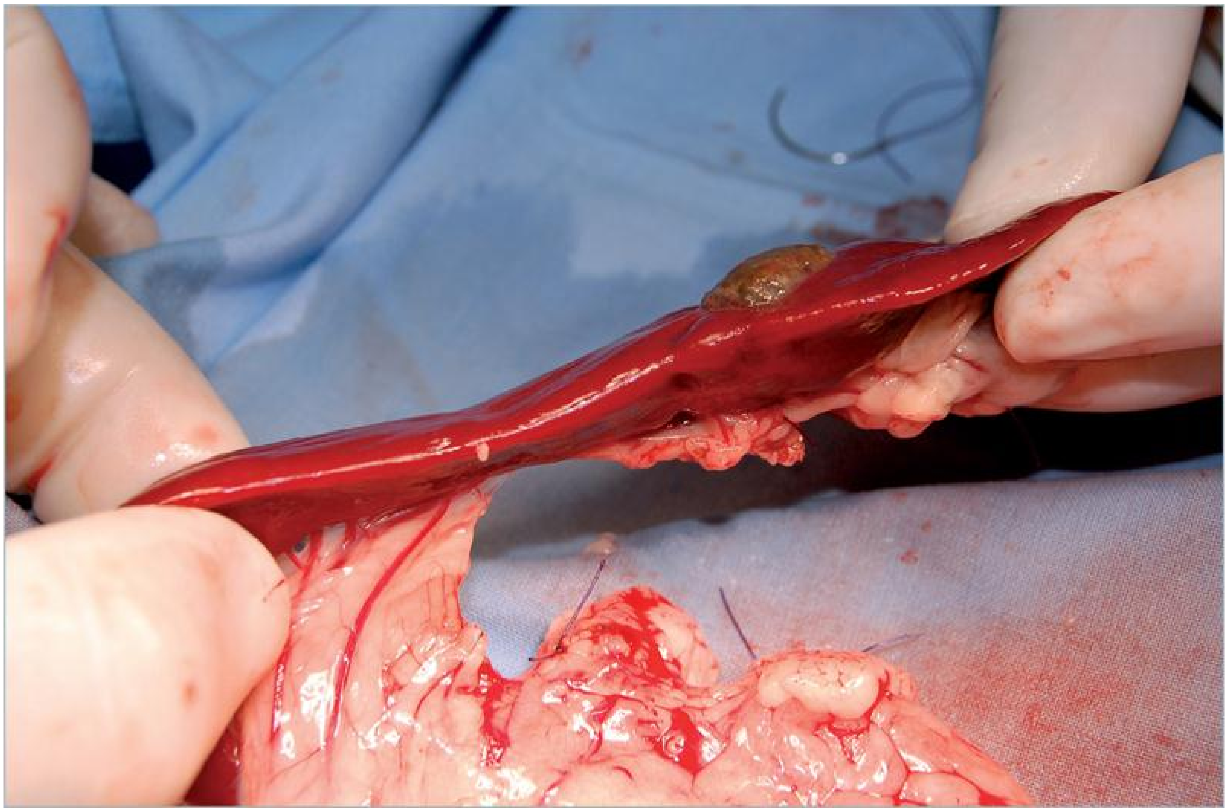

Fig. 4. Look for an area with a good blood supply because this is where the spleen should be cut.

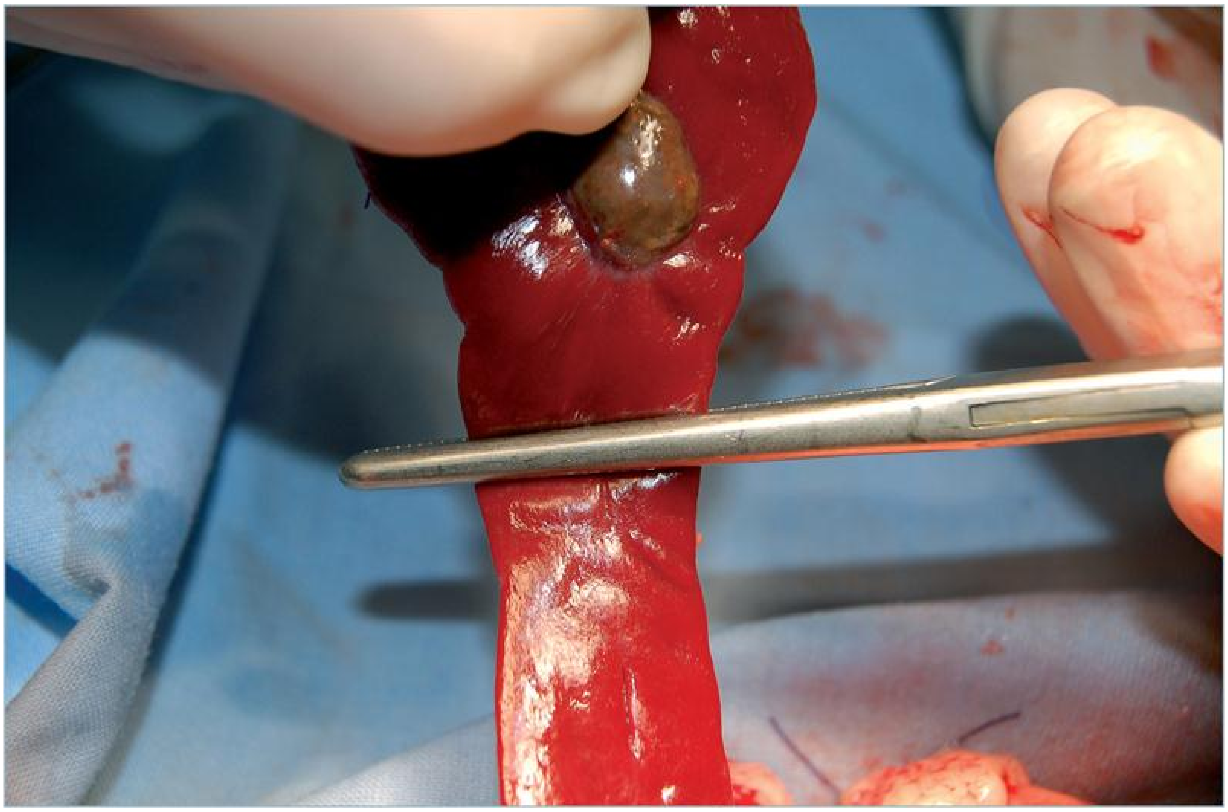

Fig. 5. Place a clamp on the spleen for preventive hemostasis but do not clamp too tightly to avoid tearing the tissue.

If the splenic parenchyma is thick, compress the tissue with the fingers from the line of incision towards the lesion: to avoid dissemination, then place the clamp over this area.

Next, make two oblique incisions in the spleen (in a V shape) to facilitate closure and hemostasis of the parenchyma (Fig. 6).

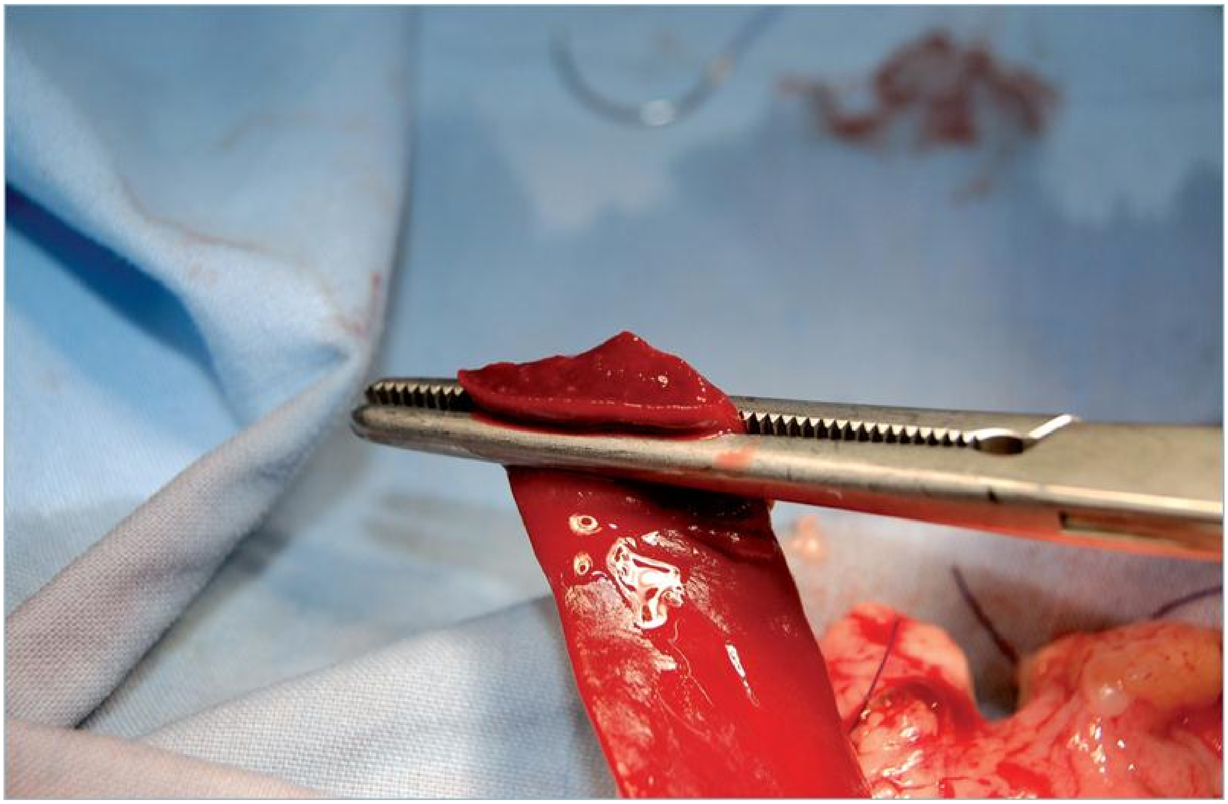

Fig. 6. The splenic parenchyma is cut using two converging oblique incisions.

The sectioned end is closed with a continuous suture using monofilament synthetic absorbable material (Fig. 7).

> ***If there is bleeding upon removal of the clamp, two superimposed continuous mattress suture lines are placed.***

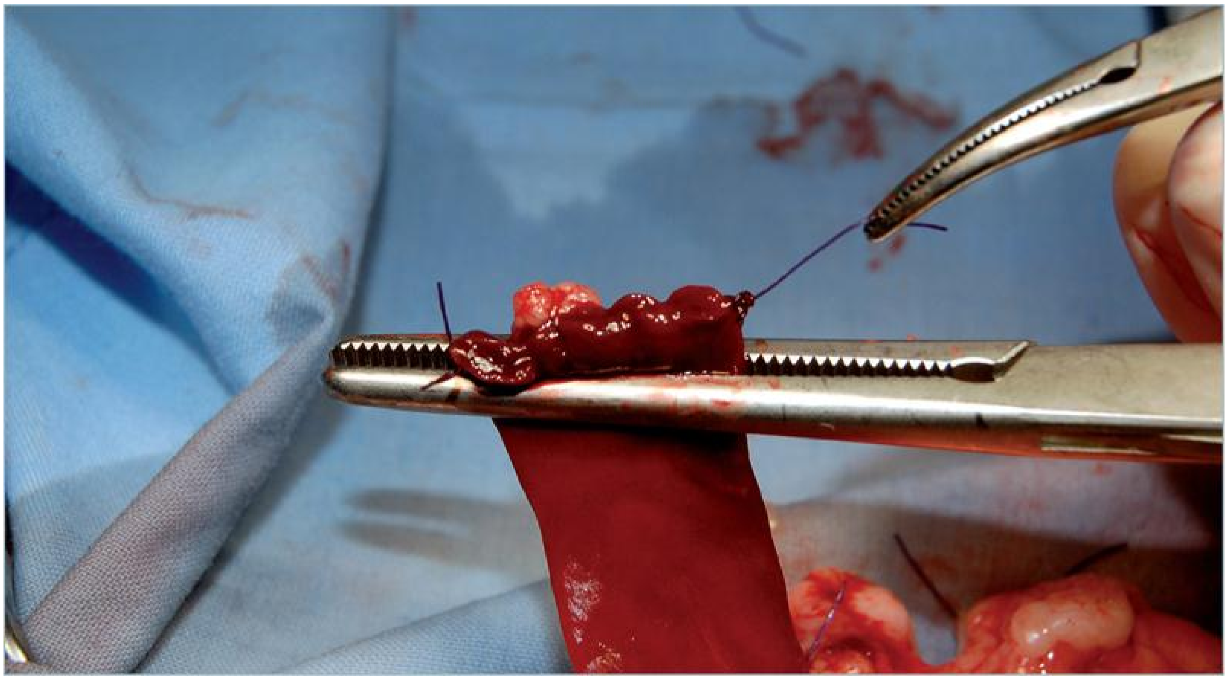

Fig. 7. Final appearance of the continuous suture placed over the surface of the cut spleen.

Alternatively, a surgical stapler (TA) can be used, with 3.5 or 4.8 staples, depending on the size of the splenic parenchyma (Fig. 8).

To ensure stability of the rows of staples, the parenchyma should not be cut too close to them.

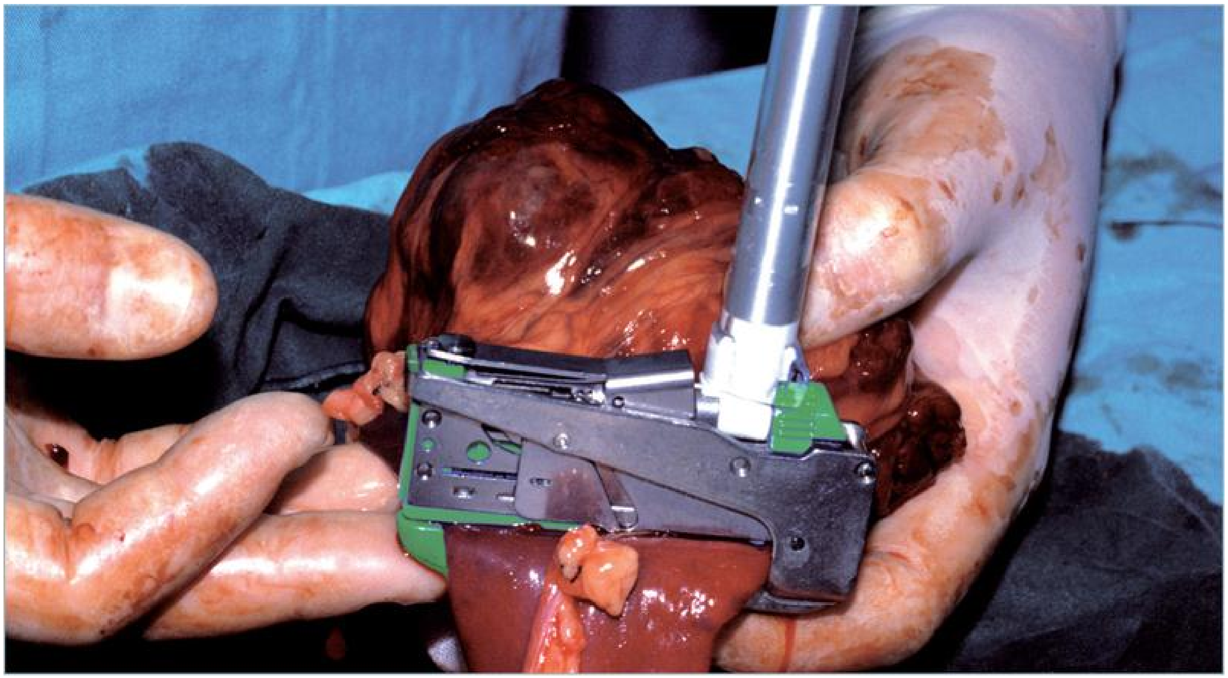

Fig. 8. Surgical staplers place two overlapping rows of staples that ensure good closure and hemostasis of the parenchyma.

Regardless of the manner in which the splenectomy is closed, it is essential to check for bleeding from the cut parenchyma (Fig. 9).
The larger the resected part of the spleen, the greater the risk of splenic torsion. For this reason, it is recommended to fix the remaining spleen to the stomach or to the intestine.

*

To prevent a possible splenic torsion, it is advisable to fix the spleen to the stomach or to an intestinal loop.

Fig. 9. After splenic resection and before closing the laparotomy, make sure that there is no bleeding from the splenectomy wound.

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Splenectomy

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Splenectomy (vessel ligations)

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Splenectomy (vessel sealants)

Ovariohysterectomy

Martínez

Prevalence

Ovariohysterectomy (OVH) or **spay** is defined as the complete surgical removal of the uterus and the ovaries.

In pets, owner demand for this intervention is relatively high, mainly in order to control the population and to eliminate sexual behaviour during estrus. There are many other indications, for instance prevention and treatment of uterine and mammary disorders like pyometra, metritis, uterine and mammary neoplasia, uterine torsion or prolapse (Figs. 1 and 2).

Early spaying, before the first estrus, appears to reduce the risk of mammary tumors in later years, because hormonal influence on the development of this type of neoplasia is important.

Sometimes OVH is indicated to aid in the control of systemic disease, for instance diabetes mellitus or behavioral changes.

> ***Removal of the female reproductive tract is possibly the most common surgical intervention in females in veterinary practice.***

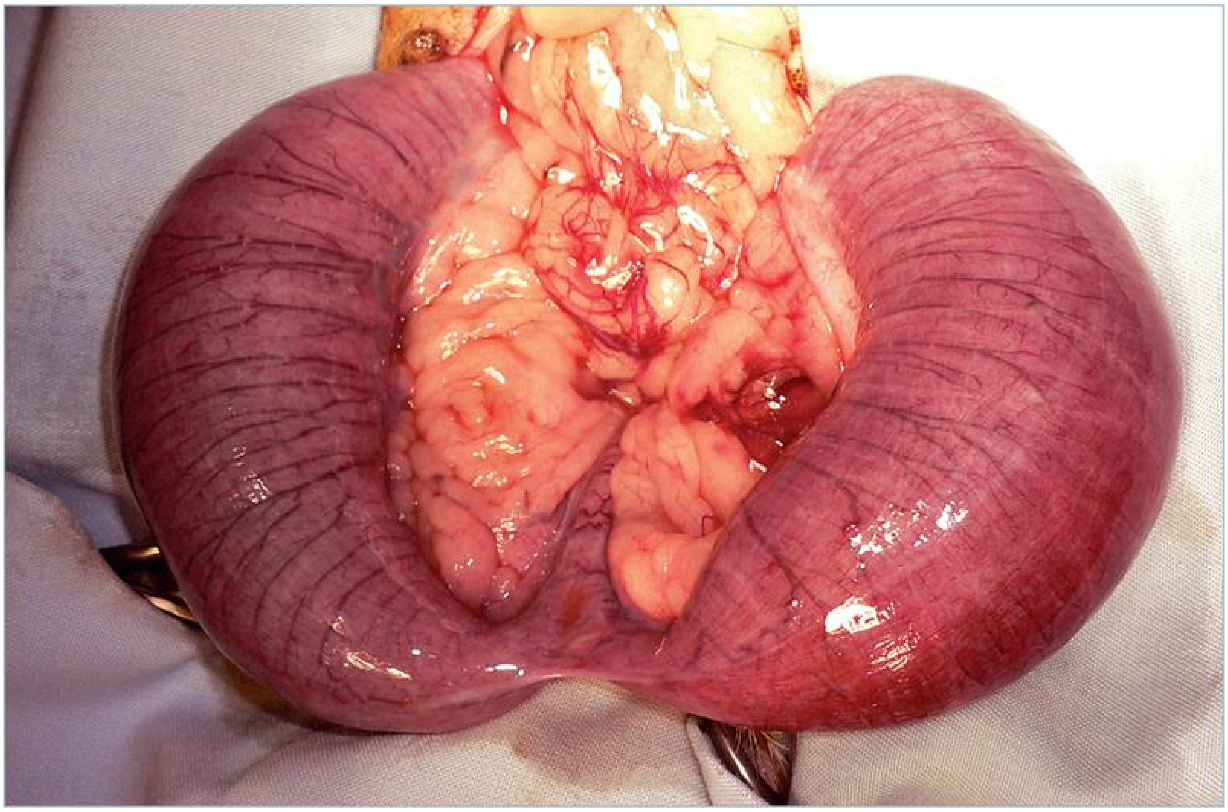

Fig. 1. Significant uterine distension caused by a pyometra.

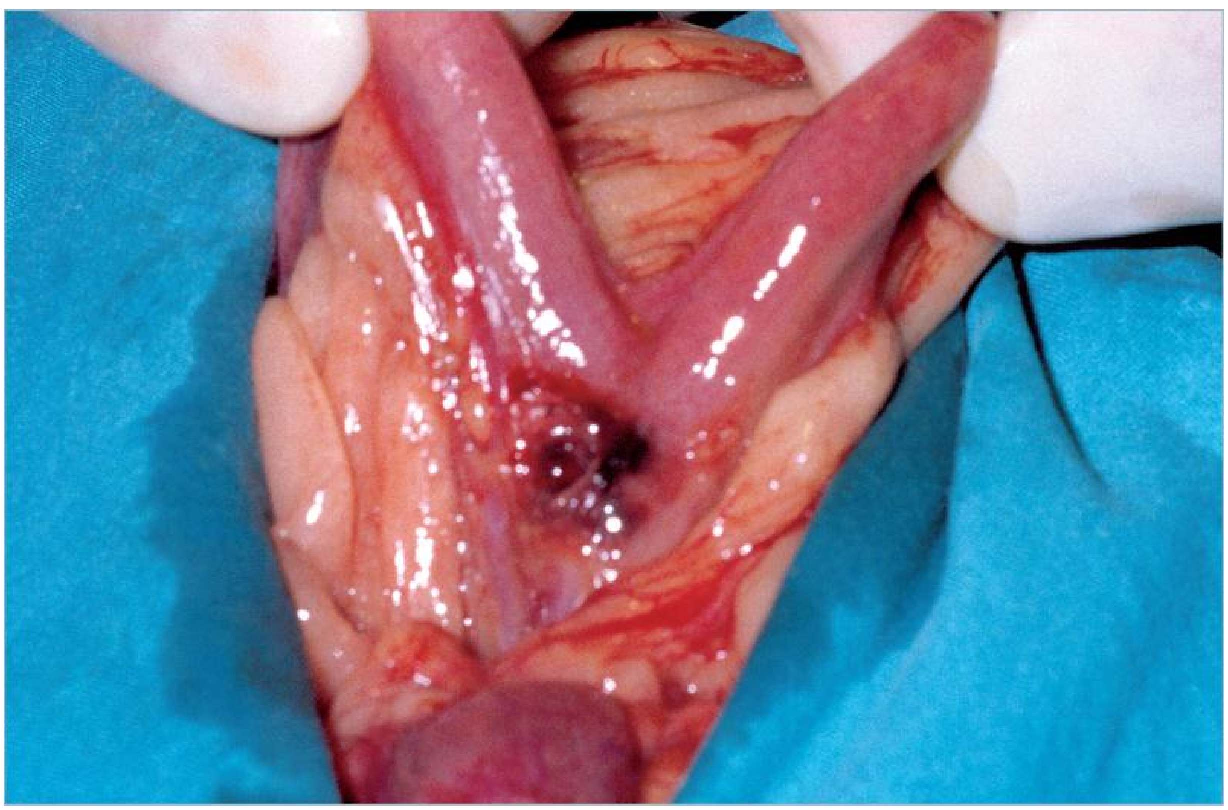

Fig. 2. Iatrogenic perforation of the uterus secondary to artificial insemination.

Ovariohysterectomy in the dog

José Rodríguez, María Eugenia Lebrero

Technical difficulty	■	□	□	□	□

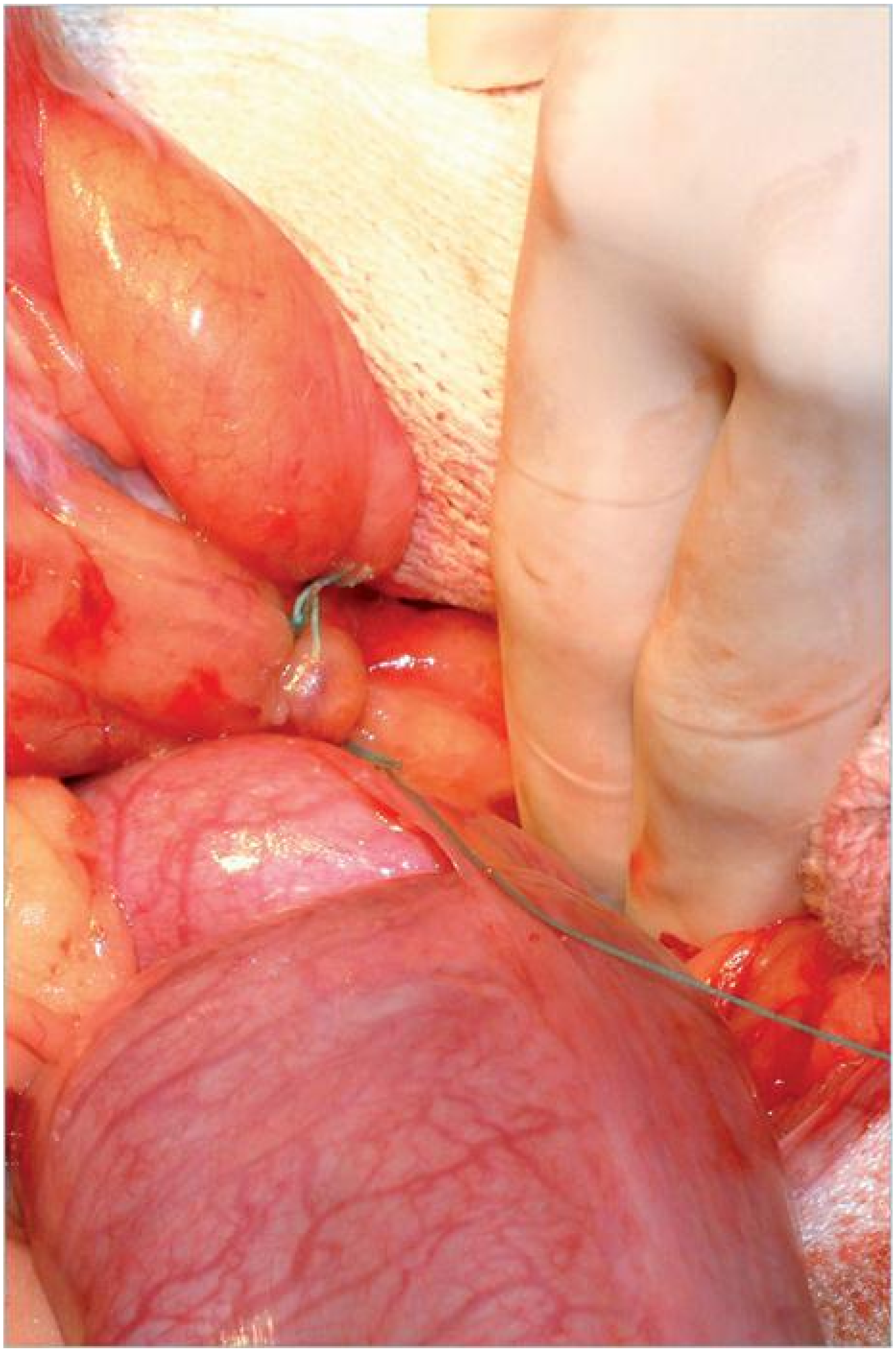

Fig. 1. Obesity is an additional problem in large dogs, because handling of the tissues and visualization of the ovarian vessels becomes difficult.

The difficult part of this surgery is the exteriorization of the ovaries and ligation of the ovarian pedicles, which are located deep in the abdomen.

This becomes even more difficult in large and obese patients, when the operation can be challenging (Fig. 1).
To access the ovaries and uterus, a midline laparotomy is performed from the umbilicus to the pubic symphysis. For a routine OVH, an incision of this length is often unnecesary.

A full bladder makes visualization of the uterus difficult and may hamper the surgery. Empty it before starting.

Remember that traction on the suspensory ligament may cause a vagal reflex with cardiac consequences.

Exteriorization of the right ovarian pedicle is slightly more difficult, because it is located in a more cranial position to the left pedicle. In patients with a large amount of adipose tissue, the correct anatomical identification of the ovary and its pedicle is more difficult.

The ovarian pedicles are exteriorized, generally starting with the right pedicle, which is slightly more difficult. To do so, gentle but firm traction is applied to the uterine horn (Fig. 2).

Fig. 2. First, the ovaries are identified. Both are located inside the ovarian bursa, caudal to the kidneys, and are connected to the abdomen by the ovarian pedicles.

Where the ovary joins the abdominal wall, the different structures in the adipose tissue should be identified: the suspensory ligament of the ovary and the ovarian vessels. The vessels that form the ovarian pedicle should be ligated separately with an absorbable monofilament material of appropriate size (Fig. 3).

With a dissector, a hole is made in the mesovarium and the ligature for the suspensory ligament is passed through (Fig. 4). The ligament is then clamped distally with mosquito forceps and sectioned with scissors (Fig. 5).

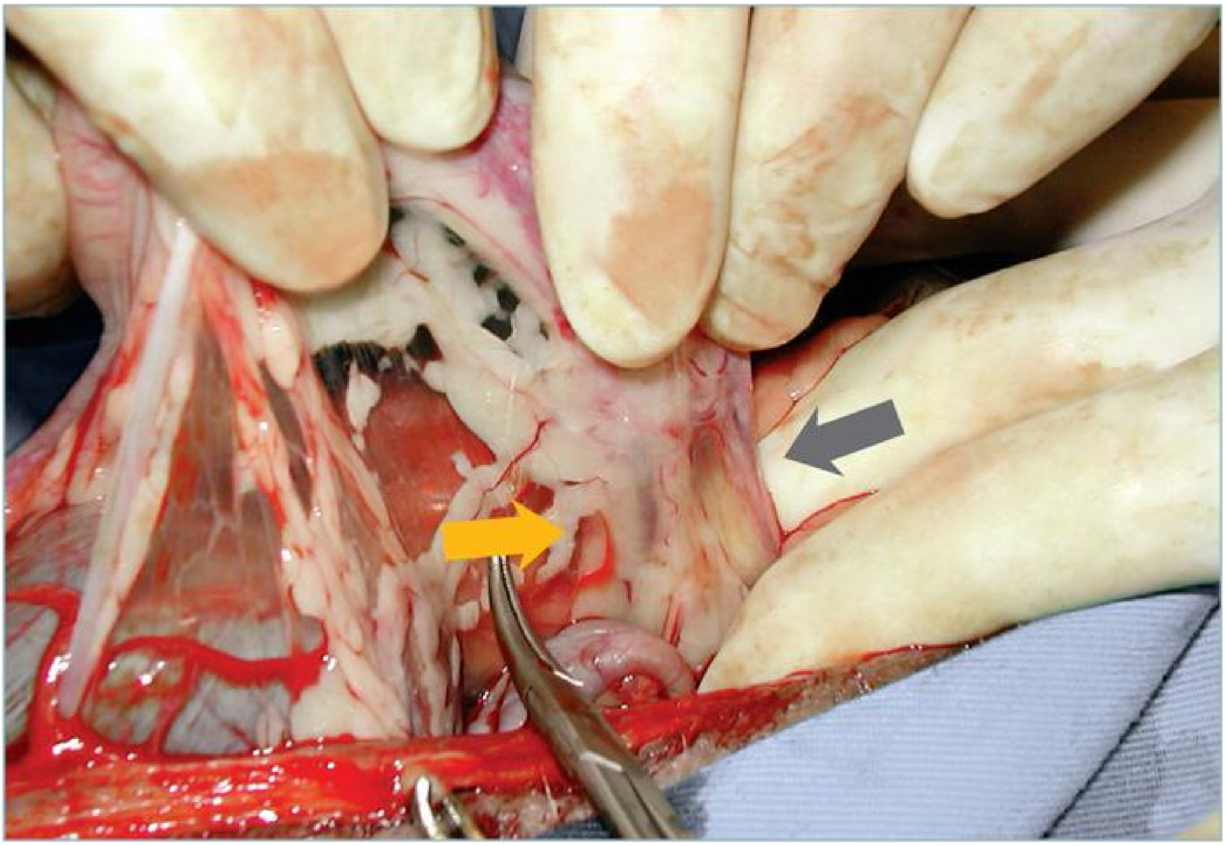

Fig. 3. The ovarian pedicle contains the ovarian artery and vein, which follow a tortuous course (orange arrow), and the ovarian suspensory ligament (grey arrow), wich may be identified by its yellow-white color and tense structure. It is attached to the caudal pole of the kidney and has its own vascularization.

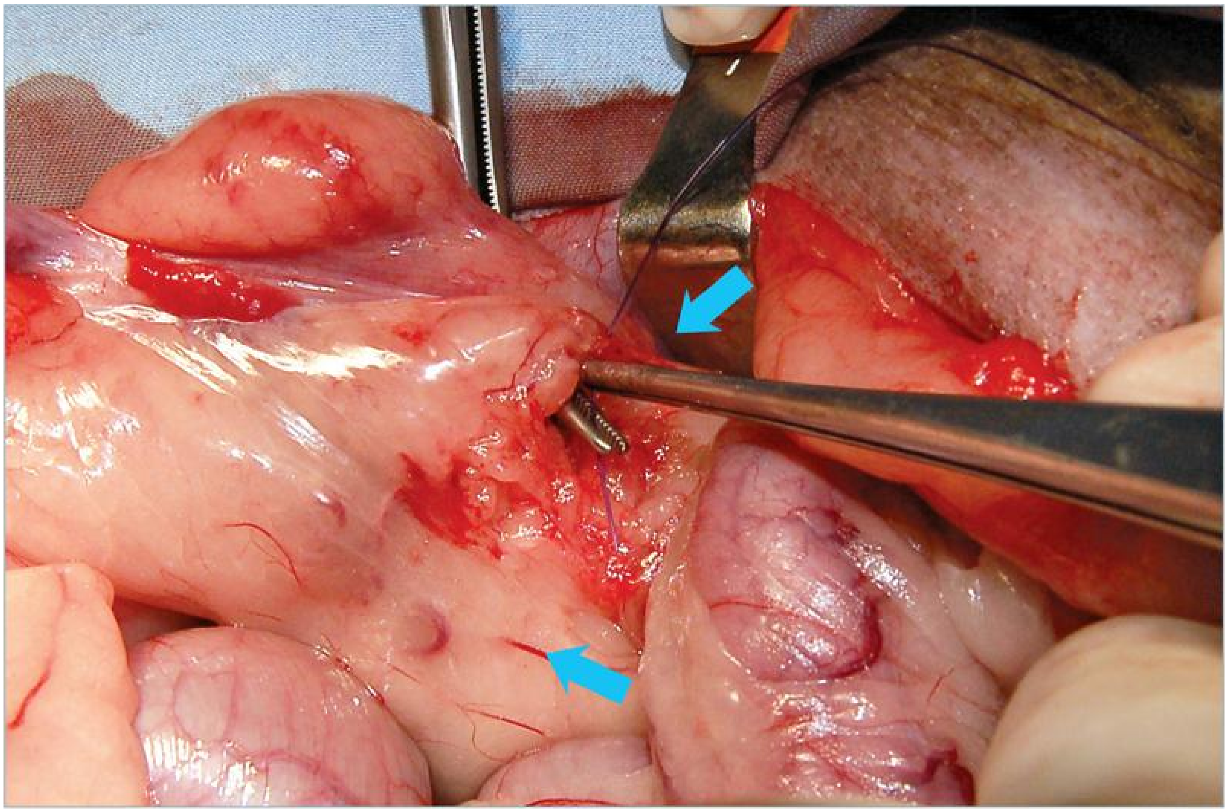

Fig. 4. Using a blunt dissection, a window is made in the mesovarium next to the suspensory ligament. Through this hole, a monofilament absorbable ligature is passed around the suspensory ligament.

Some surgeons prefer to tear off the ligament without any ligature. Remember that this may cause hemorrhage, in particular in large patients.

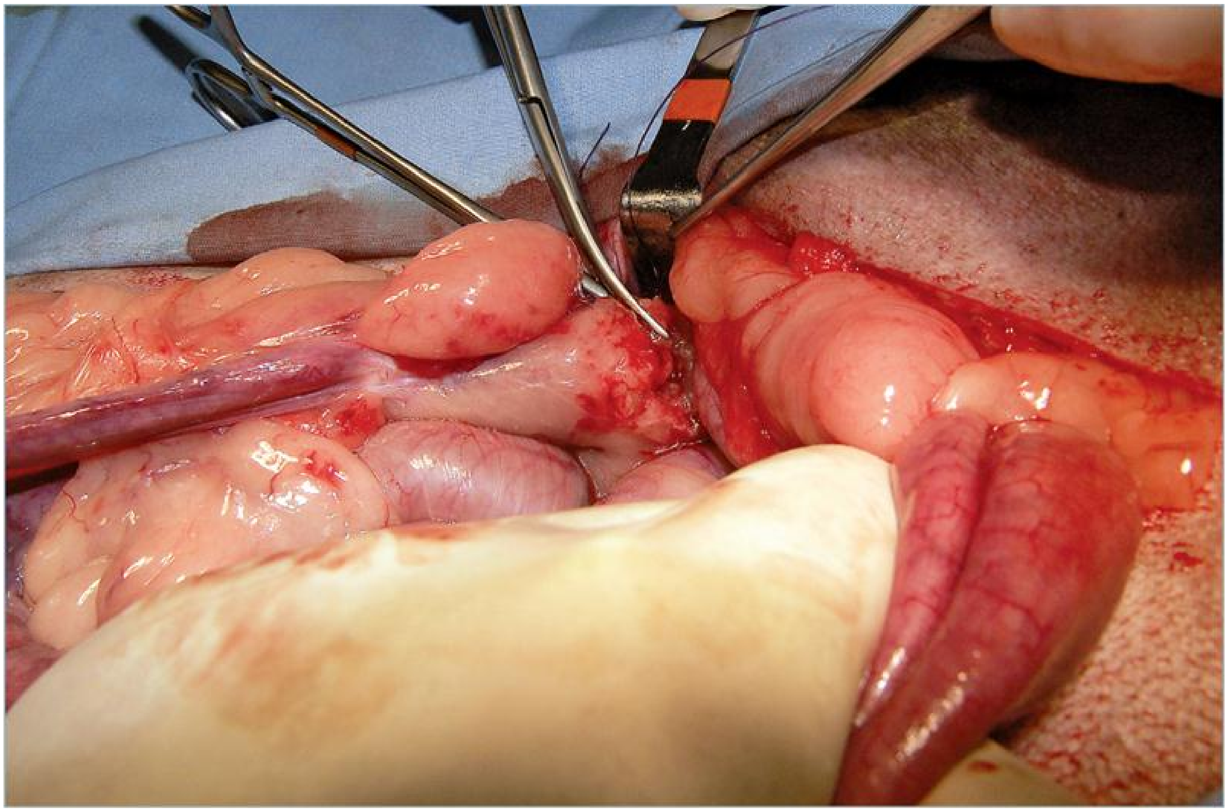

Fig. 5. After tying the ligature, the ligament is cut between the ligature and the mosquito clamp that has been placed distally in order to avoid hemorrhage of the vessel that accompanies the suspensory ligament.

The ovarian vessels are ligated together. For this, a second, more caudal, incision is made in the mesovarium (Fig. 6), through which the vessels are ligated with an absorbable monofilament thread (Fig. 7). For inexperienced surgeons, it is recommended to place two ligatures distal to the ovary to assure correct hemostasis of the pedicle.

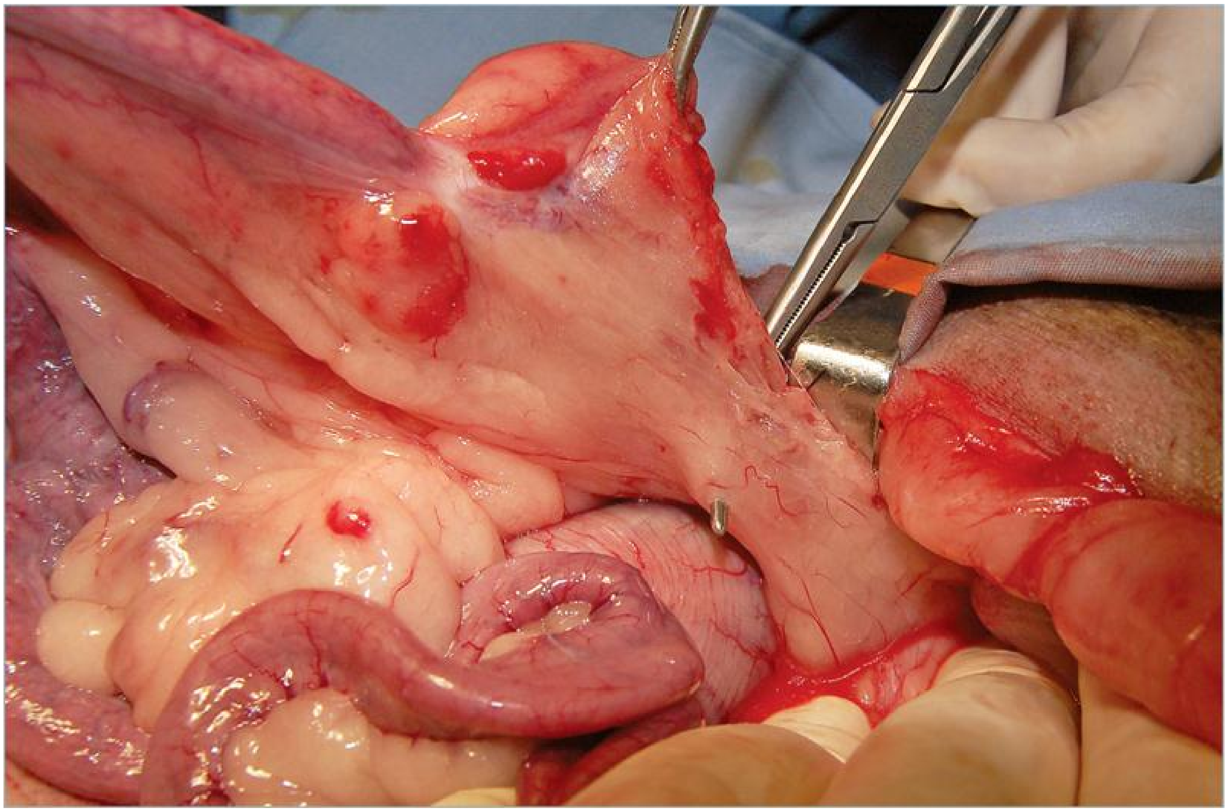

Fig. 6. Next, another hole is made in the mesovarium, as far away from the ovary as possible, and another ligature of the same material is passed through it with the aid of hemostatic forceps.

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The location of the ligatures must be as distal as possible to be able to remove the ovary without the risk of leaving tissue remnants in the patient.

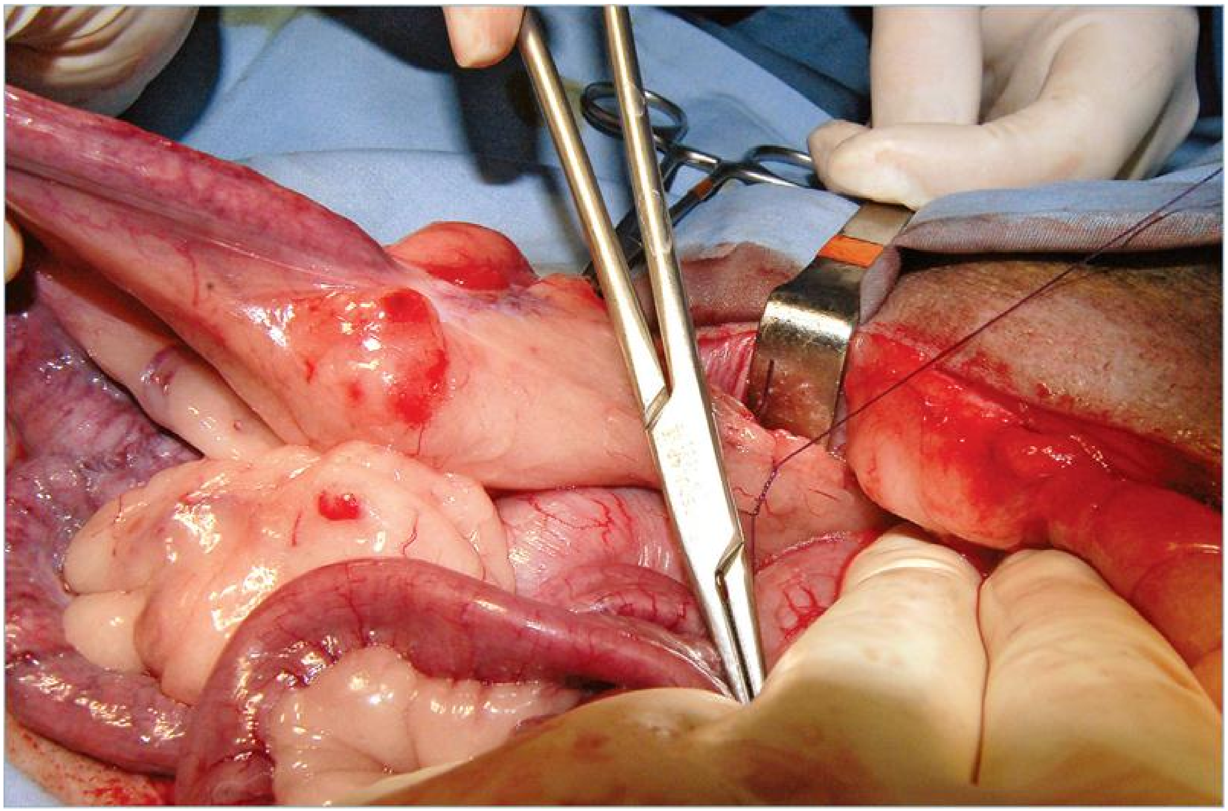

Fig. 7. The ligature is tied around the ovarian vessels as close as possible to the large abdominal vessels. In this way, there will be enough space between the ovary and the ligature and removing the ovary becomes easier. It is recommended to place two ligatures to assure perfect ligation of the ovarian vessels.

Before cutting the ligament, hemostatic forceps are placed next to the ovary to prevent reflux of blood onto the operating field (Fig. 8).

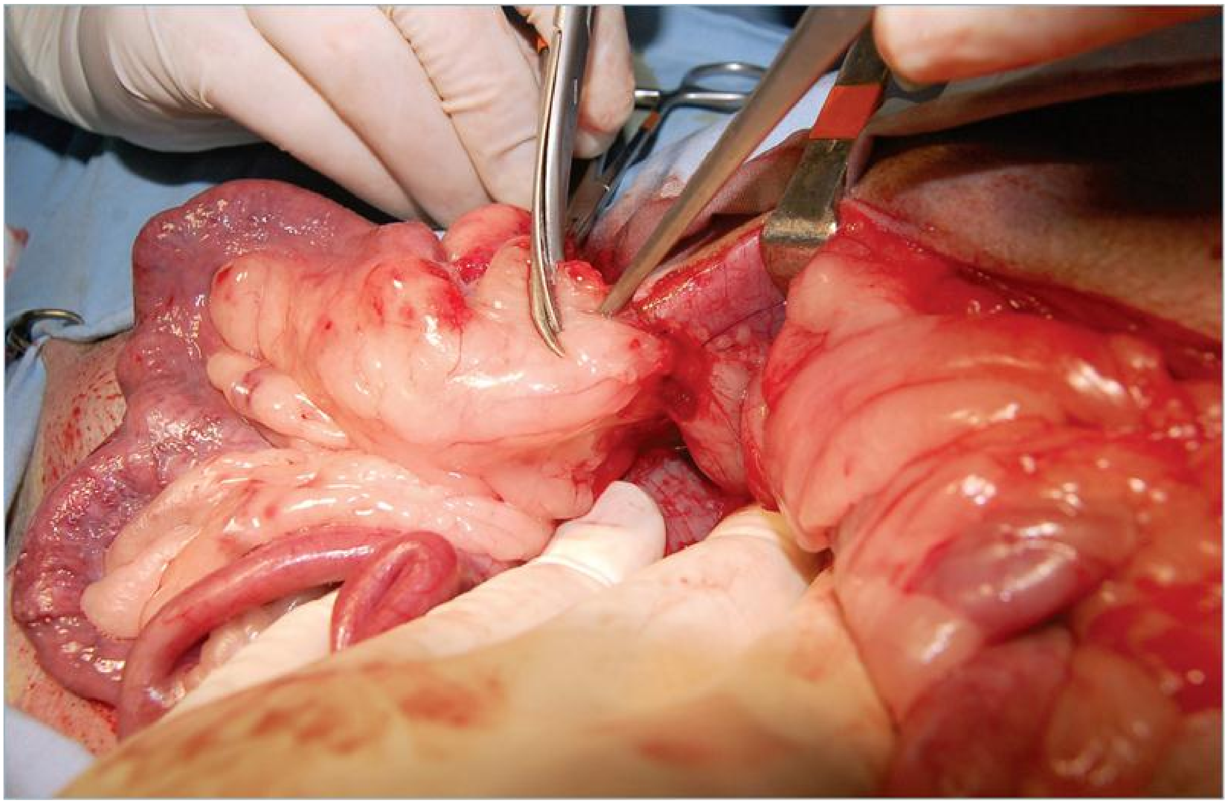

Fig. 8. Before sectioning the vessels to remove the ovary, hemostatic forceps are placed distally to the ligatures to prevent bleeding from the uterine side.

After sectioning the ovarian vessels, the ligature is checked for possible hemorrhage (Fig. 9).

When cutting the pedicle, care should be taken not to leave any ovarian tissue; this tissue will remain functional and cause recurrent estrus, with a risk of pyometra of the uterine stump.

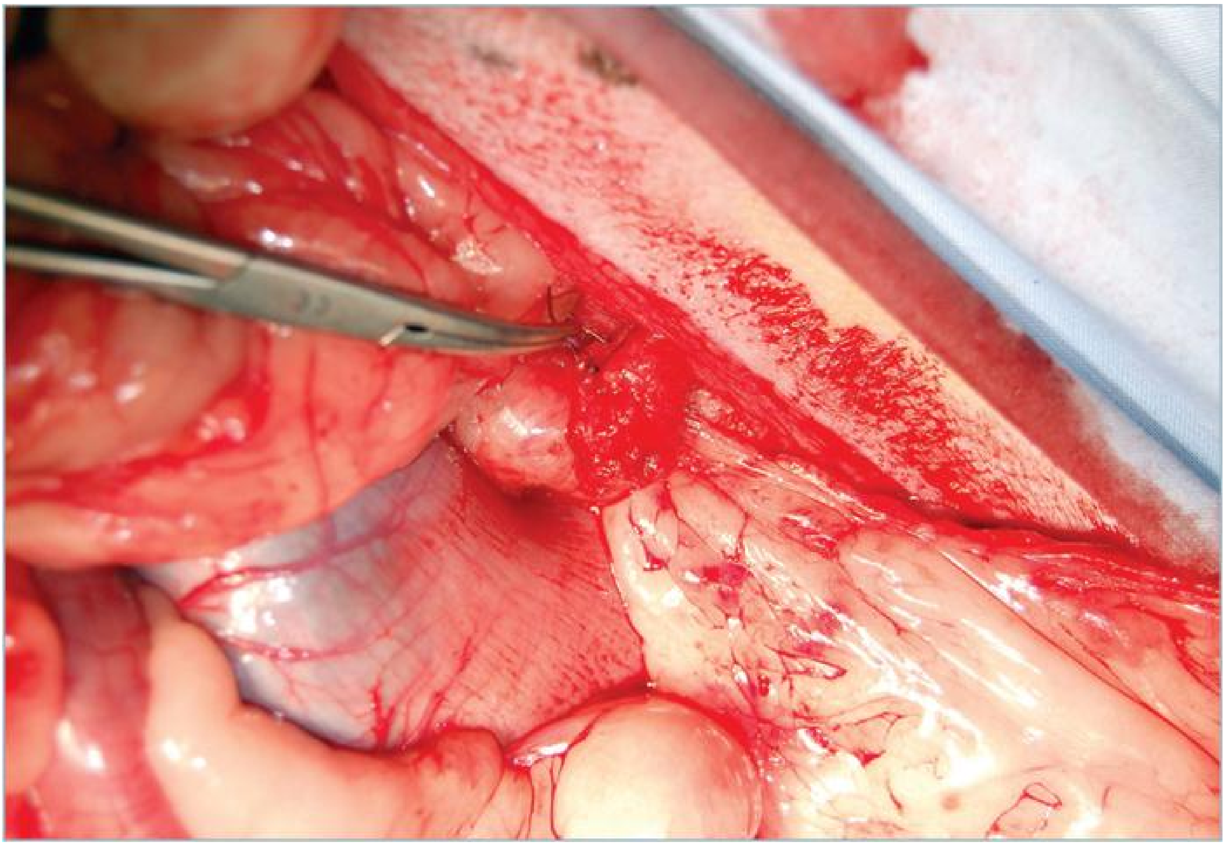

Fig. 9. The pedicle is held without tension by forceps and can be localized when it is sectioned, so that, in the case of hemorrhage because of a poorly placed ligature, it can be rapidly exteriorized.

Now the broad ligament and the round ligament that form the mesometrium and join the uterine horns and body to the abdominal wall are sectioned. Before sectioning, another inclusive ligature with absorbable monofilament material is placed (Fig. 10).

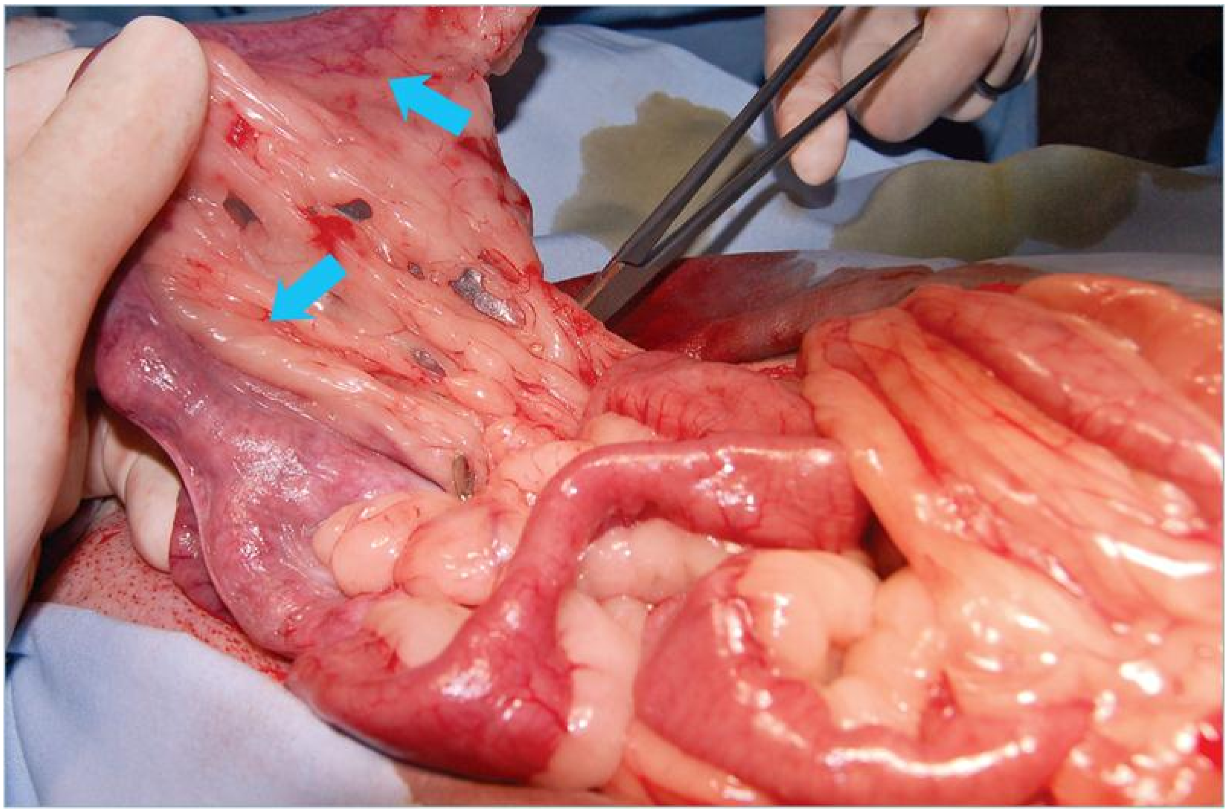

Fig. 10. The mesometrium, or broad ligament, is sectioned along the uterine horn and body. If necessary, ligate or cauterize the vessels, although these are usually only enlarged in dogs that are pregnant, obese or in oestrus.

In general, the vessels are small, with the exception of the uterine vessels, which run parallel and close to the uterus (Fig. 11).
The same operation is repeated on the other side until both uterine horns and the body are completely free.

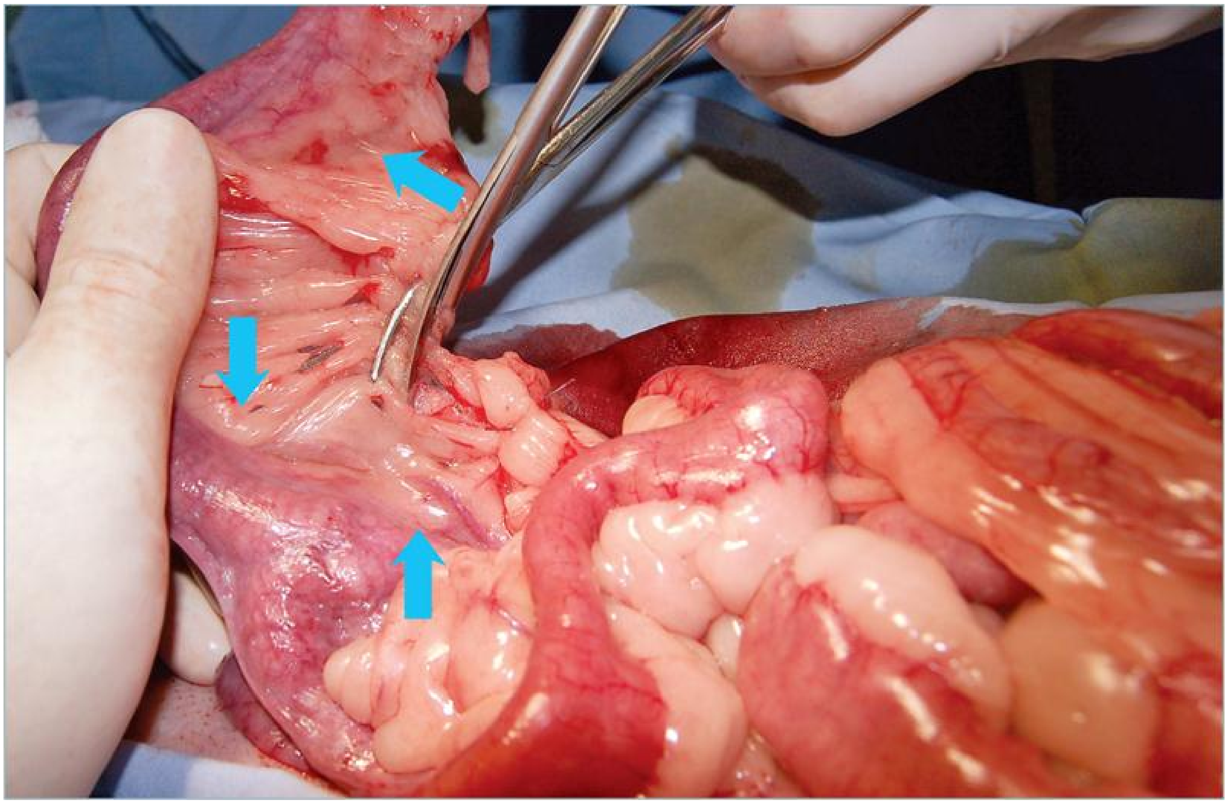

Fig. 11. The round ligament of the uterus is also sectioned in this process. The uterine vessels run in the mesometrium very close to the uterus (blue arrows), but care should be taken not to damage them when the ligament is sectioned close to the uterine body.

The following manipulations are related to the uterine cervix that is located caudally and dorsally to the bladder and can be palpated as an ellipsoid enlarged structure (Fig. 12).

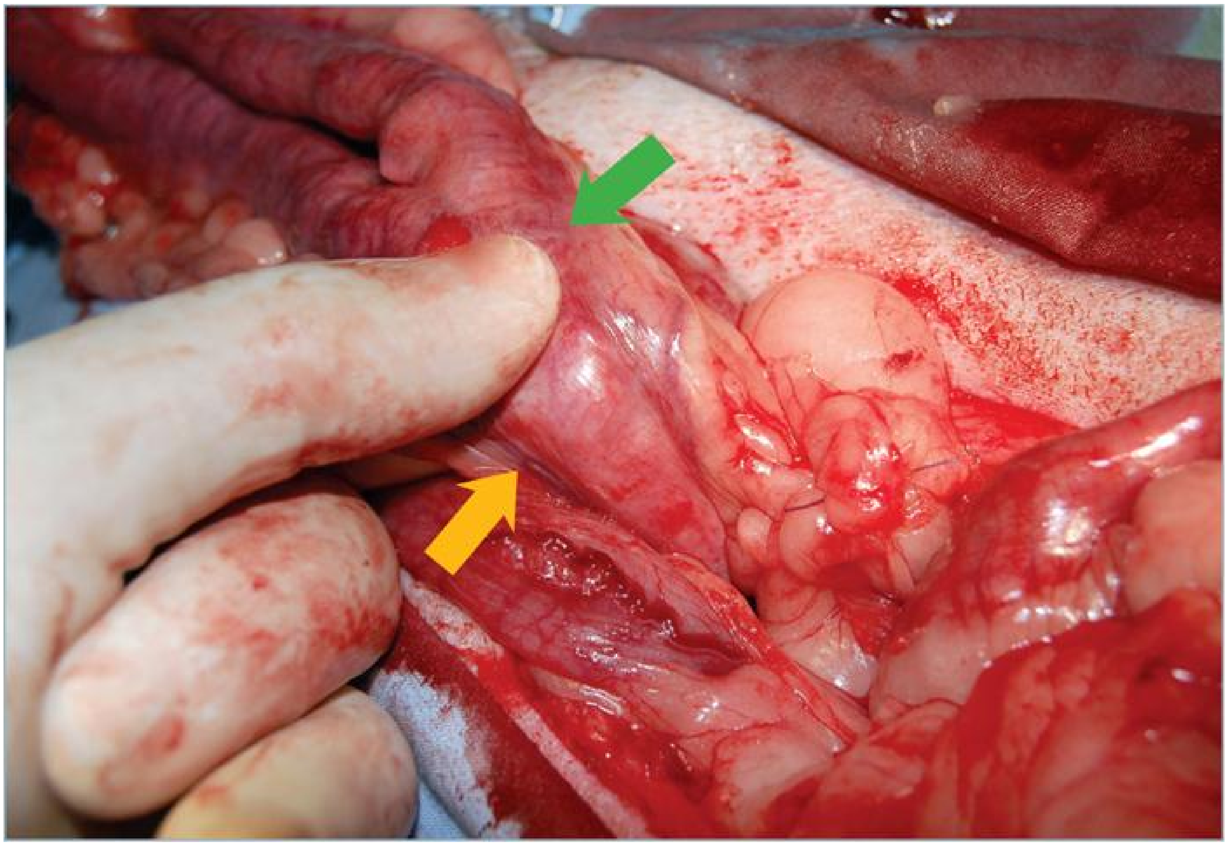

Fig. 12. Once both ovarian pedicles have been ligated and cut, the cervix (yellow arrow) is ligated. This is the enlarged section with a hard consistency that is found at the end of the uterine body (green arrow).

Manipulations in the caudal area of the abdomen close to the bladder should be carried out with care in order to prevent damage to the ureters. Accidental ligation of the ureters may be an undesired complication of ovariohysterectomy.

The caudal uterine vessels are ligated at the cervix. Two transfixing ligatures are placed and the vessels are pressed closed against the uterine tissue with a suture. This prevents the ligatures from slipping off (Figs. 13 and 14).

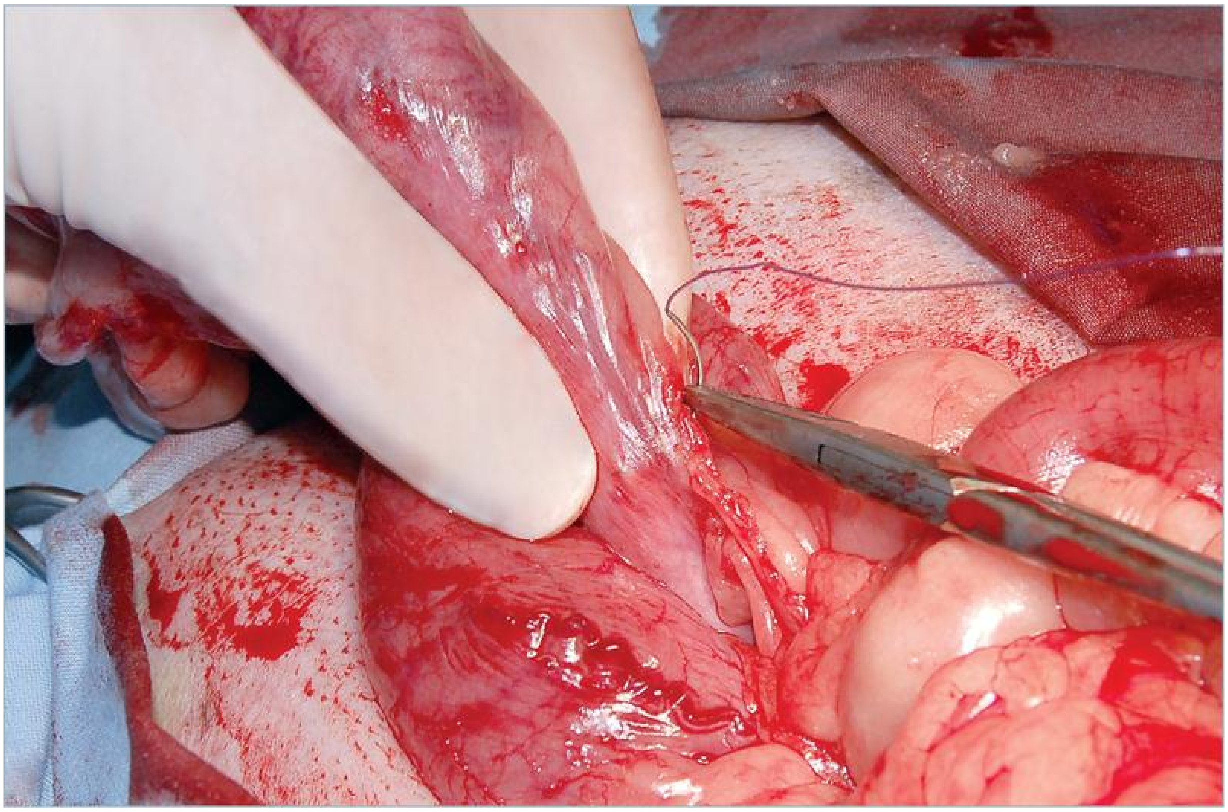

Fig. 13. A transfixing ligature with absorbable monofilament material is placed halfway through the cervix, including the uterine artery and part of the uterine wall.

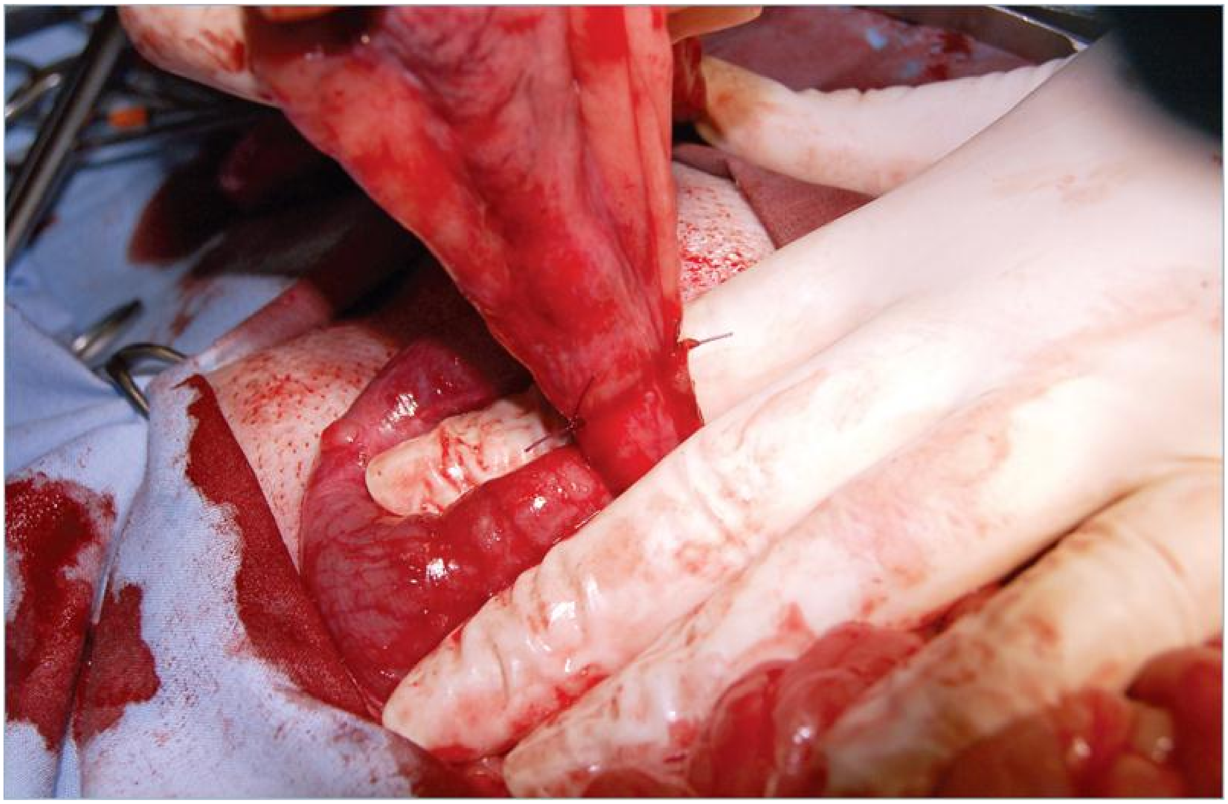

Fig. 14. The same procedure is used for the other side. When placing the ligature, perforation of the uterine lumen should be avoided to prevent potential abdominal contamination.

Before incising the cervix, two straight Pean forceps are placed cranially to the ligatures (Fig. 15). Enough space is left between them to be able to section the cervix, thus avoiding leakage of the uterine contents into the abdomen (Fig. 16).

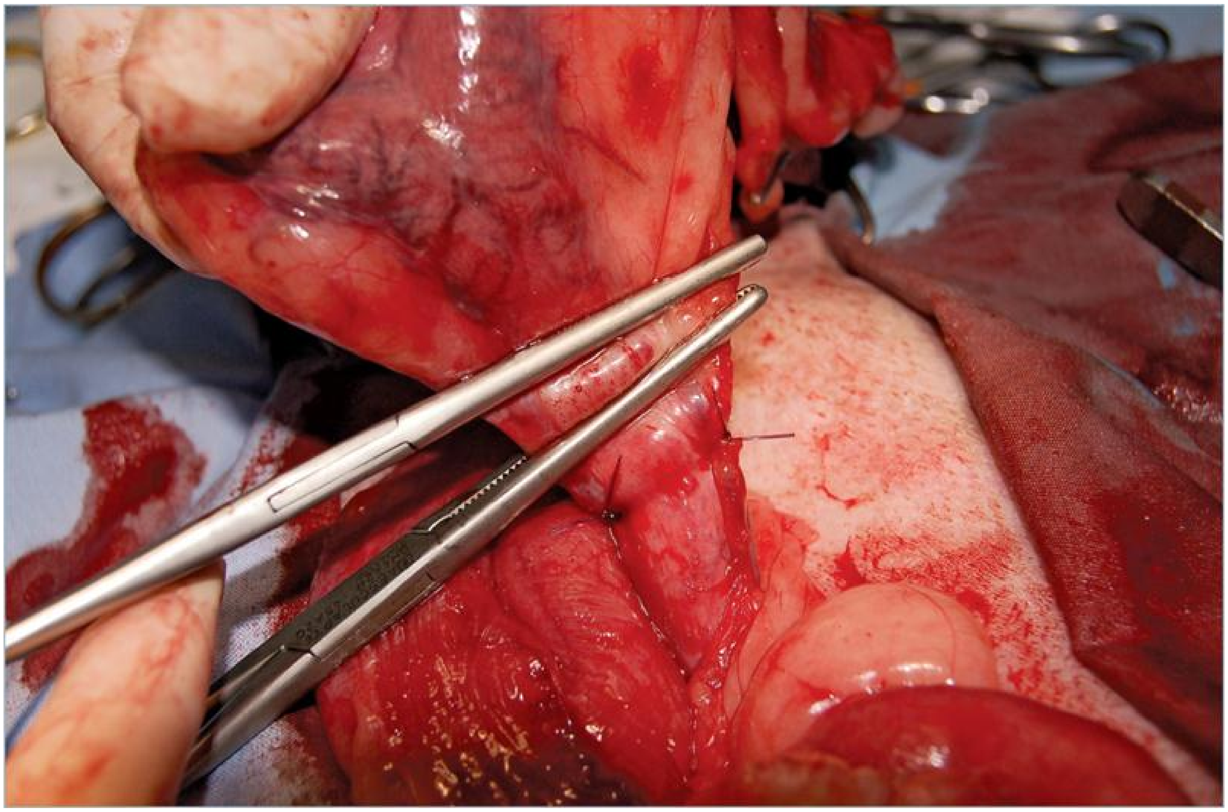

Fig. 15. Two straight Pean forceps are placed on the cervix to prevent spillage of the uterine contents during sectioning, especially in the case of pyometra.

Clamping and sectioning should be carried out just caudal to the uterine body. The uterine body should be completely removed.

Fig. 16. By placing gauze swabs under the area that will be incised, asepsis can be maintained if some secretion leaks from the incision. The incision is made with a scalpel between the two clamps and the uterus is removed.

The incision should be in the cervix, because, if any part of the uterine body remains in the patient, a stump pyometra may develop (Fig. 17).

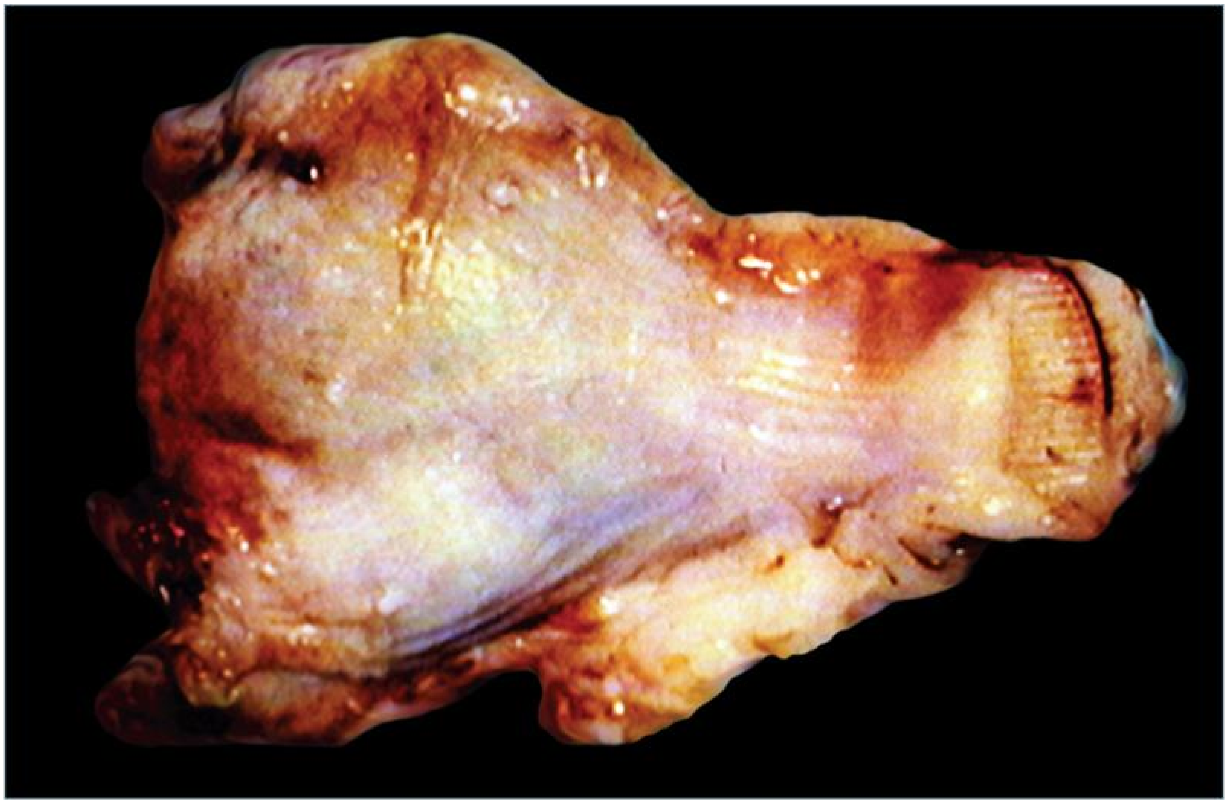

Fig. 17. Uterine body and part of the uterine horns containing purulent material from a patient that underwent an incomplete ovariohysterectomy.

After sectioning the uterus, a Parker-Kerr suture is placed over the remaining clamp, using absorbable monofilament suture and a round-bodied needle. This is a continuous suture, the ends of which are left untied (Fig. 18). The clamp is then withdrawn while opening and closing its jaws. At the same time, an assistant pulls on both suture ends in order to achieve complete closure of the cervix when the clamp is withdrawn (Fig. 19).
The suture ends are tied together and some omentum is fixed in the suture in order to avoid adhesions to the urinary bladder (Figs. 20 and 21).

Finally, the laparotomy incision is closed in the usual manner.

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Ovariohysterectomy and pyometra

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Laparoscopic ovariohysterectomy

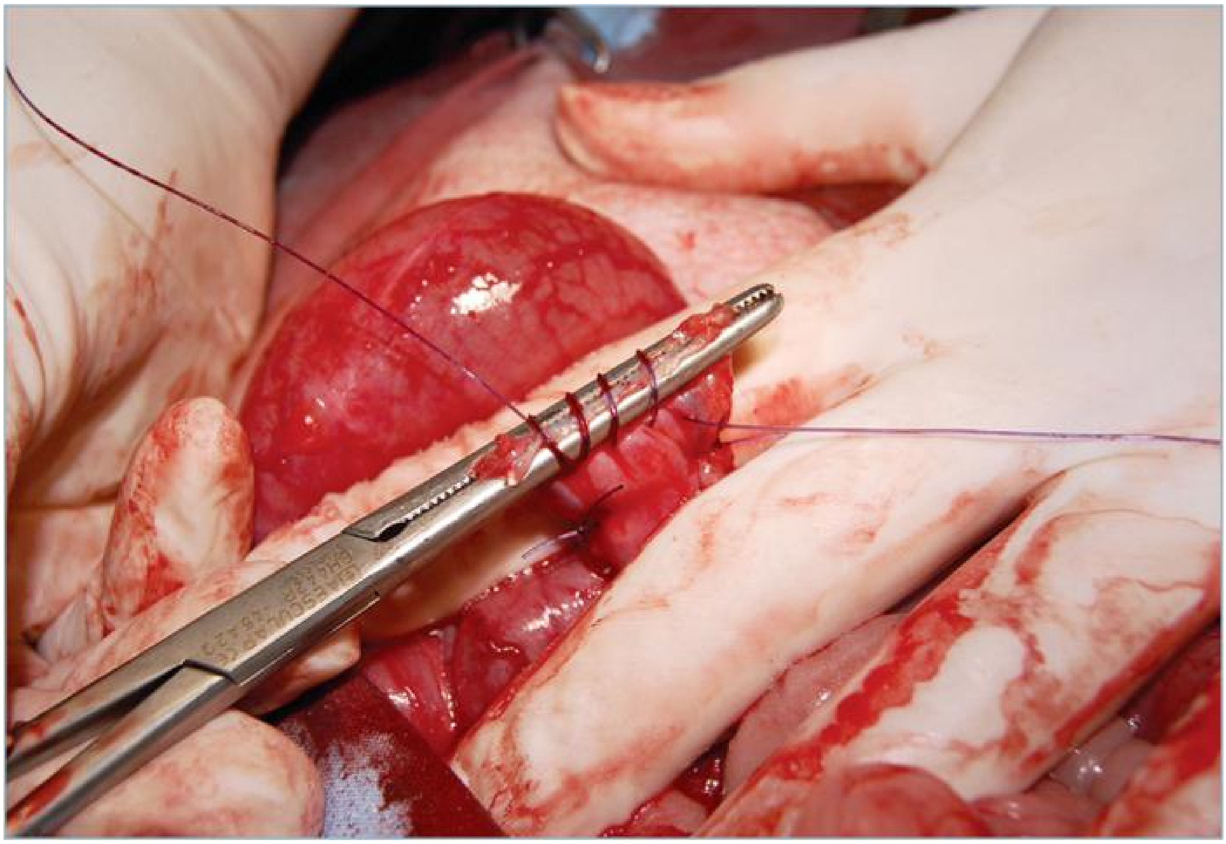

Fig. 18. Impermeability of the cervix can be achieved with a Parker-Kerr suture over the hemostatic forceps. This is a continuous suture that includes part of the cervix, leaving the suture ends untied.

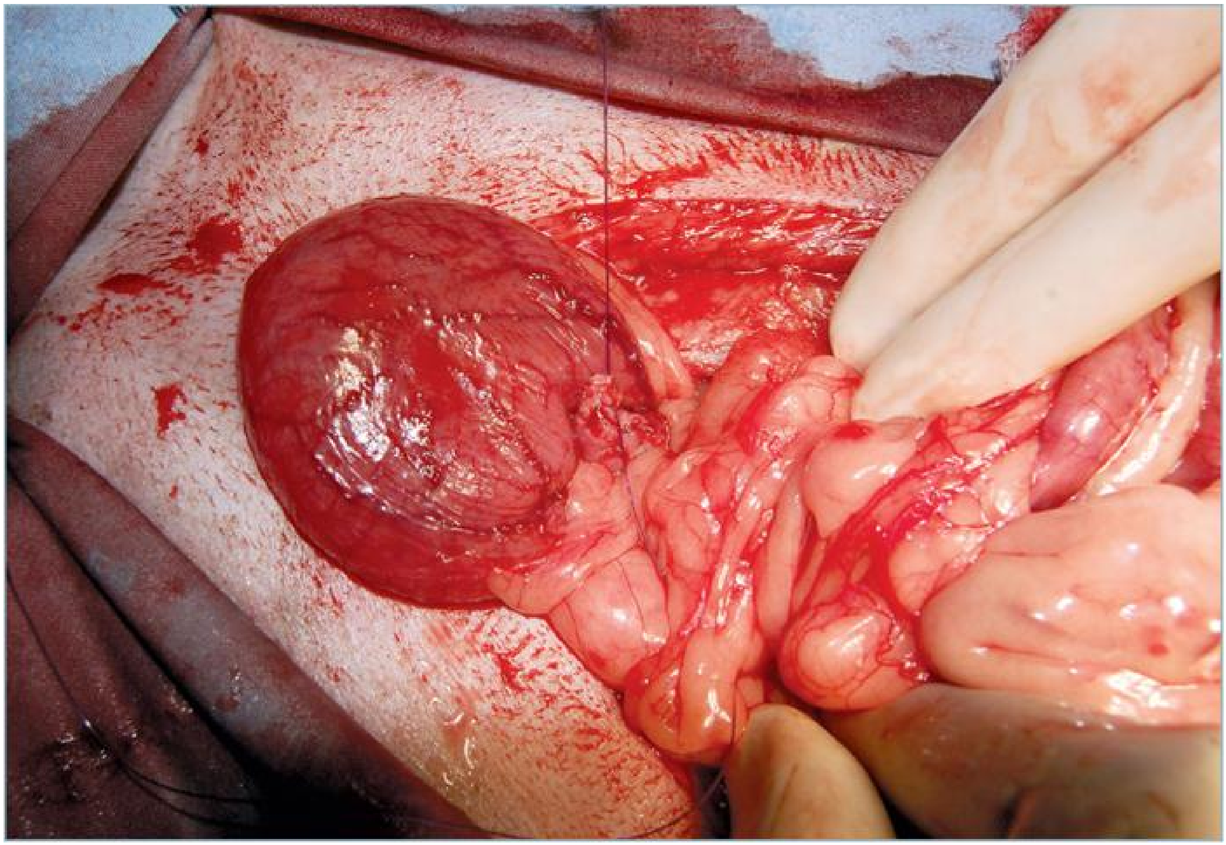

Fig. 20. The two ends of the monofilament material are tied together and the same suture is used to fix a section of omentum to the stump.

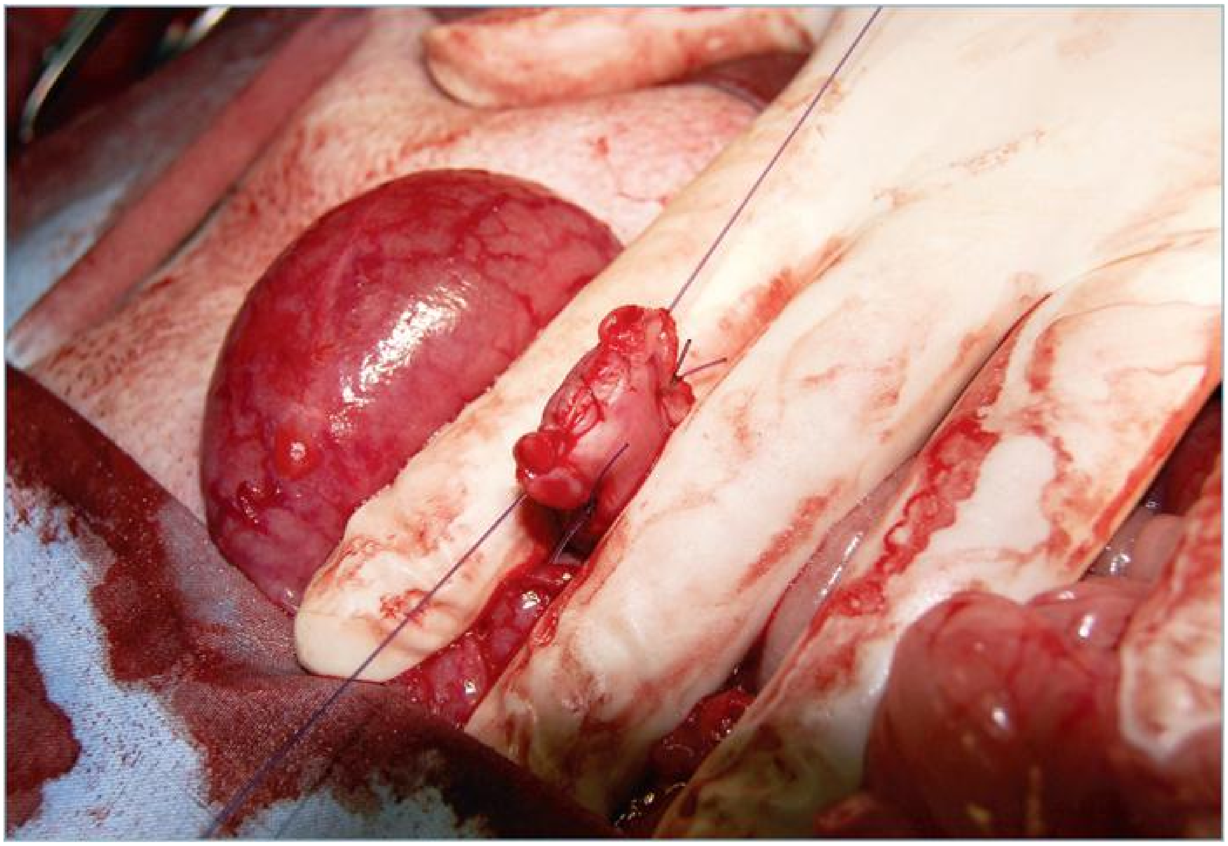

Fig. 19. This picture shows the cervix after removal of the hemostatic forceps with the suture ends pulled tight.

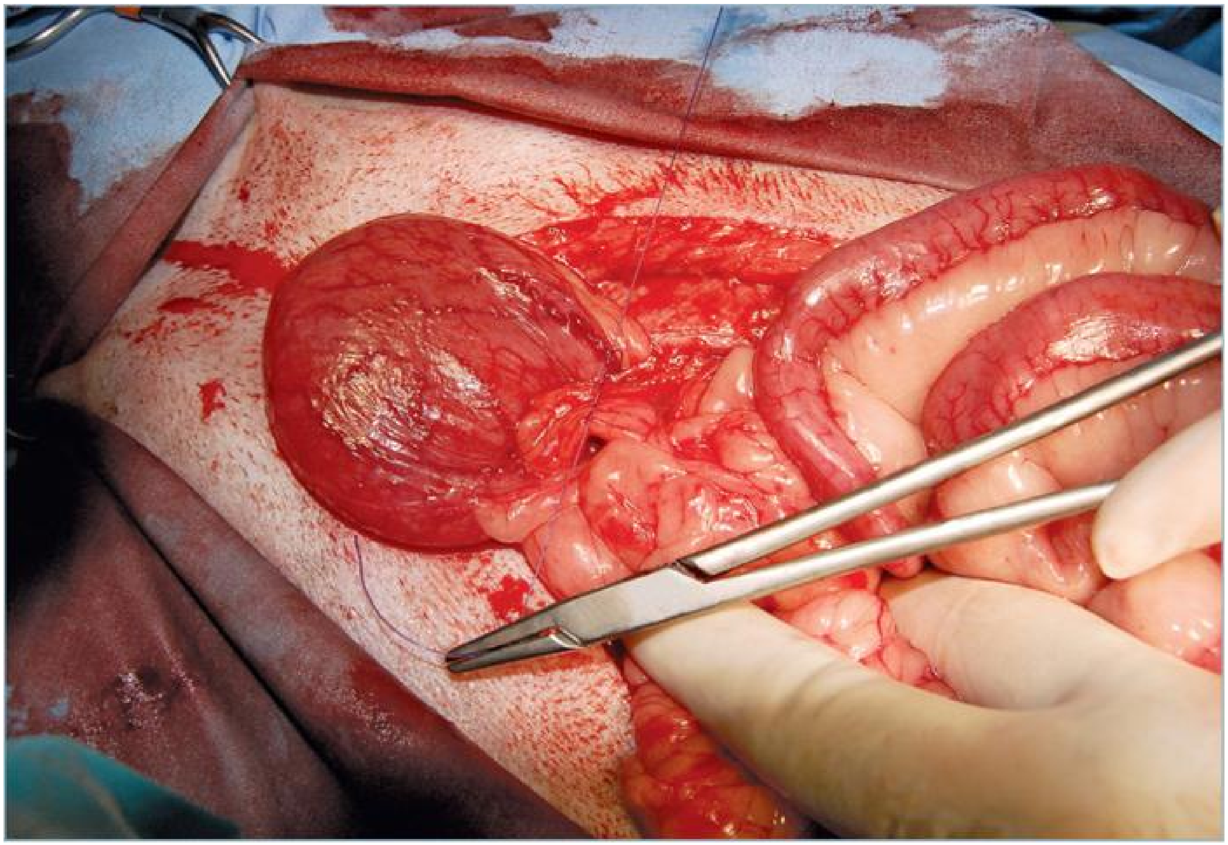

Fig. 21. By fixing the omentum to the cervix, adhesions between cervix and urinary bladder are avoided, thus preventing potential urinary incontinence.

Pyometra / Cystic endometrial hyperplasia

José Rodríguez Jaime Graus
María José Martínez

Prevalence	■	■	■	■	■
Technical difficulty	■	■	□	□	□

Cystic endometrial hyperplasia and pyometra are potentially fatal uterine disorders. It develops during diestrus, when progesterone production is high, or following exogenous administration. This hormone increases uterine secretion, reduces muscular contraction and closes the cervix.

Initially, it is an aseptic disorder, but ascending contamination from the vagina leads to a pyometra.

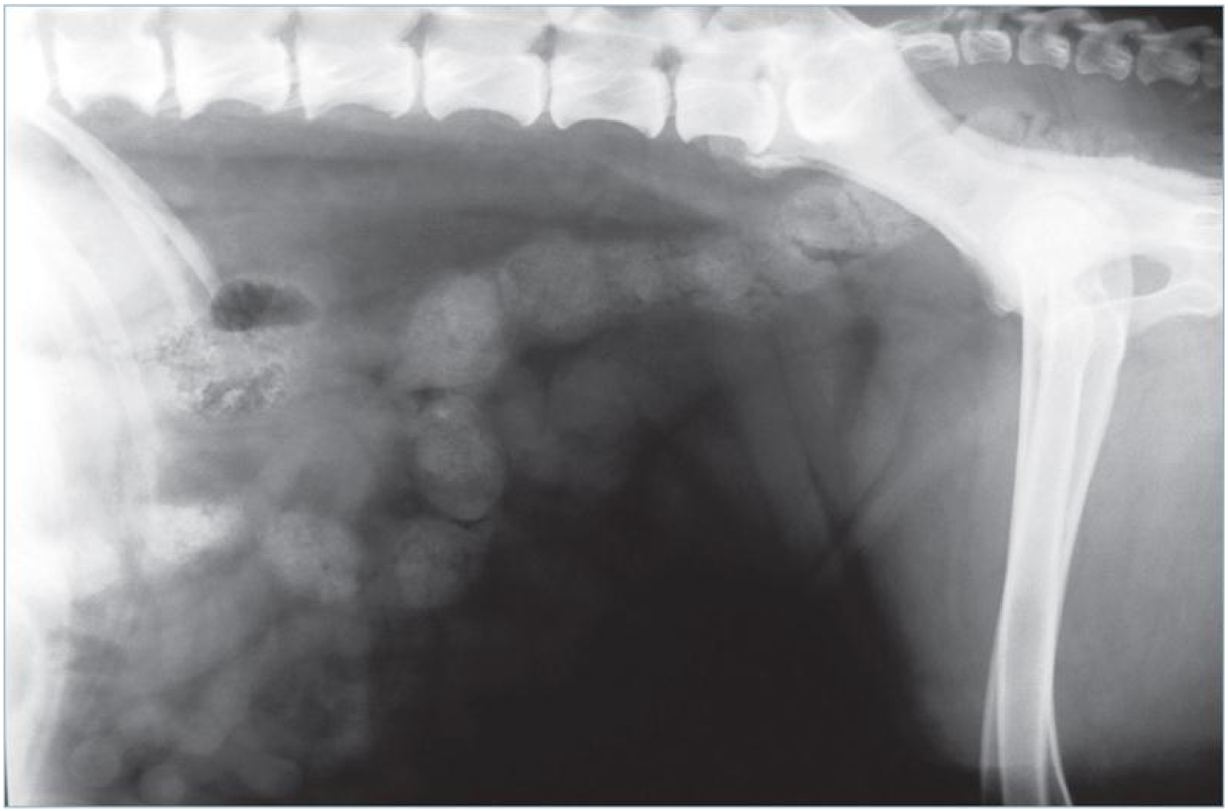

Fig. 1. Chronic open cystic pyometra, allowing pus to leave the uterus. In these cases, a distended uterus is easily visible between the colon and the bladder.

The differential diagnosis of patients with polyuria and polydypsia should include diabetes mellitus, renal insufficiency, hyperadrenocorticism and generalized hepatopathy.

Fever is not considered an important clinical sign in pyometra. Only 20 % of cases have pyrexia.

Pyometra can occur in the first 2 to 3 months after heat. It can affect patients of all ages, including young dogs after the first heat.

Pyometras can be open or closed. In the first case, the uterine distension is small (Fig. 1) and a purulent, sometimes hemorrhagic, vulvar discharge is noted. In so-called closed pyometras, the symptoms are more severe. The clinical signs in these patients include abdominal distension due to the accumulation of pus inside the uterus (Fig. 2), anorexia produced by the endotoxemia or septicemia, dehydration, polyuria and polydypsia. Temperature is not a reliable parameter, as it can be normal, increased or decreased.

E. coli ***is the most commonly isolated pathogen in pyometra.***

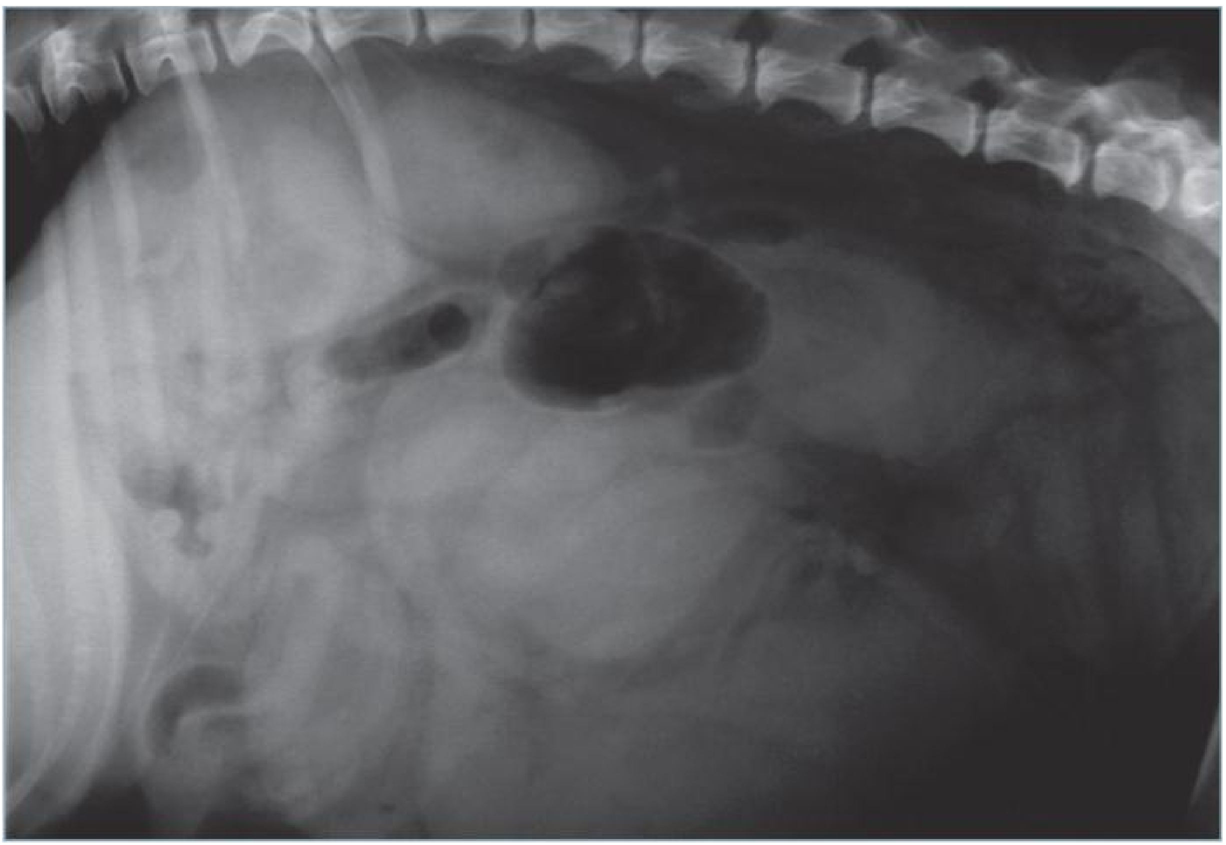

Fig. 2. In this case, where the cervix remained closed, the uterus is enlarged, occupying the medioventral region of the abdomen, displacing the intestines in a craniodorsal direction.

Laboratory tests

These patients often have leukocytosis with a left shift and toxic neutrophils. However, in some cases, the leukocyte count may be normal due to the diffusion of white blood cells into the uterus, or even low due to septicemia.
Non-regenerative, normochromic and normocytic anemia may occur.

Changes in the blood chemistry are characterized by:

- Hyperproteinemia
- Hyperglobulinemia
- High urea levels
- High creatinine levels
- Moderately increased ALT and alkaline phosphatase levels.

Urinalysis may reveal proteinuria, isosthenuria and bacteriuria.

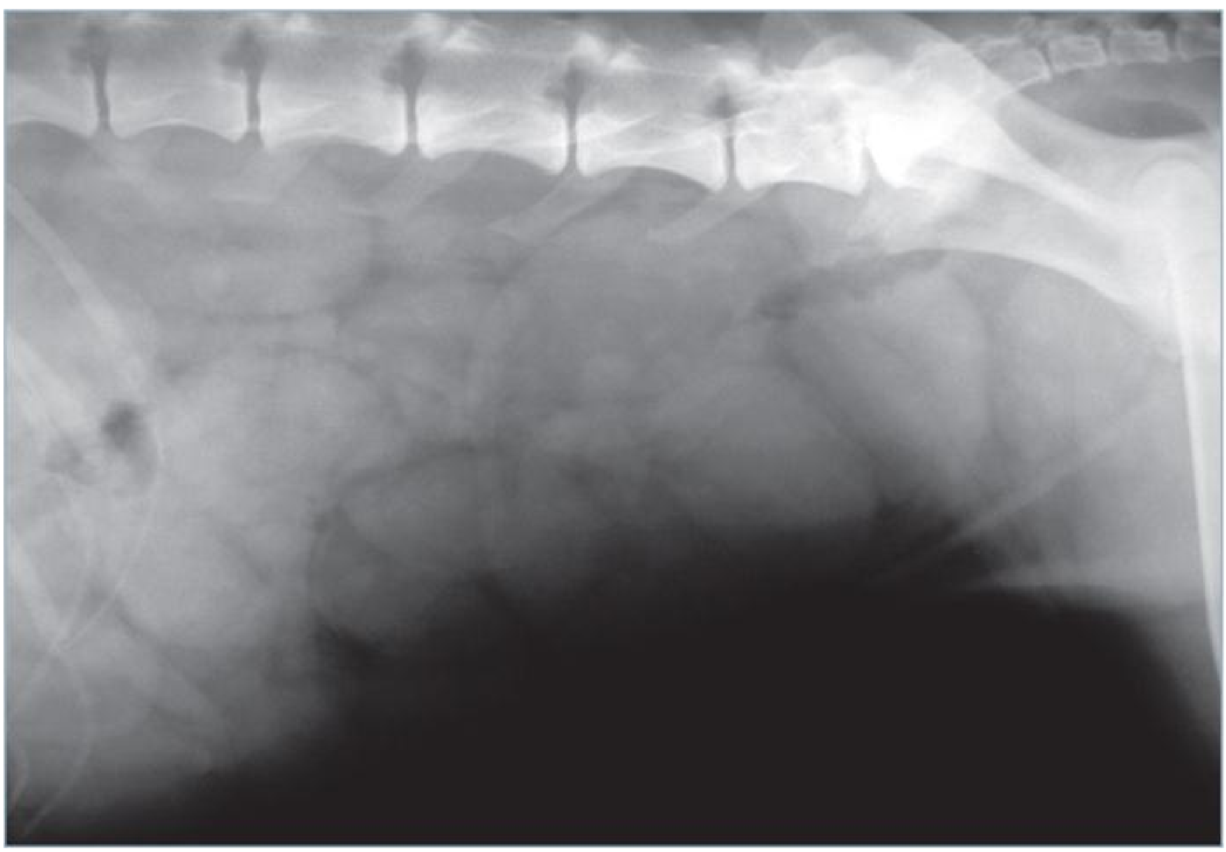

Fig. 3. Closed pyometra, with obvious uterine distension.

Treatment

Although medical treatment exists, the most common treatment for these cases is ovariohysterectomy (Fig. 5).

Diagnosis

This is based on the clinical signs and the time since the last heat, as well as radiographic and ultrasound findings.
Abdominal radiographs of cats and dogs with pyometra show a homogenous, tubular structure that occupies the caudal abdomen (Figs. 1-3). However, this may be confused with the uterus post-partum or during the first 40 days of gestation, before foetal calcification (Fig. 4).

Ultrasonography is the most reliable diagnostic method to differentiate these conditions.

Fig. 4. Distended uterus in the first weeks of pregnancy.

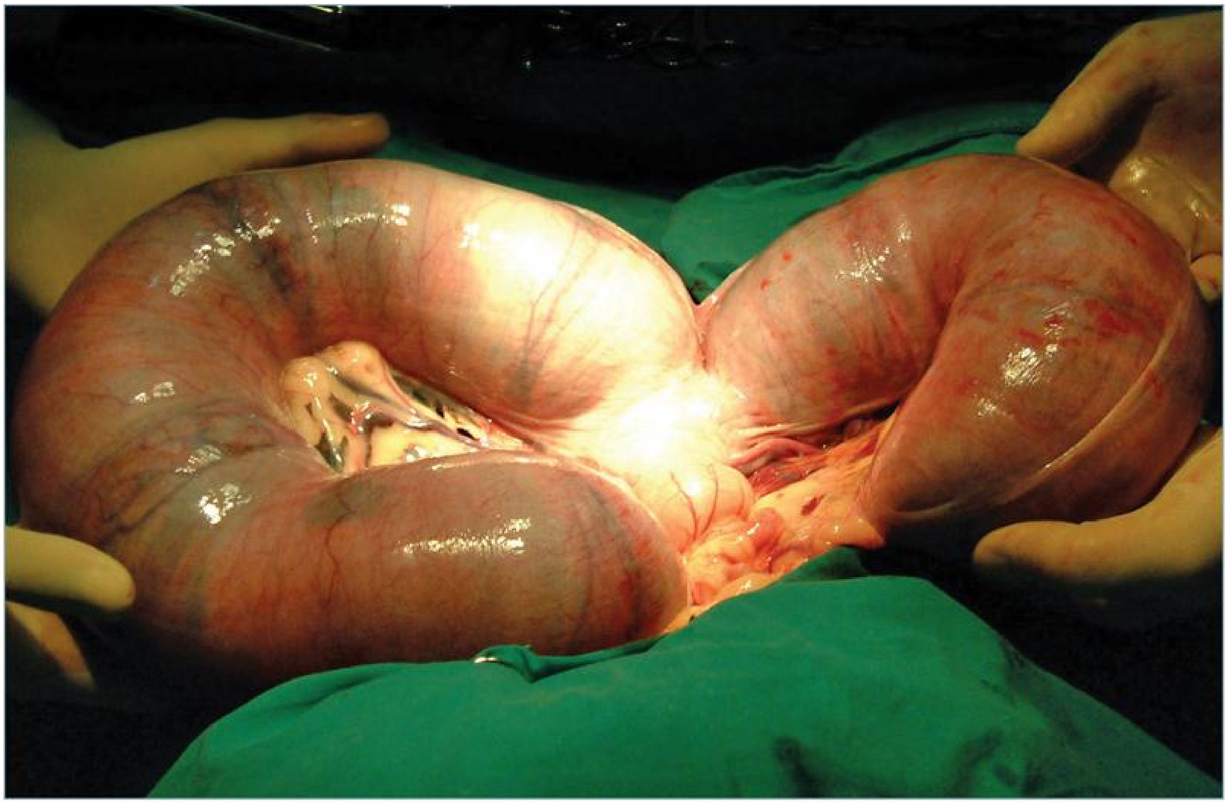

Fig. 5. This patient, with severe pyometra, will undergo ovariohysterectomy.

Before surgery

Correct any fluid and electrolyte imbalances, and ensure adequate renal perfusion during anesthesia. Antibiotic therapy against *E. coli,* e.g. ampicillin or amoxicillin-clavulanic acid, should be started as soon as possible.

A uterus with pyometra is very friable and should be manipulated gently during surgery to prevent tearing.

Before detaching the uterus, protect the abdominal cavity with sterile gauze.

Technical considerations

In this surgery, particular care should be taken when ligating vessels. Ensure there is no abdominal contamination due to purulent material from the uterus, and remove any uterine remnants that might maintain the infection, the so-called uterine stump pyometra.

To achieve this, choose between ligation and coagulation of the uterus at the cervix (technique 1, Figs. 6-9), or ligate the organ with a Parker-Kerr suture (technique 2, Figs. 10-13). Before closing the abdominal cavity, it should be abundantly lavaged with lukewarm sterile saline.

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Ovariohysterectomy and pyometra

Technique 1

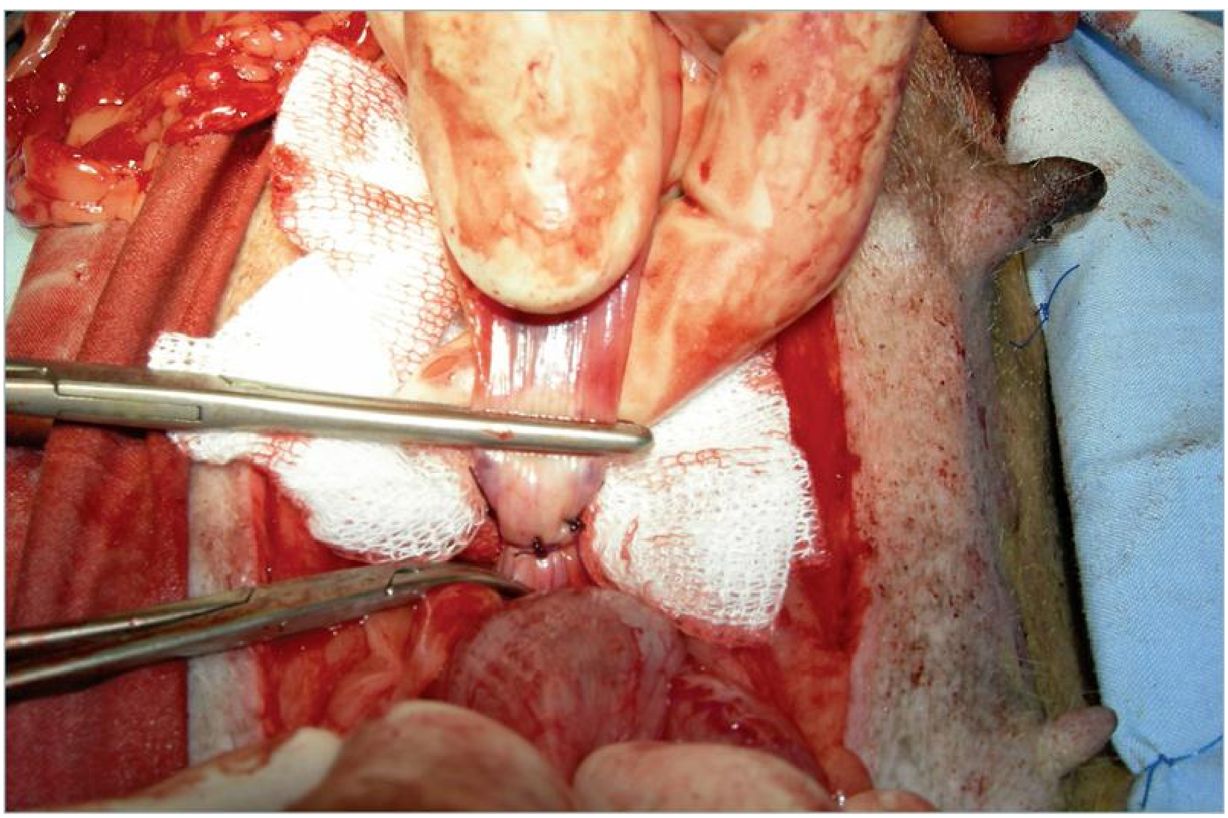

Fig. 6. After ligating the caudal uterine and uterine body vessels at the cervix, the distal end of the uterus is clamped and the abdominal cavity is protected with sterile gauze.

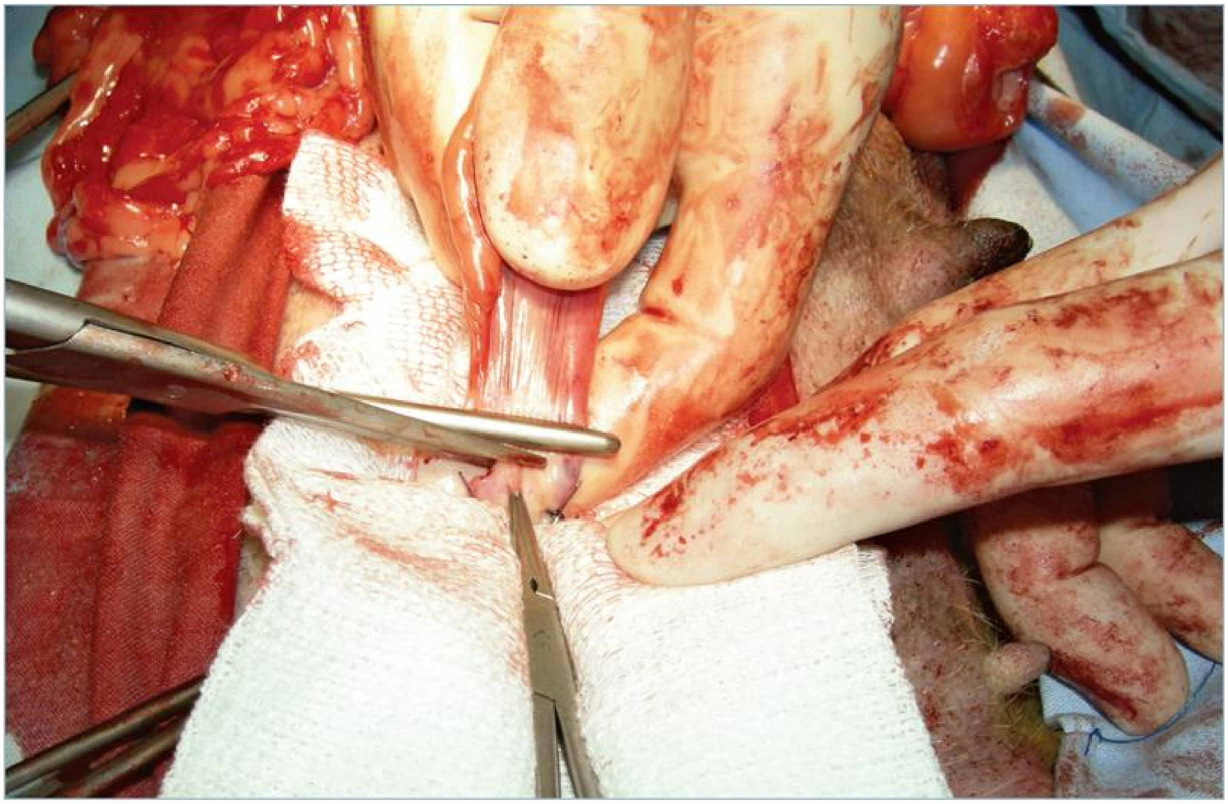

Fig. 7. To prevent the uterine stump from sliding backward, the cervix is fixed with artery forceps before severing and removing the uterus.

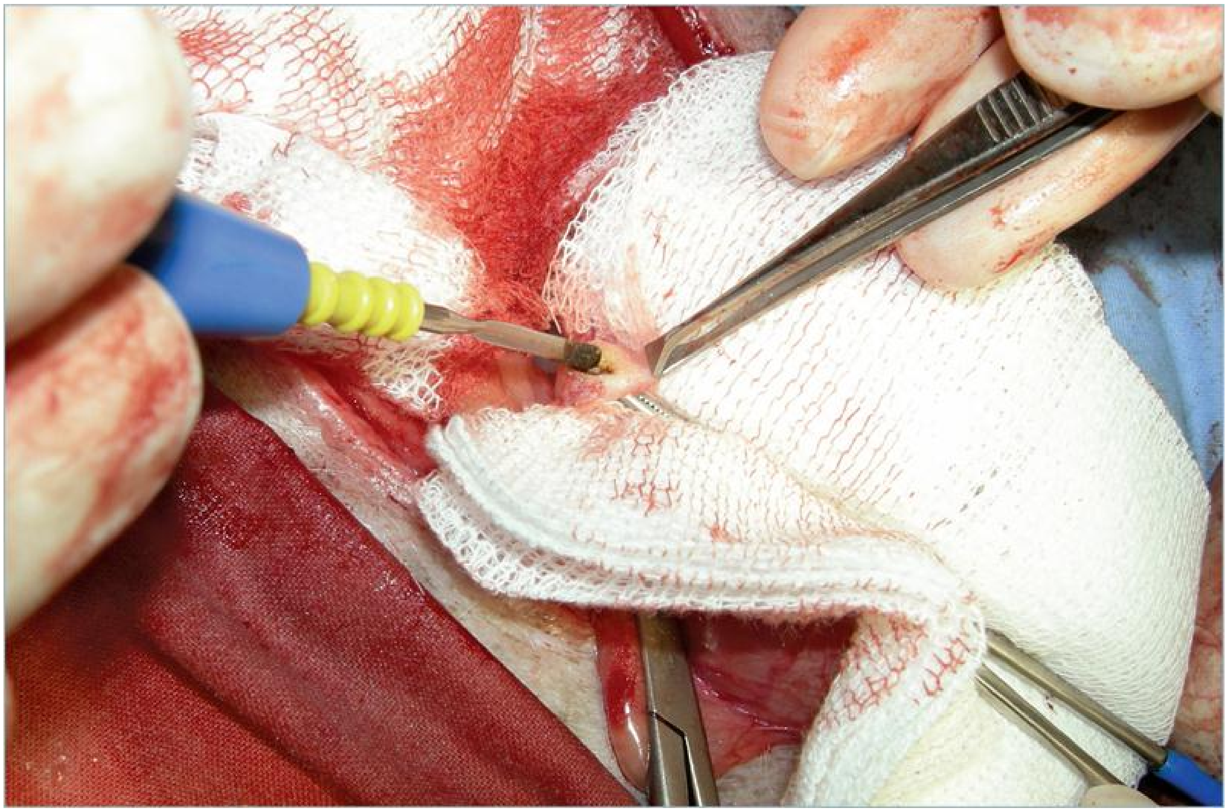

Fig. 8. Monopolar coagulation is used on the uterine stump to destroy any bacteria that may have remained.

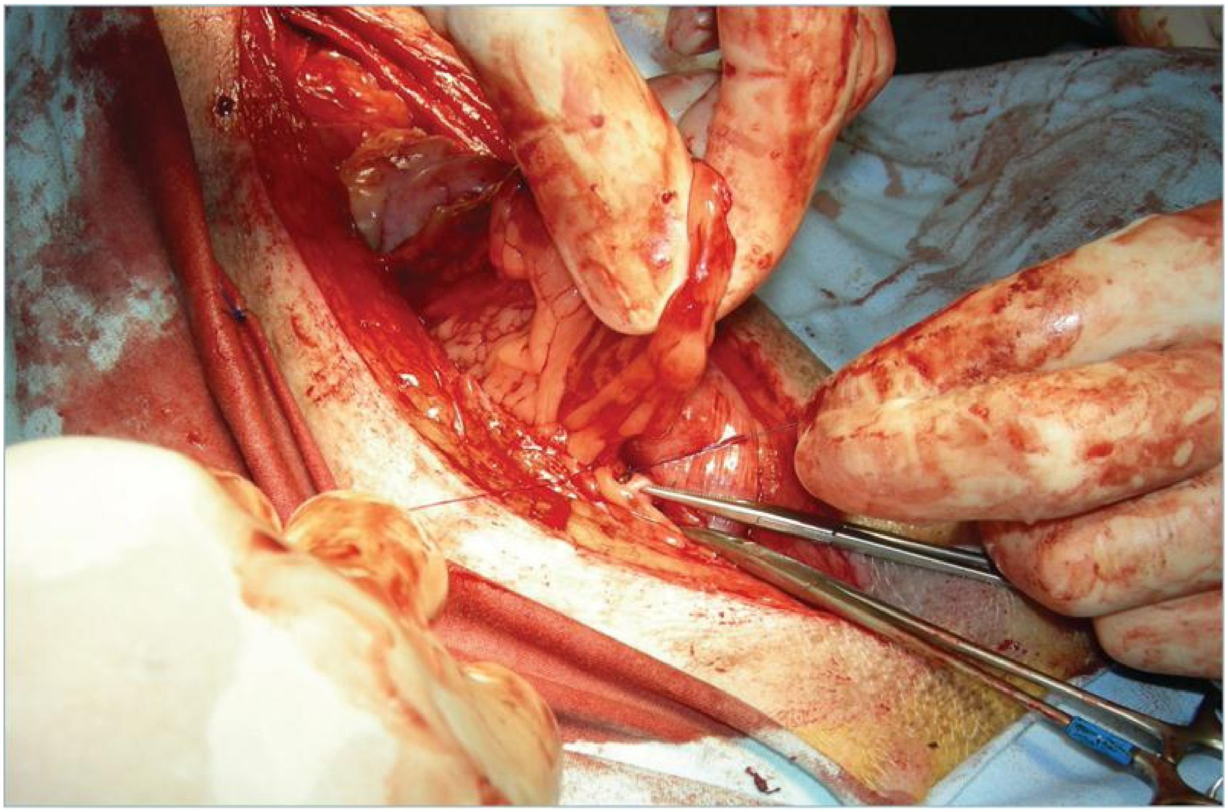

Fig. 9. The uterine stump is omentalized to promote healing, fight infection and prevention adhesions to other abdominal structures.

Technique 2

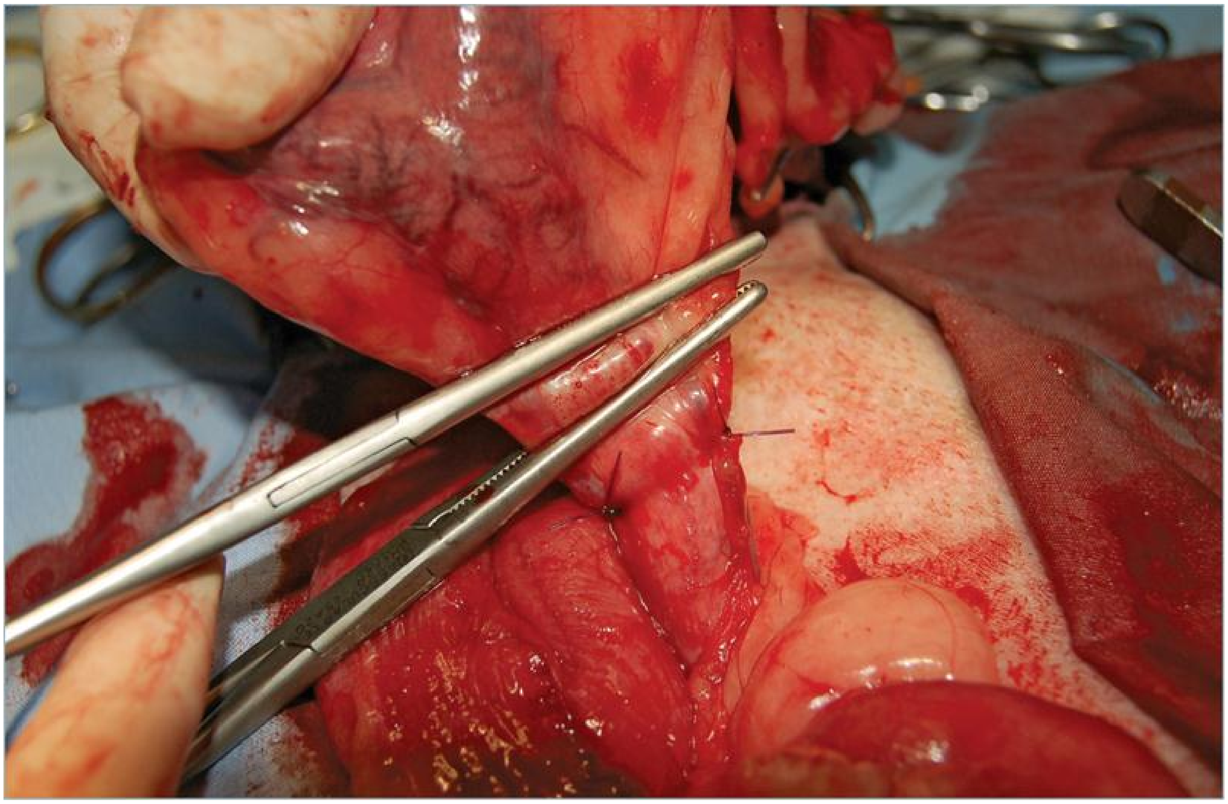

Fig. 10. To prevent leakage of uterine contents, two clamps are placed at the cervix. Make sure the caudal clamp is placed on the cervix.

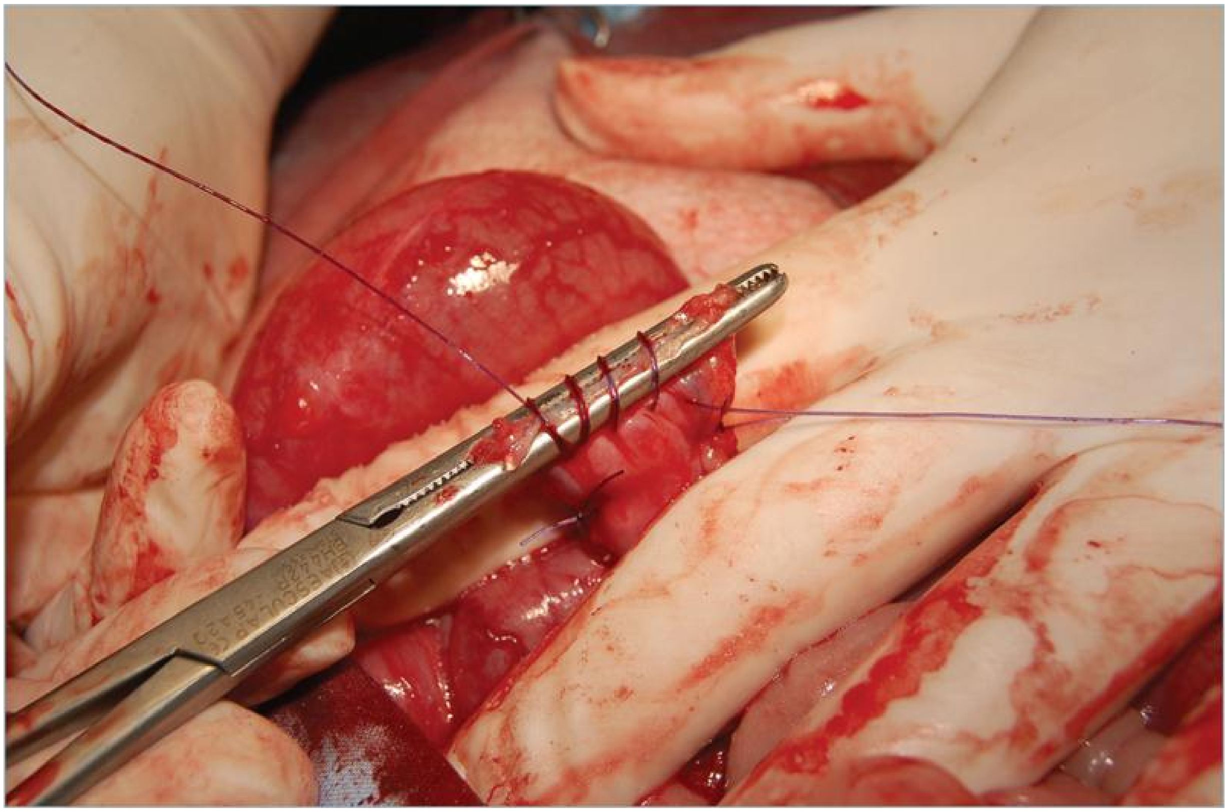

Fig. 11. After cutting between the clamps with a scalpel, a suture is placed over the remaining clamp, using monofilament synthetic absorbable material without a knot at the start.

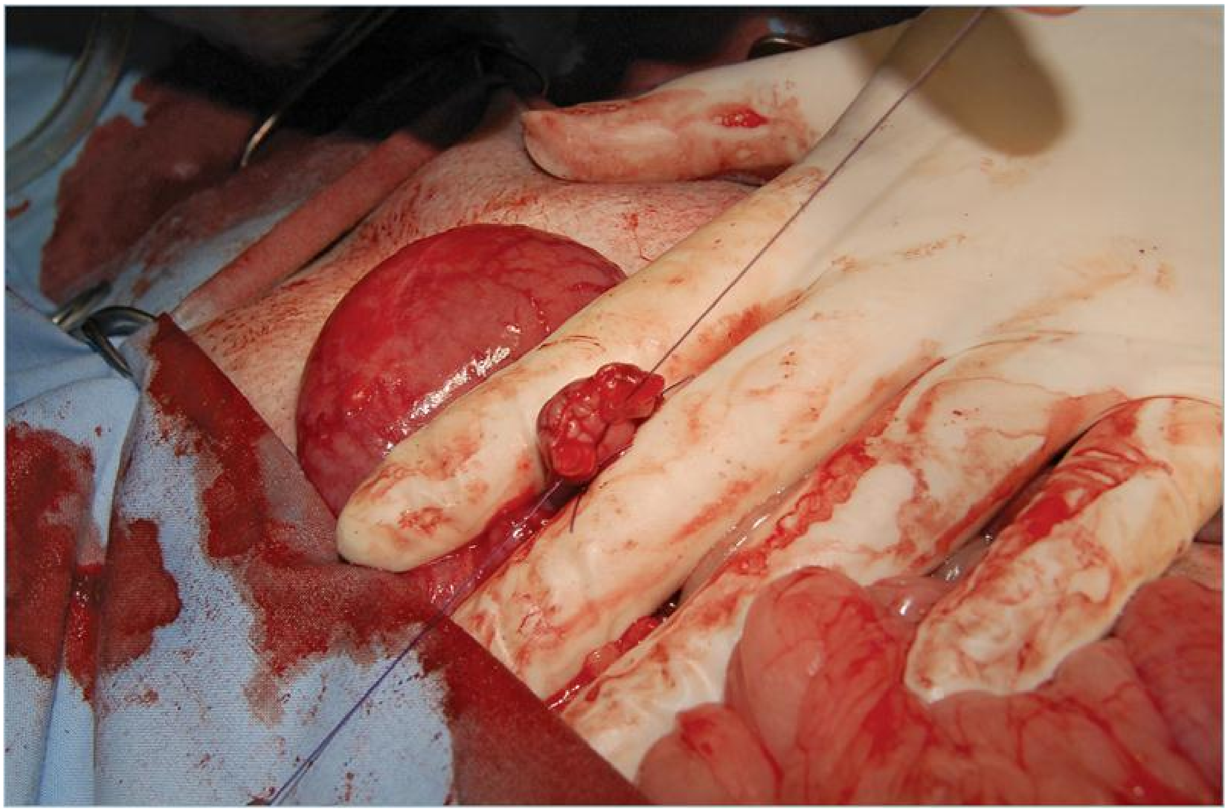

Fig. 12. The clamp is removed and, by pulling on the suture in opposite directions, the uterine stump is closed. The ends of the suture are then tied to each other.

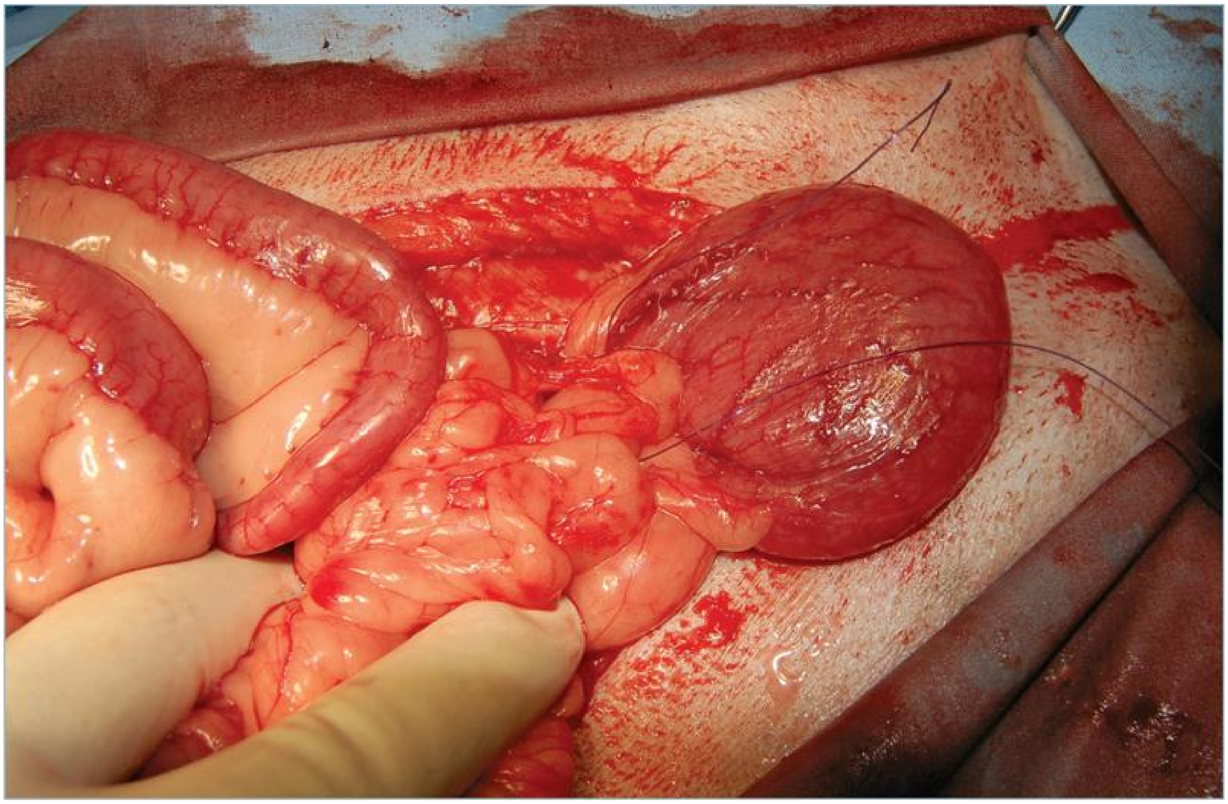

Fig. 13. As in all of these cases, the uterine stump is omentalized. In this case, a piece of omentum is placed over the suture and another knot is tied over the top.

Cystotomy

José Rodríguez

Prevalence	■	■	■	□	□
Technical difficulty	■	■	□	□	□

Cystotomy* is the surgical technique used to gain access to the inside of the bladder in order to extract calculi, remove a tumor or take a biopsy of the bladder wall.

After midline laparotomy, the bladder is identified, exteriorized and isolated (Fig. 1). To keep the cystotomy open, two stay sutures are placed on each side of the bladder midline.

Before incising the bladder, it is recommended that a urine sample is taken for microbiological culture by direct cystocentesis.

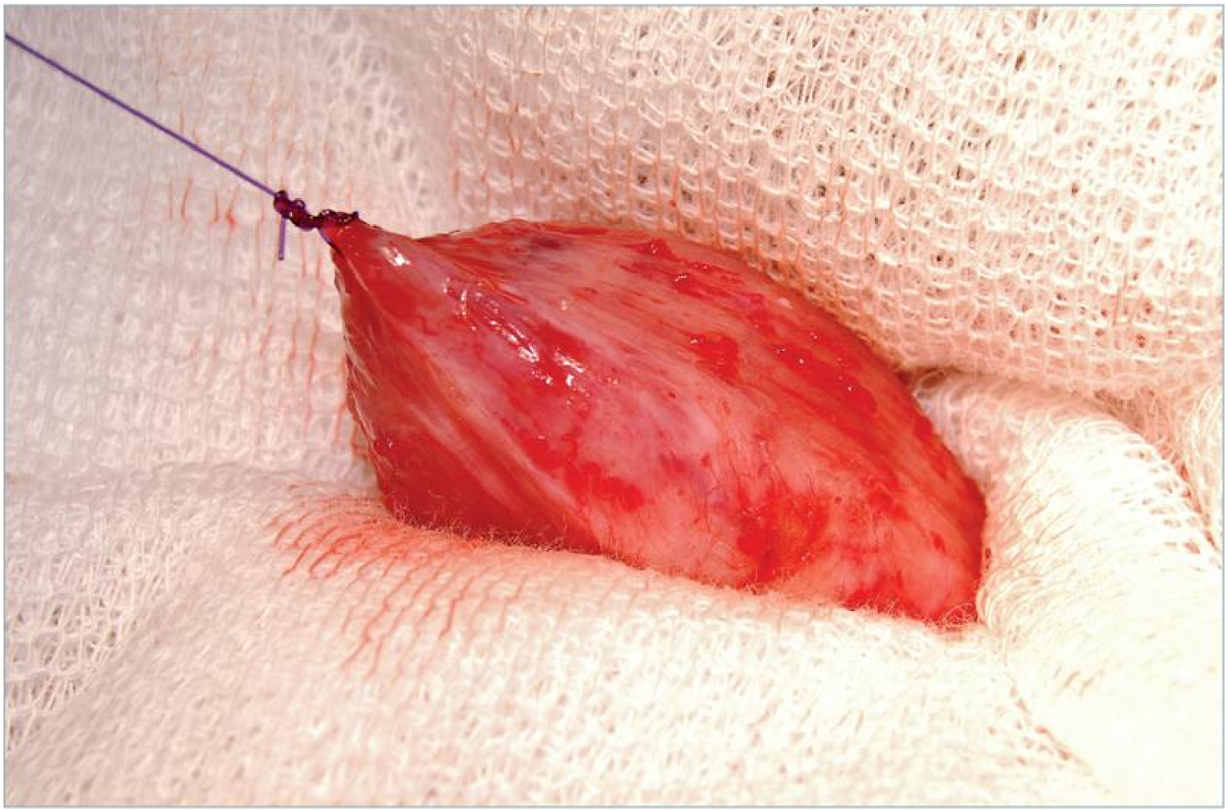

Fig. 1. The bladder is pulled from the abdominal cavity and isolated with sterile surgical compresses. To keep the bladder from slipping back into the abdomen, a stay suture is placed near the apex.

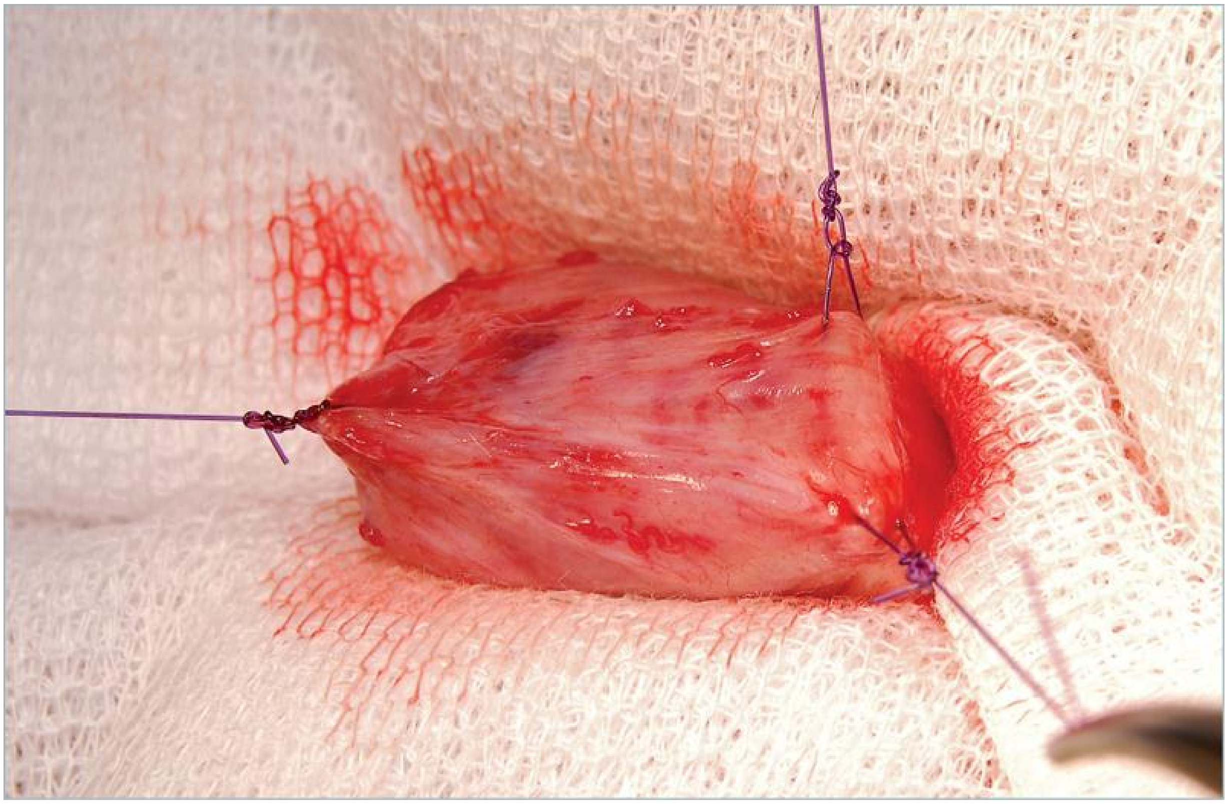

Fig. 2. Two more stay sutures are placed to keep the edges of the cystotomy open during surgery.

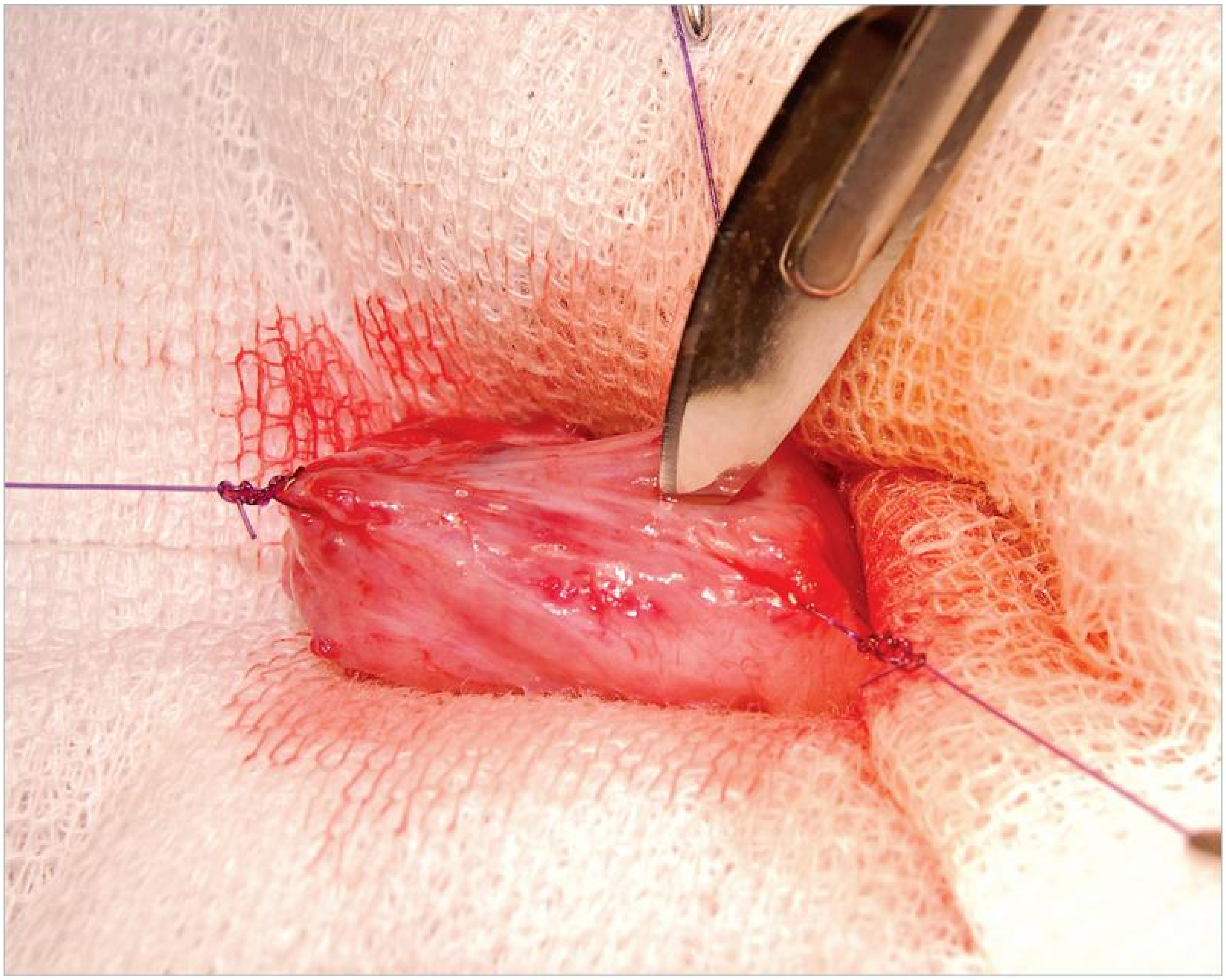

Fig. 3. Incision of the bladder with a scalpel causes little trauma. Care should be taken not to cut major vessels.

The incision is made with a scalpel between the traction sutures. A poorly-vascularized area should be chosen (Fig. 3).
Now, the intravesicular procedure that had been planned may be carried out e.g. calculi extraction (Fig. 4).

The incision can be made either on the dorsal or the ventral side, always avoiding damage to the large blood vessels.

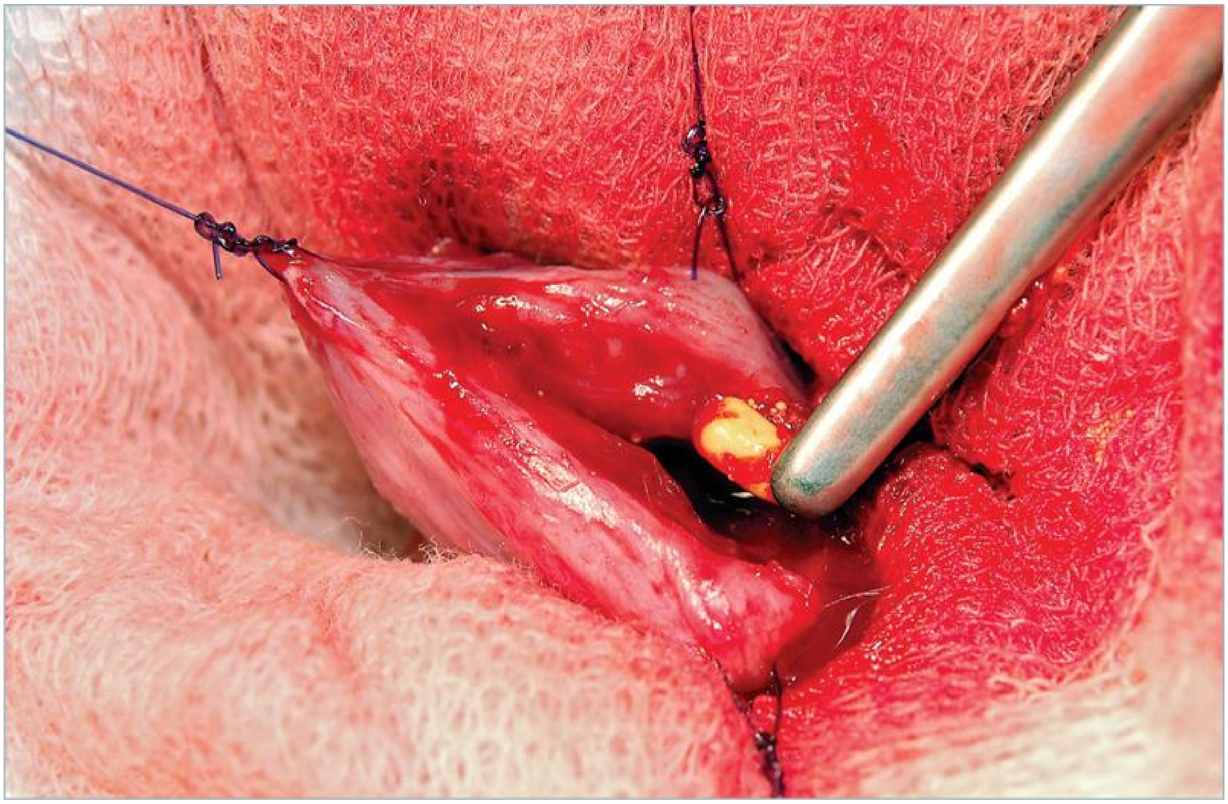

Fig. 4. This image shows the extraction of a number of calculi from the bladder.

After completing the intravesicular procedure, the bladder should be flushed through a urinary catheter; grit and blood clots are flushed to the surface (Fig. 5).

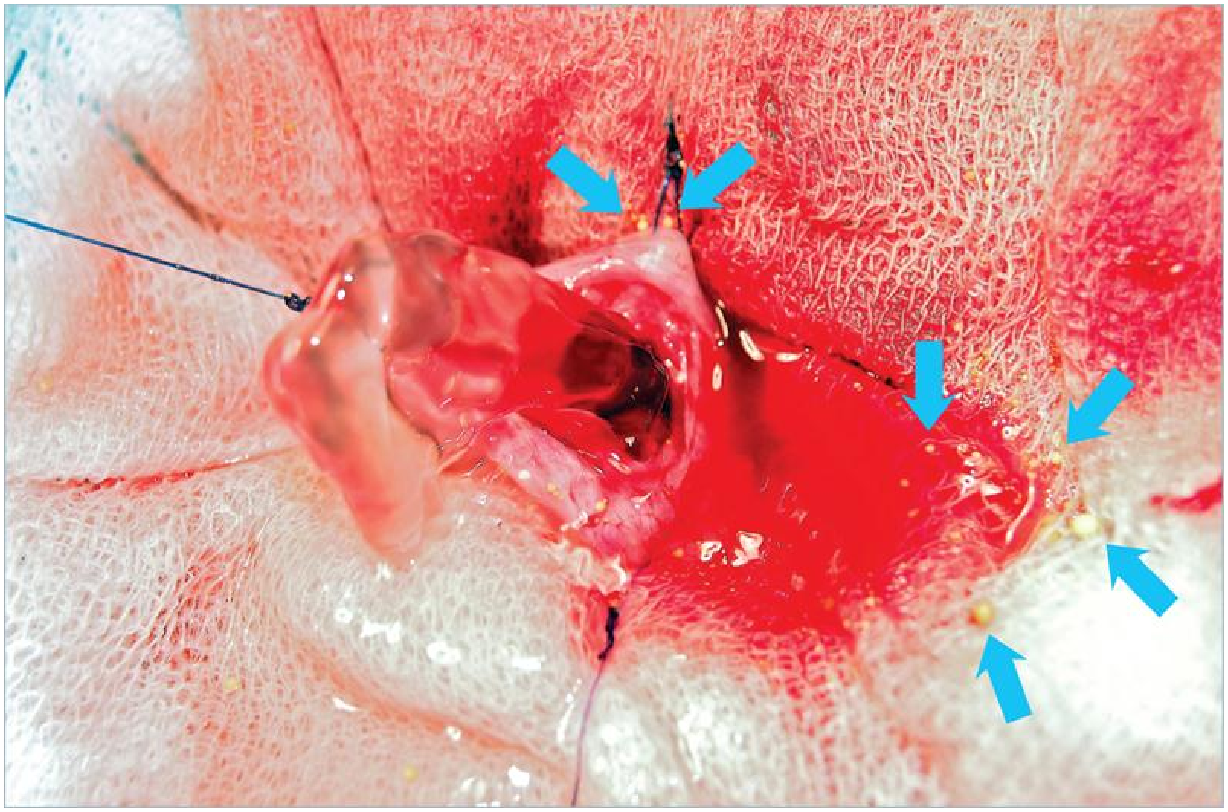

Fig. 5. Injection of sterile saline through a urinary catheter permits removal of the minute calculi (arrows) and grit that were trapped in the folds of the bladder mucosa, as well as blood clots that may have formed during surgery.

The cystotomy wound is closed with monofilament synthetic absorbable material, using the suture pattern of the surgeon’s choice, but taking care not to perforate the mucosa (Figs. 6 and 7).

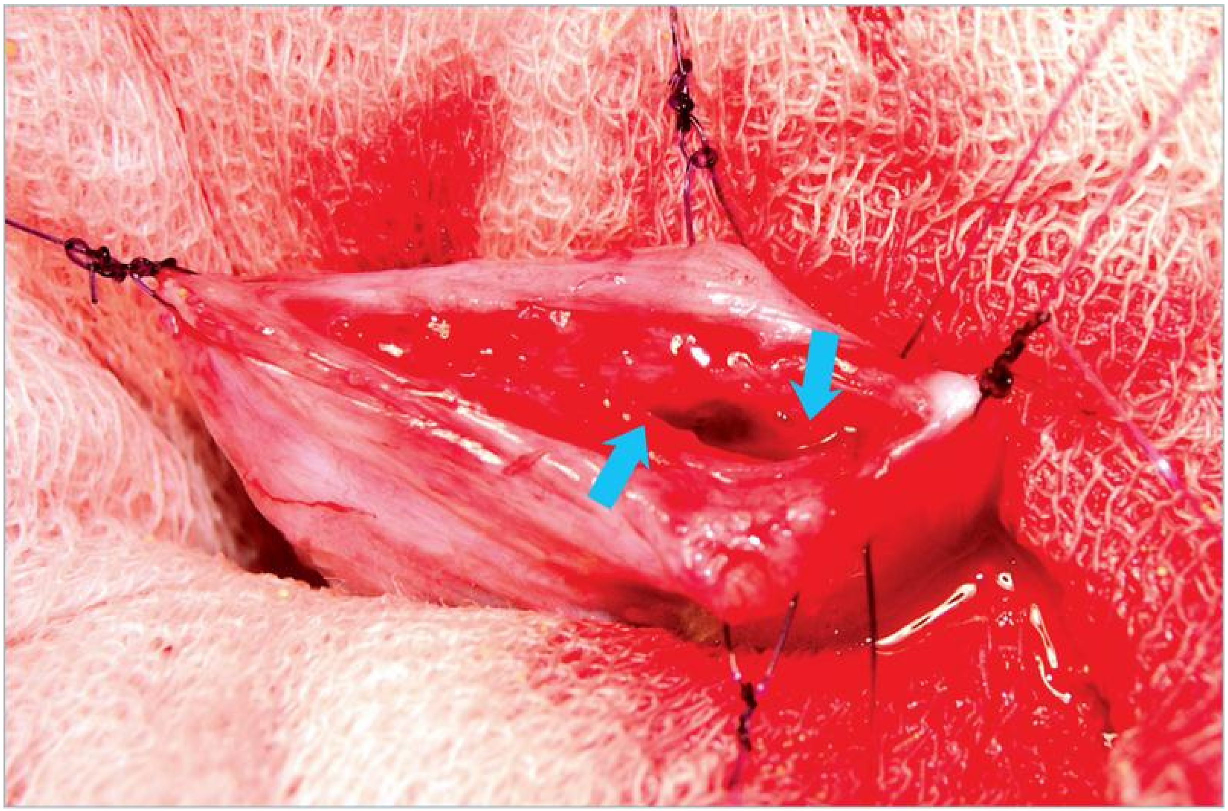

Fig. 6. In this case, a simple continuous suture will be used. Try not to perforate the mucosa (arrows) with the needle to avoid contact between the suture material and urine.

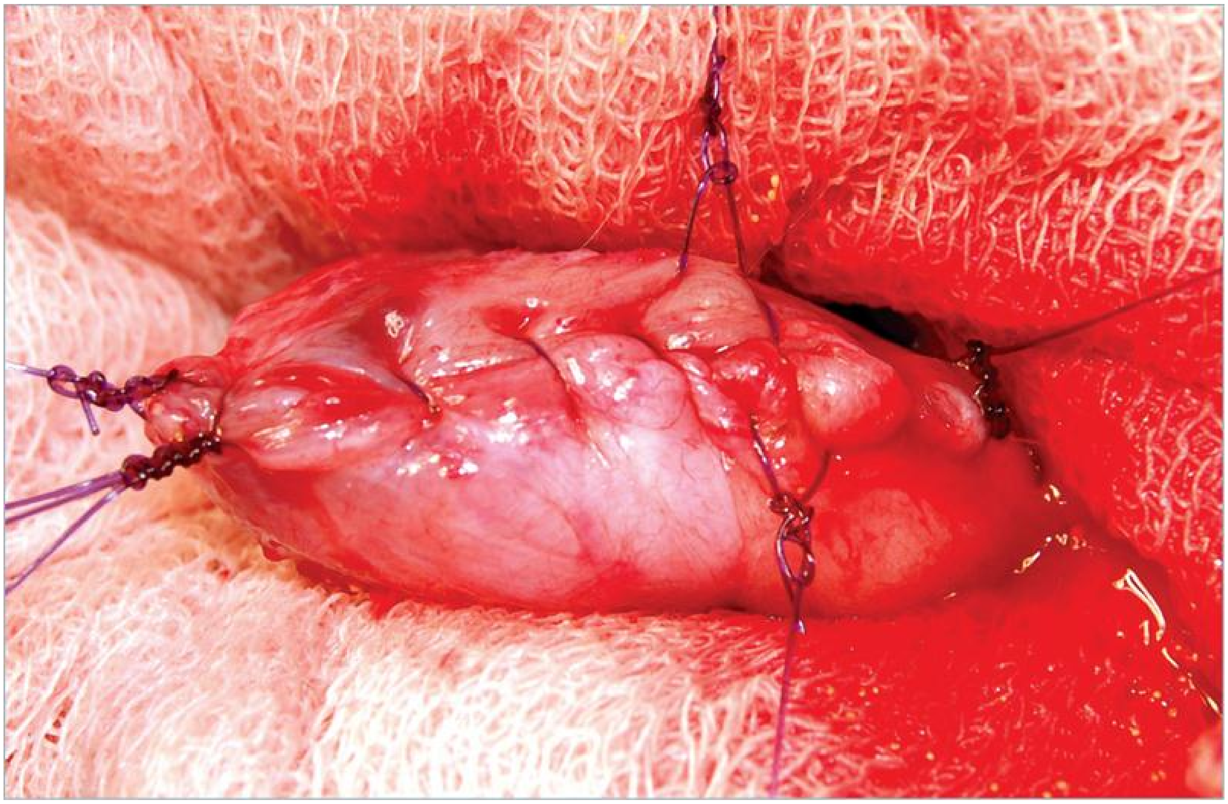

Fig. 7. The sutures should include sufficient bladder tissue on both sides of the incision to make sure that there is no wound dehiscence when the bladder distends.

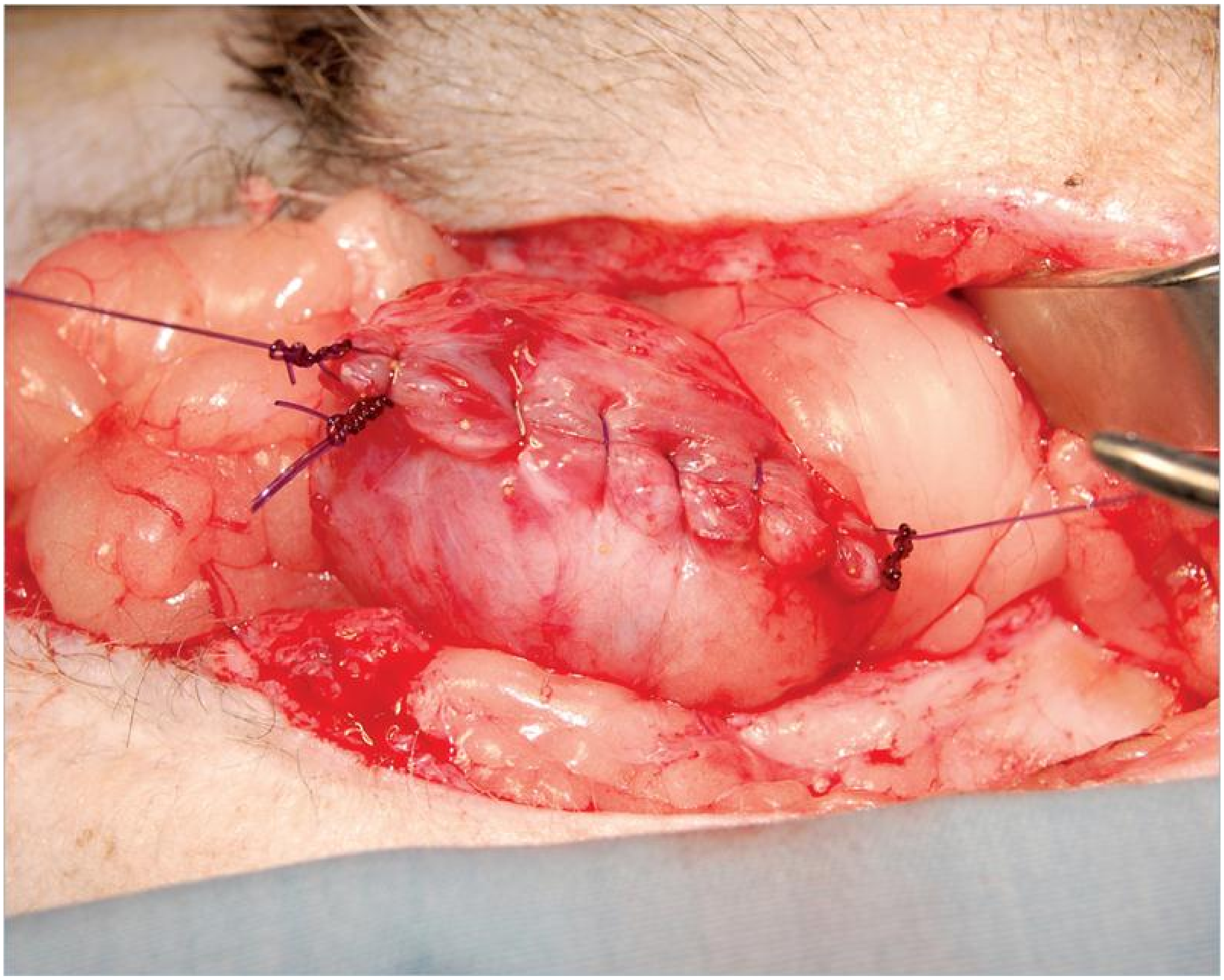

Fig. 8. This image shows the impermeability of the suture: there is no leakage of the saline that has been injected through the urinary catheter.

After closing the bladder, its lumen is filled with sterile saline to check for leakage (Fig. 8).
After closure of the cystotomy wound, the abdominal cavity is flushed and aspirated to remove any urine, grit or blood clots that might have entered it.

The bladder is then omentalized and the laparotomy wound is closed in the usual manner.

Covering the bladder with omentum promotes wound healing and prevents adhesions to adjacent structures.

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Cystotomy (bladder stones)

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* Rodríguez Gómez, J., Graus Morales, J., Martínez Sañudo, M.J. *The pelvic area: Surgery atlas, step-by-step*. 1st ed. Zaragoza: Servet, 2011.

Bladder uroliths

Jaime Graus, María José Martínez

Prevalence	■	■	■	□	□
Technical difficulty	■	■	□	□	□

Most uroliths in the dog are located in the bladder or the urethra. Struvite calculi (ammonium magnesium phosphate) are the most common, followed by calcium oxalate. Urate, cystine, silicate and other calculi are much less common.

Approximately 50 % of all diagnosed uroliths are **struvite**. In dogs under 1 year of age, they represent over 60 %. In the dog, urinary tract infections with urease-producing bacteria (e.g. *Staphylococcus, Proteus*) play a fundamental role in the formation of struvite uroliths, as this enzyme breaks down urea into ammonium and carbon dioxide. Ammonium ions make the urine more alkaline, which reduces the solubility of struvite. These uroliths are more common in females, as they develop urinary tract infections more often (Figs. 1, 2 and 3). Nevertheless, urethral obstruction due to uroliths is more common in males due to the narrower urethra (Fig. 4). In cats, however, the formation of struvite calculi is not related to urinary infection but rather to postprandial alkalinization of the urine.

Calcium oxalate calculi are the second most common uroliths after struvite and represent approximately 35 % of the total. They occur most frequently in the Yorkshire Terrier, Miniature Schnauzer, Lhasa Apso and Shih Tzu, particularly in middle-aged male dogs. A major hereditary component is suspected, which explains the prevalence in certain breeds. These uroliths occur in dogs with hypercalciuria, deficient tubular calcium reabsorption, high-oxalate diets and low urinary citrate levels. Usually, there is no previous urinary infection, and if there is, it is usually a consequence of the calculi. Acidic urinary pH promotes the formation of oxalate crystals. Diets or medication prescribed to acidify urinary pH in order to reduce the formation of struvite may in fact lead to the formation of calcium oxalate. Over recent years, an increased prevalence of this type of stone has been observed, possibly due to the excessive use of diets aimed at the prevention of struvite formation.

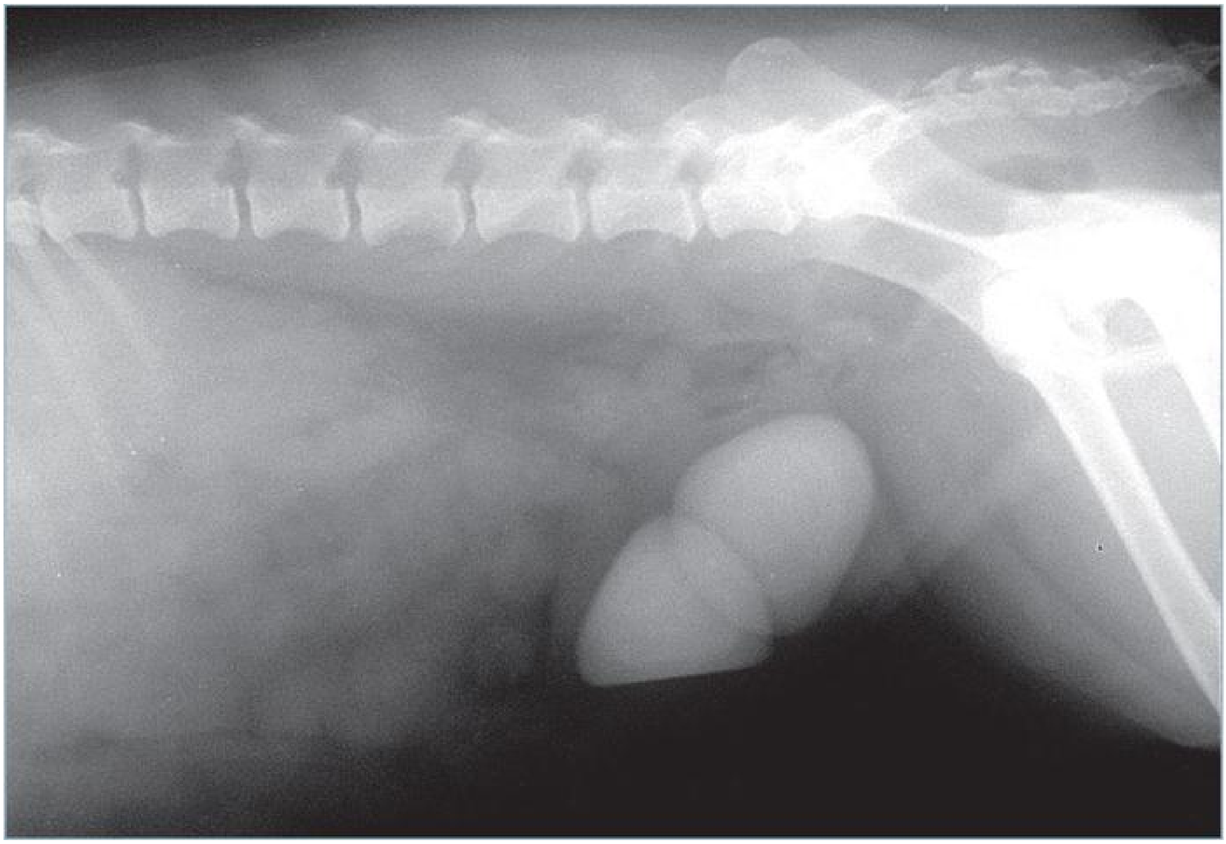

Fig. 1. Radiograph of a Miniature Schnauzer bitch showing two large uroliths that occupy the entire bladder.

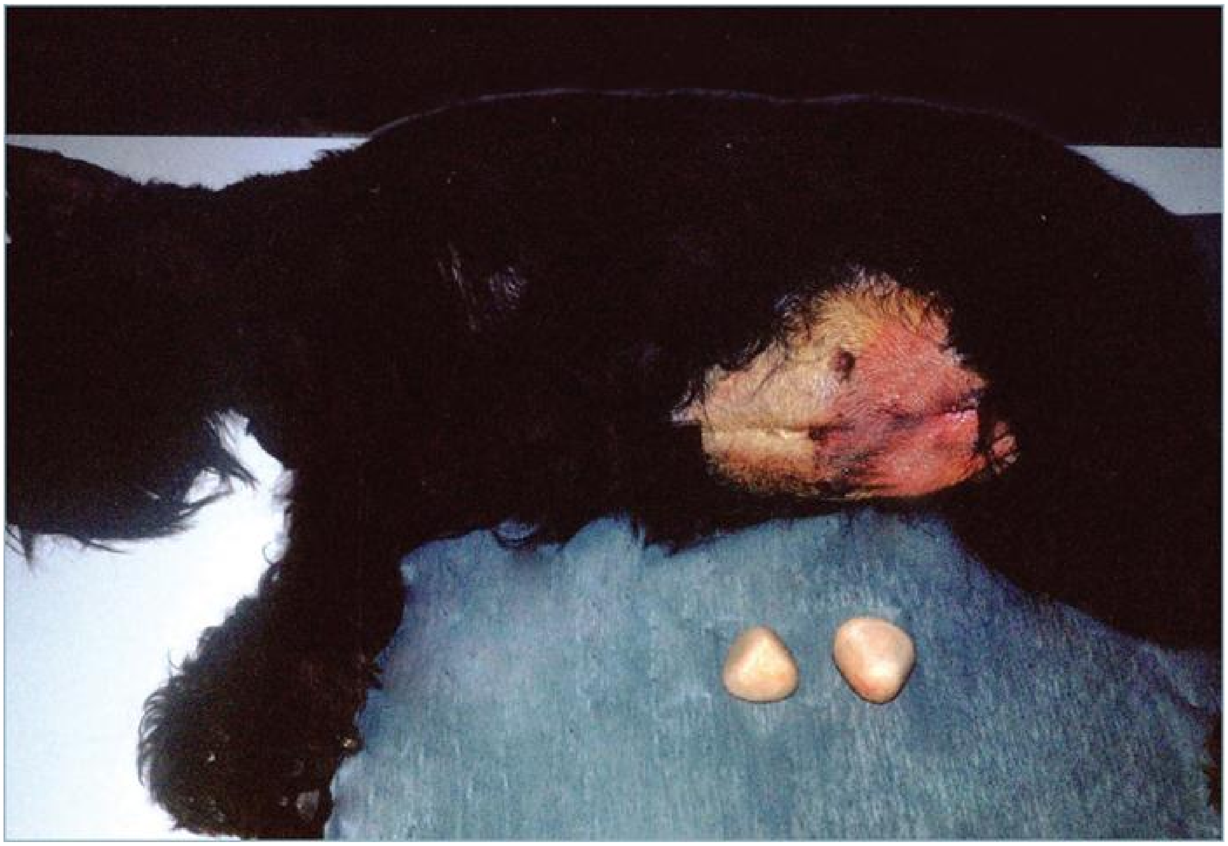

Fig. 2. The same patient with the stones removed. In spite of the relatively large size of the uroliths, the only clinical sign observed was urinary incontinence due to the reduced bladder lumen.

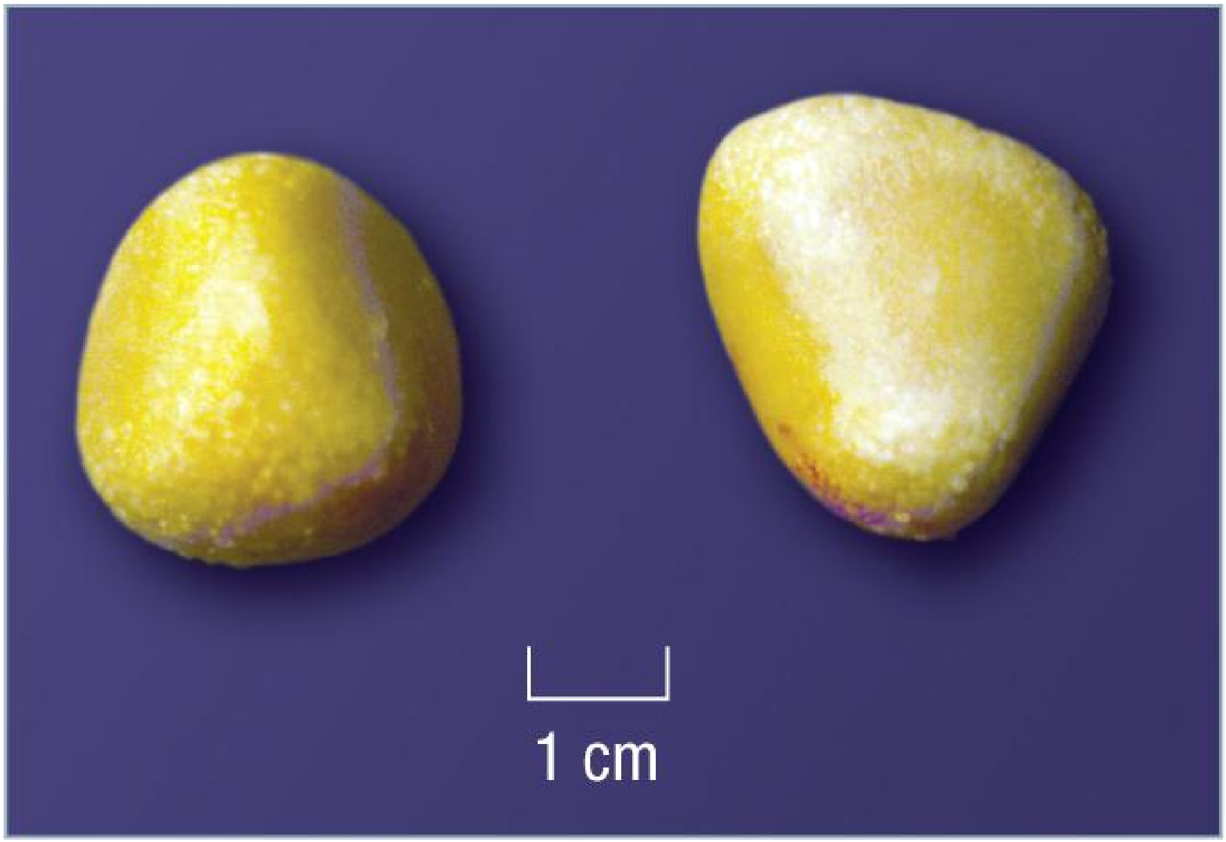

Fig. 3. Detail of the removed uroliths. Note the characteristic appearence of struvite stones.

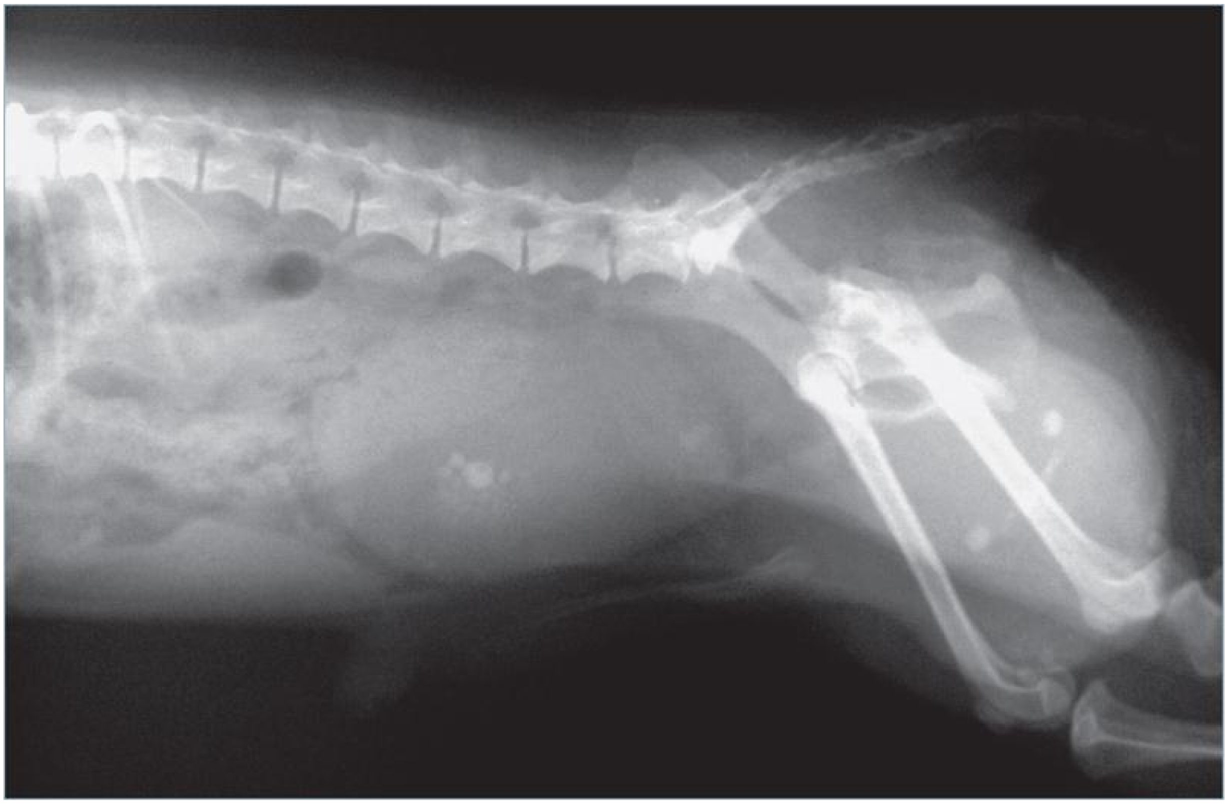

Fig. 4. Radiograph of a male dog with multiple uroliths lodged in the bladder and urethra, causing urethral obstruction.

Urate uroliths are composed of ammonium urate produced by the breakdown of nucleic acids, both from the diet and from endogenous nucleotides. Dalmatians have a capacity to oxidize uric acid to allantoin that places them between humans and other dog breeds; this leads to excess levels of urate in the urine and makes the breed very prone to the formation of this type of crystal. The English Bulldog is another breed prone to producing urate stones. Dogs with portosystemic shunts have high blood urate levels because the blood passes directly from the digestive system to the general circulation; this leads to a reduced hepatic conversion into allantoin and an increased renal excretion of urates.

Cystine stones are caused by a genetic disorder of the transport of this amino acid through the renal tubules. The stones are formed in acid urine. Cystine calculi are more common in the Dachshund, the Basset Hound and the Bulldog.

Dogs with uroliths in the bladder or urethra usually have a history of urinary tract infection with clinical signs such as hematuria, polyuria and stranguria. If the calculi are lodged in the male urethra, signs of obstruction are observed: abdominal distension, abdominal pain, paradoxical incontinence and postrenal azotemia.

Fig. 5. Radiograph of a female dog showing a single urolith that fills the entire bladder causing urinary incontinence.

Radiography is an essential part of the examination of a patient with uroliths (Fig. 5). Calcium oxalate stones are the most radiopaque, urate stones the least, and struvite and cystine stones have an intermediate radiodensity. Although retrograde cystography allows the visualization of radiolucent calculi, double contrast cystography is still considered the most sensitive technique for the detection of bladder stones, even though ultrasonography is more commonly used and is particularly useful in cases of radiolucent stones (Fig. 6).

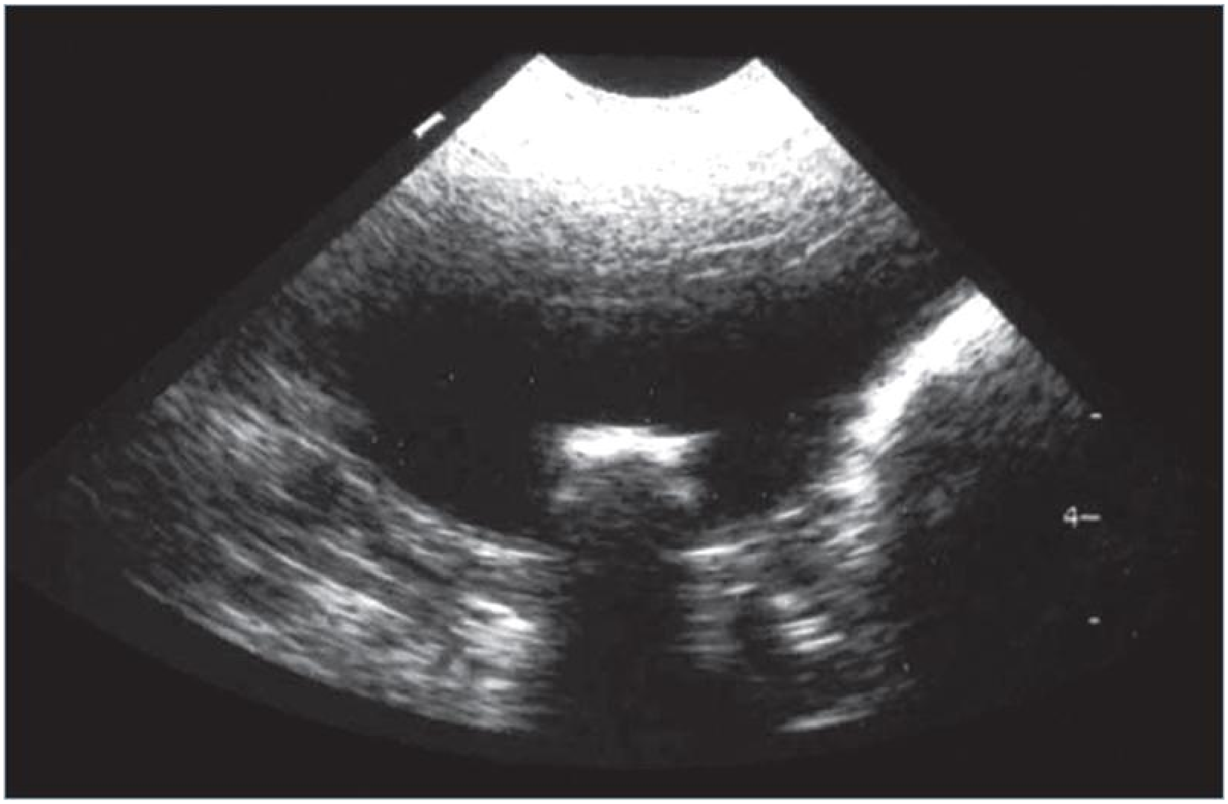

Fig. 6. Ultrasound image of a bladder stone. Bladder stones are easily recognized by ultrasonography since they are surrounded by liquid, highlighting the ultrasound “shadow”.

Urinary tract infection can be either the cause (struvite) or the consequence (all others) of urolith formation. It is common and should always be treated.

Any patient presenting with a urinary tract infection, hematuria, stranguria, polyuria or obstructive uropathy should be examined for the presence of uroliths.

It is possible to achieve the dissolution of certain calculi, although normally they are surgically removed for analysis, to determine appropriate medical treatment that will prevent recurrence. The first step should be to relieve the urethral obstruction –if any– and empty the bladder in cases of urinary retention. This is achieved by cystocentesis and a preoperative or intraoperative urohydropropulsion* (Figs. 7, 8 and 9).

It is always preferable to try to flush calculi back into the bladder and perform a cystotomy rather than an urethrotomy.

Although it is possible to dissolve **struvite** crystals with special diets, surgical treatment is often preferable in view of the costs, the need for repeated radiological or ultrasound examinations, the risk of urethral obstruction in male dogs and the often poor owner compliance regarding the administration of the prescribed diet.

The detection of uroliths alone is not a surgical indication. If it is decided to opt for medical treatment of struvite calculi, the underlying infection should first be eliminated. Antibiotics should be chosen on the basis of a bacterial culture and sensitivity testing of the urine.

Antibiotic treatment should continue until the calculi are completely dissolved, as the bacteria inside the uroliths are protected from their action. If treatment is discontinued before complete dissolution, this is nearly always followed by a recurrent infection and interrupted dissolution. Acidification of the urine, which is normally only possible after the elimination of infection and therefore of ammonium production, is usually achieved using calculi-dissolving diets. The use of urinary acidifiers (ammonium chloride, methionine) is also an option, although less commonly used these days.

Surgery is clearly indicated in cases of obstruction and strongly recommended in cases of urinary tract infection, where there is a risk of an ascending infection that may lead to pyelonephritis, renal insufficiency or septicemia. Uroliths that are refractory to medical dissolution, such as calcium oxalate, silicate and calcium phosphate stones, should be removed surgically if they are too large to be eliminated through the urethra.

Calcium oxalate calculi are considered insoluble and treatment is therefore always surgical. In order to prevent recurrence, the urinary pH should be raised. A low urinary specific gravity can be obtained by adding salt to the diet, which should be low in calcium and oxalate in order to reduce levels in the urine. Some commercial diets meet these requirements. Thiazide reduces calciuria by promoting the tubular reabsorption of calcium. The outcome of preventive treatment should be monitored by regular urinalysis to confirm the alkaline pH and the absence of typical calcium oxalate crystals.

The medical treatment of **urate** crystals is based on a calculolytic diet, allopurinol and alkalinization of the urine. Commercially available calculolytic diets for urate crystals have a low purine content and do not acidify the urine. Allopurinol is a xanthine oxidase inhibitor that reduces uric acid production by inhibiting the conversion of hypoxanthine into xanthine and of xanthine into uric acid. Alkalinization of the urine can be achieved with sodium bicarbonate or potassium citrate. The aim is to reach a pH of approximately 7. Owner cooperation is essential to monitor the urinary pH (strip tests), as values of 7.5 can readily promote the formation of calcium phosphate uroliths.

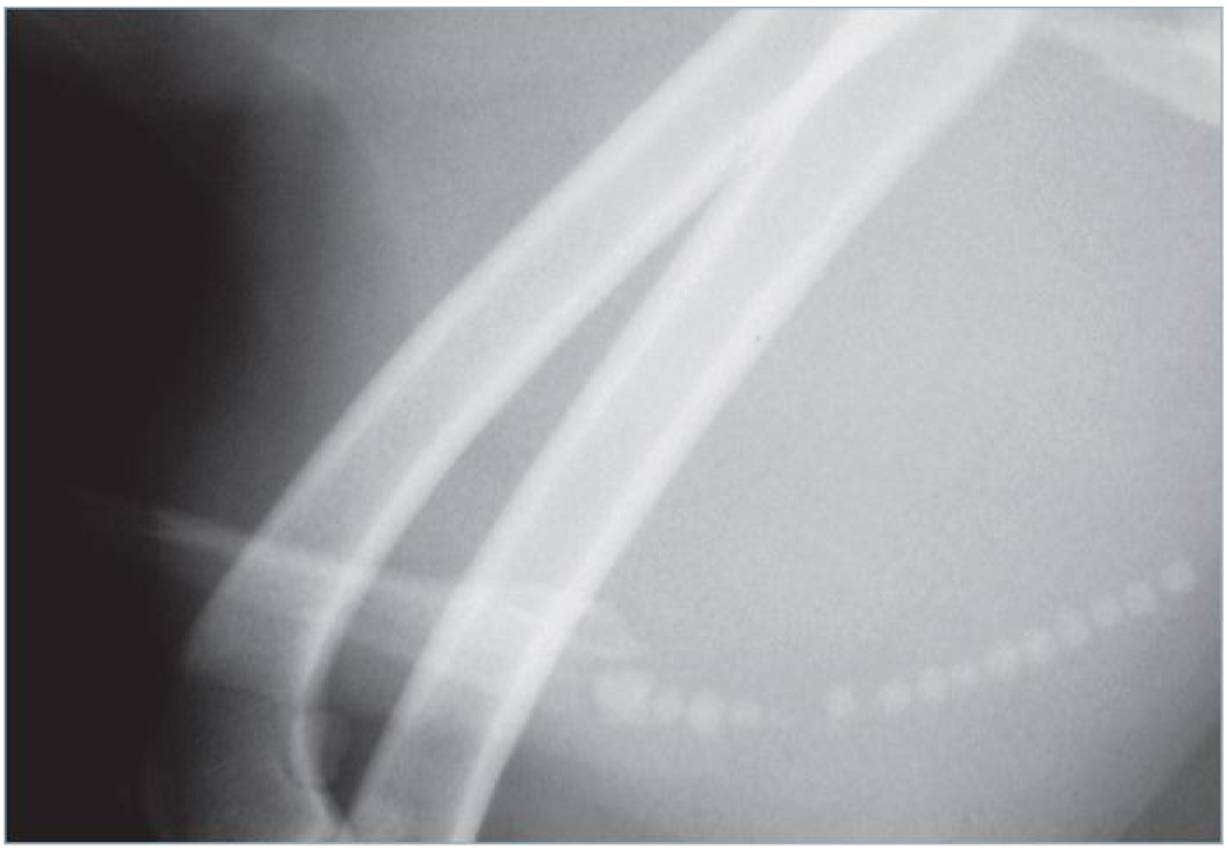

Fig. 7. Lateral radiograph of a patient with urethral obstruction due to multiple struvite calculi, before urohydropropulsion.

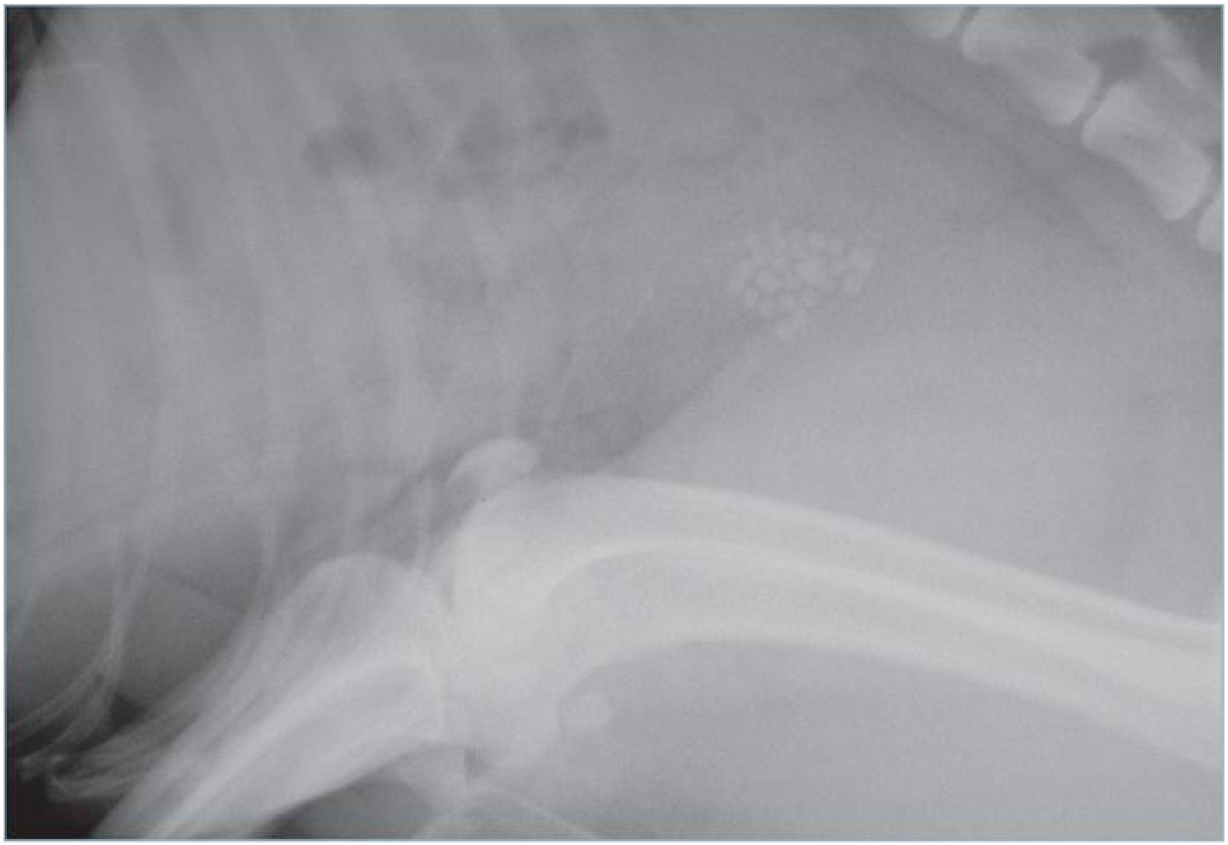

Fig. 8. The same patient, with all calculi located in the bladder after urohydropropulsion.

Uroliths should always be submitted for analysis to prevent recurrence with appropriate medical treatment.

Fig. 9. Removal of the uroliths via cystotomy in the patient as discussed earlier.

Since cystinuria is a metabolic defect, recurrence of **cystine** uroliths after surgical removal is very common; preventive treatment is therefore required. The easiest option is the use of a commercial alkalinizing low-protein diet.

Calcium phosphate stones represent less than 1 % of all uroliths and hardly ever occur in the pure form; they are usually part of other calculi such as calcium oxalate uroliths. Surgical removal is nearly always the best option, and the urine should be alkalinized to prevent recurrence, as with calcium oxalate crystals.

Mixed or compound calculi represent more than 6 % of all cases; if the conditions become less favorable for one type of urolith, they usually become more favorable for another type. For example, calcium oxalate calculi can trigger a urinary infection, thus changing the urinary pH, which, together with urease produced by the bacteria, will lead to a layer of struvite around the calcium oxalate calculi. Conversely, medical treatment of struvite calculi includes the acidification of urine, which favours the formation of calcium oxalate deposits around the original urolith.

Before surgery

- Correct any post-renal azotemia.
- Correct the hyperkalemia.
- Start antibiotic treatment based on the results of culture and sensitivity tests.
- Flush the calculi into the bladder using retrograde urohydropropulsion.

After surgery

- Watch out for signs of urinary incontinence. Excessive bladder distension can lead to a loss of tone of the detrusor muscle.
- Watch out for signs of urinary obstruction. The urethra may also become obstructed by blood clots from the bladder.
- Regularly check the urinary sediment and pH.
- Continue antibiotic treatment of the urinary infection.
- Start early with a suitable diet and medical treatment appropriate to the type of calculi that were removed.

To effectively prevent the recurrence of a certain type of urolith, therapy should prevent supersaturation of the calculogenic crystals. This is achieved by modification of the diet and the urinary pH and by increasing the volume of urine. The commercial diets that exist for each type of urolith greatly facilitate the work of the veterinarian.

Although crystalluria and calculi formation are not synonymous, the presence of crystals in the urinary sediment is an important parameter for the medical control and prevention of uroliths.

Complications of cystotomy are rare. Hematuria is the most common complication, and may persist for up to a week, resolving spontaneously.

Prognosis is favorable although the rate of recurrence is very high, around 18 % for struvite and 25 % for oxalate calculi. It is even higher for cystine

(47 %) and urate stones (33 %). Prevention of urinary infection is fundamental for the prevention of struvite calculi.

Urinary pH should be alkaline to prevent all types of uroliths except struvite, for which urine should be acidified.

https://player.vimeo.com/video/180708251

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Bladder stones (surgical treatment)

* Rodríguez Gómez, J., Graus Morales, J., Martínez Sañudo, M.J. *The pelvic area: Surgery atlas, step-by-step*. 1st ed. Zaragoza: Servet, 2011.

Case / Single urolith in a female dog

Jaime Graus, María José Martínez

A five-year old female Pyrenean Mountain Dog is presented with polyuria, hematuria and stranguria of several weeks duration.

Palpation of the abdomen reveals a hard, rounded, nut-sized mass in the bladder area. Radiography of the caudal abdomen shows a single bladder stone (Fig. 1), and removal via cystotomy is elected (Figs. 2-11).

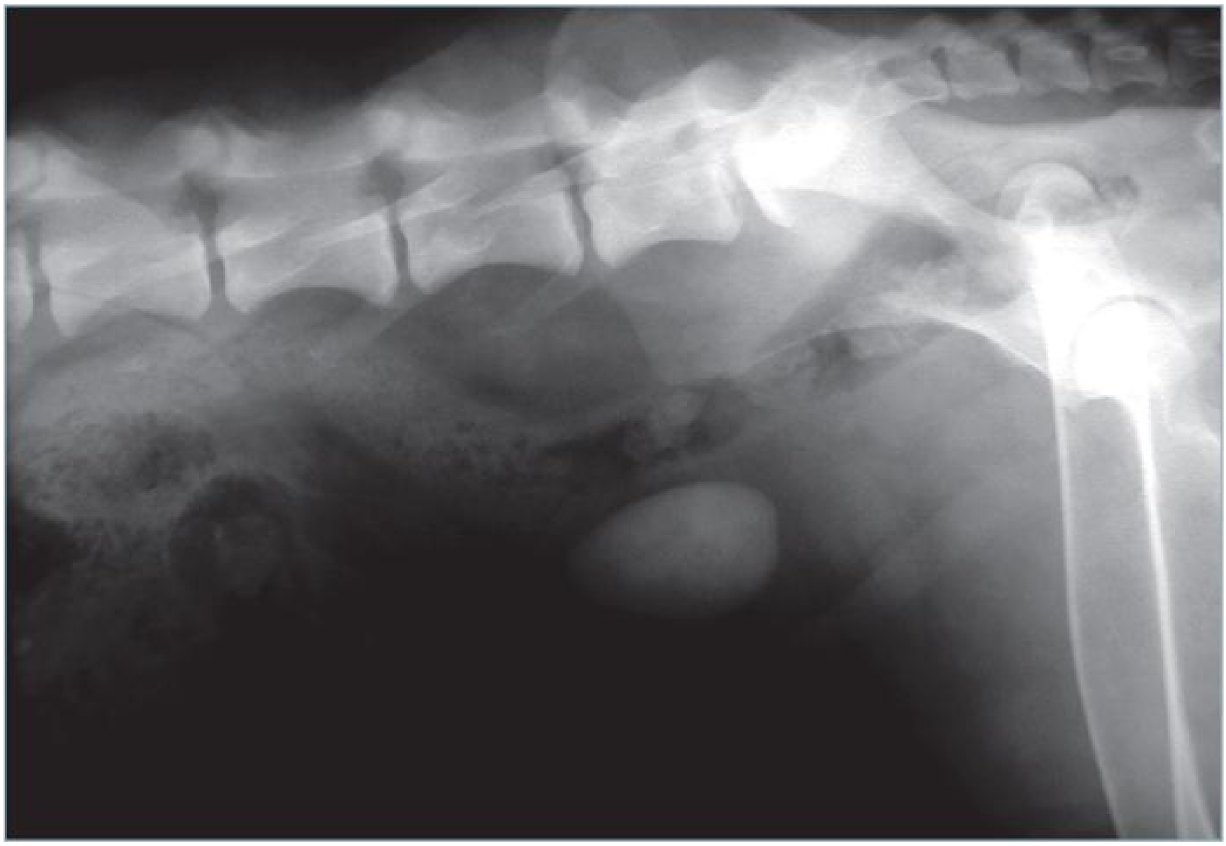

Fig. 1. Lateral radiograph confirming the presence of a large bladder stone causing dysuria, hematuria and frequent micturation due to the reduced size of the bladder lumen.

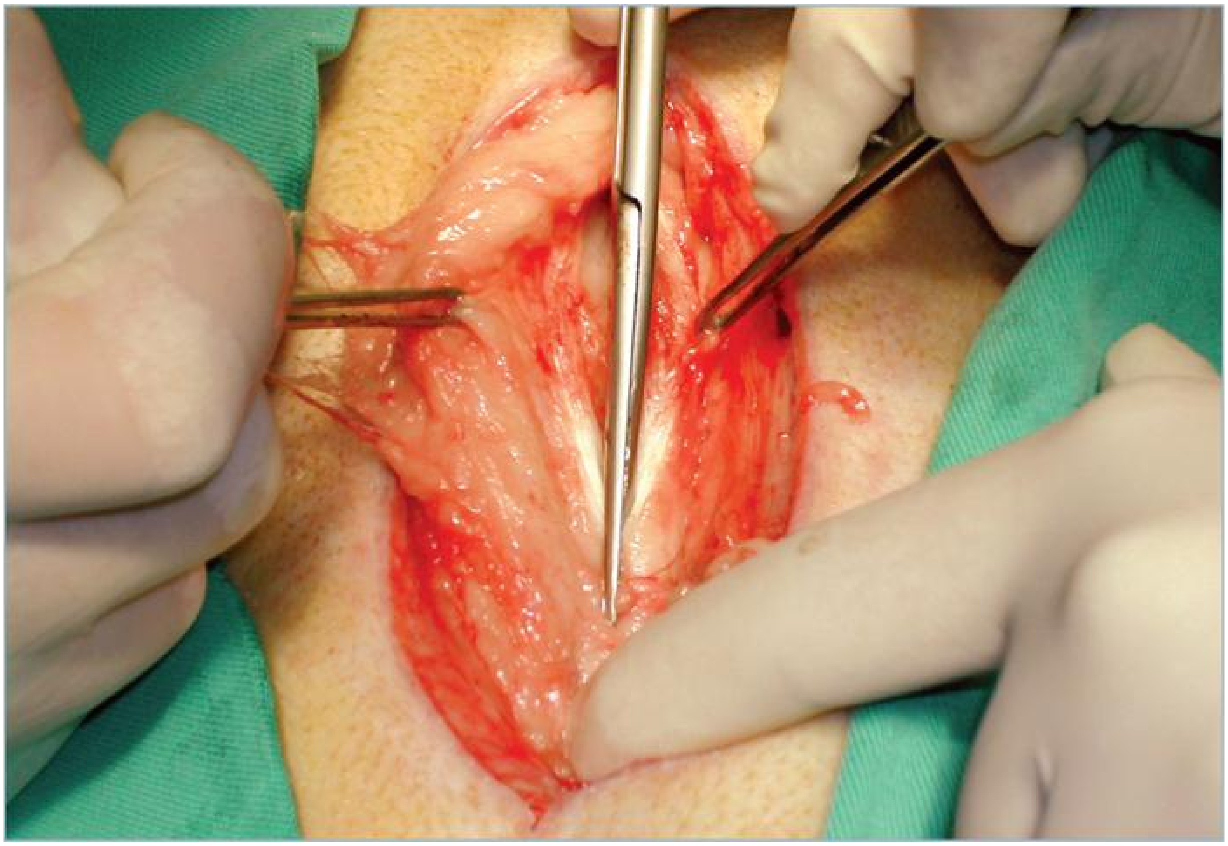

Fig. 2. Surgery starts with an infraumbilical laparotomy in the usual way.

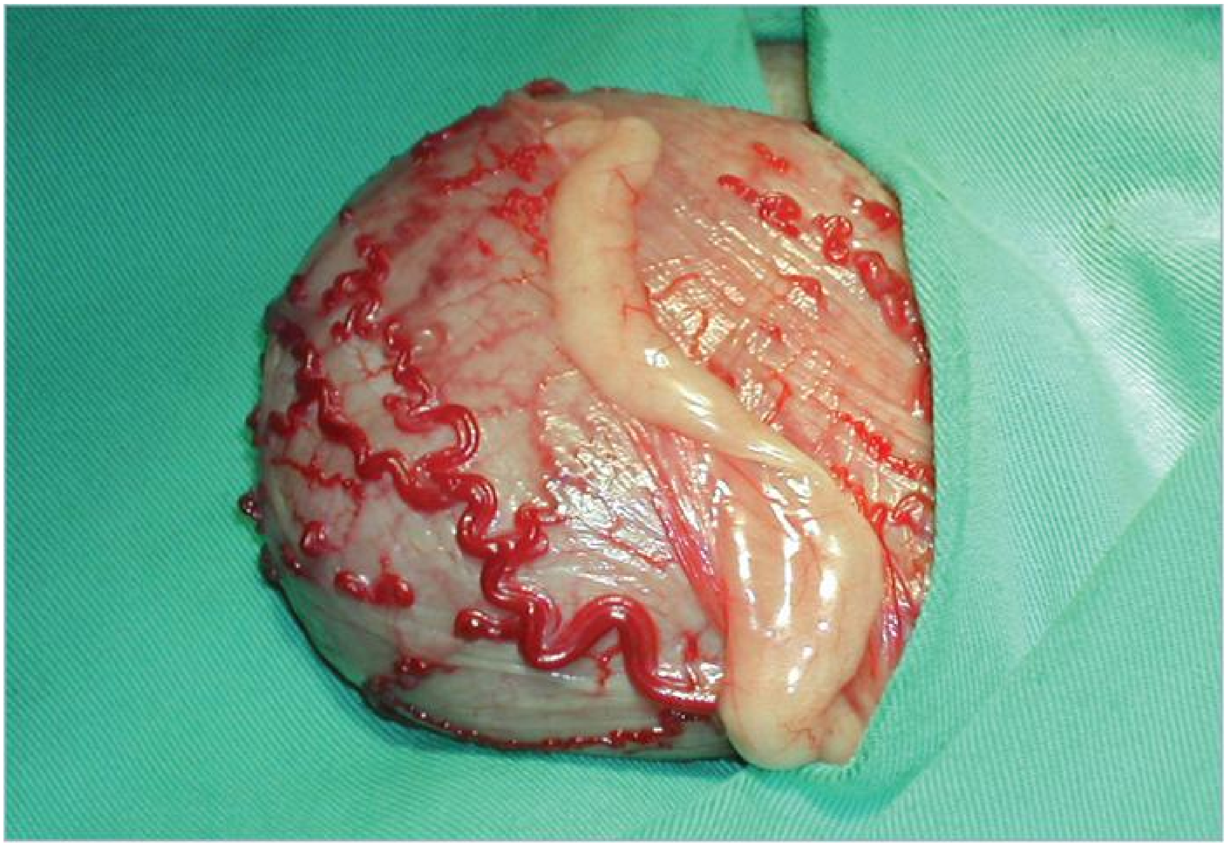

Fig. 3. The bladder is externalized completely and is surrounded by surgical drapes to isolate it from the abdominal cavity before opening it.

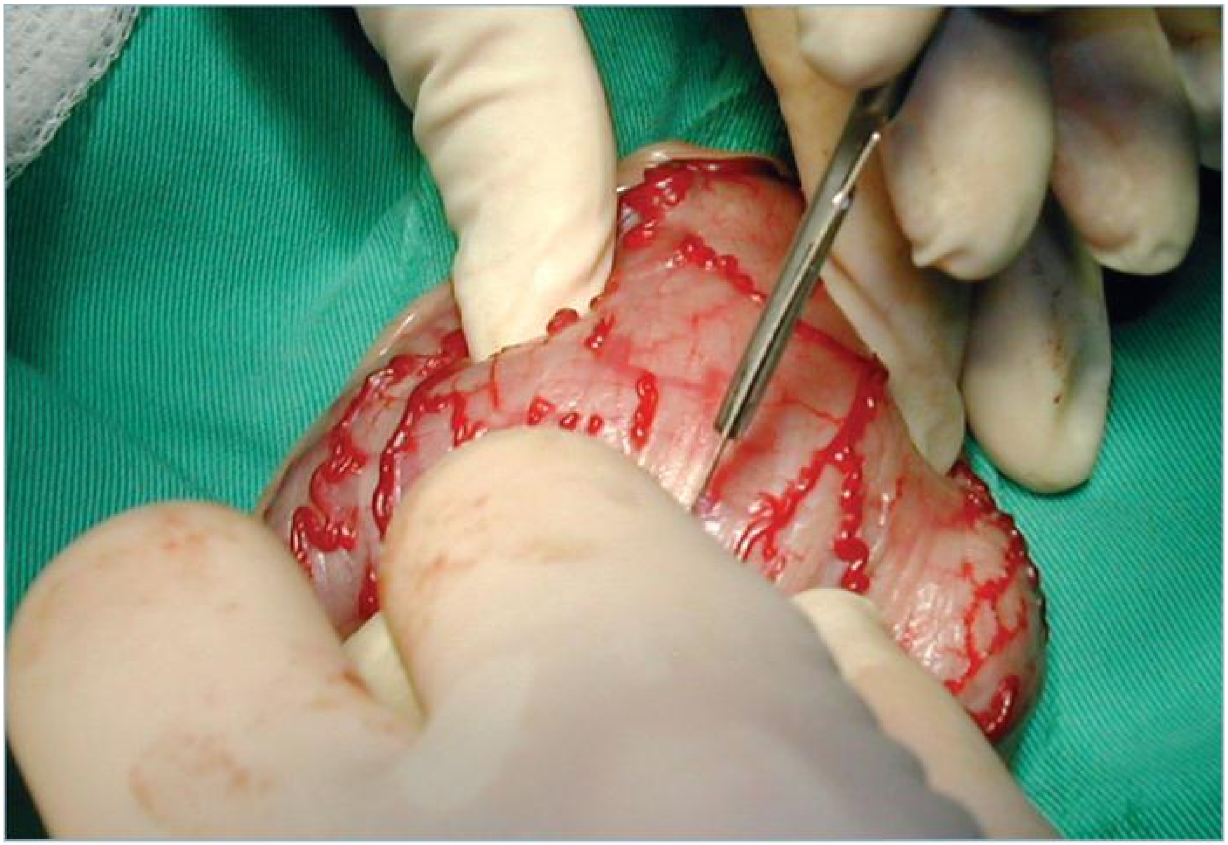

Fig. 4. The bladder is first incised with a scalpel, on its ventral aspect, avoiding highly vascularized regions.

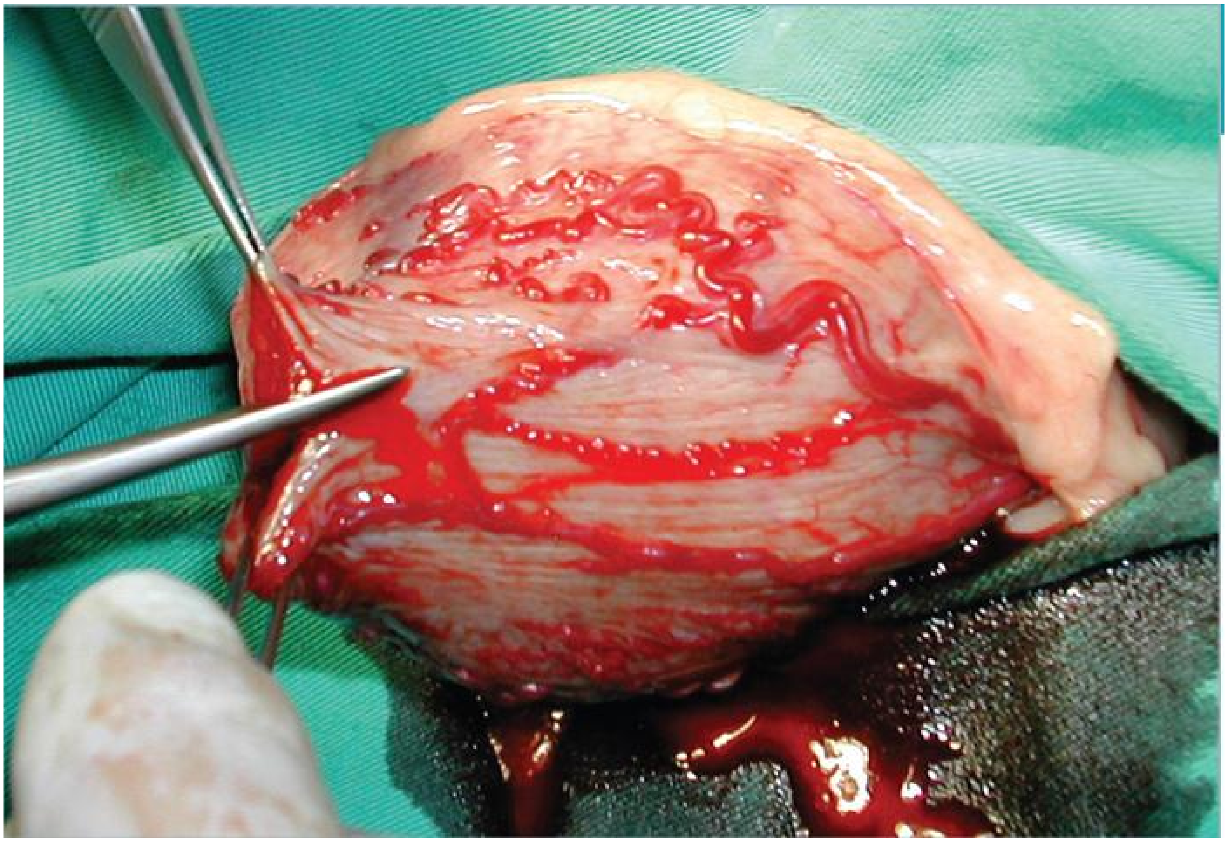

Fig. 5. Next, the incision is enlarged with scissors, taking care to avoid cutting major blood vessels.

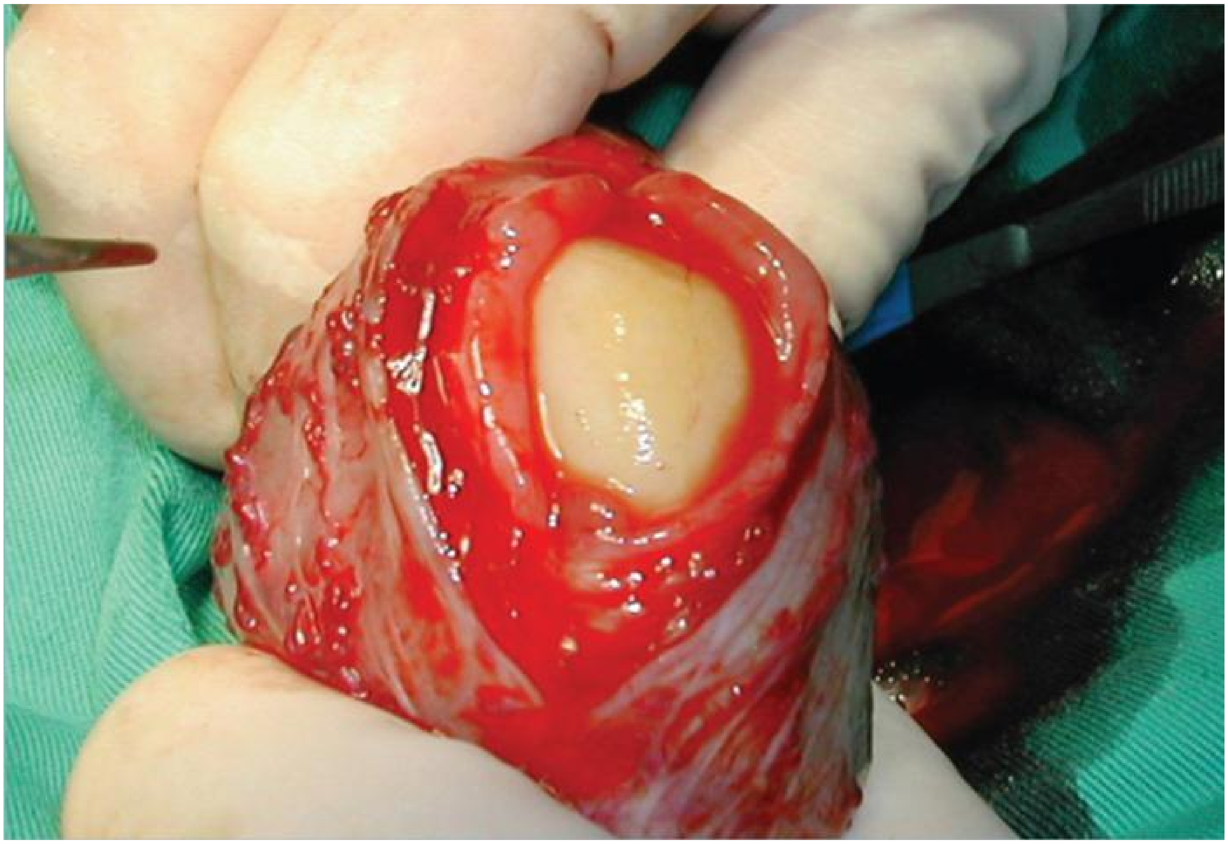

Fig. 6. The incision should be sufficiently large to allow the extraction of the stone using gentle pressure on the lower part of the bladder.

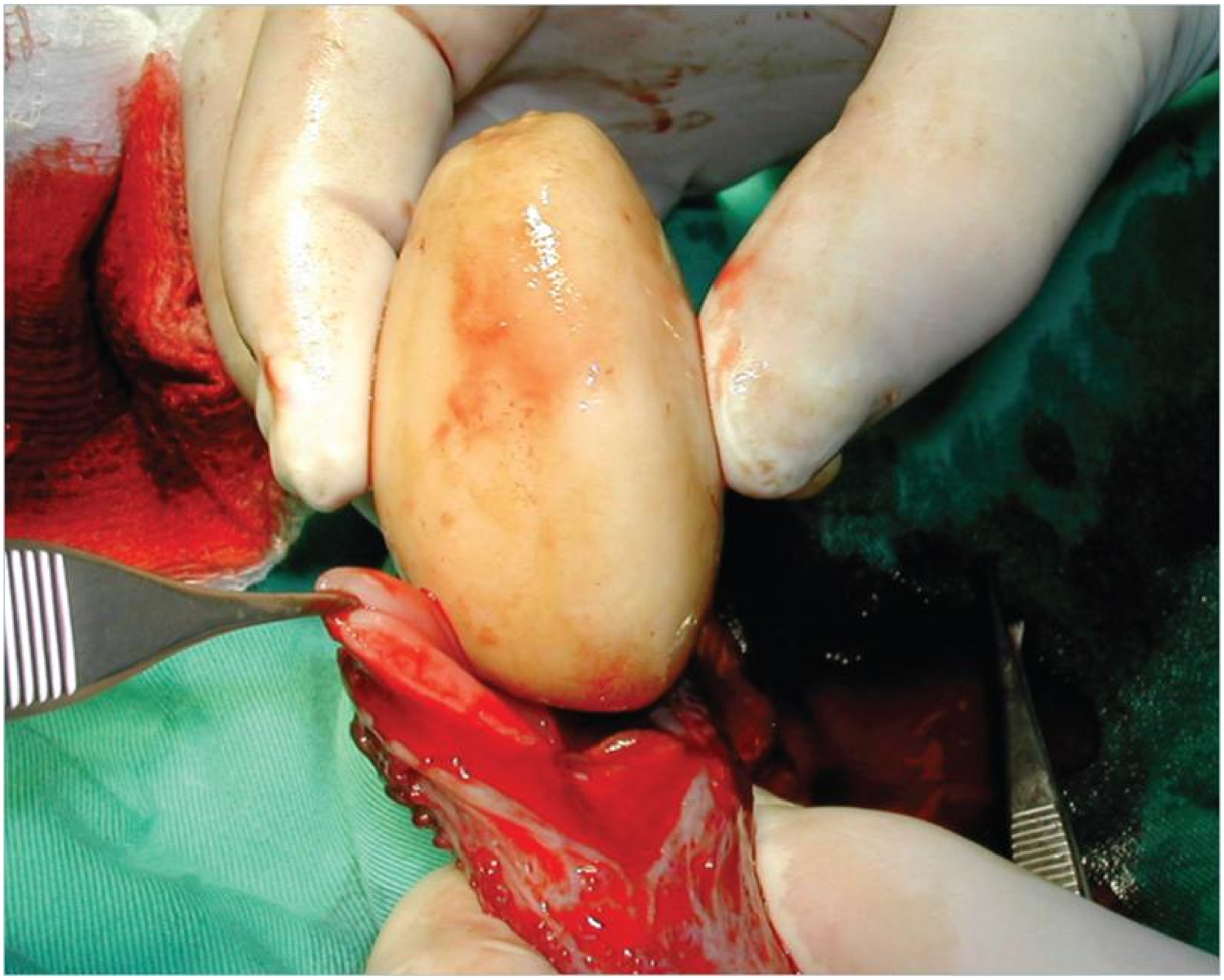

Fig. 7. Note the thickened bladder wall due to chronic cystitis caused by the urolith.

After surgery

Antibiotic therapy using amoxicillin and clavulanic acid was given for two weeks. Once the composition of the stone was known (struvite), a specific commercial diet was prescribed to reduce the risk of recurrence.
Ten days after surgery, the sutures were removed and the wound had healed.

Single large stones in females often cause urinary incontinence due to reduced bladder capacity.

Fig. 8. Appearance of the extracted bladder urolith. Analysis confirmed a struvite stone.

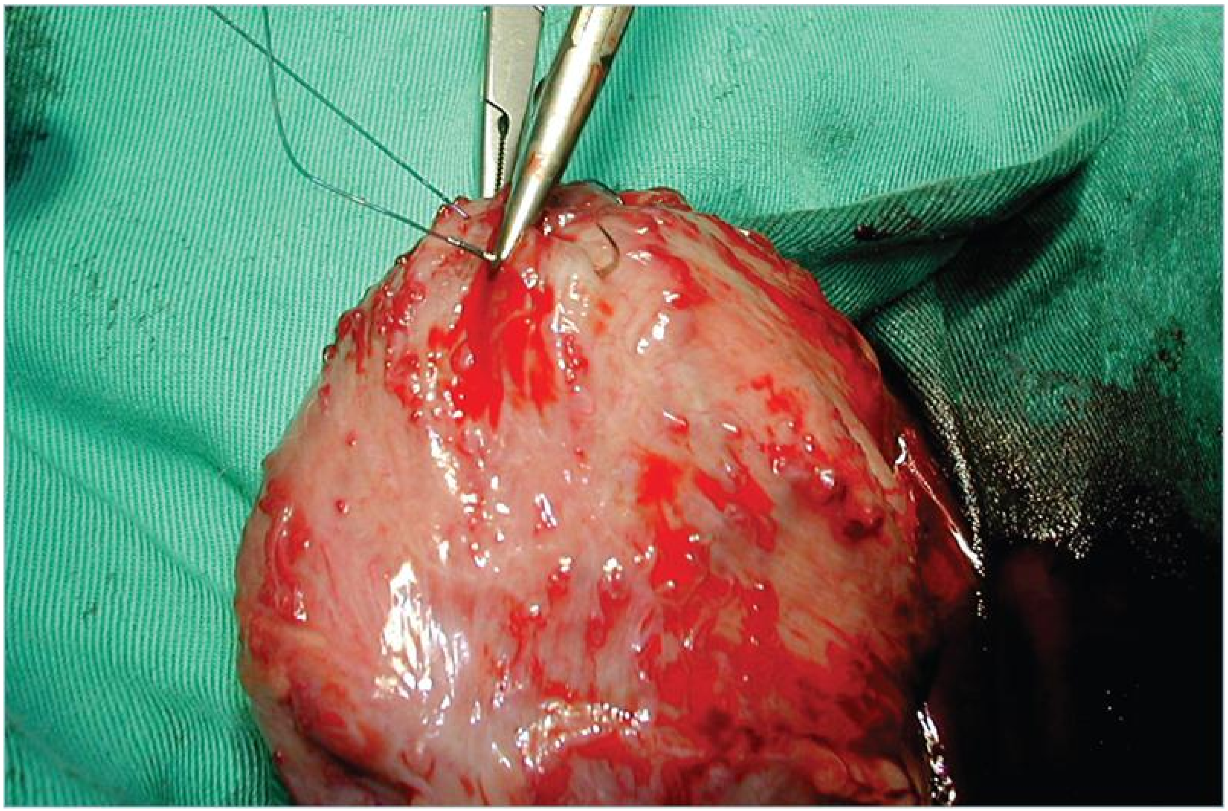

Fig. 9. Closure of the bladder is started with a continuous suture using 2/0 synthetic absorbable monofilament material.

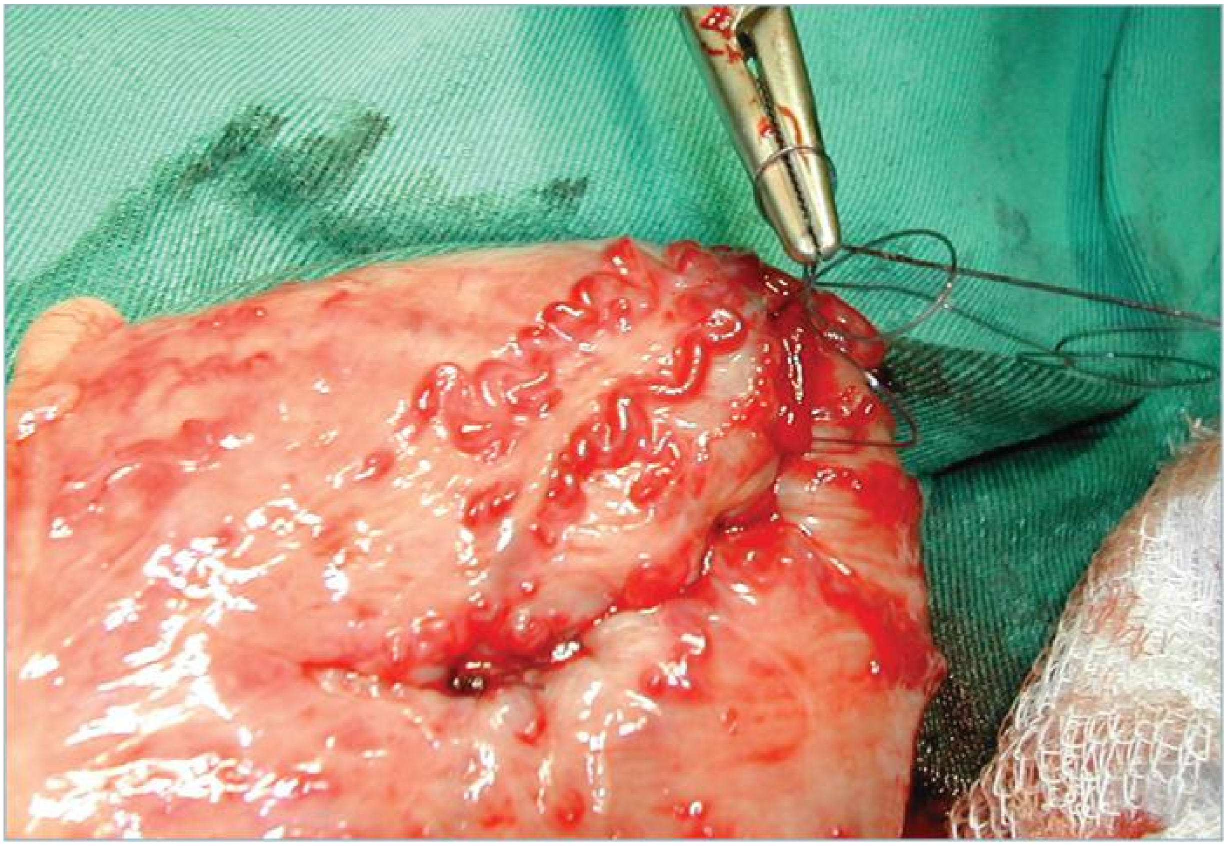

Fig. 10. Closure of the bladder is finished with a second suture, also continuous, using the same type of material. Wound edges are invaginated with this suture.

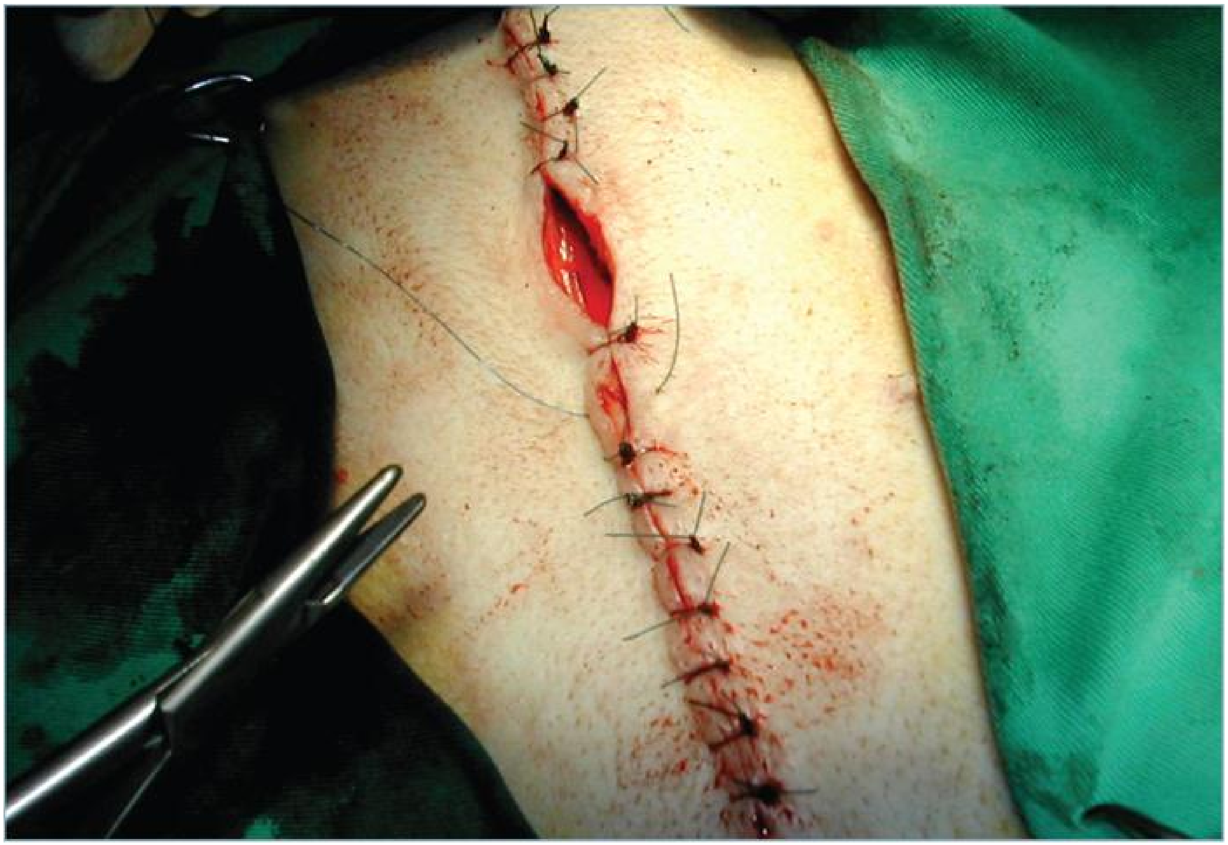

Fig. 11. Finally, the laparotomy wound is closed in layers in the usual way.

Ectopic testes

José Rodríguez

Prevalence	■	■	■	■	
Technical difficulty	■	■			

The testis forms inside the abdominal cavity and descends to its definitive location in the scrotum shortly after birth, in both the dog and cat. Cryptorchidism is the consequence of a failure of the descent of one or both testes into the scrotum. Studies of incidence provide variable data, ranging from 1 to 10 % in dogs, depending on the source.

Cryptorchidism is hereditary, even though its genetic basis is not very clear. The incidence varies by breed and is nearly three times more common in small breeds than medium-sized or large breeds. It is particularly common in Yorkshire Terriers and Miniature Schnauzers. Among the large breeds, the Boxer is most commonly affected.

A definitive diagnosis of cryptorchidism can be made from 3-6 months onwards, depending on the breed. In puppies, the small size of the testes makes palpation difficult, especially in obese animals or in those where the testes move freely between the scrotum and the inguinal canal. Furthermore, at this age, descent into the scrotum is still possible.

The ectopic testis can be in a prescrotal, inguinal or abdominal position. Statistically speaking, abdominal cryptorchidism is the most common, particularly unilateral cryptorchidism of the right testis. A complete diagnosis of ectopic testis should include its exact location. In cases of atrophy, this can be difficult. In general, the ectopic testis is smaller than the scrotal one, unless it is neoplastic or diseased. It is necessary to examine the scrotal area and the inguinal canal in detail. Intra-abdominal testes are rarely palpable. Abdominal ultrasound examination is helpful to confirm the presence of a testis in the abdomen.

Before deciding to carry out a laparotomy, make sure that the testis is not in the inguinal area. This requires careful examination.

The higher temperature to which the ectopic testes are exposed damages both germinal epithelial development and sperm cell production. Nevertheless, the interstitial cells are functional and androgen production nearly normal, maintaining secondary sexual characteristics, even in bilateral cryptorchidism cases.

Ectopic testes, in particular those in the abdomen, develop tumors and torsions much more often than scrotal testes. Torsion results from the increased mobility of the testis inside the abdomen. The risk of neoplasia is about twenty times higher than in scrotal testes. Also, neoplasia in cryptorchid testes appears at an earlier age. In cases of Sertoli cell tumors, feminization signs are more common if the affected testis is ectopic.

Medical and surgical treatments that aim to move the ectopic testis into the scrotum do not give good results. This, combined with a higher incidence of tumors and torsions, justifies preventive castration of the ectopic organ. Bilateral castration is also recommended to prevent genetic transmission of the defect.

Prescrotal and inguinal testes are removed by making an incision directly over their location. In case of an abdominal testis, an infraumbilical laparotomy is needed to locate it. This is not always easy. If the testis has atrophied, certain anatomical landmarks can be used to locate it. The simplest is to follow the vas deferens from the prostate to the testis. In most cases, the abdominal testis is found next to the bladder.

By lifting up the bladder, the vasa deferentia will become visible. The one belonging to the scrotal testis leads to the internal inguinal canal, while the other leads to the cryptorchid testis.

If a tumor is suspected, histopathology of the testes is recommended. This also indicates the prognosis. Nevertheless, in view of the low malignancy of testicular tumors, the prognosis for the cryptorchid patient after surgery is good, even if the testis turns out to be neoplastic.

https://player.vimeo.com/video/180708254

Watch this video

Ectopic testes (cryptorchidism/monorchidism)

Case / Abdominal monorchid

Fig. 1. “Rayo” on the day of arrival at the hospital. The abdominal pain has made him a little aggressive and it was necessary to muzzle him during examination.

In cryptorchid patients, signs of intermittent abdominal pain can be due to reversible testicular torsions. Given the high probability that the patient will develop an acute abdomen, castration is recommended as soon as possible.

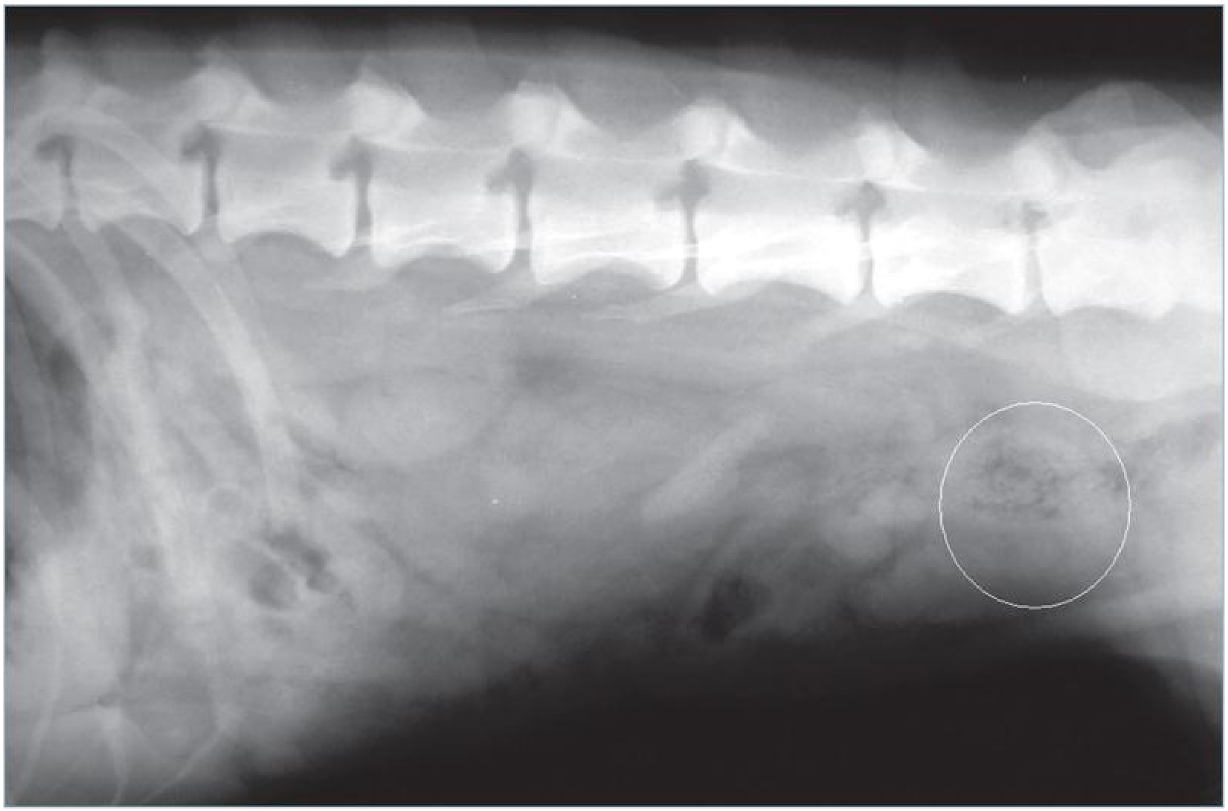

Fig. 2. Abdominal radiograph of the patient that suggests the presence of a cryptorchid, neoplastic testis.

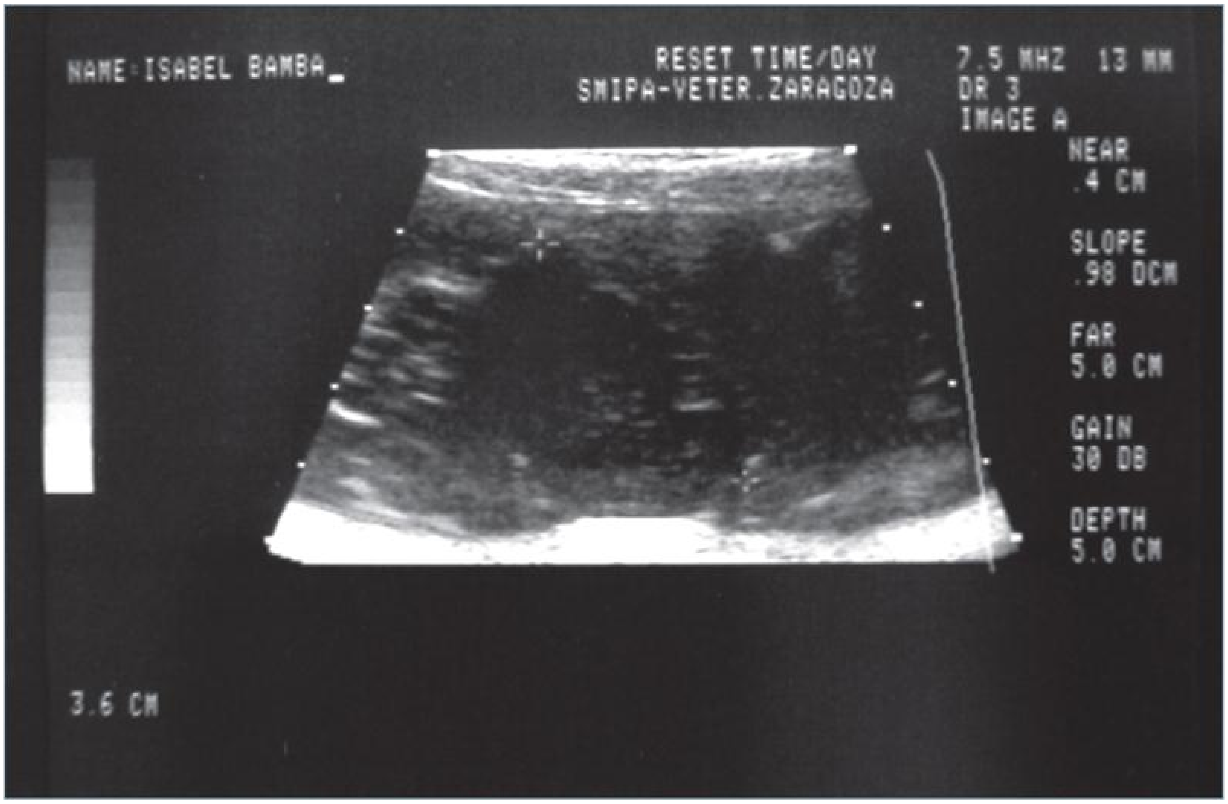

Fig. 3. The abdominal mass can be measured using ultrasonography.

A 6-year-old male Basset Hound is presented (Fig. 1) with recurrent abdominal pain. Upon examination, only one testis is found in the scrotum.

A lateral abdominal radiograph is taken which shows a mandarin-sized mass in the caudal abdomen. The mass is easily palpable and could be compatible, in view of its size, with a neoplastic intra-abdominal testis. It is therefore decided to perform a laparotomy (Fig. 2).
Ultrasound examination of the area permits measurement of the mass, and reveals an image compatible with a testicular Sertoli cell tumor (Fig. 3).

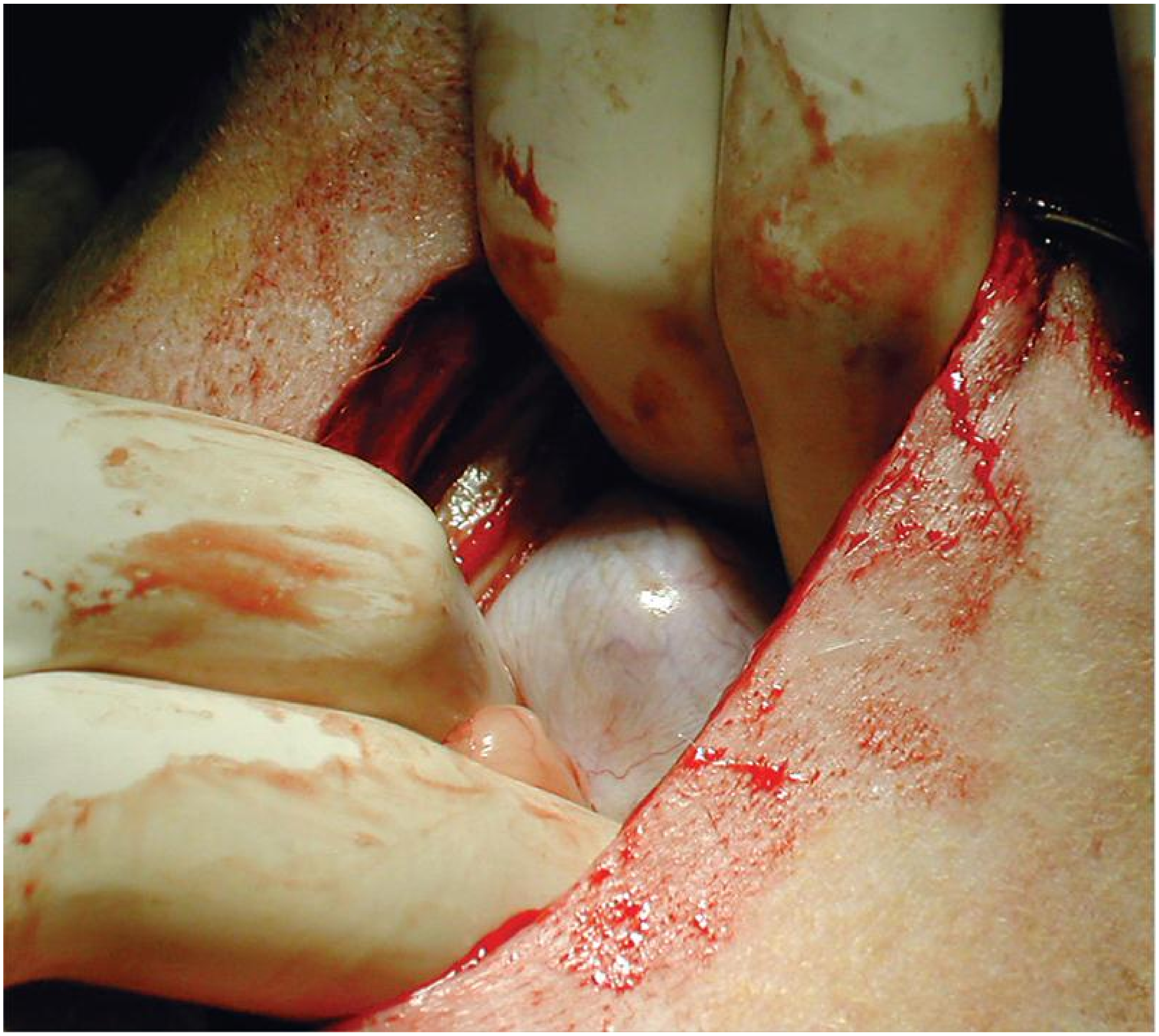

Fig. 4. Given the caudal location of the mass, an infraumbilical midline laparotomy was performed. As suspected, a large cryptorchid testis was found next to the bladder.

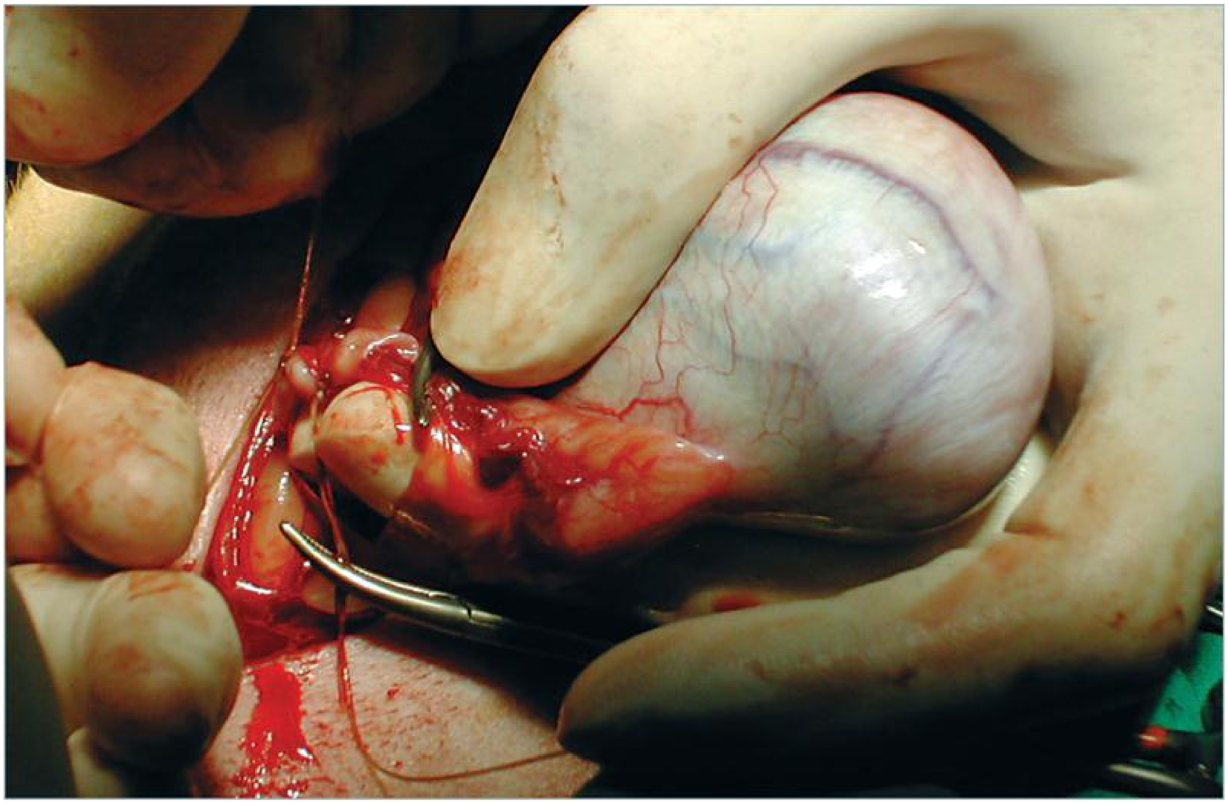

Fig. 5. The intra-abdominal testis is removed in the usual way, by ligating and cutting the structures of the spermatic cord.

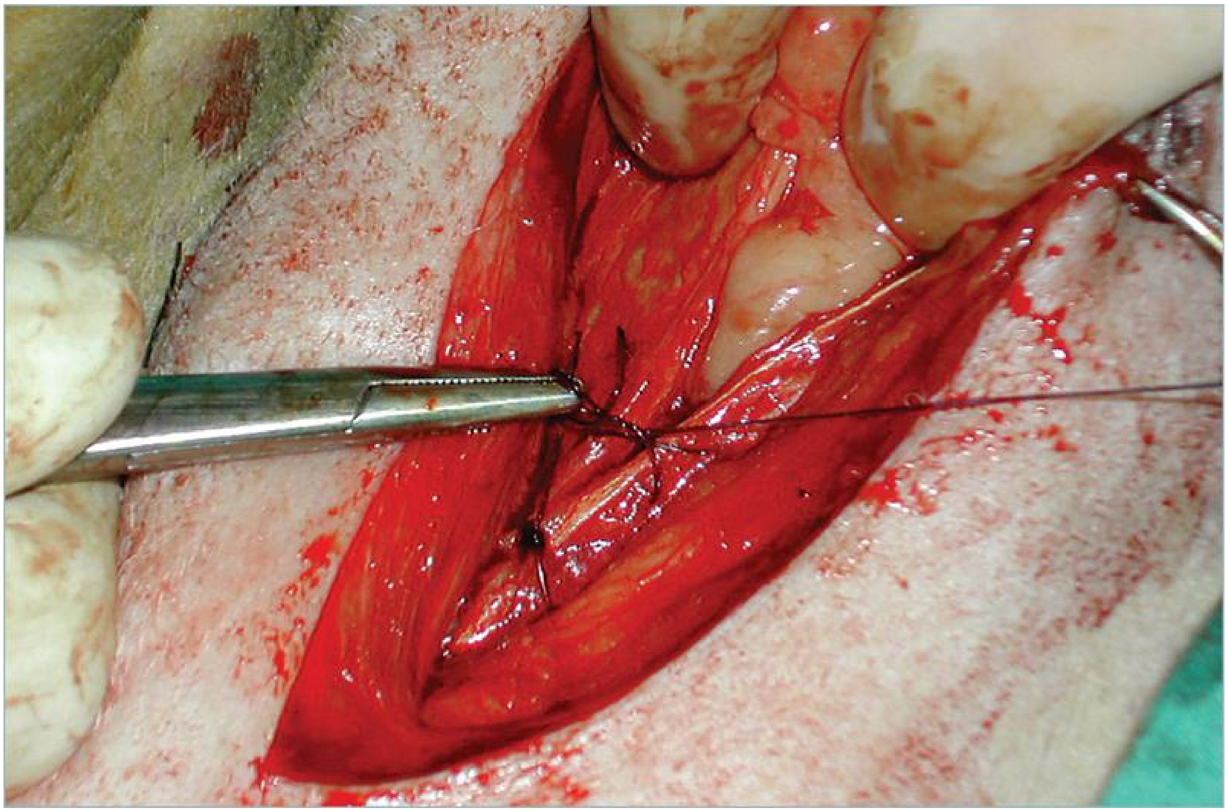

Fig. 6. The surgical wound is closed in layers.

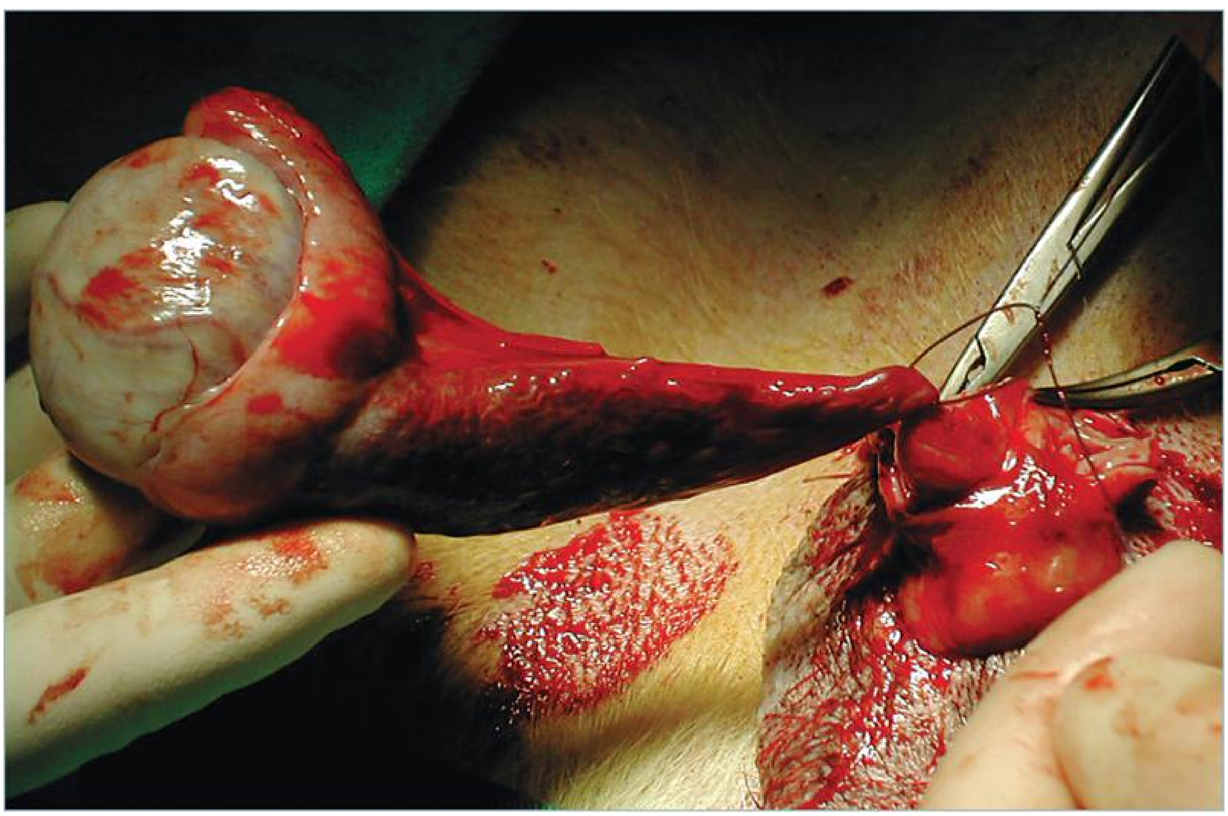

Fig. 7. The scrotal testis is removed.

Fig. 8. View of the neoplastic testis. Histopathology confirmed the diagnosis of a Sertoli cell tumor.

Nephrectomy

José Rodríguez

Prevalence	■	■	■		
Technical difficulty	■	■	■		

Removal of the kidney is indicated when there is no treatment for renal lesions or when the damage is irreversible, for instance because of infection, hydronephrosis or neoplasia.

Nephrectomy is only indicated if the contralateral kidney is functional.

After a midline laparotomy, the gastrointestinal bundle is pushed towards the affected kidney to check that the contralateral kidney looks normal and functional.

Following this, the abdominal contents are moved to the other side to expose the affected kidney (Fig. 1).

Bleeding of the blood vessels that surround the kidney is controlled (Fig. 2) and the parietal peritoneum is incised at some distance from the kidney. In this way, it will be easy to manipulate the kidney, using the fat cover to place forceps and apply traction (Figs. 3 and 4).

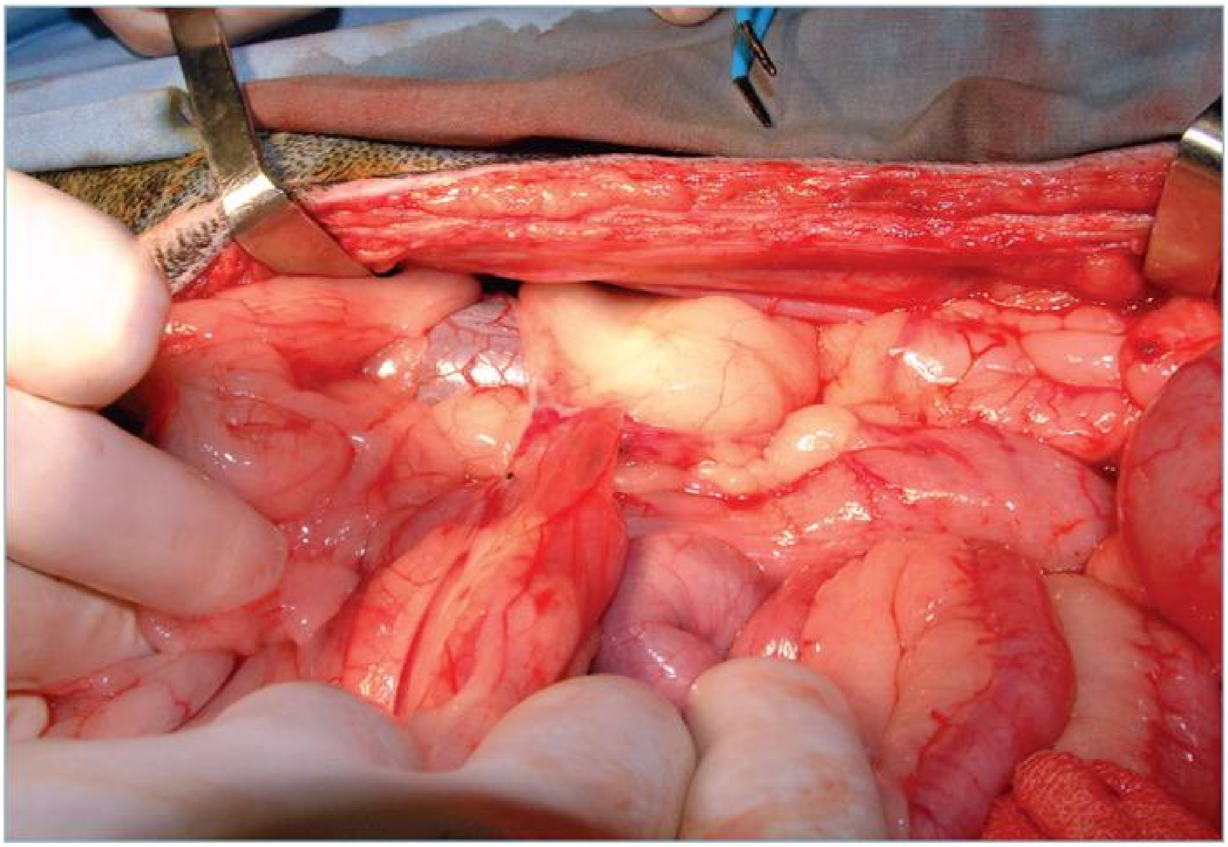

Fig. 1. This image shows the left kidney covered by retroperitoneal fat.

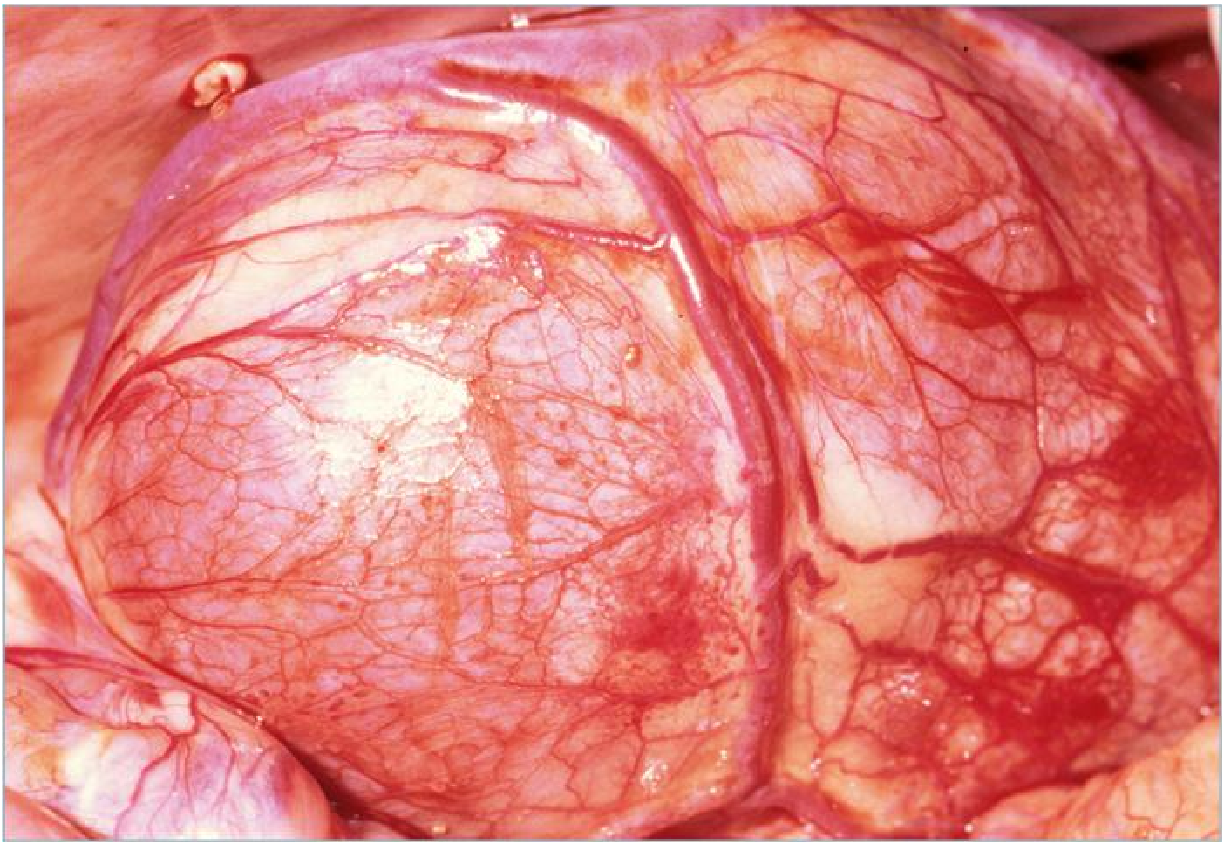

Fig. 2. Engorged peri-renal vascularization in a hydronephrotic kidney. Bleeding of all these vessels must be controlled before incising the peritoneum, in order to achieve a blood-free surgical field.

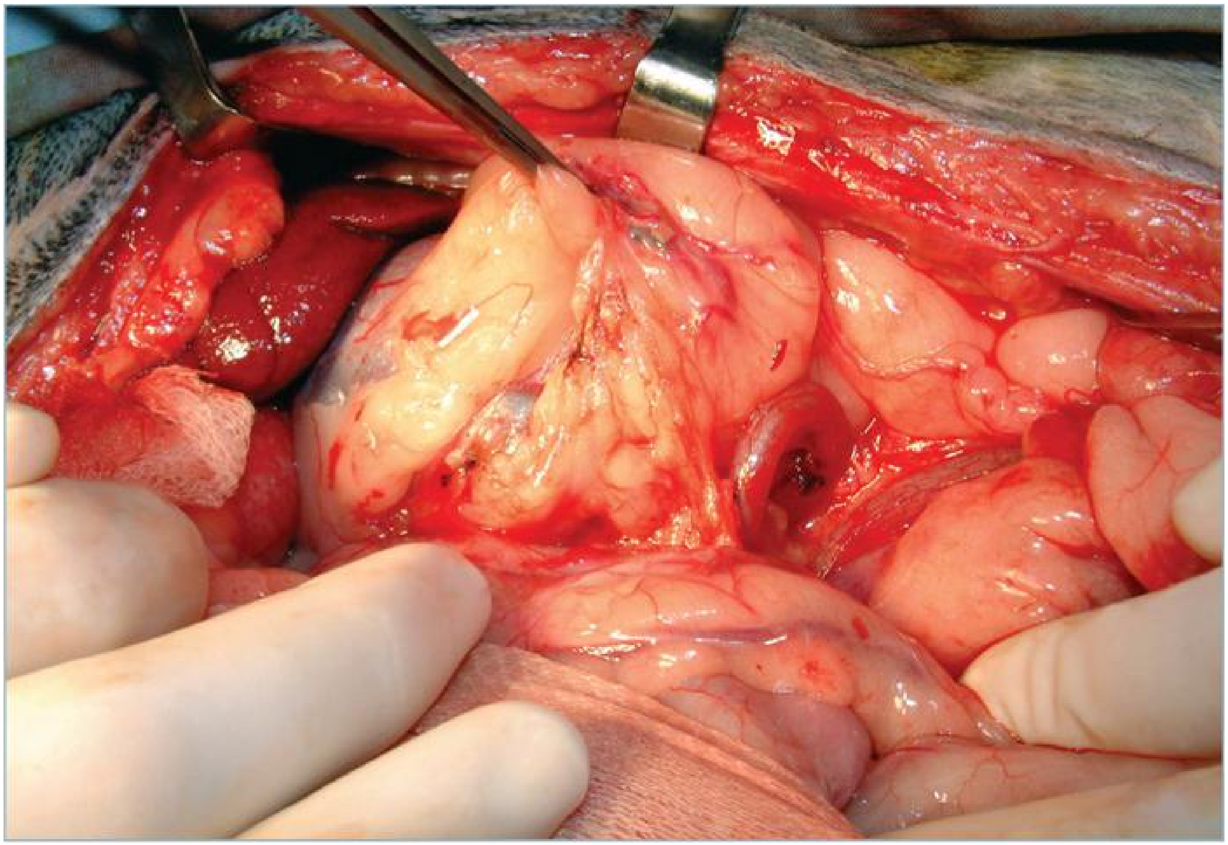

Fig. 3. Incision of the peritoneum at some distance from the kidney and dissection of the caudal pole of the kidney and the proximal ureter.

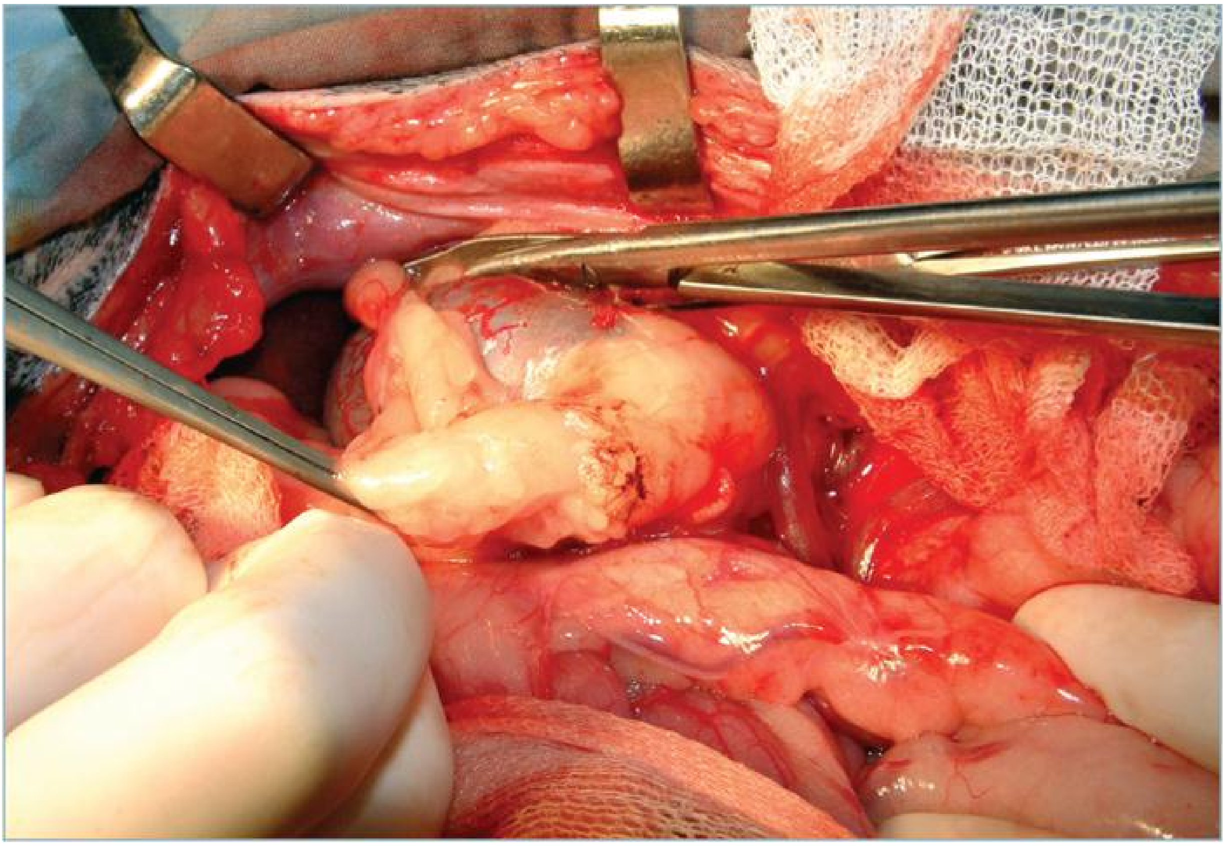

Fig. 4. Dissection of the kidney is simple and uncomplicated, but care should be taken when reaching the cranial pole because there may be accessory blood vessel, and the adrenal gland is nearby.

At the renal hilus, the renal vein should be identified, which is the vessel closest to the surgeon. The renal artery runs underneath (Fig. 5).

The renal hilus should be dissected with care, remember that the renal vein may be double.

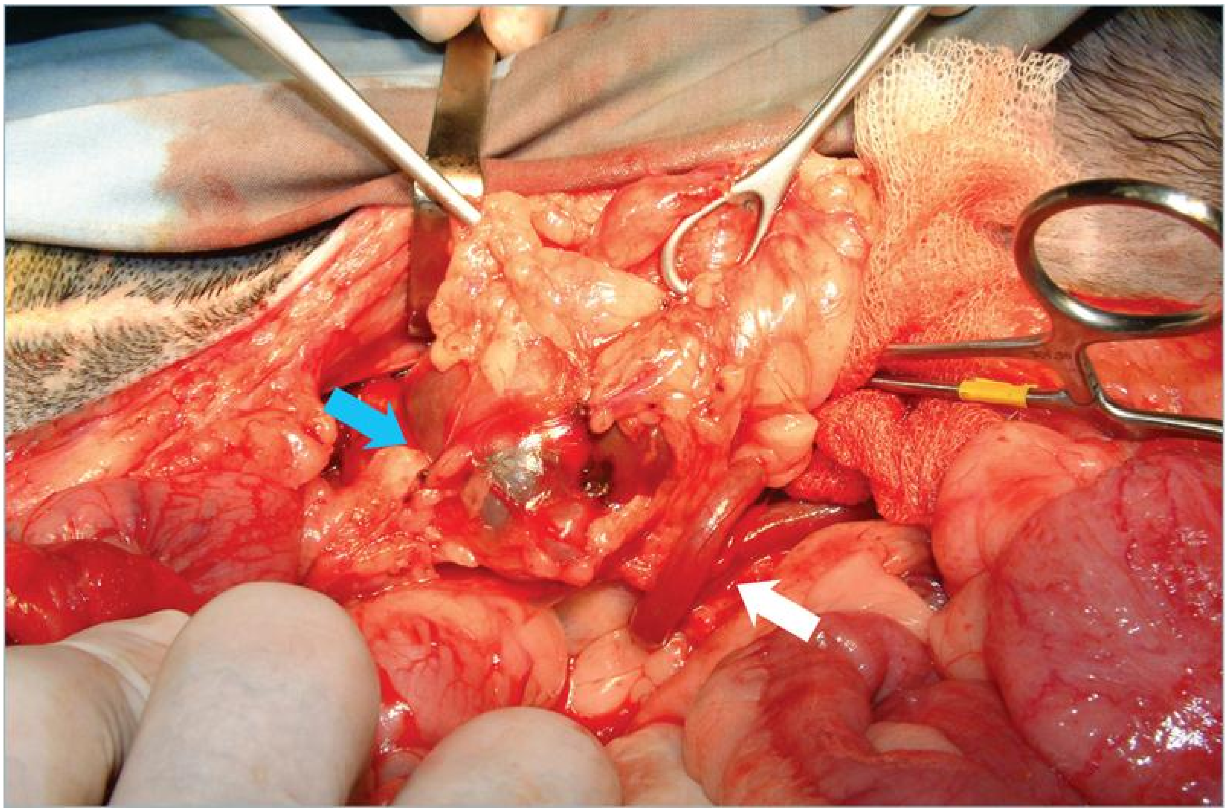

Fig. 5. Dissection of the renal hilus should be performed with care to avoid damaging the renal vessels. The vein is found first (blue arrow). The artery runs underneath. At the caudal pole, the ureter is identified (white arrow).

Blood vessels should be dissected along their length.

The vein is easy to ligate, using one or two distal ligatures and one close to the kidney (Fig. 6).

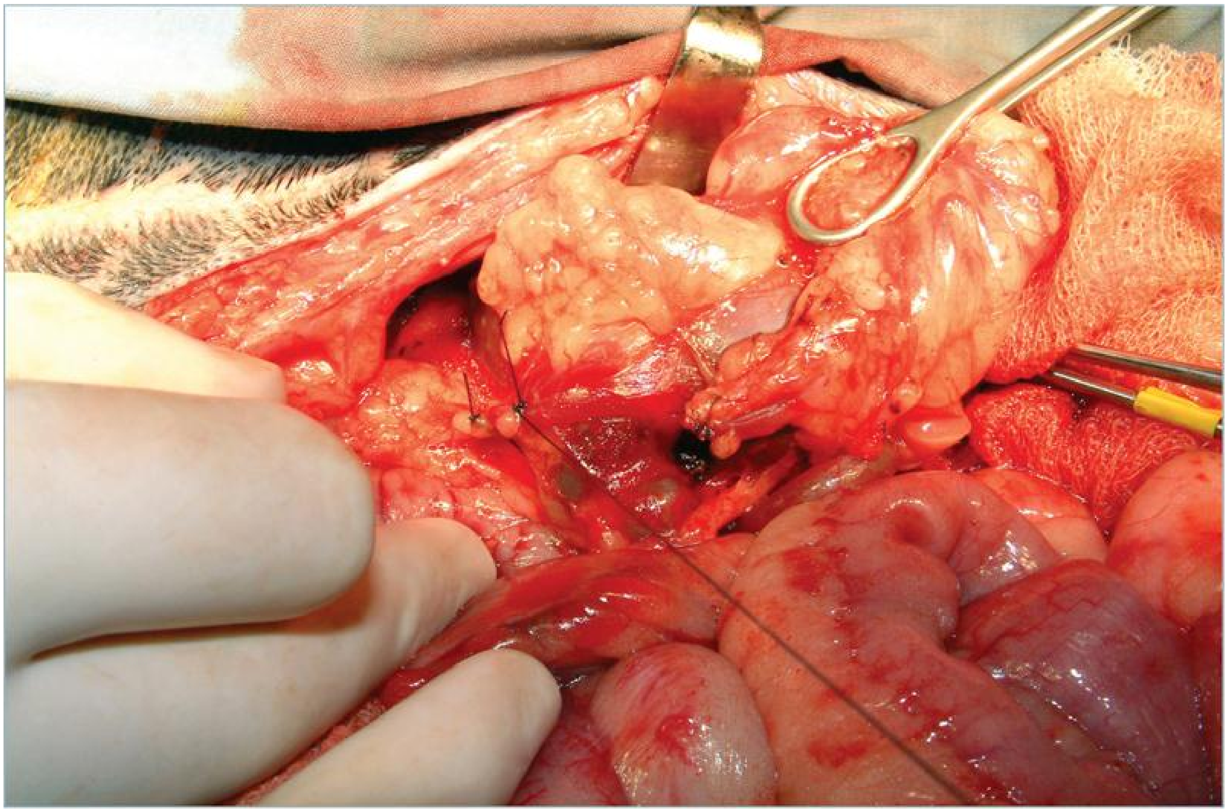

Fig. 6. Single ligature of the renal vein with synthetic non-absorbable material.

After sectioning the renal vein, it is easier to see, dissect and ligate the renal artery (Figs. 7 and 8). To prevent the ligature slipping off the renal artery, a transfixing suture should be placed distally. This suture fixes the ligature to the vessel and makes slippage due to the arterial tension impossible (Fig. 8).

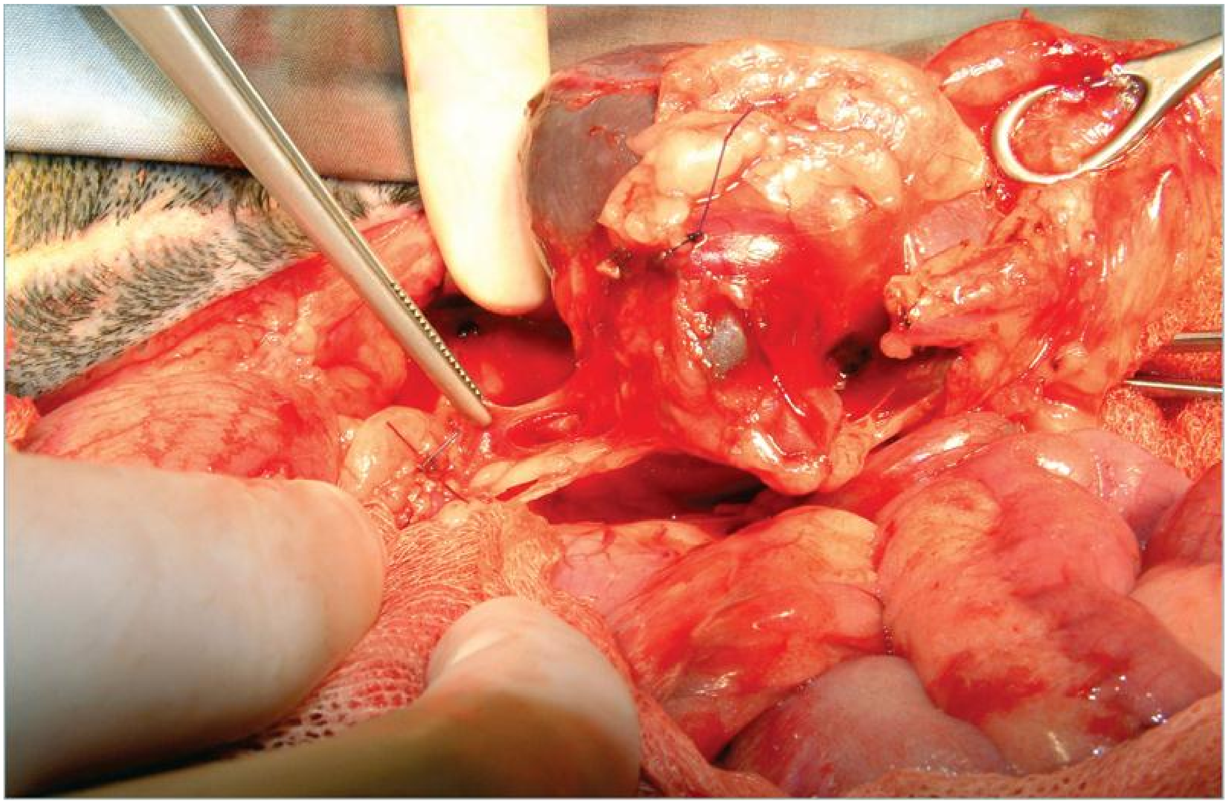

Fig. 7. The renal artery runs behind the vein. Dissection should be careful to avoid damaging it.

When placing a transfixing ligature, remember that the suture that fixes the ligature in the vessel should be located distally. Placed proximally, the vessel will bleed.

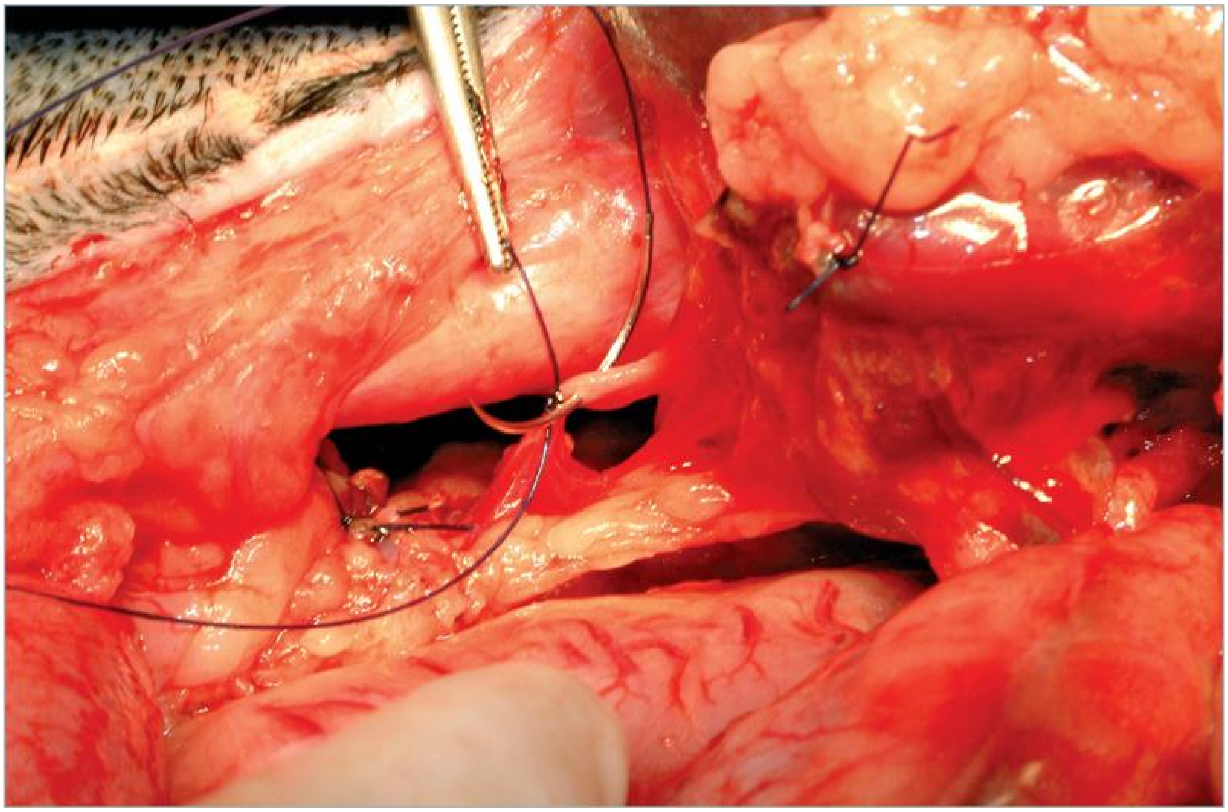

Fig. 8. As the renal artery is a high pressure blood vessel that branches directly off the aorta, it should be occluded by a transfixing ligature.

Sometimes it is easier to dissect the renal hilus from the dorsal side of the kidney. To do so, the kidney is dissected free and flipped over in a medial direction, so that the renal artery is exposed (Fig. 9).

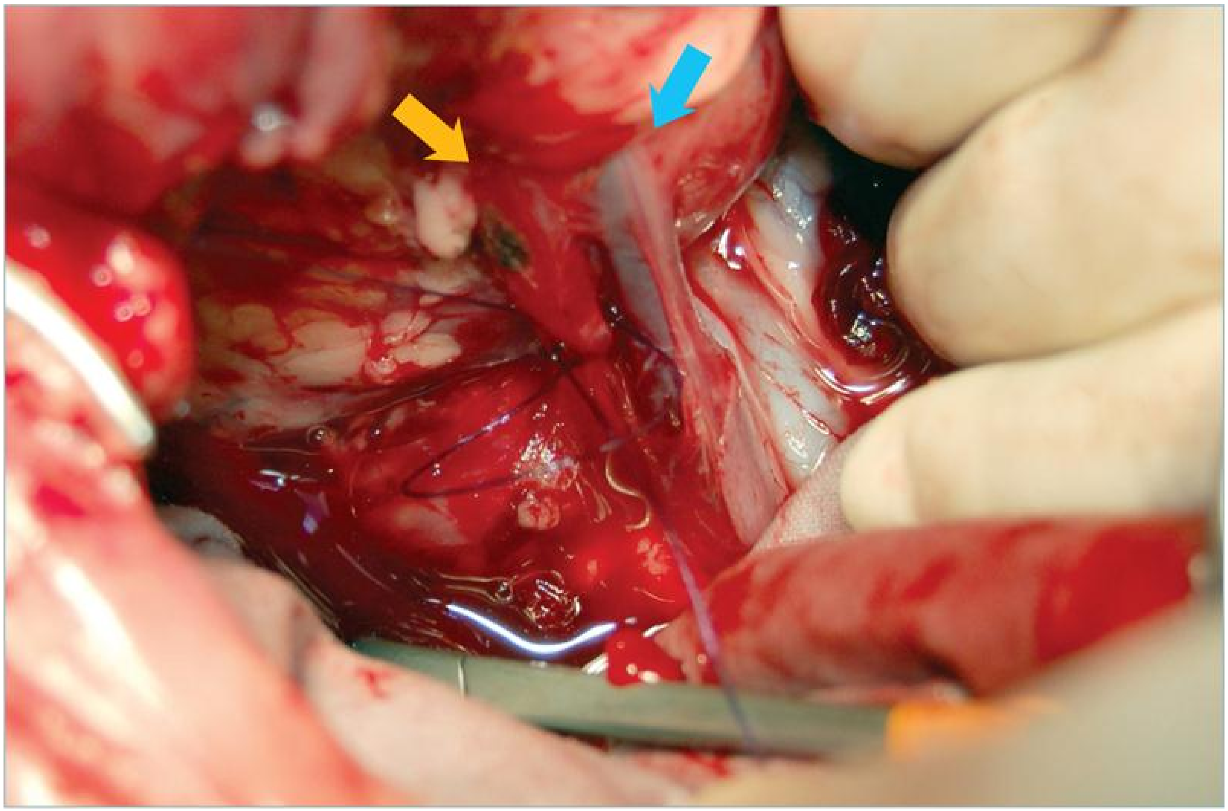

Fig. 9. Dissection of the renal hilus starting from the dorsal side of the kidney. In this way, the artery (orange arrow) is ligated first, followed by the vein (blue arrow). The image shows the transfixing suture on the renal artery.

> ***Dissection of the renal vessels from the dorsal side is indicated when the ventral side contains a large amount of fat, when there is little space between the kidney, the aorta and the vena cava, or if there are other technical difficulties.***

Dissection of the kidney is completed by dissecting all adhesions to the renal fossa (Fig. 10).

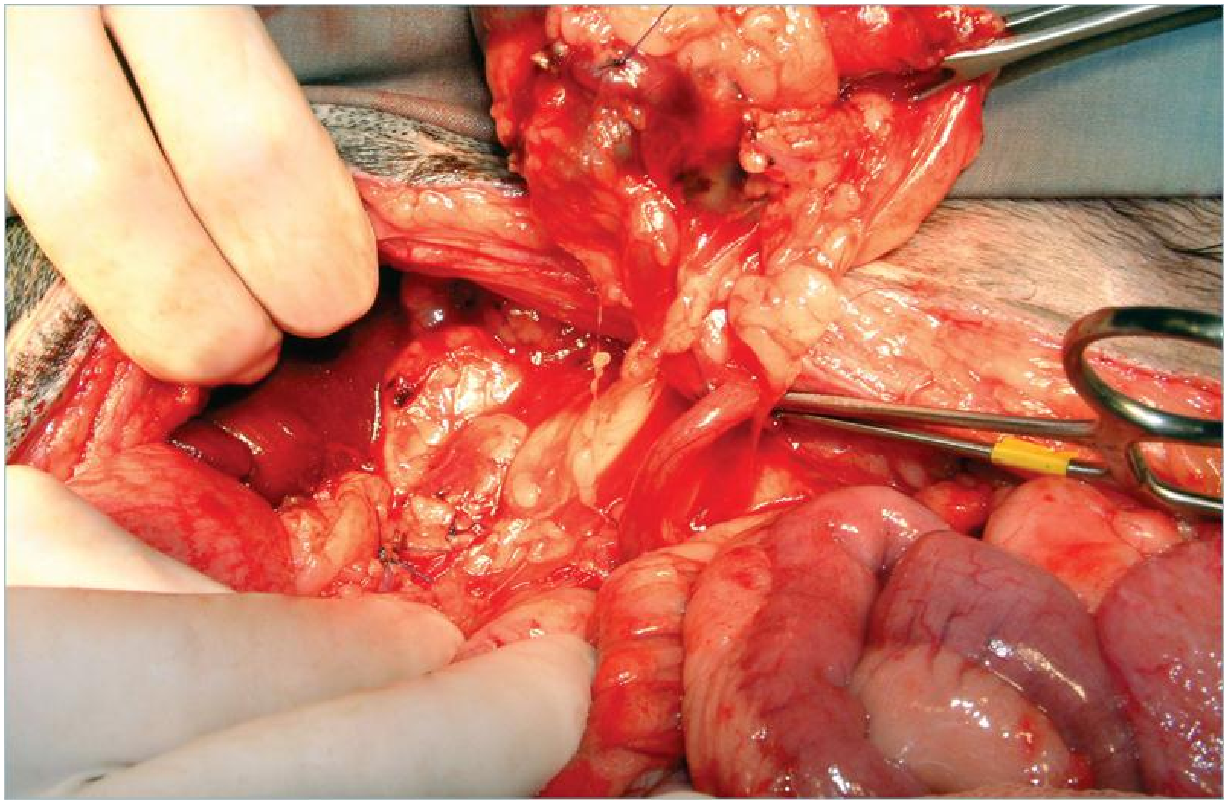

Fig. 10. The kidney is freed from its anatomical position; only the ureter is still attached.

The entire course of the ureter is dissected down to the bladder (Figs. 11 and 12). The nephrectomy is completed by clamping and ligating the ureter as close as possible to the bladder (Figs. 13 and 14).

Before closing the laparotomy incision, the renal fossa should be checked for hemorrhage from the renal or the perirenal vessels.

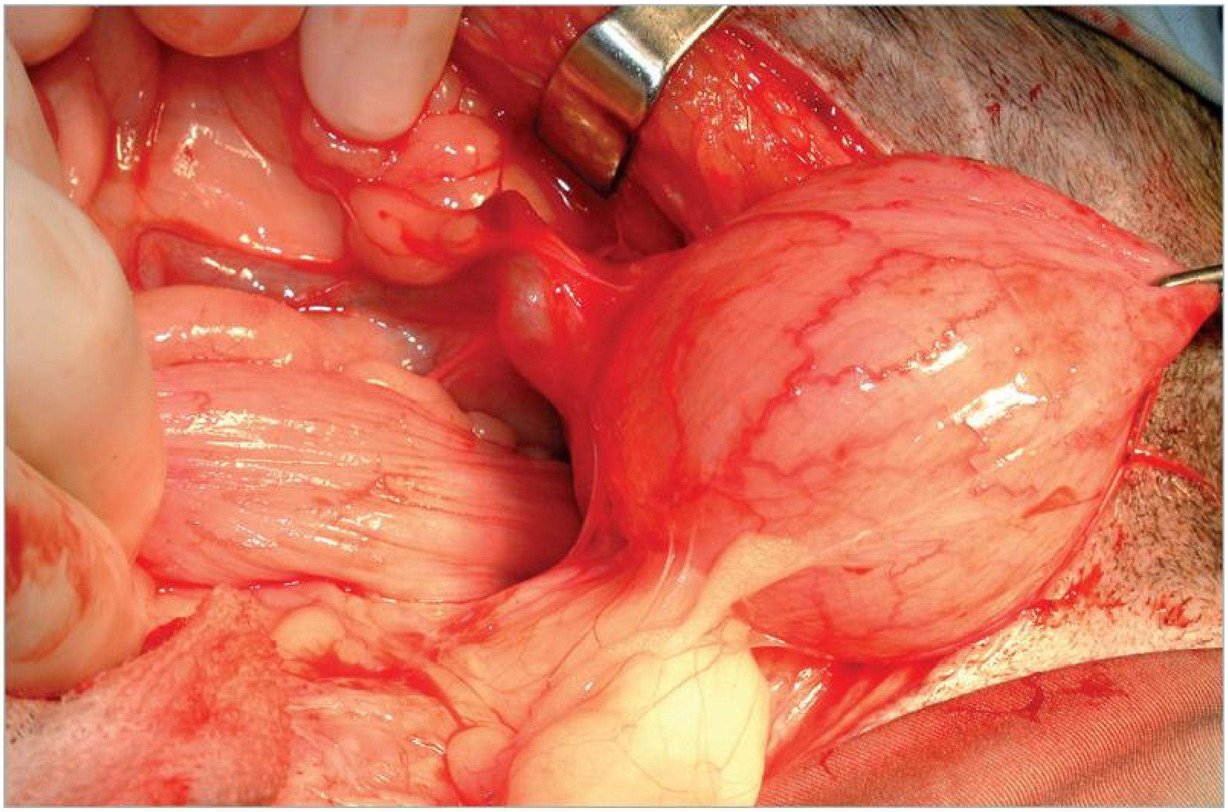

Fig. 11. Dissection of the distal ureter should be done with care to prevent damage to adjacent structures, in particular where it runs close to the bladder.

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Nephrectomy (kidney stones)

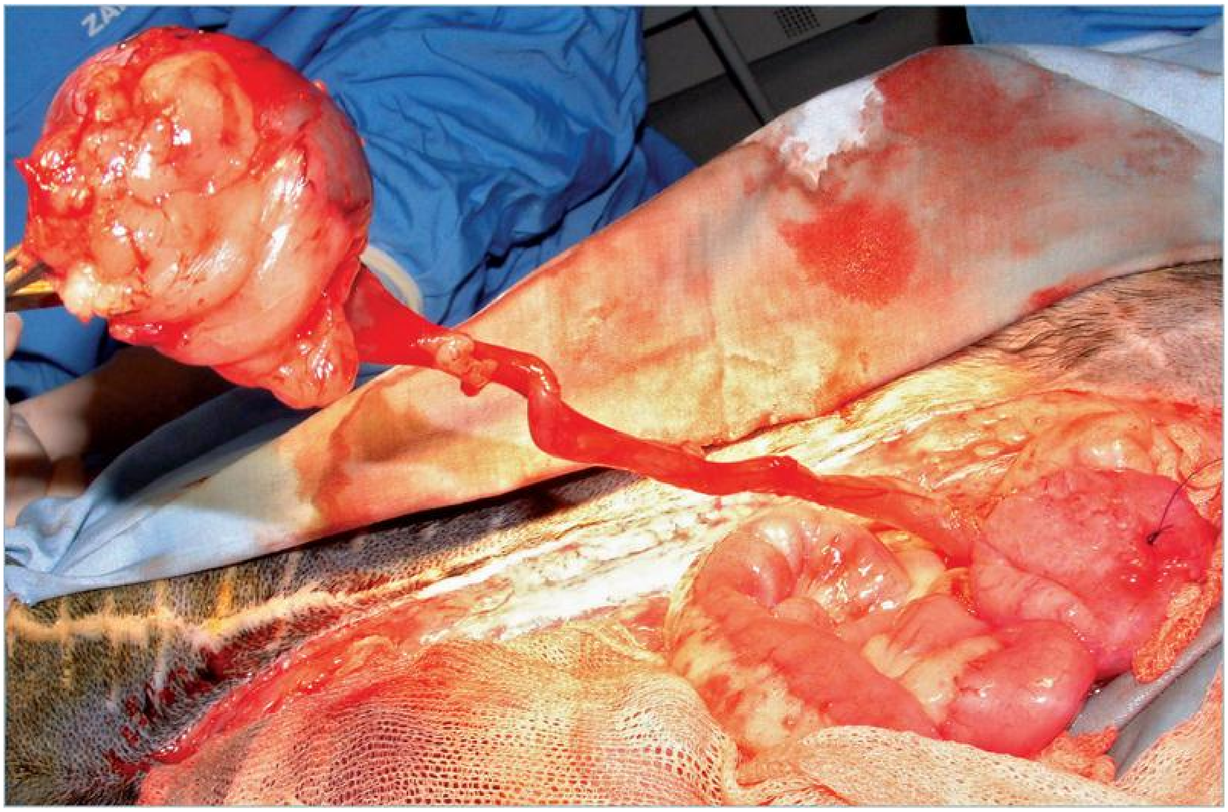

Fig. 12. Complete dissection of the kidney. It is only attached to the bladder by the ureter.

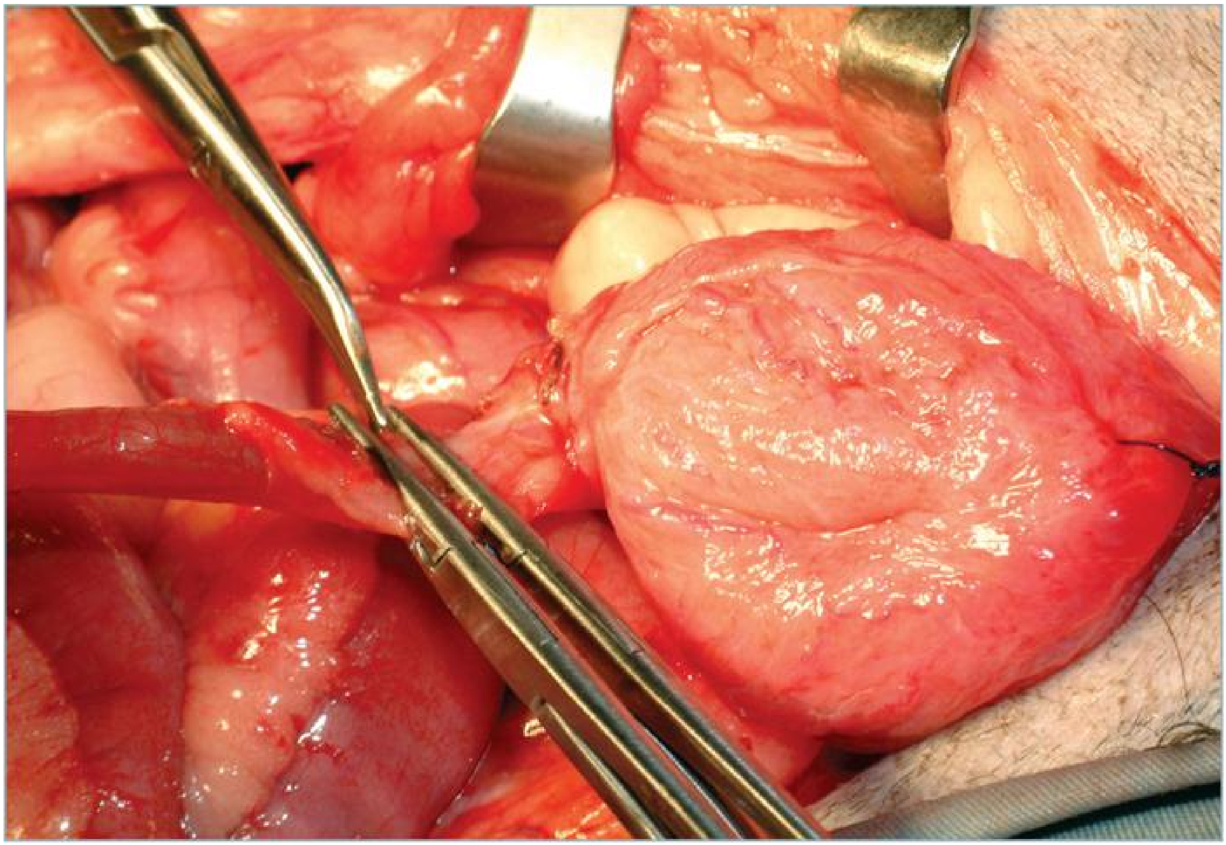

Fig. 13. Clamping and cutting the ureter close to the bladder.

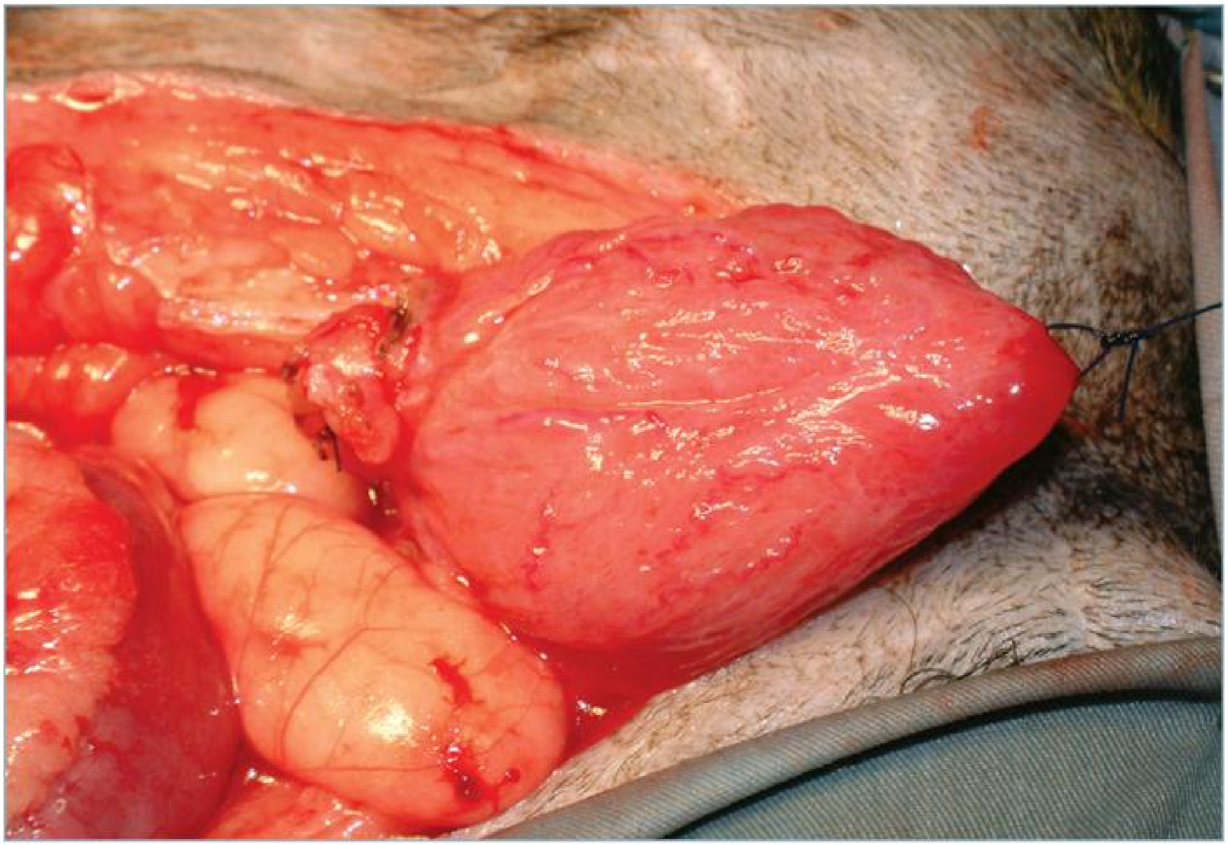

Fig. 14. The ureter is ligated as distally as possible with synthetic absorbable material.

Gastrostomy. Midline laparotomy

José Rodríguez

Prevalence	■	■	■	□	□
Technical difficulty	■	■	□	□	□

This technique is indicated if a ventral midline laparotomy has been performed, either with a diagnostic or a therapeutic aim, because this same approach can be used to place a feeding tube.

The laparotomy has to be extended to the supraumbilical area to reach the stomach and achieve good visualization and exteriorization.

Next, a full-thickness incision is made through the left abdominal wall, behind the last rib, according to the anatomical position of the gastric body (Fig. 1).

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Foreign body (gastrotomy)

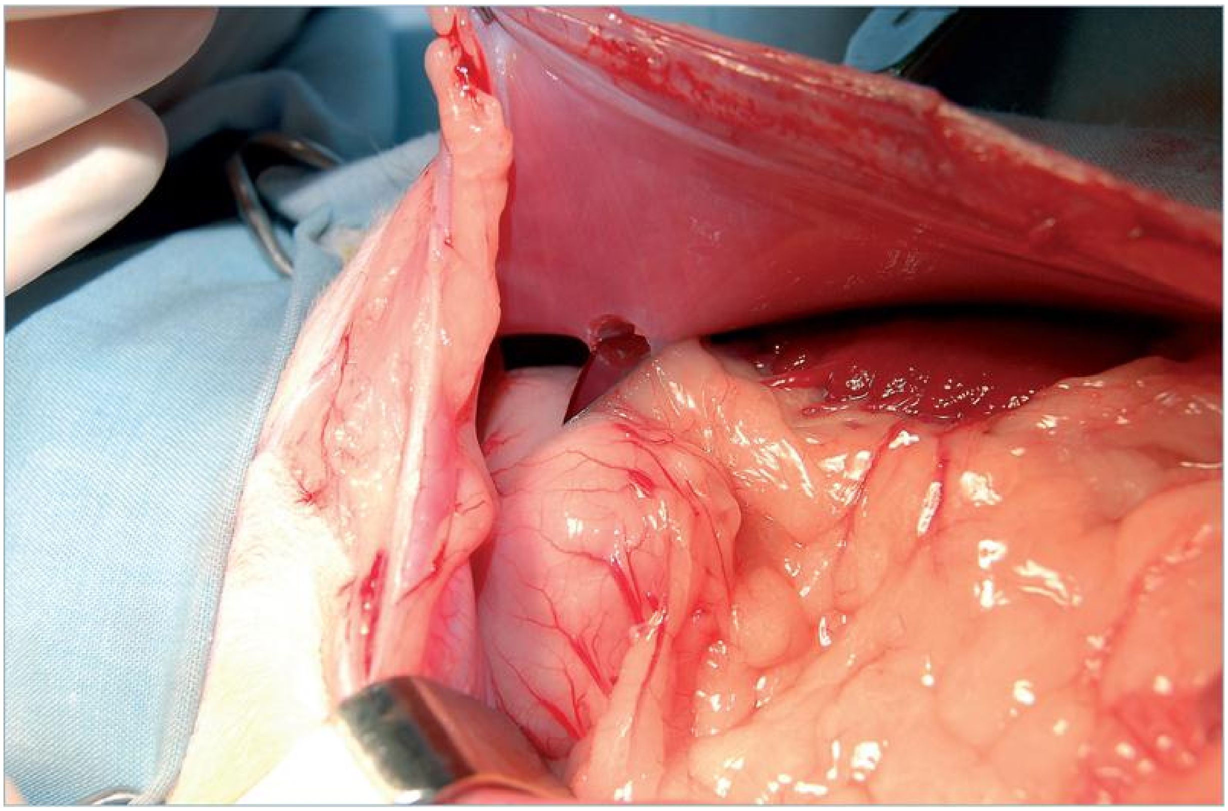

Fig. 1. Incision through the skin and muscles of the left lateral abdomen in the stomach region, in order to create a small opening.

Atraumatic forceps are passed through the hole from the inside to the outside and are clamped around the end of the feeding tube to pull it into the abdomen (Figs. 2 and 3).

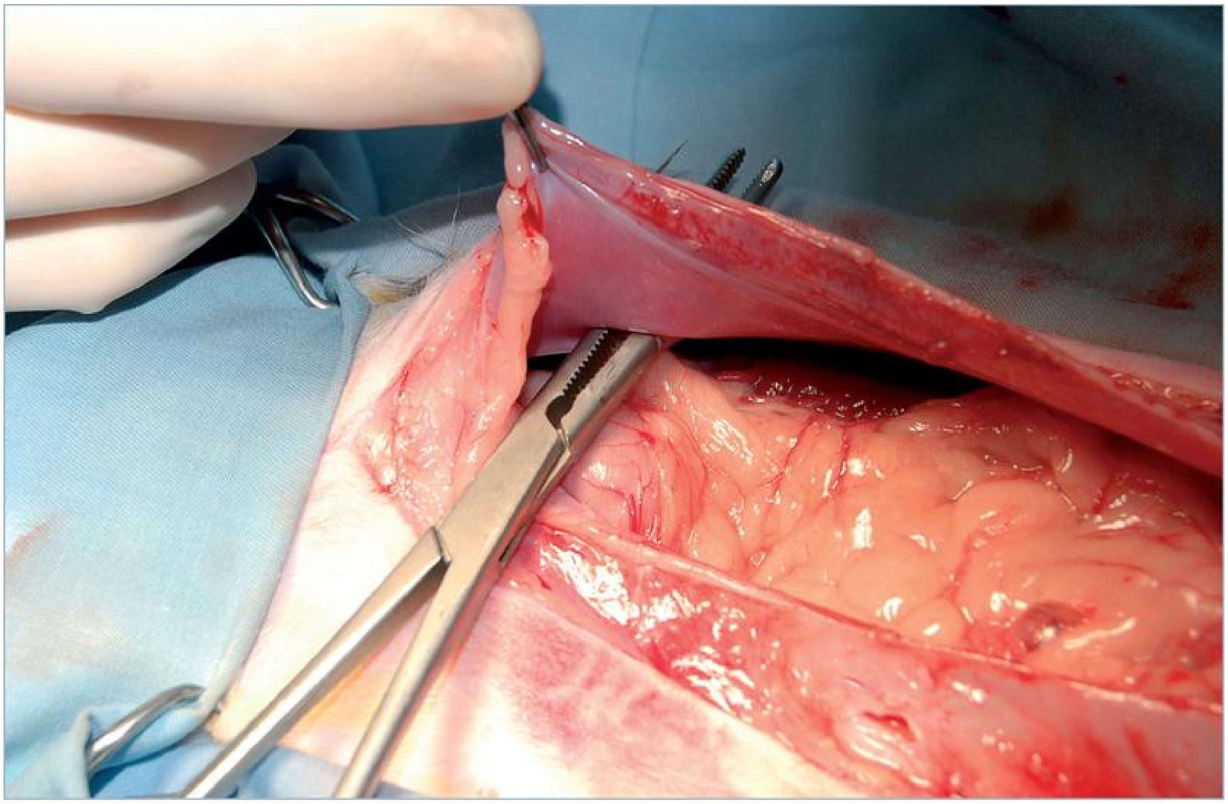

Fig. 2. Through the tunnel that has been created, a Kocher clamp is passed from the inside to the outside to grasp the stomach tube.

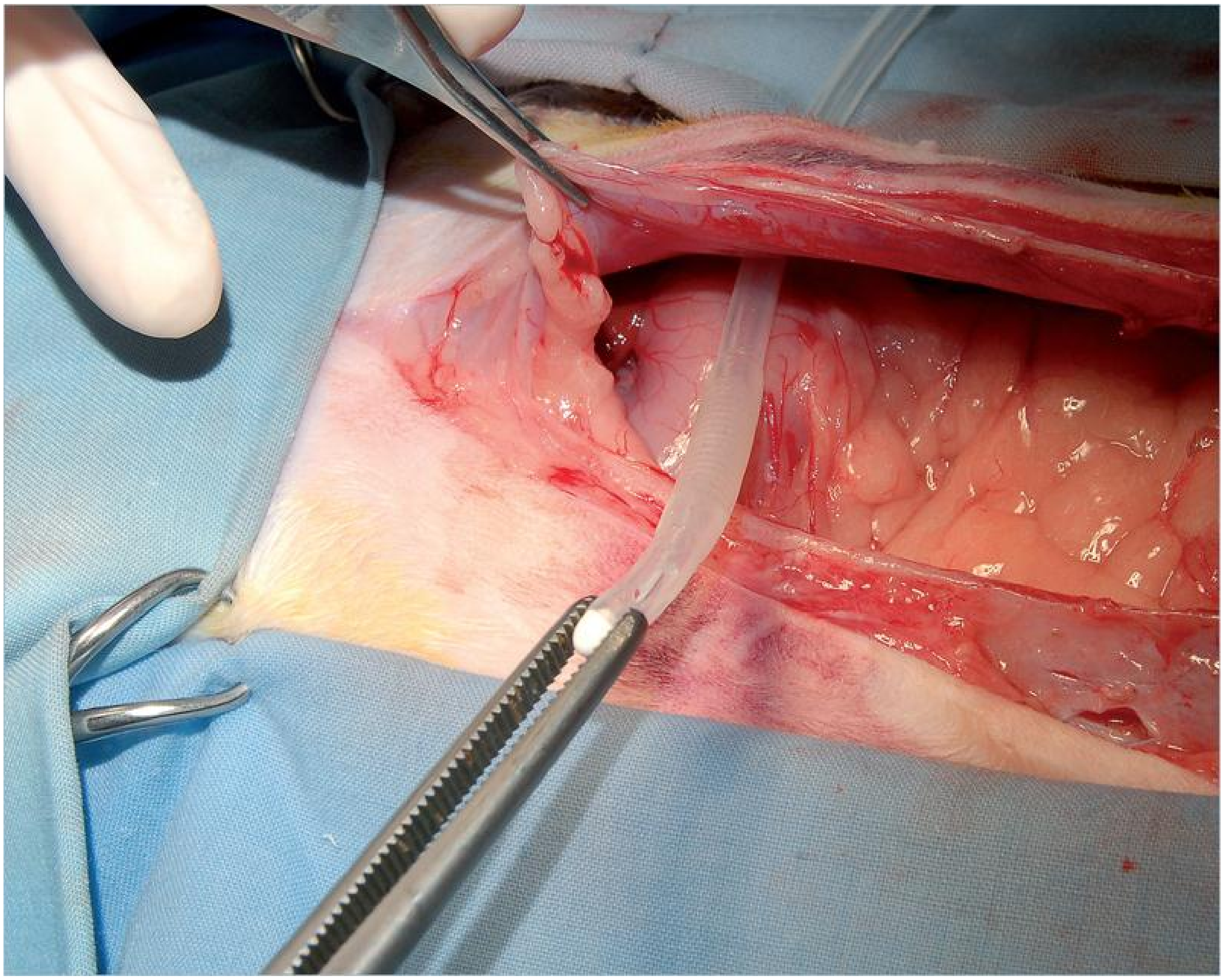

Fig. 3. The stomach tube is pulled into the abdomen with the aid of the clamp.

The stomach is externalized and isolated, and a poorly-vascularized area of the gastric body, not too near the pylorus, is selected. Using monofilament absorbable material and a round needle, a small purse-string suture is placed, only including the serosal and muscular layers of the stomach (Fig. 4).

Fig. 4. Purse-string suture in a poorly vascularized area of the gastric wall, after having isolated the stomach with sterile swabs.

Ensure the tube is not positioned in the pylorus or the pyloric antrum, because this could cause gastric obstruction and impede the passage of food into the duodenum (Fig. 5).

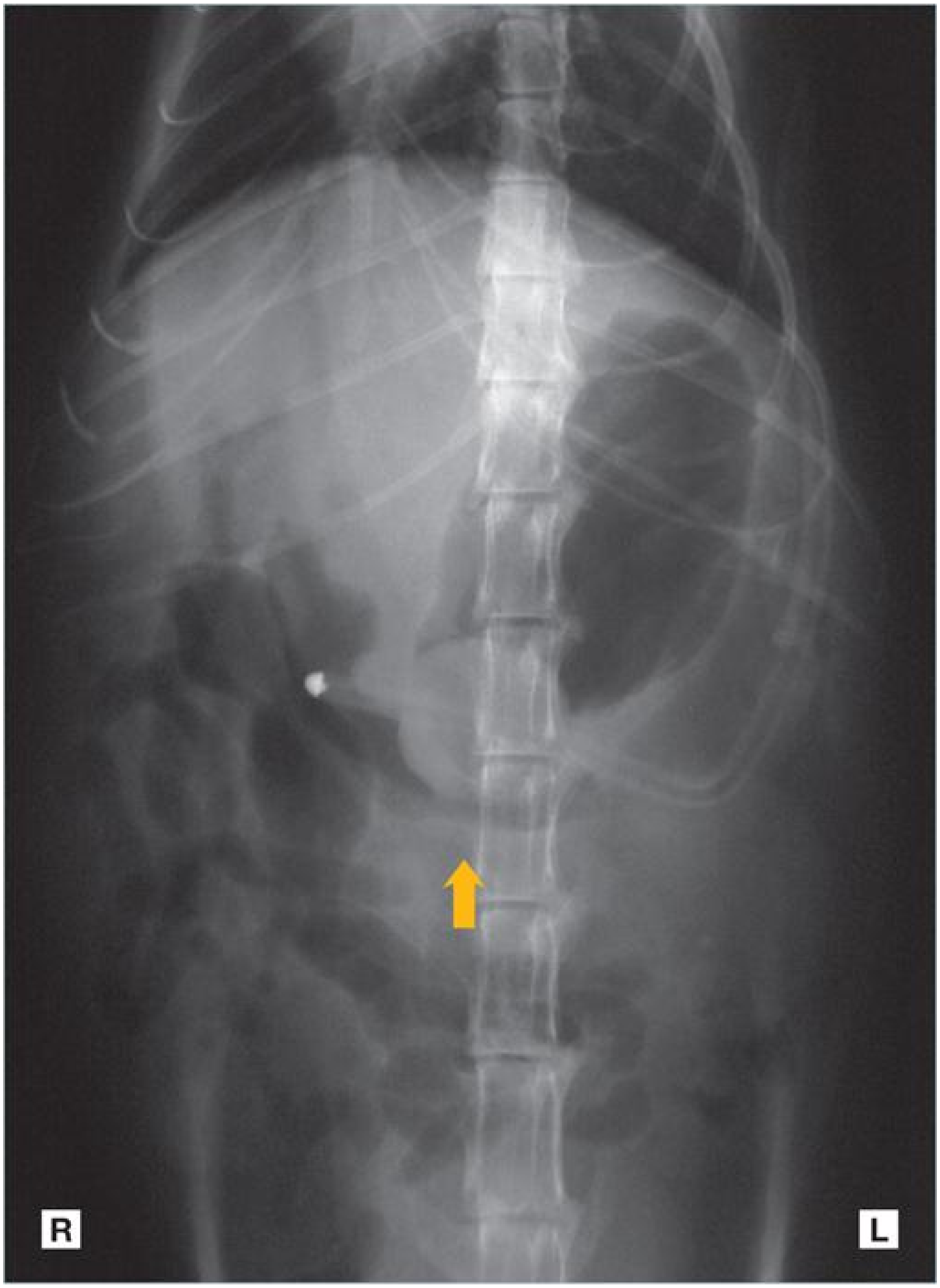

Fig. 5. This patient received a stomach feeding tube but started to vomit shortly after the introduction of food. Note that the balloon of the tube occupies the pyloric antrum (arrow) and obstructs the passage into the pylorus. This is a grave technical error in the placement of the tube.

In the center of the purse-string, a full-thick-ness incision is made through the gastric wall, using a scalpel. The feeding tube is inserted through the gastrotomy (Fig. 6).

> ***Use a firm stab incision with the scalpel to cut through all the layers of the stomach without detaching the mucosa, which peels away easily.***

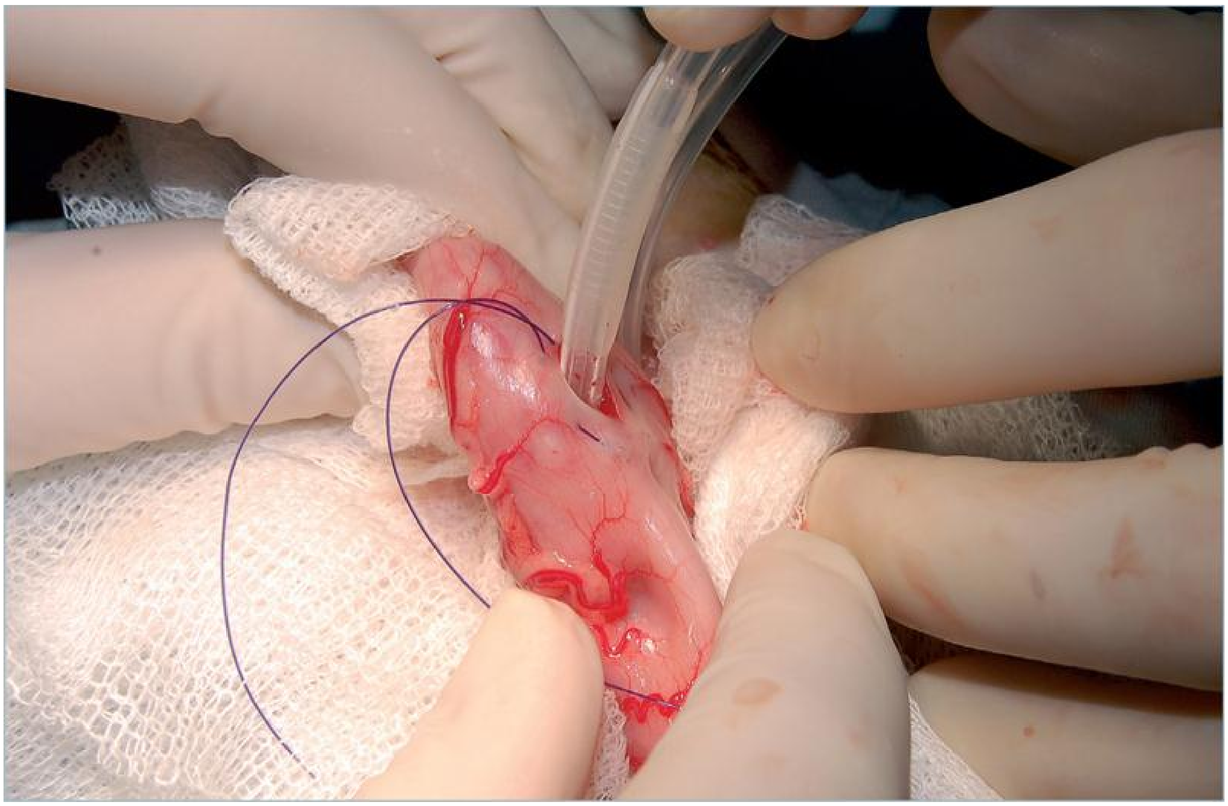

Fig. 6. A small gastrotomy is performed in the center of the purse-string and the feeding tube is inserted.

Next, the balloon of the tube is inflated with saline; this stops the tube from slipping out of the stomach into the abdominal cavity (Fig. 7).

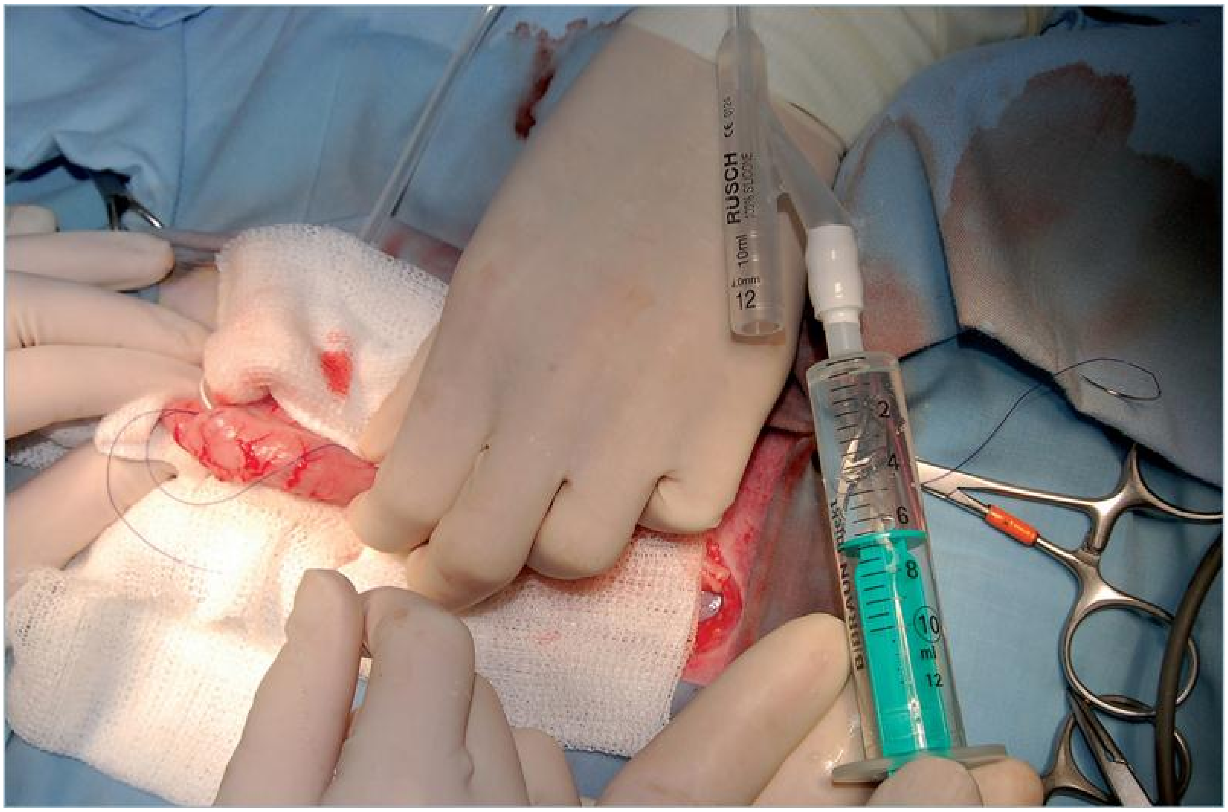

Fig. 7. The balloon of the tube, positioned inside the stomach, is distended with saline to stop the tube from slipping out of the stomach.

The purse-string suture is pulled tight and knotted around the tube to prevent leakage of gastric contents into the abdominal cavity (Fig. 8).

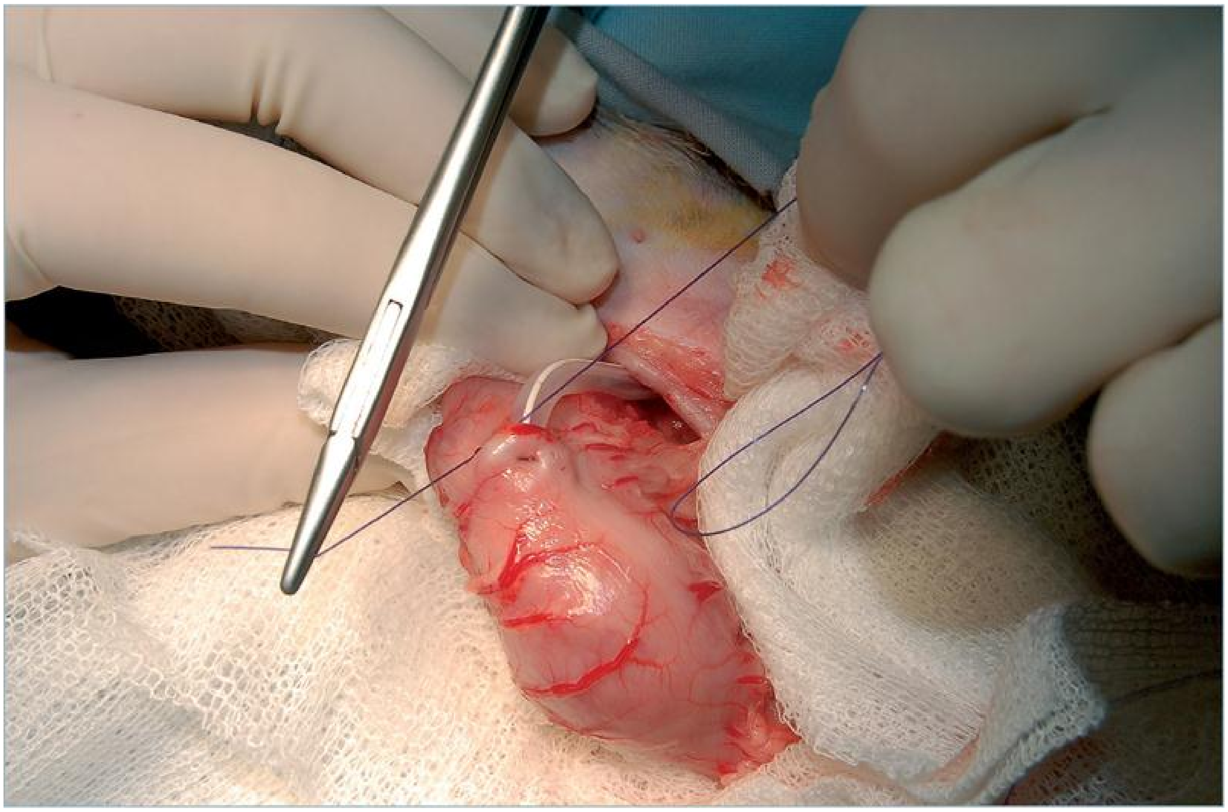

Fig. 8. Finally, a suture is tied around the tube to prevent leakage of gastric contents.

Next, the stomach is fixed to the abdominal wall in order to create a good adhesion that will avoid abdominal contamination once the tube is removed. The gastropexy is performed using two simple sutures that attach the gastric wall to the abdominal wall (Fig. 9).

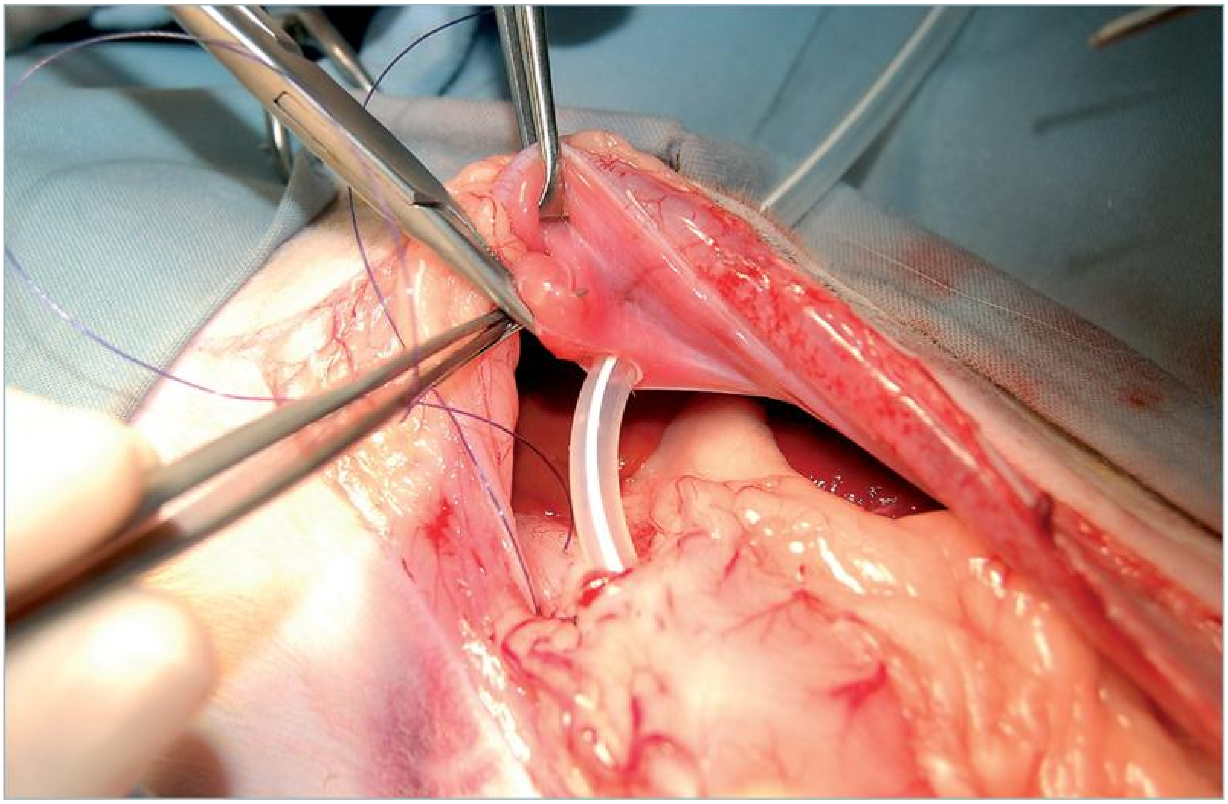

Fig. 9. A gastropexy is performed, using two simple sutures of monofilament absorbable material. This image shows the suture that is placed cranial to the tube.

As an additional safety measure, a portion of omentum is placed around the tube between the stomach and the abdominal wall (Figs. 10 and 11).

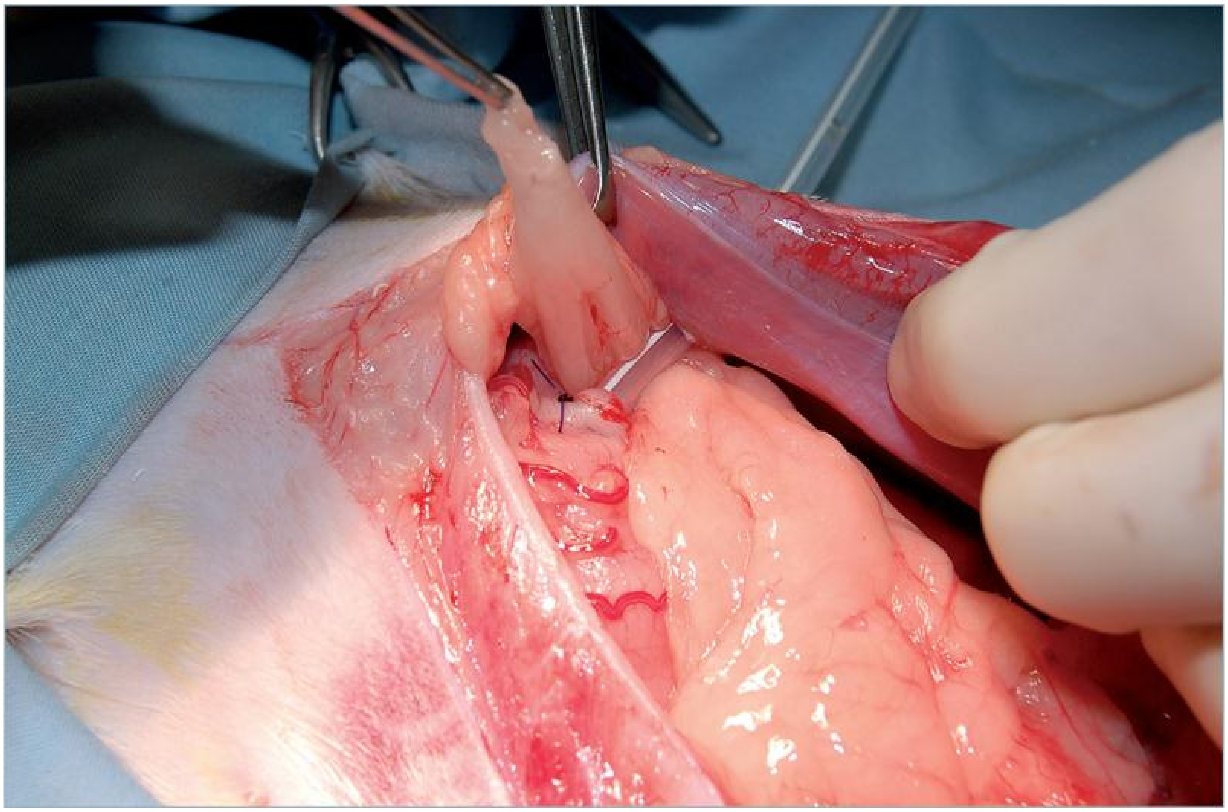

Fig. 10. A portion of omentum is placed around the tube to promote wound healing and reduce the risk of secondary peritonitis.

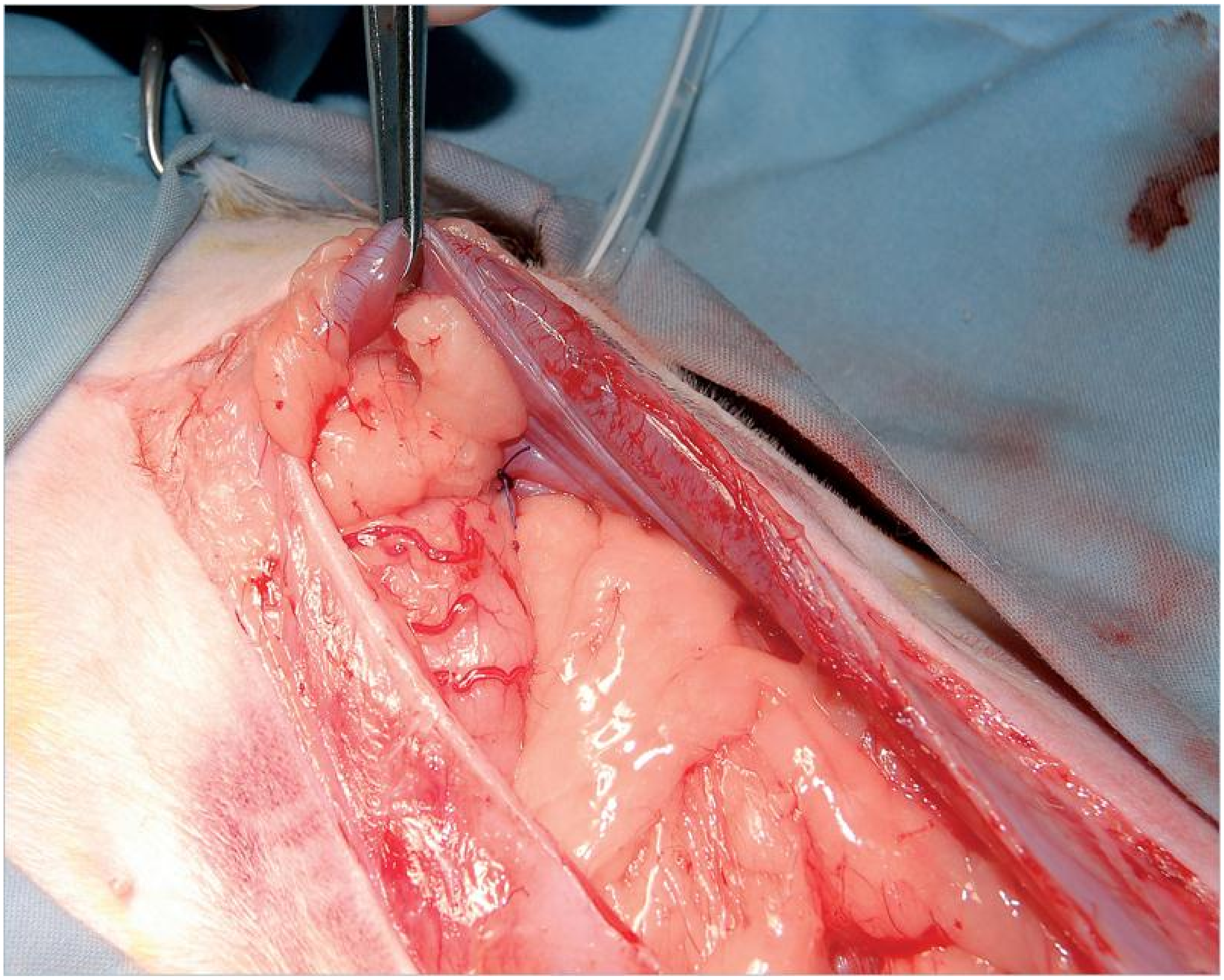

Fig. 11. The second suture, that finalizes the gastropexy, is placed the same way as the first one, except that it is placed caudal to the tube and includes part of the omentum for more secure fixation.

The tube is attached to the skin using any system that keeps it from slipping out when pulled (Fig. 12). A “Chinese finger-trap suture” is recommended for this.

To attach the tube to the skin, multifilament material should be used, because it has a better grip on the surface of the tube. Monofilament thread slips more easily.

The laparotomy is closed in the standard manner.

Do not forget to plug the tube to prevent air admission and leakage of food or gastric contents.

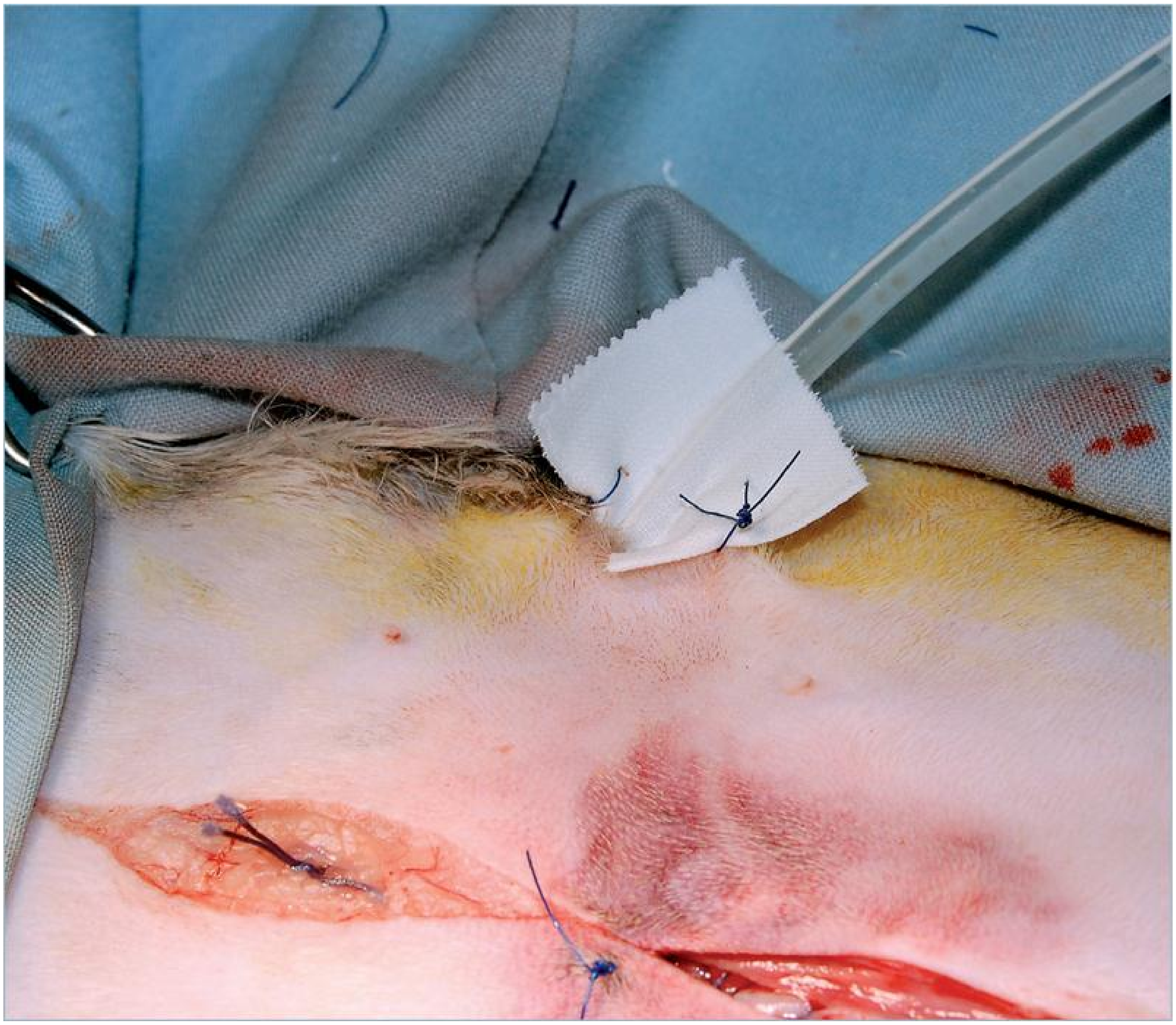

Fig. 12. In this case, the tube is attached to the skin with the aid of a piece of adhesive tape that has been stuck to the tube.

After surgery

It is advisable to protect the tube with a bandage and use an Elizabethan collar to prevent the patient from pulling the tube out too early (Fig. 13).
For the tube to work well, a liquid diet is required. The amount should be calculated for each patient, and it should be administered several times a

day. It is a good idea to flush the tube with lukewarm water before and after each feeding.
The tube should stay in place for at least ten days.
To remove it, the cuff is emptied, the skin suture cut, and the tube pulled out.
The remaining wound heals by secondary intention in approximately one week.

Food should pass through the feeding tube without difficulty; if not, a carbonated drink may help to unblock the tube.

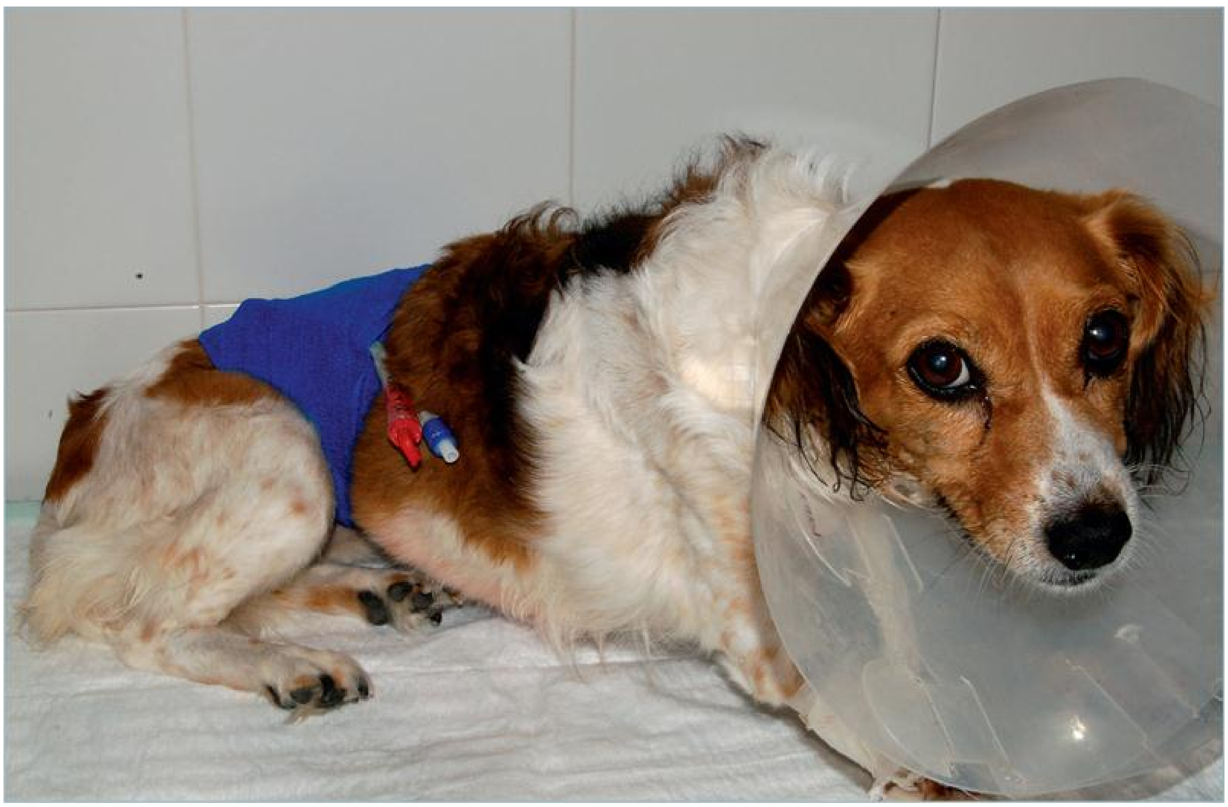

Fig. 13. Patient waking up from surgery after placement of a feeding tube.

Gastric dilatation-volvulus syndrome (GDV)

José Rodríguez
María José Martínez
Jaime Graus

Prevalence	■■■■□
Technical difficulty	■■■■□

Gastric dilatation-volvulus syndrome, also called “bloat”, is characterized by an enlarged stomach that has rotated around its hepatic and splenic attachments (Figs. 1-3).

> ***Gastric dilatation-volvulus syndrome is associated with a high mortality rate, even in correctly treated animals.***

Given the high mortality rate in these patients, a number of recommendations should be given to the owners of predisposed dogs (giant breed and those with a deep chest):

- Divide the daily ration over several meals. Avoid single, large meals.
- Avoid stress and competition with other dogs during feeding to prevent voracious ingestion rates.
- Limit physical exercise before and after eating.
- Do not use elevated food bowls.
- Avoid breeding animals that have suffered from this syndrome.
- Consider prophylactic gastropexy in predisposed patients.
- Immediately call the emergency service if you observe drooling, belching, difficulty breathing or abdominal bloating.

Pathogenesis of the disorder

If the stomach rotates on itself, its communication with the esophagus and the intestines are blocked. Gas can no longer be eliminated and accumulates inside the stomach, causing further distension. Venous congestion of the stomach causes liquid to accumulate inside. The compression of the caudal vena cava and the portal vein reduces the venous return to the heart, decreases cardiac output and causes myocardial ischemia.

The central venous pressure and mean arterial pressure decrease, causing hypovolemic shock and reduced tissue perfusion, affecting organs like the kidney, heart, pancreas, stomach and intestine.

Cardiac arrhythmias are very common, especially if there is gastric ischemia.

If the condition is not rapidly corrected, multiple organ failure and death will follow.

> ***Gastric dilatation-volvulus syndrome is one of the most severe emergencies that can happen to a dog – and to a veterinarian.***

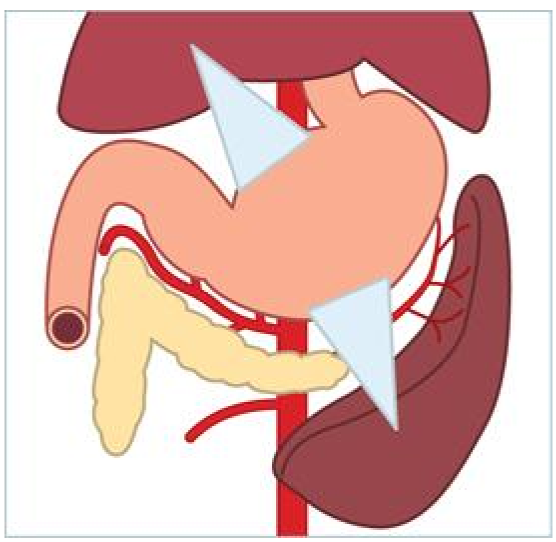

Fig. 1. The stomach is attached cranially by gastrohepatic ligaments to the liver and caudally to the omentum and the spleen. The tension forces are indicated by arrows.

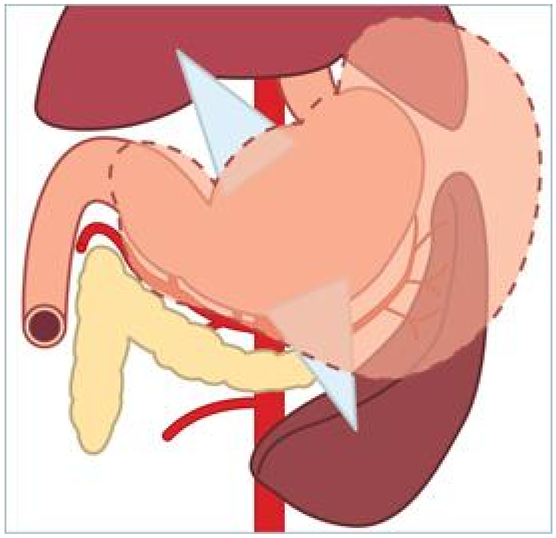

Fig. 2. If the stomach is distended, the most dilated areas are the fundus and the body, which occupy an eccentric position compared to the ligaments mentioned in the previous image.

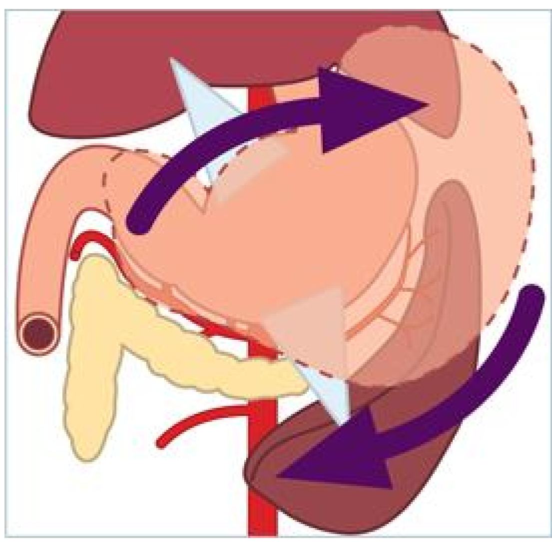

Fig. 3. For this reason a dilated stomach easily rotates around itself, leading to gastric torsion.

Clinical signs

The patient is restless, shows unproductive retching, drooling, respiratory distress and tympanic distension of the abdomen.
There may also be tachycardia, a weak pulse, pale mucous membranes and an increased capillary refill time.

What to do first?

There should be excellent written treatment protocols for these patients.

The success of the surgery largely depends on the speed with which the owner and the veterinarian react.

The more veterinarians and nurses that are available during the intervention, the better the results: several things can be done at the same time, and the patient can be better monitored over a longer period.

The first objective is to stabilize the patient and to empty the stomach.

Stabilization of the patient

The protocol for the stabilization and initial treatment of GDV at our center is as follows:

- Large-bore IV catheters are placed in either the cephalic or the jugular veins on both sides (Fig. 4).
- Hypertonic saline 7.5 % is given to rapidly increase the circulating blood volume (4 mL/kg, rapidly infused).
- Hydroxyethyl-starch plasma expander (4 mL/kg, rapid infusion). Now associated with platelet dysfunction or coagulopathies.
- Lidocaine to prevent extrasystoles or to treat them if present (0.1 mL/kg, 2 % IV bolus).
- Isotonic fluid replacement or Ringer's lactate to bolus maintain circulating volume (20 mL/kg/h).
- Premedication with midazolam (0.5 mg/kg) and a pure μ opioid (0.02 mg/kg) IV, to reduce the dose of anesthetic induction agent and to provide analgesia, respectively.
- Antibiotic combination of amoxicillin-clavulanic acid and enrofloxacin, to prevent infection due to bacterial translocation from the intestine.

- Blood pressure measurement.

Before treatment, a blood sample is taken for hematology and the measurement of plasma lactate (normal values 0.50-2.50 mmol/L).

The concentration of lactate in the blood is a good prognostic indicator because it reflects the degree of ischemia and cell damage.

Fig. 4. Placement of two large-bore catheters in the cephalic veins. Meanwhile, other veterinarians prepare the medication, carry out the blood tests and prepare the material required for gastric decompression.

Gastric decompression

While the initial medical treatment is being administered, the gastric decompression procedure starts.
First, it is attempted by placing a stomach tube.

- We use a large bore tube (the same as used in foals) and the distance between the tip of the nose and the last rib is marked (Fig. 5).
- A roll of bandage is placed between the incisors and, if possible, the tube is inserted up to the mark (Fig. 6).

Fig. 5. The distance between the nose and last rib is measured and marked on the tube. This will help us to know when the stomach is reached.
Note that the left side of the abdomen has already been shaved.

Fig. 6. In this case, the tube was inserted successfully into the stomach and it was decompressed. The patient is stabilized and will now undergo surgery.

Fig. 7. A small skin incision is made behind the last rib. The left side is chosen, because the rotated stomach has pulled the spleen with it, so that it now is on the right side of the abdomen. This reduces the risk of accidental spleen injury.

If the tube is inserted up to the mark, this means it has reached the stomach.

If the tube cannot be passed into the stomach, try to change the patient's position, by turning him over or making him sit up.

Do not force the introduction of the stomach tube, as this could injure or even tear the esophagus.

If these attempts fail, percutaneous decompression is required.

- For this, large-bore intravenous catheters, a small trocar or a long, multi-perforated probe can be used; the probe is easy to insert due to its central stylet (Figs. 7-9).

Fig. 8. The catheter with its stylet are inserted firmly into the lumen of the stomach.

Fig. 9. The stylet is withdrawn, and the stomach begins to deflate immediately.

When the stomach is decompressed and the pressure on the cardia is relieved, it becomes much easier to pass a stomach tube.

- After inserting the tube into the stomach, the organ is flushed several times with lukewarm to warm water to remove any gastric contents (Figs. 10 and 11).

Fig. 10. Warm water is poured into the stomach tube to remove the gastric contents. It is easier if the water is introduced from height.

Difference between gastric dilatation and GDV

Throughout this process, abdominal radiographs can be taken to differentiate simple gastric dilatation from the gastric dilatation-volvulus syndrome (Figs. 12 and 13).

Emptying and washing the stomach should always be performed, because the patient will have paralytic ileus after the operation and the stomach will lose its peristaltic contractions, so that the contents may easily ferment and cause dilatation again.

Fig. 11. After introducing two to three liters of water, the tube is lowered, causing the stomach contents to be siphoned out.

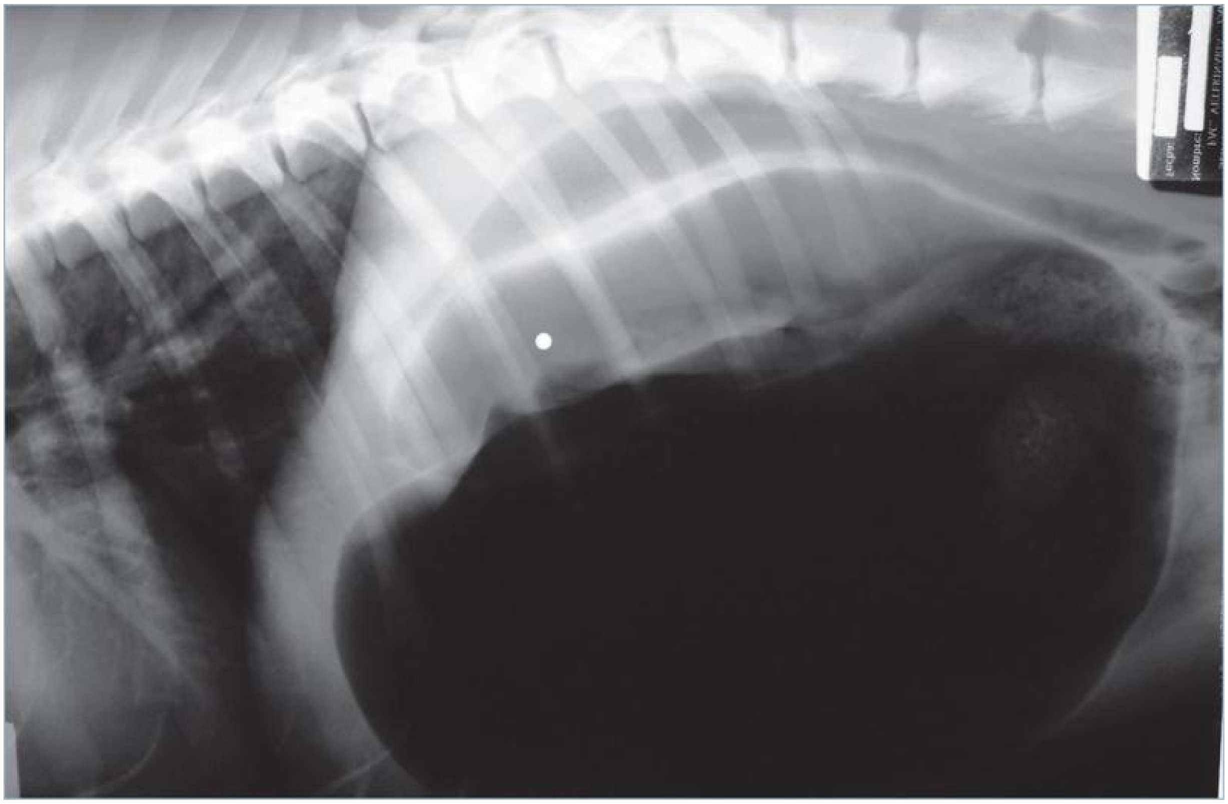

Fig. 12. Typical, inverted-C-shaped image of gastric torsion, due to the displacement of the pylorus and duodenum.

These radiographs can provide information regarding the position and contents of the stomach, which is of interest both before and during surgery.

Fig. 13. Generalized paralytic ileus and gastric dilatation with a large amount of food (dry feed pellets) inside.

The surgical plan

Once the patient is stabilized, surgery is performed.

> ***Although the stomach is decompressed, if it is rotated, there may be vascular compromise and necrosis.***

Anesthetic protocol

The patient maybe induced with propofol (3 mg/kg) to effect or ketamine (5 mg/kg) and connected to a circular circuit with 100 % oxygen, while anesthesia is maintained with isoflurane or sevoflurane.
If necessary, extra analgesia is provided with fentanyl boluses (5 µg/kg) or concentrate infusion (5ml/kg/min) during surgery.

Adequate analgesia will allow staying within the MAC* of isoflurane (1.2-1.3 %) or sevoflorane (2.3 %), thereby reducing its vasodilator and hypotensive effects.

The patient should be monitored by:

- ECG.
- Non-invasive blood pressure.
- Pulse oximetry.
- Capnography.

Electrocardiogram

If the ECG reveals ventricular arrhythmias with a sinus rhythm (between the extrasystoles, constant QRS complexes are observed), a three-way tap is placed to administer both isotonic crystalloid, and a continuous lidocaine infusion (50 µg/kg/minute), which is prepared by adding 25 mL of 2 % lidocaine to 500 mL saline.
If, on the other hand, there are ventricular complexes with no or a low sinus rhythm, no lidocaine should be administered. If the ventricular escape rhytms disappear, the heart will stop.

Lidocaine has an analgesic effect and controls ventricular arrhythmia.

Blood pressure

The mean arterial pressure should be maintained at around 70 mm Hg (approximately 90 mm Hg for the systole and 50 for the diastole) to prevent tissue reperfusion problems without causing severe hypotension compromising kidney function.
If the pressure cannot be increased beyond 70 mm Hg, the administration of a hypertonic and colloid bolus at the same dose that was used initially may be repeated.

If, on the contrary, the pressure increases too much consider further adjunctive analgesia, increased depth.

Pulse oximetry and capnography

The pulse oximeter should indicate a hemoglobin saturation of 95 to 100 %. To this end, 100 % oxygen is administered and good ventilation with assisted ventilation if required.
Additionally setting the ventilator varies based on ventilator type. Use cation with mechanical or manual assisted ventilation as they may decrease venous return and further compromise hypotension.

Ensuring good ventilation largely contributes to normalising the patient's pH.

Surgical objectives

The objectives are:

- Decompression of the stomach and replacement in its anatomical position.
- Inspection of the stomach and the spleen, checking for areas of injury and necrosis.
- Fixing the stomach to the abdominal wall to reduce the risk of a future torsion.

Derotation of the stomach

Usually, the stomach is twisted in a clockwise direction, so that the derotation should be in an anti-clockwise direction (Fig. 14). For this, the pyloric area is grasped with the left hand and pulled up into the abdominal incision, while the right hand fixes the body and fundus of the stomach, pulling it to the left of the animal and towards the operating table (Fig. 15).

To check that the stomach is correctly positioned, a hand is inserted along the diaphragm and the abdominal esophagus is

palpated. If a soft, smooth, uniform structure is encountered, the stomach is correctly positioned. If, however, a hard, irregular and tight cord is felt, the esophagus is twisted and therefore the stomach is still rotated.

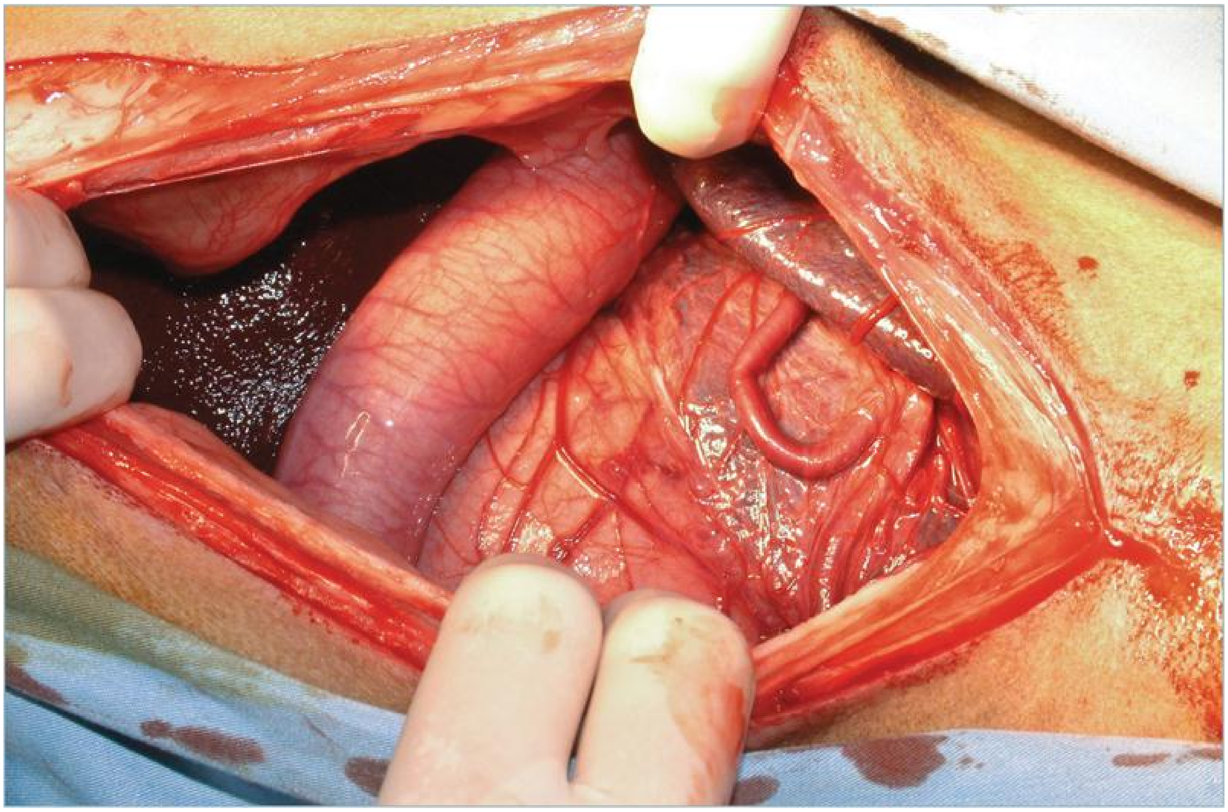

Fig. 14. After midline laparotomy, the stomach is found to be covered with omentum, with the duodenum crossing over it, because the pylorus is located on the left of the patient.

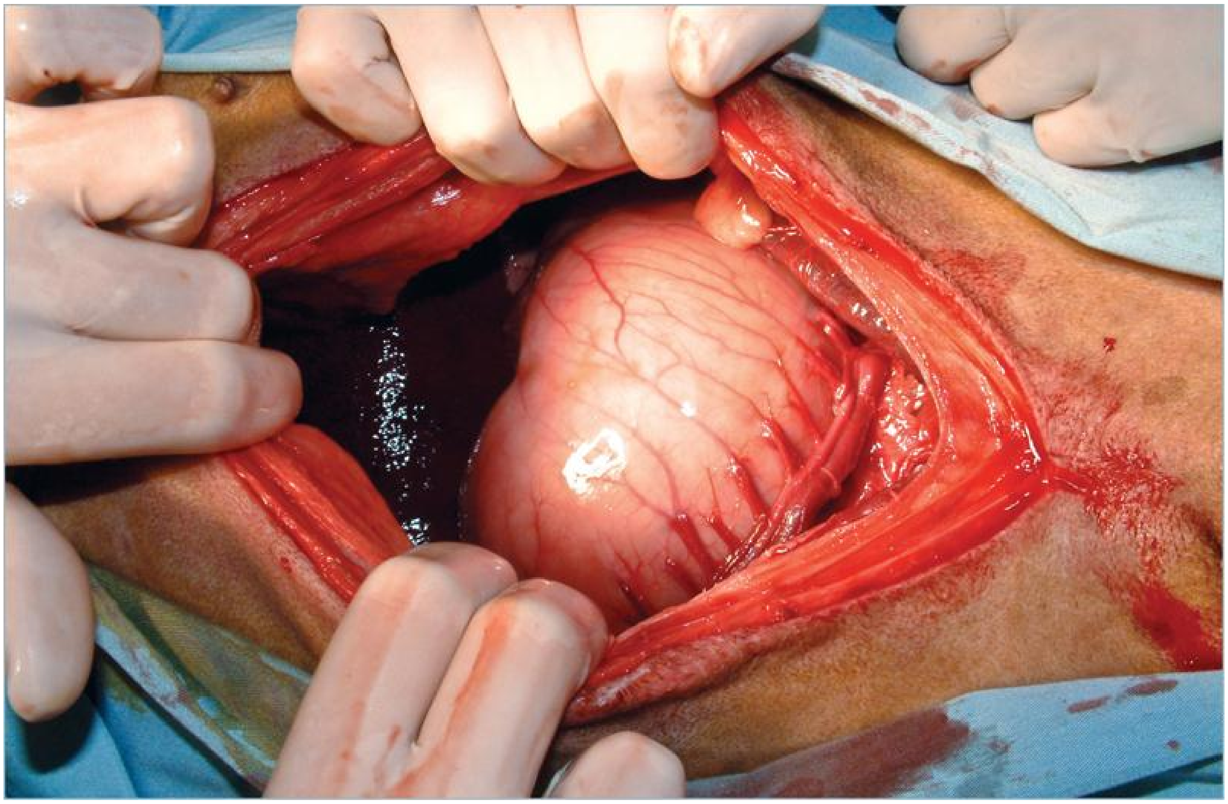

Fig. 15. After derotation in anti-clockwise direction, it is checked that the stomach is in its proper anatomical position.

Management of the ischemic lesions

Ensure that the spleen is in its anatomical position. If a serious lesion or torsion is noted, splenectomy should be performed (Fig. 16).

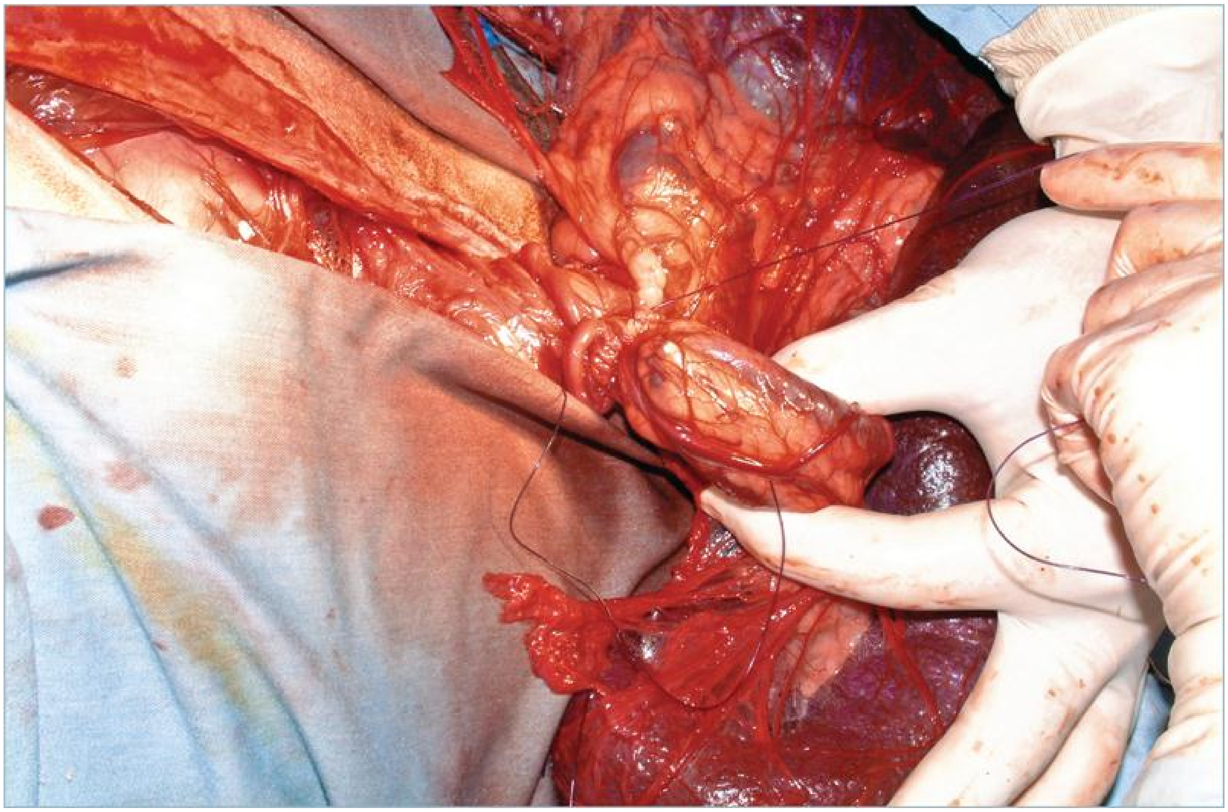

Fig. 16. In this case, gastric torsion was accompanied by a splenic torsion, and splenectomy was performed without derotating the spleen.

Injury and rupture of the short gastric vessels branching off from the splenic vessels is common. This contributes to bleeding, thrombosis, infarct and necrosis of the greater curvature of the stomach (Fig. 17).

In these cases, patience is required. The stomach is highly vascularized and its recovery capacity is high.

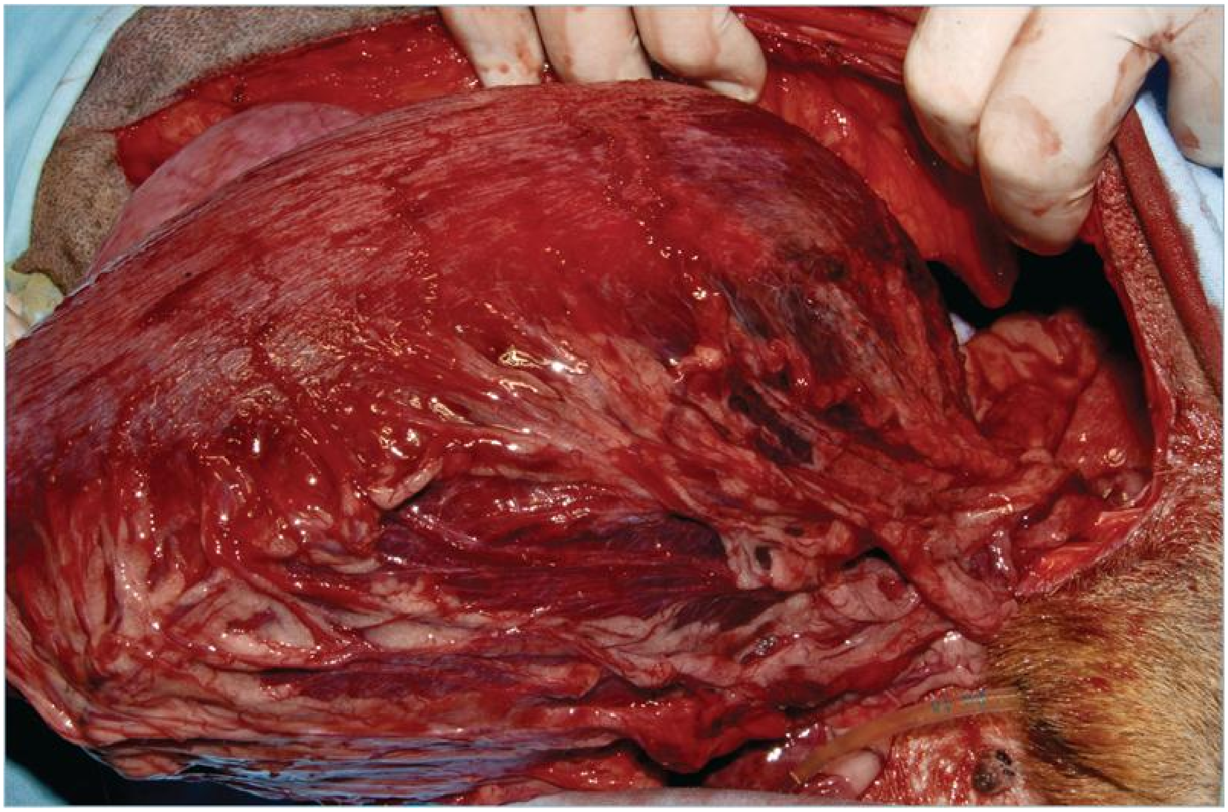

Fig. 17. Bleeding and ischemia of the greater curvature of the stomach as a result of the avulsion of the short gastric vessels.

If there are doubts about the viability of a part of the stomach, carry out an invagination of the area, suturing together well-vascularized tissues (Figs. 18-21).

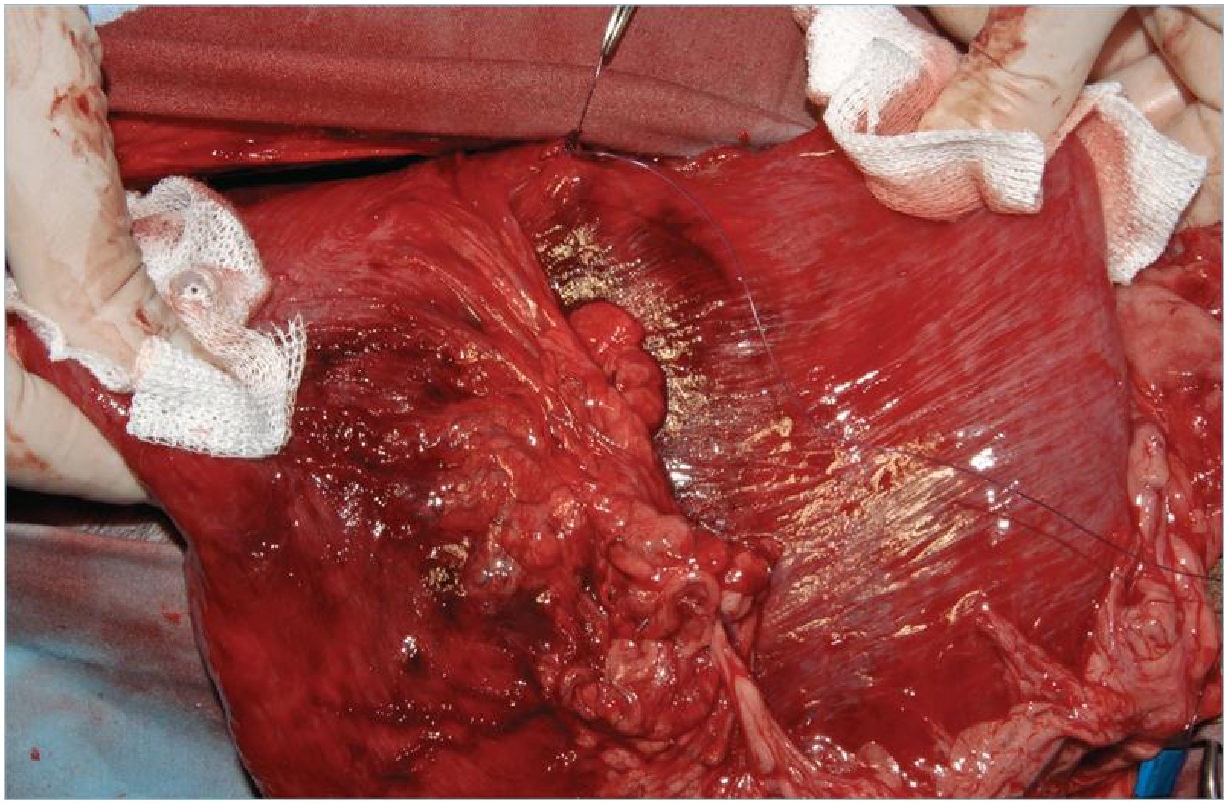

Fig. 18. The middle part of the gastric body presents an ischemic area, which we decided to invaginate. An assistant holds the stomach to facilitate suturing.

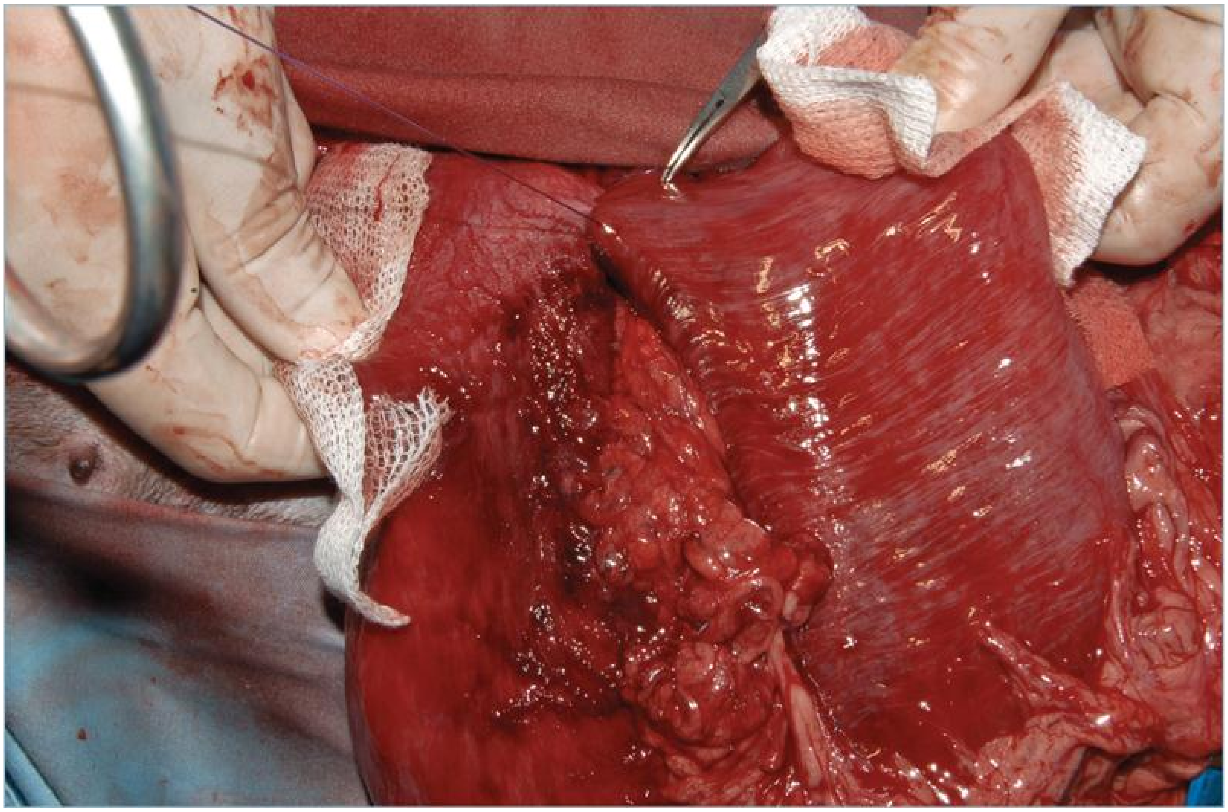

Fig. 19. A continuous suture is placed with monofilament synthetic absorbable material, which includes the muscular and serosa layers.

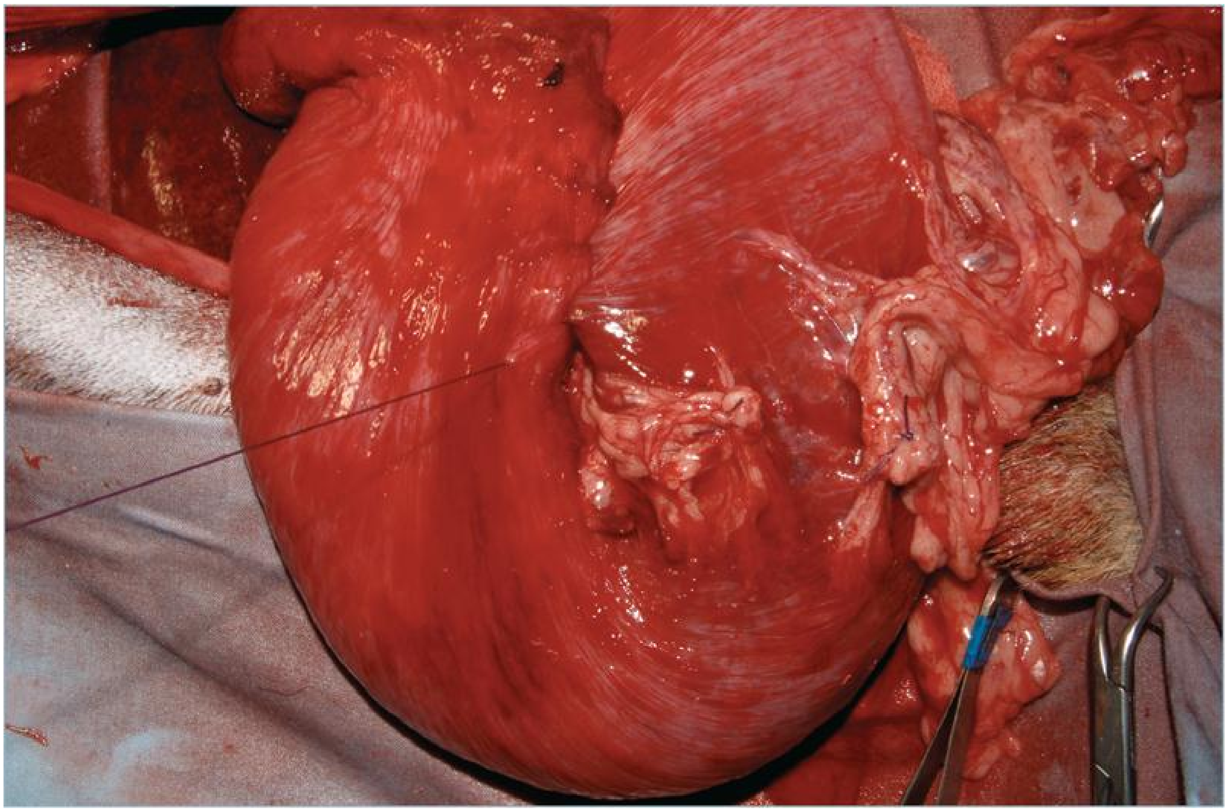

Fig. 20. Upon reaching the distal area of the suture, the connections with the remaining vessels of the greater curvature are ligated, ensuring that the omental fat does not hinder the healing of the sutured area.

This invagination technique ensures the stability and seal of the stomach in case the ischemic area does not recover and develops necrosis.

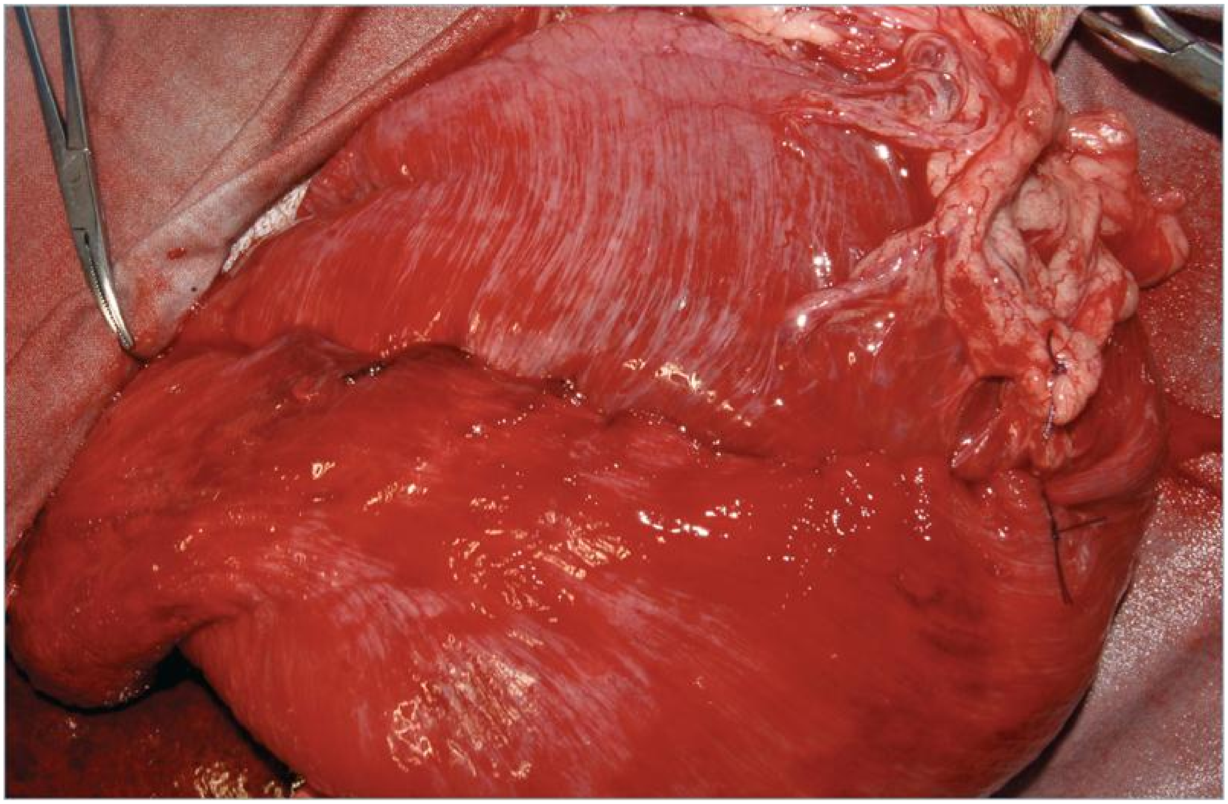

Fig. 21. Final appearance of the simple suture line. Note the perfect invagination of the entire ischemic area.

Stomach fixation

To reduce the risk of recurrence, a permanent gastropexy of the pyloric antrum to the right abdominal wall should be performed.

> ***Gastropexy prevents rotation of the stomach, but not its dilatation.***

Incisional gastropexy is the easiest technique and gives good results.
Two incisions are made, one in the pyloric antrum through the serosa and muscular layers and another in the right abdominal wall, through the peritoneum and the fascia of the abdominal muscle (Fig. 22).
Next, a continuous simple suture is placed, first joining the edges of the dorsal part of the wound (blue arrows in Fig. 22 and Fig. 23). After this, the ventral edge of the wound is sutured (yellow arrows in fig. 22 and Fig. 24).

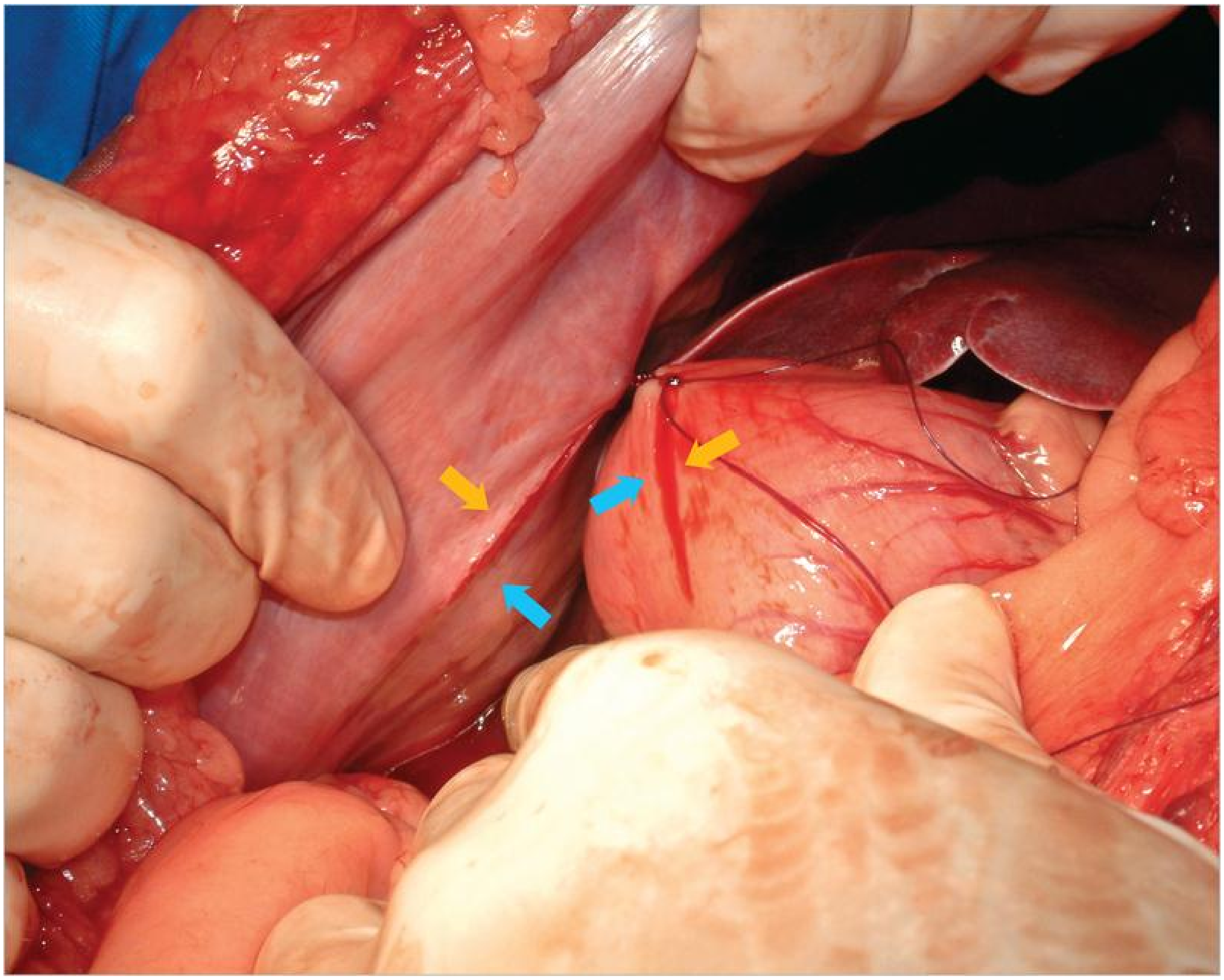

Fig. 22. To ensure good fixation of the stomach to the abdominal wall, two incisions are made with a scalpel, one in the pyloric antrum and one in the lateral muscle.

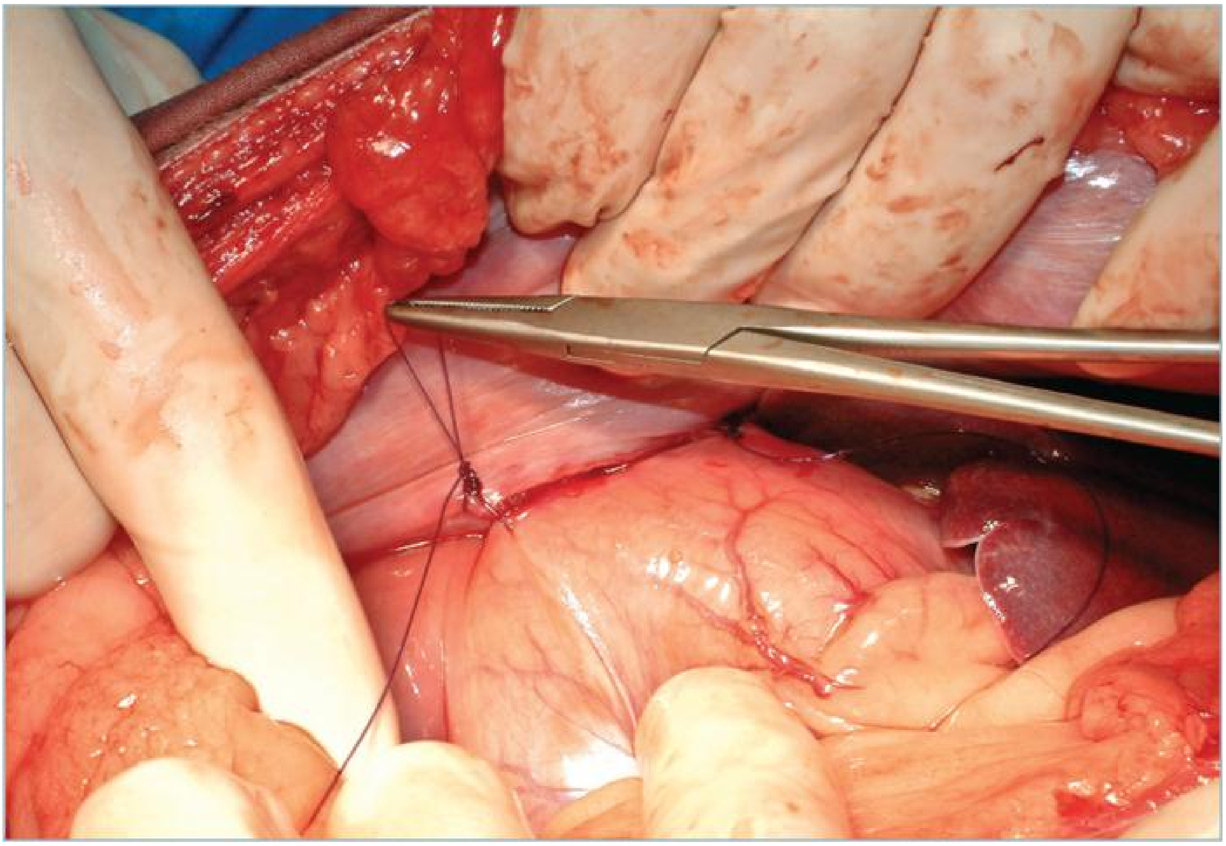

Fig. 23. Placement of the first suture, joining the two dorsal gastropexy borders.

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Watch this video

Gastric dilatation volvulus syndrome

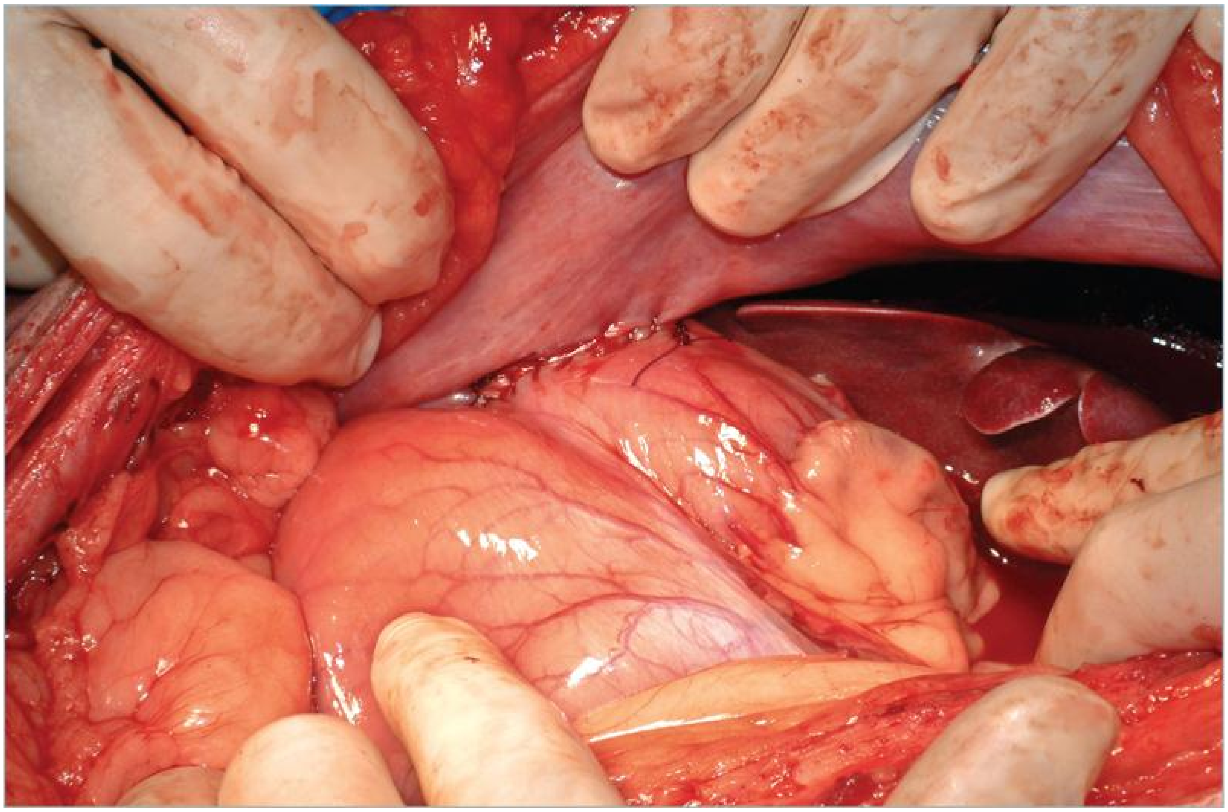


Fig. 24. This is followed by suturing the ventral margin of the incision to complete the gastropexy.

For gastropexy, 2/0 synthetic absorbable or nonabsorbable suture material is used.

Postoperative care

a. Hypokalemia

Postoperative care and monitoring is as important as the fast and accurate intervention upon presentation of the patient in the emergency department.

During the first few postoperative hours, serious complications may arise, which, if not controlled correctly, can be life-threatening.

Electrolytes should be monitored. Hypokalemia is common and fluid therapy may require supplementation with potassium. Do not exceed 0.5 mEq/kg/h.

b. Ventricular arrhythmias

Cardiac arrhythmias occur frequently in the postoperative period. To control these, the patient should be correctly hydrated and the potassium levels should be within the normal range.

Lidocaine may be administered as a bolus (2-8 mg/Kg IV) if the arrhythmia is marked, or by continuous infusion (50-75 µg/kg/minute) if the arrhythmias are sporadic.

> ***Lidocaine overdose may cause tremor, vomiting and convulsions. If these signs occur, suspend the treatment.***

c. Gastric ulceration

Ulcers may occur as a result of gastric ischemia. The use of H2 receptor antagonists (cimetidine, ranitidine or famotidine) may be useful.

Start to offer soft, low-fat food between 12 and 20 hours after surgery. The aim is to assess food acceptance and the absence of vomiting, as well as the recovery of peristalsis.

d. Peritonitis

Generalized peritonitis and sepsis may occur as a result of an undetected gastric necrosis. If detected in time, the patient should be re-operated upon urgently, to resect the affected area and to place a tube for peritoneal lavage.

Prognosis

The prognosis for these patients is guarded as it depends on many factors: when the problem was first noticed by the owner, how quickly action is taken, whether there is gastric or splenic torsion, concurrent gastric lesions, the appearance of ventricular extrasystoles and other postoperative complications. Plasma lactate levels are of great value for the prognosis. Normal values indicate that there is no excessive ischemia and the prognosis is therefore more favorable.

In dogs with gastric necrosis, the risk of death during the postoperative recovery period is ten times higher.

The risk of recurrence is minimal if a gastropexy is performed. However, the owner must change the dog's feeding habits and should follow the recommendations mentioned earlier in this chapter.

* MAC: minimal alveolar concentration.

Intestinal obstruction due to a non-linear foreign body

José Rodríguez

Prevalence	■■■■■
Technical difficulty	■■■□□

Intestinal obstruction due to a foreign body is quite common in small animal practice.
The diameter of the intestine is smaller than that of the esophagus or the stomach, so objects that may pass these structures may get stuck in the intestine.

Clinical signs

Depending on the location of the obstruction, the clinical signs may range from insidious to severe

Obstruction of the upper digestive tract:

- Persistent vomiting

- Dehydration, electrolyte imbalance
- Abdominal pain

Obstruction of the lower digestive tract:

- Anorexia, depression
- Fecaloid vomiting
- Weight loss
- Abdominal pain

Diagnosis

This condition is mainly diagnosed by radiography (Figs. 1-3), but it should be remembered that the radiographic pattern of intestinal obstruction (gaseous distension, “hairpin” appearance of the intestinal loops, delayed barium transit) may also be encountered in non-obstructive intestinal paresis (abdominal surgery or trauma, medullar lesion, changes in serum potassium levels, uraemia, peritonitis…) (Figs. 4 and 5).
For this reason, diagnosis by ultrasound is progressively gaining importance, because it permits both detection of the foreign body and an assessment of the state of the intestinal wall and the possible presence of a secondary peritonitis.

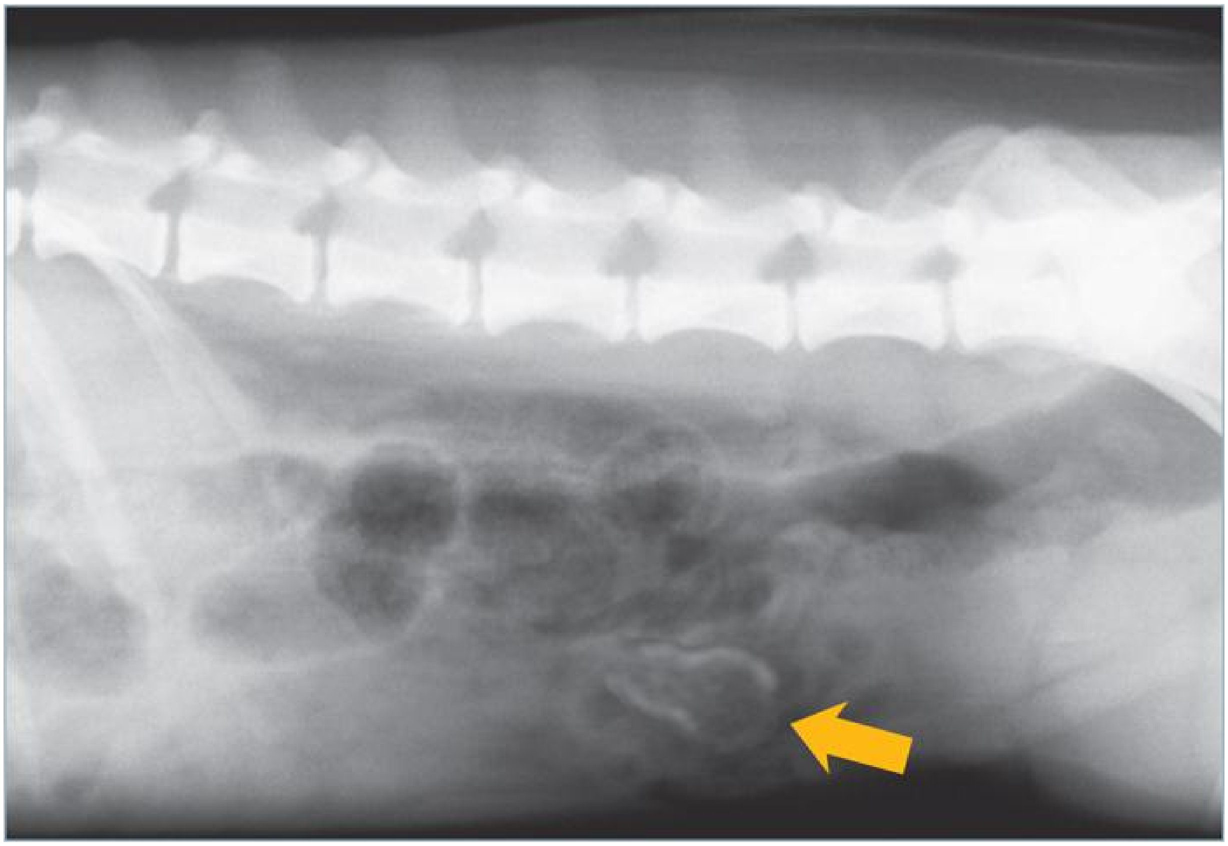


Fig. 1. Intestinal obstruction caused by a dummy. Note the silhouette of the foreign body that shows up clearly because the X-rays pass tangentially through the thin material.

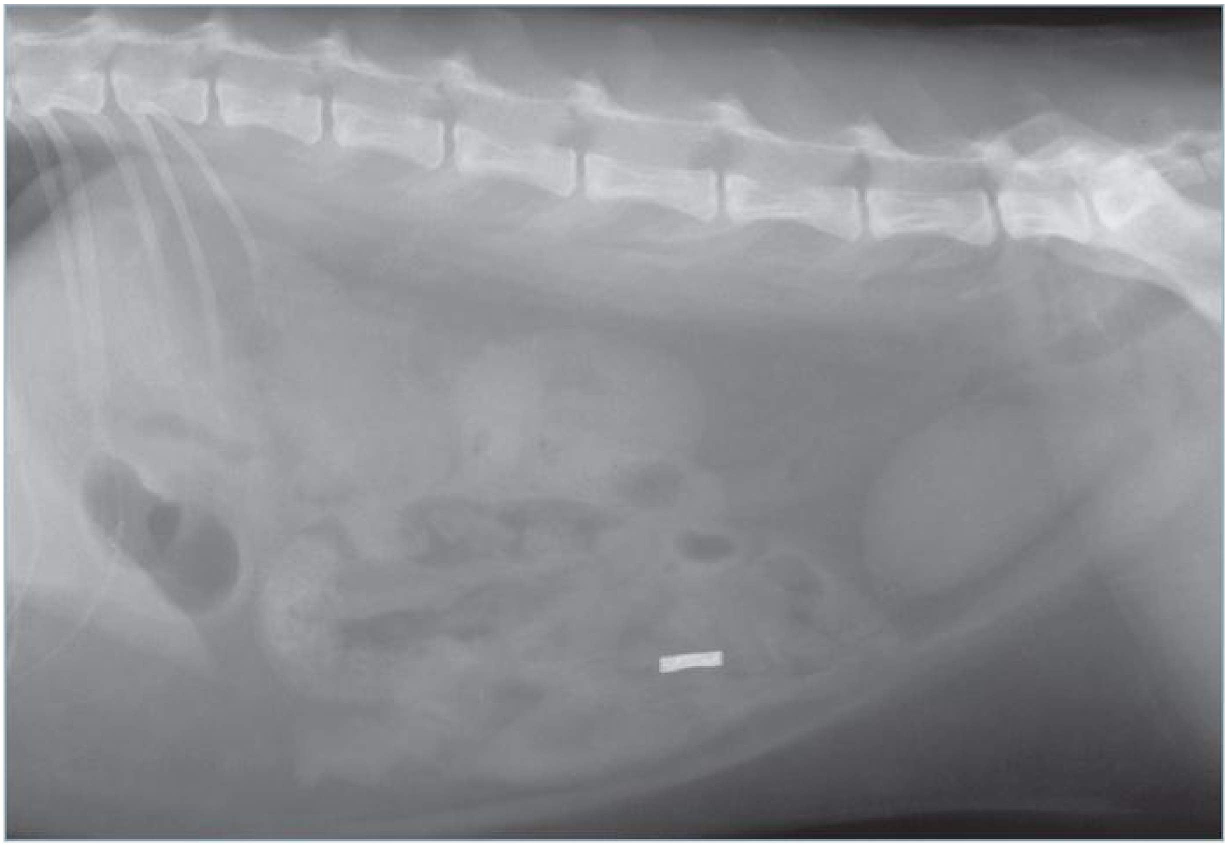


Fig. 2. Metallic foreign body in the small intestine.

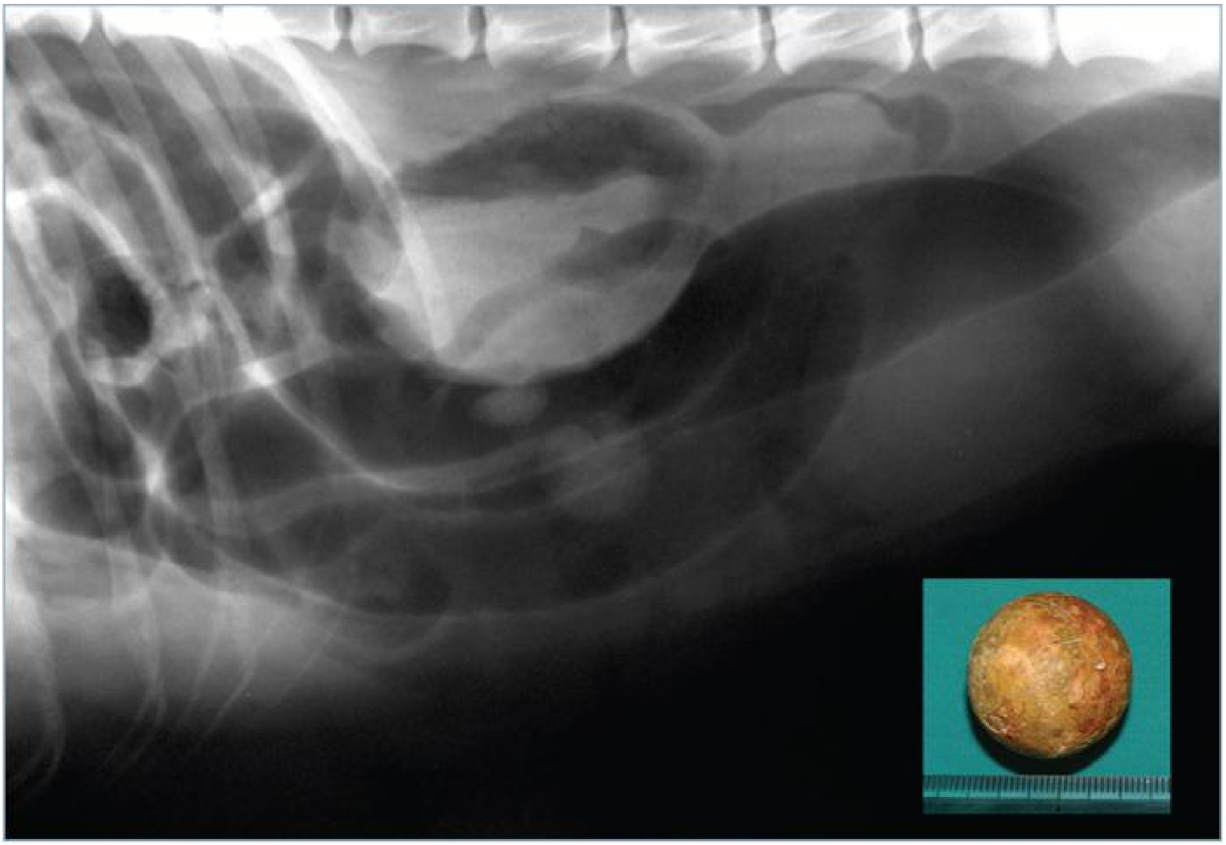


Fig. 3. Paralytic ileus and distension of the bowel loops proximal to an obstruction (the ball shown in the image). See of you can find the foreign body on the radiograph.

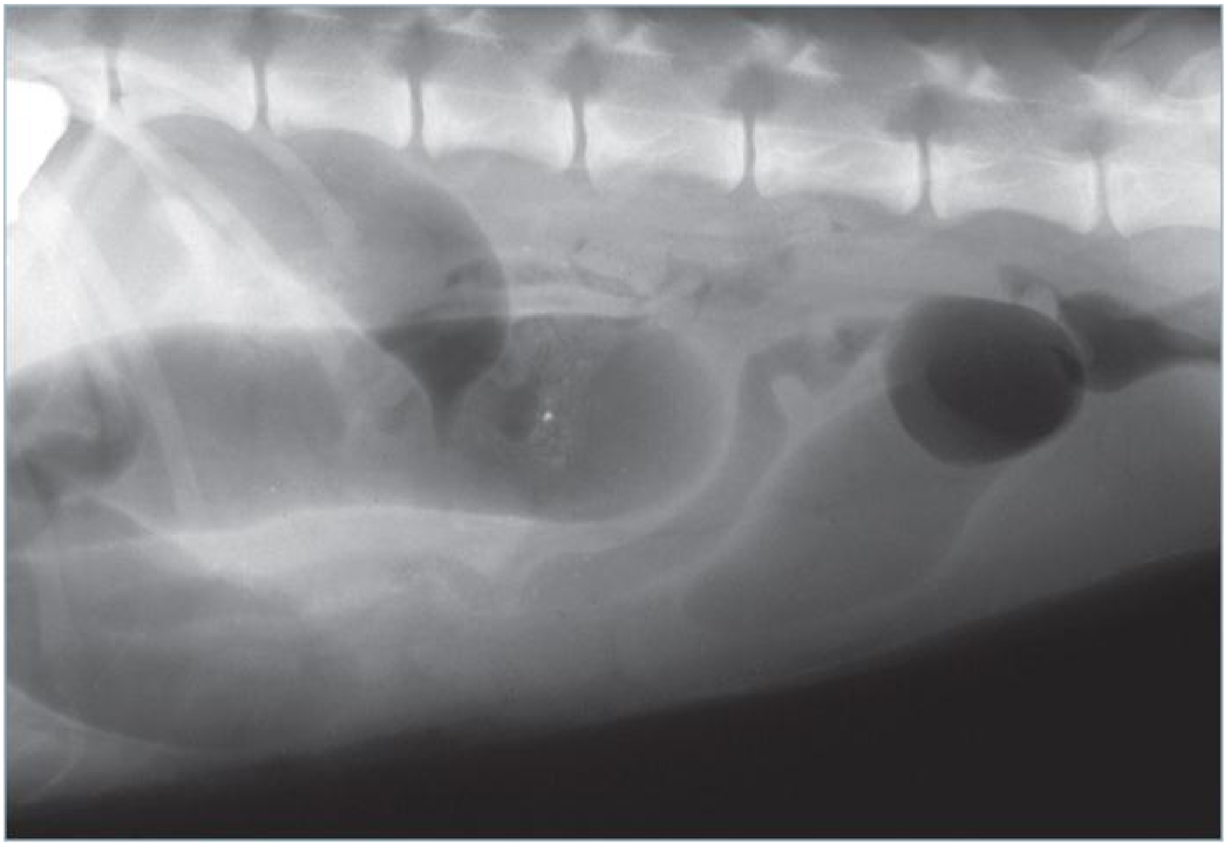


Fig. 4. Paralytic ileus. This is a case of gastroparesis caused by a hepatic lipidosis.

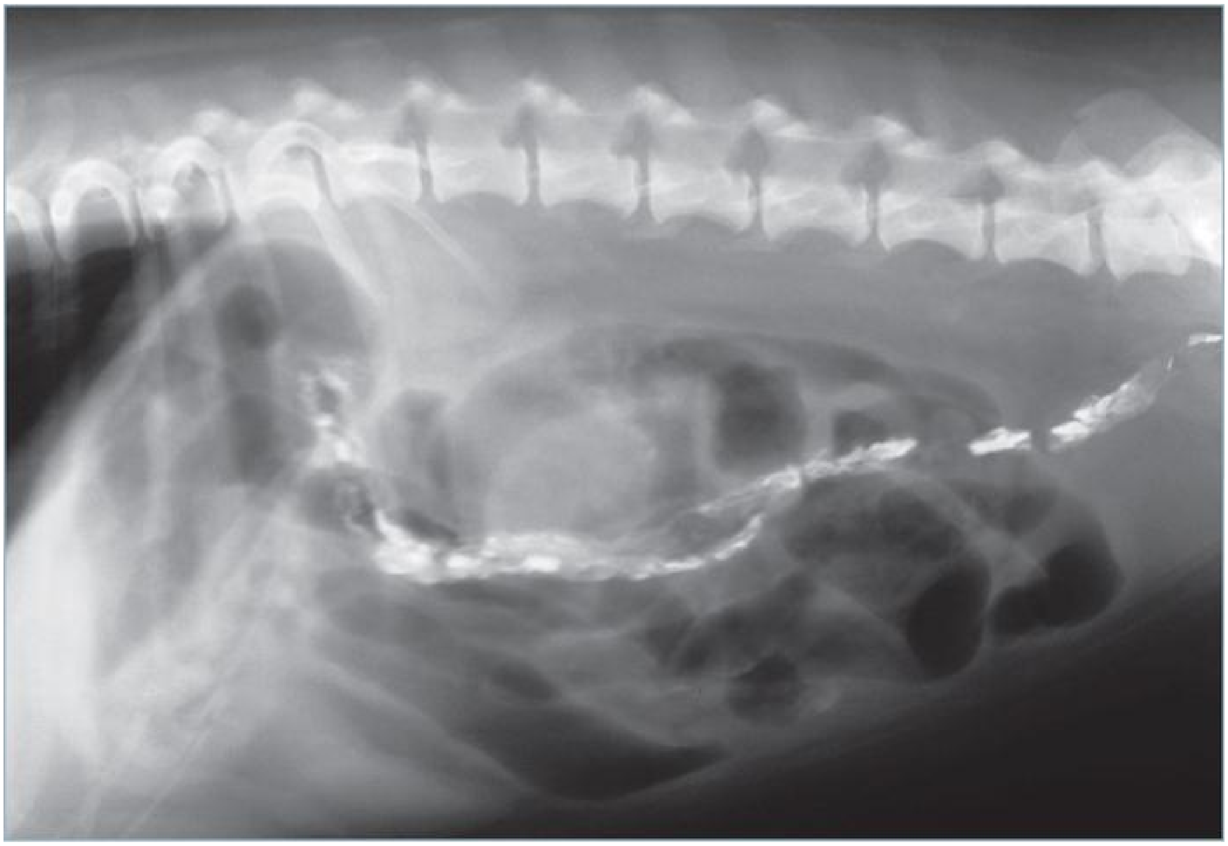


Fig. 5. Gaseous distension of the intestinal loops as a consequence of a previous surgical intervention. The barium transit confirms that there is no intestinal obstruction.

Blood tests may show the following results:

	Sample value	Reference value
WBC	20.61×10^3 /mm^3	5.50-16.90
Lymphocytes	1.02×10^3 /mm^3	0.50-4.90
Monocytes	3.73×10^3 /mm^3	0.30-2.00
Neutrophils	15.56×10^3 /mm^3	2.00-12.00
Eosinophils	0.20×10^3 /mm^3	0.10-1.49
Basophils	0.11×10^3 /mm^3	0.00-0.10
Hematocrit	57.6 %	37.0-55.0
RBC	8.60×10^6 /mm^3	5.50-8.50
Hemoglobin	20.3 g/dl	12.0-18.0
Platelets	301×10^3 /mm^3	175-500
Total protein	8.1 g/dl	5.4-8.2
Albumin	3.9 g/dl	2.5-4.4
Globulins	4.2 g/dl	2.3-5.2
Alkaline phosphatase	55 u/l	20-150
ALT	23 u/l	10-118
Amylase	404 u/l	200-1200
Total bilirubin	0.5 mg/dl	0.1-0.6
Urea	47 mg/dl	7-25
Calcium	10.8 mg/dl	8.6-11.8
Phosphorus	6.5 mg/dl	2.9-6.6
Creatinine	1.0 mg/dl	0.3-1.4
Glucose	124 mg/dl	60-110
Sodium	128 mmol/l	144-160
Potassium	3.0 mmol/l	3.5-5.8
Chloride	79 mmol/l	109-122

Ultrasound may identify hypoechoic foreign bodies and intestinal dilatation by the liquid accumulation proximal to the obstruction. The peristaltic movements of the intestine may also be visualized, as well as the blood supply to the intestinal wall using Doppler.

Treatment

Many foreign bodies pass through the digestive tract without the need for a surgical intervention (Fig. 6).

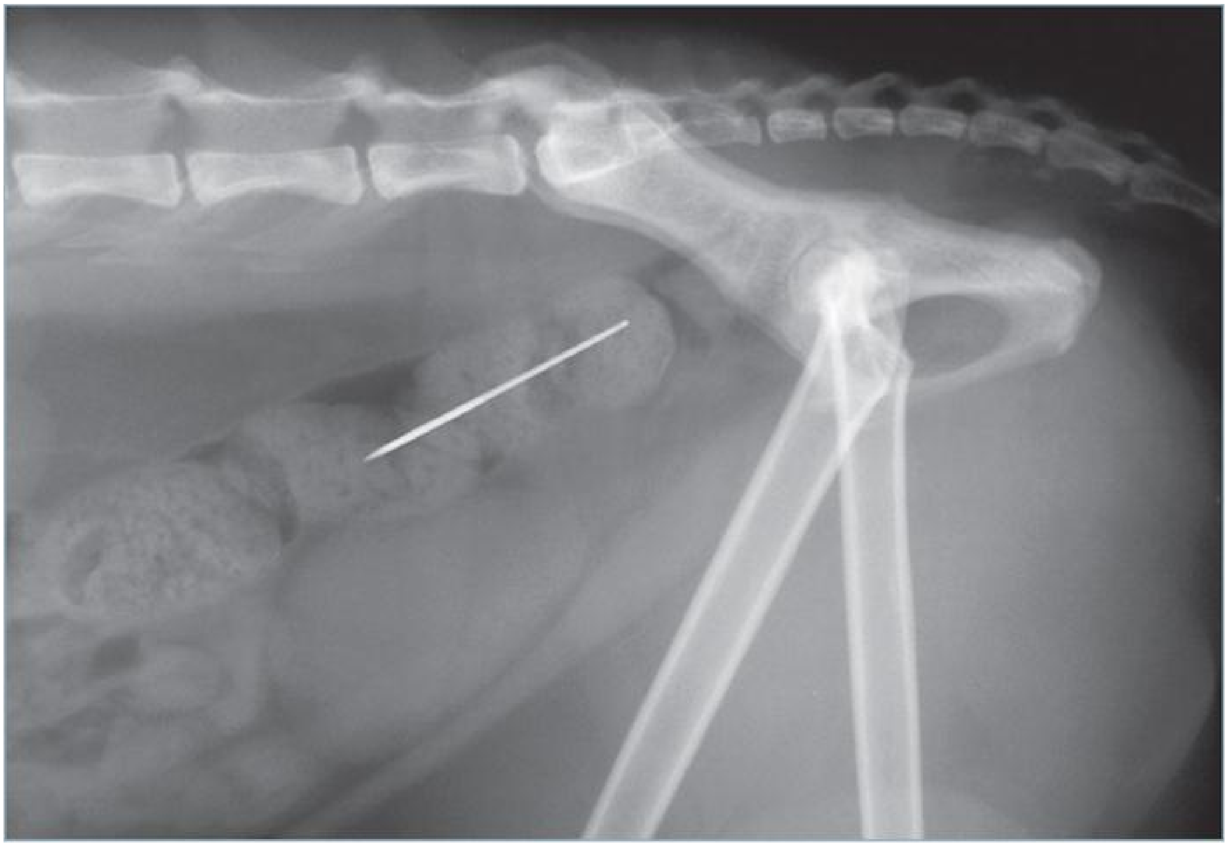


Fig. 6. Sewing needles generally are expelled with the feces without producing lesions to the organs, as long as the thread does not get trapped in some part of the digestive tract (usually in the mouth).

In these patients, radiographs should be taken to check the passage through the digestive tract and to detect any obstruction to the transit.
A surgical intervention is indicated if the following is observed:

- Obvious signs of impaction, pre-obstructive intestinal dilatation, generalized paralytic ileus, vomiting, diarrhea, abdominal pain…
- Signs of intestinal perforation, peritonitis, leukocytosis…
- The foreign body is not advancing during a period of 6-8 hours.

If an intestinal foreign body is detected and the patient does not present with vomiting, abdominal pain, leukocytosis or fever, surgery is not indicated, because it is likely that it will be expelled with the feces.

https://player.vimeo.com/video/180708260

Watch this video

Intestinal obstruction (enterotomy)

Before surgery

Correct the electrolyte imbalance and the dehydration. Prophylactic antibiotics: enrofloxacin (5-10mg/kg) together with ampicillin (22 mg/kg).

Surgical technique

After midline laparotomy, the omentum is pushed back and an intestinal loop extracted (Fig. 7); the intestine is progressively externalised in a single direction to look for the obstruction (Fig. 8). When it has been found, an enterotomy or enterectomy is performed, depending on the condition of the intestine.

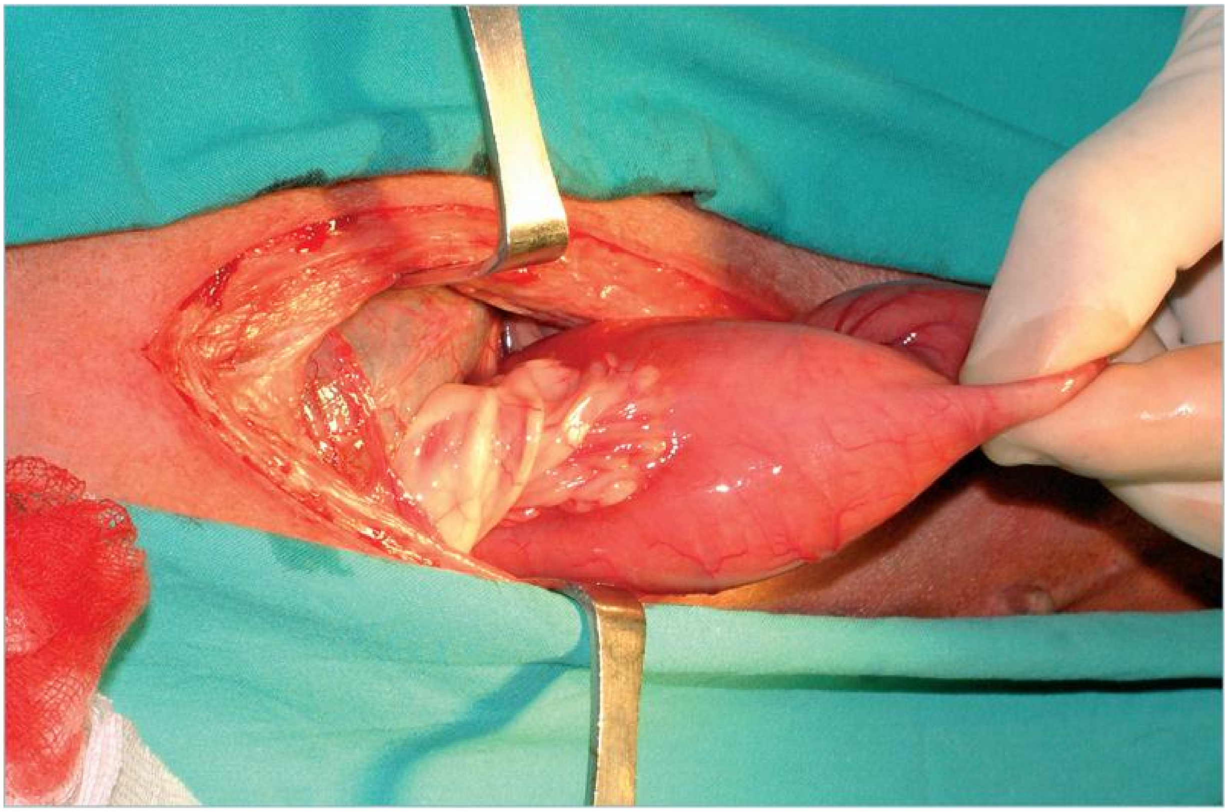


Fig. 7. A distended intestinal loop indicates a pre-obstructive segment.

Fig. 8. Identification of the obstruction, followed by an enterotomy to remove the foreign body.

Vascular recovery of the obstructed intestine is very high. But if in doubt, perform an enterectomy. What would you do in this case?

After removing the obstruction, the rest of the digestive tract should be checked to ensure that there are no other lesions (Fig. 9).

After the operation and closure of the laparotomy, the surgeon should be absolutely certain that there are no other internal lesions.

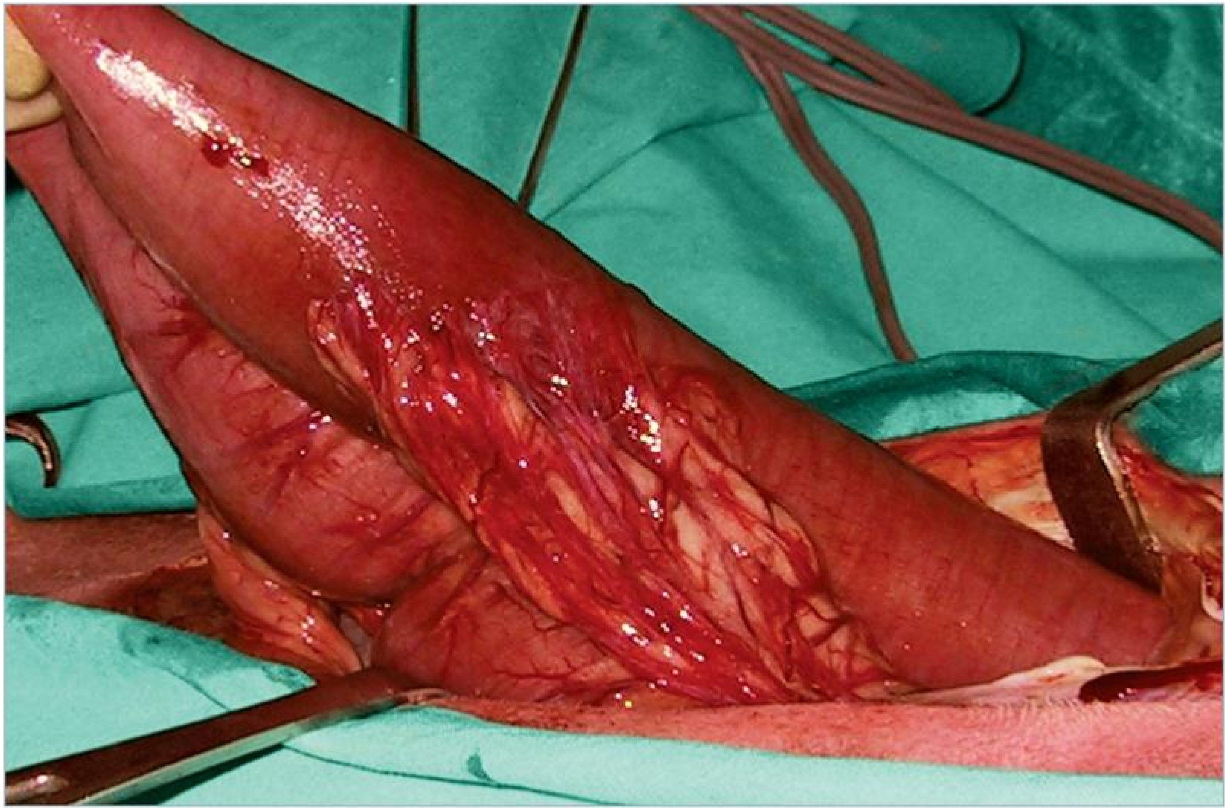


Fig. 9. In this case, there is adhesion of the omentum to the bowel. This indicates a serious tissue lesion, so enterectomy of this intestinal segment is indicated. This patient underwent an enterotomy to remove the foreign body and an enterectomy to remove the affected intestinal segment.

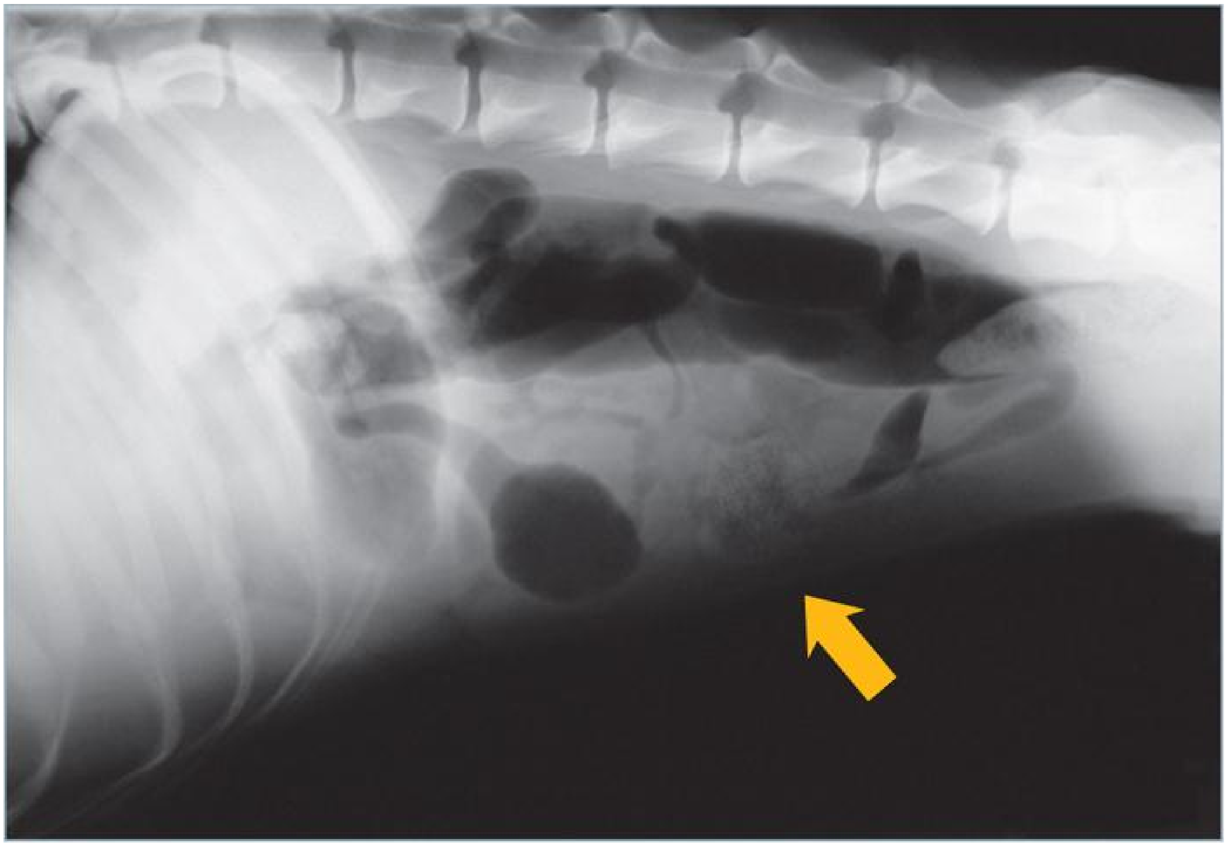


Fig. 10. Radiograph of the previous case. The foreign body that caused the obstruction can be seen in the medioventral area of the abdomen.

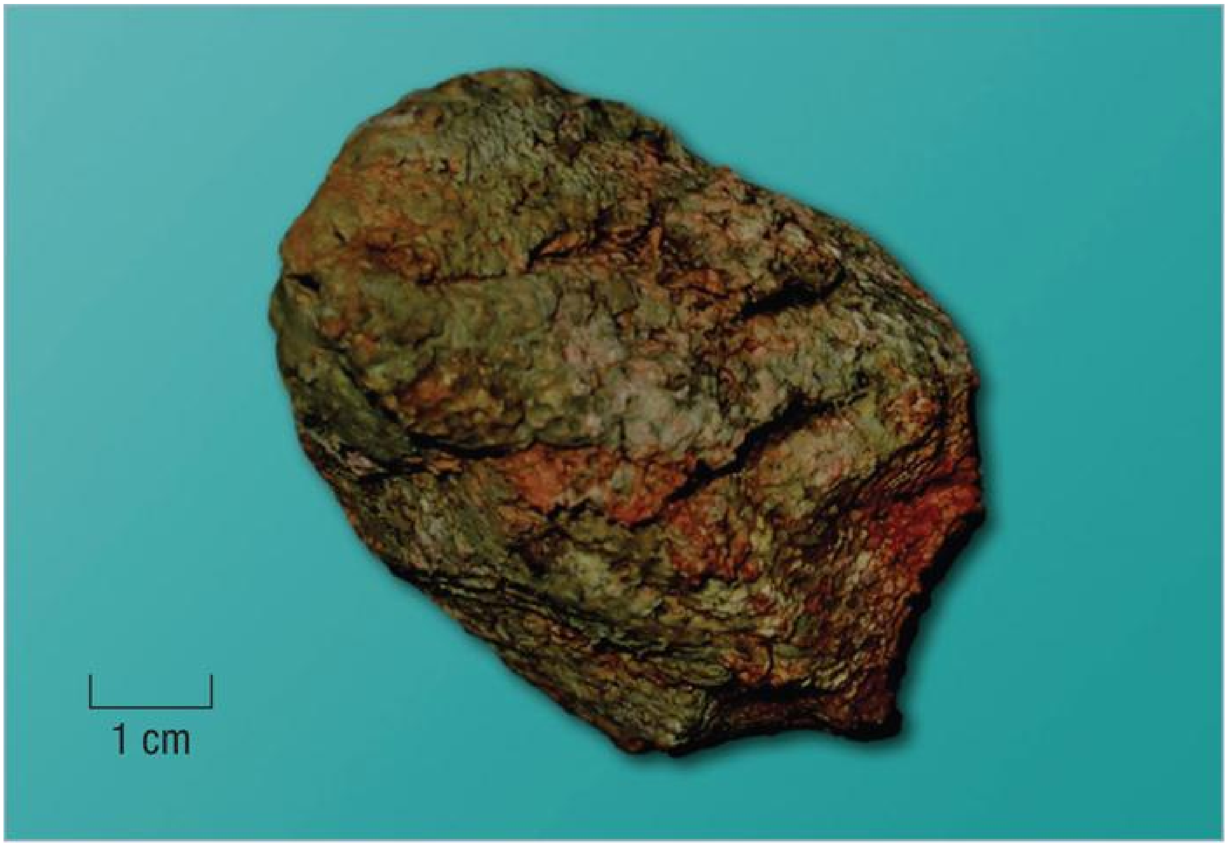


Fig. 11. This piece of a rubber ball was responsible for the obstruction.

Enterotomy

José Rodríguez

Prevalence	■■■■■
Technical difficulty	■■□□□

Enterotomy is performed to extract foreign bodies if the changes in the intestinal wall are reversible, or to obtain full-thickness intestinal biopsies. For the best result:

1. Identify the affected intestinal loop. Exteriorize it and isolate it from the rest of the abdomen using surgical compresses or sterile drapes that have been humidified with lukewarm sterile saline (Fig. 1).

2. Express the intestinal contents gently in both directions to empty the area that will be operated on and interrupt intestinal transit. For this

operation, an assistant is required, who occludes the intestine using his index and middle finger as clamps (Fig. 2); if an assistant is not available, atraumatic intestinal clamps should be used.

3. The least damaged intestinal section is selected, which means that the enterotomy is performed in the post-obstruction area (Fig. 3A). If the foreign body cannot be moved distally, the incision is made in the pre-obstruction area (Fig. 3B). The enterotomy incision should not be made over the foreign body, because in this area, there is a higher risk of suture dehiscence.

> ***Before making the incision in the intestine, isolate the affected loop from the abdominal cavity.***

Fig. 1. After a small midline laparotomy, an intestinal loop is exteriorised. Following this, the intestine is extracted and returned to the abdomen bit by bit until the obstructed area is identified and isolated from the abdominal cavity by sterile surgical compresses or drapes.

Fig. 2. An assistant clamps the intestine with his fingers to impede the passage of the intestinal contents and contamination of the peritoneum during surgery. In his absence, atraumatic intestinal clamps (Doyens).

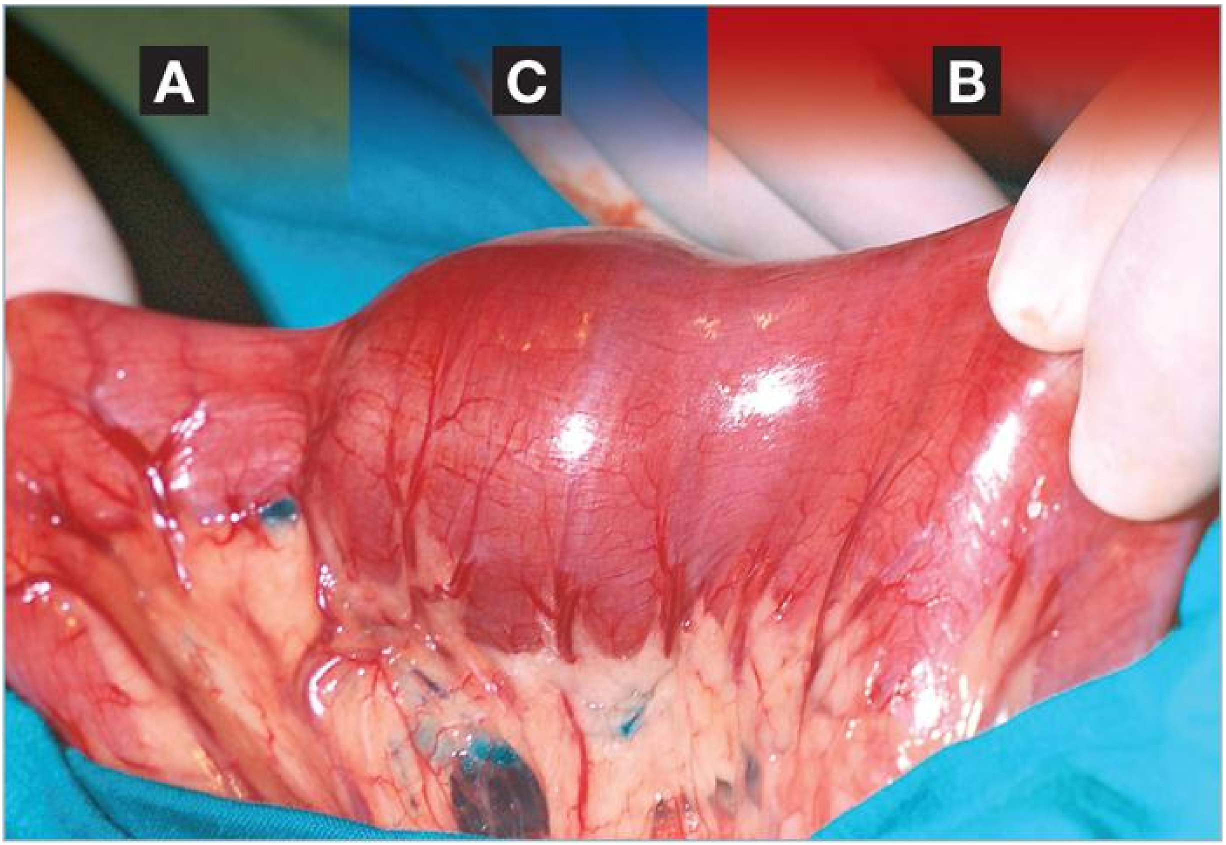


Fig. 3. (A) Distal to the obstruction. This is the recommended site for extraction of the foreign body. (B) Proximal to the obstruction. Alternative location for enterotomy in case of a large foreign body. (C) Obstructed area. Avoid incising the intestine in this area.

4. The incision into the intestinal wall should be made with a scalpel on its anti-mesenteric border.
5. The enterotomy incision should be adapted to the foreign body in order to extract it without damaging the intestinal wall (Fig. 5). Extraction of an intraluminal object through a small incision may cause the tissue to tear, which will hamper closure of the incision.
6. Many foreign bodies are trapped by the mucosa and adhere to the intestinal wall. For this reason, they should be freed by gentle traction (Figs. 6 and 7).

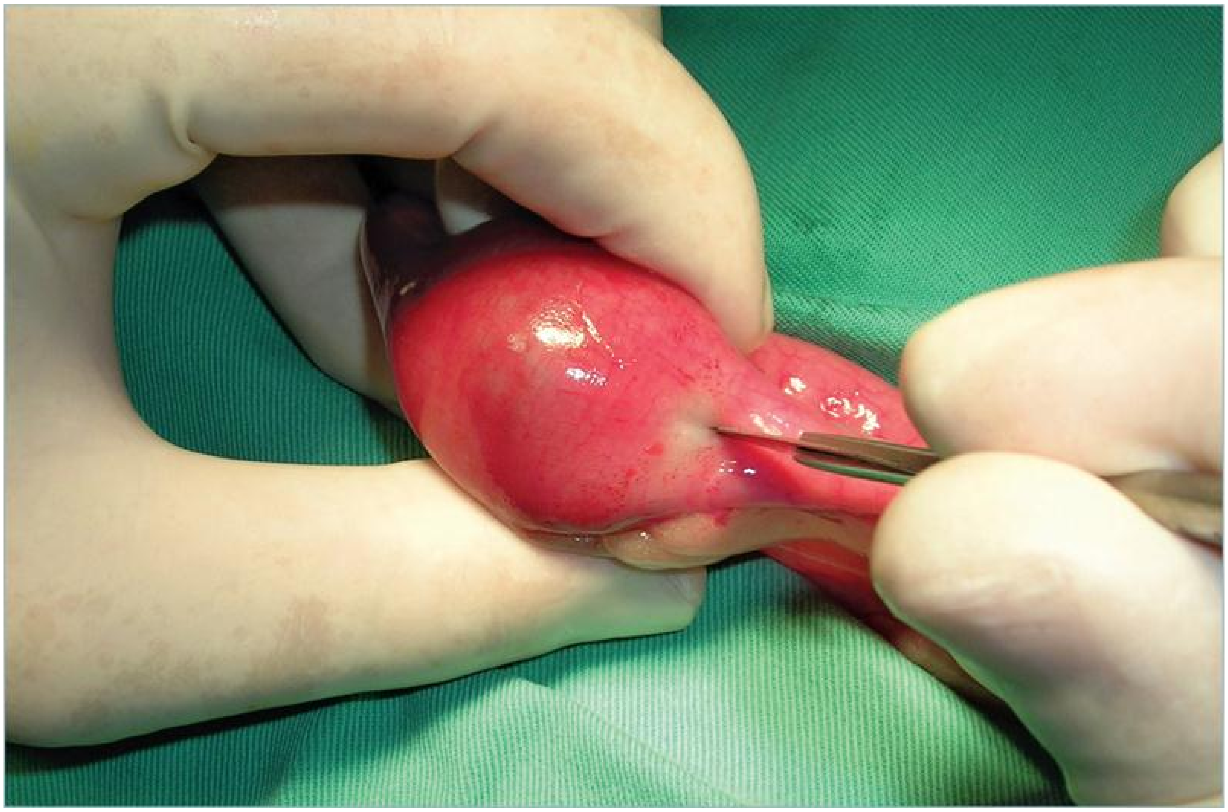


Fig. 4. The enterotomy incision is made in the anti-mesenteric border in a longitudinal direction.

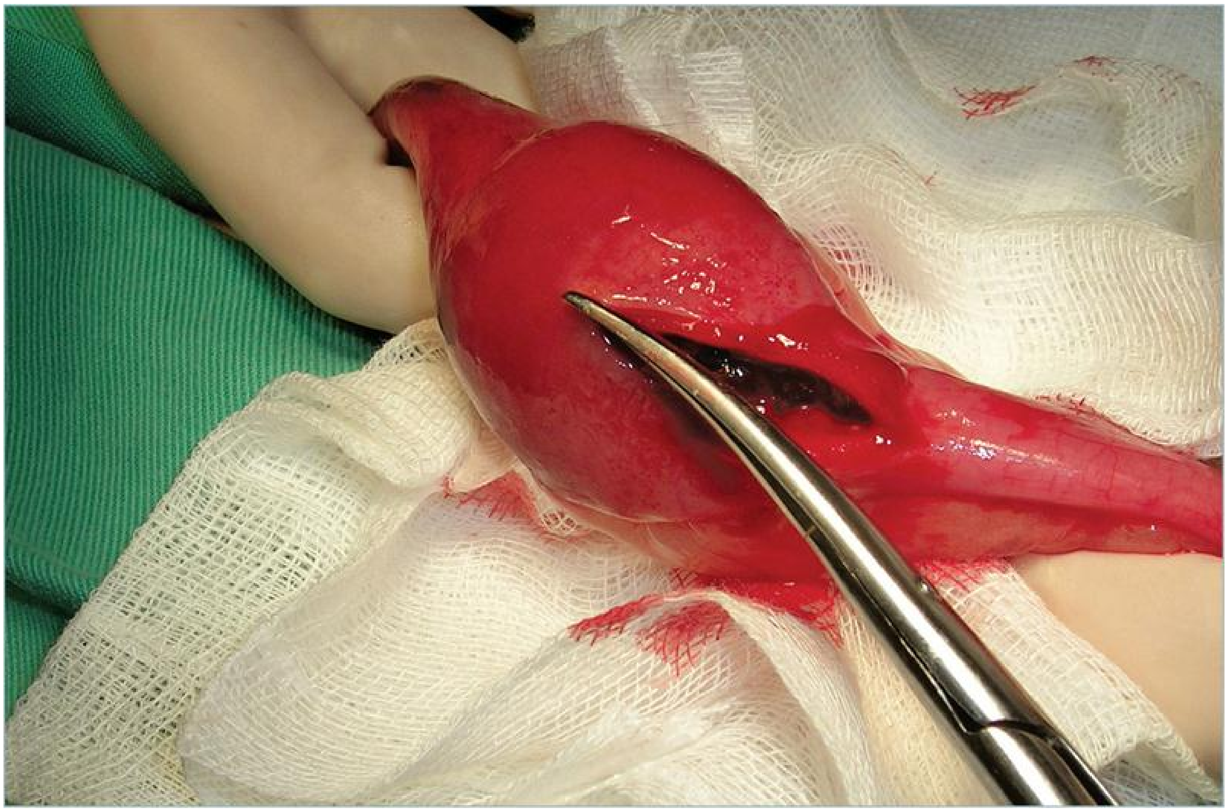


Fig. 5. The incision in the intestine should allow extraction of the foreign body without tearing the wall.

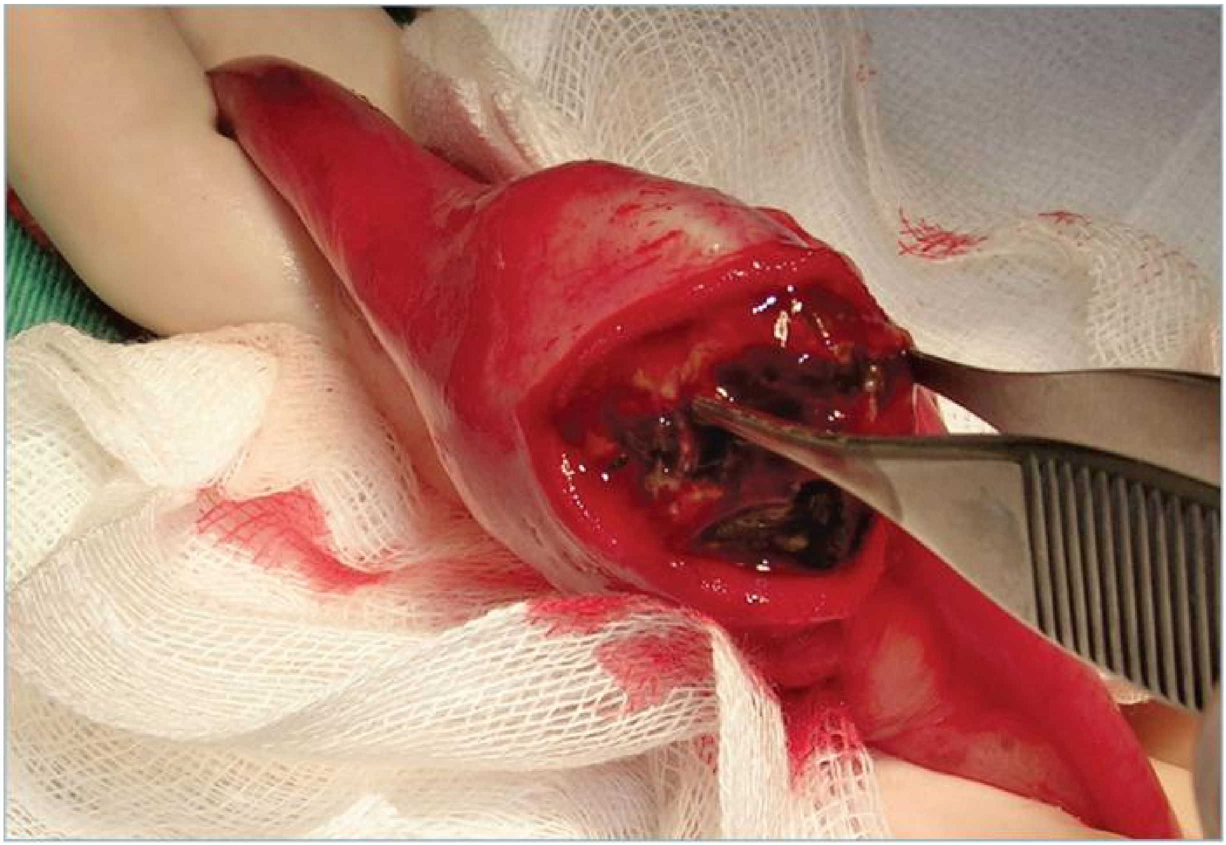


Fig. 6. Foreign bodies may adhere to the intestinal mucosa. For this reason, they should be handled gently during extraction, by peeling them off the wall.

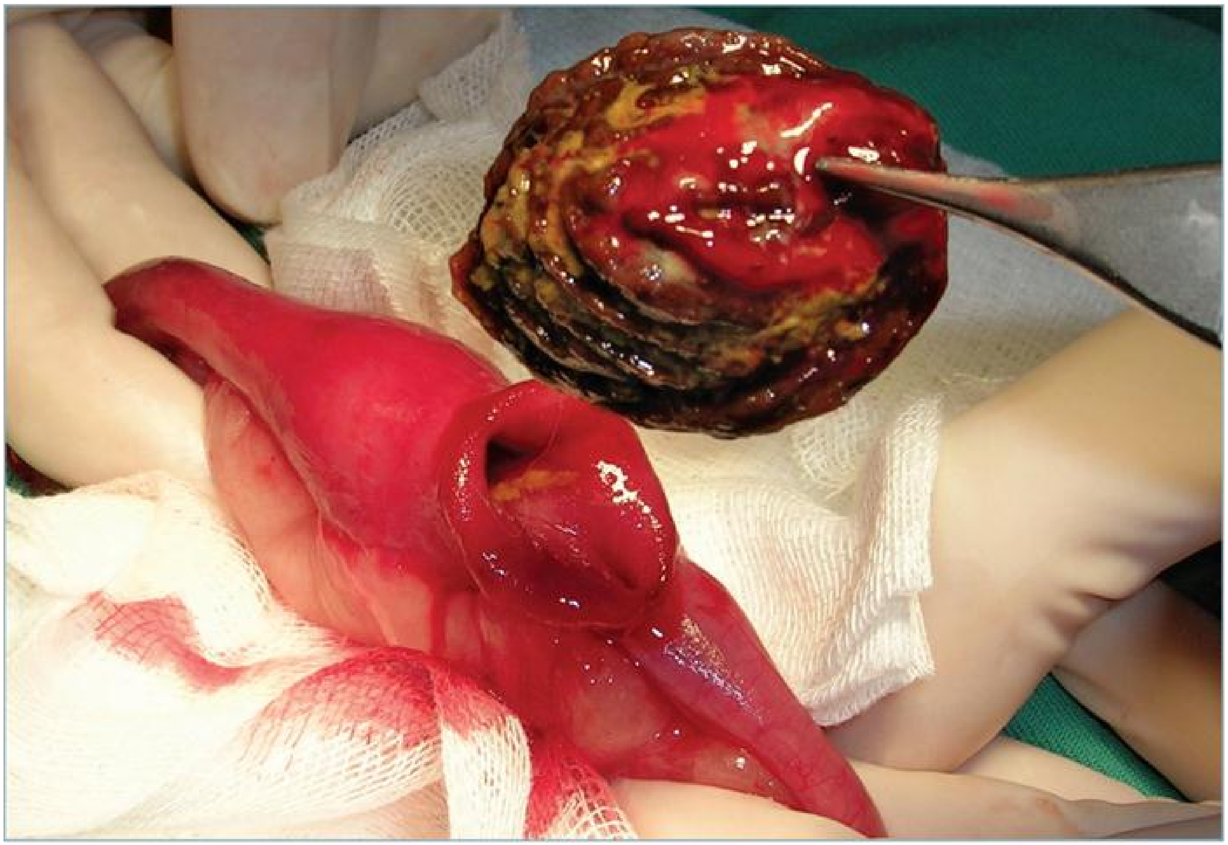


Fig. 7. Extraction of a peach pit that caused the obstruction in this case.

7. Following this, the contents of the loop are aspirated or removed to ensure that they do not leak during suturing, contaminating the peritoneum.
8. To close the enterotomy, any suture pattern may be used, but the degree of stenosis produced by each suture pattern should be taken into account (table I).

Table I. Degree of stenosis produced by intestinal sutures, depending on the suture pattern.

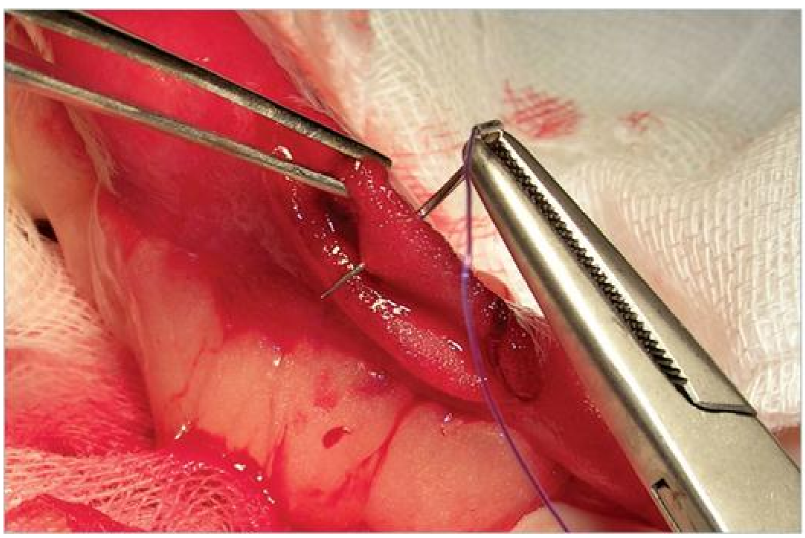
Suture pattern	Evaginating	Invaginating	Apposition
Degree of stenosis			

The following diagram shows how to place a Gambee suture (apposition suture) to close an enterotomy:

> *Use monofilament synthetic absorbable materia (non-absorbable in patients with severe hypoproteinaemia) mounted on an atraumatic round needle.*

> ***The use of an apposition suture is recommended.***

> ***The Gambee suture is very resistant, because it encompasses the submucosal layer twice. At the same time, the stenosis caused by this suture is minimal.***



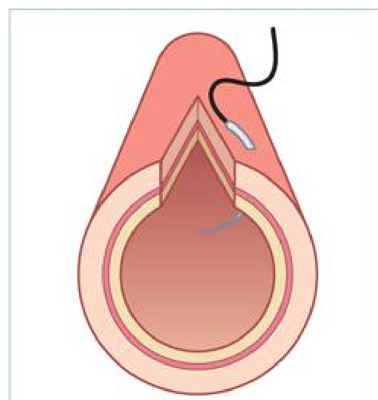
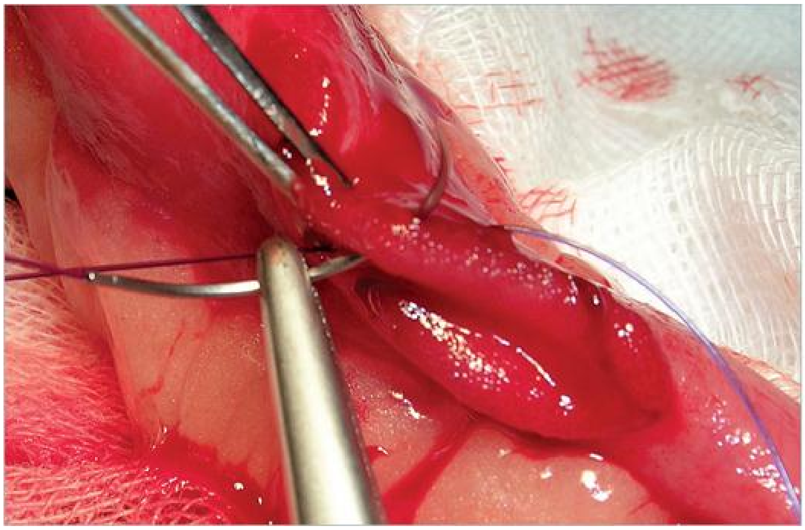


Fig. 8. The needle passes through all layers of the intestinal wall approximately 3 mm from the edge of the incision.



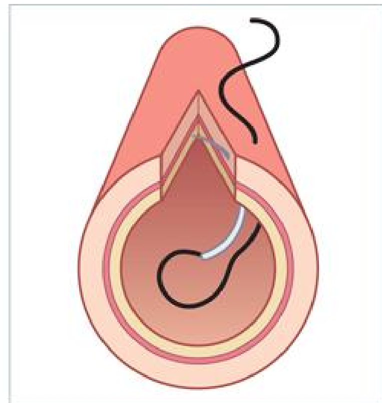
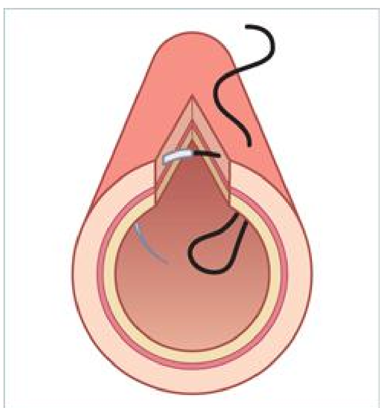


Fig. 9. Next, the needle is directed towards the mucosa, entering it approximately 1 mm from the incision. It comes out through the intestinal wall, trying not to include the serosa.



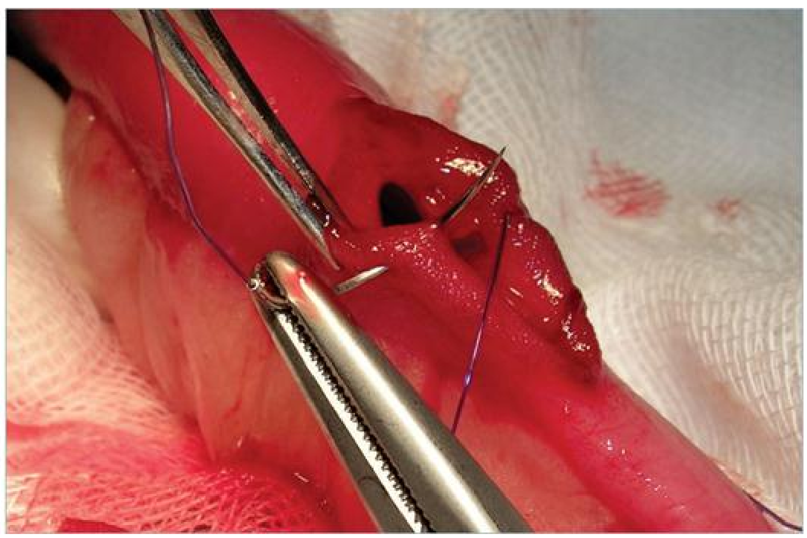


Fig. 10. The same procedure, but the other way around, is repeated on the other side of the incision. The needle penetrates the wall to come out in the lumen approximately 1 mm from the edge.

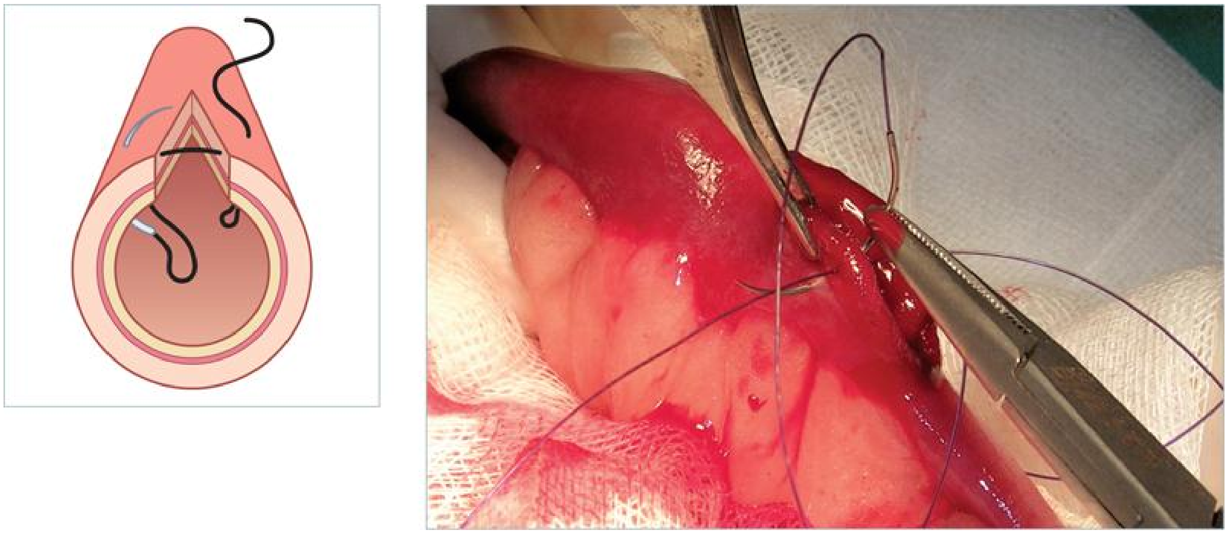


Fig. 11. All intestinal layers are penetrated again, with the needle exiting 3 mm from the edge of the enterotomy.

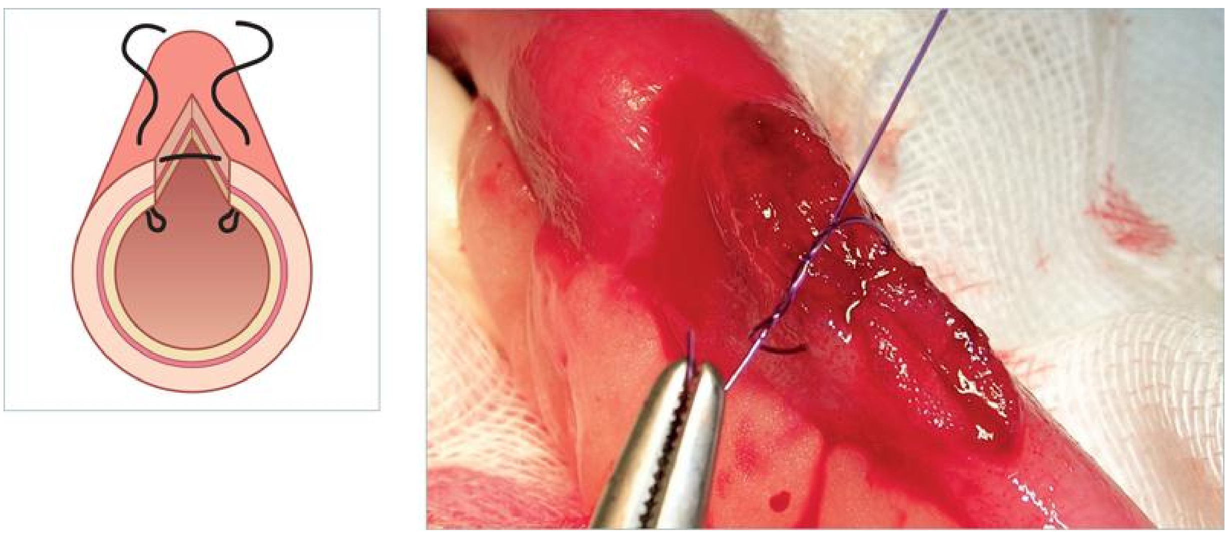


Fig. 12. The suture is tied under sufficient tension to appose and fix the edges of the enterotomy, but without tearing the tissue.

9. When the suturing is finished, the seal should be checked by injecting saline at moderate pressure into the intestinal lumen. Observe the sutures for leaks (Fig. 13). If leaks are observed, the necessary sutures should be added to inhibit all liquid loss.
10. The intestinal loop should now be flushed with saline before returning it to the abdomen. If there is a suspicion of abdominal contamination, a peritoneal lavage is carried out with abundant lukewarm sterile saline.

11. Assess the rest of the digestive tract to ensure that there are no other problems that derive from the passage of the foreign body, and also examine the abdominal organs that are visible.

12. Finally, a segment of omentum is placed over the loop to seal off the suture and prevent adhesions to other abdominal structures (Fig. 14).

Before closing the laparotomy, the entire intestine should be examined to make sure that the problem has been resolved.

When finishing the surgery, check that there are no other abdominal disorders or lesions.

Fig. 13. The impermeability of the suture is checked by injecting saline at moderate pressure into the lumen of the intestinal segment. No leaks should be observed through the suture line.

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Watch this video

Intestinal obstruction (enterotomy)

Fig. 14. Omentalization of the enterotomy in order to improve wound healing and prevent adhesions to other abdominal structures.

Enterectomy

Prevalence	■	■	□	□	□
Technical difficulty	■	■	■	■	□

Enterectomy is used to remove areas of the intestine that have undergone ischemia or necrosis due to different processes.

Steps for the best result:

1. Exteriorize the intestinal loop using the precautions that have been described previously.
2. If the intestine is not perforated, assess its capacity for vascular recuperation. In case of reasonable doubt, it is recommended that the affected segment is removed (Fig. 1).

3. Determine the length of intestine to be resected. This depends on the extent of the affected area, as well as on the blood vessels supplying the area (Figs. 2-9).

Remember that the capacity for vascular recuperation of the intestine is high once the obstruction has been removed; when in doubt, have patience before deciding to resect a segment.

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Intestinal lesion (enterectomy)

Fig. 1. Necrotic area in the anti-mesenteric border caused by the pressure of a foreign body on the intestinal wall. The intestinal segment is extracted from the abdominal cavity and isolated on a second operation field.

Fig. 2. The affected area to be resected and the vessels that perfuse it.

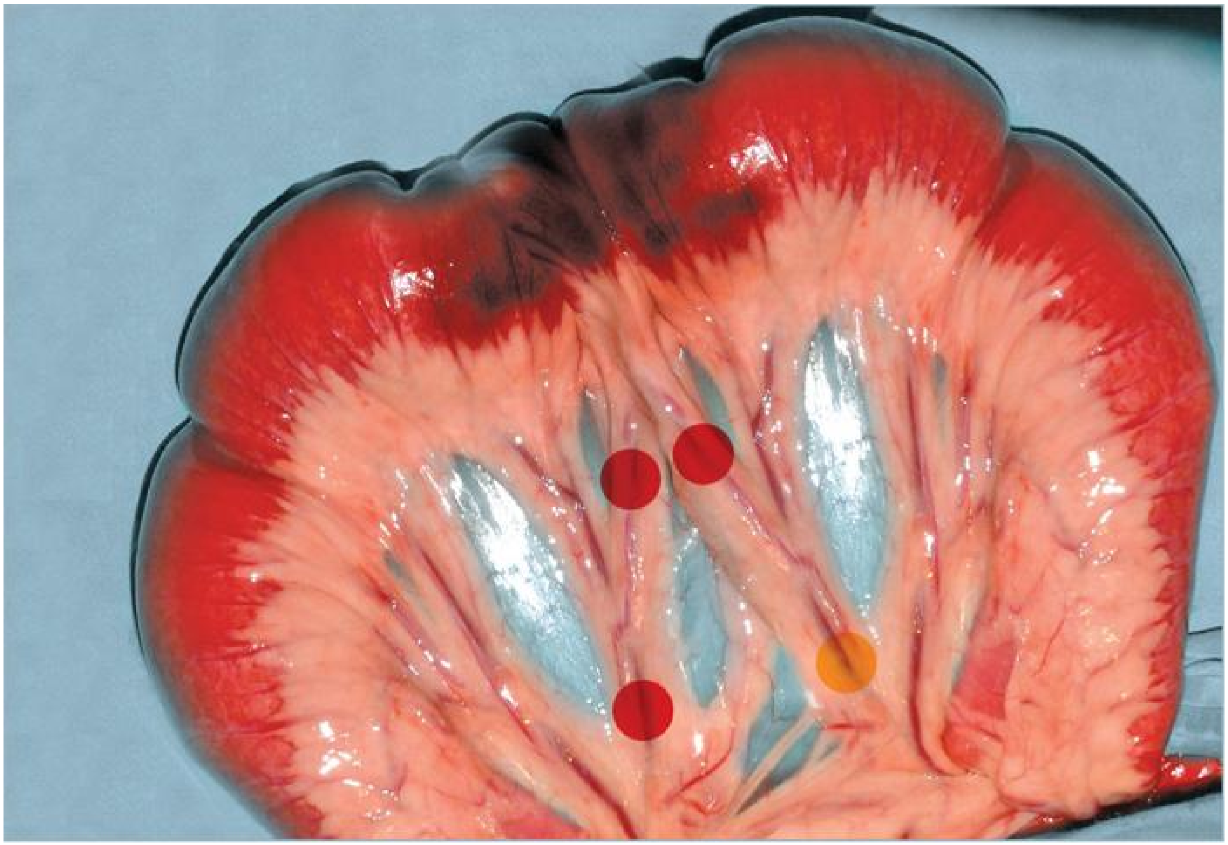


Fig. 3. In this case, it appears obvious that the vessels marked with a red dot should be ligated, because they vascularize necrotic areas. The vessel with the orange dot should also be ligated, because this is an area where necrosis is suspected.

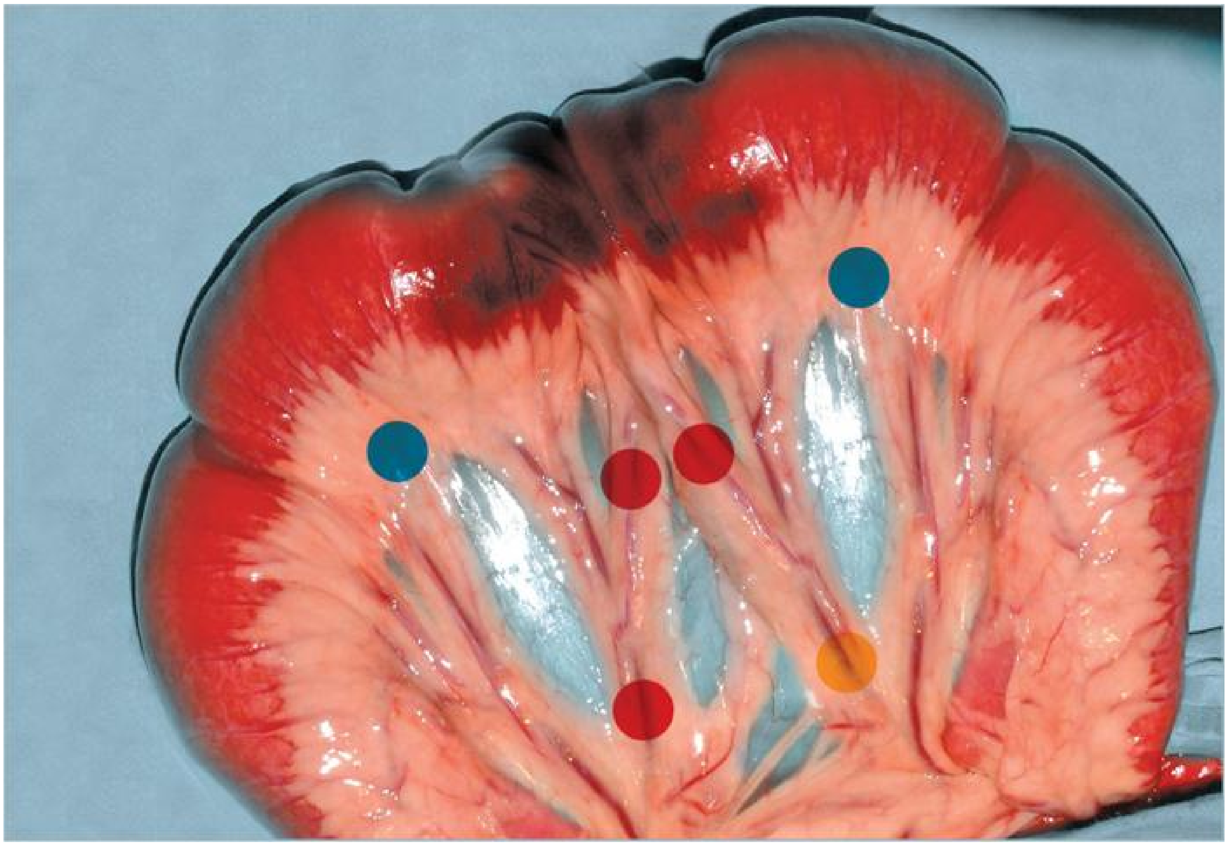


Fig. 4. Finally, the vessels of the mesenteric arcade that run towards the necrotic area should also be ligated (blue dots).

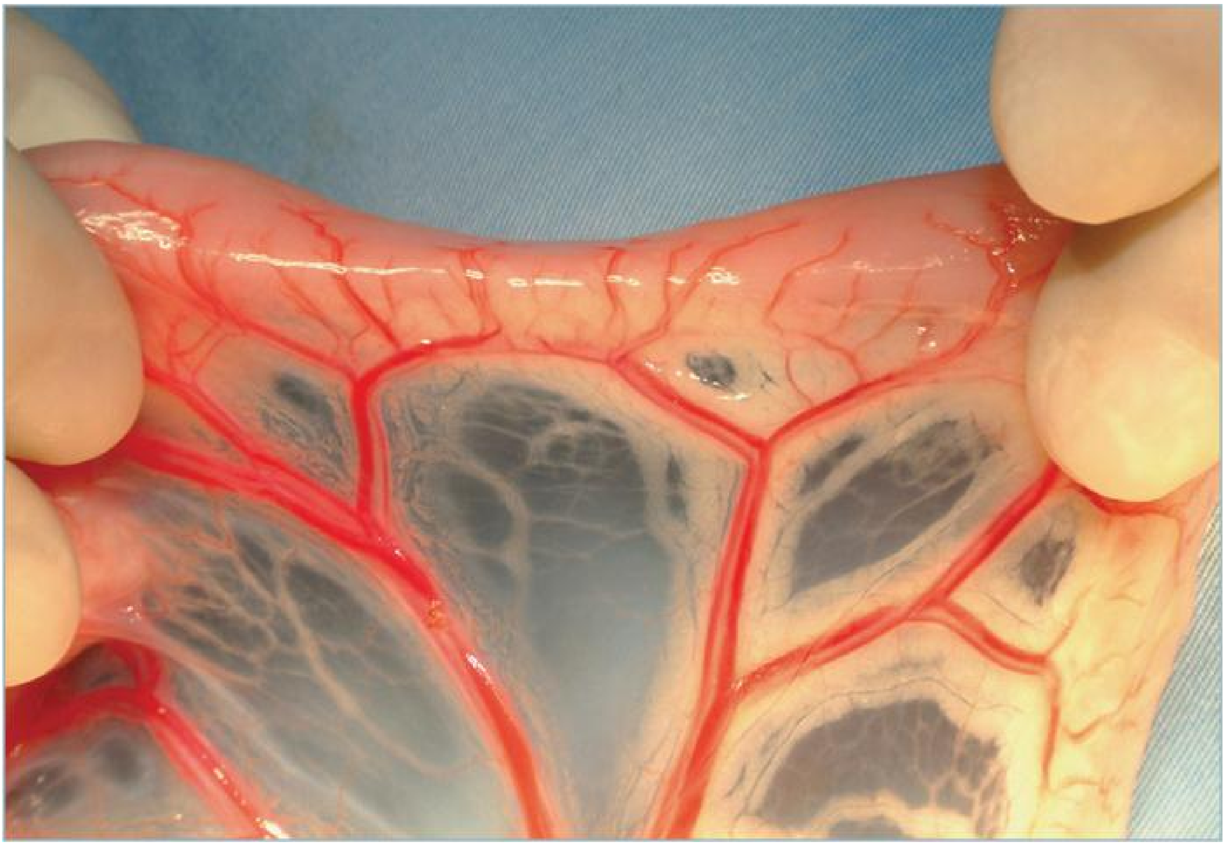


Fig. 5. Identification of the vessels of the mesenteric arcade that are to be ligated.

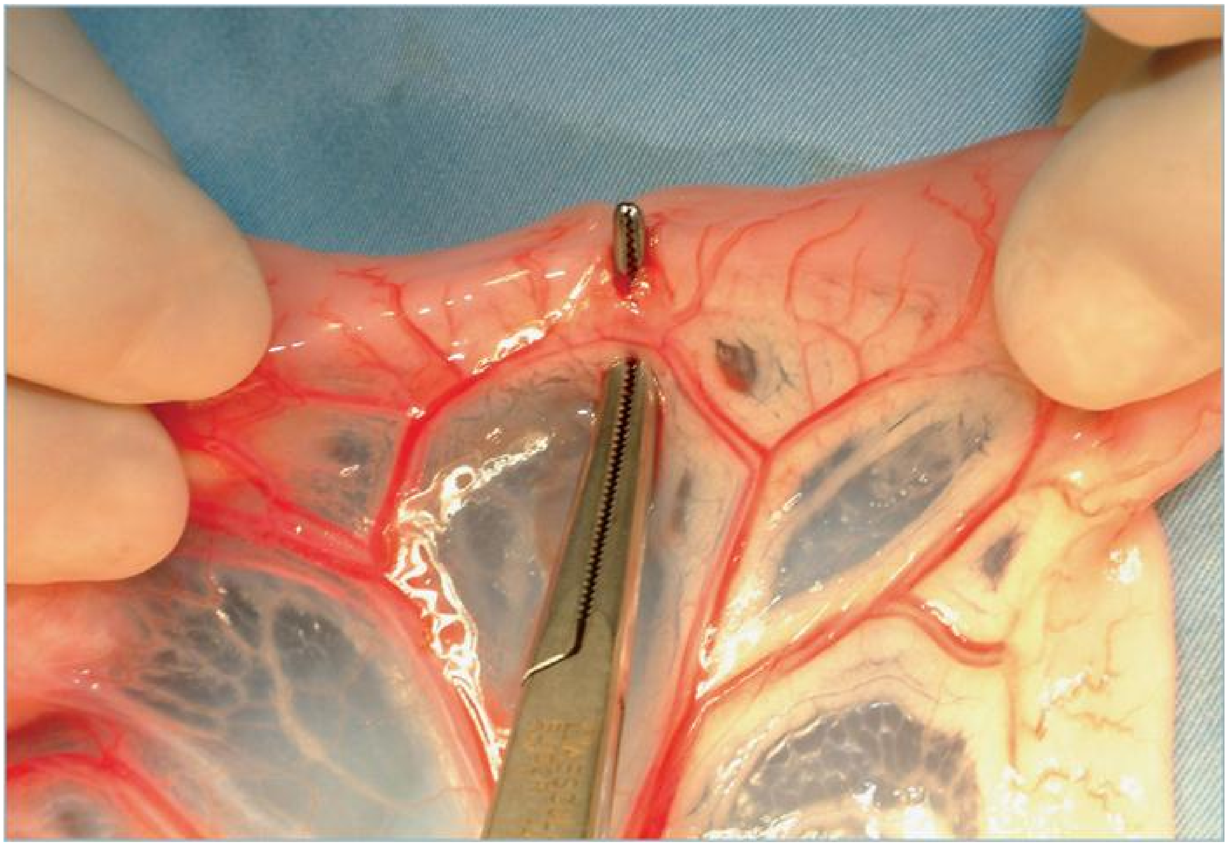


Fig. 6. The necessary holes for ligature placement are made in the mesentery with a curved atraumatic clamp.

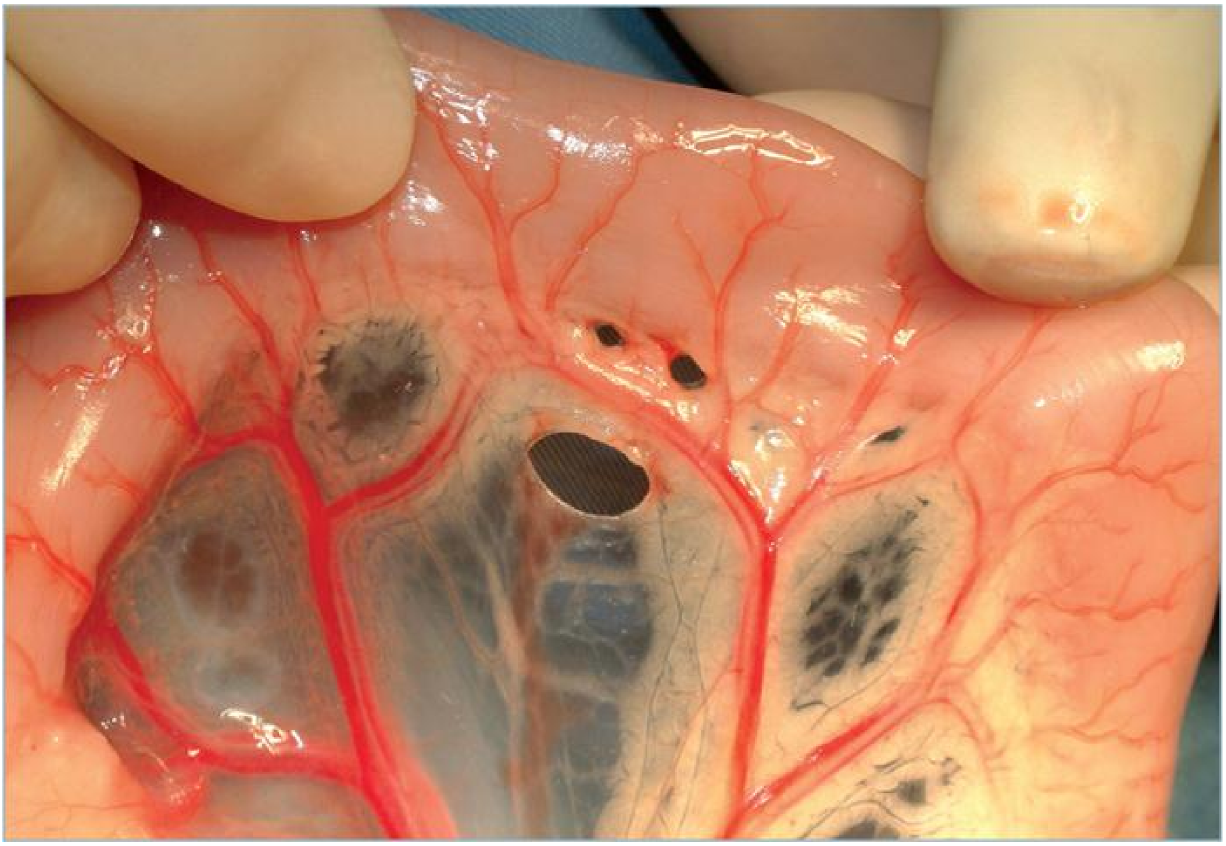


Fig. 7. The dissection and perforation of the mesentery should be carried out as close to the intestine as possible.

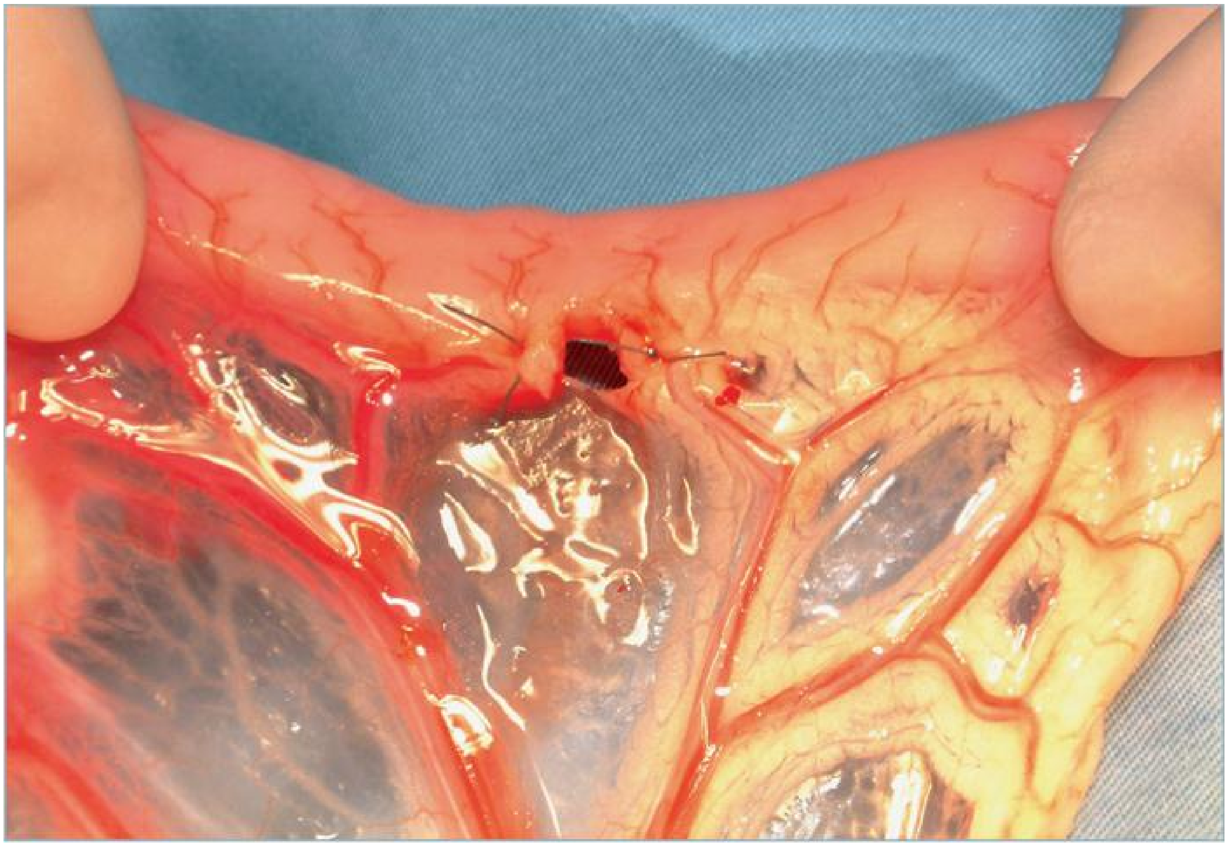


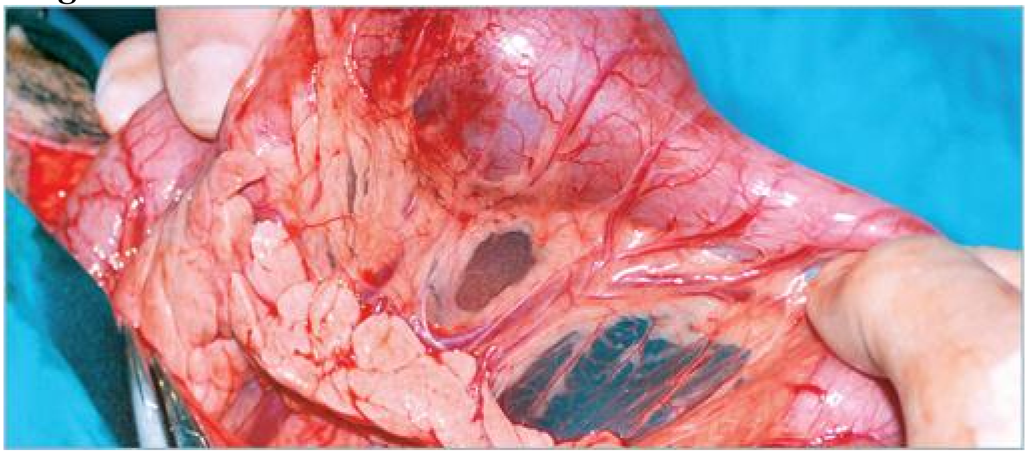
Fig. 8. The ligature of absorbable material on the vessels of the mesenteric arcade should not obstruct the blood flow to the intestinal surface that is to be anastomosed.

Fig. 9. Theoretical view of the intestine after ligation of the aforementioned vessels. In this way, it is possible to clearly identify the limits of the intestinal segment to be resected.

It is very important to decide which vessels have to be ligated before resection. Remember that the blood supply to the anastomosis ends should be preserved, and that this should be as straight as possible.

If the area to be resected includes the duodenum, the pancreatic branches of the pancreaticoduodenal vessels should be preserved; only the branches that perfuse the duodenum should be ligated or

coagulated.



4. The mesentery is incised as far as possible from the vessels that will perfuse the anastomosis. Remember that the mesentery should be sutured after finishing the anastomosis, to avoid intestinal entrapment (Figs. 10 and 11).

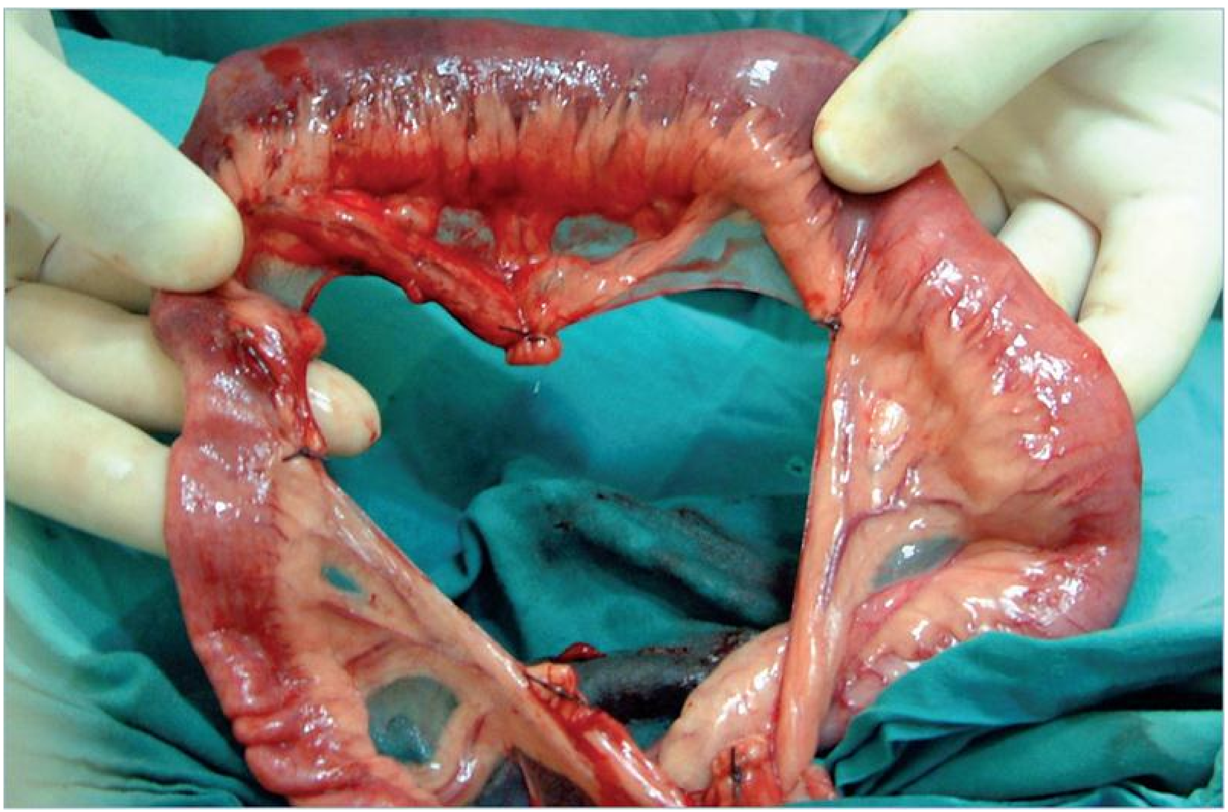


Fig. 10. The limits of the area to be resected have been marked by the ligature-induced ischemia. The mesentery is incised along its vessels,

preserving as much tissue as possible to be included in sutures.

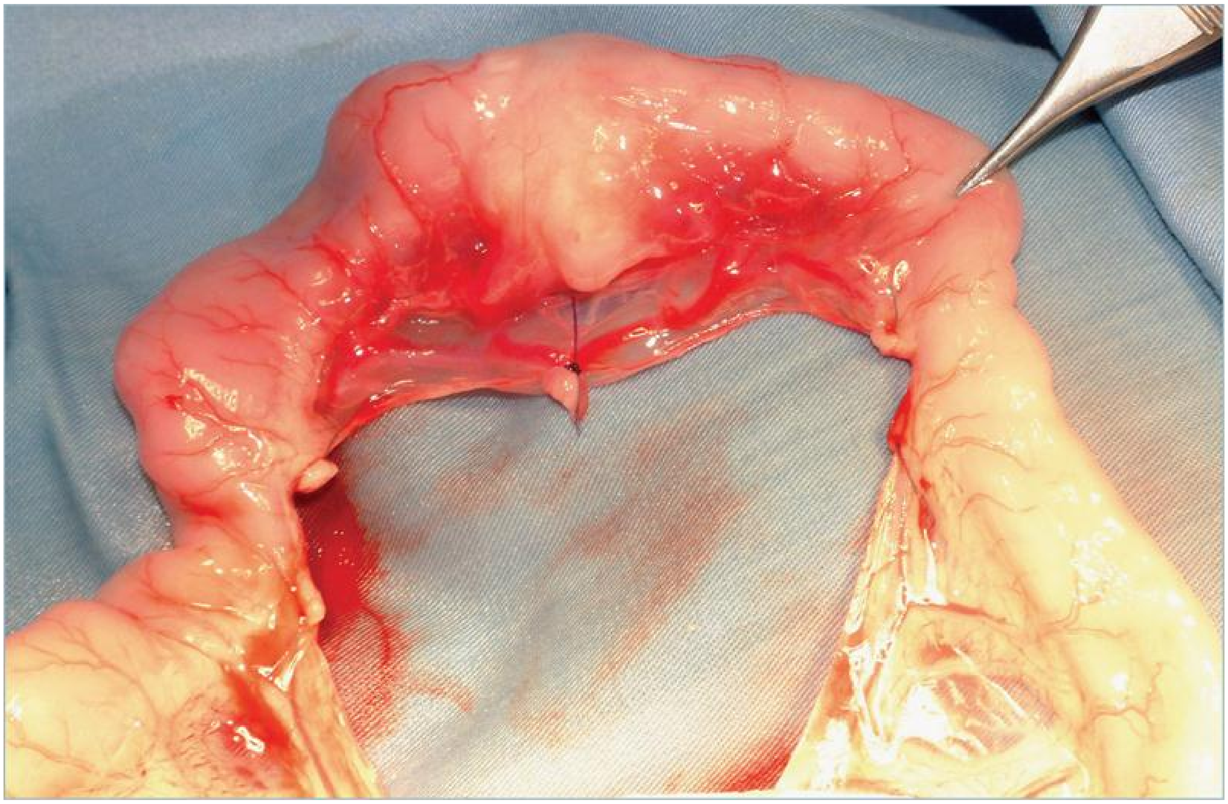


Fig. 11. Enterectomies performed to remove intestinal tumors should include approximately 4 cm of healthy intestine on either side of the tumor.

5. Empty the intestinal contents on both sides of the area that will be resected by “milking” the contents with the fingers in a proximal and distal direction.
6. Interrupt intestinal transit with intestinal clamps (atraumatic Doyen clamps) or the help of an assistant to avoid spillage of the intestinal content from the digestive tract (Figs. 12 and 13).
7. Place a clamp on each side of the area to be resected to avoid spillage of the contents.
8. Incise the intestine through 360º, both proximally and distally to the obstruction. Make a perpendicular incision if the two anastomosis segments have a similar diameter; if the diameters differ, the incision in the segment with the smallest diameter should be oblique.

9. Remove the affected intestinal segment and try not to contaminate the abdominal cavity.

10. Aspirate and remove (with moist gauze) the digestive contents from the anastomosis ends.

11. Inexperienced surgeons are advised to resect the everted mucosa of the ends, as well as the fat of the mesenteric border, without damaging the vessels that run in it (Fig. 12).

12. Start the anastomosis with a suture in the mesenteric border, taking care not to include any fat belonging to this area. One of the suture ends is left long in order to maintain the tension and create a traction suture (Fig. 13).

A round atraumatic needle and monofilament synthetic material should be used. Although, in principle, the suture material should always be absorbable, it is recommended a non-absorbable material is used in patients with peritonitis or hypoproteinemia.

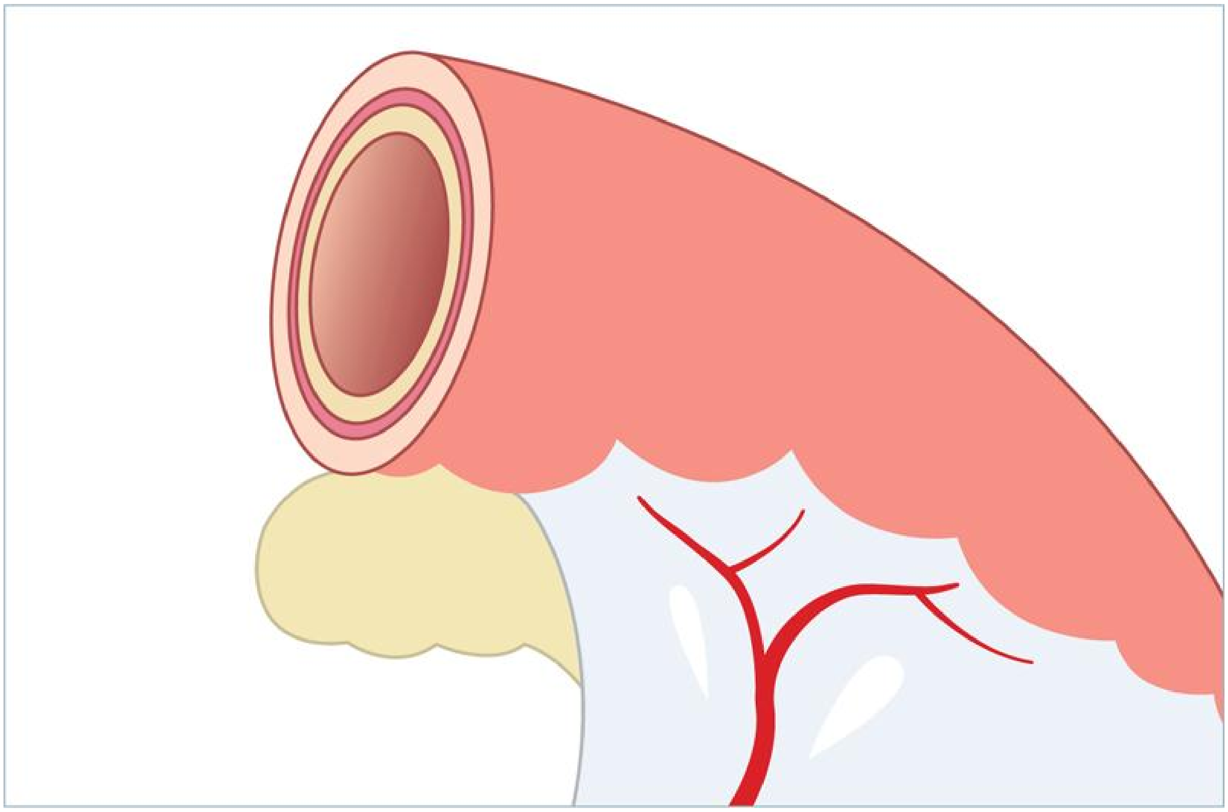


Fig. 12. Special care should be taken with the fat of the mesenteric border, up to the point of resecting it. If this fat ends up in the suture line of the anastomosis, the consequence will be a digestive fistula and peritonitis.

Make absolutely sure that no fat from the mesenteric border has been included in the anastomosis suture line. If fat is trapped in the suture, there will be leakage of the intestinal contents into the peritoneal cavity.

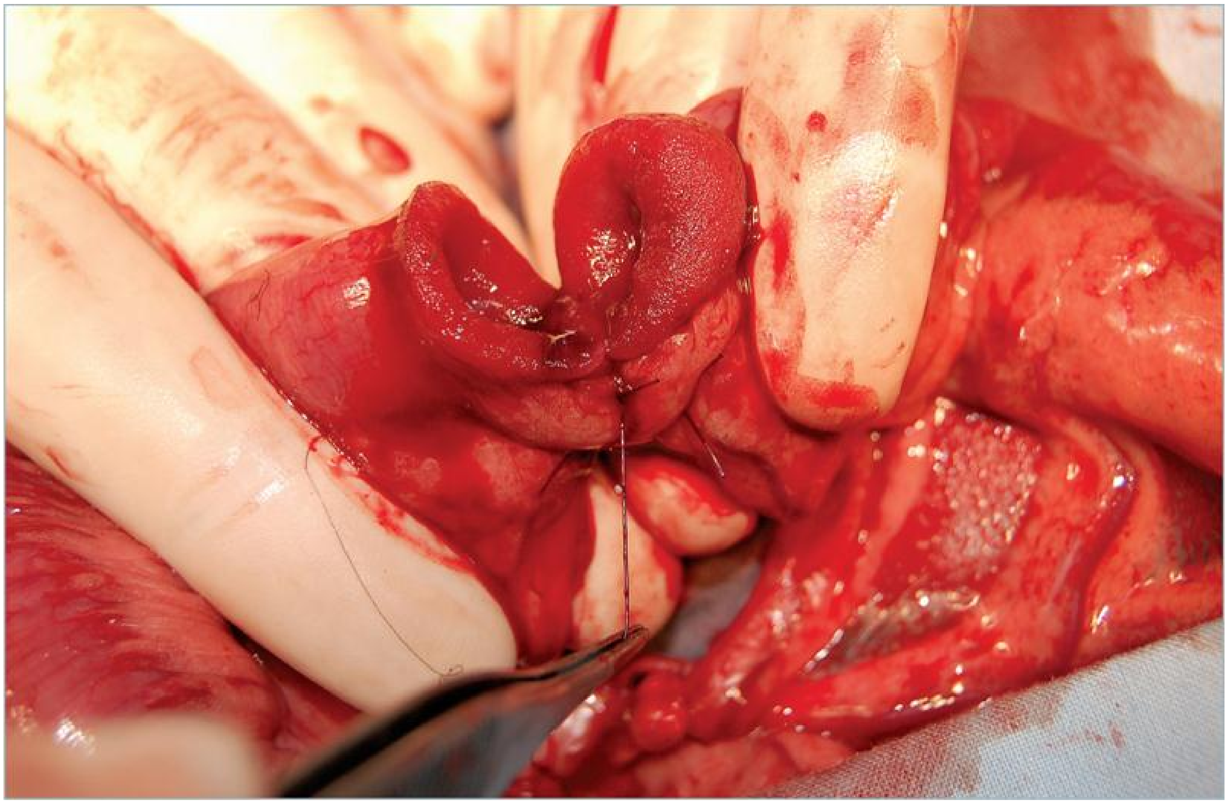


Fig. 13. The first suture of the anastomosis is placed in the mesenteric border, taking utmost care that no fat remains in this suture or any part of the suture line.

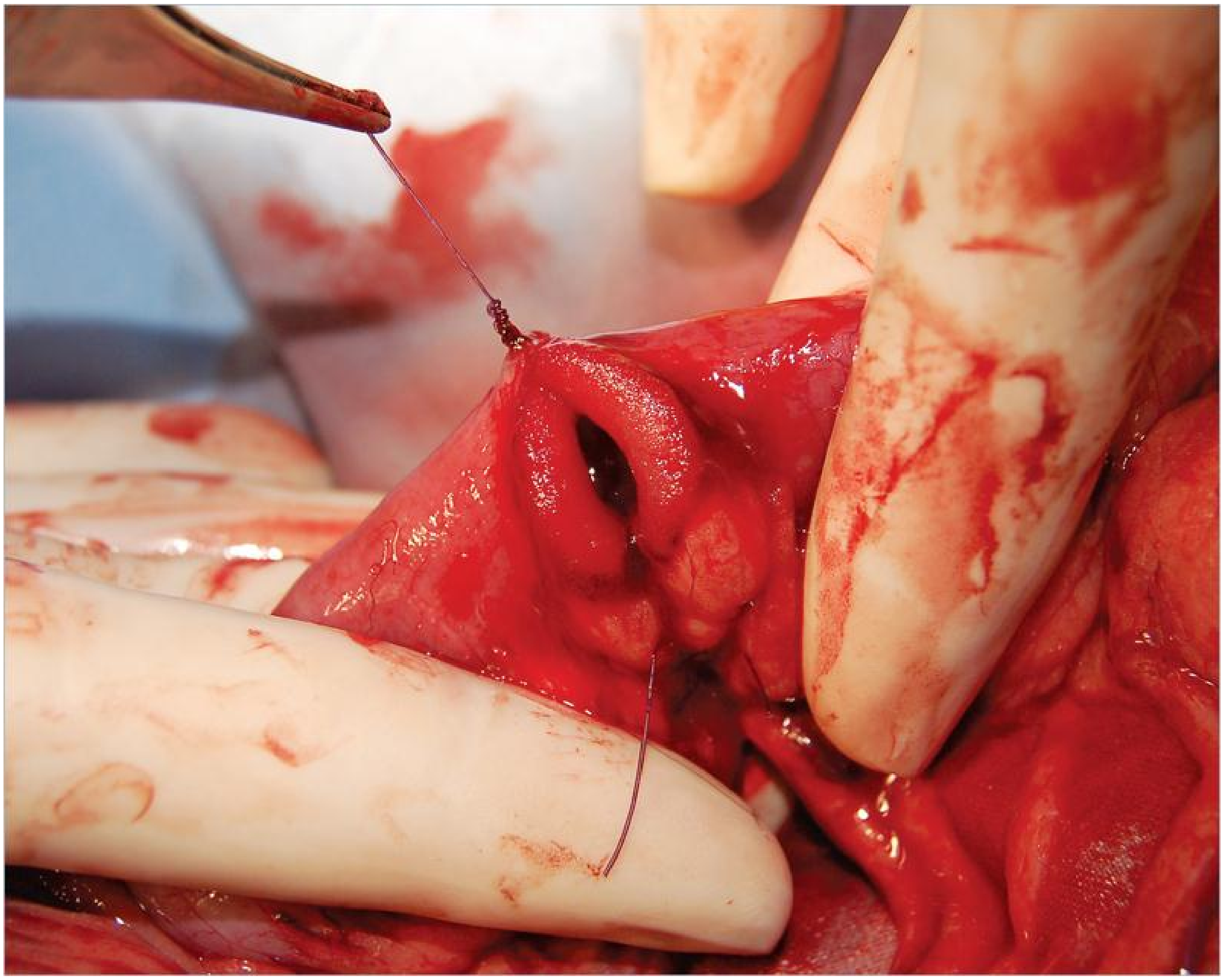


Fig. 14. The second traction suture is placed in the anti-mesenteric border; this simplifies the correct distribution of the sutures on both sides of the anastomosis.

13. The next suture is placed in the anti-mesenteric border, at 180º to the first; this becomes the second traction suture (Fig. 14).
14. Suture the side of the anastomosis that is closest to the surgeon with the suture of the surgeon's choice.
15. When this is finished, the bowel is rotated to access the other side of the anastomosis and suture it (Fig. 15).

*

The sutures should be placed with precision and distributed evenly around the anastomosis. The knots should be tightened just enough to form a stable suture line without strangling the tissue.

Excessive tension on the sutures will produce tissue ischemia, suture dehiscence and peritonitis.

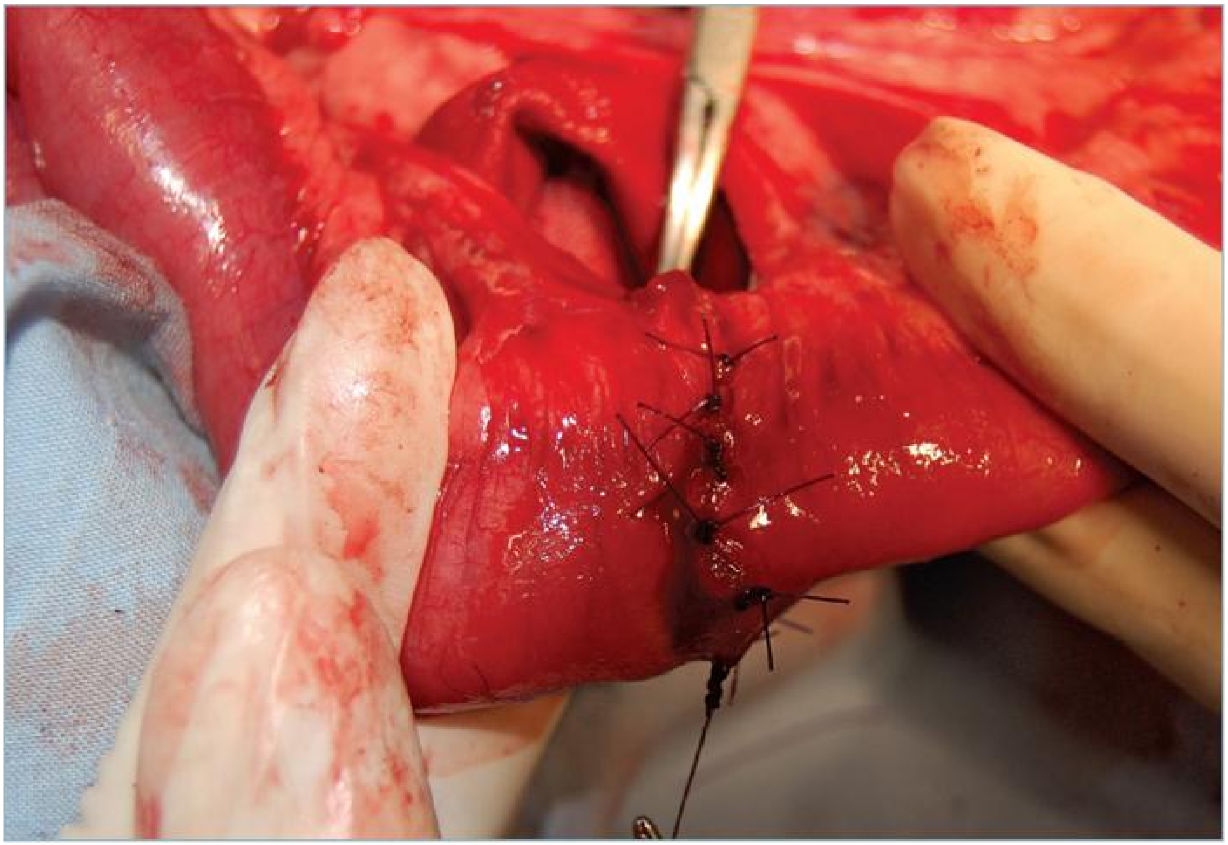


Fig. 15. Final appearance of an end-to-end anastomosis in a cat's intestine, with simple interrupted sutures using 4/0 monofilament material.

16. Once the anastomosis is finished, the impermeability of the suture line should be checked. To do so, saline is injected under moderate pressure into the intestinal lumen without taking off the clamps and the sutures are observed for leaks (watch the mesenteric area in particular) (Fig. 16).

17. Suture the opening in the mesentery to prevent intestinal entrapment; take special care not to include the adjacent blood vessels in the sutures (Fig. 17).

18. Flush the intestinal loop and return it to the abdomen.

19. Flush and aspirate the peritoneal cavity with abundant sterile saline if there is a suspicion of abdominal contamination by leaked intestinal contents.

20. Omentalize the anastomosis (Fig. 18).

21. Close the laparotomy using the standard technique.

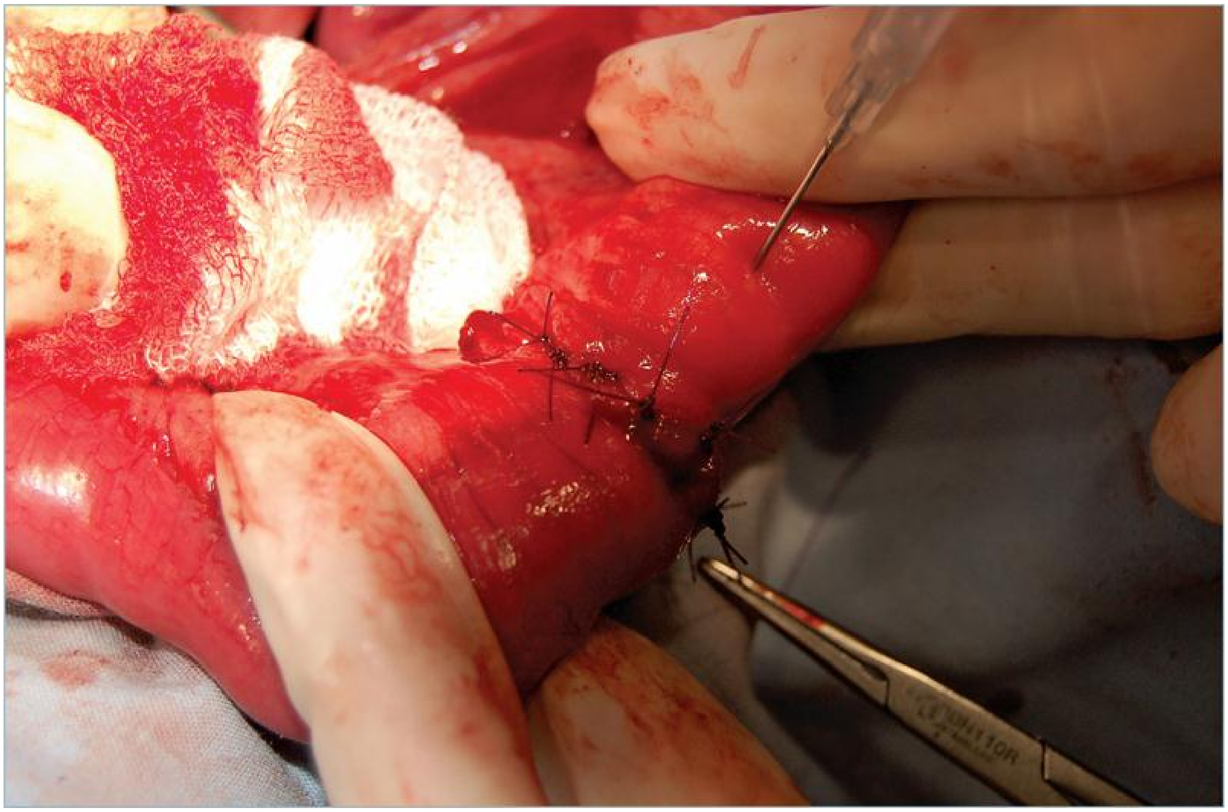


Fig. 16. When the anastomosis is finished, the suture is checked for leaks by injecting saline under moderate pressure into the intestinal lumen.

> ***Once the enterectomy is finished, check the rest of the digestive tract as well as other abdominal structures.***

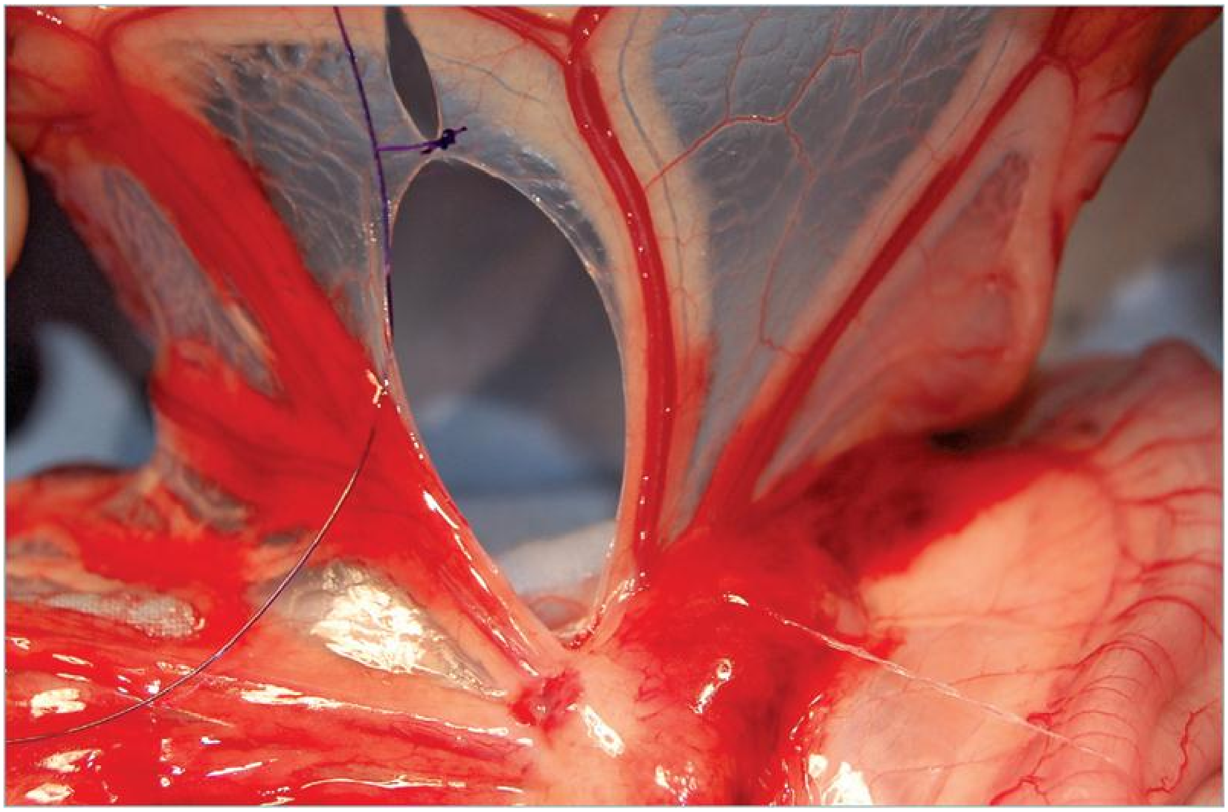


Fig. 17. Closure of the mesentery is performed with the same material used for the intestinal anastomosis. Three or four simple interrupted sutures are placed, taking care not to damage nearby mesenteric vessels. This image does not correspond to an enterectomy, but to a post-traumatic mesenteric rupture.

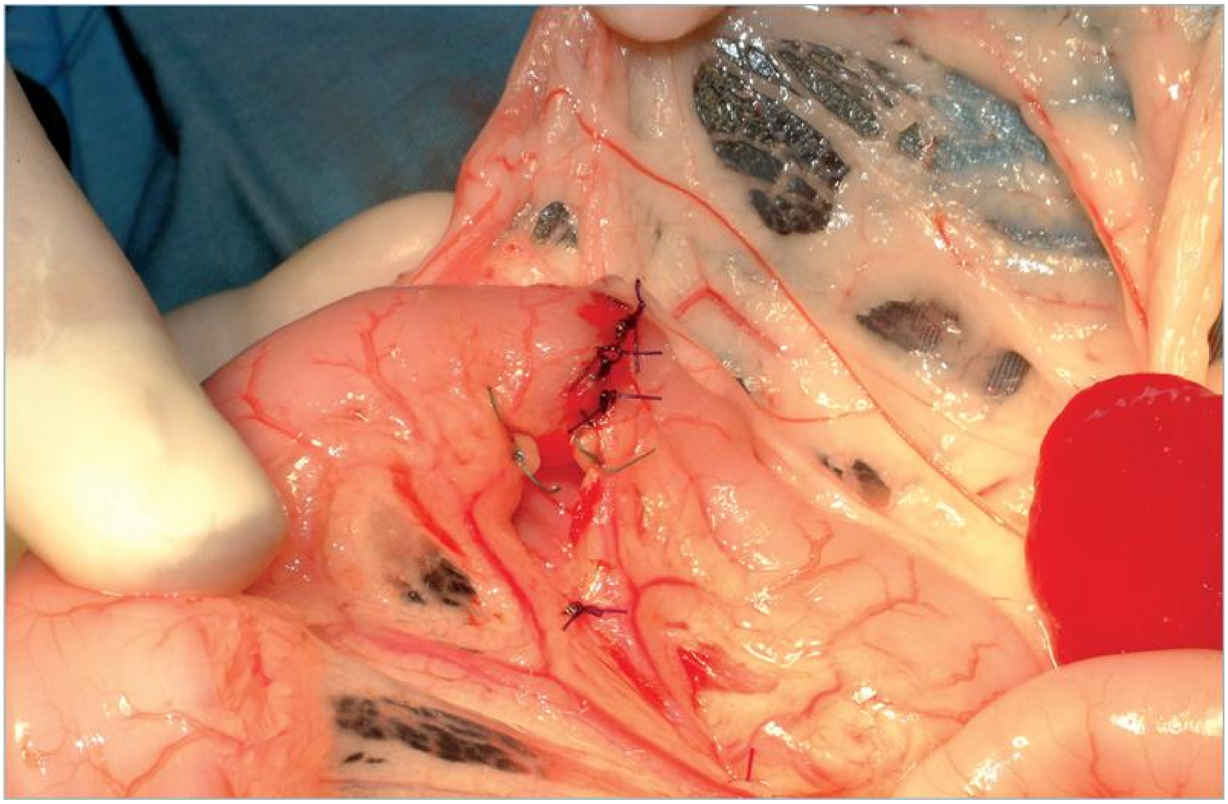


Fig. 18. In order to improve local wound healing, reduce the risk of digestive fistulas and prevent adhesions to other abdominal organs, a segment of omentum is placed over the anastomosis.

Intestinal intussusception

José Rodríguez

Prevalence	■	■	■	□	□

Invagination of one bowel segment into another, usually the distal, segment is called intussusception. It may cause obstruction and strangulation of the intestine.

Usually, intussusception is associated with a previous irritation or inflammation, for instance:

- Intestinal parasitism

- Parvovirus
- Dietary changes
- Foreign bodies
- Surgical interventions of the abdomen

If the bowel invaginates, its vessels collapse, resulting in a perfusion deficit in the bowel loop. The wall becomes edematous and friable. If the problem is not resolved, tissue necrosis and secondary peritonitis will follow.

Patients are nearly always young animals with a history of a digestive disorders or a recent surgical intervention in the abdomen. The clinical signs are not very specific and vary depending on the severity of the lesions:

- Abdominal pain
- Melena
- Vomiting, anorexia
- Depression
- Weight loss

Diagnosis

On abdominal palpation, a hard sausage-shaped mass is detected, which corresponds to the intussuscepted bowel segment.
The mass can be seen on abdominal radiographs, although it is not always easily identified (Figs. 1-2).
Abdominal ultrasonography in these patients produces images that are pathognomonic for intestinal intussusception (Fig. 3).

Ultrasonography is a good diagnostic aid in intestinal intussusception.

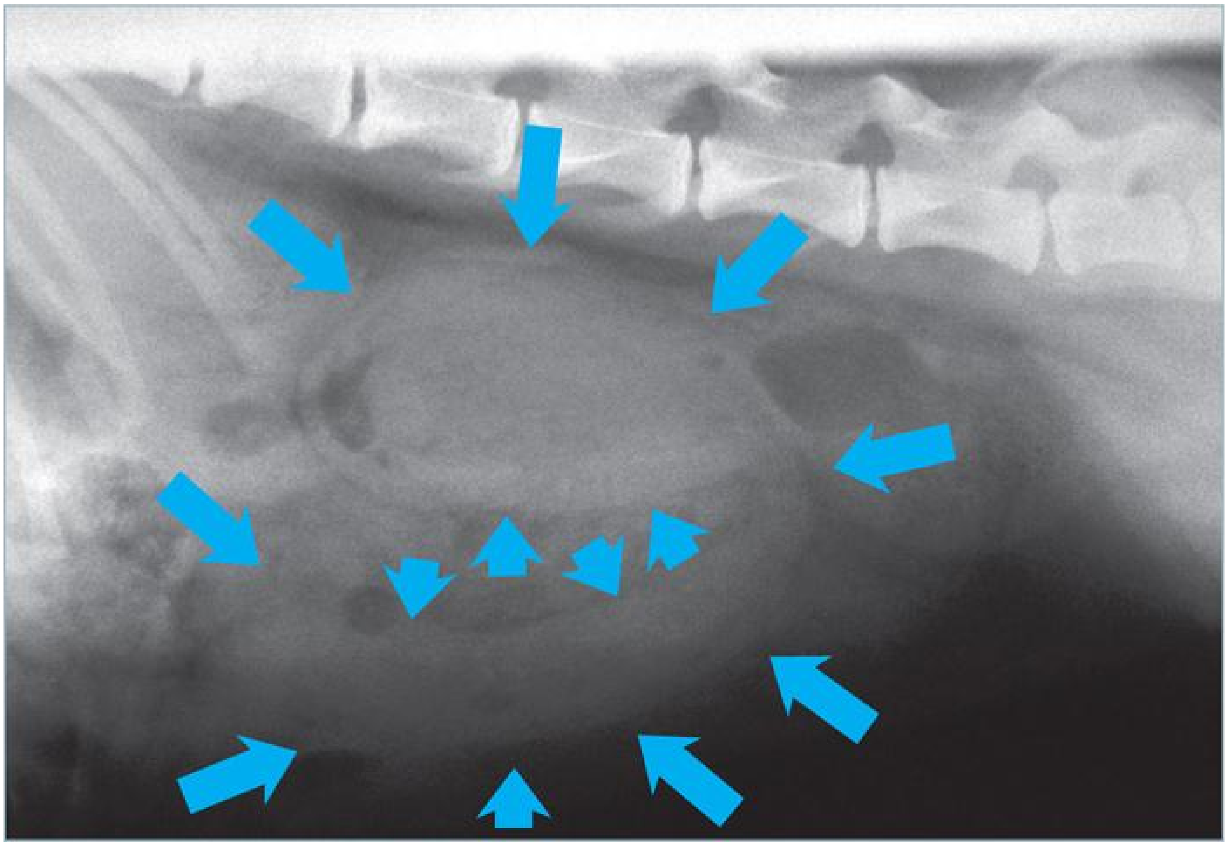


Fig. 1. Radiodense mass in the form of an inverted C located in the center of the abdomen, corresponding to an intestinal invagination.

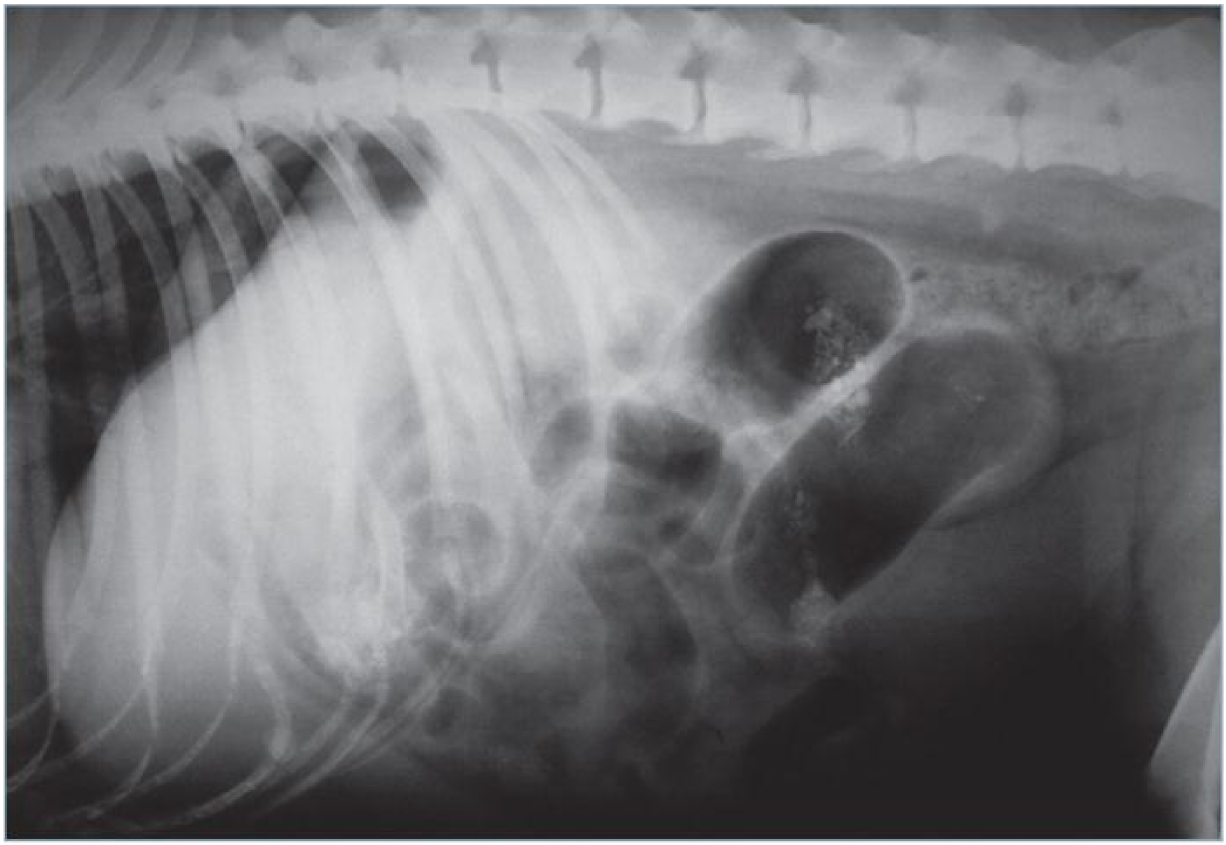


Fig. 2. In this patient with an intussusception, the radiograph does not show the typical sausage shape.

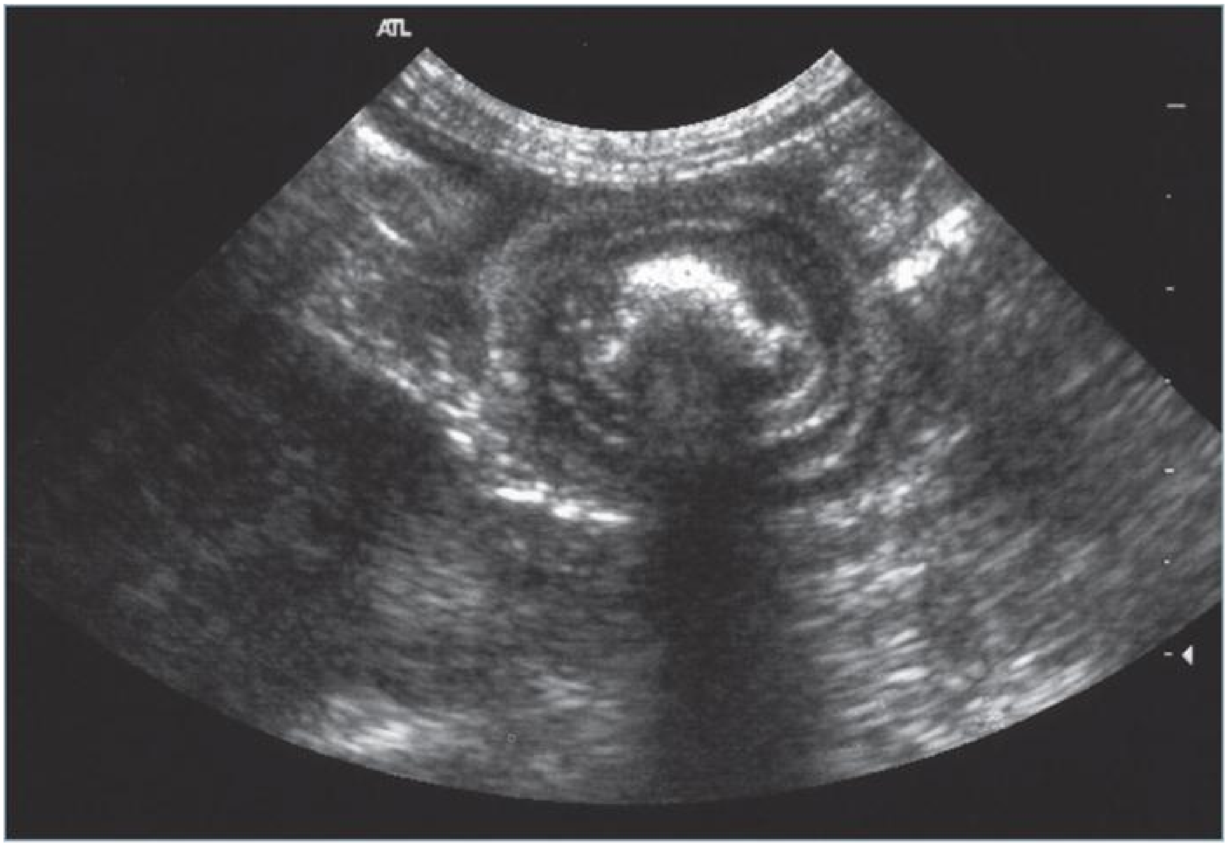


Fig. 3. Onion-shaped transverse view of an intestinal segment. This ultrasound image is typical for intestinal intussusception.

Surgical intervention

Technical difficulty	Reduction	■	□	□	□	□
	Enterectomy	■	■	■	■	□

Due to the serious intestinal complications, surgery should be performed as soon as possible.

Prior to surgery, dehydration and electrolyte imbalances should be corrected and appropriate antibiotic prophylaxis initiated.

After midline laparotomy and isolation of the affected segment (Fig. 4), a manual reduction of the invagination is attempted.

All handling and manipulations of the intestine should be performed with care due to its fragility (Figs. 5-11).

The operation is straightforward if the intussuscepted bowel is not too edematous and there are no fibrinous adhesions.

Reduction should not be performed by traction alone because the intestine could tear.

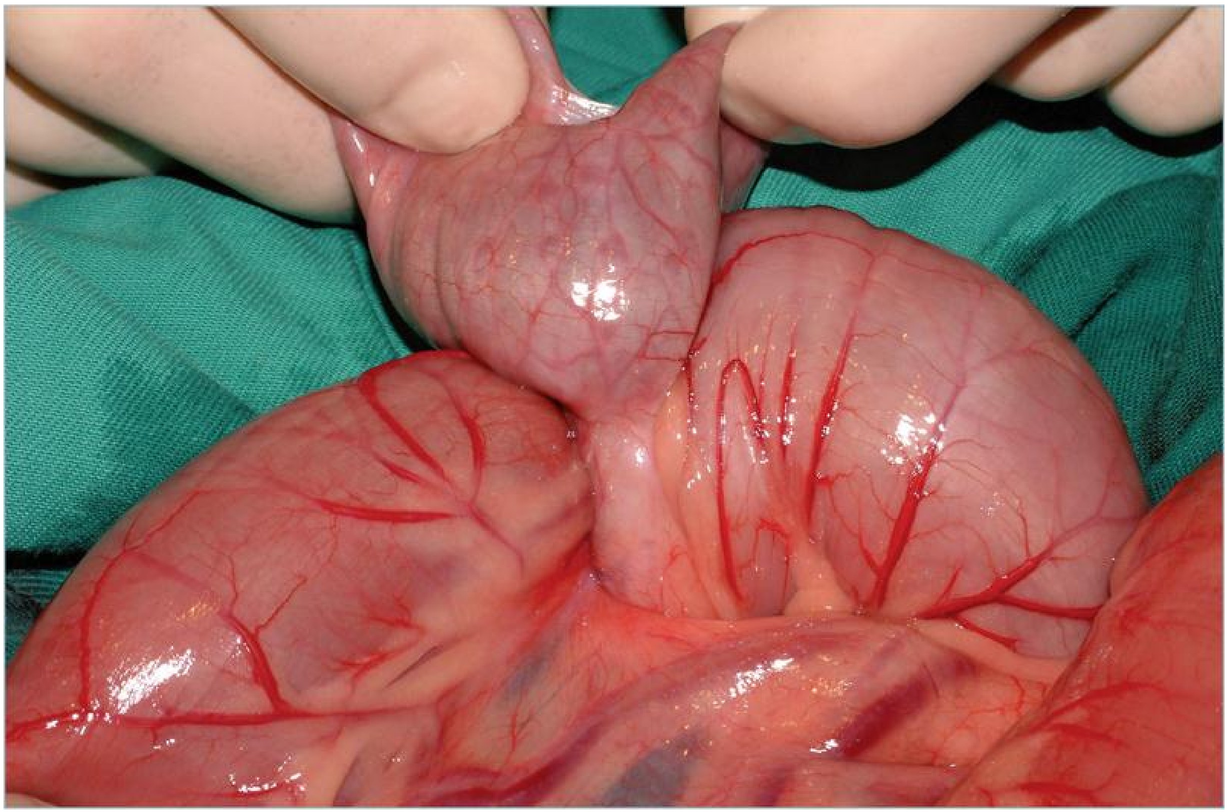


Fig. 4. This patient has an ileocolic intussusception. It has occurred recently; there is no apparent vascular compromise so the prognosis is, in principle, good.

Fig. 5. To avoid damage to the invaginated intestine, it should be “milked” out of the distal area (like squeezing a tube of toothpaste).

✱

The intussusception is reduced by squeezing the distal segment, while pulling gently on the proximal segment.

Fig. 6. The area should be flushed to prevent it from drying out; this also facilitates the extraction of the invaginated segment.

Fig. 7. Gradually and patiently, the intestine is extracted from the distal segment. The shorter the time between intussusception and surgical intervention, the easier these manipulations are.

Fig. 8. Once the bowel has been returned to its normal position, a small lesion is detected on the intestinal wall, which does not require surgery.

Intussusception is caused by irritation. To avoid recurrence, the bowel loop should be attached to the abdominal wall (enteropexy) or to other bowel segments.

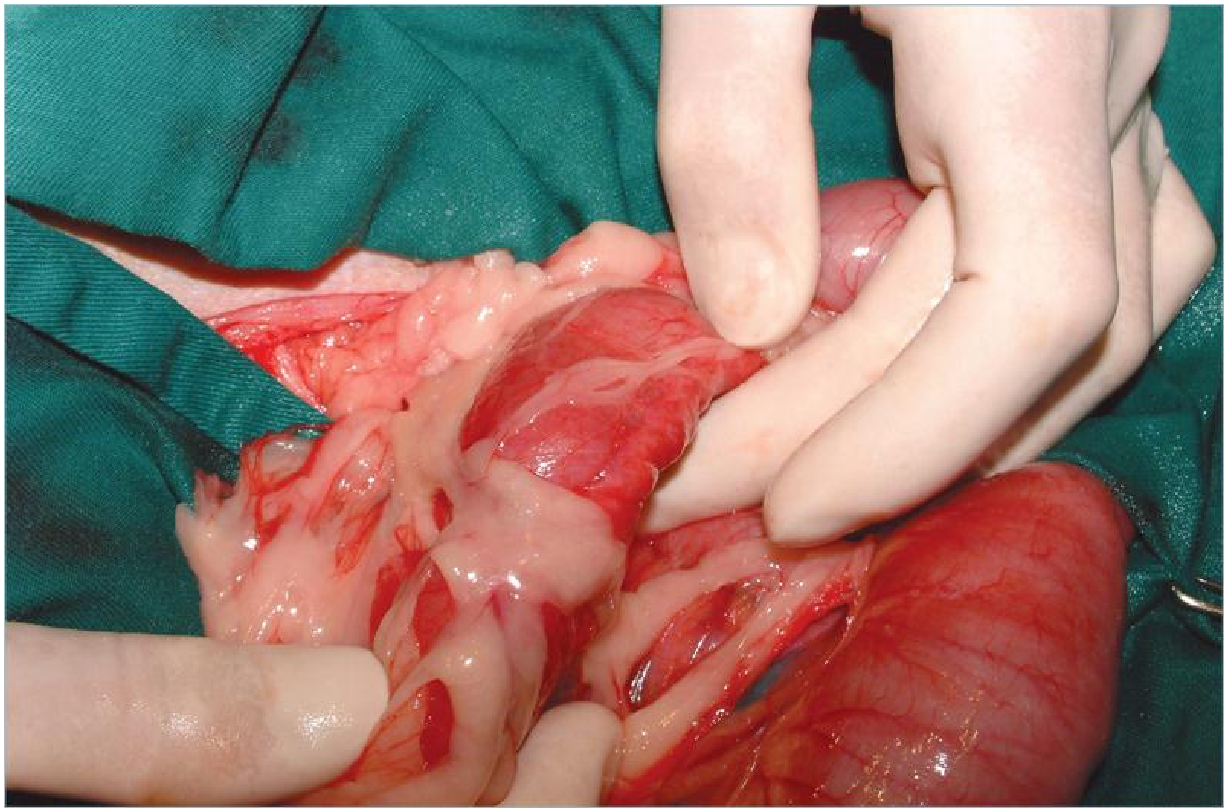


Fig. 9. In this case, it was decided to omentalize the area to accelerate healing and speed the patient’s recovery.

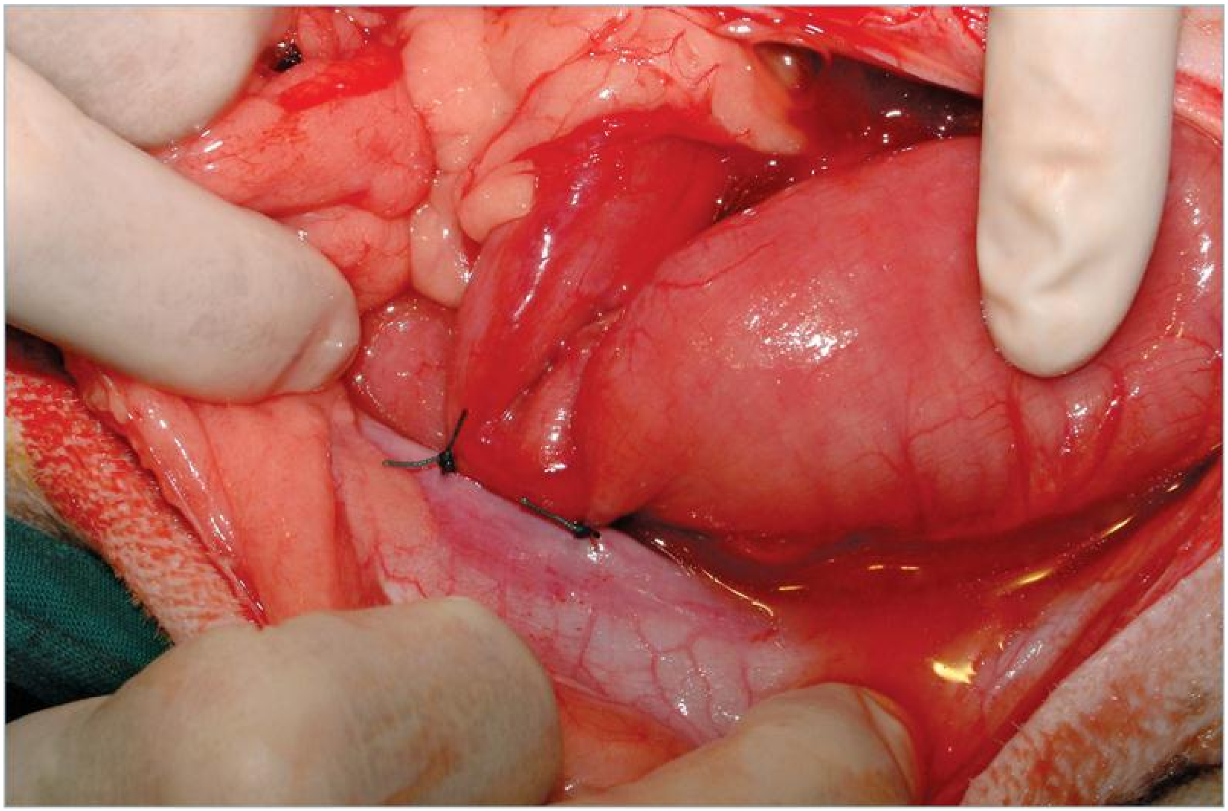


Fig. 10. To avoid recurrence of the intussusception, the bowel loop is fixed to the abdominal wall…

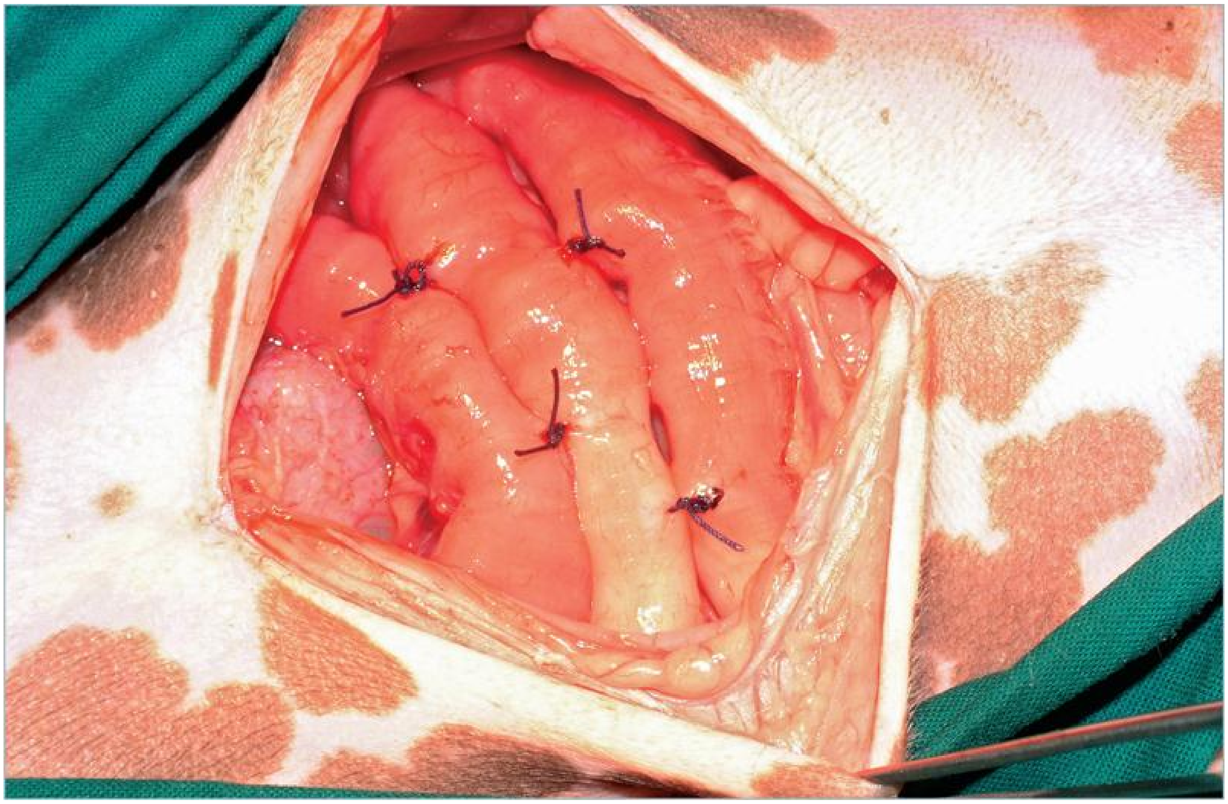


Fig. 11. …or to other bowel loops with simple sutures in absorbable material.

If manual reduction proves impossible or the tissue lesions are severe, an enterectomy should be performed (Figs. 12-13).

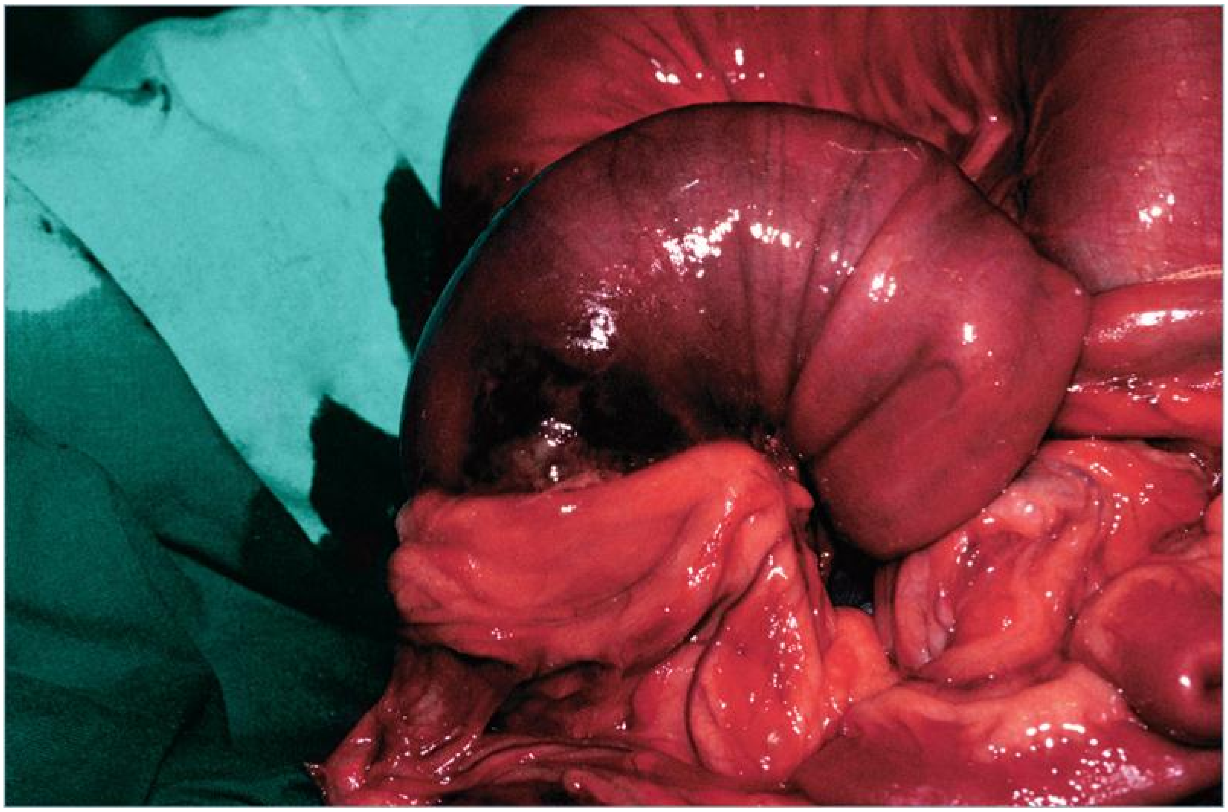


Fig. 12. In this patient, manual reduction was impossible. The congestion and edema in the wall and the fibrinous adhesions between the intestinal loops impede reduction of the intussusception.

Sometimes, a large section of intestine has to be resected, which may lead to short bowel syndrome, a postoperative complication.

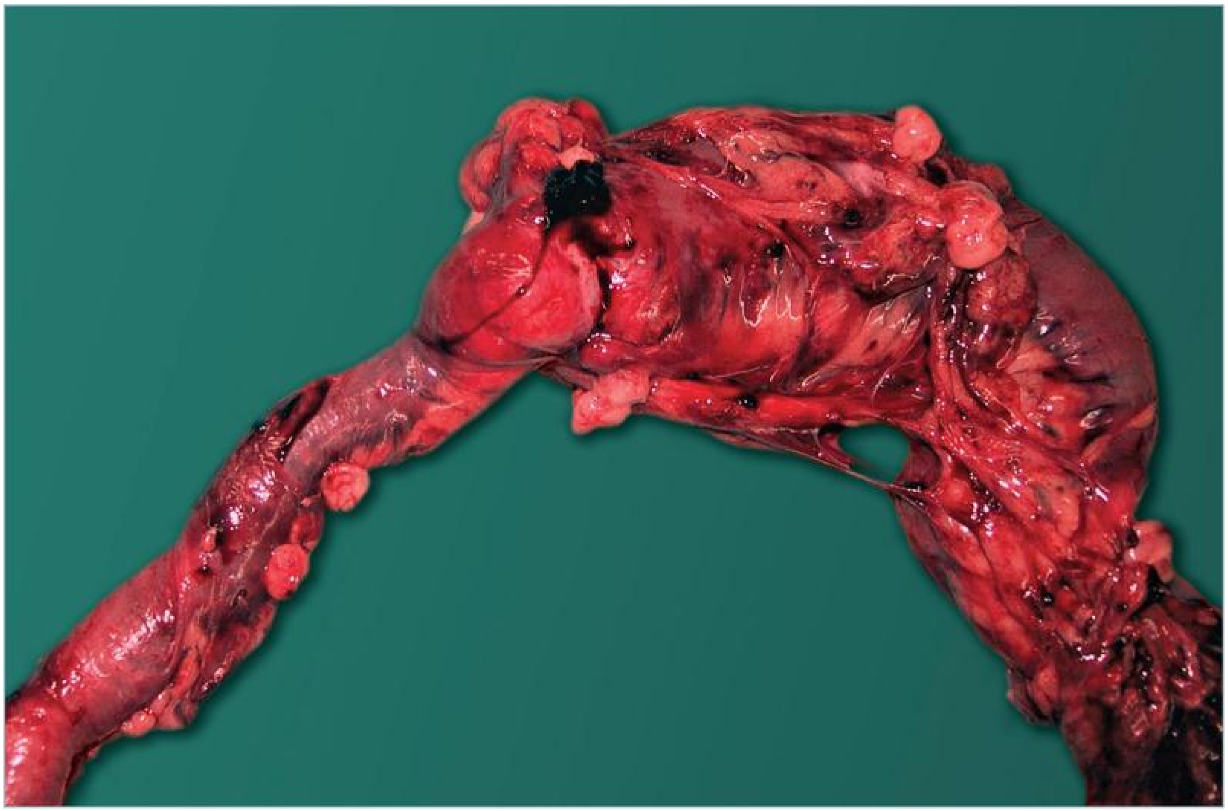


Fig. 13. In these patients, there is no choice but to perform an enterectomy to remove the affected bowel segments. Image kindly provided by Dr. Cairó, Canis Veterinary Hospital, Girona.

https://player.vimeo.com/video/180708261

Watch this video

Intestinal intussusception

Complications

If diagnosis was reached at an early stage and surgery is carried out promptly, postoperative recovery of these patients is usually fast and without complications arising from the reduction of the intussusception.

If it has been necessary to perform an enterectomy, the following complications may appear:

- Peritonitis

- Stenosis of the anastomosis
- Short bowel syndrome if a long bowel segment has been resected.

Colectomy / Case

José Rodríguez

Prevalence	■				
Technical difficulty	■	■	■	■	

This 11-year-old dog was referred to the hospital to investigate the hematochezia and dyschezia that he had been suffering for the last 2 months and that had worsened during the last week.

On rectal palpation, a rounded mass was detected in the ventral part of the cranial rectum. On radiography of the abdomen and the thorax, and ultrasonography of the abdomen, no metastases were detected.
The neoplastic process was localized between the final part of the colon and the start of the rectum, so it was decided to perform a resection by a caudal abdominal approach (Fig. 1).

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Megacolon (colectomy)

Fig. 1. Preparation of the operative field for a low infraumbilical laparotomy, and placement of the patient on the operating table.

After laparotomy and caudal displacement of the bladder, the descending colon is identified. When this is pulled in a cranial direction, the area affected by the neoplasia becomes visible (Fig. 2).

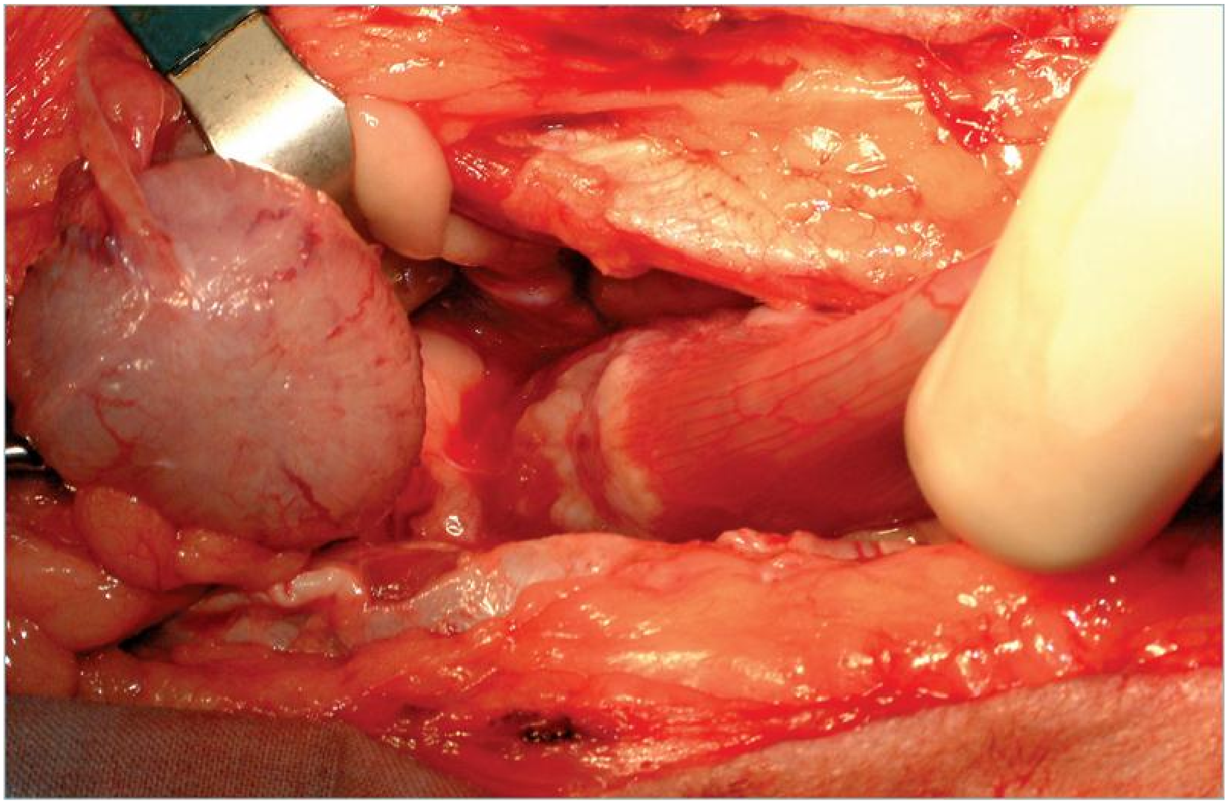

Fig. 2. Localization of the tumor in the caudal part of the descending colon, which was easily identifiable after retracting the bladder.

To avoid leakage of fecal contents into the abdominal cavity, atraumatic bowel clamps are placed on the caudal rectum and the distal colon, as well as two artery forceps on the bowel segment to be removed (Fig. 7).

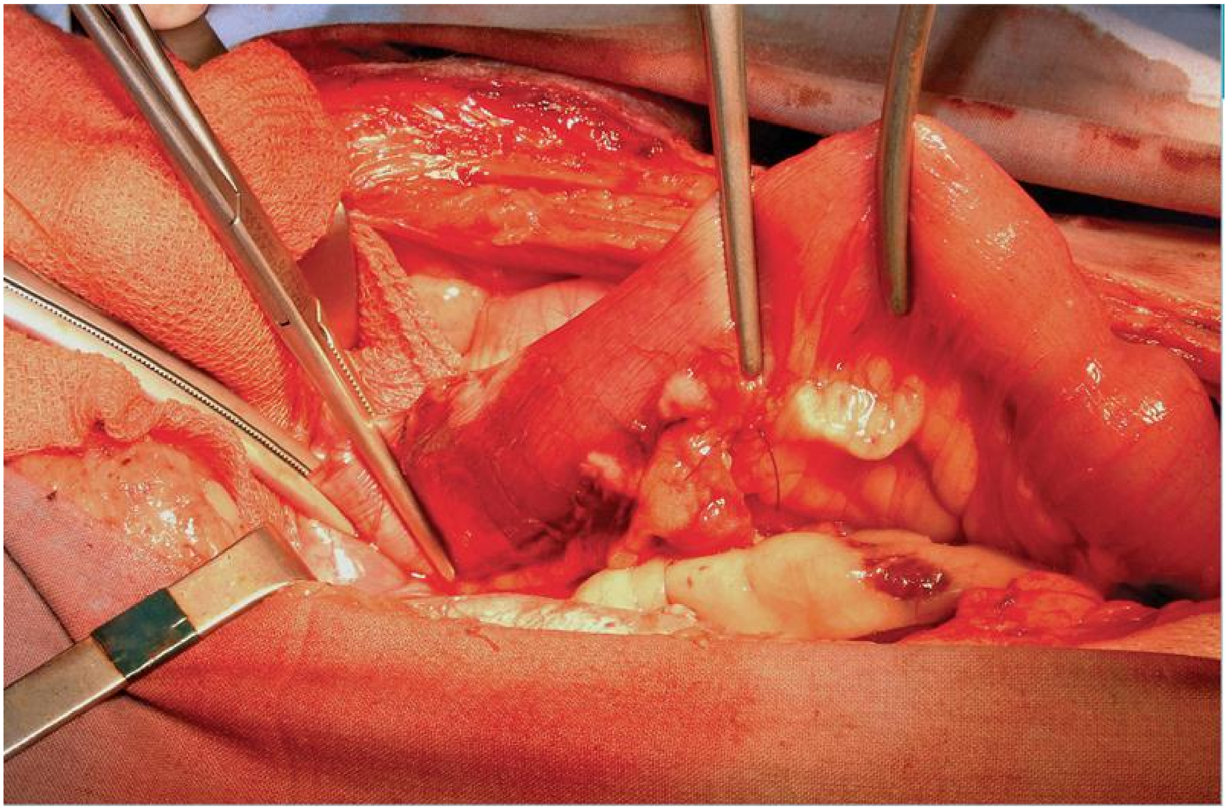

Fig. 7. Clamping of the bowel prevents leakage of the bowel contents that may cause abdominal contamination.

Bowel resection starts in the distal area and the first suture is placed in the mesenteric border. Next, the proximal segment is cut and its mesenteric border is fixed with the suture that has already been placed (Figs. 8 and 9).

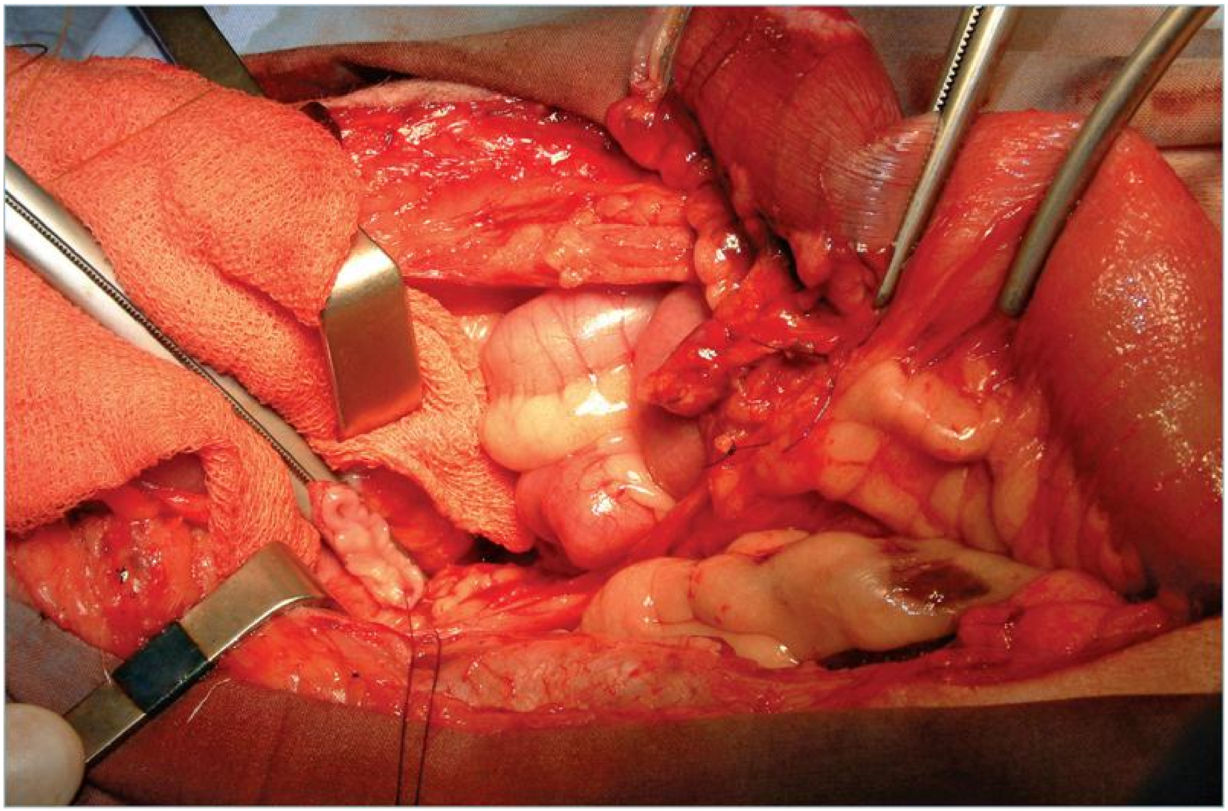

Fig. 8. Section of the rectum and placement of the first suture on the mesenteric border.

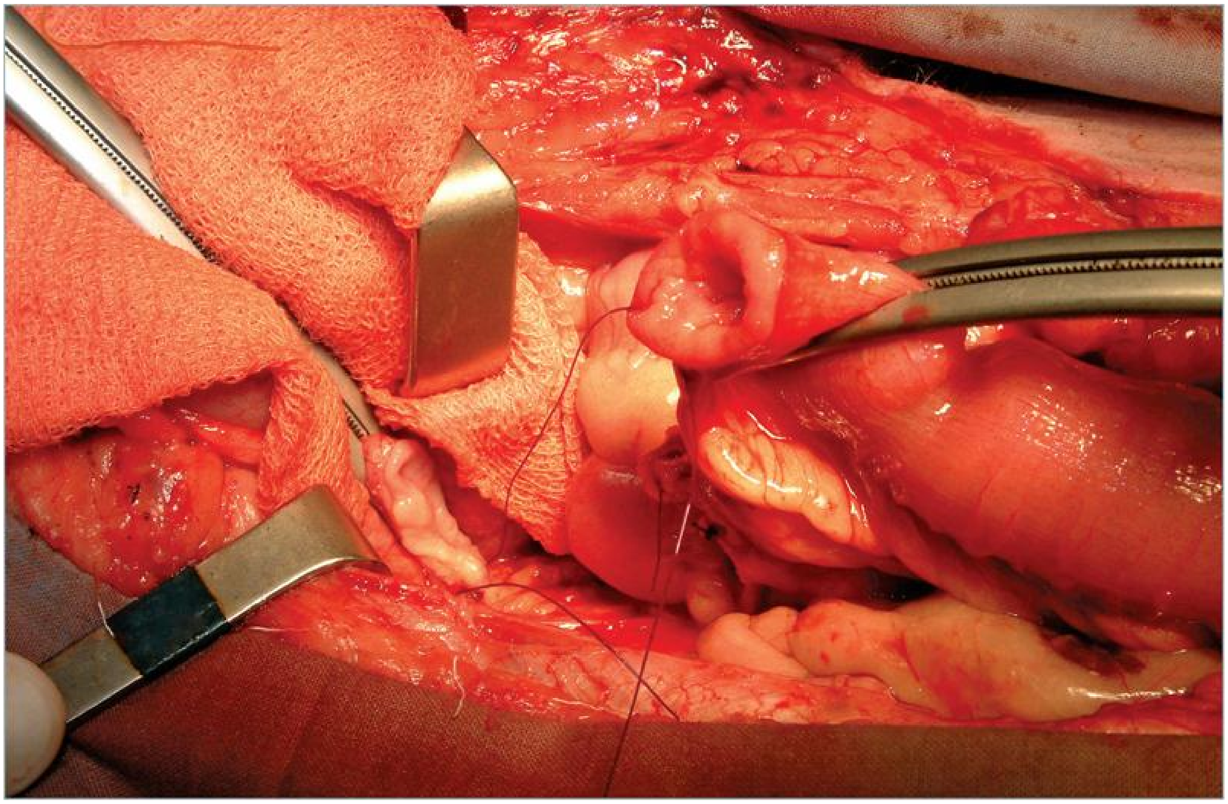

Fig. 9. Resection of the affected bowel segment and placement of the first suture of the anastomosis. Extreme care is taken not to include mesenteric fat in the anastomosis.

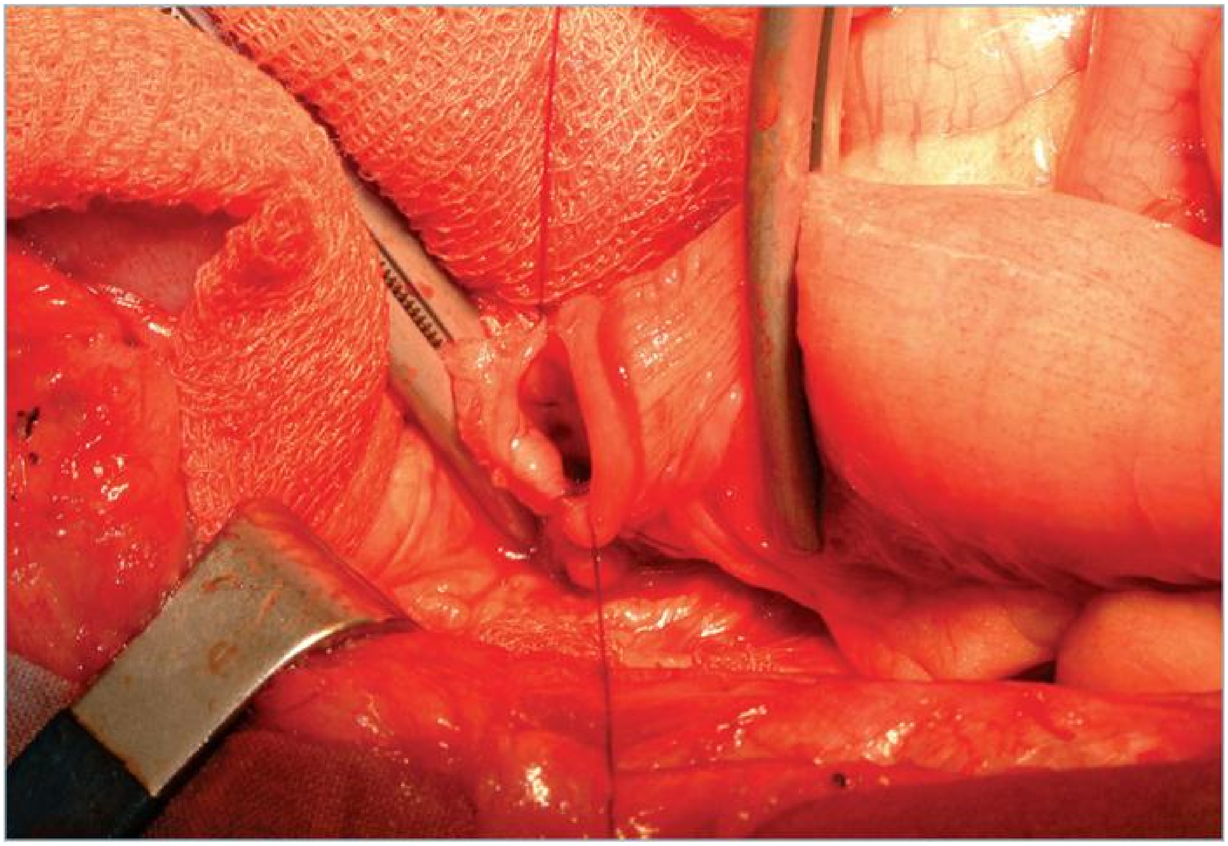

Fig. 10. Completed suture of the posterior side of the anastomosis with a continuous suture using monofilament absorbable material.

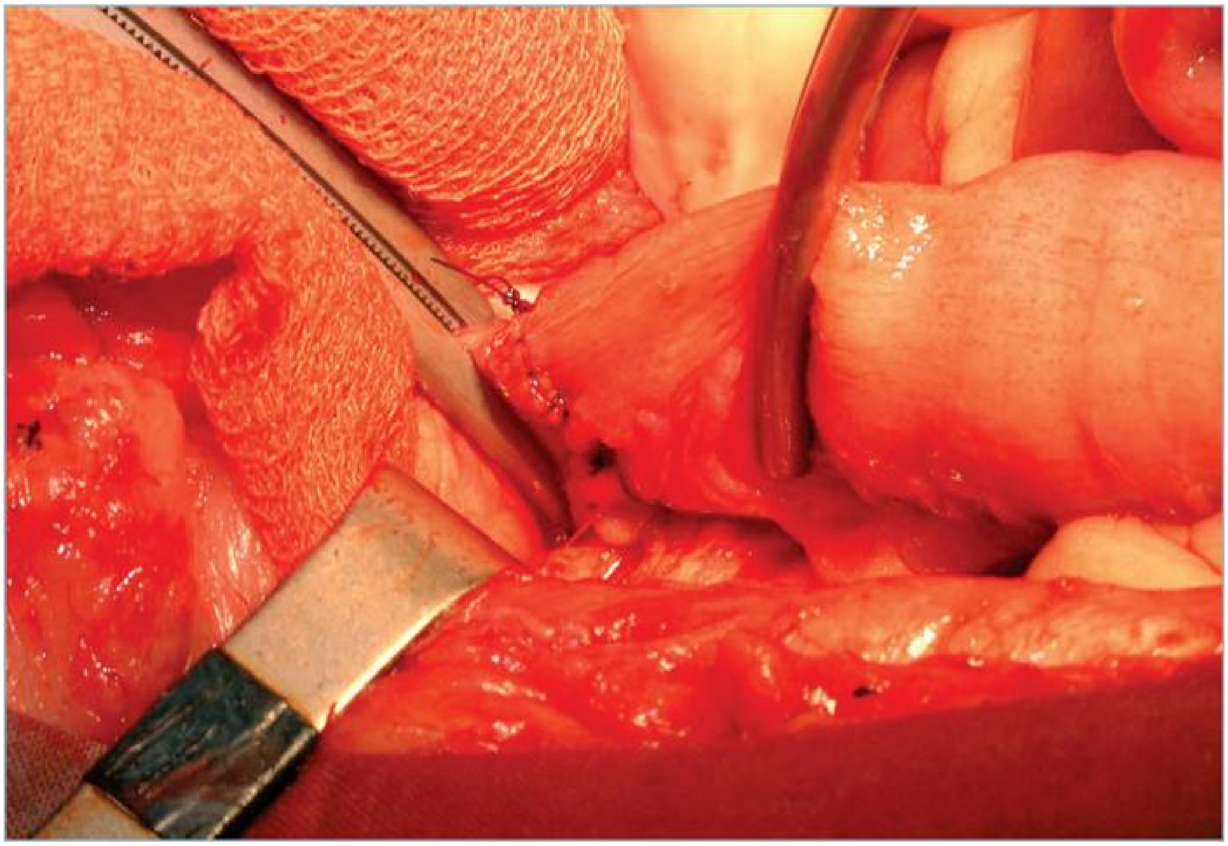

Fig. 11. Final appearance of the end-to-end anastomosis, performed with two simple continuous sutures.

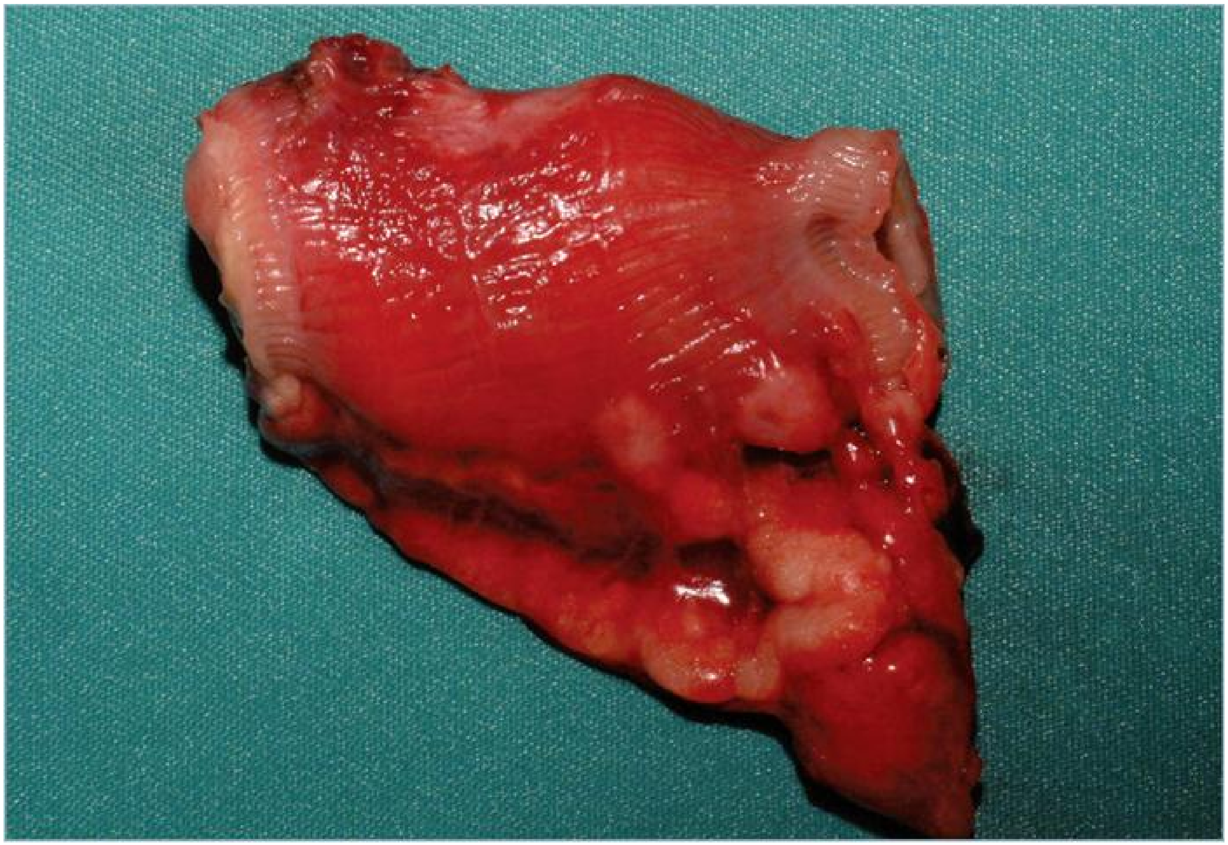

Fig. 12. Resected bowel segment. In this case, the caudal security margin was smaller than the other side because resection of the distal area is technically difficult.

The suture on the posterior surface of the anastomosis is a continuous suture using 4/0 monofilament synthetic absorbable material; it finishes on the anti-mesenteric border (Fig. 10).

*

When using a continuous suture, the thread should not be under too much tension. The higher the tension, the more stenosis it will produce in the anastomosis.

Following this, the anterior part is sutured with the same suture pattern, starting with a simple suture in the mesenteric area and finishing on the anti-mesenteric side, as with the previous suture (Fig. 11).

*

As with all intestinal anastomoses, it should be checked for leaks by injecting saline in the intestinal lumen and observing the sutures.

In all tumor resections, wide margins of healthy tissue should be included to reduce the risk of recurrence due to local metastasis (Fig. 12).

Follow-up

The patient recovered well from the surgical intervention and bowel transit returned to normal.

Although all looked well, after five weeks the patient returned to his veterinarian with dyschezia and hematochezia. The owner declined further diagnostic tests, so symptomatic treatment was prescribed and two weeks later the patient was euthanised.

Histopathology confirmed an adenocarcinoma.

Thoracocentesis

José Rodríguez, Rocío Fernández, Amaya de Torre, Carolina Serrano

Prevalence	■	■	■	□	□
Technical difficulty	■	□	□	□	□

Thoracocentesis is the aspiration of air or fluids from the pleural space in order to improve lung expansion and restore normal thoracic function.

Thoracocentesis is the easiest and quickest way to remove fluid or air from the pleural space.

Thoracocentesis is performed using a 21-23G butterfly needle attached to a syringe via a three-way tap, or with an intravenous catheter attached to an extension tube and a syringe via a three-way tap (Figs. 1 and 2).
The choice of the needle insertion site is based on the clinical examination and a dorsoventral radiograph (Fig. 3).

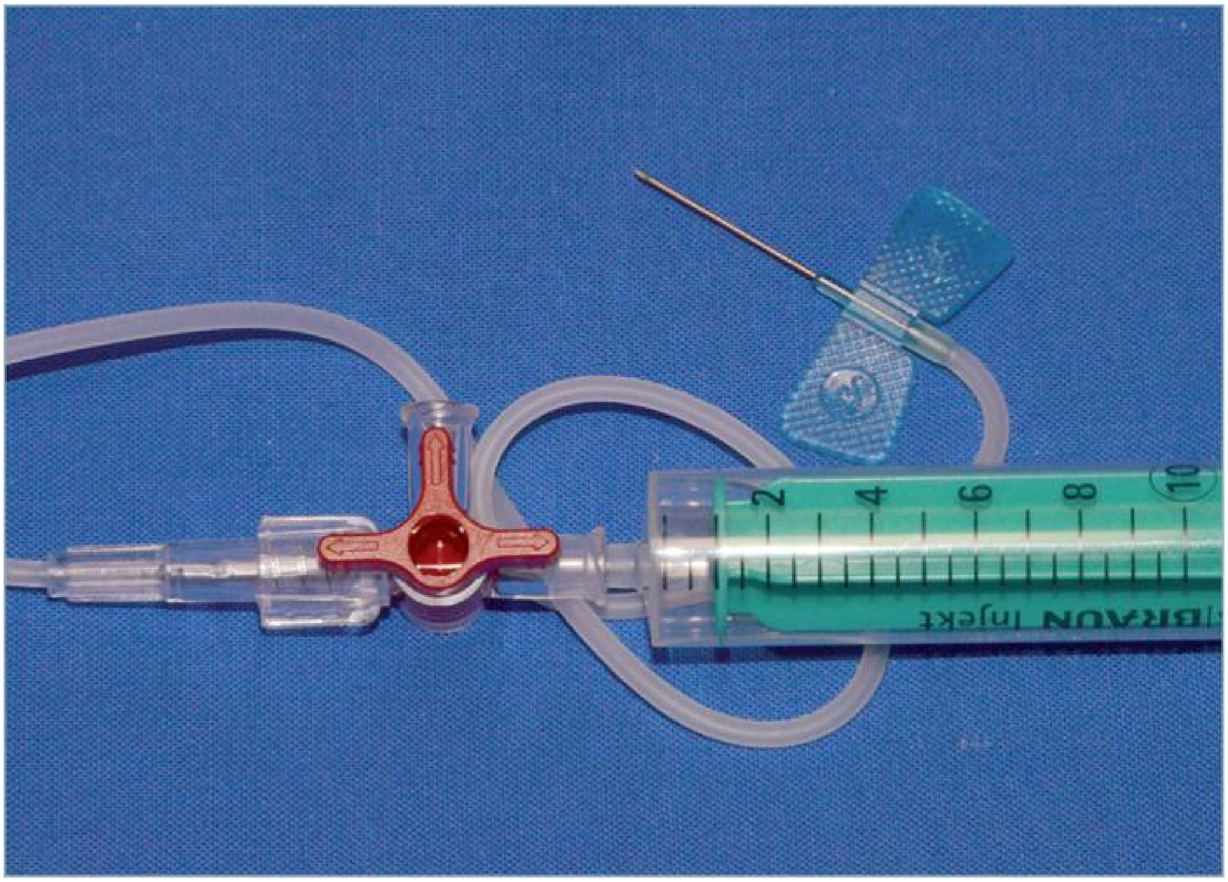

Fig. 1. Material required for thoracocentesis: (butterfly) needle or intravenous catheter, three-way tap and syringe. Note that the syringe is attached to the correct port of the tap.

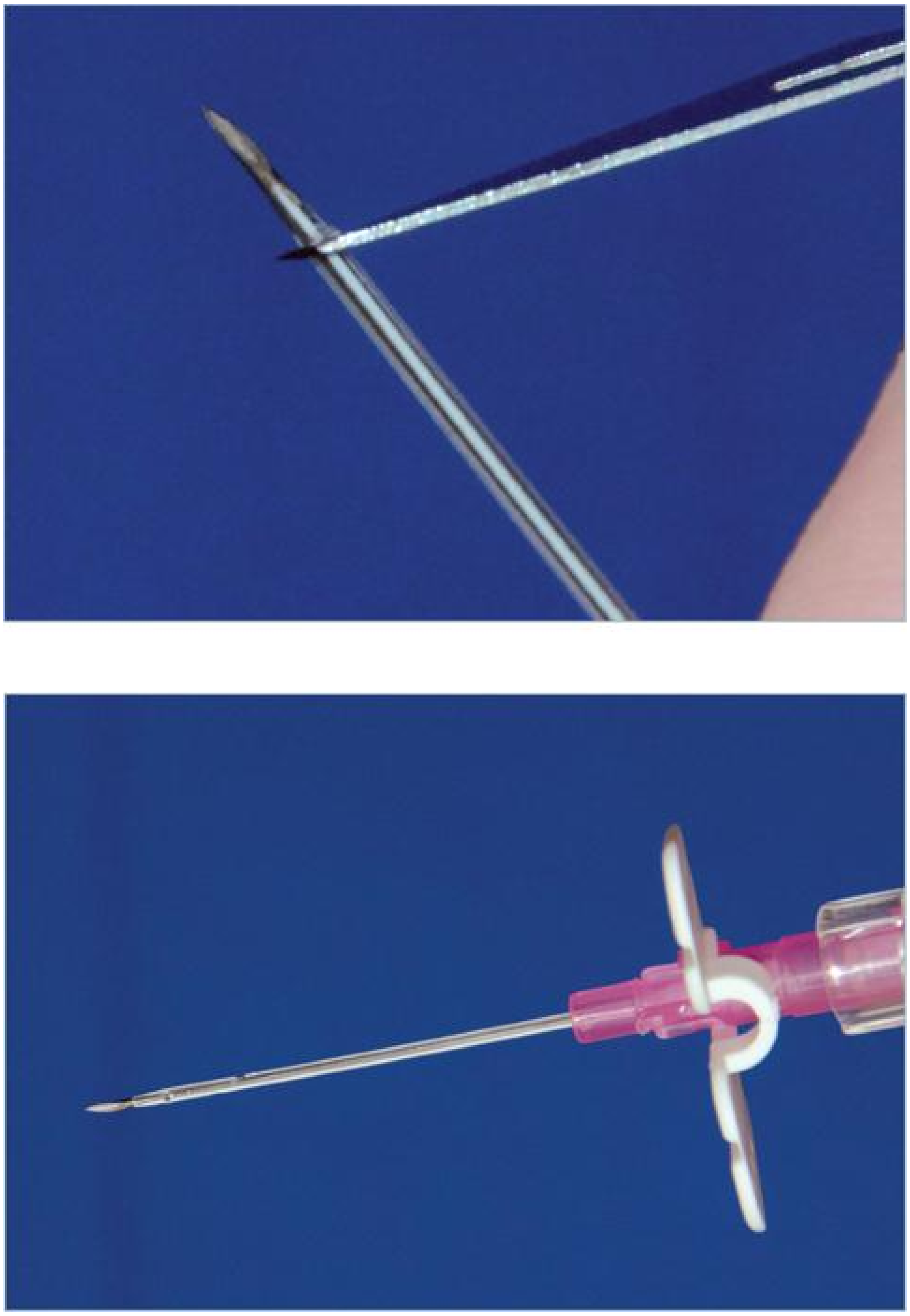

Fig. 2. An intravenous catheter is less traumatic than a needle but can kink in patients with very thick skin, and may bend during thoracic aspiration. In this case, a small skin incision should be made using a no. 11 scalpel.

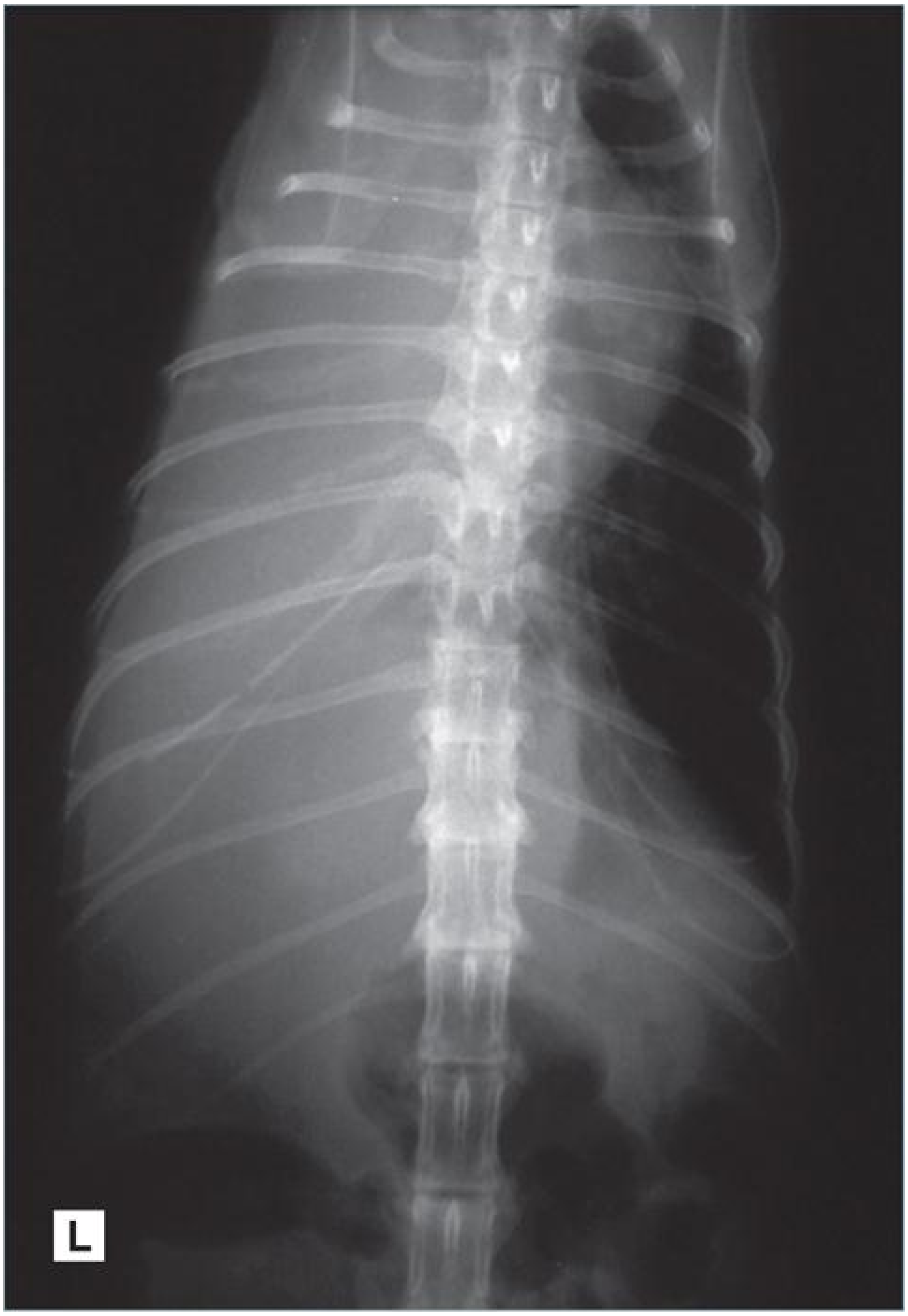

Fig. 3. A dorsoventral radiograph of this patient’s thorax shows an increased density in the left hemithorax, compatible with fluid accumulation. Thoracocentesis should be performed on the left side.

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✱

Ventrodorsal positioning for thoracic radiographs in these patients may dramatically reduce their lung capacity.

Generally, the choice of side for thoracocentesis is not very important as the mediastinum in dogs and cats is thin and permeable. But chronic intrathoracic processes may result in unilateral effusion due to thickening of the mediastinum.

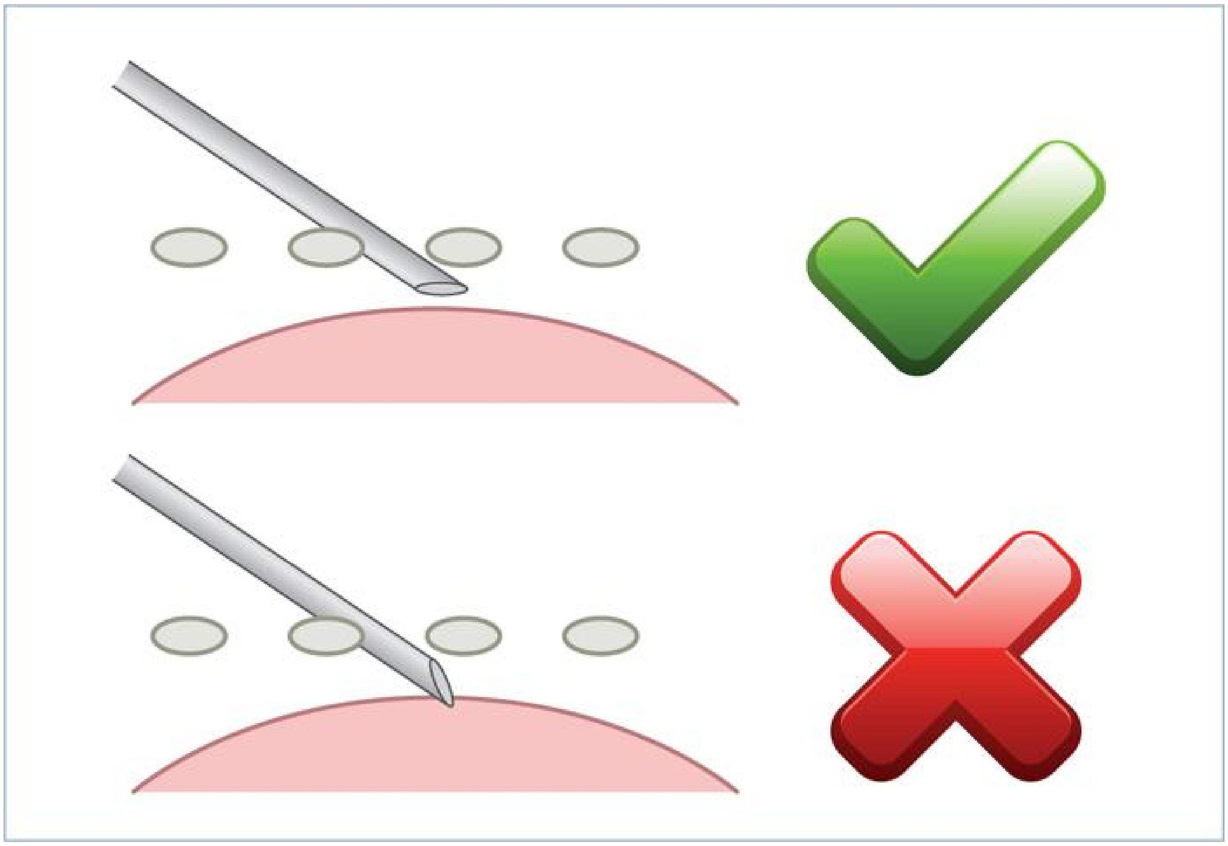


Fig. 4. The bevel of the needle should be oriented towards the inside of the thoracic cavity so that the tip does not enter the lung parenchyma.

Fig. 5. This patient is undergoing aspiration of a pneumothorax via a butterfly needle introduced through the left seventh intercostal space.

The patient should be placed in a position that is as comfortable as possible and allows the best respiration. In most cases, this means sternal recumbency.

Thoracocentesis is performed between the sixth and ninth intercostal space, at the costochondral junction. The site is clipped and disinfected. The needle is inserted along the cranial edge of the rib, at a slight angle (approximately 45°) and with the bevel oriented towards the lung, as shown in figure 4, until no further resistance is felt.

It is attached to the three-way tap, the connection tube and the syringe (Figs. 5 and 6) and aspiration is started.

The aspiration of fluids should be done carefully and samples should be taken in a tube with anticoagulants for a blood cell count and in a plain tube for biochemistry (Fig. 6).

The three-way tap should be handled with care to prevent the entry of air into the pleural space.

The pleural contents are removed until there is a negative pressure or until fluids are no longer aspirated.

After thoracocentesis, radiographs are taken to check that the aspiration has been successful and to identify the underlying cause that might have been hidden by the pleural fluid and the pulmonary collapse.

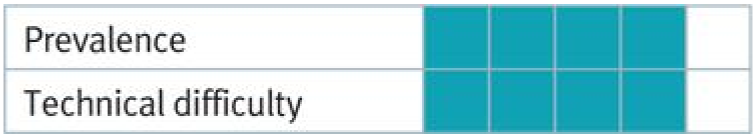
Possible complications of this technique include pulmonary haemorrhage and lung injury, but the risks are small if the procedure is performed with care and precision.

If after successful aspiration of the pleural space, dyspnoea persists, the presence of associated lung disease should be considered, such as pulmonary oedema, pneumonia, neoplasia or bruising.

Fig. 6. Thoracocentesis in a patient with post-traumatic haemothorax.

Thoracotomy

José Rodríguez, Amaya de Torre, Carolina Serrano, Rocío Férnandez



Thoracotomy refers to the surgical intervention performed on the chest wall to gain access to the contents of the thorax. It may be performed between the ribs (lateral or intercostal thoracotomy) or through the sternum (midline thoracotomy or sternotomy).

The thoracotomy may be planned or may be an emergency intervention. In the latter case, the patient should first be stabilized, using oxygen therapy and/or placing a chest drain (Fig. 1) among other procedures.

> ***The materials used for thoracocentesis or for placing a chest drain should always be at hand. Any small animal vet should be able to perform these techniques.***

General considerations

The clinical workup of the patient should pay particular attention to cardiopulmonary function, the color of the mucosae, capillary refill time, cardiac and pulmonary auscultation and the pulse rate and type.

> ***Lesions in the thoracic cavity may hamper respiration and lead to hypoxemia. These patients should be oxygenized with a mask or nasal tube prior to anesthesia.***

The thoracic cavity of patients with severe pleural effusion should be drained before taking radiographs or performing surgery.

An appropriate anesthetic protocol should be selected in order to minimize respiratory depression and severe hypotension. Anesthetic induction and intubation should be fast to gain immediate control of the patient's ventilation and anesthetic management. Opioids may produce cardiorespiratory depression, but their analgesic properties outweigh any negative effects.

When the thoracic cavity is opened, the patient should be ventilated with intermittent positive pressure ventilation not exceeding 20 cm H_2O. Correct ventilation prevents hypoxemia, respiratory acidosis and alveolar atelectasis.

For antibiotic prophylaxis, cefazolin is recommended (20 mg/kg/IV).
For access to the thoracic cavity, a lateral or midline thoracotomy may be used, depending on the target organ and its disorder. It is crucial to select the correct side and intercostal space to obtain sufficient exposure of the surgical target (table I).

Fig. 1. Patient with severe chest trauma hospitalized in the Intensive Care Unit. It has been sedated, is receiving oxygen therapy through a nasal tube and its thorax is being drained.

The approaches to the thoracic cavity can be lateral or midline (Figs. 2 and 3).

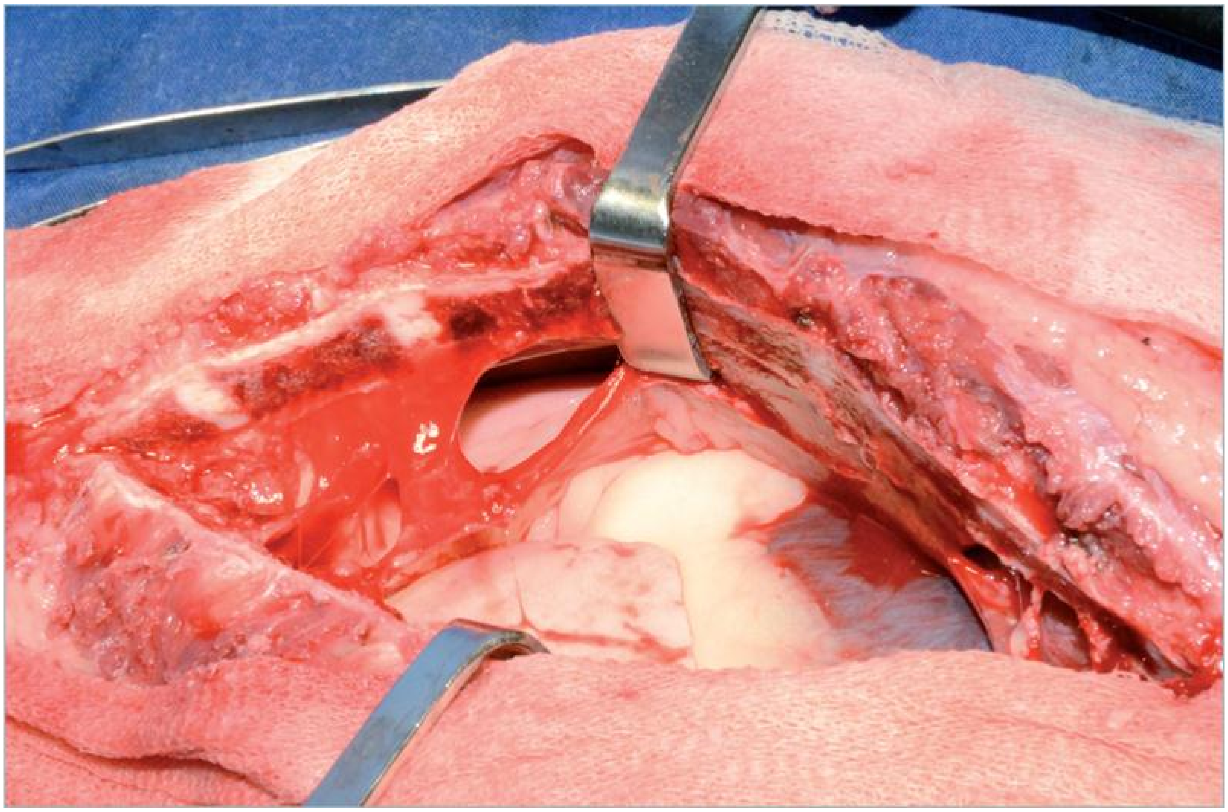


Fig. 2. Final stage of the sternal incision during midline thoracotomy. Cutting through the sternum with an oscillating saw has been facilitated by the Farabeuf retractors.

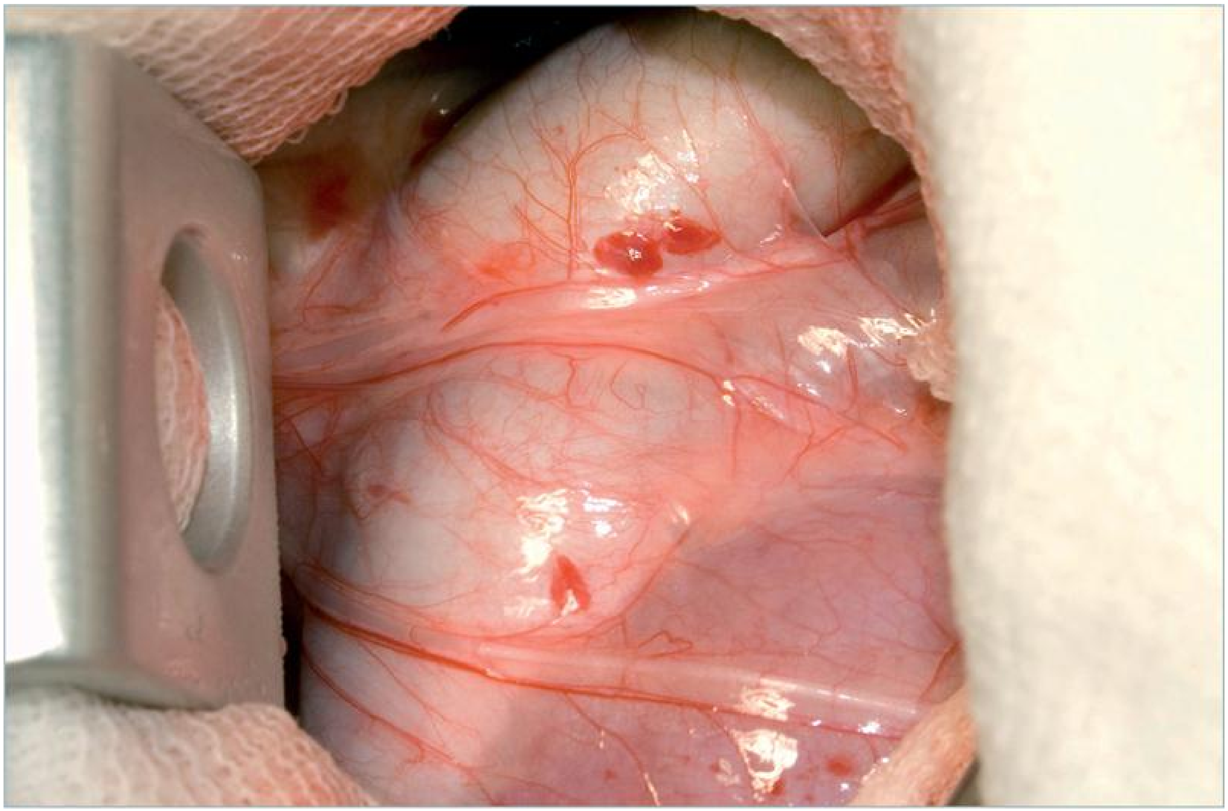


Fig. 3. Lateral thoracotomy through the fourth intercostal space to access the base of the heart. This patient had a patent ductus arteriosus, which required dissection and ligation.

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Intercostal thoracotomy

Table I.

Recommendations for the site of the surgical approach, depending on the organ or on the intervention		
Thoracotomy	Intercostal space	Target
Right or left lateral	4th, 5th	Heart
	4th-6th	Pulmonary lobectomy
Right lateral	4th	Cranial vena cava
	6th, 7th	Caudal vena cava
	4th, 5th	Esophagus near the base of the heart
Left lateral	4th	Patent ductus arteriosus Persistent right aortic arch
	3rd, 4th	Cranial esophagus
	9th	Caudal esophagus
Midline		Exploratory thoracotomy

After surgery

The patient should be hospitalized in the Intensive Care Unit where fluids and air should be evacuated every 4-6 hours.

Postoperative pain is controlled by:

- Methadone 0.2-0.4 mg/kg/4h IV, IM.
- Butorphanol 0.2-0.4 mg/kg/2-4h IV, IM.
- Buprenorphine 0.005-0.02 mg/kg/6h IV, IM.
- Fentanyl skin patches: 50-75 µg in dogs, 25 µg in cats.

Pleural infiltration with bupivacaine (2 mg/kg) should also be used.
The patient should remain well oxygenated. It is therefore necessary to check the respiration rate and depth.

Opioid analgesics may depress respiration, however the benefits outweigh the risks.

To reduce postoperative pain and improve spontaneous ventilation, bupivacaine may be instilled between the pleurae when closing the thorax, or the intercostal nerves of the two intercostal spaces on both sides of the thoracotomy block may be blocked (Fig. 4).

Local analgesia with bupivacaine (total dose 2 mg/kg) improves the patient's breathing.

Fig. 4. (A) Bupivacaine infiltration in the intercostal spaces on both sides of the access to the thorax. (B) In the postoperative period of a midline thoracotomy, bupivacaine is instilled through the drain and the patient is positioned as in the photograph to distribute it through the cranial pleural cavity.

To improve patient oxygenation, it is recommended to administer oxygen through a nasal tube (Fig. 5).

Fig. 5. Postoperative recovery after a thoracotomy. Immediately after surgery, a nasal tube for oxygen administration was placed, because the patient was hypoventilating.

The chest drain is removed when no more air is extracted or when the volume of aspirated liquid does not exceed 1-2 ml/kg/24 h (Fig. 6).

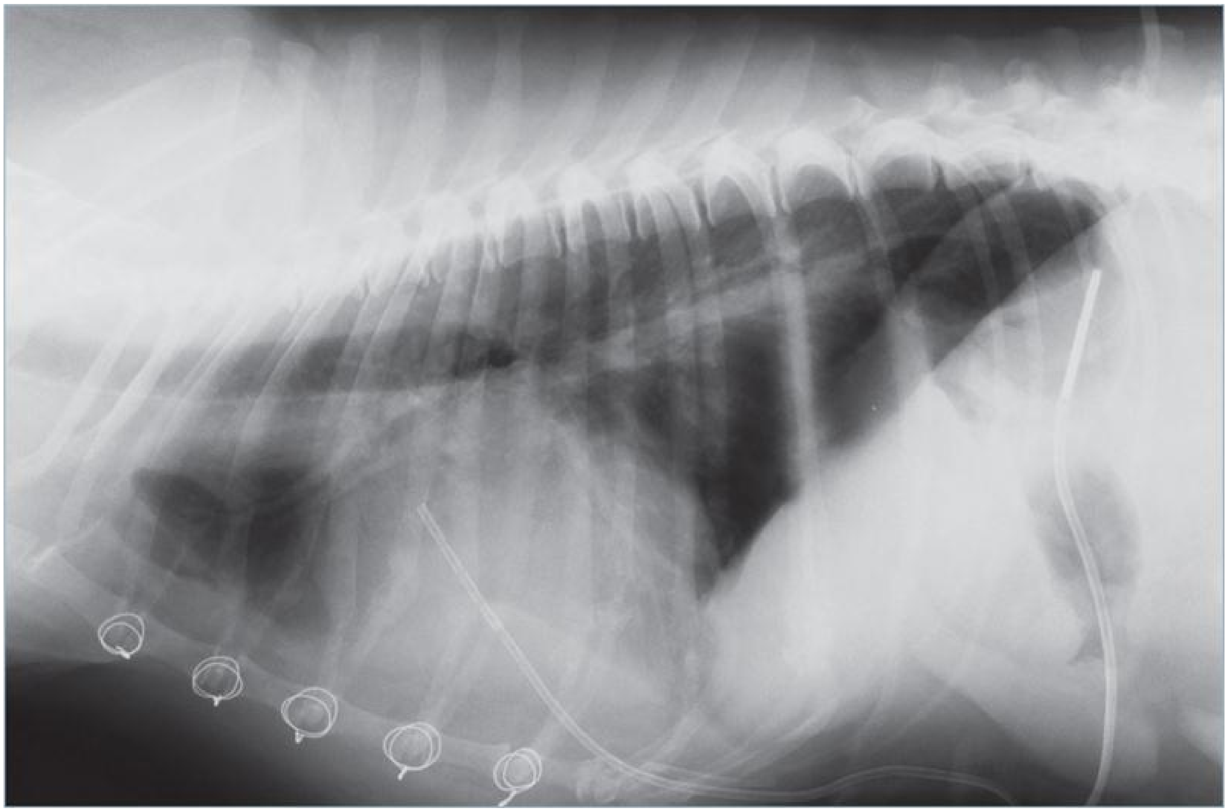

Fig. 6. Radiographic check-up of a patient that underwent a midline thoracotomy 48 hours earlier. As there is no pneumothorax, and no more than 2 ml of pleural fluid can be aspirated, the chest drain is removed.

Possible complications

The following complications may occur after thoracic surgery.
The surgeon should be aware and avoid them:

Pneumothorax

Residual air between the pleurae after a thoracotomy is normal and rarely the source of problems; because the pleura absorbs the air within 24-48 hours under normal conditions.
However, there may be a serious problem if a pneumothorax persists any longer after lung or airway surgery. In these patients, the drain should be connected to a continuous aspiration system while waiting for the pleural inflammatory reaction to seal the air leak. Pleurodesis of the affected area

may also be tried; this is done by perfusion of autologous blood (6 ml/kg) in the pleural space[1]. If these methods do not resolve the problem, the patient should be reopened to suture the defect.

Hemothorax

It is common to aspirate blood-stained contents after cardiovascular or oncologic surgery, especially if the liquid used to flush the thorax has not been completely removed, which is usually the case.

If the hematocrit of the aspirated liquid is similar to that of blood and if there is a significant amount of this bloody fluid, the rate of fluid administration should be increased and a blood transfusion may be necessary.

If the recorded blood loss exceeds 2 ml/kg/hour during the first 3 to 4 hours after surgery, the patient should be reopened to control the hemorrhage.

> ***Hemothorax may be a serious postoperative complication. For this reason, hemostasis during surgery should be good and all precautions should be taken not to injure the blood vessels of the chest wall. Blood loss from these vessels may cause confusion as to the origin of the hemothorax.***

Chylothorax

Chylothorax is secondary to rupture of the thoracic duct due to poor surgical technique or following interventions close to the aorta, although most commonly cause is idiopathic. Possible treatments are:

- Gentle continuous drainage and a low-fat diet.
- Rutin 15 mg/kg/8h PO (eliminates the proteins from pleural fluid, facilitating their absorption).
- Pleurodesis with diluted tetracycline hydrochloride (the results are not good and this should be performed under general anesthesia).
- Surgical treatment: thoracic duct ligation, pleuroperitoneal drains…

Cardiac arrhythmias

> ***In thoracic surgery, especially when the heart is manipulated, arrhythmias may occur.***

The principle causes are usually electrolyte imbalances (hypokalaemia and hypomagnesaemia), direct surgical manipulation and displacement of the heart when operating close to it during cardiovascular surgery and alterations due to ischemia. Other causes are an insufficient anesthetic plane, pain, hypovolemia, hypothermia and drugs, in particular the anesthetics.

The most common alterations on the electrocardiogram are premature ventricular contractions and ventricular tachycardia with or without hemodynamic compromise (Fig. 7).

The standard treatment is a lidocaine bolus (2-4 mg/kg) followed by continuous infusion (50-100 µg/Kg/min). If the arrhythmias persist, amiodarone (2-5 mg/kg IV) may be used; and if the patient still does not respond, procainamide (3-6 mg/kg IV). In some cases, beta-blockers may be indicated (propanolol, esmolol).

If the problem is severe bradycardia (Fig. 8), (usually caused by the anesthetics or excessive vagal stimulation, although hypoxia, hypothermia and hyperkalemia may also be the cause), the treatment is atropine (0.02-0.04 mg/kg IV).

Faced with ventricular, a defibrillator should be used. If the thorax is open, it is applied directly to the heart, where it is more effective at a lower voltage.

For supraventricular tachycardia, diltiazem may be used (0.25 mg/kg IV).

Sometimes it is necessary to correct metabolic acidosis with bicarbonate, or a persistent hyperkalemia with calcium gluconate or insulin.

To detect these arrhythmias and complications, the patient should be monitored during the first 24-48 hours after surgery.

Edema due to pulmonary re-expansion

Edema due to pulmonary re-expansion may appear in patients with a chronically collapsed lung after resolution of the collapse. The origin is not clear, but a few hours after surgery, the patient presents with dyspnea and tachypnea, which worsens rapidly and, unfortunately, is fatal in most cases.
Prevention and treatment of this condition is very difficult. In these patients, it is recommended to close the thorax on the collapsed lungs, and aspirate the air from the thorax little by little, so that re-expansion is slow and gradual.

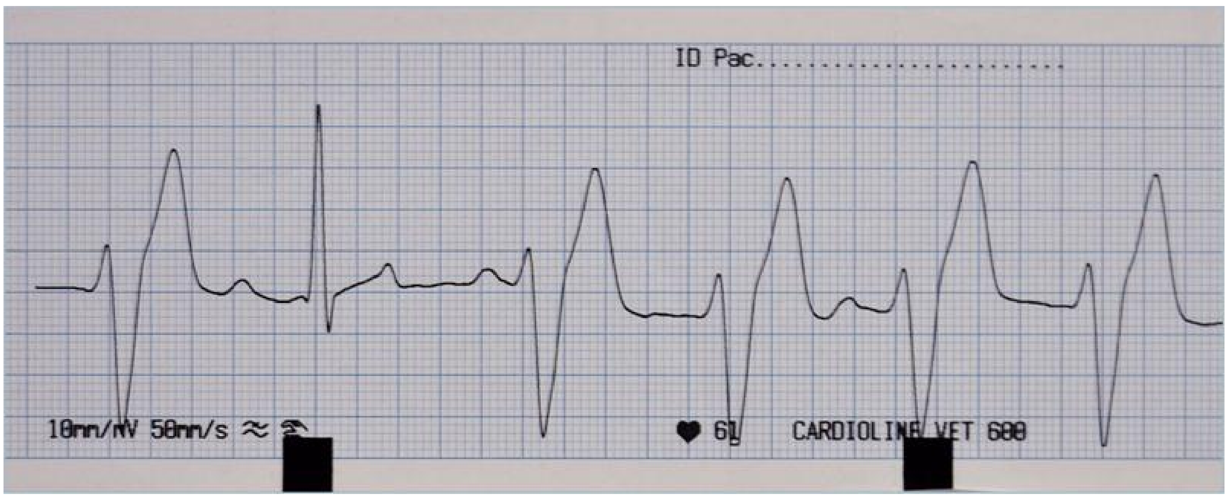

Fig. 7. Ventricular extrasystoles due to cardiac manipulation.

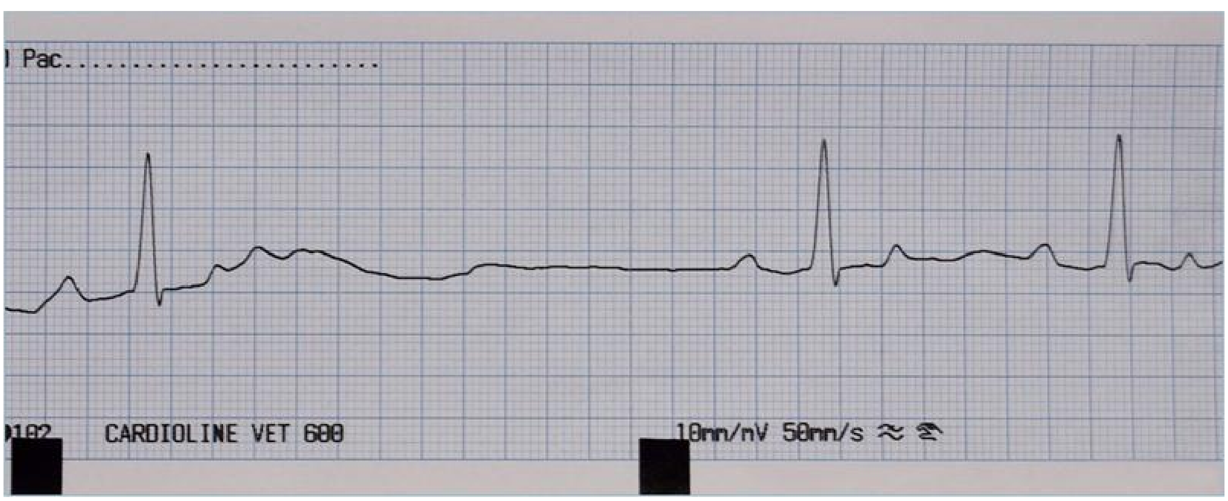

Fig. 8. Bradycardia caused by vagal stimulation.

[1] Merbl, Y, Kelmer, E, Shipov, A, Golani, Y, Segev, G, Yudelevitch, S, Klainbart, S. Resolution of persistent pneumothorax by use of blood pleurodesis in a dog after surgical correction of a

diaphragmatic hernia. *J. Am. Vet. Med. Assoc.* 1 August 2010; vol. 237(3):299-303.

Peritoneal-pericardial diaphragmatic hernia

José Rodríguez, Rodolfo Brühl-Day, Roberto Bussadori, María Elena Martínez, Pablo Meyer, Silvia Repetto

Prevalence

Peritoneal-pericardial diaphragmatic hernia (PPDH) is the most common congenital pericardial abnormality in companion animals.

It is the result of an abnormal development of the septum transversum, creating a defect in the ventral midline of the diaphragm, so that the abdominal organs may become displaced towards the pericardial cavity. Depending on the size of the defect, the displaced abdominal organs may move around freely or become entrapped in the pericardial cavity (Fig. 1).

This closure defect of the diaphragm may be associated with ventral hernia in pups, located cranial to the umbilicus and should not be mistaken for an umbilical hernia (Figs. 2 and 3).

There may be additional abnormalities such as non-union of the sternebrae, pectus excavatum or cardiovascular malformations.

What the pet owner believes to be a large umbilical hernia may be a much larger defect: a peritoneal-pericardial hernia.

It is not known if there is a hereditary component in peritoneal-pericardial herniation.

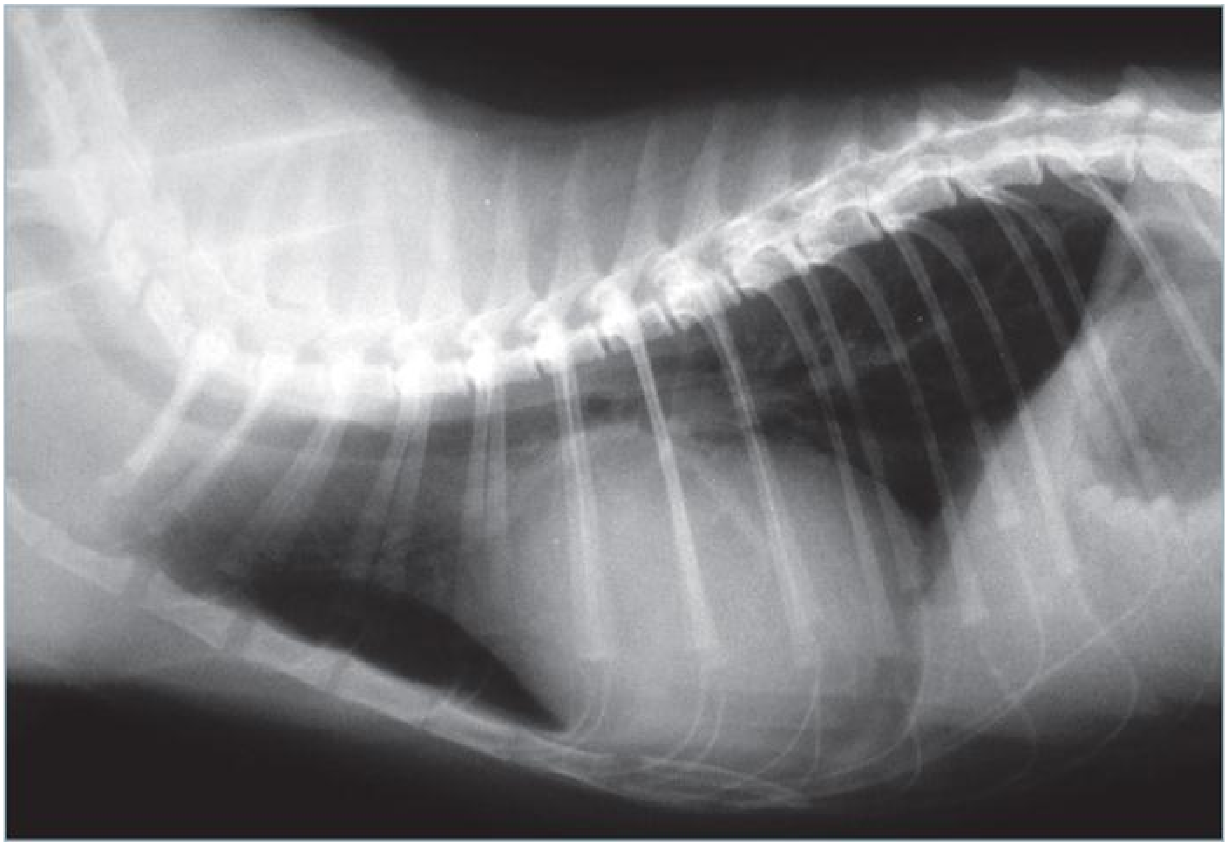

Fig. 1. Lateral radiograph of a patient presenting with anorexia, exercise intolerance and sporadic cough; an increase in the size of the cardiac silhouette can be observed.

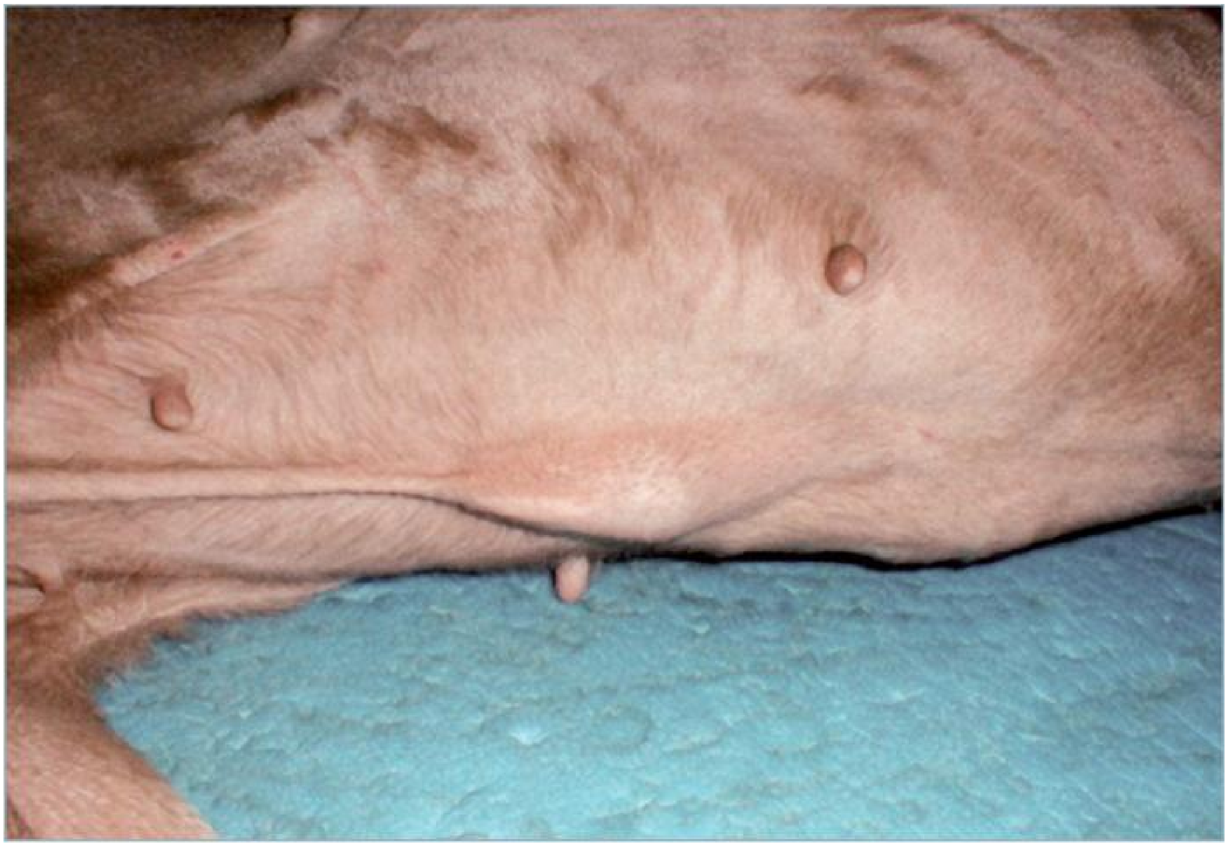

Fig. 2. Cranial ventral hernia: the location of deformation is cranial to the umbilical scar.

Fig. 3. Placing the patient in dorsal recumbency makes diagnostic palpation for ventral hernias easier during the clinical examination.

Peritoneal-pericardial hernias are present at birth and may remain asymptomatic for a long period of time.

The clinical signs presented by the patient depend on the organs in the hernia and on their functional alteration:

- Vomiting.
- Anorexia.
- Diarrhea.
- Exercise intolerance.
- Cough.
- Dyspnea.
- Retarded growth (Fig. 4).

Cardiac alterations such as congestion or tamponade are rare; they are due to the effusion that is a consequence of the vascular compromise of a herniated liver lobe.

Some animals may remain asymptomatic for their entire life.

Diagnosis

On a thoracic radiograph, the cardiac silhouette is very large, rounded or egg-shaped, and the silhouettes of the heart and the diaphragm are superimposed in the ventral area (Fig. 1).

The differential diagnosis of a possible cardiomegaly on a thoracic radiograph should include:

- Peritoneal-pericardial diaphragmatic hernia.
- Pericardial effusion.
- Dilated cardiomyopathy.
- Severe valve defects.
- Others.

Fig. 4. Seven-month-old patient diagnosed with PPDH. He presents with ill-thrift and never achieved the same weight as his litter mates.

To confirm the diagnosis, an intestinal transit radiograph may be performed to show the presence of digestive organs in the pericardial cavity (Figs. 5 and 6), or peritoneography where the passage of contrast medium from the abdominal cavity into the pericardial cavity may be observed. Ultrasonography may be very useful in these patients.

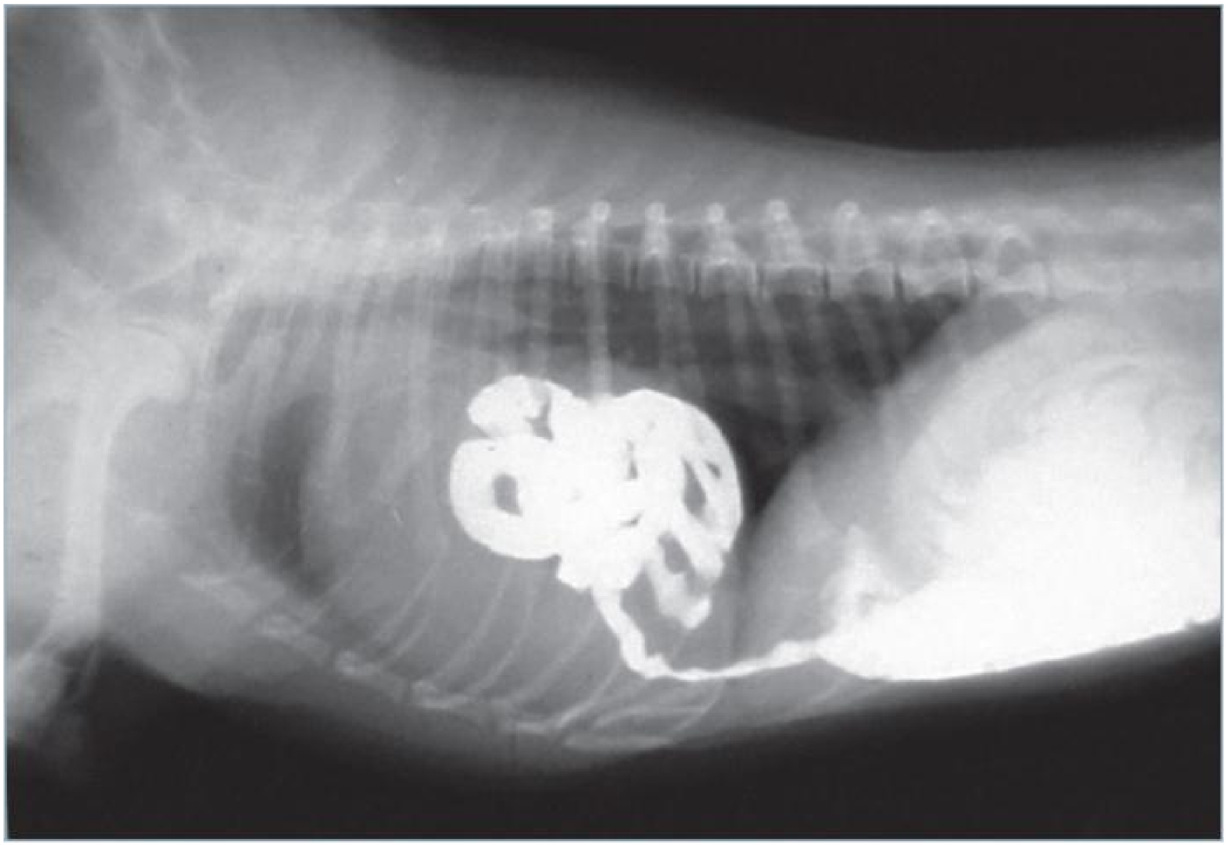

Fig. 5. Gastrointestinal transit radiograph revealing the presence of loops of the small intestine in the thoracic cavity superimposed on the heart.

Fig. 6. Dorsoventral view of gastrointestinal transit in the same patient, confirming the presence of intestinal loops within the pericardium.

Surgical treatment

Technical difficulty

The principles of surgical correction of PPDH are the same as those described for diaphragmatic rupture.

In PPDH there is no communication with the pleural cavity. This is important, because the clinical, anesthetic and surgical management may differ from the management of a diaphragmatic rupture.

In principle, assisted ventilation of the patient is not necessary, because the pleural space is not opened. However, its use is recommended to improve oxygenation and to re-expand the lungs gradually.

The approach is by supraumbilical midline laparotomy with a paraxiphoid extension.

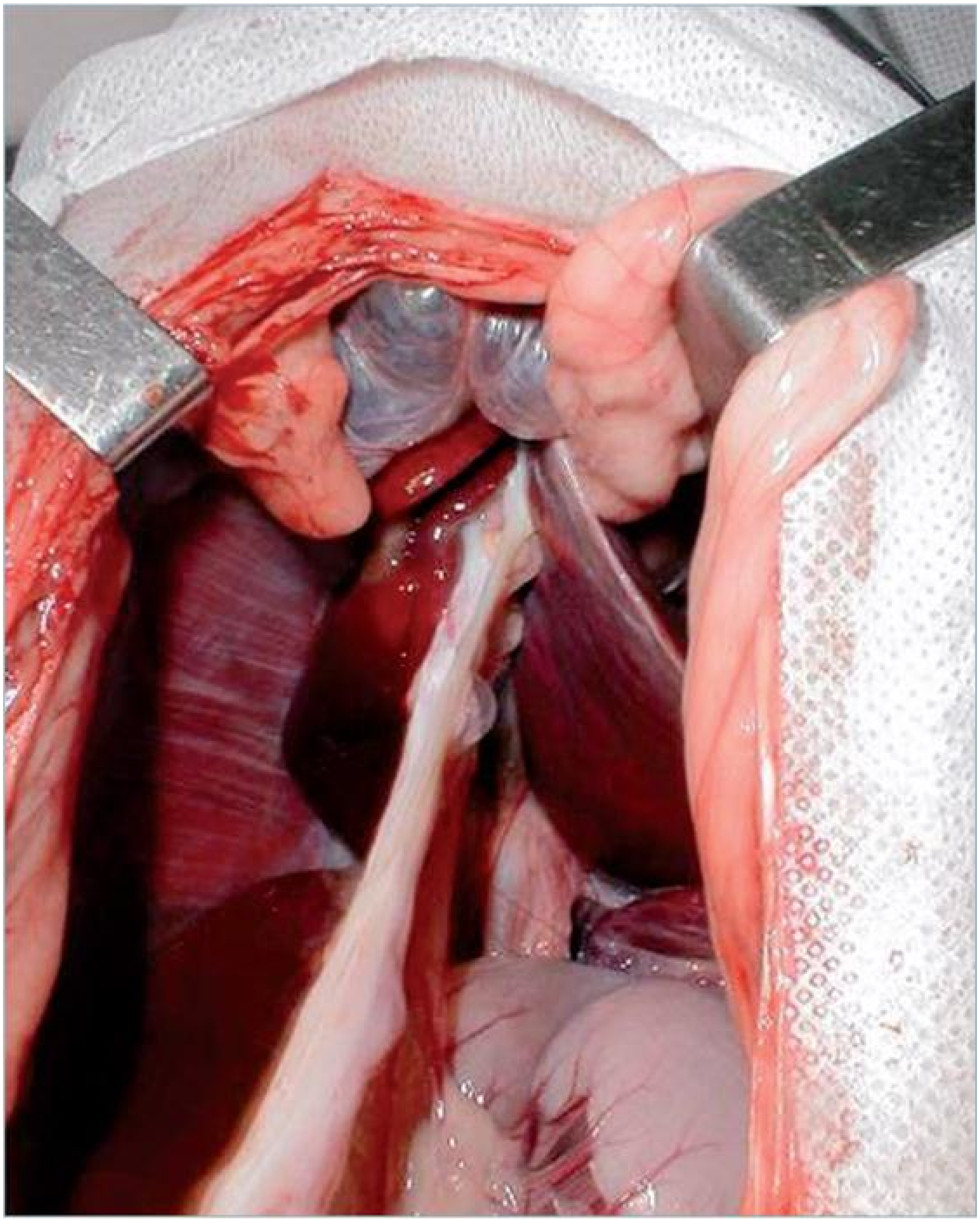

Fig. 7. After supraumbilical midline laparotomy, it can be seen that the liver lobes have been displaced cranially into the pericardial sac through a diaphragmatic defect.

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The defect is detected in the ventral midline of the diaphragm; abdominal viscera protrude through it into the thoracic cavity (Fig. 7).
Special care should be taken when repositioning the liver, which is usually friable and may bleed when handled. Adhesions between the herniated viscera and the pericardium are rare (Fig. 8).

Returning the liver to the abdominal cavity may lead to the release of large amounts of toxins into the circulation.

The most common complication in these cases is injury and hemorrhage of the herniated organs during repositioning. They should be handled with care.

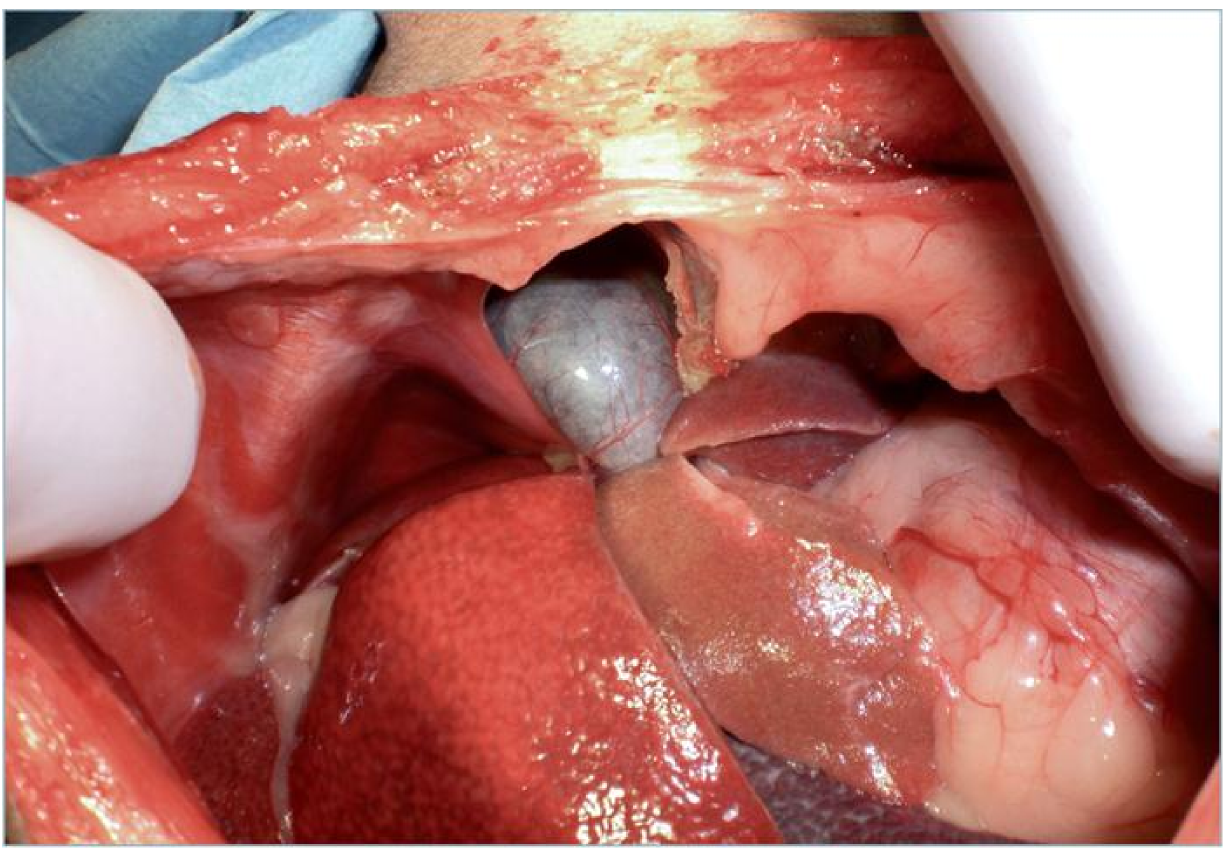


Fig. 8. Usually, it is easy to return the viscera to the abdominal cavity; in this case, only the quadrate and right medial liver lobes and the gall bladder remain to be repositioned.

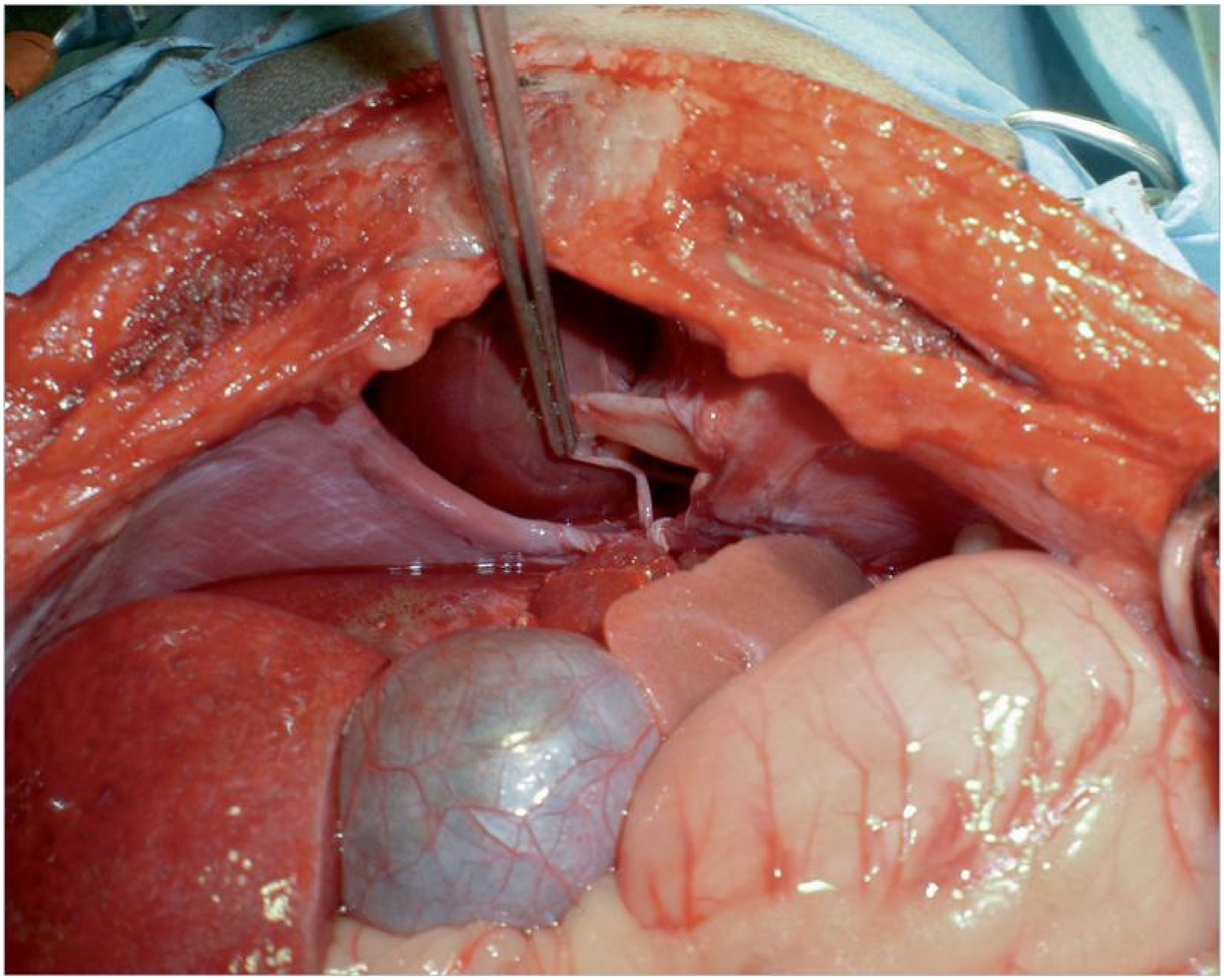


Fig. 9. In this patient, the pericardium has been incised; if it is sutured, a pneumopericardium may be produced, with grave consequences. In such cases, mechanical ventilation of the patient should be maintained until the end of the operation.

The hernia is closed with an interrupted suture in synthetic non-absorbable monofilament material, correcting both the diaphragmatic and the pericardial defects with the same suture. If the pericardium is opened, it should not be sutured (Figs. 9-11).

For easier closure of the PPDH, all sutures should be placed along the defect before tying them (Fig. 10).

Ensure that the omentum is not included when suturing the diaphragmatic defect, to allow proper closure.

In principle, a chest drain is not necessary, unless there is pericardial effusion or pneumothorax.

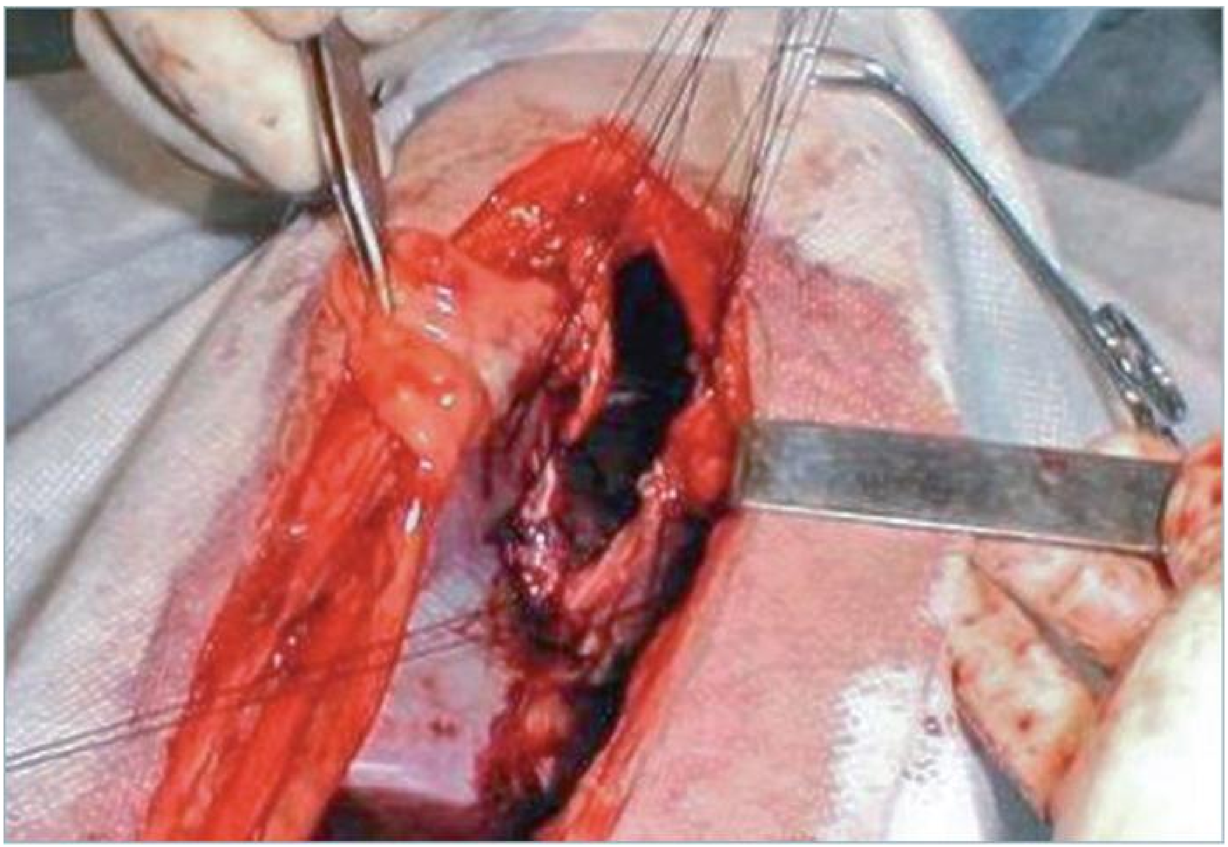


Fig. 10. The placement of untied single sutures makes it easier to check that each of them has been placed correctly.

If the hernia is very large and there is a large diaphragmatic defect, a surgical mesh or a flap of the transversus abdominis muscle

should be used to avoid tension on the sutures and recurrence of the hernia.

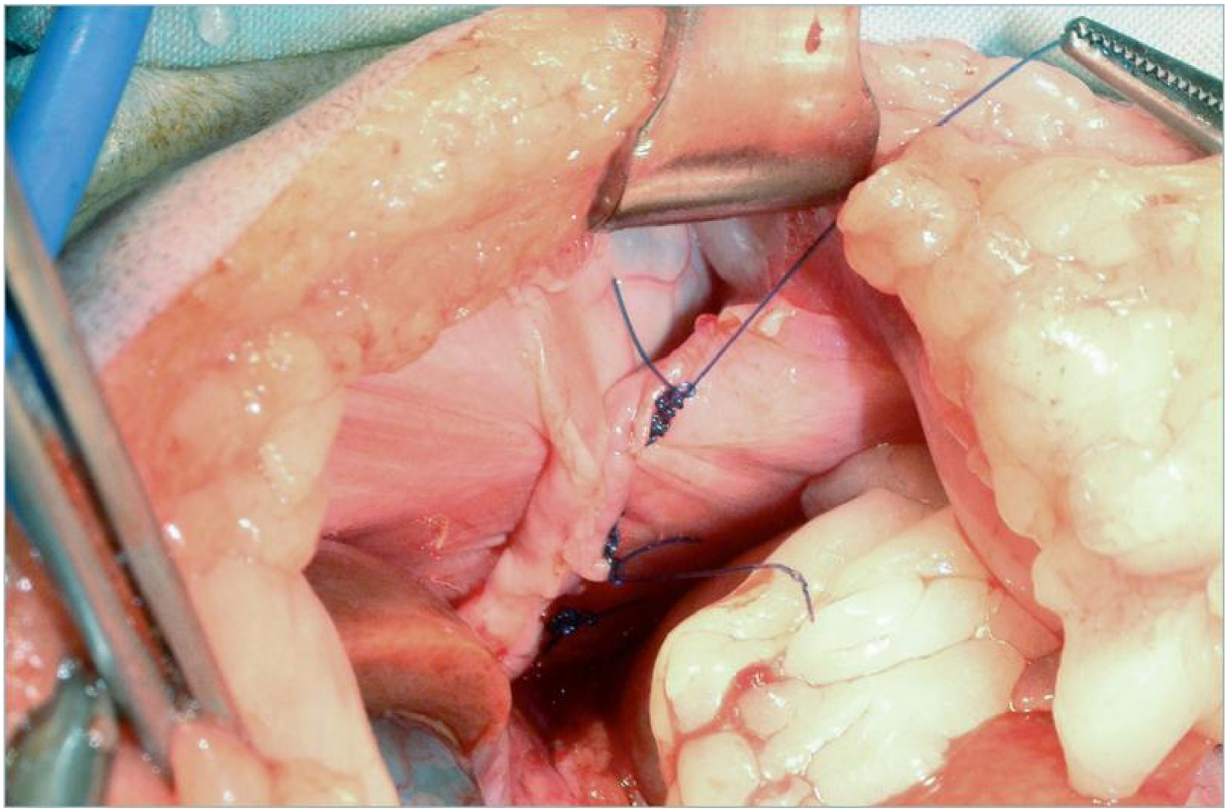


Fig. 11. Closure of the diaphragmatic defect using horizontal mattress sutures. In most patients there is sufficient tissue to close the defect without excessive tension on the sutures.

To remove the air from the pericardial cavity or the pleural space (if the pericardium was opened), the last suture should be tied while the anesthetist maintains forced inspiration, or, alternatively, transdiaphragmatic thoracocentesis should be performed (Fig. 12).

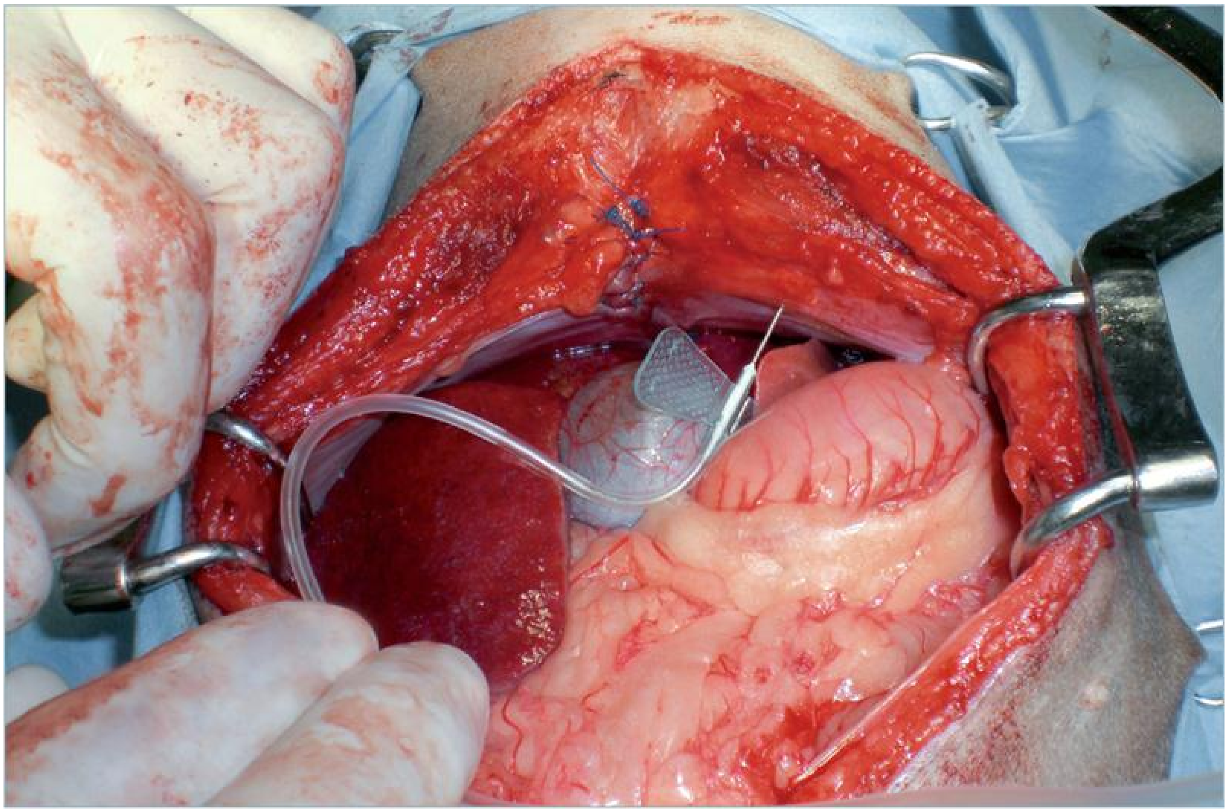


Fig. 12. The air in the pleural space is removed by transdiaphragmatic thoracocentesis in a patient that has suffered an iatrogenic pneumothorax following incision of the pericardium.

After surgery

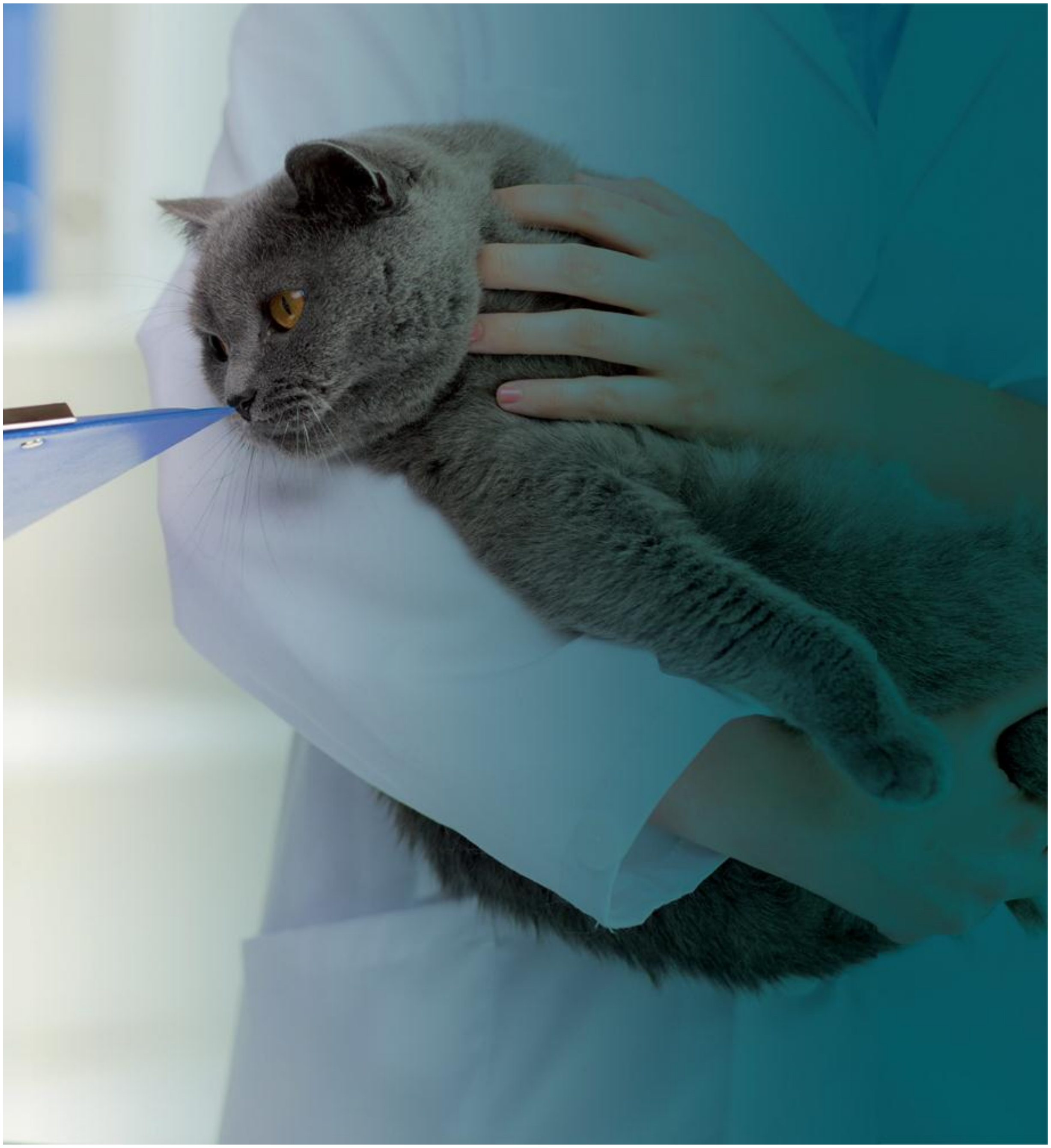
Postoperative recovery is usually fast and uncomplicated and the prognosis is good unless there are associated cardiac lesions.

> ***After recovery, a full cardiac examination should be performed to rule out further cardiac disorders.***

The complications that may occur are:

- Cardiac tamponade. Pericardiocentesis should be carried out through the right fourth intercostal space below the chondrocostal union.

- Pulmonary edema. Treatment consists of oxygenation and the use of diuretics.



Advanced surgical techniques

Ear surgery: ablation of the external ear canal

Brachycephalic syndrome

Tracheal collapse

Urethral stenoses

Prolapse of the urethral mucosa

Thoracoscopy

Exploratory laparoscopy and laparoscopic surgery

Portosystemic shunt

Hepatic surgery: hepatic lobectomy

Intramural ureteral ectopy. Ureterocystostomy

Extramural ectopic ureter. Neo-ureterocystostomy

Esophageal hiatal hernia

Megaesophagus

Adrenal gland surgery. Adrenalectomy

Pheochromocytoma

Cardiac tamponade. Pericardiectomy

Patent ductus arteriosus (PDA)

Perineal hernia

Perianal fistulas

Ear surgery: ablation of the external ear canal

José Rodríguez, Beatriz Belda, Amaya de Torre, Carolina Serrano, Jorge Llinás, Vicente Cervera

Prevalence	■	■	■	□	□
Technical difficulty	■	■	■	■	□

Total ear canal ablation

Total ear canal ablation (TECA) is indicated in cases of chronic end-stage otitis and tumors that invade the ear canal (Figs. 1 and 2). Chronic end-stage otitis is apparent when:

- *The ear canal is occluded by hyperplastic tissue.*
- *There are recurrent, antibiotic-resistant infections.*
- *Severe calcification or rupture of the ear cartilages is observed.*
- *Pets are uncooperative or owners do not comply with the treatments.*

Fig. 1. Complete occlusion of the ear canal by hyperplastic tissue, which developed as a consequence of an uncontrolled recurrent otitis.

> ***The treatment of choice in patients with end-stage otitis is ear canal ablation and lateral bulla osteotomy.***

The most difficult part of this surgery is the identification and atraumatic dissection of the facial nerve, which runs through the caudal and ventral part of the ear canal (Fig. 3). Clinical signs secondary to transient neuropraxia of the facial nerve frequently appear (lacrimal hyposecretion, dryness of the nose and Horner's syndrome) (. 4).

Total ear canal ablation should be performed with lateral bulla osteotomy to facilitate the removal of infected material and reduce the incidence of postoperative fistulae.

Fig. 2. Neoplasm of the ear canal (sebaceous adenoma), which completely occludes it, thus favoring recurrent otitis.

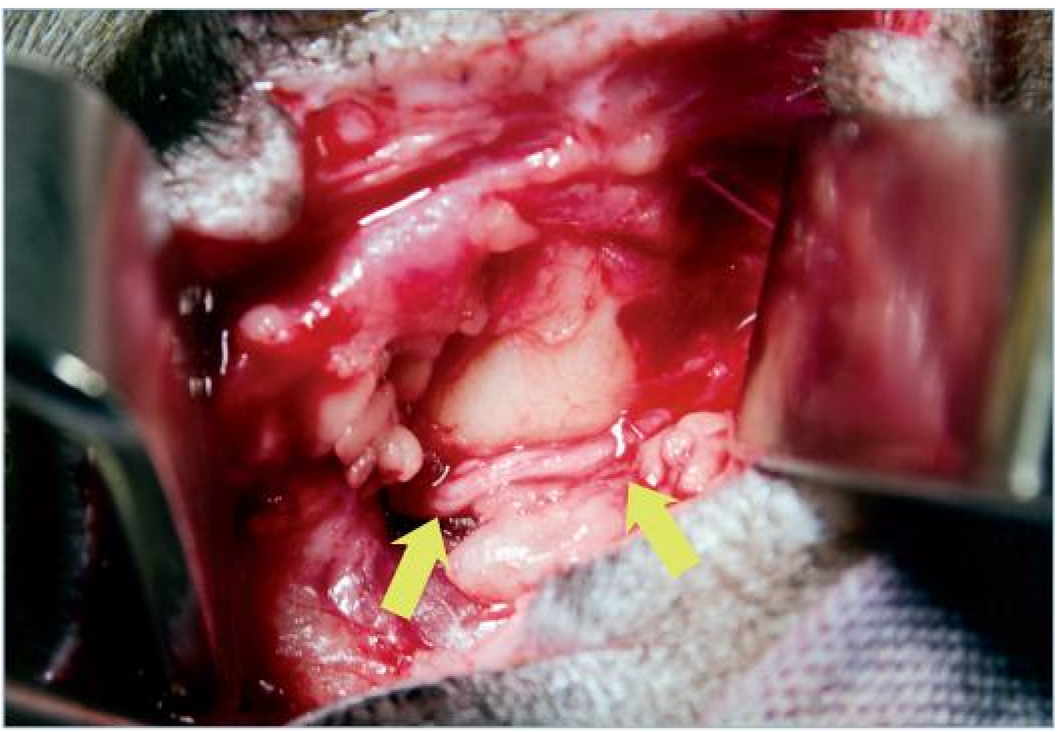


Fig. 3. The facial nerve is located in the lower part of the vertical ear canal (arrows). If it cannot be seen as clearly as in this picture, it will be

necessary to identify it via gentle blunt dissection, as its identification is important.

A meticulous and gentle surgeon may expect a 10 % incidence of transient neuropraxia of the facial nerve during the postoperative period.

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Watch this video

Ablation of the external auditory canal

Cholesteatoma of the middle ear

Cholesteatomas are an unusual and destructive sequela of chronic inflammation of the middle ear.
Cholesteatomas are formed when the ear drum is displaced into the bulla, which is usually due to dry concretions. The epithelial debris from desquamation accumulates in this “pocket” until the bulla is filled.

The term cholesteatoma is not very appropriate, since it is not a neoplasm (-oma) and it does not contain fat (-estea) or cholesterol (cholest-). However, this is the termed used to refer to this disease.

A cholesteatoma is an epidermal cyst lined by keratinized epithelial tissue, which contains keratin debris. It is characterized by its progressive growth, which causes the destruction of the adjacent tissue, including the bone. Its growth may be slow, as a result of the accumulation of keratinized material; or it may be fast if there is a rapid production of sebaceous material.
The inflammatory reaction inherent to a cholesteatoma may be moderate or severe depending on the production of cytokines by the epithelium, the exposure to the sebaceous material and the presence or absence of an infection.

If there is an infection, treatment will be difficult due to the poor vasculature of this area and the formation of a biofilm on the walls.

Fig. 4. Postoperative Horner's syndrome as a consequence of manipulation and inflammation caused by the removal of the ear canal. This complication is more frequent in cats.

The most common clinical signs in these patients include:

- Chronic otitis.
- Ear discharge.
- Pain when palpating the area of the tympanic bulla (otodynia).
- Pain when palpating the temporomandibular joint, or discomfort when opening the mouth.
- Neurological signs:
  - Head tilt towards the affected side.
  - Facial paralysis.
  - Ataxia.

- Circling.
- Tremors.

The alterations observed in the computed tomography (CT) scan image correspond to an expansile, invasive and non-vascularized lesion in the tympanic cavity, which is not enhanced by the contrast agent, in addition to lytic changes in the walls of the bulla. In chronic cases, sclerosis of the temporomandibular joint and even lysis of the petrous portion of the temporal bone are observed. CT scans are a key tool in the diagnosis of the cholesteatoma as the above findings are considered pathognomomic.

The only effective treatment is surgical, and consists in the removal of the stratified squamous epithelium, the evacuation of the keratin debris and the control of the infection.

The percentage of recurrence is high (40 %). Generally, they recur from two to thirteen months after the surgery. In order to reduce this percentage to a minimum, it is necessary to obtain good exposure of the tympanic cavity to ensure the complete removal of the keratin debris and stratified epithelium.

Case / Ablation of the external ear canal

José Rodríguez, Beatriz Belda, Amaya de Torre, Carolina Serrano, Jorge Llinás, Vicente Cervera

An 8-year-old male French Bulldog, with a history of chronic otitis that has not responded to the different topical and systemic treatments administered for more than a year, is referred to the veterinary practice.

If the presence of a cholesteatoma in the right ear is confirmed, a total ear canal ablation and a lateral tympanic bulla osteotomy are performed.

The patient exhibits head shaking, experiences discomfort when opening his mouth and shows the following neurological signs: peripheral vestibular syndrome, convulsion and spasms.

The CT scan image shows an expansile bone lesion, which causes an increase in the size of the bulla with lysis of the cochlea. The lumen of the bulla is completely obstructed by an isodense, non-enhancing fluid (Figs. 1 and 2).

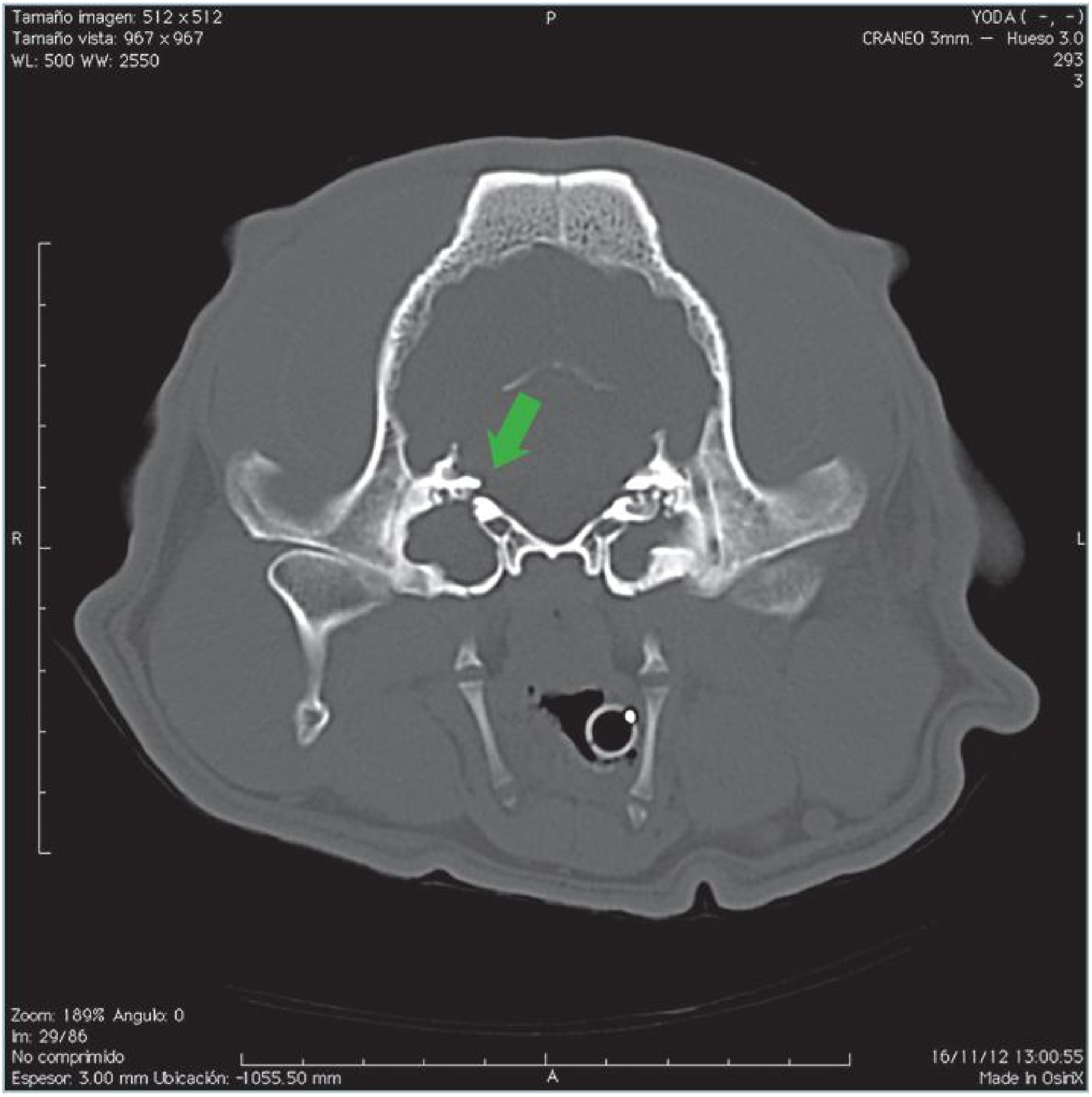

Fig. 1. CT scan in transverse plane. The right tympanic bulla is completely obstructed by an isodense fluid, which is not enhanced by the intravenous contrast agent. The bulla is enlarged and the image also shows thinning of the free wall and lysis and absence of the right cochlea (green arrow), which is consistent with an expansile lesion in this area. The isodense material that obstructs the bulla extends to the ear canal through the tympanic membrane (not visible).

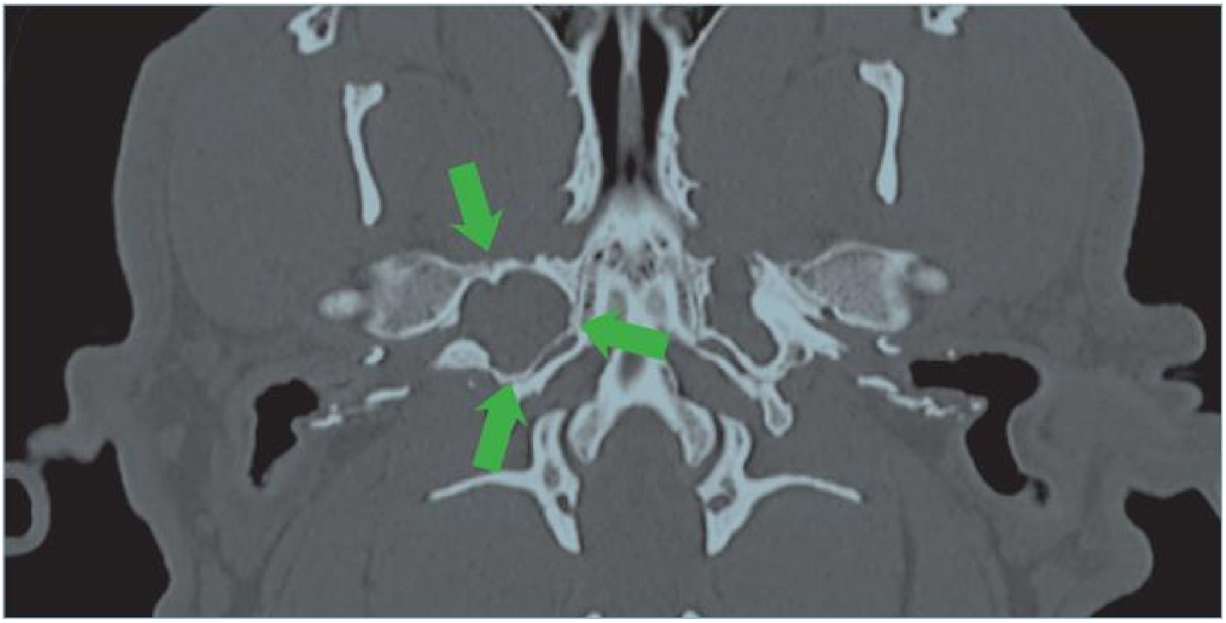

Fig. 2. Coronal image. The right tympanic bulla is completely obstructed by the same isodense material, which is not enhanced by the intravenous contrast agent. Compare the size of the right bulla (green arrows) with that of the left tympanic bulla, which is also obstructed by isodense material that is not enhanced by the intravenous contrast agent.

Surgical procedure

Total ear canal ablation (TECA)

A T-shaped skin incision is performed following the direction of the ear canal, the cutaneous flaps that have been created are retracted, and the lateral part of the canal is dissected and exposed (Fig. 3).
An incision is then performed around the ear canal opening (Fig. 3 dotted blue line), and the vertical portion of the ear canal is dissected (Fig. 4).

In order to facilitate dissection and reduce bleeding, 20 ml of saline with 1:200,000 epinephrine are previously injected around the ear canal.

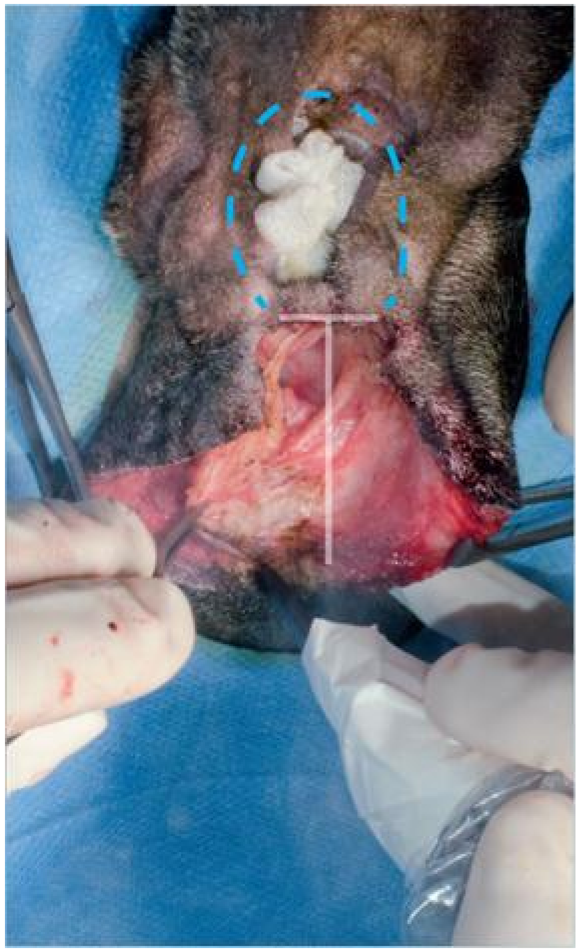

Fig. 3. After making a T-shaped incision (white lines), the ear canal is dissected from the connective tissue and muscles that surround it. In this case, in order to minimize bleeding and postoperative inflammation, CO_2 laser is used in supepulsed mode. The dotted blue line shows the horizontal incision that is performed next.

The dissection of the vertical ear canal must be performed as close to the ear cartilage as possible, so as not to accidentally damage the auricular artery, which runs through the caudomedial area, and the facial nerve, which runs through the caudoventral area.

The dissection of the ear canal must be performed as close to the cartilage as possible. Muscle insertions are cut with CO_2 laser or electrocautery to minimize bleeding.

Fig. 4. The vertical portion of the ear canal is dissected. The dissection must be performed close to the cartilage so as to avoid any damage to the caudal auricular artery and facial nerve.

It is necessary to frequently palpate the area of dissection to feel the pulsations of the carotid artery and its branches, as well as the facial nerve. Deep dissection in the cranial area, close to the tympanic bulla, must be performed with great care and precision so as not to damage the retroauricular vein, which is not visible, but whose presence should be remembered (Fig. 7).
The facial nerve, which should be identified and isolated, is located in the caudoventral part of the horizontal canal. If it is blocked due to a hypertrophic reaction or to the ossification of the canal, it should be dissected with caution in order to avoid damaging it (Fig. 3, Figs. 5 and 7).

In chronic processes, the facial nerve may be intimately adhered to the ear canal. In these cases, great caution is required during its dissection.

When reaching the skull, the ear canal is dissected free from its attachments to the opening into the middle ear with a scalpel or Mayo scissors. The incision is performed in cranioventral direction. Small incisions should be made, paying attention to the position of the tips of the scissors before cutting, in order to avoid damaging the facial nerve (Fig. 6).

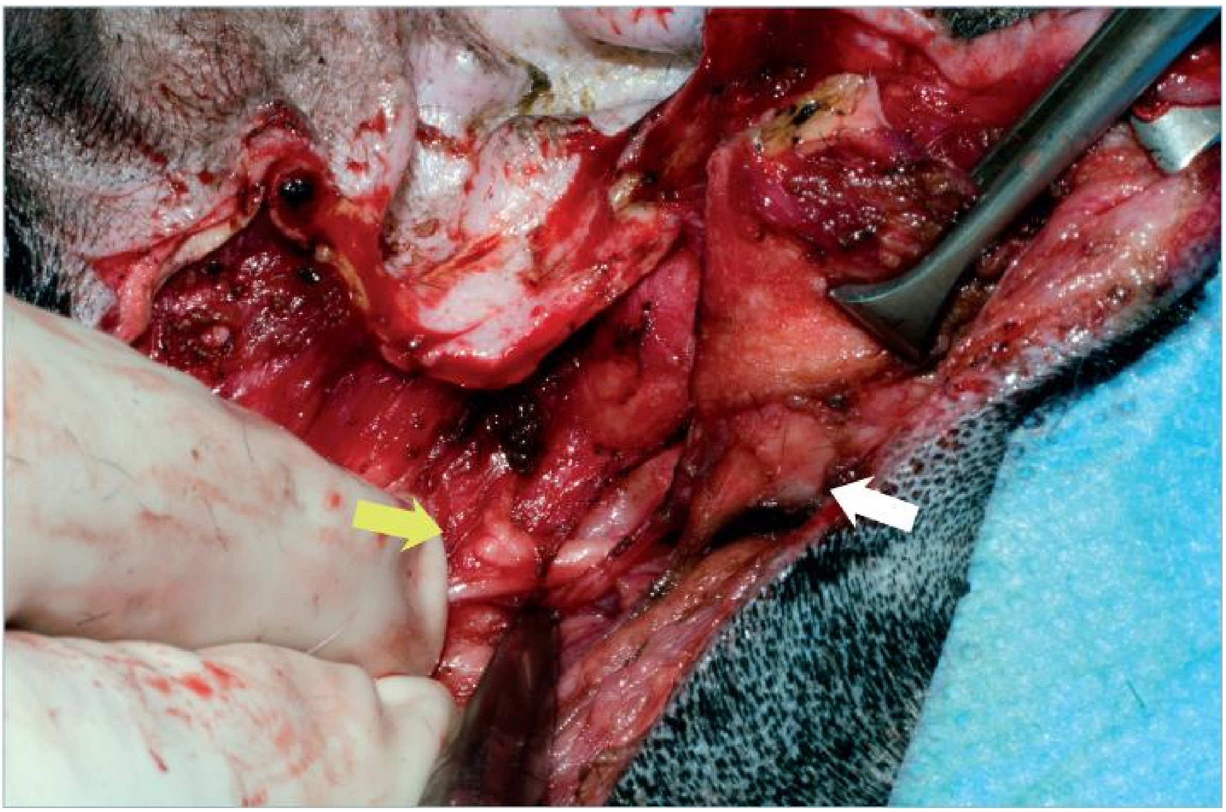

Fig. 5. The facial nerve (yellow arrow), which should be identified and isolated during the dissection of the horizontal canal, is located in the caudoventral area of the horizontal ear canal (white arrow).

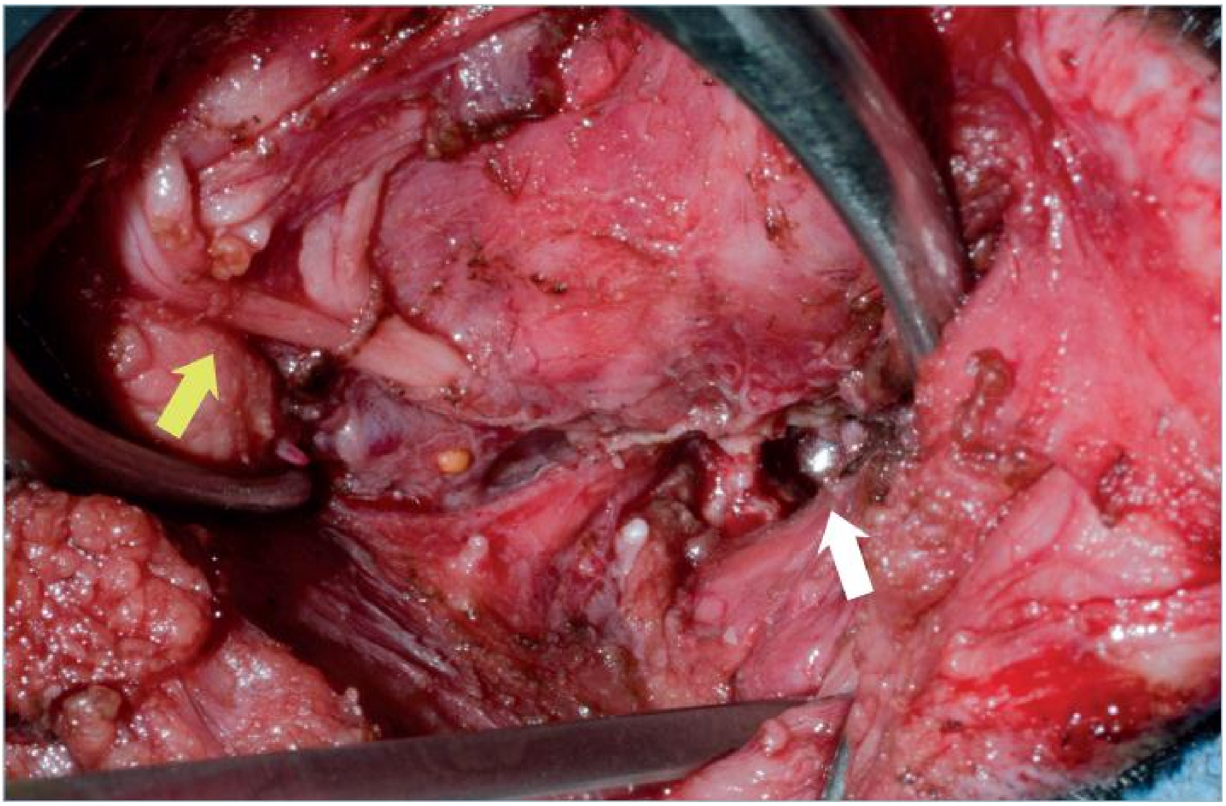

Fig. 6. Image of the opening into the middle ear (white arrow) after cutting its attachment to the ear canal. The yellow arrow shows the facial nerve.

If self-retaining retractors such as Gelpi retractors are used, great care should be taken when placing them, so as not to damage the facial nerve or proximal vessels (auricular artery, retroauricular vein).

Samples from the tympanic cavity should be collected for microbiological culture and antibiogram.

Next, a lateral osteotomy of the tympanic bulla should be performed together with curettage to remove all the epithelial tissue from the area as well as its contents to prevent chronic fistulae.

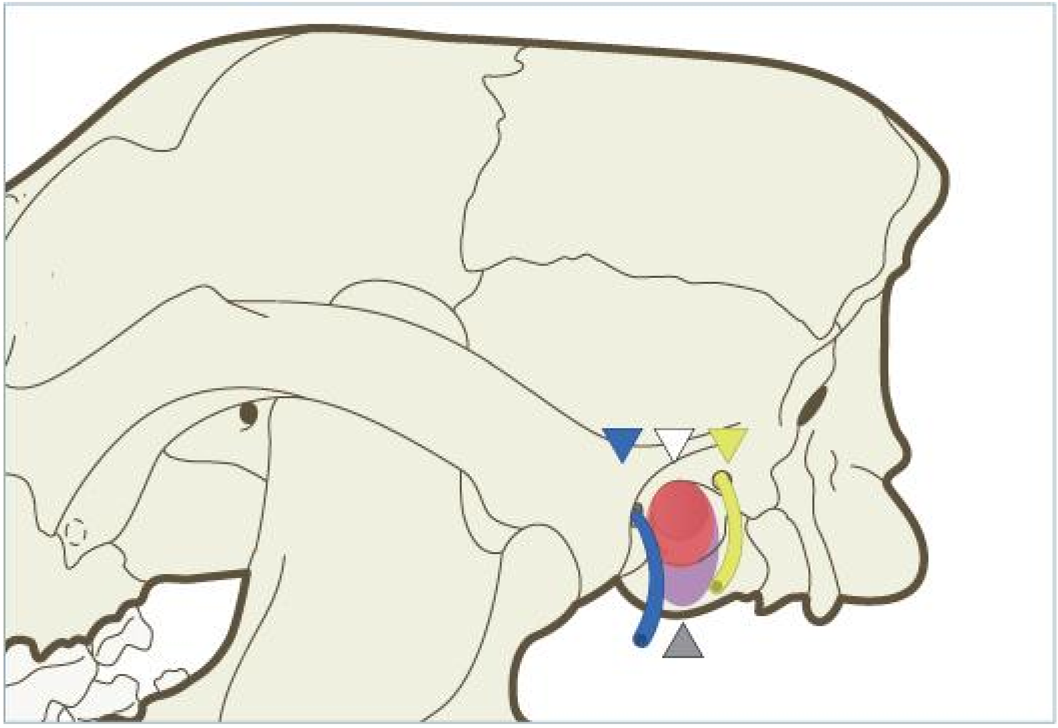

Fig. 7. Diagrams of the anatomical relations of the tympanic bulla (grey arrow) and of the entrance into the tympanic cavity (white arrow). Facial nerve (yellow arrow). Retroauricular vein (blue arrow). The red area represents the area of the tympanic bulla that is going to be removed. The purple area represents the extension of the initial osteotomy.

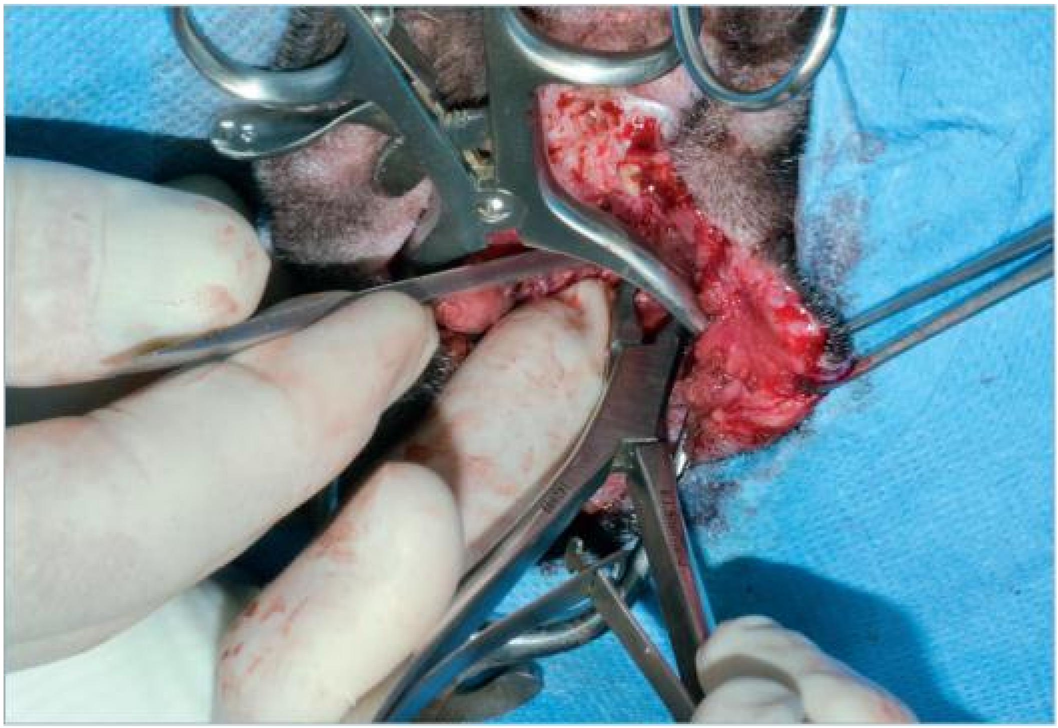

Fig. 8. The tissue of the external ear canal that was still attached to the upper and cranial area of the opening into the middle ear is excised with *rongeurs*.

Lateral tympanic bulla osteotomy

The lateral tympanic bulla osteotomy is performed with *rongeurs* (Cleveland or Lempert) in its ventral area (Fig. 7, area shown in red; Fig. 8). All the tissue of the ear canal that is still attached to the cranial, dorsal and caudal areas of the opening into the middle ear is excised, taking care not to damage the facial nerve or caudal auricular artery.

The osteotomy should be large enough to allow the interior of the bulla to be viewed correctly and to ensure the complete elimination of its contents (Fig. 9 and 10).

Fig. 9. View of the opening into the middle ear after the ventral osteotomy of the bulla (white arrow). The orange arrow shows the area where the promontory and auditory ossicles (malleus, incus, lenticular bone and stapes) are located.

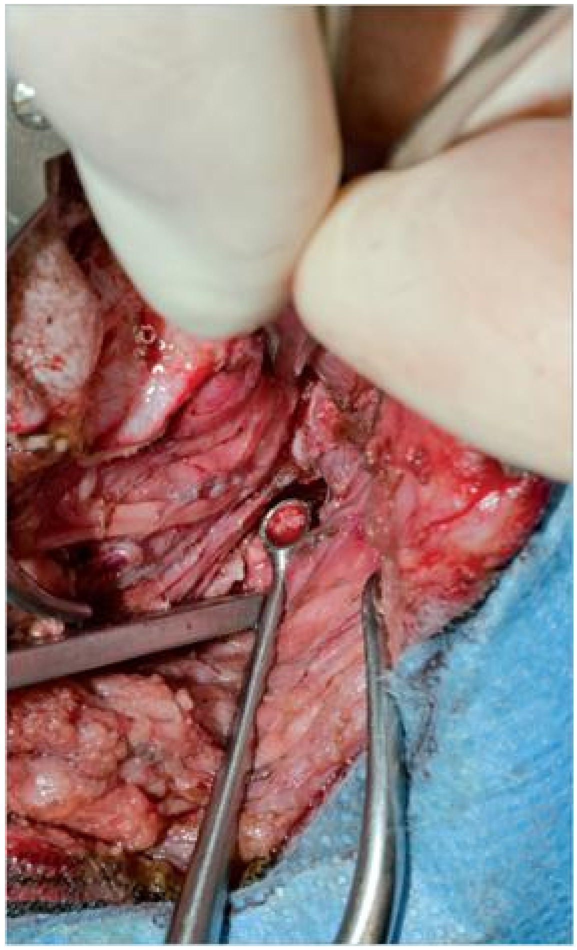

Fig. 10. A curette is used to remove the abnormal material and the infection from the tympanic cavity. The upper or dorsomedial areas should be avoided.

*

If the bulla is sclerotic and proliferative, the osteotomy of the ventral area may be difficult due to the hardness of this area. Great care must be taken not to damage the external carotid artery or any of its branches.

The osteotomy may be extended to the caudolateral area (Fig. 7, purple area) by retracting the facial nerve caudally.

It should not be extended to the cranial area, since the retroauricular vein (Fig. 7), which is very difficult to identify unless it is damaged and starts to bleed, runs through this area. If hemorrhage occurs, it should be controlled

by means of compression with a gauze swab for five minutes. If this technique is not effective, bone wax may also be used to block the retroauricular foramen through which the vein exits.
All abnormal epithelium inside the tympanic cavity should be removed using a curette. The dorsal or dorsomedial area should be avoided so as not to damage the auditory ossicles or the promontory located at the entrance of the inner ear (Fig. 10). In this case, the CO_2 laser is also used to vaporise the epithelium of the bulla.

Fig. 11. Insertion of a fenestrated tube inside the tympanic cavity to evacuate its content and to be able to administer topical treatments during the postoperative period.

During the evacuation and curettage of the tympanic cavity, the craniodorsal area should be avoided in order not to damage the

ossicles of the inner ear.

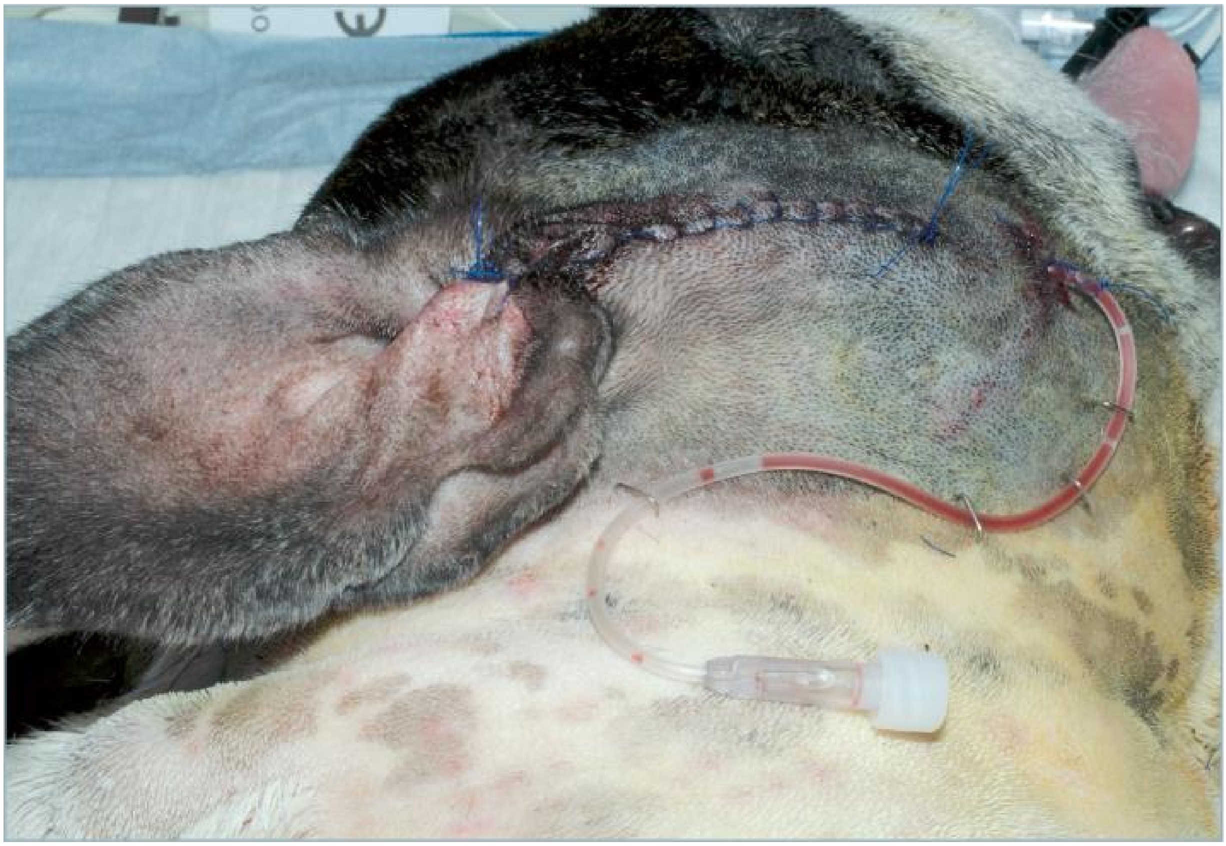

Fig. 12. End of surgery after suturing the skin and fixing the drain tube with a finger-trap suture and several skin staples to prevent it from being displaced during the postoperative period.

The deepest aspect of the bulla (its medial area) should not be curetted with excessive force as this may break this thin bone and damage the internal carotid artery, which would cause great hemorrhage and be difficult to control.

Eliminating all the epithelial tissue is difficult due to the adherences that form between this tissue and the damaged bone of the bulla.

The tympanic cavity is irrigated with warm saline solution and gently aspirated to eliminate tissue debris, microorganisms and bony fragments.

Before closing the wound, a fenestrated drain tube is placed in the tympanic cavity. The drain tube exits through the skin in the caudomedial area, and is fixed to it with a finger-trap suture (Fig. 11). An injection of 0.4 ml/kg of lidocaine-bupivacaine (50:50) is performed in the area to provide additional analgesia.

It is recommended to place a drain in the following cases:

- ***When there has been significant intraoperative contamination.***
- ***When the hemorrhage has been difficult to control.***
- ***If an auricular abscess was present.***
- ***When it has not been possible to properly clean the bulla.***

Finally, the internal tissues are closed with thin, synthetic absorbable suture to reduce the dead space, and the skin is sutured with non-absorbable suture (Fig. 12).

After the surgery

Depending on the case, the drain is maintained for five to ten days.
The postoperative treatment of this patient consisted of the administration of local analgesia with bupivacaine while the drain was in place, non-steroidal anti-inflammatory drugs (robenacoxib 1 mg/kg/day) for 10 days and a 21-day antibiotic treatment (cephalexin 20 mg/kg/8 h).

Considerations

In the case described, despite the chronicity of the signs and the bone changes observed on the CT scan, the surgery was satisfactory.
The CO_2 laser allowed the vaporization of the epithelium lining the bulla and the reduction of postoperative pain and edema.
After nine months of follow-up, the animal showed no signs of recurrence.

Brachycephalic syndrome

José Rodríguez, Jorge Llinás, Roberto Bussadori, Luis García

Brachycephalic syndrome presents a multifactorial element that determines the clinical signs in each patient and the extent of respiratory dysfunction they suffer. It may include stenosis of the nostrils, tracheal hypoplasia, eversion of the laryngeal saccules, edema of the pharyngeal mucous membranes and the arytenoid cartilage, elongations of the soft palate, enlargement of the tonsils and different degrees of laryngeal collapse.

The clinical manifestations include throat clearing, associated emesis, snoring and occasional dyspnea. The condition commonly evolves to laryngeal collapse and syncope.

In brachycephalic dogs the tip of the soft palate enters the larynx during inspiration, obstructing the passage of air into the trachea. Where there is stenosis of the nostrils, respiratory work increases due to the increased resistance to the passage of air and causes the tip of the soft palate to drop deeply, worsening the degree of obstruction and adding to the inflammation and edema of the palate and surrounding laryngeal structures (Fig. 1).

Severe tracheal hypoplasia increases the efforts to breathe, “sucking” the palate up between the horned arytenoid processes. There may be difficulty in swallowing as during occlusion of the airway when swallowing depresses ventilation.

In these patients it is easy to recognise the stertor that increases with excitement; increased effort to breathe is evident with the retraction of the corners of the mouth, open-mouthed breathing and panting and excessive movement of the ribs by the abdominal muscles.

Animals can present signs of congestion, hyperthermia and cyanosis.

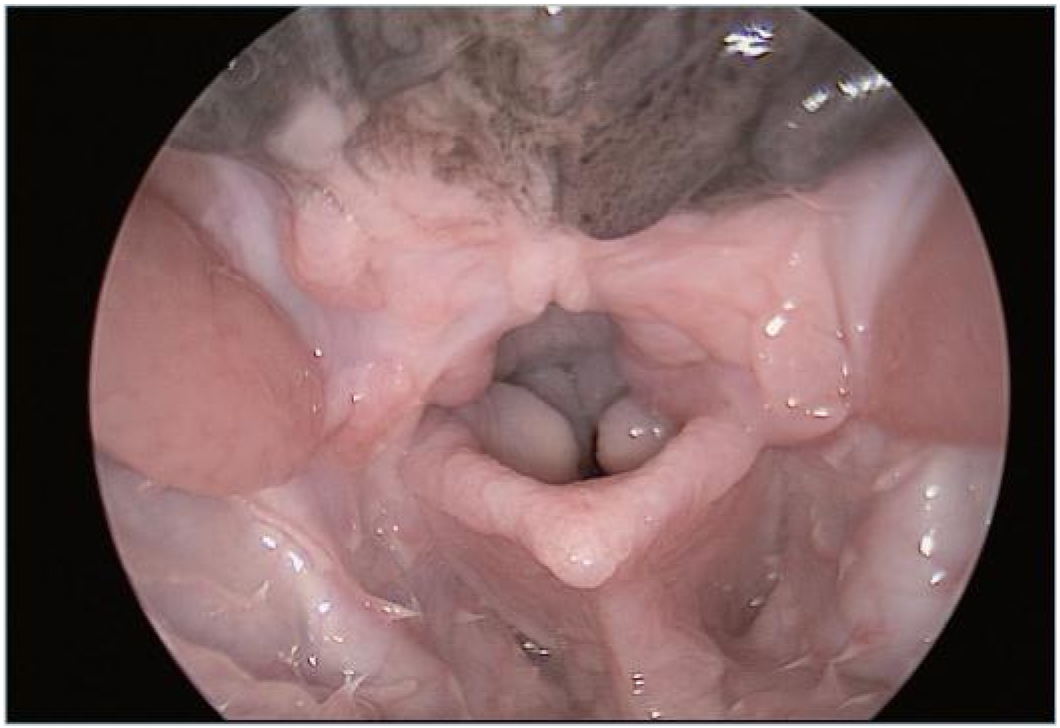

Fig. 1. The elongation of the tip of the palate causes alterations to the pharynx and larynx. The area becomes inflamed and edematised, the tonsils increase in size and the larynx loses function and finally collapses.

The animal must be sedated or anesthetized for examination of the soft palate. Normally it can be seen how the palate overlaps the epiglottis by several millimeters, or even centimeters, and the thickness of the elongated part of the soft palate is assessed as it is a significant sign in the patient's symptoms, as the clinical condition worsens as the thickness of the soft palate increases (Fig. 2).

It is important to complete a full examination of the patient and distinguish between other diseases presenting obstruction of the upper respiratory tract, such as laryngeal paralysis, masses on the glottis, larynx and trachea, laryngeal mucous and trauma to the upper airways.

Medical treatment with corticosteroids at anti-inflammatory doses can control the condition in the acute phase or in case of acute respiratory crisis, but will not prevent the progression of degenerative changes.

In dogs with tracheal hypoplasia it is vitally important to minimize secretions in the airways as much as possible, by prescribing mucolytics. Bronchodilators should be used in all cases.

Surgical treatment should be performed to correct several alterations, depending on the patient.

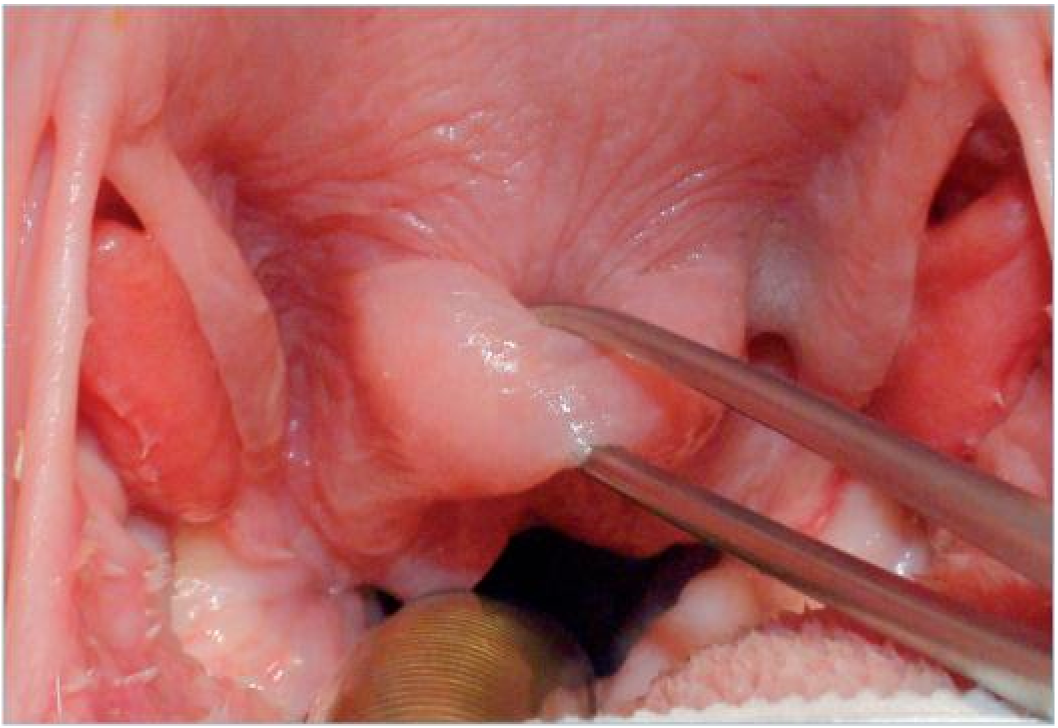

Fig. 2. Assessment of the length and thickness of the palate tip and its involvement in the laryngeal dysfunction.

> ***In the authors' experience, despite completing the excision of the laryngeal saccules or even the reshaping of the larynx by photovaporising of the cuneiform processes, tracheotomy is an accidental procedure, and very uncommon if appropriate management is used.***

Widening of nostrils

Nostrils are widened using CO_2 laser with a vertical wedge-shaped resection. It is important to work at the appropriate distance (the maximum

possible for making a precise incision), normally in super pulsed mode at 15 W output. Continuous mode at a low output can also be used, between 10 and 12 W, depending on the patient, the distance and the equipment used (Fig. 3).
It is important to keep wetting the snout and the damaged area.
The authors avoid making too large a wedge as this can cause an excessively large scab. It is preferable to photovaporise at depth to achieve the desired width.
It is not necessary to suture the wound, although healing takes almost a month, with the formation of scabs and mucus.
In some cases there may be permanent de-pigmentation, especially if the resection was excessive. For this reason it is important to warn owners in advance of this possibility.

Palatoplasty

Palatoplasty on staphylectomy can be performed using CO_2 or monopolar electroscalpel.
When using CO_2 the authors recommend the technique known as pharyngoplasty, the purpose of which is to reduce the length of flap of the soft palate and its entire thickness, as well as the lateral columns.
The first step is always to place a gauzepad soaked in saline behind the soft palate to protect those structures from the laser beam (Fig. 4). If the gauzepad is not properly soaked, it may ignite and cause burns.

Fig. 3. Nostril plasty is performed by resecting a wedge shape of tissue from the medial area of the nasal wall.

A key point is the dorsal edge chosen for the plasty. There is no established fixed anatomical reference point and it is important to adapt to each patient. It must be checked that the posterior nasal aperture must not remain exposed to prevent the risk of diversion of food and nasal fluid. It is also important to take the decision, depending on each case, how aggressive to make the procedure as, still avoiding deviation, sometimes the posterior nasal aperture is left too exposed, allowing a strong flow of fluid and causing rhinitis. In these cases with patients suffering from pharyngeal hypertrophy and significant macroglossia, a decision must be made depending on the surgeon's experience and knowledge to maintain a physiopathological balance with the changes that will take place.

The incision of the soft palate starts at the center, using continuous mode between 15 and 25 W depending on the thickness of the palate. The minimal distance possible should be used, allowing wrist movements to make a dome shape and perfectly identify the oral, muscular, nasal mucous membrane (Fig. 5).

Fig. 4. Gauze soaked in saline solution are placed behind and under the palate flap to protect the pharynx and endotracheal tube.

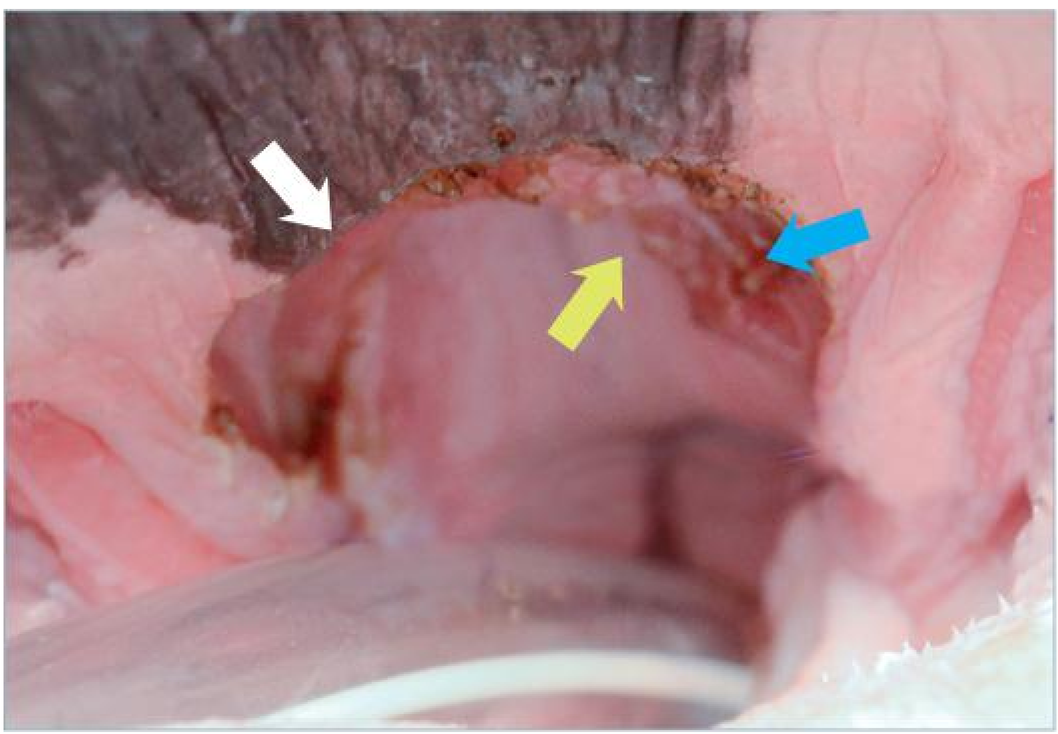

Fig. 5. Palatoplasty is made in a dome shape to prevent the palatal flap from obstructing the entrance to the larynx.

This image shows the oral mucous membrane (white arrow), the nasal muscle (blue arrow) and the nasal mucous membrane (yellow arrow).

The lines cut along the planes should be made as identical as possible. The nasal line is taken as the edge of the incision, to guide healing and achieve the optimal result for the short and long term.
The authors recommend leaving sufficient margin along the edge of the epiglottis and widen the pharynx by removing excess mucous membranes from the sides using cytoreduction and photovaporization of the tissue using the CO_2 in super pulse mode with an output of 10 and 20 W at a minimum distance of 3 cm.

Photovaporization of the lateral column of the palatal flap widens the pharynx and allows air to pass through to the larynx.

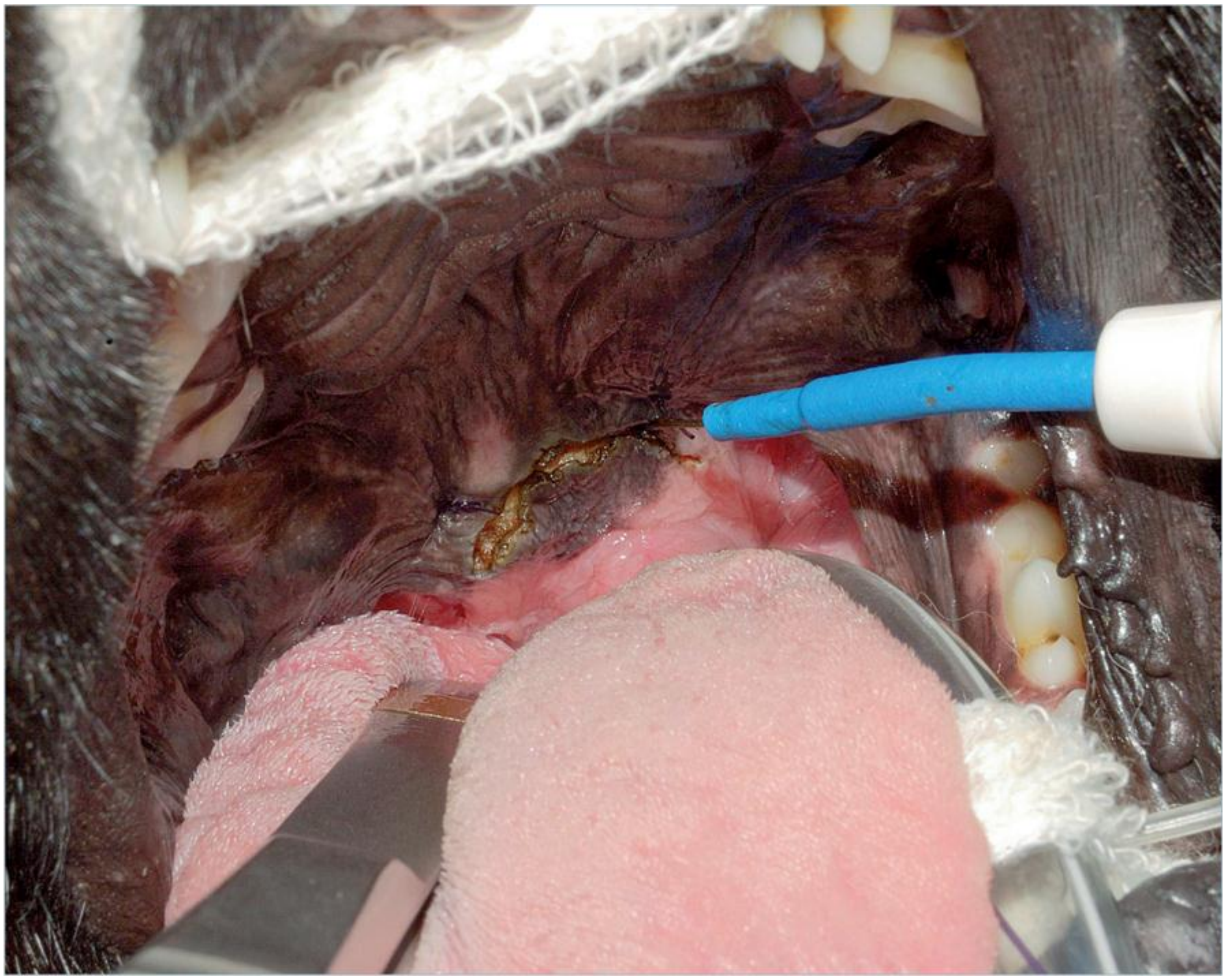

Fig. 6. When the palatoplasty is performed with an electroscalpel, the finest active electrode available should be chosen. It is recommended to use a 0.2 mm needle to create high energy density and low power output requirements.

The authors do not usually suture, except where considered appropriate, to ensure the closure of one or both oh the minor palates. In this case it is advisable to use a fast absorbing braided suture (3/0 or 4/0) to prevent discomfort to the patient caused by "wire effect" of mono filament material. When using a monopolar electroscalpel, a 0.2 mm lance or needle tip should be chosen, or if a spatula tip is used, as fine a tip as possible (Fig. 6). The power selected should always be the lowest possible to allow the incision to be made smoothly, normally between 10 and 15 W, depending on the generator and the active terminal selected.

The excess soft palate is completely removed and the nasal mucous membrane is then sutured to the oral membrane, although some surgeons opt not to use sutures in these cases.

Excision of laryngeal saccules

The excision of the laryngeal saccules is performed if eversion is causing laryngeal obstruction. This resection is performed with fine dissection scissors and a traction clamp. The saccules are sectioned from the base between the vestibular and oral folds of the oral chords (Fig. 7). Bleeding is minimal and if it occurs, it is controlled by compression with a cotton bud soaked in an epinephrine solution.

If CO_2 laser is available, the area can be photovaporized in super pulsed mode at over 3 cm distance in order to close the area preventing bleeding and reducing edema.

Resection of the laryngeal saccules increases the risk of dyspnea in the immediate postoperative period by increasing the possibility of obstructive edema, although bleeding at the base is uncommon.

Where there is advanced laryngeal collapse, the CO_2 laser can be used to photovaporize the cuneiform processes of the arytenoid cartilage.

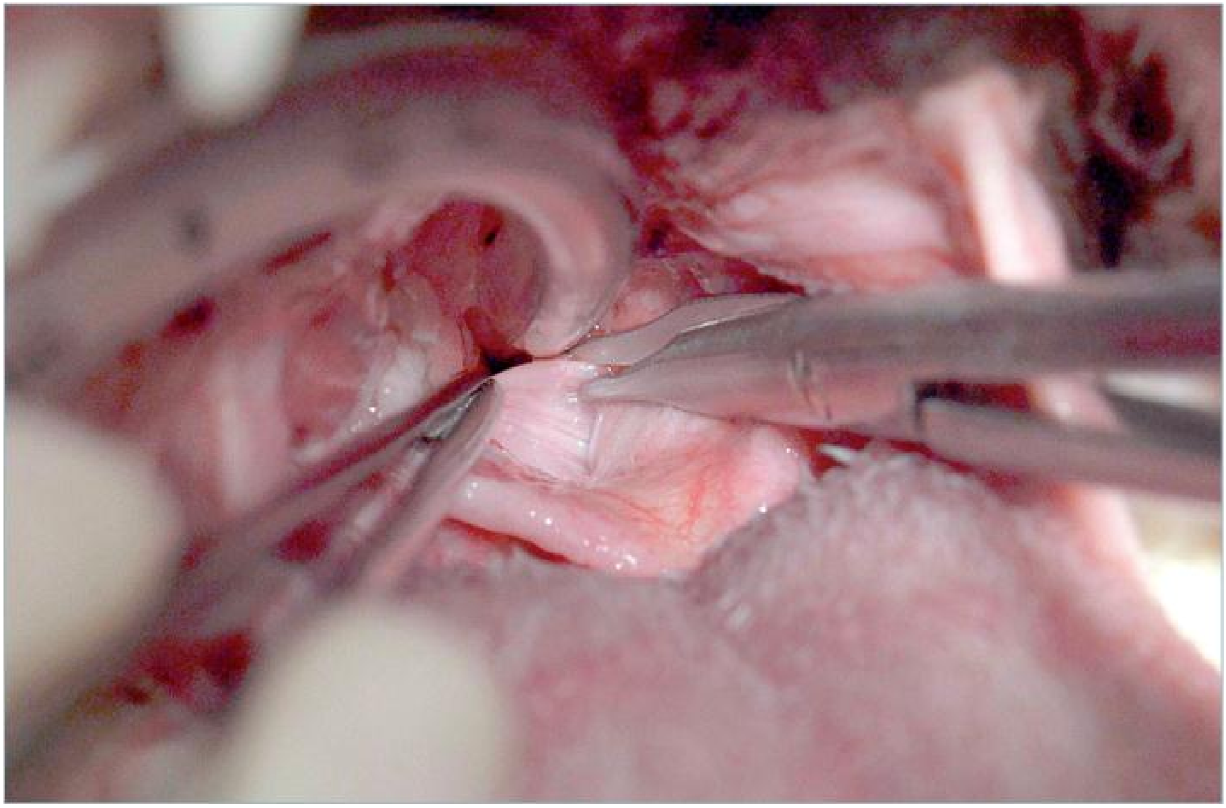

Fig. 7. This image shows the resection of the left laryngeal saccule using fine scissors. The area will then be photovaporized to minimize bleeding and postoperative inflammation.

This procedure allows the larynx to be re-shaped and the space for air to pass between the arytenoid is larger.
It is a delicate technique but, performed precisely, clear clinical improvement is observed, in many cases removing the need for tracheotomy (Figs. 8 and 9).

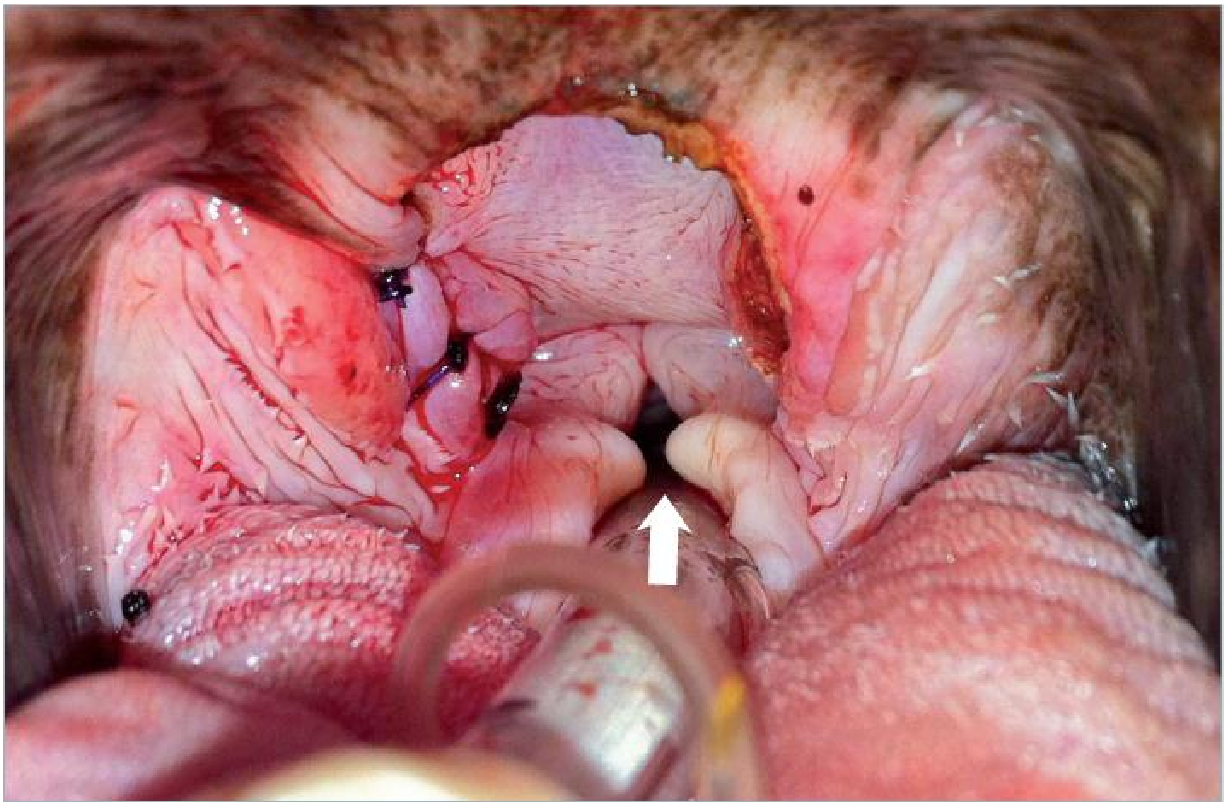

Fig. 8. In this patient it can be seen how the cuneiform processes are displaced medially and obstruct the entrance to the larynx (arrow).

*

Even if surgery is successful, panting causes predisposition to inflammation of the larynx and pharynx and can cause epiglottal edema.

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Watch this video

Brachycephalic syndrome

Fig. 9. The solution lies in the precise photovaporization of the left cuneiform process, but in severe cases such *as this one*, it can be performed on both sides.

This is always done in super pulsed mode between 10 and 15 V at the fastest pulse speed and intervals available.

The correct angle must be found to pinpoint the apex of the cuneiform process to apply the principle of cytoreduction until the arytenoid edge is left “flat”, without the protuberance occluding the entrance to the larynx.
The authors only use antibiotic therapy on the day of surgery in most cases. Marbofloxacin is the treatment of choice.
During the immediate postoperative period, upon awaking, it is essential to supervise breathing, as respiratory collapse may occur due to edema and inflammation.
The patient must be allowed to awaken in a calm and relaxed environment, preferably not in a cage, and if possible allowed to breathe without panting.
Where there is dyspnoea and it is suspected that this may be the result of surgical site inflammation, corticosteroids should be administered to avoid tracheotomy as far as possible.
It is advisable to restrict ingestion of water and food for the first 12 hours. After 12 hours, if the dog is stable, a little cold water can be offered, and bland diet can be given after 24 hours. Bland diet should be given for ten days to allow healing and facilitate swallowing.
Patients normally adapt to their new situation after a few days and considerable clinical improvement is observed in most cases. It is important to keep the owner informed and to explain the multifactorial aspect of brachycephalic syndrome and the purposes of surgery, given that it is always palliative.

Tracheal collapse

José Rodríguez, Carolina Serrano, Rocío Fernández, Amaya de Torre

Prevalence	■■■■□
Technical difficulty	■■■■□

Tracheal collapse is a type of tracheal obstruction that is secondary to the weakening of the cartilage that maintains the tubular structure; it hampers air flow into the lungs.
Due to idiopathic degeneration, the tracheal cartilages lose their rigidity and are unable to maintain the shape of the trachea during breathing; they collapse in a dorsoventral plane (Fig. 1).

If the cervical trachea is affected by the collapse, the problem worsens during inspiration, while collapse of the thoracic trachea causes worsening during expiration.

This disorder occurs mainly in small and toy breeds, especially in 5 to 9-year-old Yorkshire Terriers.

Animals with tracheal collapse suffer from a respiratory distress that is characterized by a chronic harsh or dry cough similar to the honking of geese, dyspnea, cyanosis and even fainting. A vicious cycle is initiated with: coughing, labored breathing and increased intrathoracic pressure further damaging the tracheal mucosa. The chronic epithelial damage leads to inflammation and desquamation of the epithelium, which reduces mucociliary clearance, so that secretions accumulate; this aggravates the cough and the tracheal collapse. Once the vicious cycle has been established, the patient gets progressively worse.

Fig. 1. In tracheal collapse, the hyaline cartilage is substituted by fibrocartilage. The tracheal ring loses its rigidity and becomes flattened dorsally.

Table I. There are four grades of tracheal collapse.

Grades of tracheal collapse with their respective anatomical-functional changes			
Grade	Reduction of the tracheal diameter	Shape of the cartilage	Trachealis muscle
I	25 %	Practically maintains its C-shape.	Slightly protrudes into the tracheal lumen.
II	50 %	U-shape that starts to widen.	Stretched and pendulous.
III	57 %	Very open U-shape.	Very stretched and loose.
IV	› 80 %	Completely flattened.	In contact with the ventral side of the ring.

Clinical signs

The clinical signs may appear even in pups, but worsen with age:

- Respiratory wheezing sounds.
- Cyclic cough that may have a characteristic "goose honk" sound.
- Dyspnea.
- Exercise intolerance.
- Fainting.

Clinical details that should be considered:

- 30 % of patients also present with laryngeal paralysis or collapse.
- Nearly 50 % of patients have some sign of bronchial collapse.
- Usually the entire trachea is affected, but in most cases there is a particular site that is most severely affected.

Diagnosis

If the symptoms are suggestive of tracheal collapse, further tests should be performed to confirm the disease. Diagnostic imaging, including radiography (during inspiration and expiration), fluoroscopy, ultrasonography, CT scan or tracheobronchoscopy can all be used for this (Figs. 2 and 3).

Bronchoscopy and fluoroscopy are considered the most useful tests for the diagnosis of tracheal collapse. However, not all veterinary centers have the equipment required.

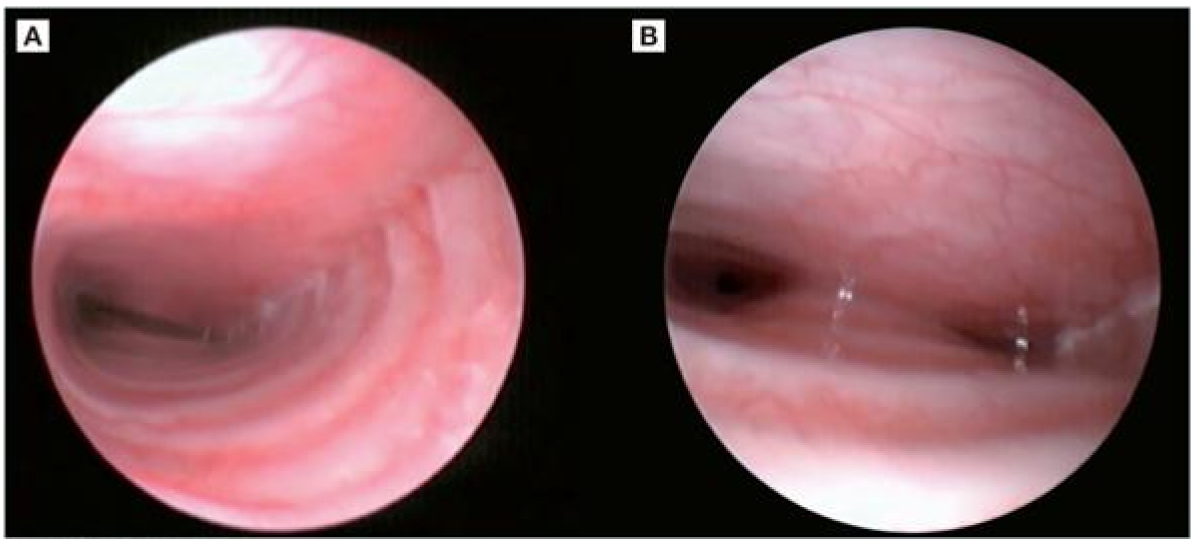


Fig. 2. Endoscopy in patients with tracheomalacia causing tracheal collapse: (A) Grade II-III, (B) Grade IV.

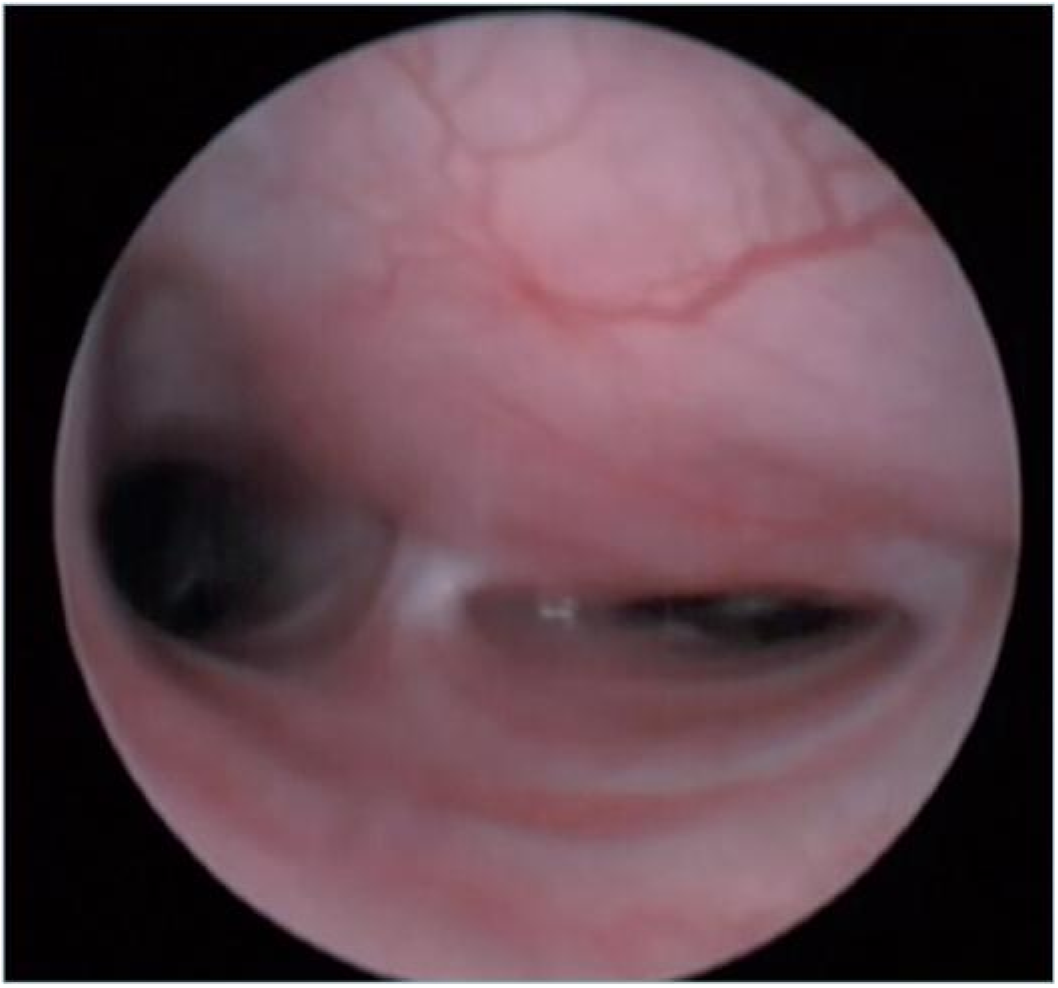


Fig. 3. In this case, the cartilages of the left bronchus are also affected. (The dog is in sternal decubitus position).

Conventional radiography is affordable for most vets and may be a good diagnostic test if used correctly. The radiographs should be taken during inspiration and expiration to visualize the cervical and thoracic changes (Fig. 4). A skyline projection of the caudal cervical region may also be performed to assess the degree of tracheal collapse (Figs. 5 and 6).

Lateral radiographs may give rise to false positive or false negative results due to poor positioning or technique, or because the cervical muscles or the esophagus become superimposed on the trachea.

The head and neck of the patient should be kept straight without excessive stretching (false image of tracheal narrowing) or flexion (dorsal curvature in the trachea).

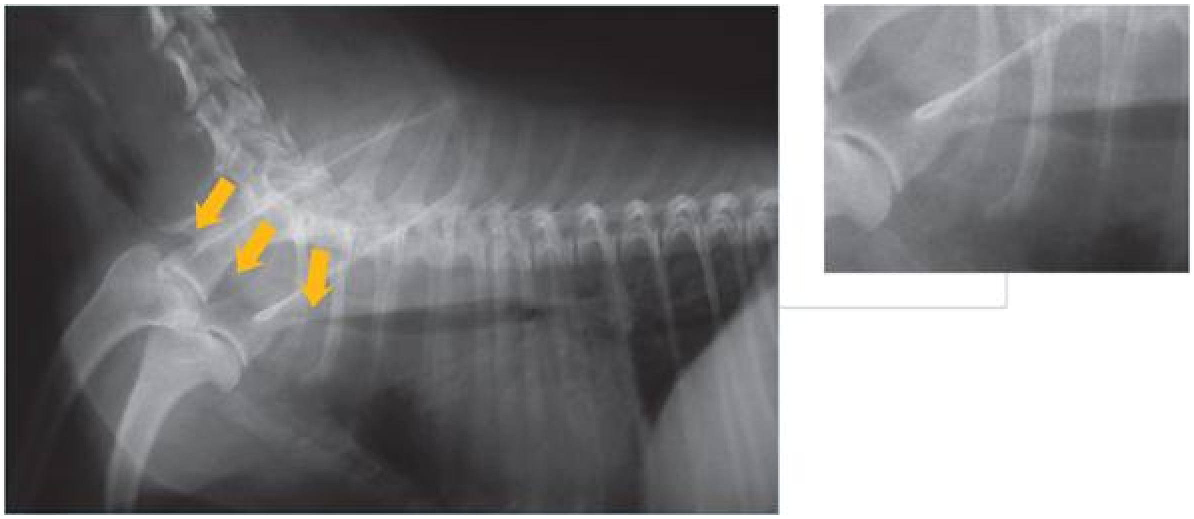


Fig. 4. Radiograph showing a tracheal collapse that mainly affects the caudal cervical region.

Fig. 5. On the skyline projection, the diameter of the caudal cervical segment of the trachea may be assessed. This image shows a normal trachea (arrow).

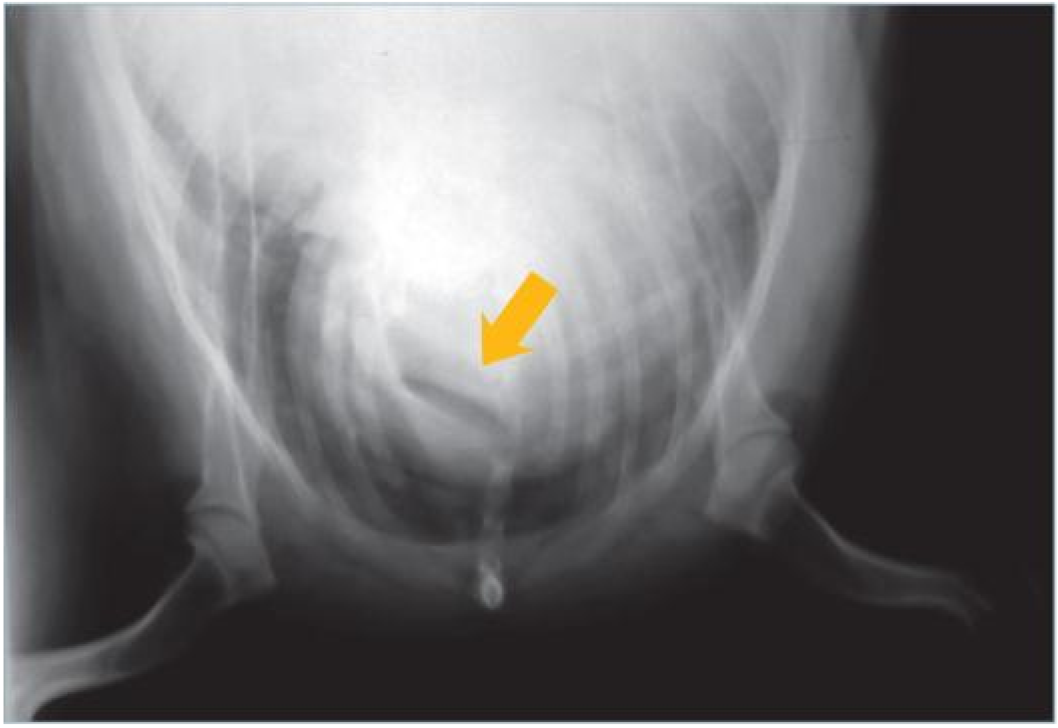


Fig. 6. A radiograph taken during inspiration in a patient with tracheal collapse shows that the caudal cervical segment is affected. Note the severe deformation of the trachea (arrow). Compare this image with Figure 5.

Thoracic radiographs in these patients may also show cardiomegaly due to concurrent cardiac changes. An electrocardiogram should be performed to detect possible sinus arrhythmia, cor pulmonale or left ventricular dilatation.

Ultrasonography is another useful diagnostic tool, but is difficult to interpret, due to the air in the lumen; it should therefore be performed by a specialist.

The differential diagnosis of tracheal collapse should include disease processes like tonsillitis, laryngeal paralysis, stenosis of the nares or trachea, everted laryngeal saccules, elongated soft palate, primary or foreign body bronchitis or tracheitis and chronic decompensated mitral valve insufficiency.

Therapeutic approach

The treatment of choice in these patients is medical. The main aim is to break the vicious cycle and prevent the disease worsening. Surgery is indicated in patients that do not respond to medical treatment and in those with severe collapse.

Patients with a grade I or II collapse can be controlled with medical treatment. Those with advanced grade II, grade III and grade IV will need surgery.

Medical treatment

First, all external factors that can be modified should be corrected: avoid contact with irritating factors like noxious gases, smoke or dust, put the animal on a diet (high fiber, low fat) to achieve the body weight that is indicated for the breed, and reduce physical activity. Concomitant diseases should also be treated, for instance bronchitis or heart failure.

Medical treatment aims to reduce the intensity and frequency of the secondary clinical symptoms, but remember that this is a progressive disease.

Medical treatment for grade I and II patients is based on:

- Antitussive drugs
  - Butorphanol (0.5-1 mg/kg/8-12h PO) is interesting because it has a sedative effect. The dose should be adjusted in each patient to achieve an antitussive effect without too much sedation.
  - Codeine (2-5 mg/kg/6-8h PO).
- Bronchodilators
  - Aminophylline (dogs: 10 mg/kg/8h PO, IM; cats: 5 mg/kg/12h PO).
  - Theophylline (dogs: 9 mg/kg/6-8h PO; cats: 4 mg/kg/8-12h PO).

- Terbutaline (1.25-2.5 mg/animal/8-12h PO).
- Corticoids. These may have secondary effects and predispose to respiratory infections. They are used during coughing bouts in acute cases of tracheal inflammation due to mechanical trauma.
  - Dexamethasone (0.2 mg/kg/12h IM, SC).
  - Prednisone (0.25-1 mg/kg/12-24h PO).
- Sedatives (for nervous and stressed patients).
  - Acepromazine (0.05-2 mg/kg/8-24h PO, IM or SC).
  - Diazepam (0.2 mg/kg/12h PO).
- Antibiotics (in case of associated infection).
  - Ampicillin (22 mg/kg/8h PO, IM or SC).
  - Cefazolin (20 mg/kg/8h IM).
  - Enrofloxacin (5-10 mg/kg/8h PO, IM or SC).
  - Clindamycin (11 mg/kg/12h PO, IM).
  - Oxygen therapy in patients with severe dyspnea, but only if it does not cause further distress.

A study in 100 patients with tracheal collapse showed good results with Lomotil (diphenoxylate hydrochloride and atropine sulfate)[1] in 71 % of cases, although the mechanism of action was not very clear; it is an option to be considered.

The veterinary surgeon should recommend the use of a harness instead of a collar, weight loss for obese animals and exercise restriction; the environment should be as free as possible from irritant products, smoke and allergens.

In the long term, the results of medical treatment are usually not very good, because degeneration of the cartilage is progressive.

Surgical treatment

Technical difficulty	■■■■□

Surgical treatment is indicated in patients with a lumen reduction of 50 % or more and in those that do not respond noticeably to the medical treatment.

Numerous surgical techniques have been described to solve this problem. Corrective chondrotomy that transforms the elliptical lumen into a pyramidal shape is efficacious if the cartilage is still sufficiently rigid to maintain this shape, while most patients have very flaccid cartilage. Plication of the dorsal membrane with mattress sutures improves the tracheal shape but reduces its diameter in small patients. In 1976 the first use of an external annular prosthesis was described, using small syringes. Recently, there have been descriptions of the use of metallic stents in the tracheal lumen to maintain its diameter.

> ***Medical treatment rarely gives good long-term results because the cartilaginous degeneration progresses over time.***

Surgical treatment (with extraluminal Fig. 8 or intraluminal) is based on the support of the cartilages and the trachealis muscle prostheses, this can achieved using conventional surgery or minimally invasive surgery for their placement, without altering mucociliary clearance.

Follow-up of the patient

The owners should be informed that their pet suffers from a progressive disease and that the symptoms may become worse. The duration of the benefits obtained from surgery varies from case to case. It is important that periodic checkups are planned to eliminate risk factors and concurrent lesions that aggravate and accelerate the progression of the tracheal collapse.

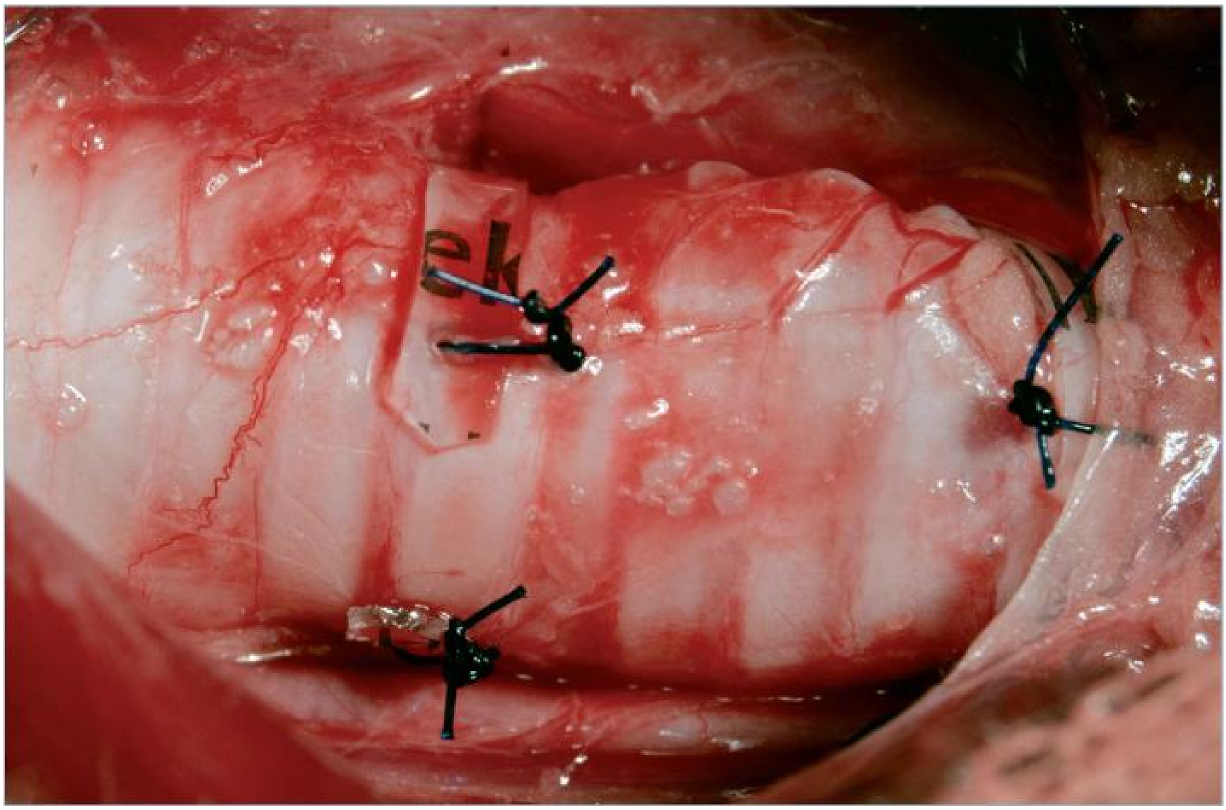


Fig. 7. Extraluminal prostheses to maintain the tubular shape of the trachea.

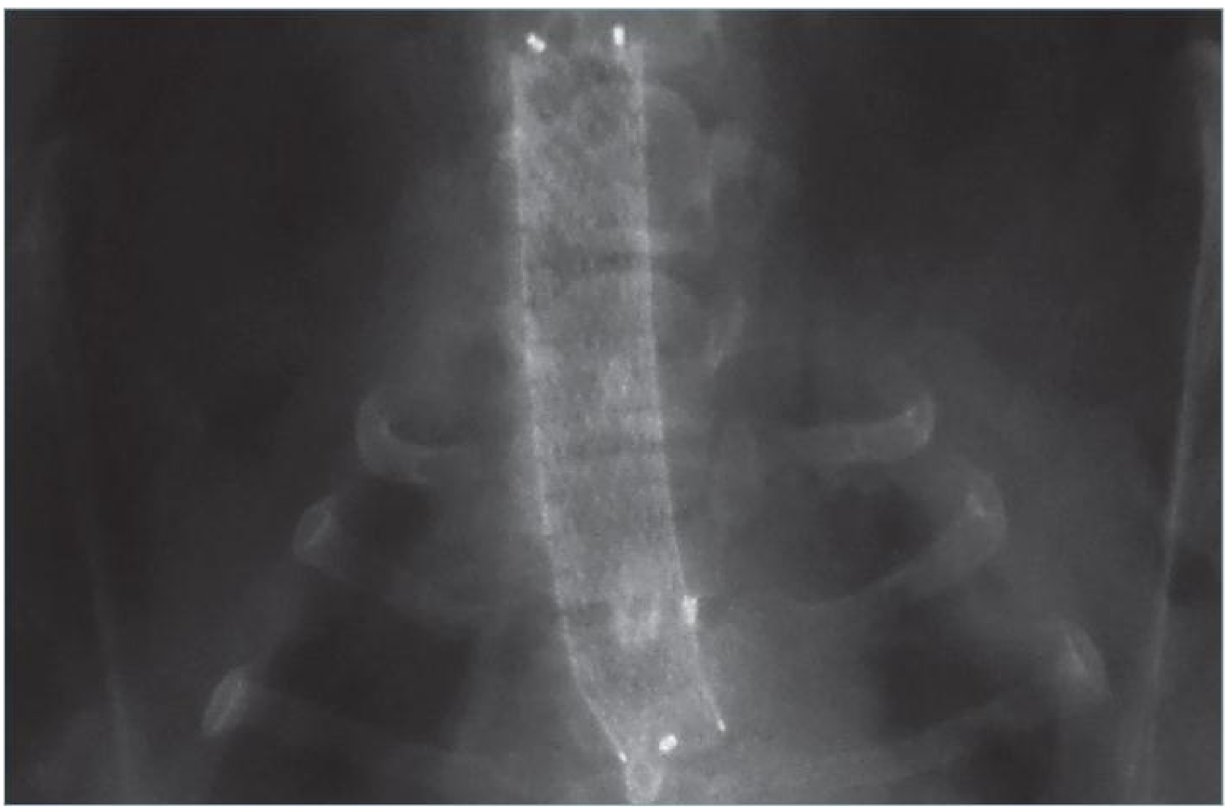


Fig. 8. Stent in the cranial thoracic region for treatment of a collapse that mainly affected that area.

[1] White, R.A.S., Williams, J.M. Tracheal collapse in the dog. Is there really a role for surgery? A survey of 100 cases. *J Small Anim Pract*, 1994. No. 35: 191-196.

Tracheal collapse. Extraluminal cervical tracheoplasty

José Rodríguez, Carolina Serrano, Rocío Fernández, Amaya de Torre

Technical difficulty

The aim of extraluminal cervical tracheoplasty is to offer support to the cartilages and trachealis muscle without affecting the segmental innervation and vascularization of the trachea.

Before surgery

Preparation of the prostheses

The ring-shaped prostheses that will be used in the tracheoplasty are prepared from a 2 or 5 mm syringe. The syringe is cut with a scalpel or scissors in segments that are approximately 5 mm wide. Each cylinder is then cut lengthwise to enable placement around the trachea. All edges and sharp borders should be rounded off with a scalpel and a small file (Figs. 1 and 2) to avoid tissue injury.
The rings are then washed well and put into an autoclave bag to be sterilized (avoid chemical sterilization).

Patient preparation

It is recommended to administer prophylactic antibiotics during the induction of the anesthesia, e.g. cefazolin (20 mg/kg) IV, and repeat the

dose every 8 hours after surgery.
Corticosteroids should be used to reduce inflammation of the tracheal mucosa caused by the sutures of the prostheses.
The patient should also be pre-oxygenated before induction of anesthesia and tracheal intubation.

Surgical procedure

The patient is placed in dorsal recumbency with the neck in hyperextension over a roll (for instance a rolled-up towel) to facilitate manipulation of the trachea (Fig. 3).

https://player.vimeo.com/video/180708266

Watch this video

Extraluminal tracheoplasty

Important anatomical references:

- ***The blood supply and innervation to the trachea are segmental and arise from vessels and nerves that run on each side of the trachea.***
- ***The left recurrent laryngeal nerve is located in the lateral pedicle, very close to the trachea.***
- ***The right recurrent laryngeal nerve is usually located in the carotid sheath.***

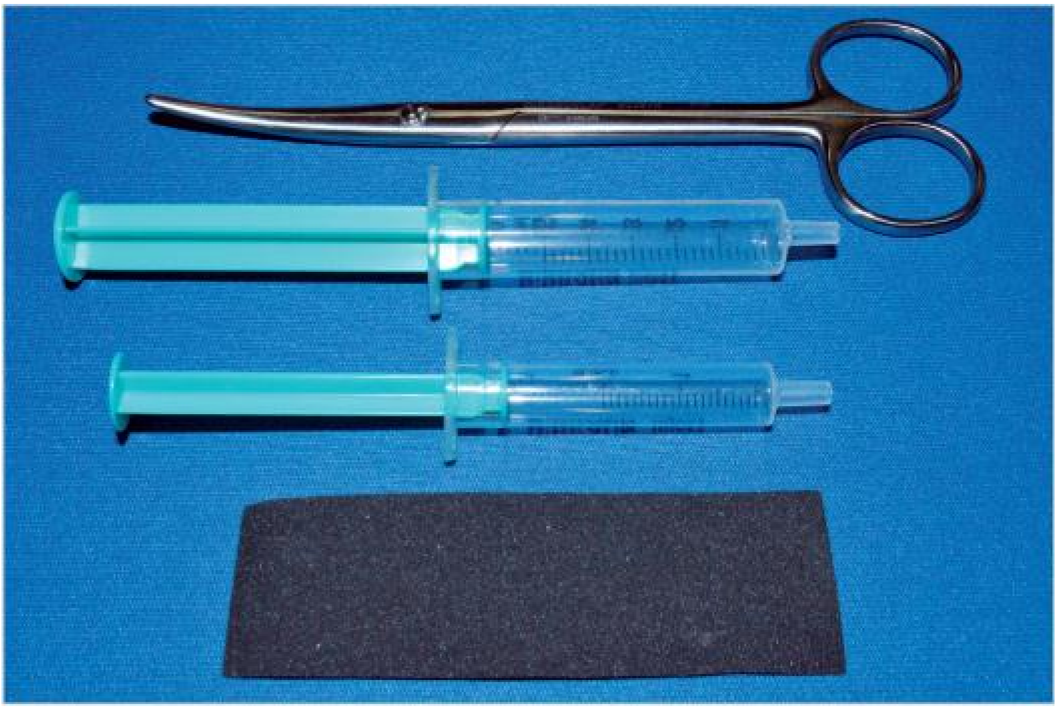


Fig. 1. The material required for making tracheal prostheses.

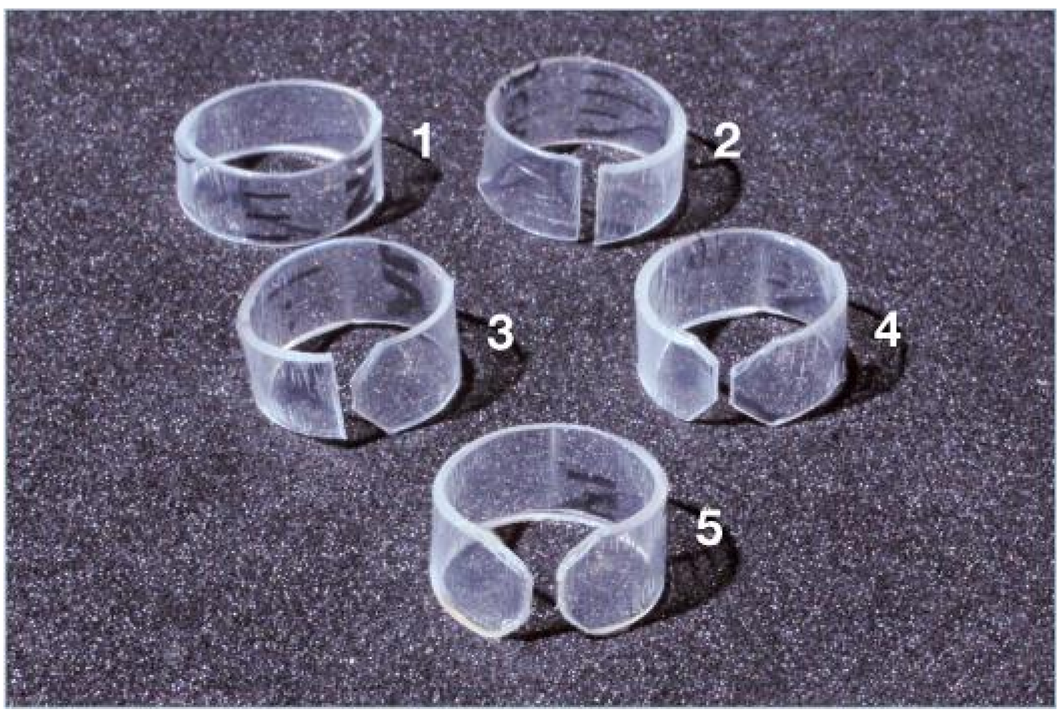


Fig. 2. This image shows the steps in the preparation of the rings. After filing off the sharp edges and rounding off the borders of each prosthesis, they should be cleaned and sterilized.

Fig. 3. Preparation of the operating field. The animal has been placed in dorsal recumbency with the neck in hyperextension (a rolled towel under the neck achieves correct positioning of the trachea).

The skin and subcutaneous tissue are incised from the larynx to the manubrium sterni. Following this, the sternohyoideus and sternocephalicus muscles are dissected along the midline to expose the trachea (Fig. 4).

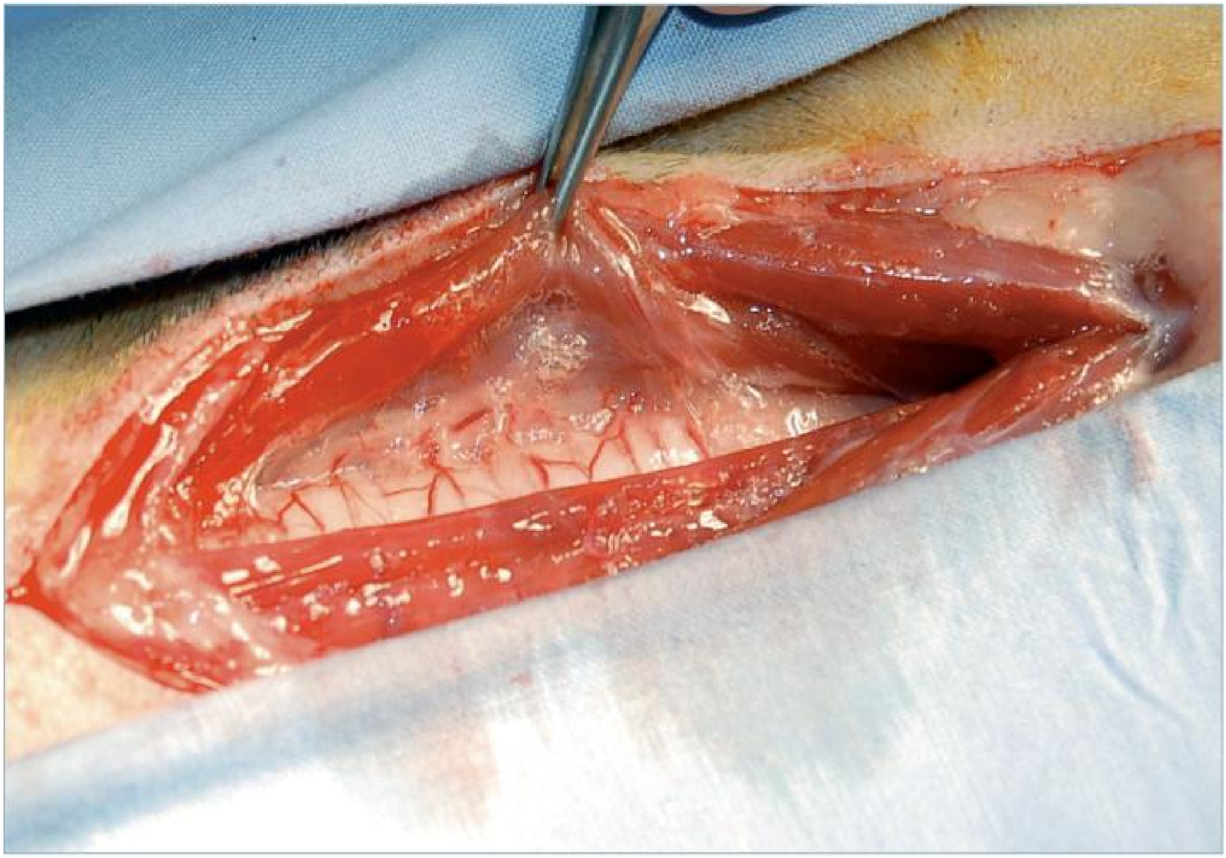
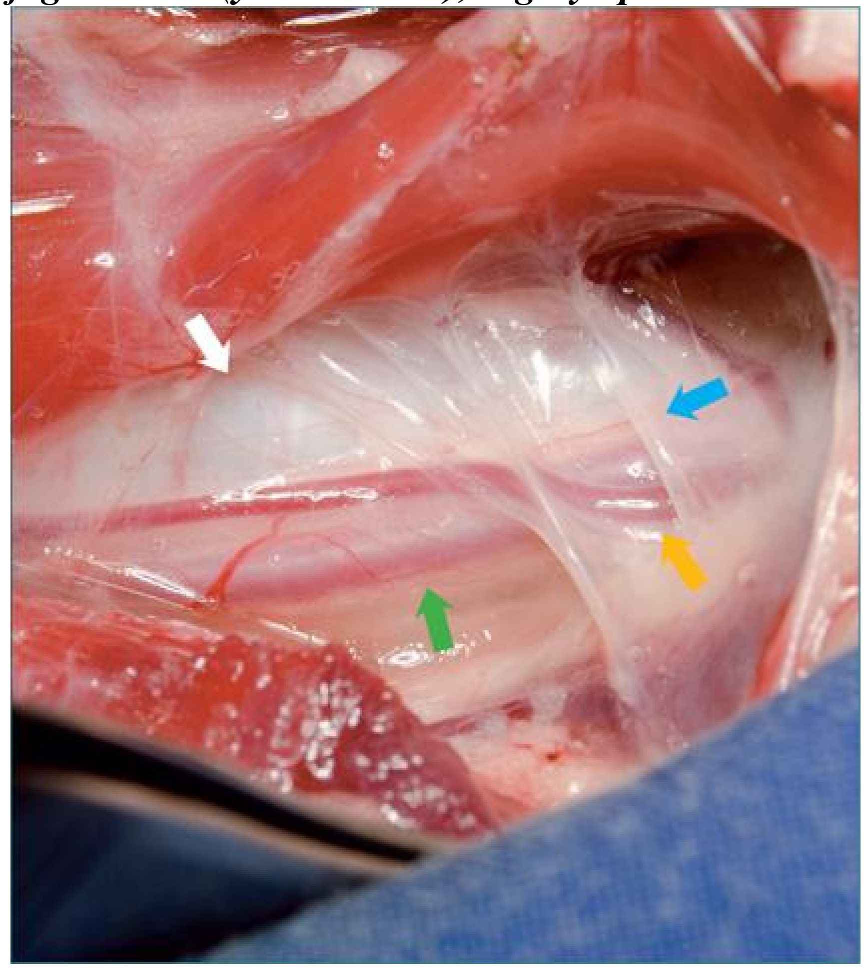


Fig. 4. To access the trachea, the skin is incised and the sternohyoideus and sternocephalicus muscles are dissected along the midline.

*

Great care should be taken when dissecting the trachea to preserve the vessels of the blood supply and the nerves that innervate it.
This image shows the dissection of the caudal cervical trachea: trachea (white arrow), carotid artery (green arrow), internal

jugular vein (yellow arrow), vagosympathetic trunk (blue arrow).



To reduce the risk of damage to the left recurrent laryngeal nerve, the trachea is mainly dissected on the right side, while limiting the maneuvers on the other side to a minimum (Fig. 5). Dissection is performed in small segments to conserve the blood supply to the trachea (Fig. 6).

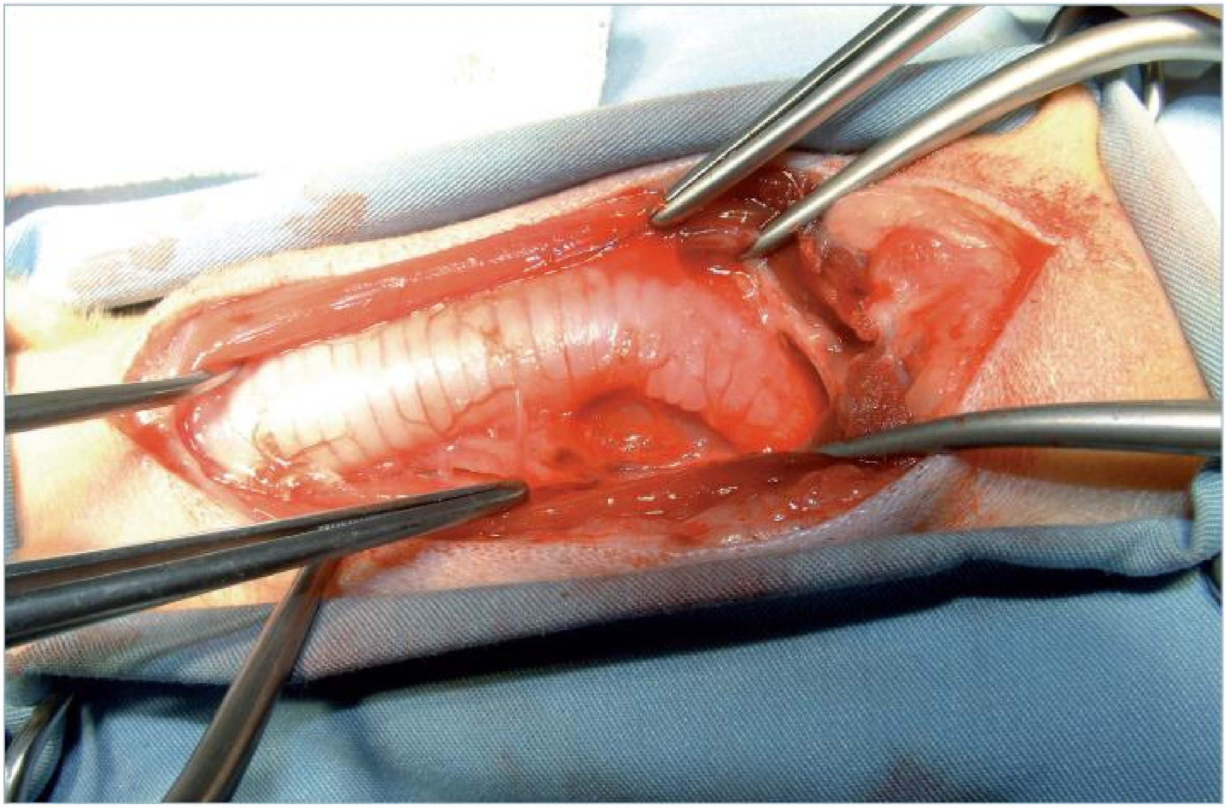


Fig. 5. Dissection of the trachea to gain access to the dorsal side is mainly performed on the right side to avoid damage to the left recurrent laryngeal nerve.

The dissection on the right side is segmental, to avoid damage to the blood supply of this area, while permitting rotation of the trachea to visualize the dorsal side when placing the sutures of the prostheses in that area.

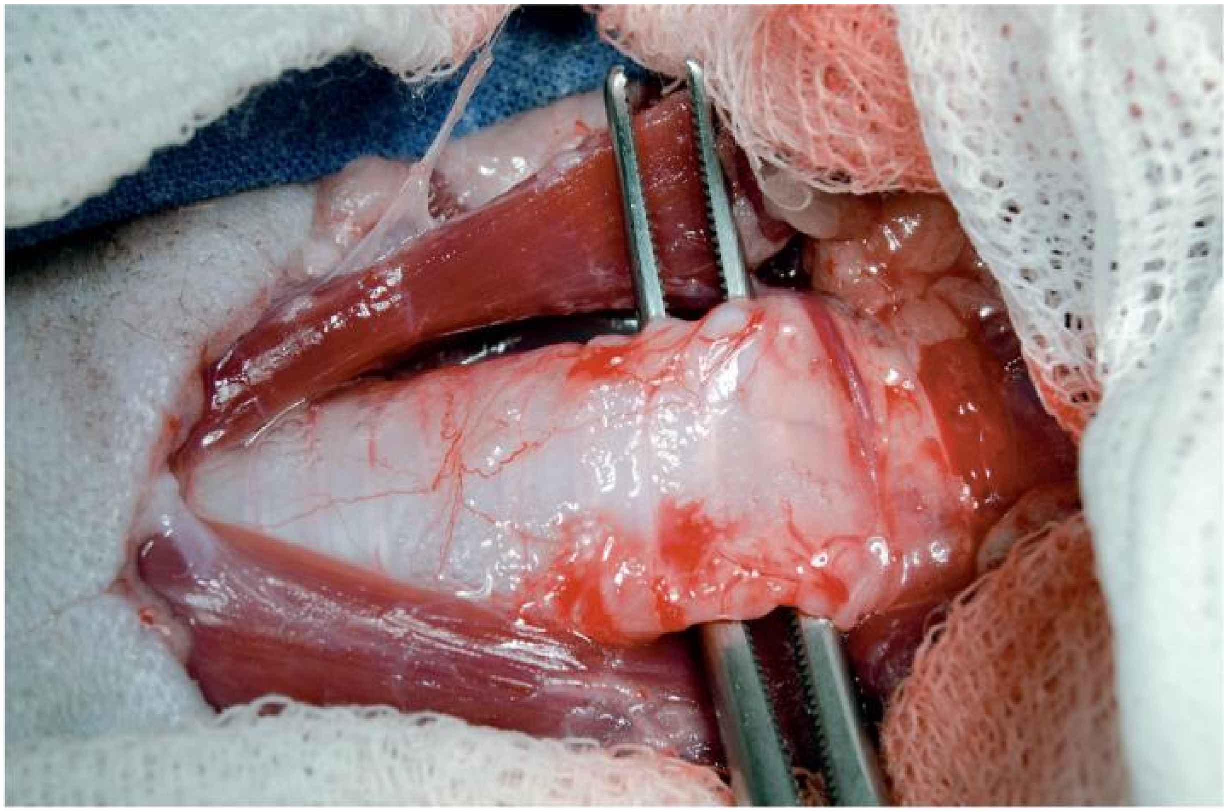


Fig. 6. The trachea should be dissected in small segments to minimize damage to the blood supply.

Dissection should be careful and precise so as to avoid damage to the recurrent laryngeal nerve leading to iatrogenic laryngeal paralysis.

On the left side, a tunnel is created around the trachea and the prosthetic ring is guided with a dissector (angled forceps) or curved long artery forceps to place it around the trachea (Figs. 7 and 8).
Next, the prosthesis is sutured to the trachea with several simple sutures using synthetic monofilament non-absorbable material. The sutures are distributed evenly around the trachea, partially rotating the trachea to access the dorsal side (Figs. 8-11).

The trachealis muscle should be sutured to the prosthesis to keep it from obstructing the tracheal lumen.

The surgeon should ensure that the endotracheal tube is not included in the sutures that fixate each prosthetic ring to the trachea.

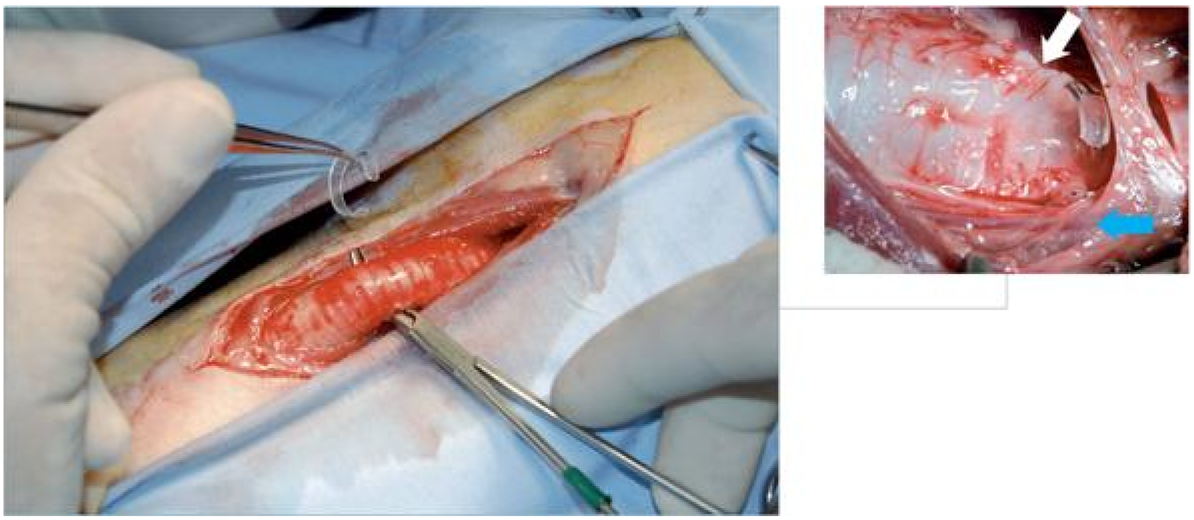


Fig. 7. With long artery forceps the prosthesis is passed around the trachea, taking great care not to damage the peri-tracheal structures (blue arrow). On the close-up it can be observed that the tracheal rings are so slack that they become inverted when the prosthesis is introduced (white arrow).>

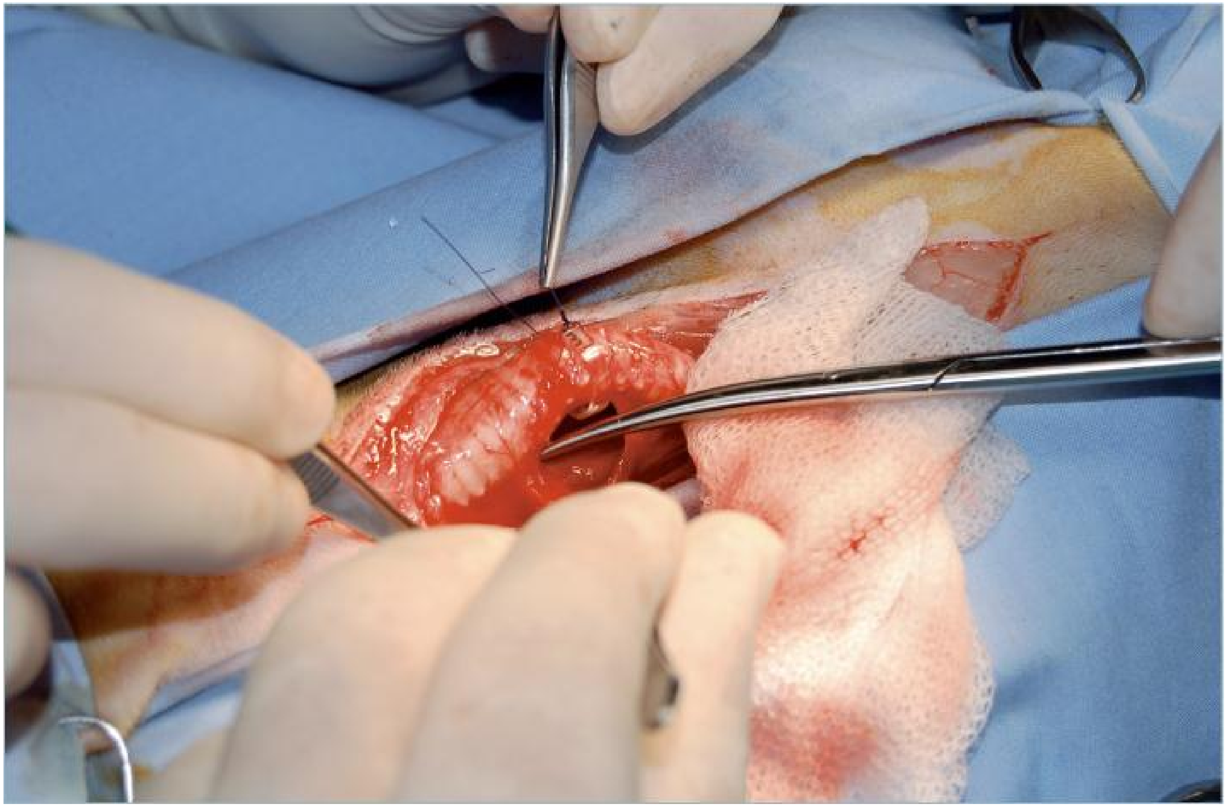


Fig. 8. The prosthesis is sutured to the tracheal ring on its ventral side and the rest of the sutures are evenly distributed around the trachea. In this image, the dissection is extended to visualize the lateral and dorsal sides of the trachea.

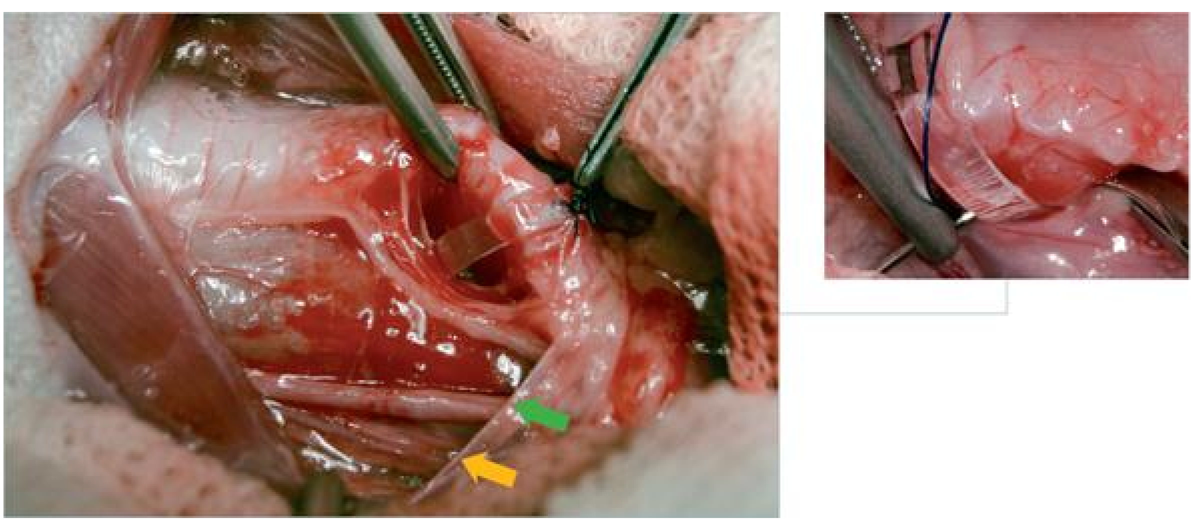


Fig. 9. By traction on the lateral suture, the trachea is partially rotated to gain access to the dorsal side and fix the trachealis muscle to the prosthesis. The structures close to the trachea should be identified: vagosympathetic trunk

(blue arrow), carotid artery (green arrow), internal jugular vein (yellow arrow).

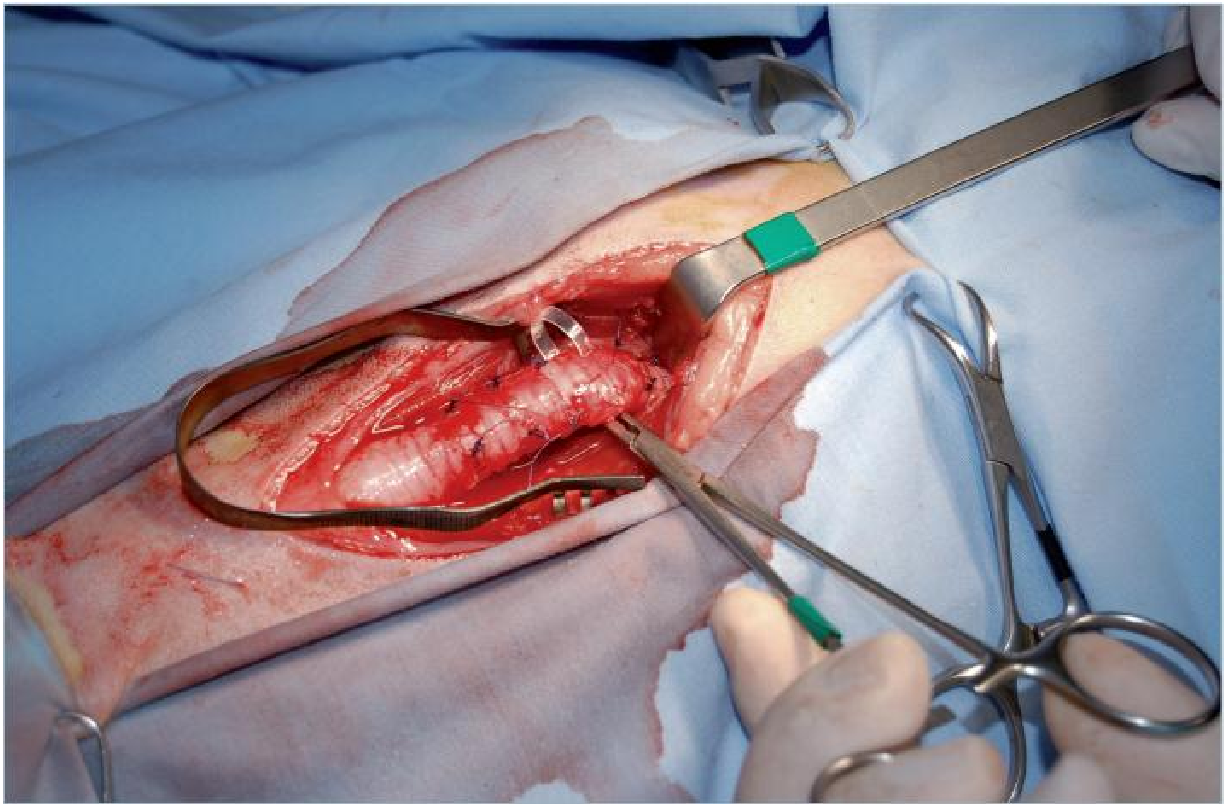


Fig. 10. The prosthetic rings are distributed every 10-15 mm along the affected segment to help the trachea regain its normal shape.

> ***To place one or two rings at the thoracic inlet, the trachea can be pulled forward by traction on one of the prosthetic rings that has already been sutured in place.***

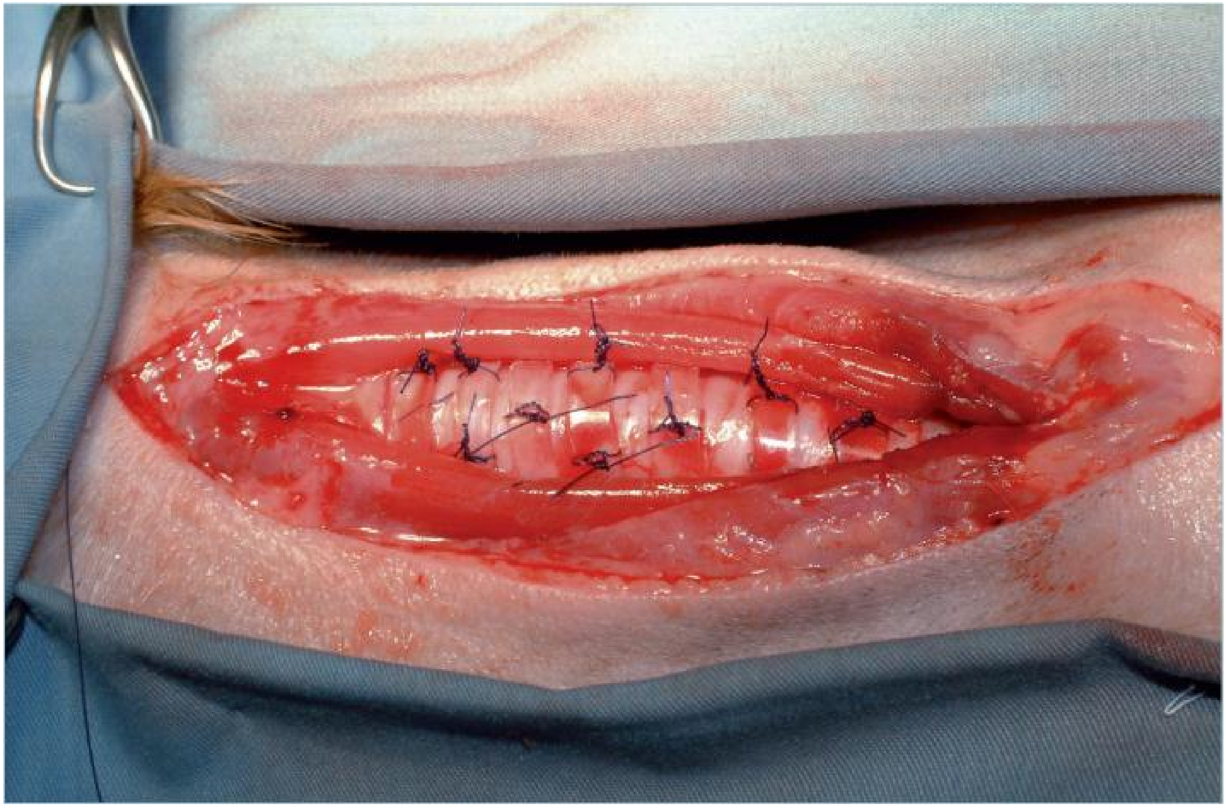


Fig. 11. Final result after placement of the prosthetic rings in the cervical area of the trachea.

An alternative to the use of individual rings is a spiral-shaped prosthesis (Fig. 12). In the authors' experience, this technique is more difficult and causes more tracheal ischemia and other complications, so is not recommended.

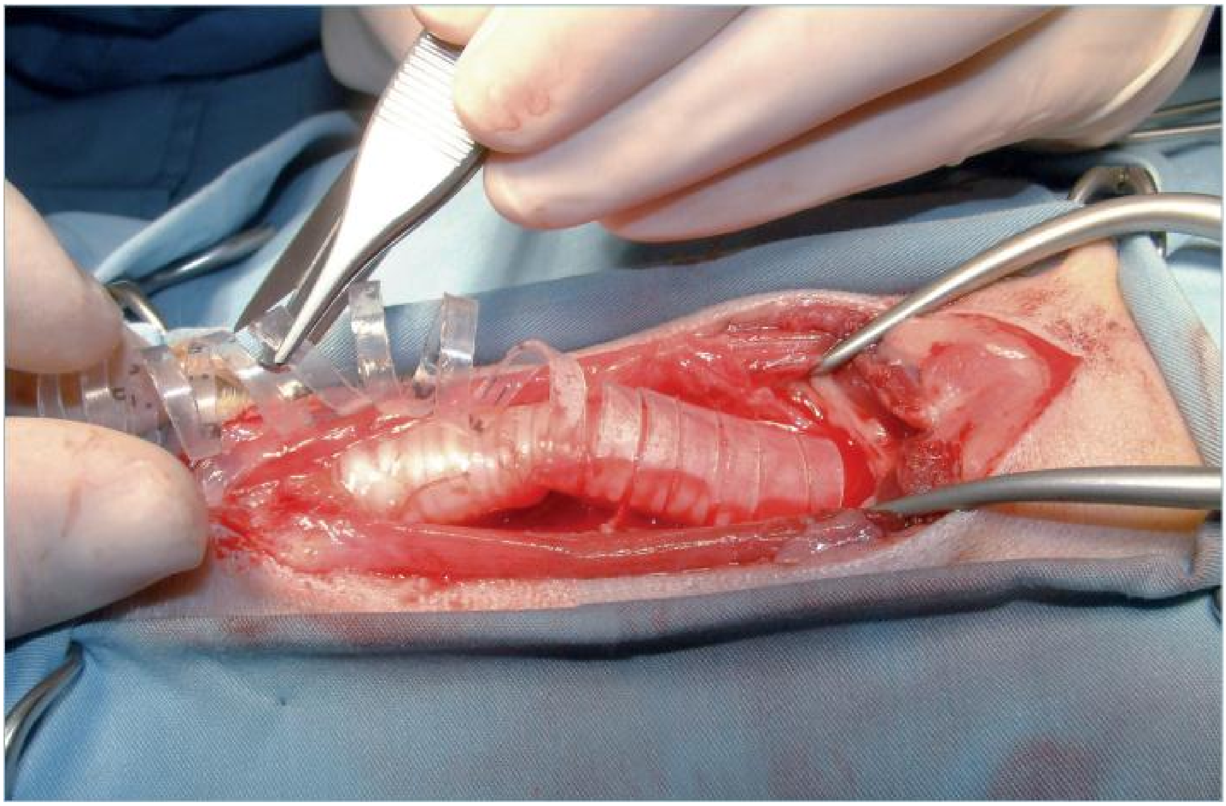


Fig. 12. Placement of a spiral-shaped tracheal prosthesis. This technique requires more handling of the trachea and the surrounding tissues with an increased risk of postoperative complications.

Finally, the surgical field is flushed with sterile saline, the dissected muscle planes are apposed with simple interrupted sutures and the subcutaneous tissue and the skin are sutured with the technique of the surgeon's choice (Figs. 13 and 14).

The success of the operation depends upon the experience and skill of the surgeon.

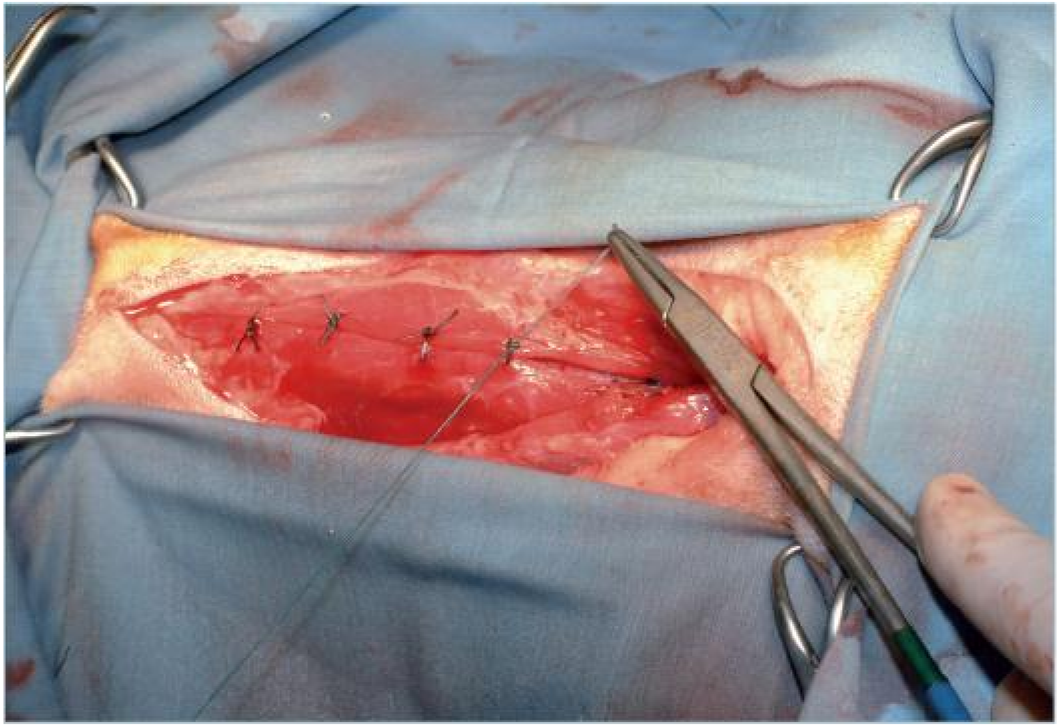


Fig. 13. The sternohyoideus and sternocephalicus muscles are sutured with synthetic absorbable material.

Fig. 14. The surgeon’s technique of choice is used for apposition of the subcutaneous tissue and the skin.

After surgery

- To enhance recovery, oxygen should be supplied via a nasal cannula and corticoids administered.
- The recovery of these patients should be monitored constantly to detect possible respiratory complications.
- The medical treatment used prior to surgery (antitussive drugs, bronchodilators, antibiotics) should be maintained as necessary in each case.

It is possible that for several weeks there is no noticeable clinical improvement due to the postoperative peritracheal inflammation and the irritation produced by the sutures in the mucosal trachea.

In most cases, the quality of life of the patient improves even if the clinical symptoms do not disappear completely.

This operation can improve the clinical symptoms in the long term: in 84 % of patients coughing is reduced, in 80 % dyspnea is reduced, in 55 % the activity level improves and in 60 % respiratory infections are reduced[1].

Possible complications of a tracheoplasty

- Infection of the prosthesis through colonization by tracheal bacteria.
- Tracheal necrosis, if the lateral sides are dissected excessively.
- Laryngeal paralysis due to injury to the recurrent laryngeal nerves.

The surgeon should take all possible precautions to avoid these complications.

The prognosis for patients with tracheal collapse is directly associated with the severity of the tracheal lesion and with the presence of risk factors such as obesity and concomitant disease.

In patients under 6 years of age, the collapse is usually more severe, but the postoperative prognosis is better.

[1] Tangner, C.H., Hobson, H.P. A retrospective study of 20 surgically managed cases of collapsed trachewa. *Vet. Surg.*, 1982. No. 11:146-149.

Tracheal collapse. Intraluminal tracheoplasty

Carolina Serrano

Technical difficulty ■■■□□

If a dog with tracheal collapse does not respond to medical treatment, surgical treatment is indicated (Fig. 1). Many surgical techniques have been described, such as chondrotomy of the tracheal rings, plication of the dorsal membrane, resection and anastomosis, or extraluminal prostheses. The latter is the most commonly used technique, because it offers support to the trachea without interfering with its physiological function. These treatments are limited to certain locations, because they can only be used in cases of collapse of the cervical trachea. They may also cause important complications such as tracheal necrosis or infection, or laryngeal paralysis.

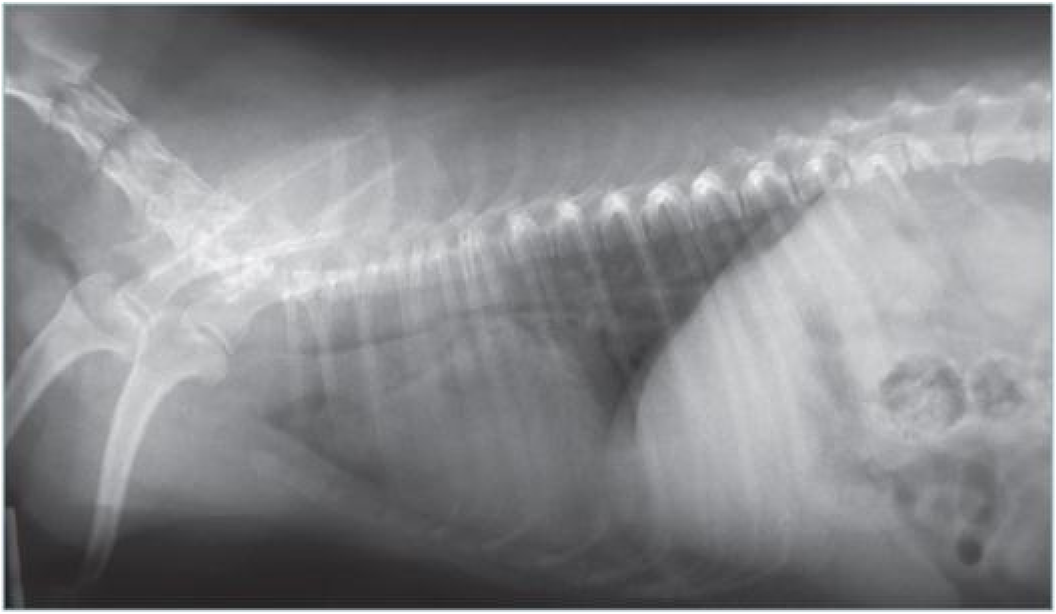


Fig. 1. Patient with a tracheal collapse affecting mainly the intra thoracic trachea. The patient did not respond well to medical treatment. In these patients intraluminal tracheoplasty should be considered.

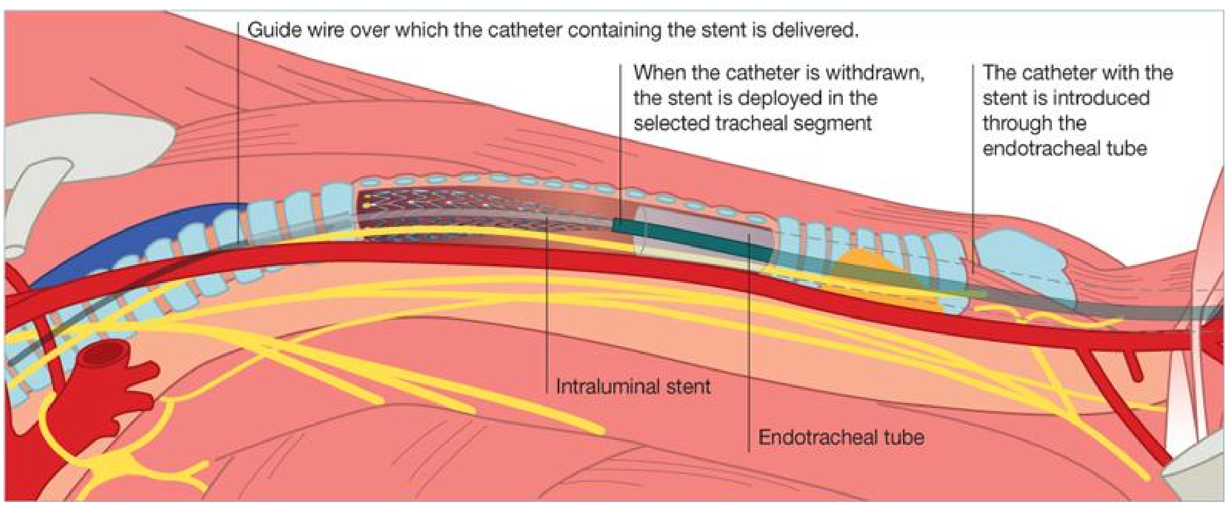


Fig. 2. Schematic drawing showing the deployment of a self-expandable metallic stent in the trachea.

To select treatment for each case, the location, degree, length and diameter of the collapse should be considered.

Compared with conventional surgical treatment, the implantation of a self-expandable metallic stent for treatment of tracheal collapse offers some advantages (Figs. 2 and 3).

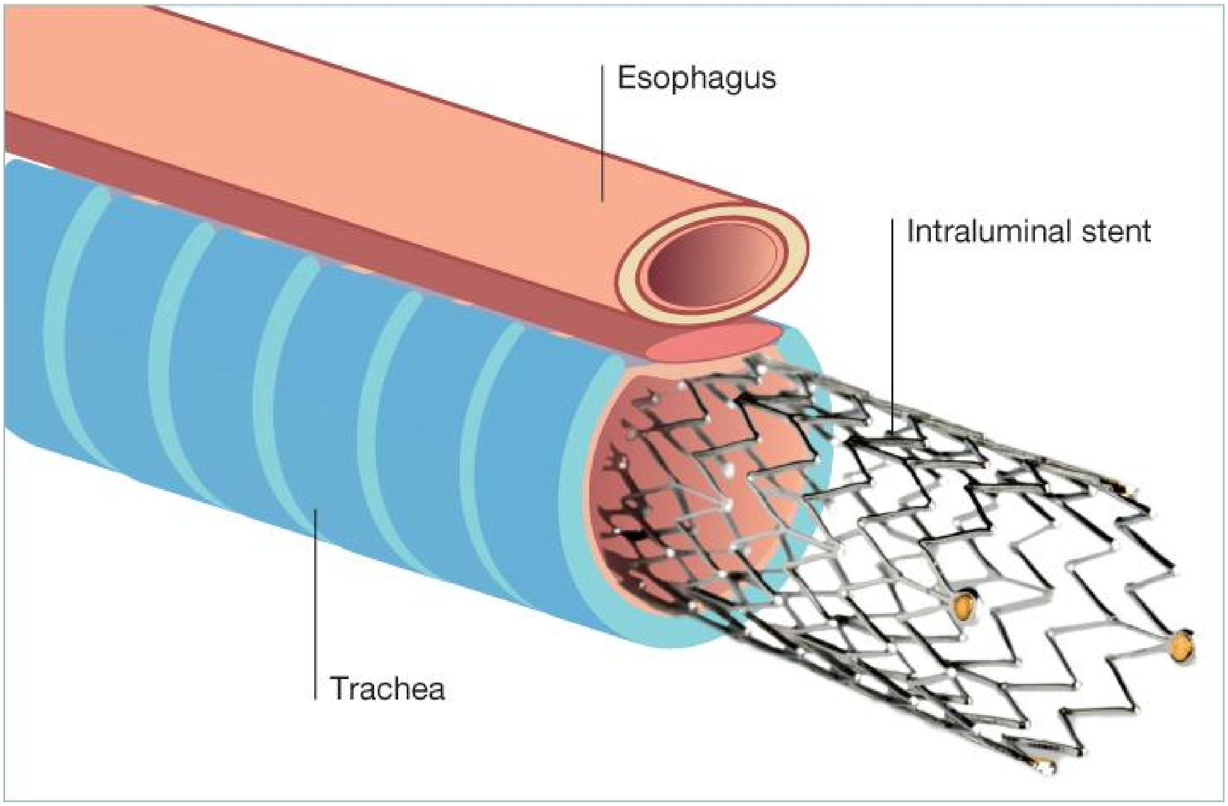


Fig. 3. Self-expandable metallic stent placed in the trachea.

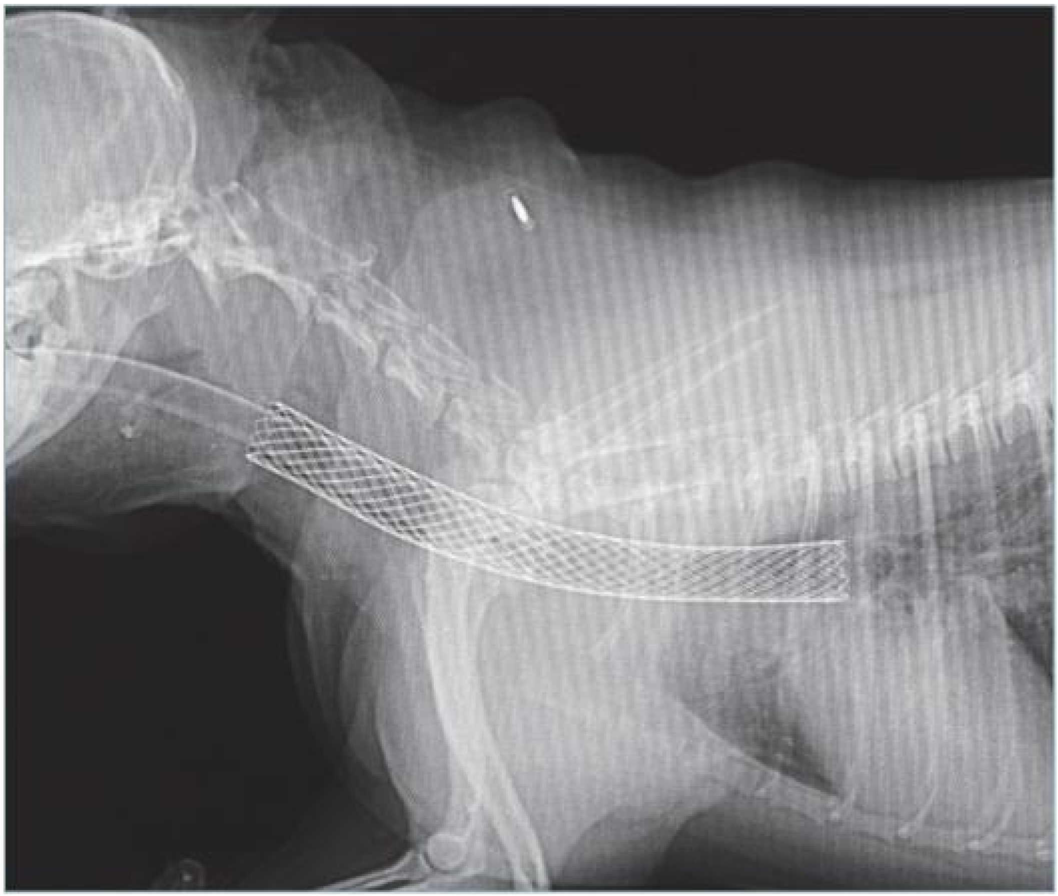


Fig. 4. Nitinol self-expandable stent in a patient that presented a tracheal collapse that was mainly located in the cranial thorax.

Characteristics of the ideal stent
Easy to deliver and deploy.
Sufficient radial force to keep the trachea open and avoid migration.
High elasticity to avoid material fatigue.
Good longitudinal flexibility.
Good biocompatibility to avoid formation of granulation tissue or infection and to maintain mucociliary clearance.

It is a fast and minimally invasive method that eliminates the risk of surgical complications following manipulation of the outside of the trachea, produces an immediate improvement and reduces recovery time (Fig. 4).

Placement of intraluminal prostheses (stents)

Image-guided, minimally invasive surgery using fluoroscopy makes it possible to access the interior of the trachea and place intraluminal devices while reducing injury to a minimum.

Tracheal endoprosthesis placement by minimally invasive surgery is a rapid alternative that avoids dissection around the trachea and the complications of conventional surgery.

This surgical alternative is mainly indicated in patients with extensive intrathoracic collapse or those that are poor candidates for conventional surgery.

There are two types of metallic stents:

- Stents with a fixed diameter, which need a dilatation balloon.
- Self-expandable stents that have a predetermined diameter and adjust well to different diameters of the trachea. They may be covered or bare (Fig. 5). There are specific size stents based on radiographic/fluoroscopic measurement of the tracheal diameter.

Deployment of self-expanding stents is easy and fast, guided by fluoroscopy. The balloon-expandable stents are more likely to migrate.

The main disadvantage of the use of self-expandable metallic stents in the bronchotracheal tree is the foreign body reaction they provoke in the trachea and the accumulation of secretions due to changes in the epithelium. Other complications are also possible, for instance: pneumonia, chronic

cough, erosion of the epithelium, stent migration or rupture, and restenosis due to reactive hyperplasia of the tracheal epithelium.
The literature describes the use of different types of stents, in particular two: stainless steel and nitinol.

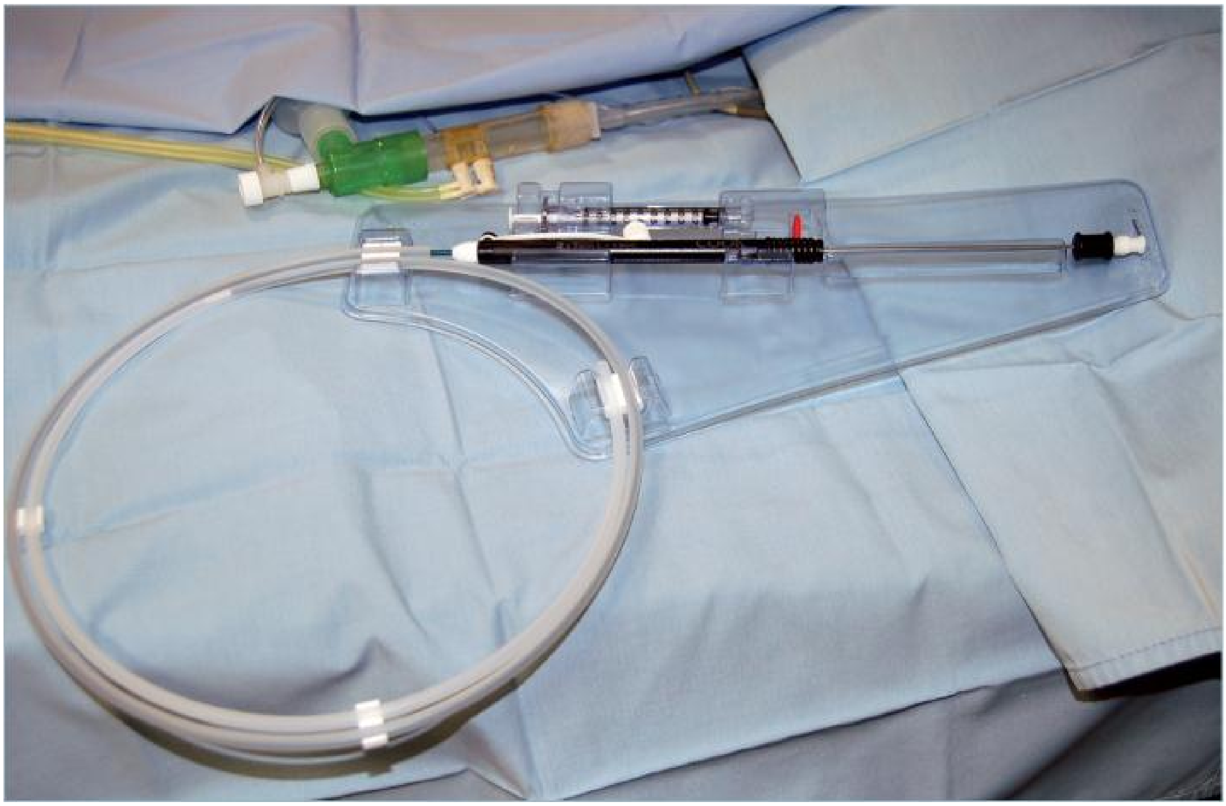


Fig. 5. Nitinol stent ready to be introduced through the endotracheal tube.

Surgical technique

The key factor in this technique is determining the correct diameter and length of stent to be used. The diameter is measured by introducing a marker catheter in the esophagus (Fig. 6). The length of the lesion is determined beforehand by fluoroscopy on a conscious patient; if this is impossible, a bronchoscopy should be performed to measure the distance between the beginning and end of the collapse.
The measurements are taken during an inspiration that is maintained by the anesthetist to avoid pulmonary lesions, peak inspiratory preassure should

not exceed 20 cm H_2O. Remeber that the diameter of the cervical trachea is wider than in the thoracic segment.

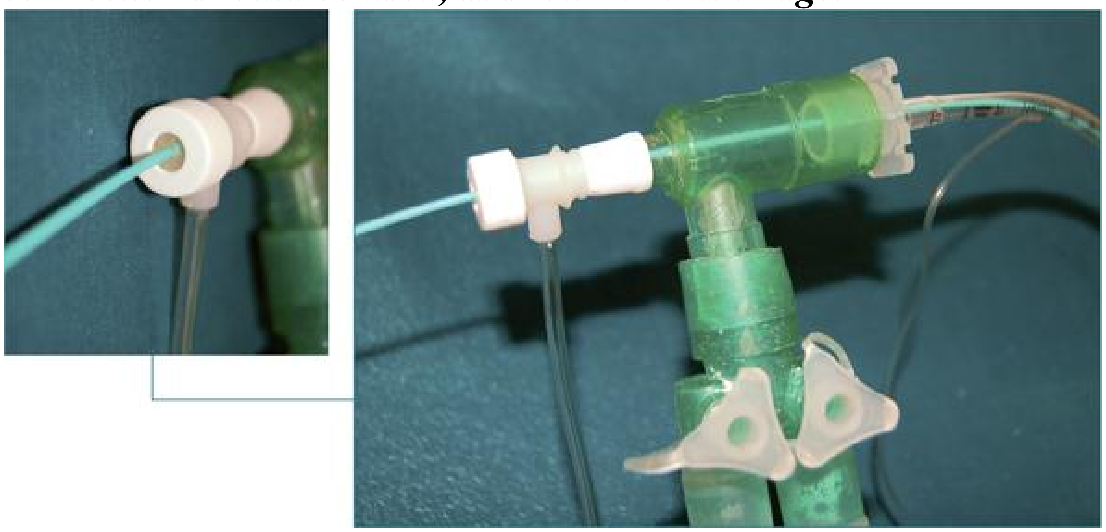
The stent diameter should be 10 % wider than the maximum diameter calculated on both sides of the collapse. It should be 1 cm longer than the length of the collapse.

The delivery system of the stent is introduced, under fluoroscopic control, to the correct location and the prosthesis is deployed (Figs. 2, 4 and 6).

Fig. 6. To determine the size and length of the stent, the normal trachea and the collapsed area should be measured. This is done by introducing a

marker> catheter into the esophagus, with radiopaque markings spaced one centimeter apart.

To introduce the catheter through the endotracheal tube, a T-connection should be used, as shown in this image.



After surgery

The following postoperative complications may occur:

- In the short term:
  - Cough.
  - Tracheal hemorrhage.
  - Tracheal perforations, pneumomediastinum.
- In the long term:
  - Excessive granulation tissue formation.
  - Shortening of the prosthesis.
  - Stent rupture.
  - Progressive tracheal collapse.

https://player.vimeo.com/video/180708289

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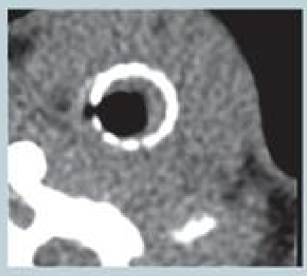
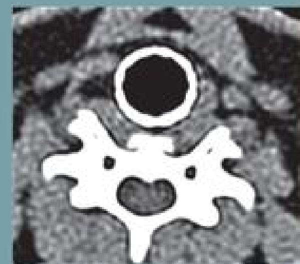
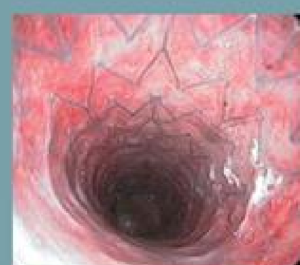
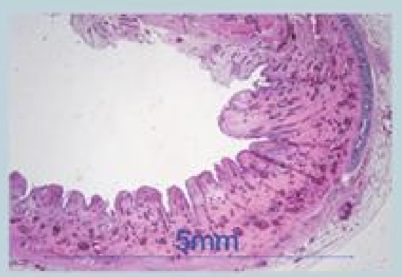
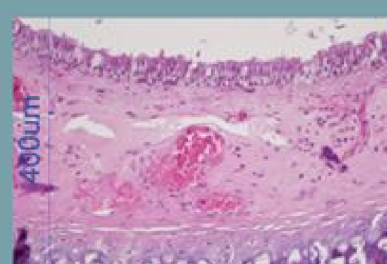
Intraluminal tracheoplasty

The authors have studied the response of the tracheal wall to two types of stent (stainless steel and nitinol). The illustration below shows the results.

In the authors’ experience, the tissue reaction of the tracheal wall to a self-expandable metallic stent of braided stainless steel is more significant than that to a nitinol self-expandable metallic stent. Therefore, in those patients that will benefit from image-guided minimally invasive surgery, the recommended option would be a nitinol self-expandable metallic stent.

Study of the tracheal reaction to self-expanding stents

	Stainless steel stent	Nitinol stent
Computerized tomography 90 days after surgery		
	Annular overgrowth that occupies part of the tracheal lumen.	Clear tracheal lumen.
		
	Overgrowth at the proximal end of the stent.	Clear tracheal lumen.
Tracheal endoscopy 90 days after surgery		
	Retention of secretions and annular thickening at the end of the stent.	Complete and homogeneous re-epithelization.
Histopathological study 90 days after surgery		
	Thickening of the tracheal wall and formation of invaginations.	The appearance is similar to that of a normal trachea.

Urethral stenoses

José Rodríguez

Prevalence	■	■	□	□	□

Urethral stenosis can be caused by fibrosis due to urethritis following recurrent urolithiasis or prior surgery, as well as external trauma and wounds (bite wounds, cuts…) (Figs. 1 and 2). Extrapelvic stenoses should be resolved by permanent urethrostomy at the site of the stenosis.

5 % of dogs suffering from pelvic trauma (mainly due to road traffic accidents) have urethral lesions. A possible rupture should be considered when attending these patients.
If this is the case, a urinary catheter should remain in place for 4 or 5 days.

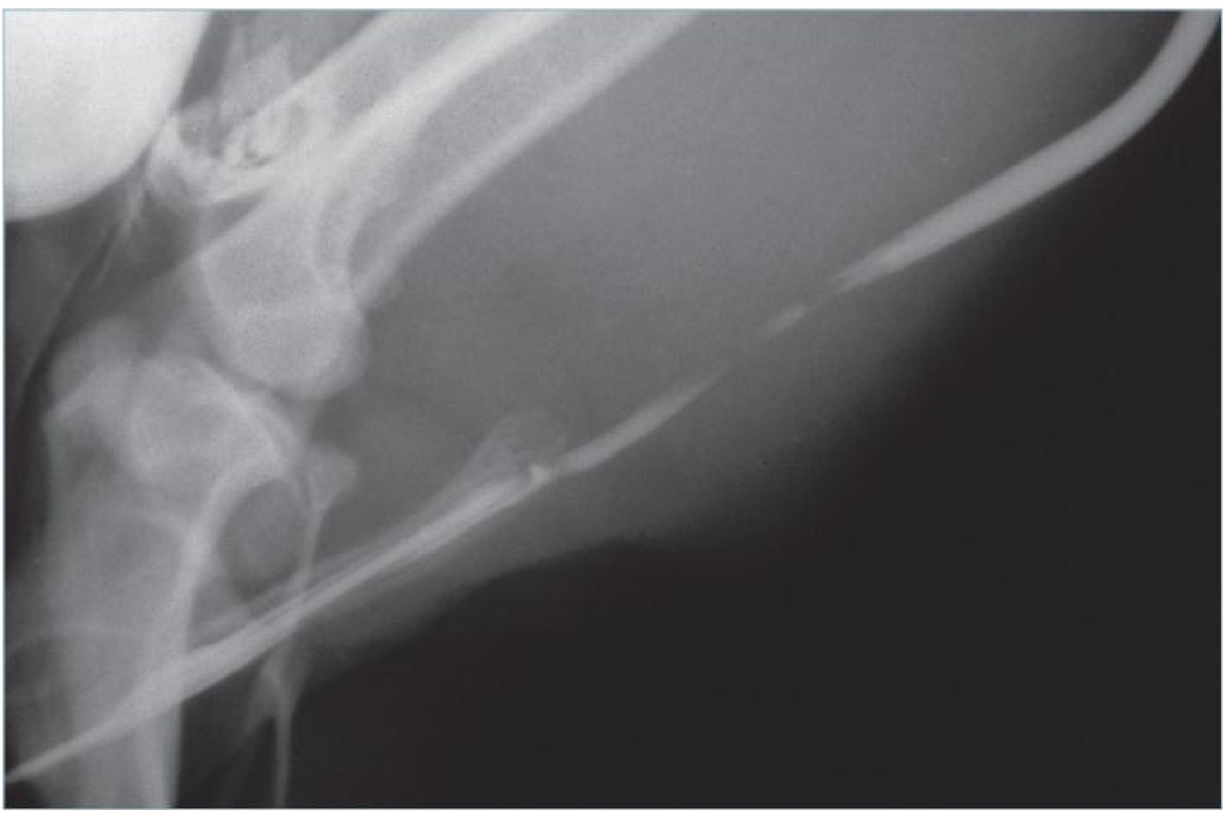


Fig. 1. In this case, marked stenosis of the urethra is observed caudal to the os penis. Cause of the stenosis was previous urethral surgery.

Fig. 2. Rupture of the intrapelvic urethra as a result of a pelvic fracture. The patient should be catheterized to avoid leakage of urine and thereby limit secondary scar formation.

Case / Scrotal urethrostomy

Technical difficulty ■■■□□

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Scrotal urethrostomy

"Jan" is an 8-year-old mixed-breed dog that has had problems urinating for 2 weeks. At first, he could still urinate with effort, but now only a few

drops are passed.

Radiography

Urohydropropulsion, the standard protocol for this type of obstruction, is performed to move the stone into the bladder so it may be extracted via cystotomy (Fig. 2).

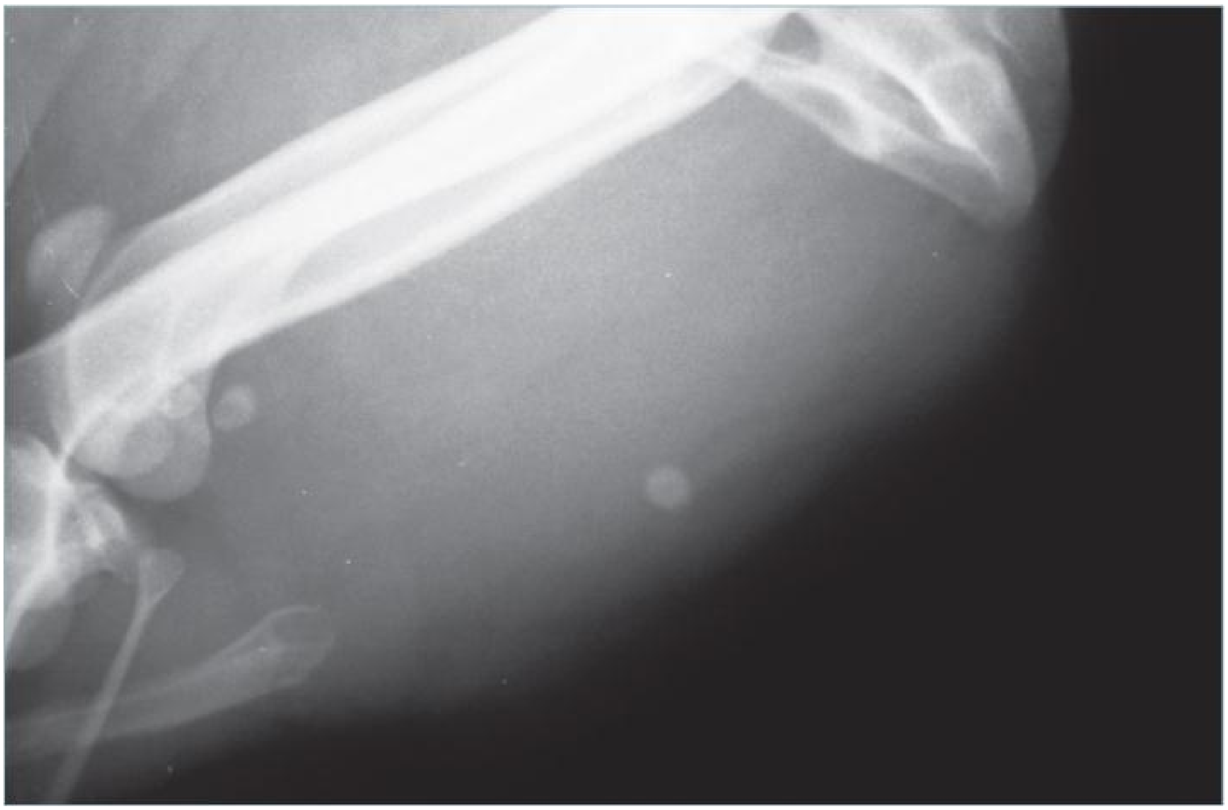

Fig. 1. The perineal radiograph shows a stone lodged in the middle section of the urethra.

Fig. 2. This radiograph shows the stone in the bladder. No other obstruction is visible in the urinary tract.

On reflection, it does not seem logical that the urethra has become obstructed at the level of the scrotum; there must be stenosis.
To examine the urethra, contrast radiographs are taken of the perineum (Figs. 3-4).

Fig. 3. By injecting air into the urethra, the dilated bladder can be seen (as well as a thickened bladder wall due to cystitis) and a dilated urethra over its entire length, with the exception of an area just behind the os penis, is visible.

Fig. 4. Using (water soluble) contrast medium, the degree and extent of the stenosis can be accurately determined.

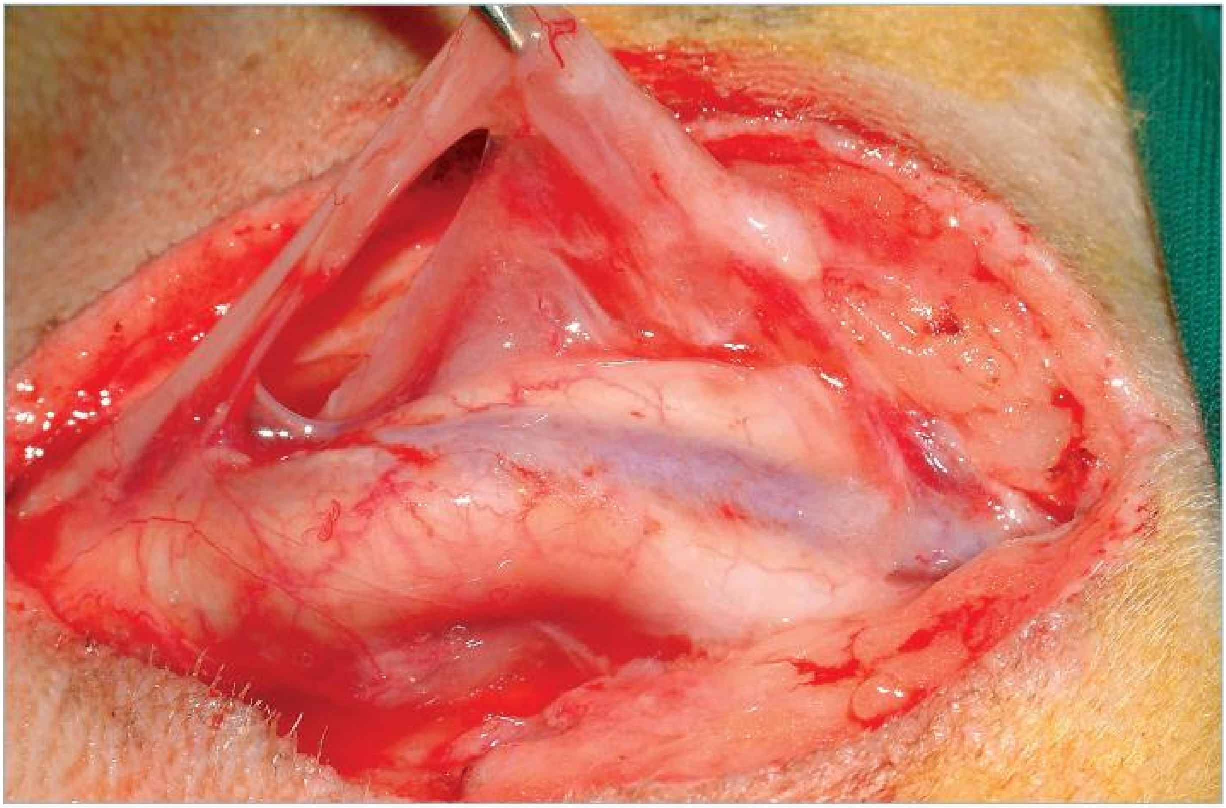

Fig. 5. As a first step in the urethrostomy, the retractor penis muscle is dissected and moved aside.

Fig. 6. The urethra is incised along its median raphe over approximately 3 or 4 cm. Next, the urethral mucosa is sutured directly to the skin using monofilament material.
In this case, a 4/0 non-absorbable suture was used.

Surgical indication

Scrotal urethrostomy is performed to avoid recurrent obstruction by a small stone that could be eliminated with the urine in the absence of urethral stenosis (Figs. 5 and 6).

Postoperative care

During the postoperative period antibiotic therapy should be administered based on sensitivity testing of a urine sample. The healing process should be closely monitored.

The patient should be kept from licking the area and secondary contamination should be avoided as this may lead to suture dehiscence (Figs. 7 and 8).

Fig. 7. 3 days after the urethrostomy. The result is satisfactory.

Fig. 8. 11 days after surgery, the sutures are removed and Jan's treatment is complete. In the two years since the operation, the dog has had no more obstructive problems.

Prolapse of the urethral mucosa

José Rodríguez

Prevalence

Prolapse of the urethral mucosa mainly occurs in young animals following prolonged sexual arousal. The dog will be constantly licking its prepuce and glans penis.

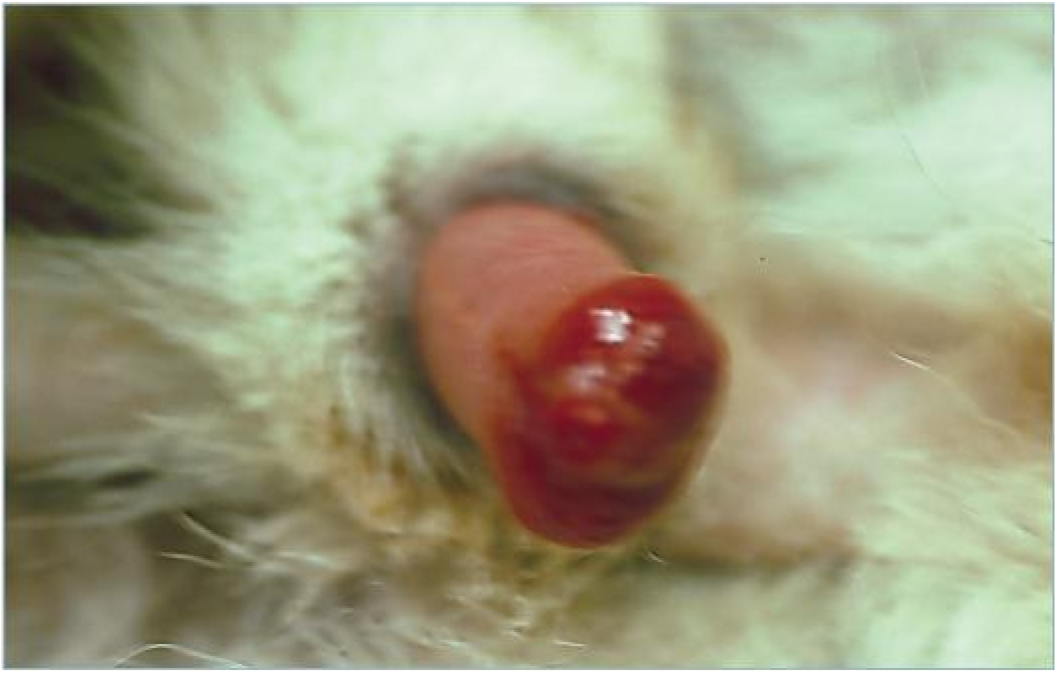

Fig. 1. Diagnosis is straightforward; by exteriorising the penis the prolapsed urethral mucosa becomes visible. The entire area is severely congested.

Conservative treatment

Technical difficulty ■□□□□

“Bullit” is a male, 8-month-old Bulldog referred due to constant penile hemorrhage (Fig. 2).

The problem began two days ago when he tried unsuccessfully to mount a bitch in oestrus.

Fig. 2. “Bullit” is constantly bleeding from the penis, particularly noticeable when getting up after lying down for a while.

Examination of the penis with the prepuce retracted reveals the origin of the bleeding (Fig. 3).

Fig. 3. Exteriorization of the glans penis reveals urethral mucosa that has prolapsed through the penile orifice.

The initial treatment requires placement of a urinary catheter a short distance into the urethra (not into the bladder) and fixed with two sutures for 2 or 3 days (Figs. 4-6).

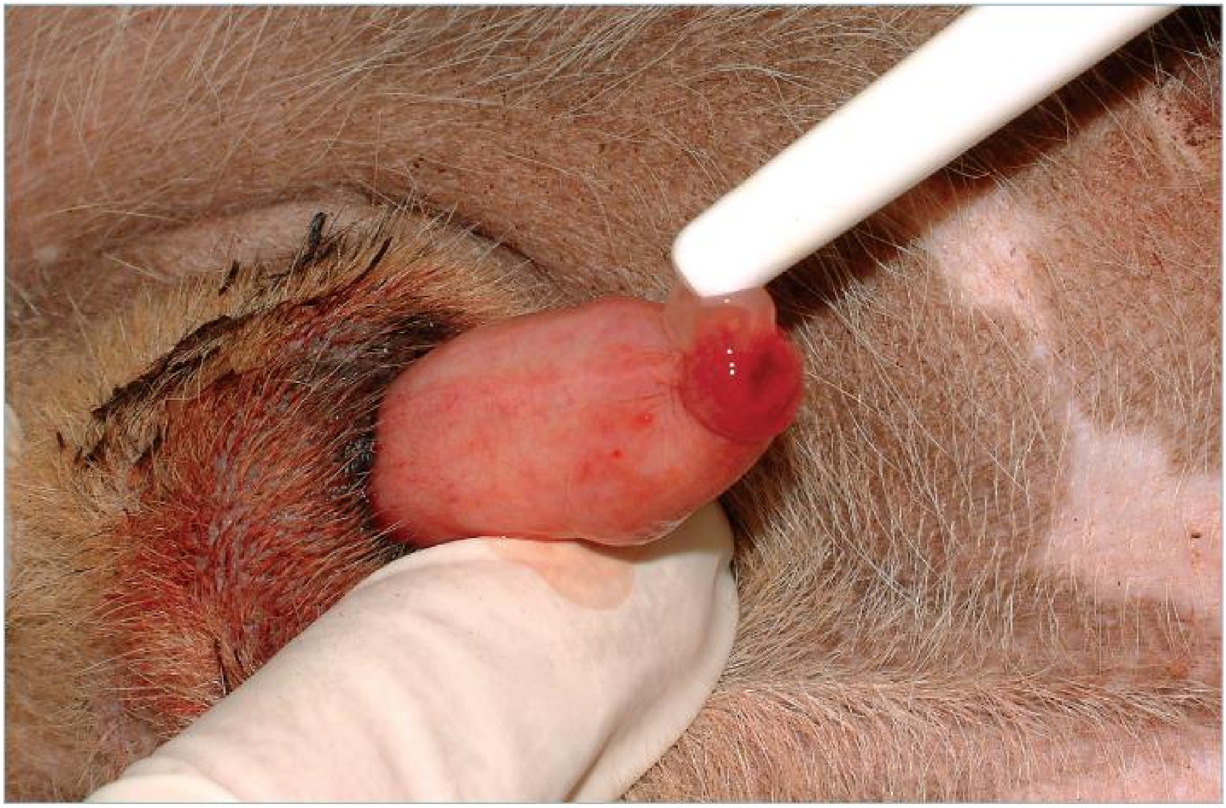

Fig. 4. A urological water-soluble gel is applied to anesthetise the area and to facilitate urinary catheterization.

Fig. 5. The urethra is gently catheterized to ensure that the next time the patient urinates, the urine passes easily and a mucosal prolapse is avoided.

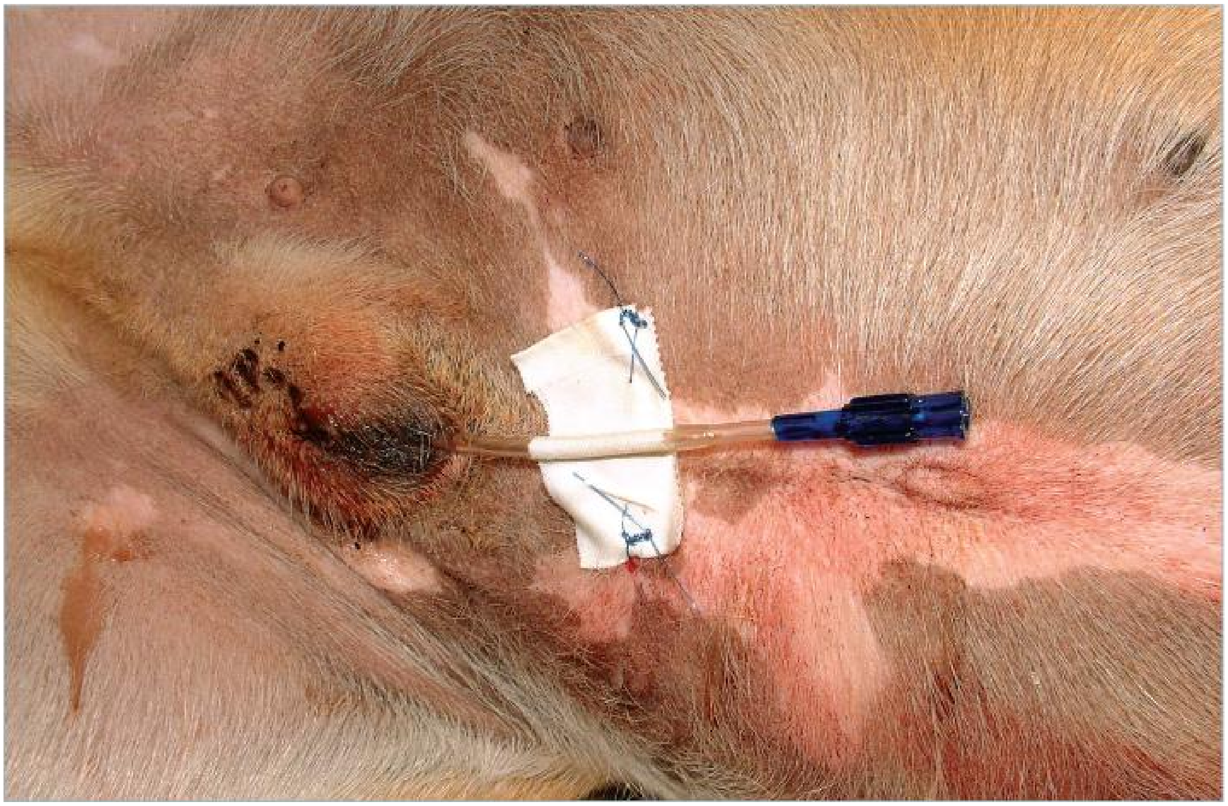

Fig. 6. The catheter is fixed to the skin with two sutures to keep it in place for the next two days.

Next steps

- Topical antibiotic and anti-inflammatory treatment for 5 or 6 days.
- Sufficiently large Elizabethan collar so the patient cannot lick the area.
- Use of sedatives or anxiolytics if required.

Surgical treatment

Technical difficulty

Initially, this patient responded well to conservative treatment but a few days later the prolapse recurred and surgical treatment was recommended (Figs. 7-14).

Where recurrence or marked injury to the urethra has occured, resection of the prolapsed mucosa is indicated.

Before surgery

Prior to surgery, the penis and the interior of the prepuce should be disinfected with a 50% iodine solution every ten minutes until entering the operating room.

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Urethral prolapse

Fig. 7. To keep the penis exteriorized, a gauze swab is placed around its base to prevent the prepuce from sliding back into its normal position.

Fig. 8. This photograph shows the prolapsed urethral mucosa that will be resected.

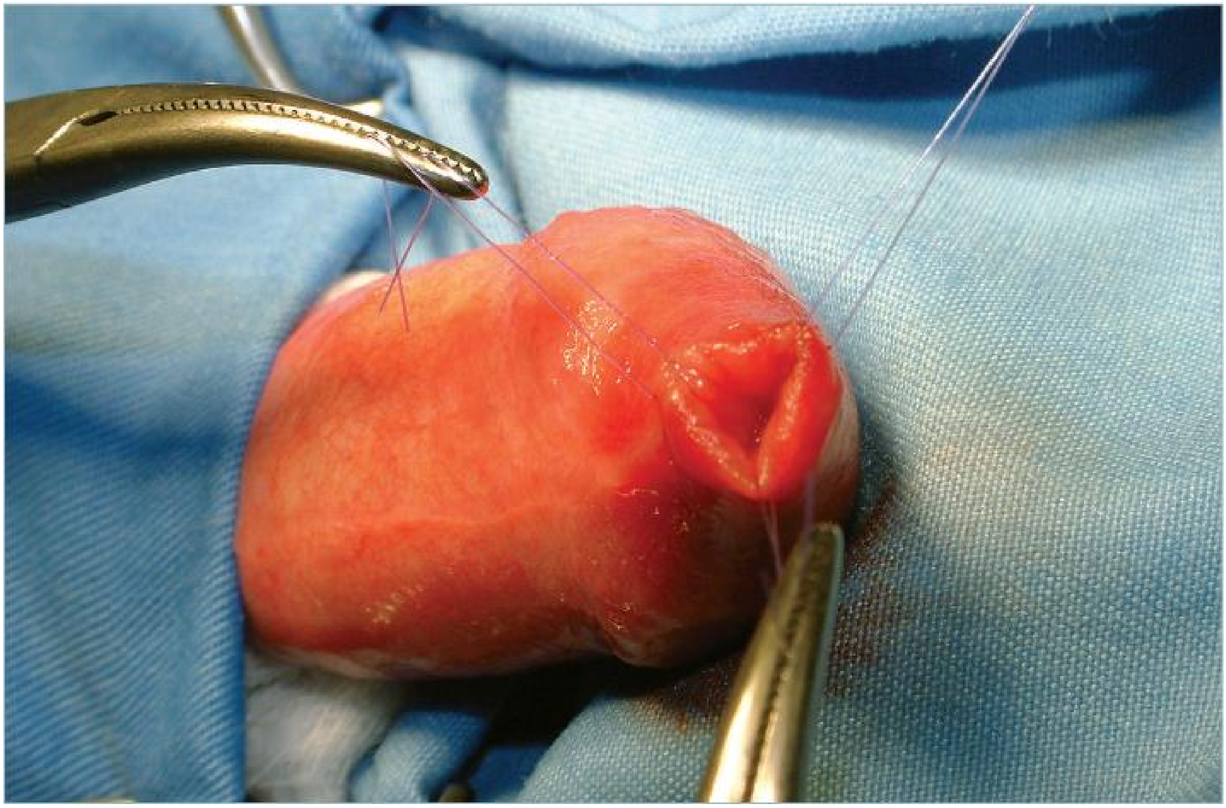

Fig. 9. To prevent retraction of the wound edges during resection, the urethra is fixed with stay sutures that keep the urethral mucosa permanently in view.

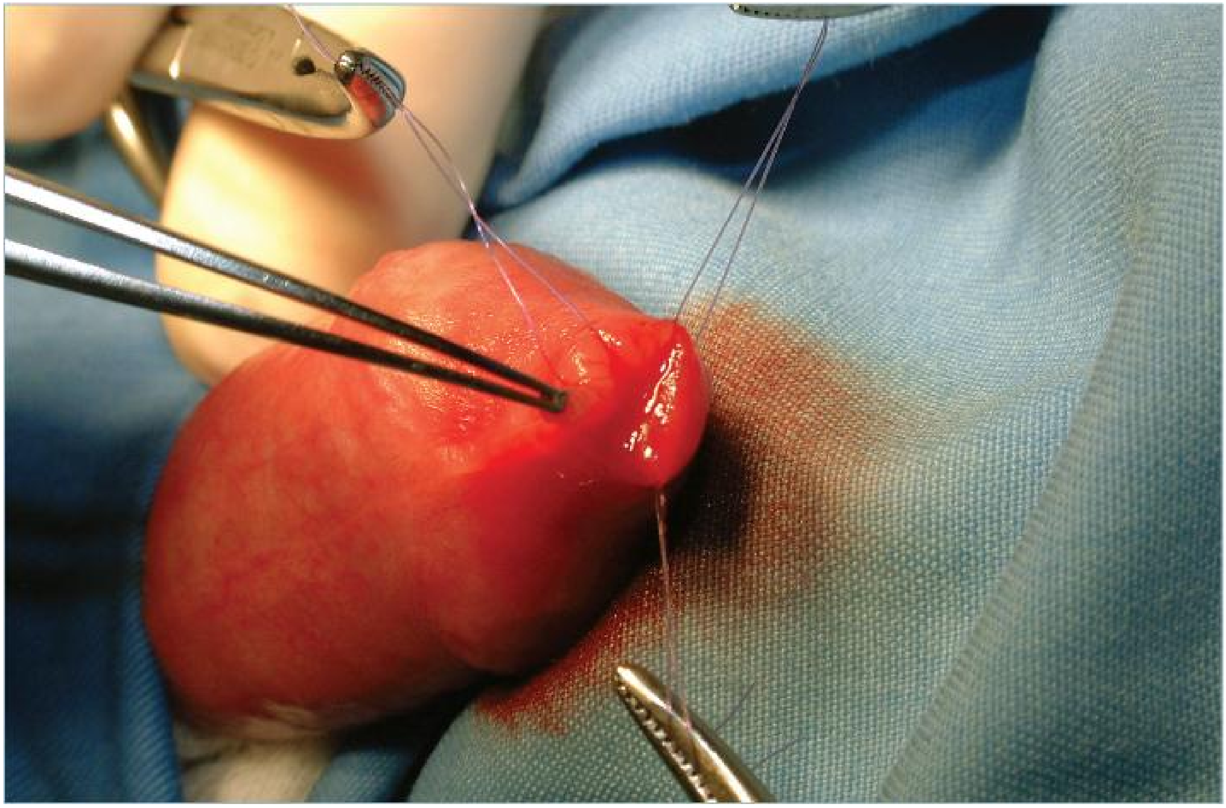

Fig. 10. The prolapsed mucosa is cut with scissors between two stay sutures. Intense hemorrhage of the wound will occur.

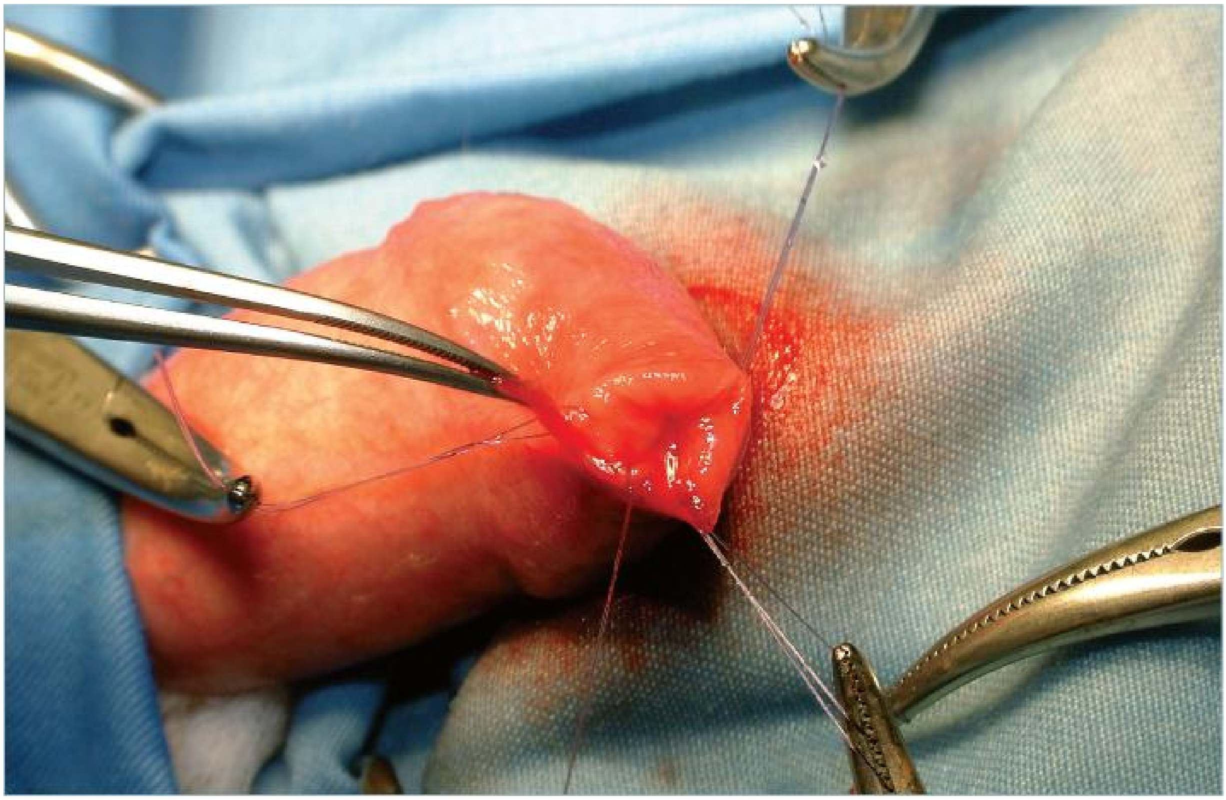

Fig. 11. To prevent excessive bleeding, the urethral mucosa is sutured to that of the penis.

Fig. 12. Two continuous interlocking sutures are placed, using synthetic absorbable 6/0 monofilament material.

✱

The needle used for suturing should be round-bodied and atraumatic to minimize damage to the urethral mucosa.

Fig. 13. If the urethra is inflamed, it is recommended to place a urinary catheter for the first few postoperative days, to maintain patency and elimination of urine.

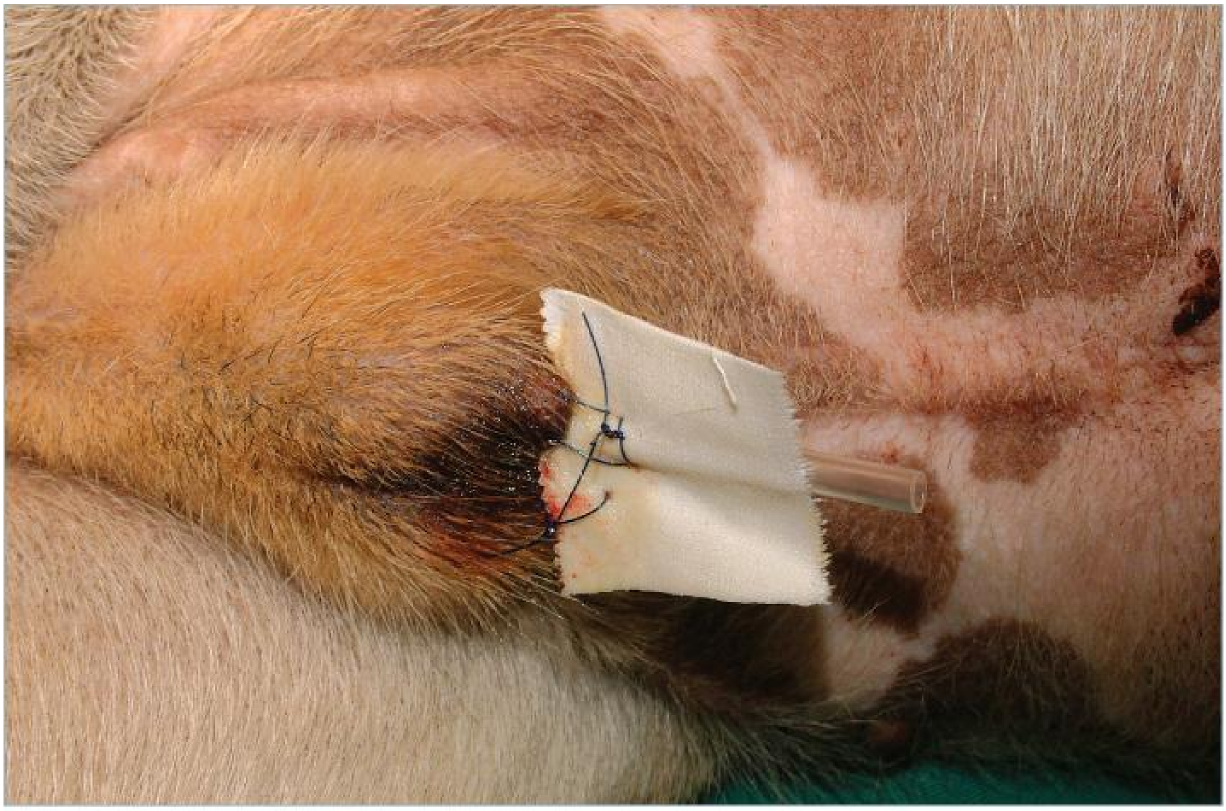

Fig. 14. The catheter is fixed to the prepuce with two sutures.

Postoperative care

- Topical antibiotic and anti-inflammatory treatment for 5 to 6 days.
- Systemic anti-inflammatory drugs (NSAID) for 6 days.
- Large Elizabethan collar to prevent licking of the area.
- Use of tranquilizers or anxiolytics depending on the demeanor of the patient.

Slight postoperative bleeding from the penis is normal. The sparse bleeding will diminish over the next few days.

Thoracoscopy

José Rodríguez, Javier Gómez-Arrue

Prevalence	■□□□□
Technical difficulty	■■■■□

Thoracoscopy is a technique that forms part of the family of endoscopic surgeries or endosurgeries; it consists of endoscopic access to the thoracic cavity for diagnostic or treatment purposes for certain disorders (Fig. 1).

Thoracoscopic procedures immediately bring to mind other techniques, such as laparoscopy or arthroscopy. However, there are some factors that are specific to the thorax and its structures.

In thoracoscopy, there is no need to create a working space by insufflating with liquid or air. If it is possible to selectively intubate one lung, the lung on the "problem side" will collapse when air is let into the pleural cavity, which will create a working space between the ribs and the visceral pleura, eliminating the need to distend the area. It is possible to help or accelerate the lung collapse by gas insufflation, but the surgeon should be aware of the problems this may generate.

If the inflation pressure is too high, this may produce the same effect as a tension pneumothorax. The clinical signs are reduced cardiac output and compression of the contralateral lung. The use of gas for the creation of a working space is therefore not recommended, with very few exceptions. If it is used, the inflow rate of the gas should not exceed 1 L/min and the pressure should never rise above 5 mm Hg, because a higher pressure provokes the aforementioned symptoms.

Another aspect to consider in thoracoscopic interventions is the use of monopolar coagulation. If the monopolar coagulation mode of a diathermy unit is used, the high-frequency current (510 kHz) flows from the active electrode through the tissue to the contact plate under the patient.

The coagulation effect is only produced in the active electrode, but it is possible that low-frequency (50-60 kHz) stray currents are produced. The myocardium is particularly sensitive to currents between 30 and 110 kHz and these stray currents are in that range. In this frequency range, a current of just 10 mA may provoke alterations in the heart rhythm. This current is exceeded by energy generators working at over 30 W.

The use of monopolar diathermy may induce ventricular fibrillation or even asystole.

In thoracoscopic surgery, diathermy, ultrasound or laser is recommended to control bleeding.

Furthermore, while in laparoscopic surgery the surgeon has a homogeneous surface for inserting the trocars for the access ports, in the case of a thoracoscopic intervention, the ribs will be a problem.

If the endoscope or the instruments have to be moved in a perpendicular direction to the ribs, their range is seriously reduced, so they should be placed in such a way that the necessary trajectory is as short as possible.

When the animal is prepared for surgery, it should be prepared as for a thoracotomy; if any problem occurs, the surgery can then be rapidly changed to a conventional approach.

See exploratory and surgical laparoscopy in the book "The cranial

abdomen”

page 321

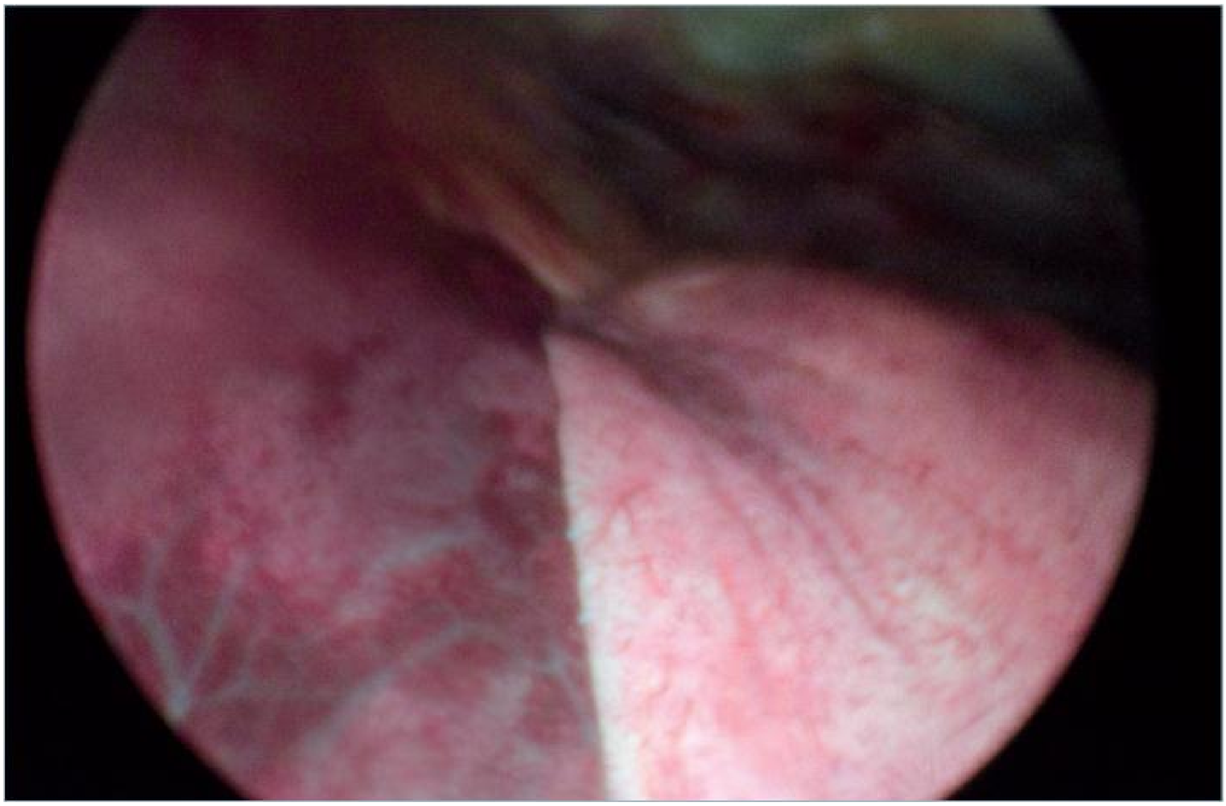

Fig. 1. In this patient, it can be observed that the left apical lung lobe has lesions that are not seen in the intermediate lobe.

Even though some animals have two separate pleural cavities, it is not unusual to find pores in the mediastinum that connect the two sides. This is why it is advisable to intubate the animal and use intermittent positive pressure mechanical ventilation. Although not strictly necessary, the use of a double-lumen endotracheal tube is recommended. This is used for the selective intubation of one bronchus, leaving the contralateral bronchus free for the lung to collapse when the surgeon enters the pleural cavity.

Fig. 2. Special thoracoscopy trocars with a blunt tip make it possible for the trocar to pass through the intercostal muscles without injury to the vessels on the caudal side of the ribs.

Fig. 3. Laparoscopy trocar with a three-way tap to connect it to the insufflator and to a valve on top, to avoid gas leaking out when surgical or optical instruments are exchanged.

Selective bronchial intubation of the non-affected lung is crucial for the removal of a pulmonary bulla or an abscess, in lobectomy or for the creation of a permanent solution to the obstruction of one of the principal airways.

During minimally invasive surgery, the possible hemodynamic alterations are the same as in thoracotomy. These depend more on the surgeon's technique and skill than on the access site for thoracoscopy or the size and location of the thoracotomy wound.

During thoracoscopy, alterations in arterial pressure and cardiac output are to be expected. These alterations depend more on the animal's position and the surgical maneuvers during the intervention than on the thoracoscopy technique itself. CO_2 insufflation of the thoracic cavity to create a working space may decrease cardiac output and cause compression of the contralateral lung. It may also provoke extrasystoles and arrhythmias due to direct stimulation of the heart muscle.
Thoracoscopy should not cause any changes in the oxygen saturation or the capnogram wave form.

Access and closure techniques
Creation of a working space

Once the surgery has been planned and the access site to the pleural cavity has been chosen, the trocars that act as access ports have to be inserted.

These trocars may be of two different types:

- Special thoracoscopy trocars: Straight plastic or metal cannula sets. These come in several diameters (5, 10, 12 mm) for the use of different instruments. They have a blunt tip (Fig. 2).

- Laparoscopy trocars: Plastic cannula sets with a valve at the end to avoid gas leakage. These also come in several diameters (5, 10, 12, 15 mm). They may have a tap to connect a CO_2 insufflator (Fig. 3). The trocar tip may be blunt (non-cutting trocar) or sharp (cutting trocar) to separate the different muscle layers. There are trocars that allow the use of optical devices to access the cavities under visual control (optical trocars). They may have a blade that cuts the muscle layers (sharp trocar) or have a special design that allows it to be pushed in by force (blunt trocar).

If the intervention requires gas insufflation, it is preferable to use laparoscopy trocars as these will permit the creation of an airtight cavity from which the insufflated gas does not leak.

Access technique

1. Make a skin incision corresponding to the diameter of the trocar. It should not be too big, because if gas is used, it will leak out. If it is too small it will prevent the trocar from passing smoothly. When the pressure on the trocar is increased and the skin suddenly gives way, the control over the trocar is lost and it may damage intrathoracic structures. When inserting the trocar, bear in mind that the intercostal vessels run along the caudal border of the ribs, so that it is preferable to place the trocar on the cranial border of a rib.
2. After incising the skin, the different layers are dissected with mosquito forceps until the parietal pleura is reached. A characteristic sound is heard when perforating the pleura (Fig. 4).
3. A blunt trocar, or, a bladeless trocar, is inserted. Bladed trocars are not recommended unless there is no risk of the protector shield becoming retracted (Fig. 5).
4. The optical device is inserted and the area is viewed to ensure that no structures have been injured (Figs. 6 and 7).
5. Repeat the procedure with the other trocars under visual guidance from the inside of the thorax.

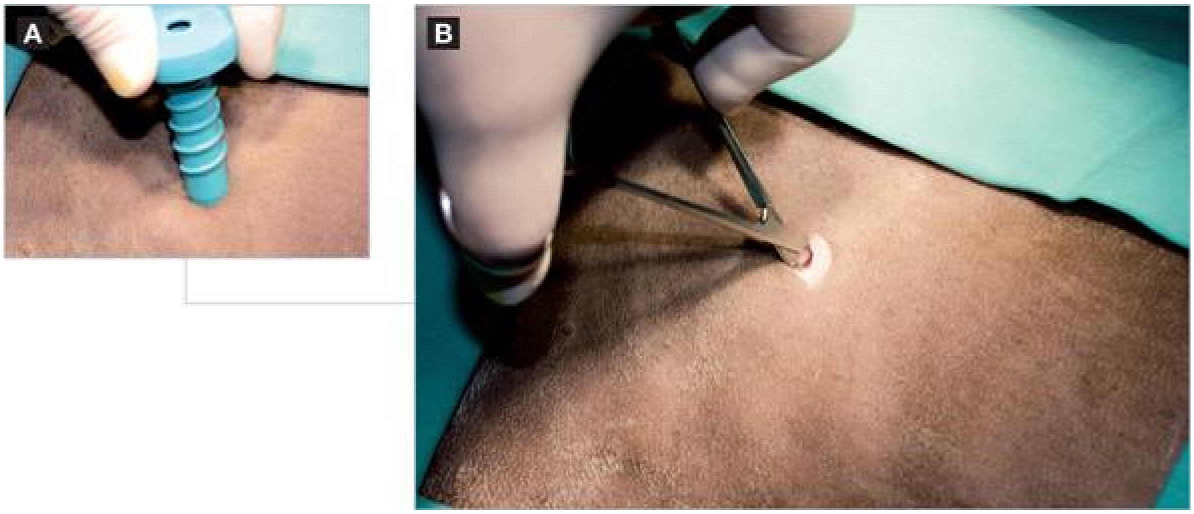

Fig. 4. (A) The diameter of the trocar shaft is marked on the skin to obtain an optimal-size skin incision. (B) After incising the skin with a scalpel, the intercostal muscles are penetrated with blunt forceps until reaching the pleural cavity.

Fig. 5. The trocar and its blunt obturator are introduced. This is done by twisting the trocar in a clockwise direction to screw it into the chest wall.

The skin should be pulled tight during insertion to prevent it twisting around the trocar.

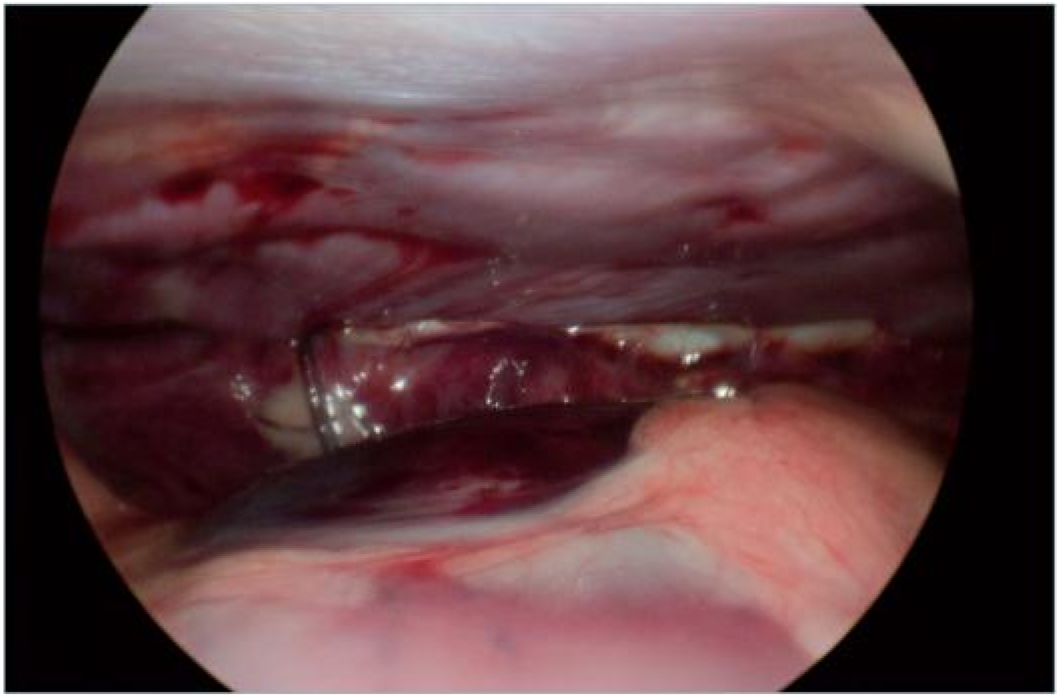

Fig. 6. Examination of the central area of the thoracic cavity. This image shows the dorsal region with one of the vertebral vessels at the bottom, the atelectatic lung lobes on both sides and the pericardium in the ventral part.

Viewing systems

- **Cold light source:** this consists of a halogen, xenon or LED lamp with a bulb cooling system and a system to project the light into the cold light cable.

> ***Xenon bulbs have a shorter life span, some 500 hours, and do not tolerate repeated on/off cycles.***

- **Cold light cable:** An independent fiber optic bundle carries the light from the cold light source to the optic system. "Cold light" means that there is no heat 10 cm from the tip of the optic cable. However, both the tip of the optic system and its connection with the cold light cable may get hot enough to produce burns.

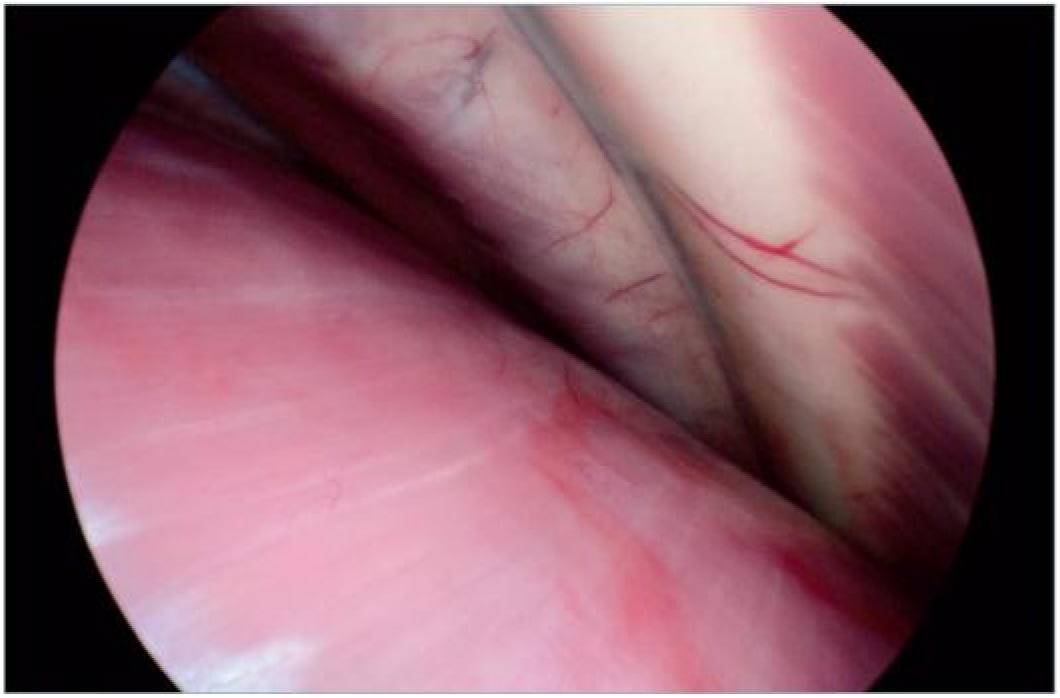

Fig. 7. Examination of the thoracic cavity. This image shows the left side of the diaphragmatic cupola, the ribs and one of the internal intercostal muscles.

- Optical system:
  - **Endoscope:** rigid or flexible with an angled tip at 0, 30, 45, 90 or even 120º. For thoracoscopic surgery, a 30º endoscope is recommended. The endoscope may have a working channel. The diameters range from 2.7 to 10 mm. For thoracoscopy, the 5 mm endoscope is recommended.
  - **Video camera:** micro-camera adapted to the eyepiece of the optical system. This micro-camera can be equipped with one or three CCDs (charge-coupled devices); one CCD means that a single receptor interprets all color information, whereas with three CCDs, there is a receptor for each color (red, green and blue). At present, there are cameras equipped for the capture of high-definition images (up to 1080 pixels).

Fig. 8. Rigid 5 mm endoscopes with 30º angled (A) or straight vision (B).

The 30^0 angled vision is the most suitable for working in the thorax, because the structures adjacent to the optic system can be observed without forcing the ribs.

- Television monitor: Analog or digital, taking into account the video output of the camera. The analog signal is usually emitted in a 5:4 format, while the high-definition signal will always be a 16:9 format.
- Recorder.

Instruments

The range of instruments for thoracoscopic surgery is as varied as for conventional surgery: nearly the entire range of instruments for thoracic surgery by thoracotomy has been adapted. However, the basic instruments should include (Figs. 9-12):

- Dissectors.
- Scissors.
- Grasping forceps.
- Dissecting forceps.
- Hemostatic instruments.
- Staples.

Bipolar coagulation instruments and tissue sealants using vapor pulses (LigaSure or PlasmaKinetic type instruments) deserve a special mention.

Fig. 9. Surgical instruments for thoracotomy:
(A) Dissecting forceps. (B) Babcock-type grasping forceps. (C) Bipolar scissors.

Fig. 10. This fan-shaped separator is unfolded using a screw at the tip of the instrument.

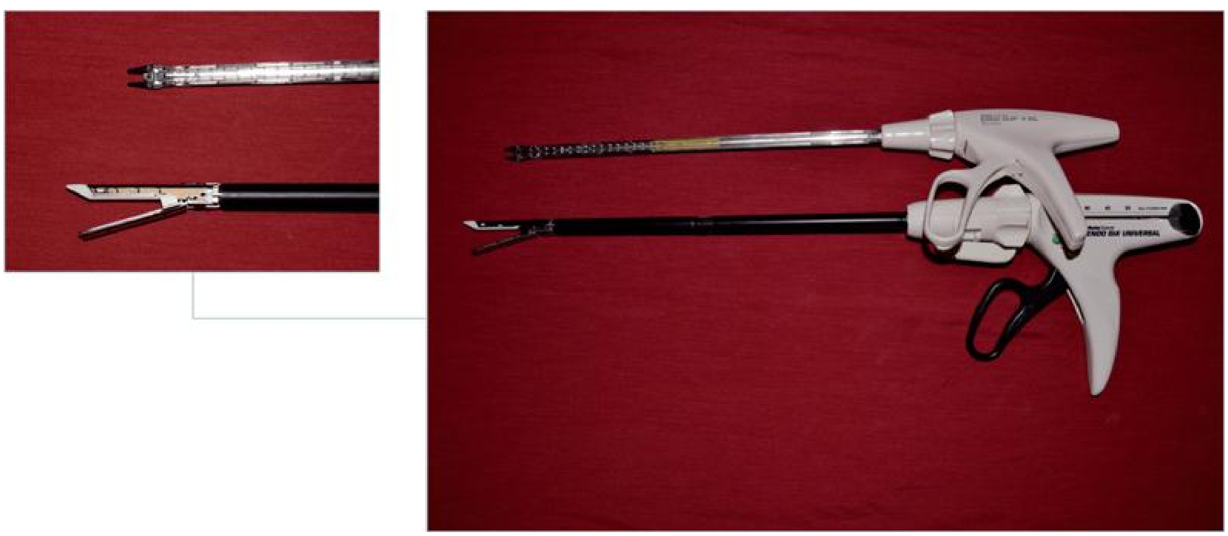

Fig. 11. This image shows a hemostatic stapling device at the top, and an endoscopic surgical stapler at the bottom.

Fig. 12. Endosurgical staplers may fire different types of staples depending on the thickness of the tissue to be stapled. Some have a Roticulator^{TM} system that makes it possible to angle the tip of the instrument and make it easier to grasp the tissue.

Indications and applications

In human surgery, a wide variety of techniques have been adapted for thoracoscopic surgery.
Although fewer techniques have been adapted in veterinary surgery, the transposition of a technique from conventional to keyhole surgery is not difficult, provided that the surgeon has a thorough knowledge of the area in which the surgery will be performed.

- Access to the dorsal thorax: the trocars should be placed along the line that divides the dorsal third of the chest wall from the ventral two thirds. As there is enough space once the lung has been displaced to the ventral area, it is less important that the thorax is accessed through an exact intercostal space, because there is a certain freedom of movement. In this area, the thoracic vessels, persistent right aortic arches, the esophagus, the thoracic duct and the trachea may be found (Figs. 13 and 14).
- Access to the medioventral thorax. In this case, the access ports for the surgical instruments are placed one intercostal space behind the area where the procedure will take place, and the access port for the optic system one intercostal space further back. The heart can be accessed to

create a pericardial window and observe the entire lung to perform full or partial lobectomy, drain abscesses, take a biopsy or perform a bullectomy; in the pleural cavity, pleurodesis may be performed (Figs. 15-17).

Fig. 13. Visualization and dissection of the dorsal thorax. Note the caudal aorta and its vertebral branches.
This image is from teaching practice on a cadaver.

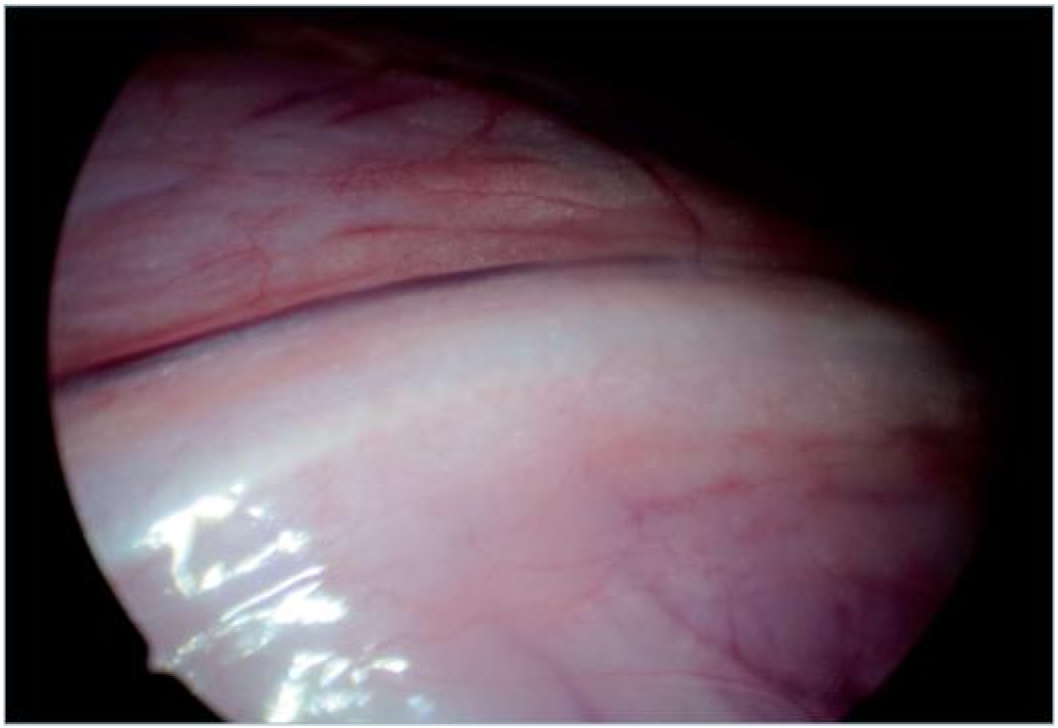

Fig. 14. Endosurgery makes it possible to visualize the anatomical structures under high magnification. This is a detailed image of the phrenic nerve.

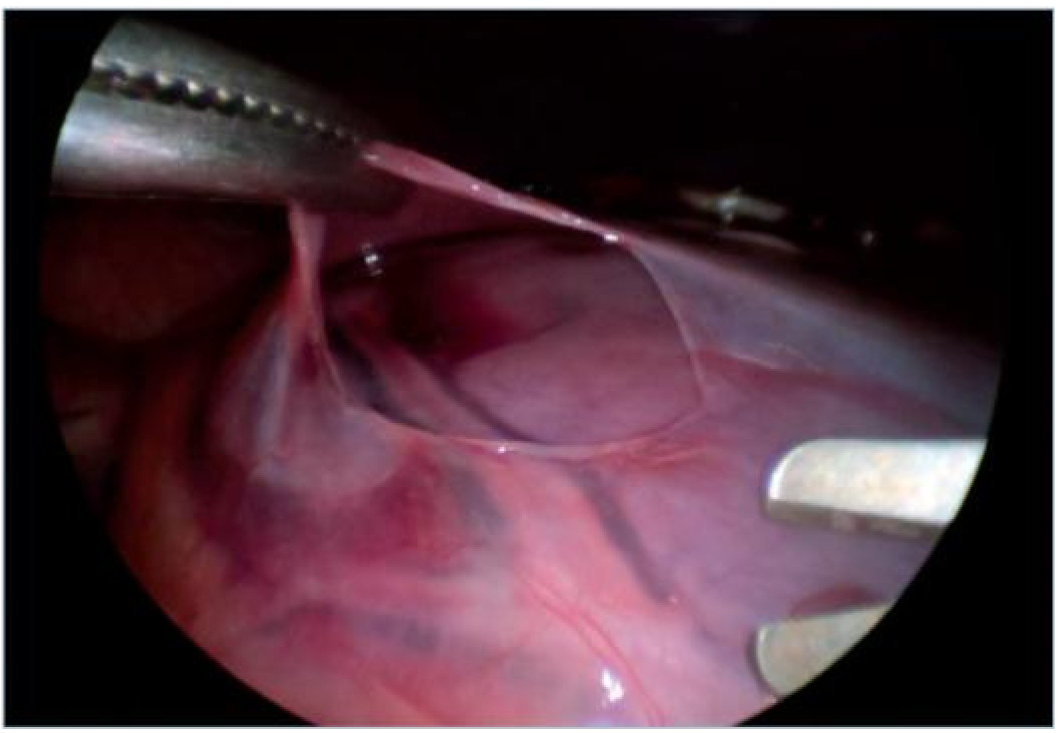

Fig. 15. This image shows a pericardiectomy, practiced on a cadaver during a training class.

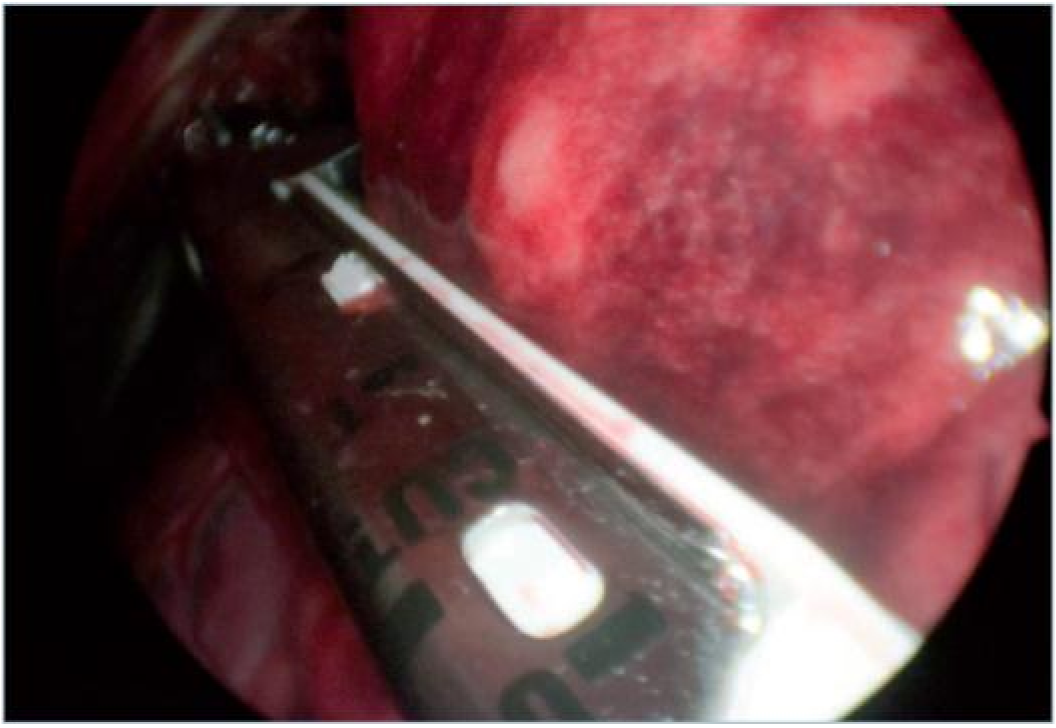

Fig. 16. Endo-GIA stapler use during a partial lobectomy of the lung. *This image is from teaching practice on a cadaver.*

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Thoracoscopy

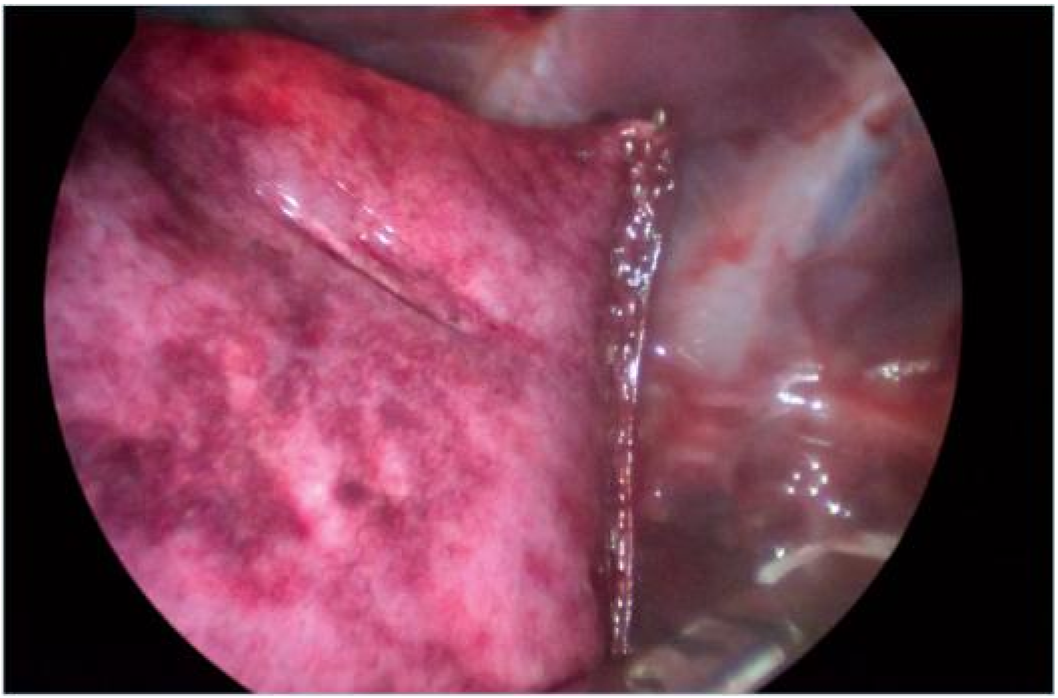

Fig. 17. Final appearance after using a surgical stapler on the lung. The stapler has placed two mechanical sutures of three staple rows each and has cut the tissue in between. *This image is from teaching practice on a cadaver.*

Main complications

Most of the complications that may arise from thoracoscopic surgery are similar to those in conventional surgery.
The specific complications that may present themselves during thoracoscopic surgery are:

- **Tension pneumothorax.** There are two main causes:
  - Too much gas used for insufflation.
  - If spontaneous respiration is used instead of mechanical ventilation, and laparoscopy trocars have been placed, environmental air will enter through the caudal part of the trocar every time the animal inhales. If the three-way tap is kept closed when the animal expires, this air becomes trapped, because it cannot get out through the valve. The intrathoracic pressure rises with each inhalation.

- **Damage to the intercostal vessels;** this occurs if the trocar is placed at the caudal border of the rib. It may cause continuous bleeding that eventually leads to hemothorax. It is easy to avoid by accessing the thorax at the cranial border of the rib.
- **Section or perforation of the lung parenchyma:** this occurs if the thoracic cavity is entered abruptly. It is easy to avoid if care is taken and all the layers, including the pleura, are dissected previously.
- **Section or perforation of the major vessels:** this may occur due to the abrupt insertion of a long trocar or when dissecting around the vessels. This is an emergency that requires immediate conversion to open surgery.
- **Lung edema secondary to sudden re-expansion;** sometimes, if a lung has been collapsed and is then re-oxygenated, it results in the liberation of free radicals and infiltration of inflammatory cells that may lead to acute unilateral lung edema. For this reason, the patient should be monitored during the first hours after re-expansion.
- **Stenosis or perforation of the esophagus:** this is due to a poor dissection technique or the use of electrocautery instruments. As the dorsal thorax contains abundant fat tissue, the surgeon should be very careful when working in this area.
- **Ventricular fibrillation and asystole;** this may be due to the use of monopolar electro-surgical device close to the myocardium. This should be avoided as much as possible, or be substituted for bipolar devices.
- **Chylothorax:** this is due to severing the thoracic duct. It is difficult to identify during surgery, because it is usually empty due to patient fasting. If it is cut, it should be ligated to prevent the formation of a chylothorax.

Exploratory laparoscopy and laparoscopic surgery

Javier Gómez-Arrue,
Américo J. Viloria

In minimally invasive surgery, the surgical intervention is performed through a small incision controlled by high-technology, miniaturized

imaging systems to reduce surgical trauma to a minimum.
There are only two dimensions: movement is extremely limited and there is practically no tactile sensation. This requires a different way of operating and a demanding learning process.
Because of this type of surgery, there is a reduction in scar tissue and adhesions, as well as reduced surgical trauma.
In laparoscopic surgery, a number of special considerations should be taken into account:

- Pneumoperitoneum.
- Techniques of entry and progression.
- Visualization techniques.
- Working tools / instruments.
- Position of the patient, the optics and the surgical team.

Pneumoperitoneum

This consists of creating a working space inside the abdomen. Gas is insufflated into the abdomen to create a true cavity and permit visualization of the area and mobility of the instruments. The gas used should be colorless, non inflammable, highly soluble in plasma to allow its elimination without the risk of embolism and as physiologically inert as possible.
Usually, CO^2 is used, although it has been shown to react with liquid present in the abdomen to produce carbonic acid, which may irritate the peritoneum. However, it has been proven that it causes less irritation than other gases, such as medical air, helium or nitrous oxide.

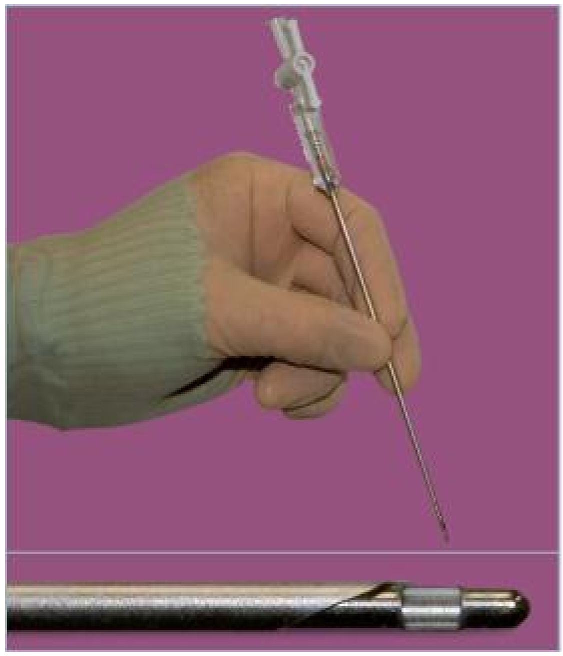

Fig. 1. Veress needle. It should be held as shown in this image to prevent excessive penetration of the abdomen and possible injury to the viscera. Detail of the trocar tip.

There are two techniques for insufflating the abdominal cavity:

- **Blind technique**: This consists of penetrating the abdominal wall using a Veress needle (Fig. 1). This is a needle with a diameter of 7 French gauge containing a blunt stylet inside and a stopcock at its proximal end. When passing through the various layers of the abdominal wall, the stylet is pushed back and forth due to a spring system, making a noise as it penetrates each layer. The blunt tip of the stylet also reduces the risk of injury to the abdominal viscera and the large vessels, although such complications have been described. Once two clicks are heard, a drop of saline is placed on the hub of the needle. If the drop penetrates into the cavity by gravity, it may be assumed that the needle is inside the abdomen (Fig. 2).

  To check this, the syringe is aspirated; if the liquid is recovered or if a sense of vacuum is experienced, the needle is not inside the abdominal cavity; if, in contrast, the liquid is not recovered and there is no vacuum, then the needle is correctly positioned.

  Once the needle is inside the abdomen, gas is introduced through the needle.

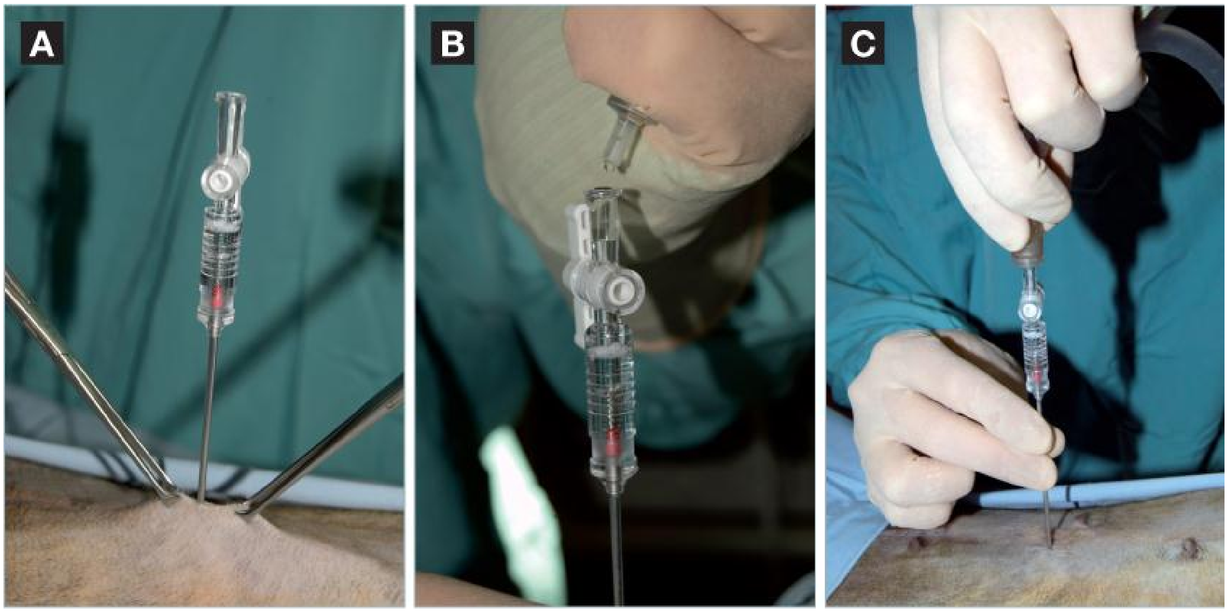

Fig. 2.

(A) Veress needle introduced.

(B) Detail of the hub of the needle, through which saline is descending into the abdomen.

(C) Connection of the CO_2 insufflator tubing.

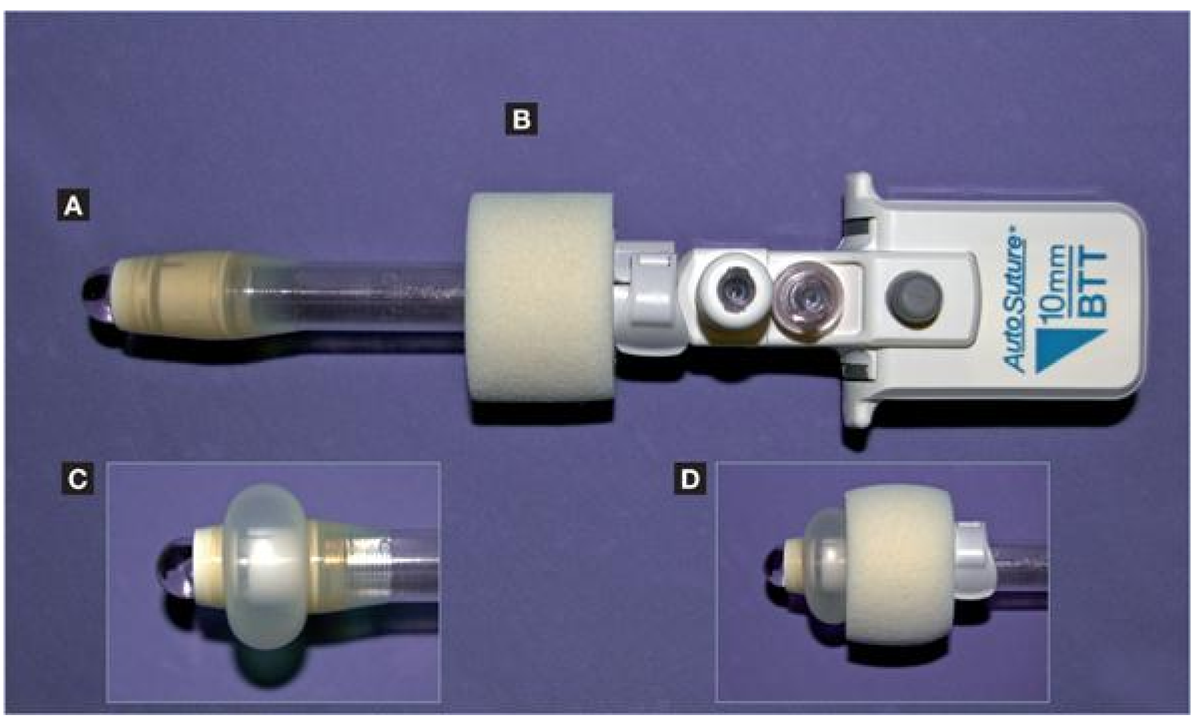

Fig. 3. Hasson trocar for the open access technique. (A) Non-inflated balloon cuff tip. (B) Foam disc to compress the abdominal wall against the inflated

cuff. (C) Detail of the inflated cuff. (D) Detail of the foam disc pressing against the inflated cuff.

- **Open technique**: through a micro-laparotomy of approximately 1 cm, the abdominal cavity is accessed and a Hasson trocar is introduced. The trocar consists of a blunt plastic cannula and a sleeve with a balloon cuff at its tip as well as a foam ring with a fixating mechanism at the proximal end. Once the cuff is inside the abdomen, it is inflated and the foam ring pushed down until it compresses the abdominal wall and the balloon is fixed (Fig. 3). This prevents leakage of gas around the trocar and possible injury to the abdominal structures as well as inhalation of CO^2 by the surgical team.

After correctly positioning the trocar, the abdomen is inflated with CO^2. The intraabdominal working pressure should be between 8 and 14 mm of mercury and never exceed 15 mm Hg as this leads to hemodynamic changes without creating more space. The pressure should be maintained with an automated system, both for the comfort of the surgical team and for the security of the patient (Fig. 4).

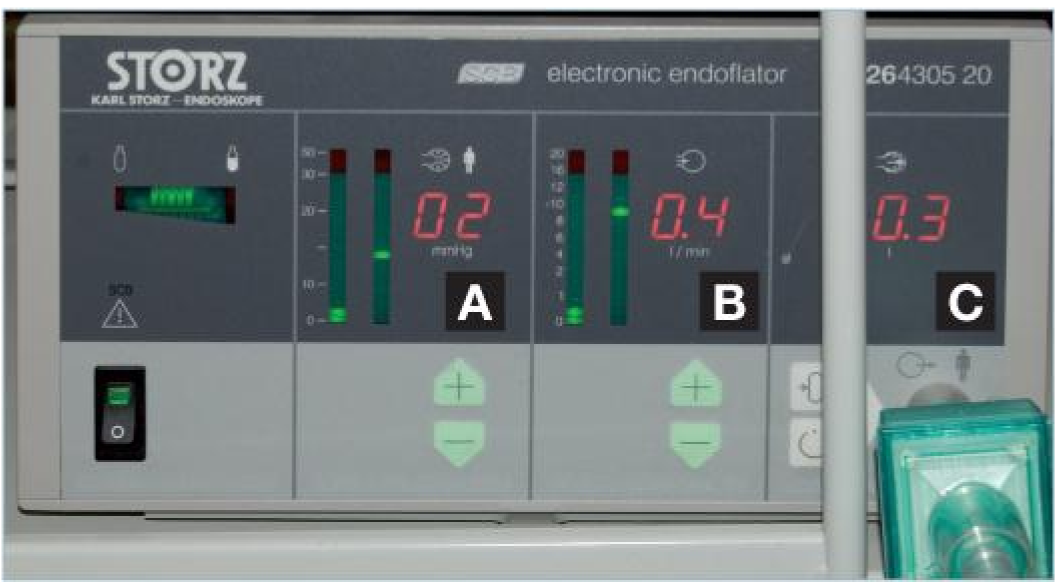

Fig. 4. Automatic CO_2 insufflator. (A) Current pressure inside the abdomen. (B) Gas input. (C) Total volume of gas introduced during the procedure.

In case no automated insufflating system is available, a Richardson bulb can be used. This is a handheld device that introduces ambient air into the abdomen. When using this device, the intraabdominal pressure is measured manually and care should be taken not to create excessive pressure that would affect the hemodynamic balance or respiration of the patient.

Creating and maintaining a pneumoperitoneum has a number of cardiorespiratory consequences for the patient that, although not necessarily life-threatening, should be kept in mind:

- Increased central venous pressure.
- Increased heart rate.
- Increased systemic vascular resistance.
- Increased pulmonary vascular resistance.
- Increase/Decrease in the cardiac output (Trendelenburg position).
- If the abdominal pressure is raised above 15 mm Hg, the caudal vena cava and the diaphragm become compressed.

In case insufflation to create a pneumoperitoneum is undesirable, there are several mechanical techniques that create a distended abdomen and a working cavity. They include passing a silk thread through the abdominal wall and applying vertical traction or the introduction of a steel coil into the abdomen through a small incision and lifting the entire wall up.

Access and progress techniques

Several manners of access and progress are used to access the abdominal cavity, create the pneumoperitoneum and later as entry and exit points of the working cavity.

Creation of the pneumoperitoneum

- **Pneumoperitoneum needle (Veress)**: consists of a 7 French gauge needle with a spring inside which helps to identify the moment the different layers of the abdomen are penetrated by emitting a sound. At its hub it has a stopcock allowing the entry of gas or fluids through the working channel.

- **Blunt trocar (Hasson)**: a trocar with a blunt cannula and a sleeve fitted with a balloon cuff and a proximal foam ring. This is introduced through a 1-cm micro-laparotomy opening after which the balloon is inflated and compressed against the foam ring to ensure a seal and prevent the leakage of gas.
- **Insufflator**: this device pumps gas into the abdomen while maintaining constant intra-abdominal pressure, keeping track of the volume of gas that has been used. There are models that, besides introducing the gas at a controlled rate, also warm it to decrease the irritation of cold gas on the abdominal viscera.

Incision-insufflation-working channel instruments: trocar-sheath system:

- **Conventional trocars** (5-10-12 mm) (plastic/metal): These trocars consist of a smooth sleeve with a valve in the proximal end to prevent leakage of gas, a reducer system in case the instrument to be introduced is of a smaller diameter and a stopcock for gas infusion. They have a cannula that can be blunt or sharp (Fig. 5). Their function is to penetrate the muscular layers and the fascia creating an adjustable orifice to prevent leakage of gas.

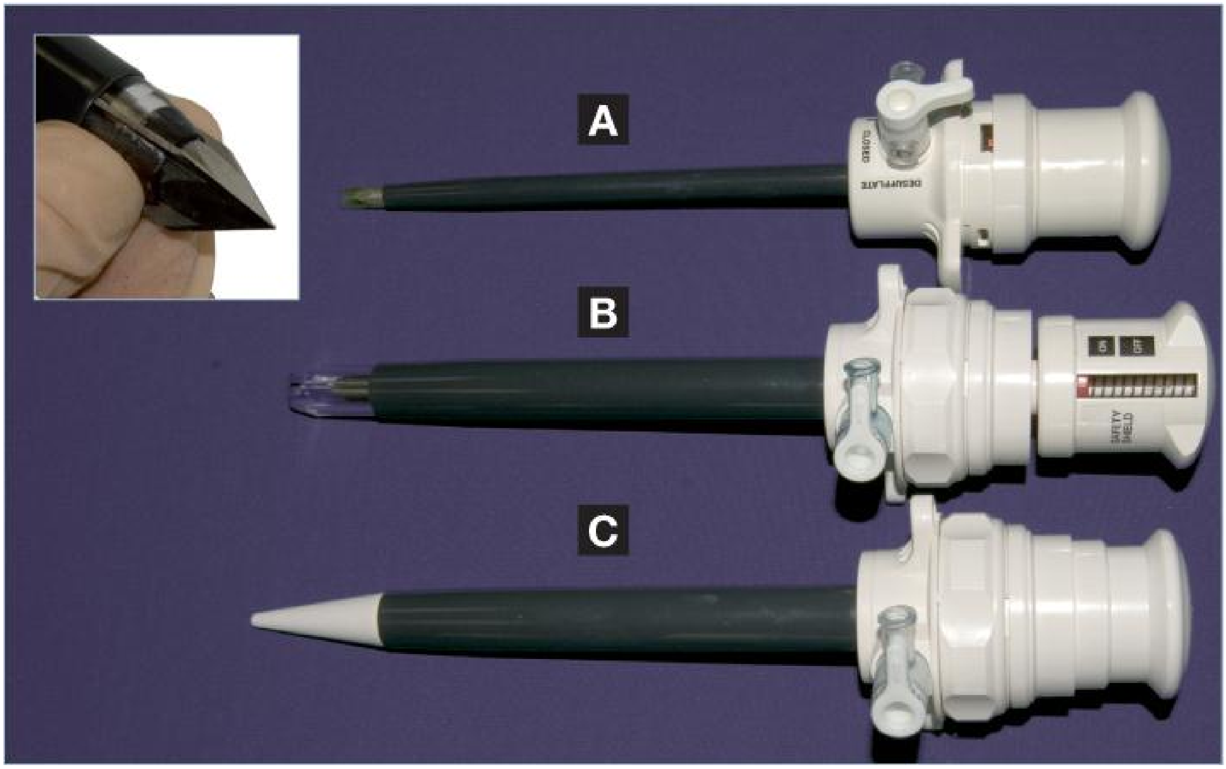

Fig. 5. (A) Sharp trocar, 5 mm. (B) Sharp trocar, 10 mm.
(C) Blunt trocar, 10 mm.
The detail shows the blade of the trocar with a retracted safety shield.

The point is normally protected with a “safety shield” that retracts under pressure from the muscular wall, once the trocar reaches its final position the shield cannot be retracted again. This is to prevent injury to the abdominal viscera when the trocar reaches the abdomen (Fig. 6).

Fig. 6. Insertion of a sharp trocar.

Fig. 6A. Correct way of holding the trocar. Like with the Veress needle, one of the fingers acts a brake to prevent a sudden entry of the trocar that could lead to internal injury.

Fig. 6B. Inserting the trocar. When inserting the trocar, the force should be constant and controlled, without sudden movements to prevent the shield returning to its original position, which would require removal and "reloading" of the trocar to retract the shield.

Fig. 6C. Sheath of the trocar in position before connecting to the gas insufflation system.

Fig. 6D. Inserting the optical system for initial orientation. When maneuvring the camera, pay attention to its position. The knobs on the top of the camera indicate the upper part of the image on the monitor, and should always be in vertical position.

- **Optical trocar**: This consists of a hollow cannula with a transparent tip allowing the insertion of a 0° optical device which is introduced into the sleeve of the trocar or in a device equipped with a sheath that separates the different layers of the abdominal wall during its perforation. This permits access to the abdominal cavity under direct visualization. There are two types of optical trocars: atraumatic ones with a system that separates rather than cuts the layers so that healing is quicker, although more force must be exerted by the surgeon; and cutting ones fitted with a blade that cuts through the various tissue layers until it reaches the peritoneal cavity (Fig. 7).

Fig. 7. Example of a bladed optical trocar.
(A) Hollow cannula (obturator) with a transparent tip fitted with a blade.
(B) 12 mm trocar port through which the obturator is introduced.
(C) Rigid 10 mm 0° endoscope to be inserted into the obturator.
In order to identify the structures clearly, the optical system should be focused on the blade of the cannula.

Instruments and tools

Viewing systems (Fig. 8)

- Cold light source: device with a halogen bulb (or xenon bulb), a bulb cooling system and a system that projects the light into the cold light cable.
- Cold light cable: independent optic cable for the transmission of light linking the cold light source to the optic system.
- Optical system:
  - Endoscope: rigid or flexible. The tip may be 0º or 30º and equipped with a working channel. Usually, 10 mm endoscopes are used in medium to large animals and 5 mm endoscopes in small animals.
  - Video camera: micro-camera adapted to the eyepiece of the optical system. This micro-camera can be equipped with one or three CCDs (charge-coupled devices); the difference between models is that in the

first case, a single receptor interprets all color information and in the latter, there is a receptor for each color (red, green and blue).

- Television monitor: Analog or digital, taking into account the video output of the camera.
- Recorder.

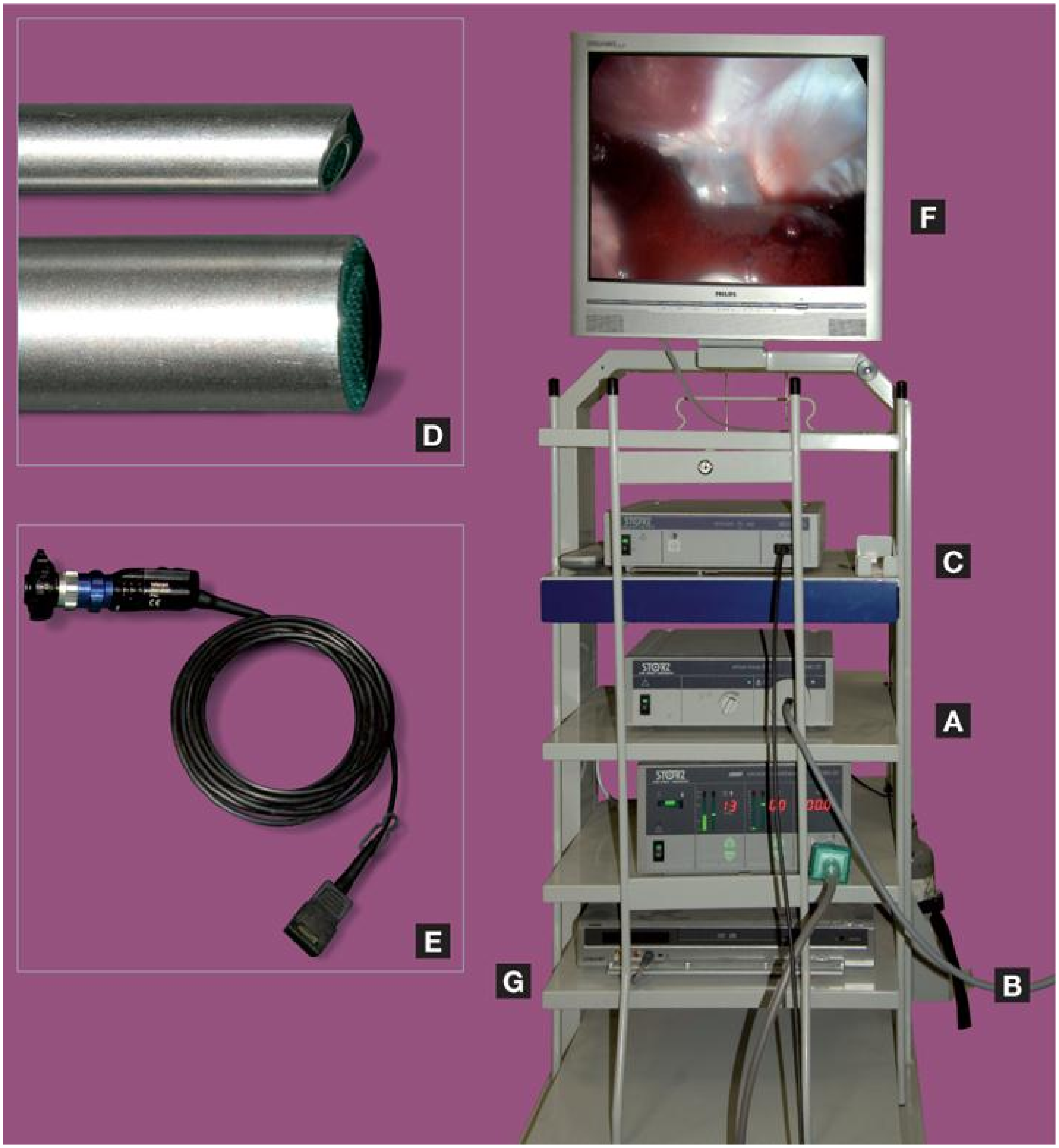

Fig. 8. Full laparoscopy tower.
(A) Cold light source.

(B) Cold light cable.
(C) Endoscopy camera receiver.
(D) Detail of the tip of two rigid endoscopes, 30° (top) and 0°.
(E) Endoscopy camera.
(F) Monitor.
(G) Recorder.

Instruments (Fig. 9)

Instruments for laparoscopic surgery are as varied as for conventional surgery. However, a basic set of instruments should include:

- Dissectors.
- Scissors.
- Clamp grip.
- Hemostatic instruments.
- Staples.

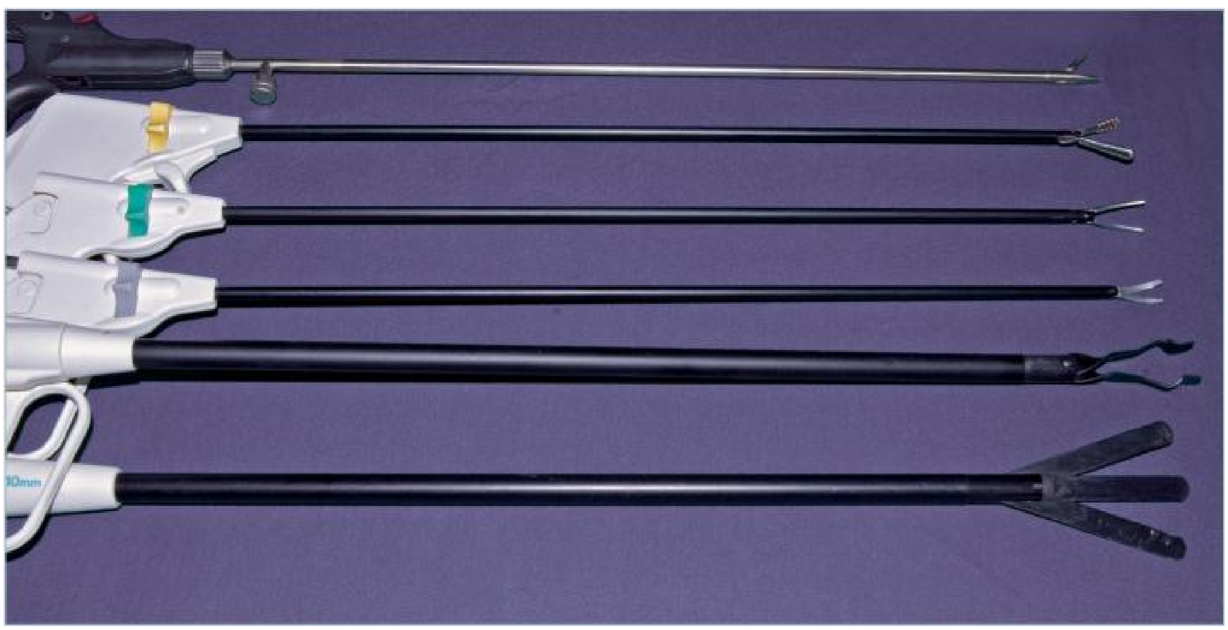

Fig. 9. Instruments for laparoscopic surgery. From top to bottom, needle holder, grasping forceps, curved dissector, scissors, Babcock forceps, separator.

Complications

Pneumoperitoneum

- **Subcutaneous emphysema**: this results from incorrect positioning of the trocars or their accidental exit and repositioning. The gas is absorbed after laparoscopy and this complication does not have any major implications apart from the technical difficulty during surgery.
- **Gas embolism**: occasionally, due to accidental cannulation or perforation of a vein, massive absorption of CO^2 may occur that, combined with the elevated intra-abdominal pressure, insufficient respiratory compensation, an increased cardiac output and peripheral resistance may lead to gas embolism. This is detected by a sudden increase in blood CO^2 and usually occurs during insufflation or immediately afterwards and is sometimes accompanied by acute pulmonary edema. The moment an increase of blood CO^2 is detected, the insufflation should be stopped, the pneumoperitoneum should be drained and the hemodynamic balance should be maintained until the patient recovers, while monitoring for acute pulmonary edema. The incidence of this complication is low (15 per 100,000 operations) but it is a very serious complication that may cause neurological disorders, cardiovascular failure or even death.

https://player.vimeo.com/video/180708271

Watch this video

Laparoscopic surgery

Insufflation and access

- **Injury to parietal vessels**: when inserting the trocar, there is a risk of damaging the vessels that run in the abdominal wall. Particular attention should therefore be paid during insertion of the trocars, which should be performed under visual guidance whenever possible.
  With an optical trocar, it is not possible to see whether vessels are perforated during insertion, so that it is always advisable to enter through the midline whenever possible. When exiting, first remove the trocar and then the optical system to ensure the absence of bleeding vessels in the

pathway. In case of bleeding, this should be controlled by compression or by dissection and ligation of the vessel.

- **Atypical insufflation**: when starting CO^2 insufflation, ensure that the distribution of gas in the abdomen is uniform. If this is not the case, insufflation should be stopped immediately as this may mean that gas is being insufflated into other structures (intestinal loops, bladder, etc.).
- **Injury of abdominal viscera**: when entering with the Veress needle or a trocar, it is possible to damage the digestive tract, the spleen or other viscera. For this reason, once the abdomen is insufflated and the trocar is inserted, a systematic check of the viscera should be performed. It is advisable to always carry out this check in the same manner (clockwise or counterclockwise) and be as systematic as possible.
- **Injury to large vessels**: as with the viscera, it is possible to damage large vessels during entry. When an injury occurs it is necessary to revert to conventional surgery to stop the bleeding.

Indications

- Exploratory laparoscopy.
- Gastropexy, gastrotomy, pylorotomy, pyloroplasty.
- Liver biopsy, cholecystectomy.
- Hiatal hernia.

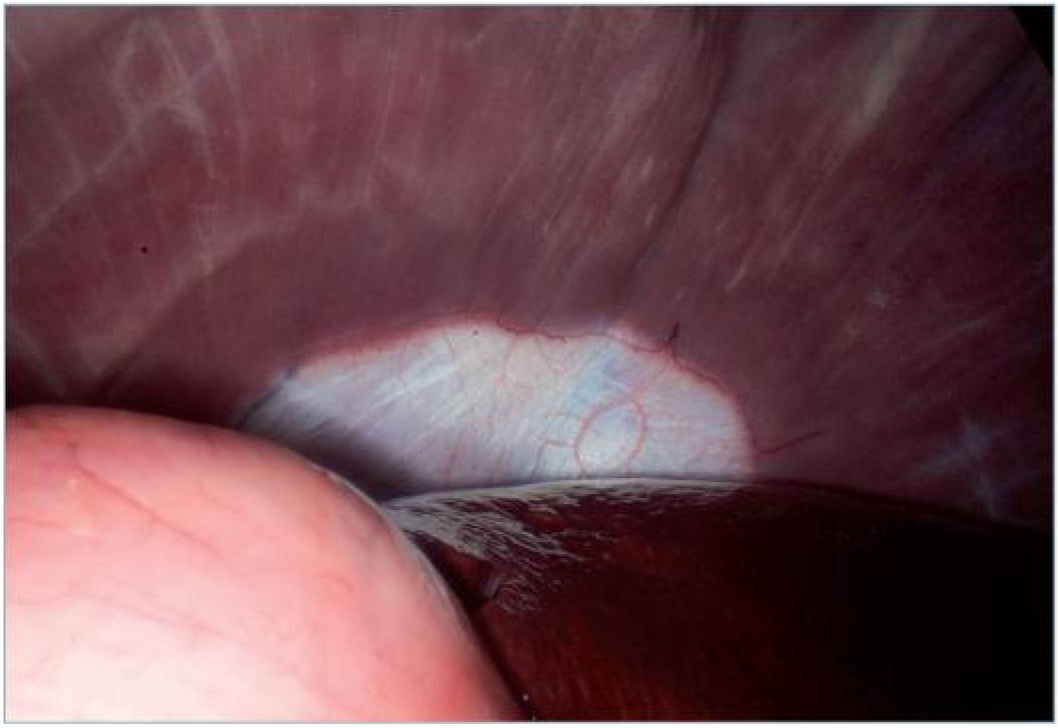

Fig. 10. Image inside the abdomen. In the background, the diaphragm (tendinous center and sternal portion), to the left the stomach and to the right, the liver.

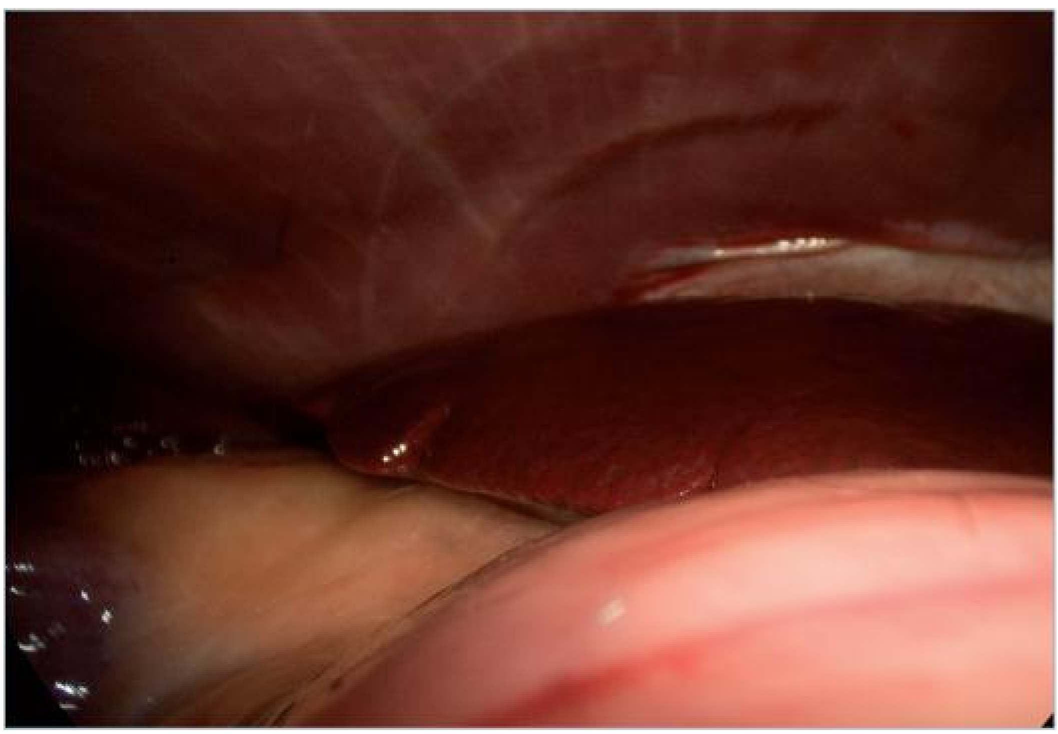

Fig. 11. Inside the abdomen, right side. In the background the diaphragm, on the lower left the stomach and the liver above it.

Fig. 12. Inside the abdomen, left side.

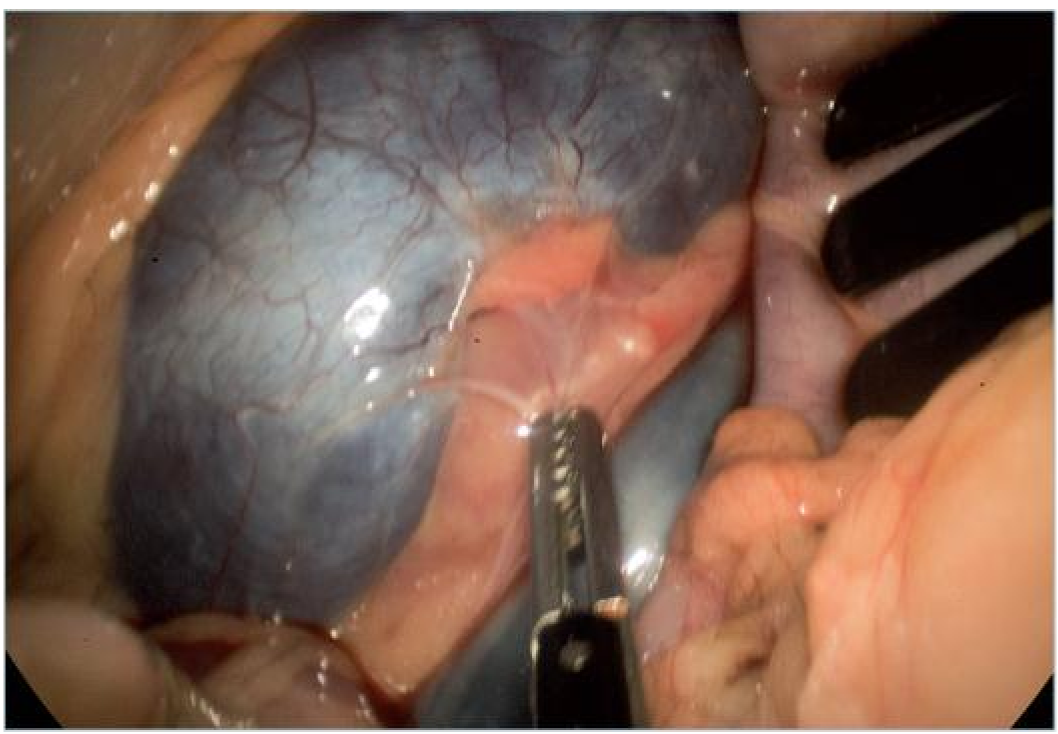

Fig. 13. Left kidney.

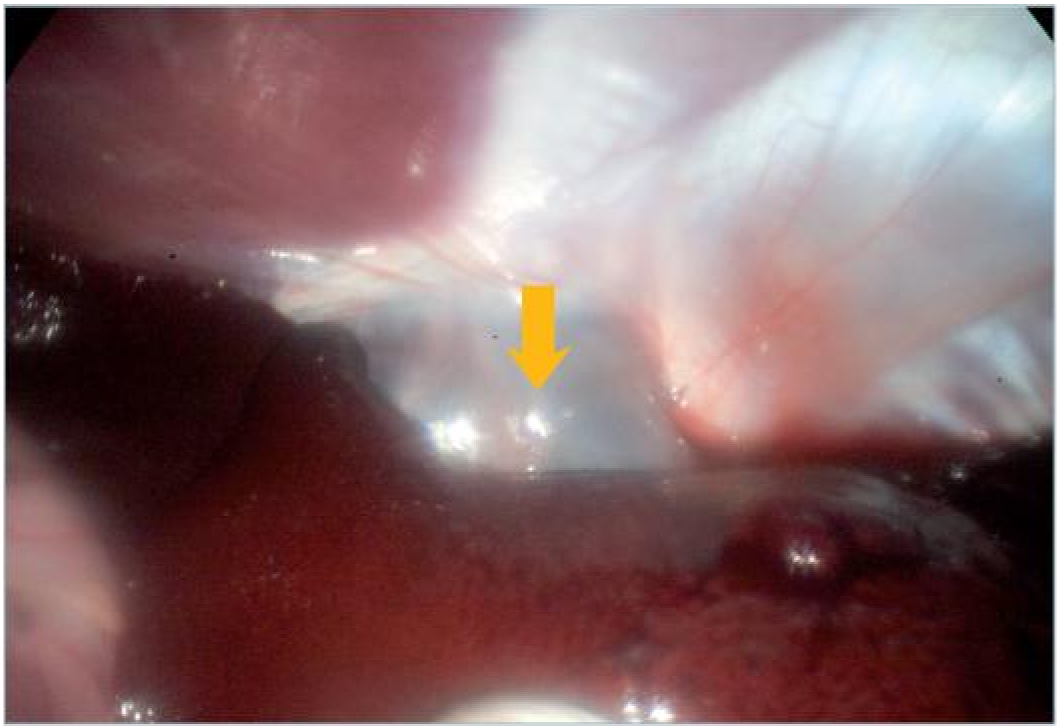

Fig. 14. Detail of the foramen of the vena cava. The liver is seen in the lower part of the image.

Portosystemic shunt

José Rodríguez

Prevalence	■	■	■	□	□
Technical difficulty	■	■	■	□	□

The aim of surgical treatment is to obtain a progressive closure of the portosystemic shunt so that blood from the portal area is redirected towards the liver.
For this purpose, ameroid constrictors can be used (Fig. 1) as well as cellophane strips (Fig. 2) or partial silk ligatures (Fig. 3).

Closure of the portosystemic shunt should be gradual, to prevent fatal portal hypertension.

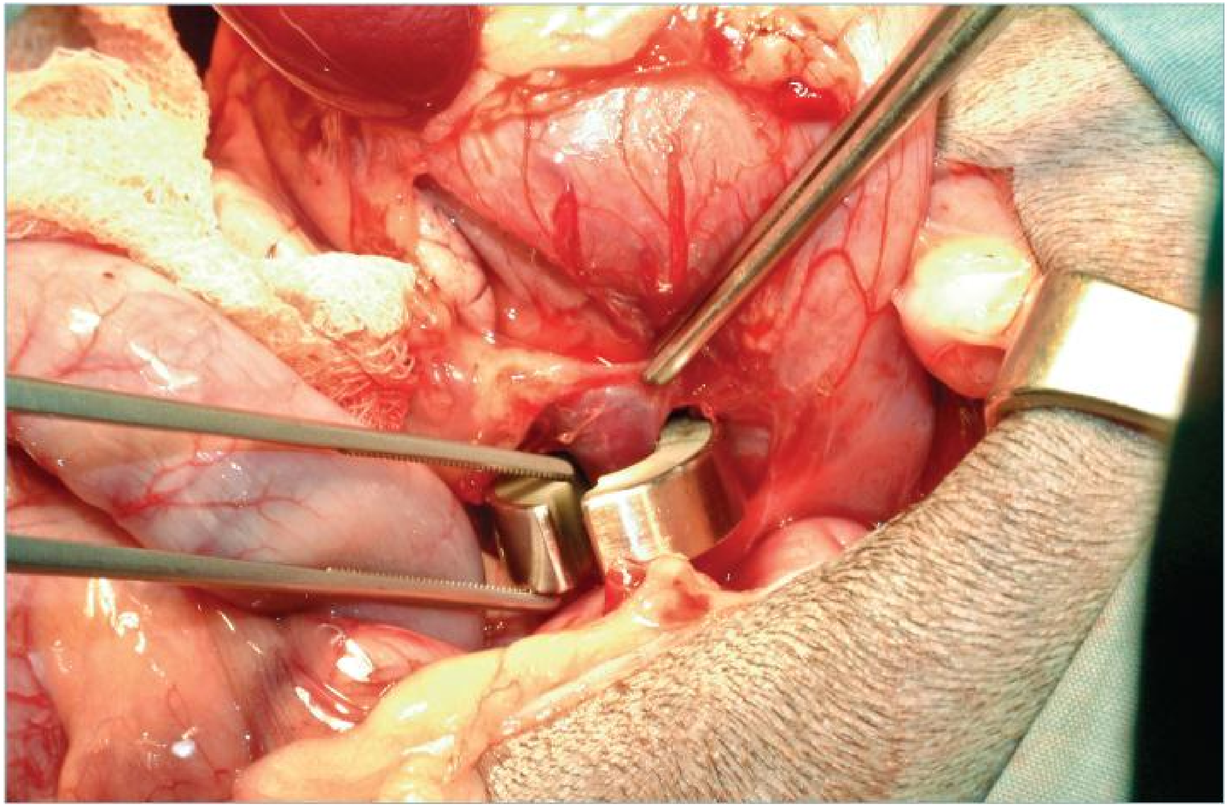

Fig. 1. The ameroid constrictor progressively closes the vessel due to swelling of the hygroscopic material inside. This image shows the placement of an ameroid ring around the shunt. The opening in the ring seen here will now be closed with a small rod or “key”.

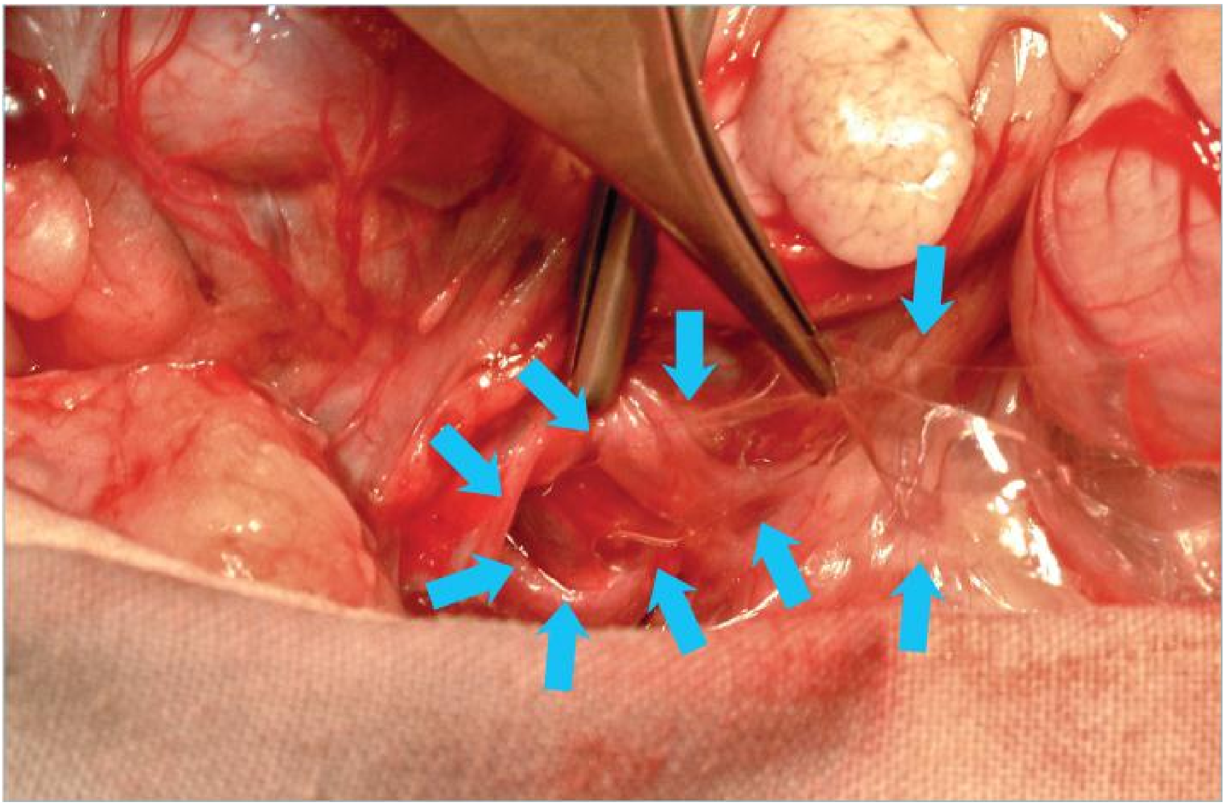

Fig. 2. Placement of a cellophane strip around the shunt produces a foreign body reaction, which will gradually close the vessel. This image shows the placement of a cellophane band (blue arrows) around a portocaval shunt.

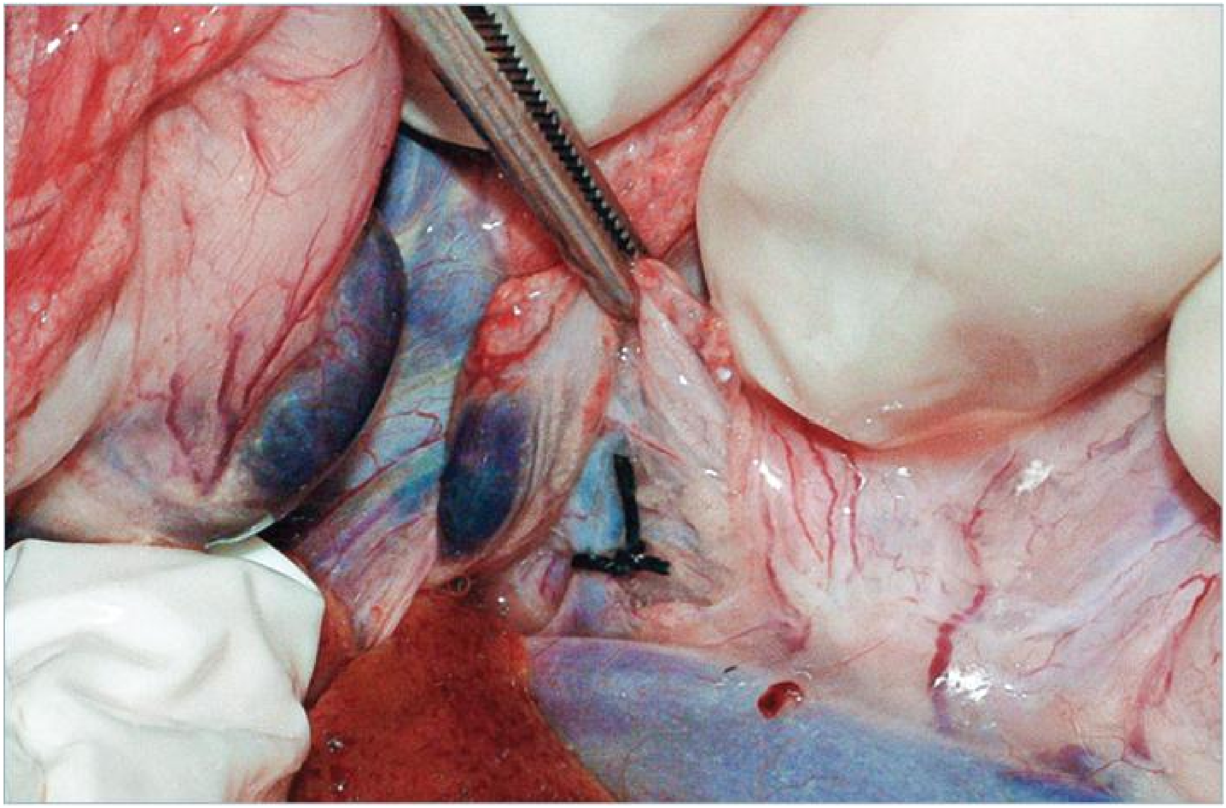

Fig. 3. Incomplete silk ligature around the vessel. In addition to partially closing the vessel, it causes fibrosis of the wall, which leads to complete closure. In these patients, it is necessary to measure the venous pressure in the splanchnic area to prevent portal hypertension.

Before a surgical procedure such as this one, it is essential to have an in-depth knowledge of the vascular anatomy, including both the portal vein and the caudal vena cava, as well as their respective relations with the liver.

Patients with encephalopathy should be treated before surgery.

Anesthesia of these animals should avoid the use of drugs that are metabolized in the liver or that bind to serum proteins, such as phenothiazines and diazepam.

Ameroid constrictor

Ameroid constrictors can have different diameters depending on the vessel around which they are to be placed, although the 5.0 mm diameter is most commonly used.

After performing a midline laparotomy, the colon is moved to the right side of the patient to expose the caudal vena cava, the left renal vein and the left phrenicoabdominal vein.

If there is another vein cranial to the left phrenicoabdominal vein, this probably is the portocaval shunt (Fig. 4).

> *
>
> ***Excessive dissection of the vessel and the surrounding tissues may lead to movement of the constrictor along the vessel and may cause sudden stenosis, portal hypertension and death.***

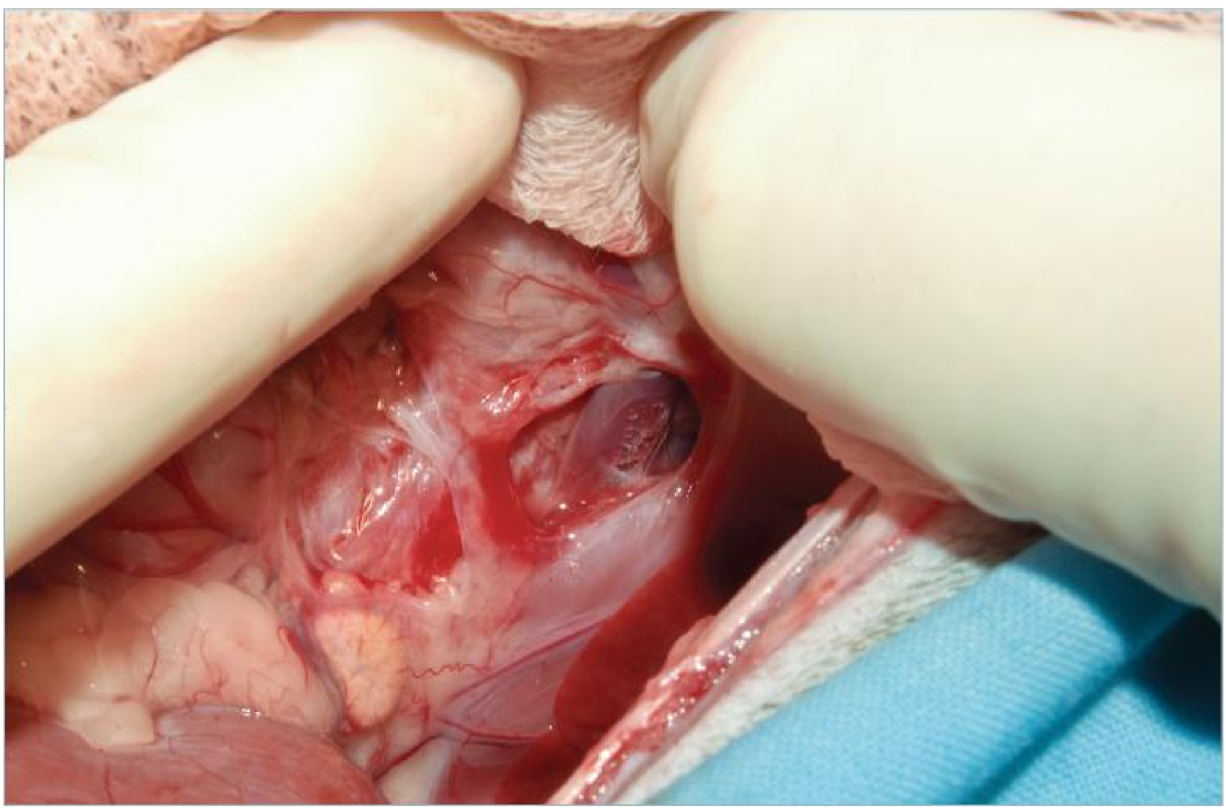

Fig. 4. Location and dissection of a vein cranial to the left renal and phrenicoabdominal veins. This is probably the portocaval shunt.

The ring is passed around the vessel with the help of a dissector (Fig. 5). To facilitate this procedure, and because the vessel is thick, a ligature is placed to interrupt the blood flow temporarily. The vessel is then placed inside the ring and the ligature is removed, after which the ring is closed with a small "key", using a needle holder (Fig. 6).
The ameroid constrictor should not be too large, as its weight could kink the vessel and obstruct it prematurely, leading to portal hypertension.

Avoid large and heavy constrictors, as these may move and kink the vessel, causing portal hypertension.

Before closing the laparotomy, the intestinal loops should always be checked for signs of congestion. Intraoperative hypertension is very rare in theses cases.

From 2 weeks after the operation onwards, complete closure of the ameroid ring may be confirmed by ultrasonography.

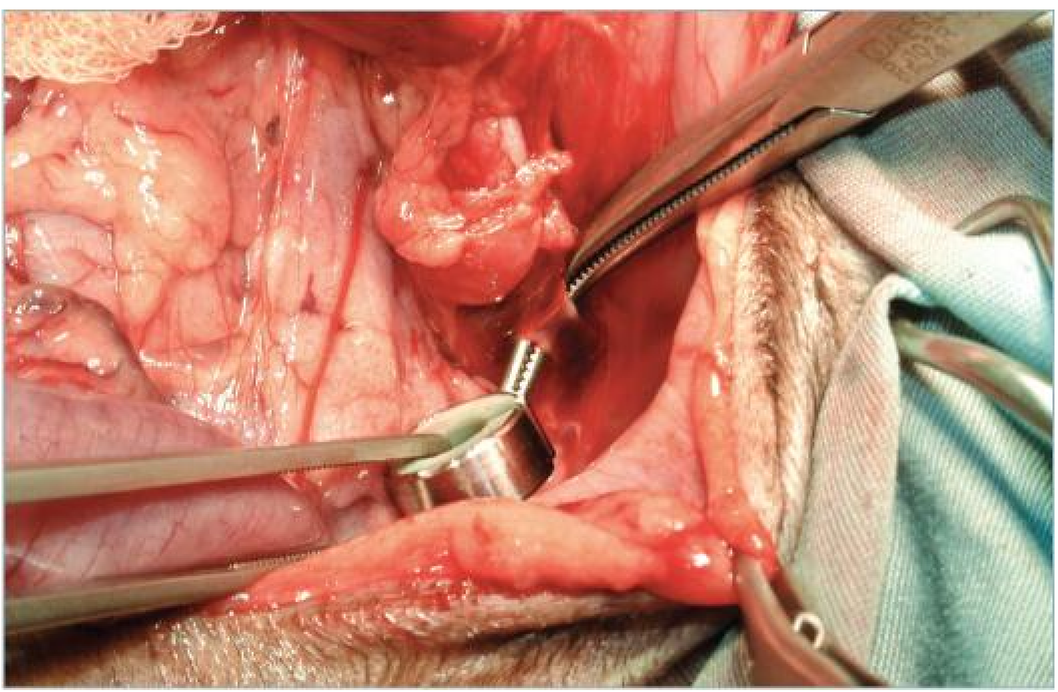

Fig. 5. Careful dissection of the abnormal vessel and placement of the constrictor around the portocaval shunt. Sometimes it may be difficult to pass the ring around the vessel, and patience is required. Alternatively, the blood flow may be interrupted by temporarily ligating the vessel.

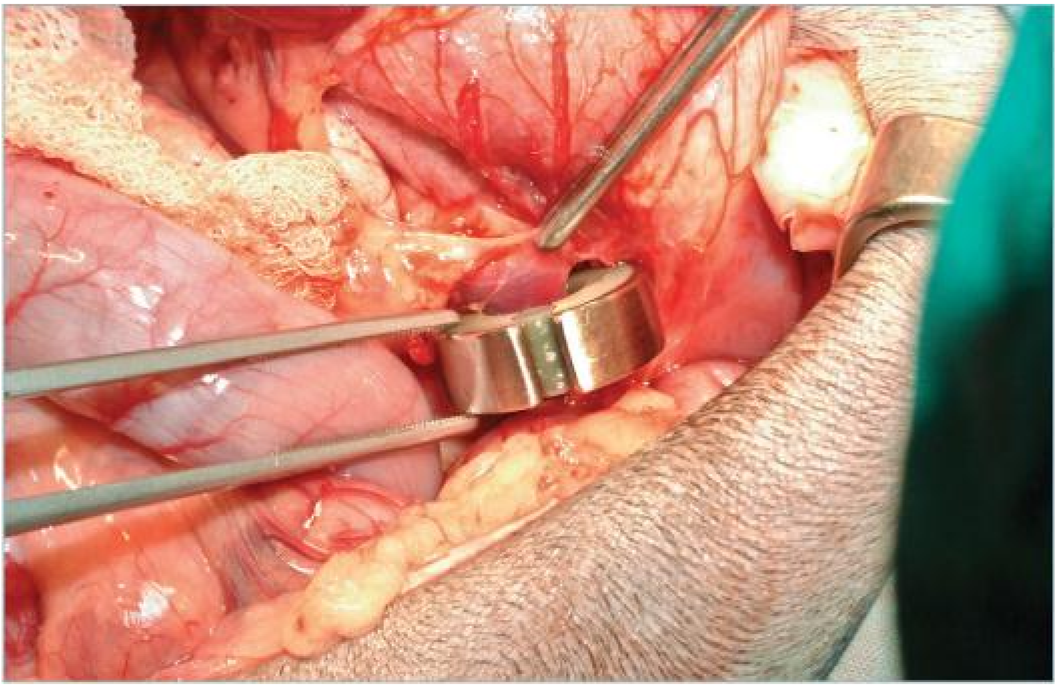

Fig. 6. Closing the constrictor by inserting the 'key', thereby immobilising it around the vessel. The rod may be of metal or ameroid as shown here.

Cellophane tape

Cellophane tape placed around the portosystemic shunt causes a granulomatous reaction that will gradually close the vessel in 3-4 weeks. This material is inexpensive and readily available. The tape (10-16 mm wide) is cut in strips 15 cm long, placed in a pouch and sterilised.

> ***Cellophane tape can be used in a single layer or can be folded several times before placing it to obtain a thicker tape.***

As in all cases, the congenital malformation is located and dissected (Fig. 7). Using a dissector, the cellophane tape is then placed around the vessel.

One or two vascular staples are used to fix it into place (Fig. 8).

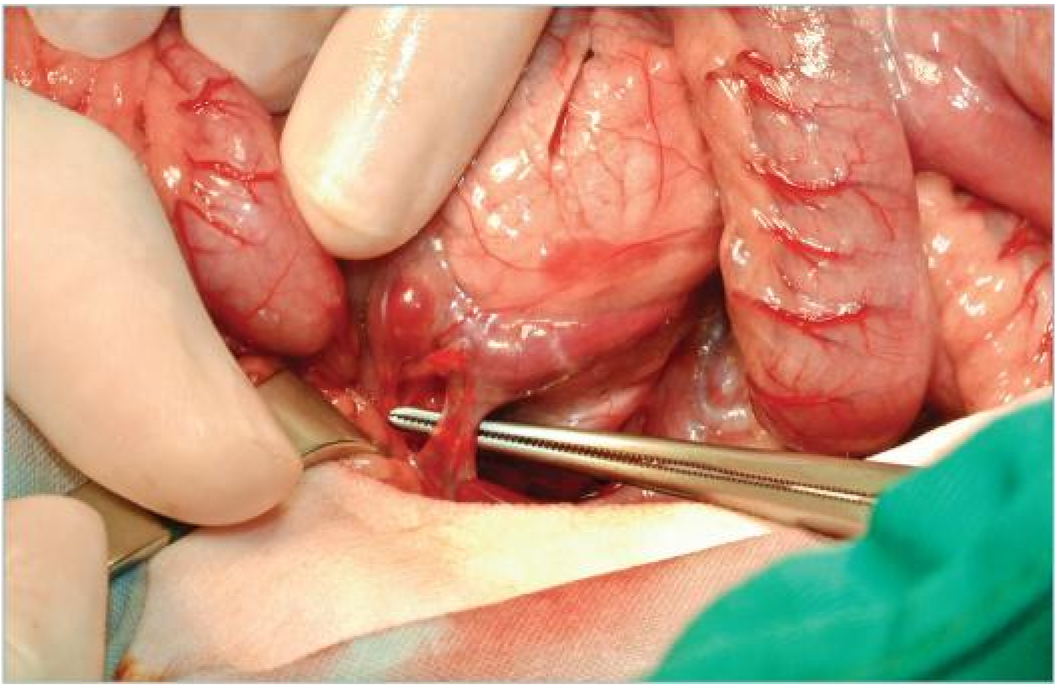

Fig. 7. Dissection of the portocaval shunt, in this case from the right of the patient using a right-sided approach.

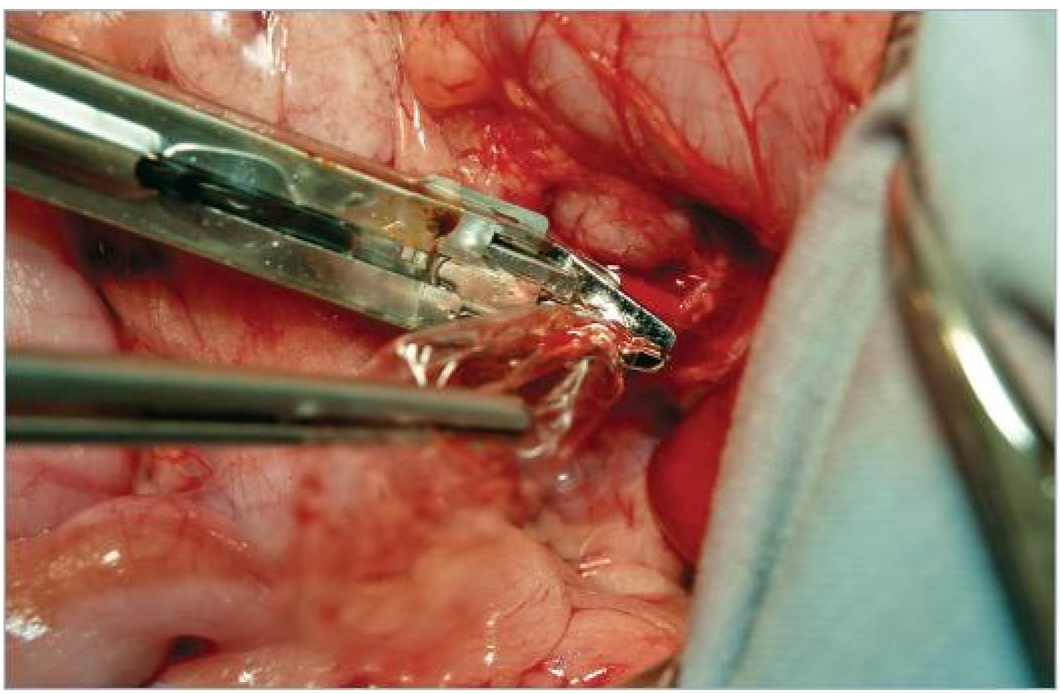

Fig. 8. The cellophane strip is placed around the shunt and is fixed into place with 1 or 2 metal staples, without occluding the vessel.

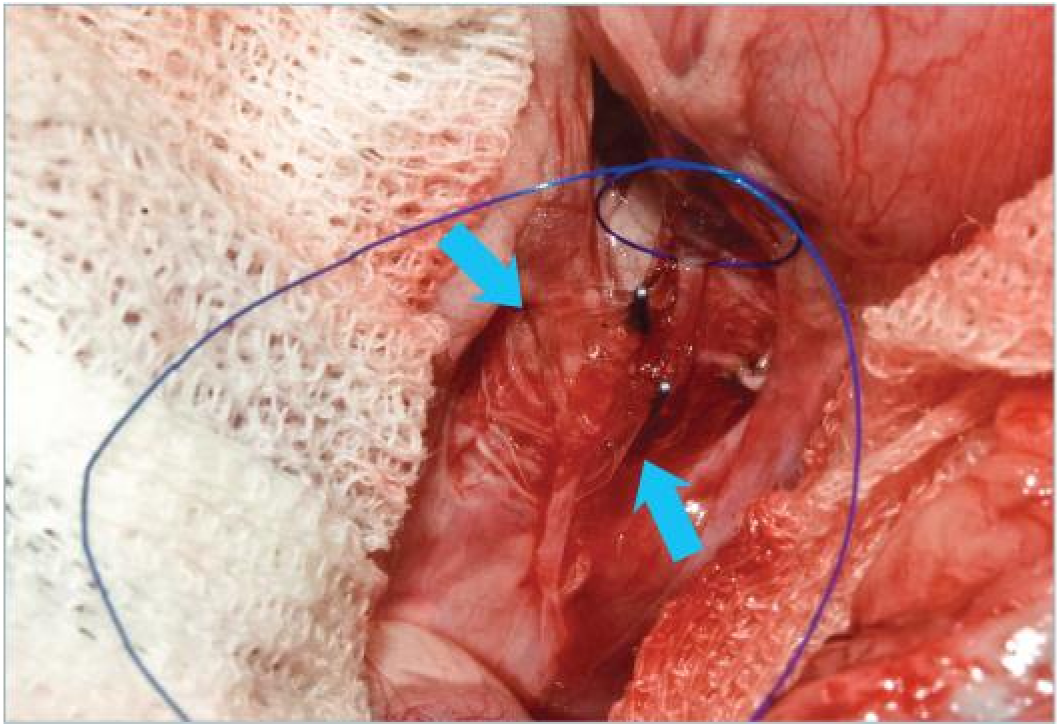

Fig. 9. In this case, two cellophane strips were placed (blue arrows), as well as an untied ligature that may be used later, if necessary, to completely occlude the shunt.

Ligating the shunt

Partial ligation of the shunt can be achieved by using a non-absorbable material such as silk, although these patients require close monitoring for possible portal hypertension.
After locating and dissecting the shunt, a 2/0 silk ligature is placed around the vessel (Fig. 10).

Prior to placing the ligature, an IV catheter should be inserted in a jejunal vein to measure the basal portal blood pressure.

The ligature is temporarily closed, the portal blood pressure is measured, which nearly always increases immediately. In case of doubt, mesenteric portography is performed, using the catheter in the jejunal vein.

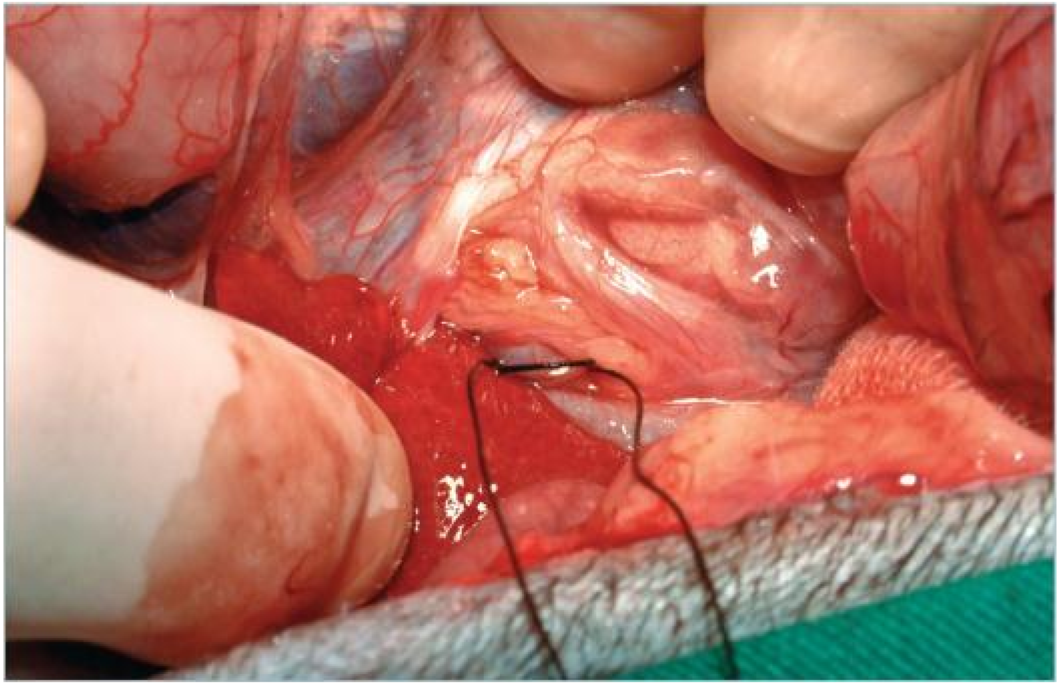

Fig. 10. Placement of a 2/0 silk ligature around the portocaval shunt.

The efficacy of this method is very good for vessels up to 3-4 mm diameter. For bigger vessels, the occlusion may be partial, necessitating a second operation.

In some cases, the fibrous reaction induced by the cellophane does not lead to complete occlusion of the vessel. This is why an untied ligature is placed around the vessel. If, after 5 to 6 weeks, blood continues to flow through the shunt, the patient is re-operated and the pre-placed ligature is tied (Fig. 9).

After confirming that the ligature is placed around the shunt, it is slowly tied off while the portal blood pressure is measured. The pressure should not exceed 20-25 cm H^2O. If it does, the shunt is only partially closed to prevent further portal hypertension (Figs. 11 and 12).

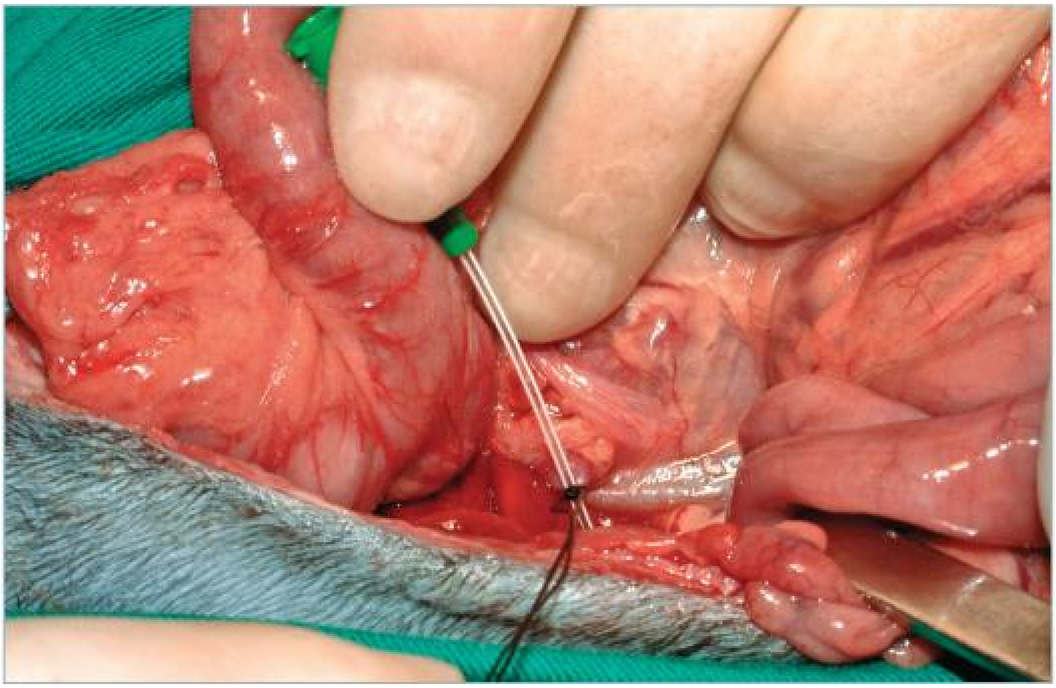

Fig. 11. To avoid complete occlusion of the vessel during ligation, an IV catheter was used to ensure the knot is not too tight.

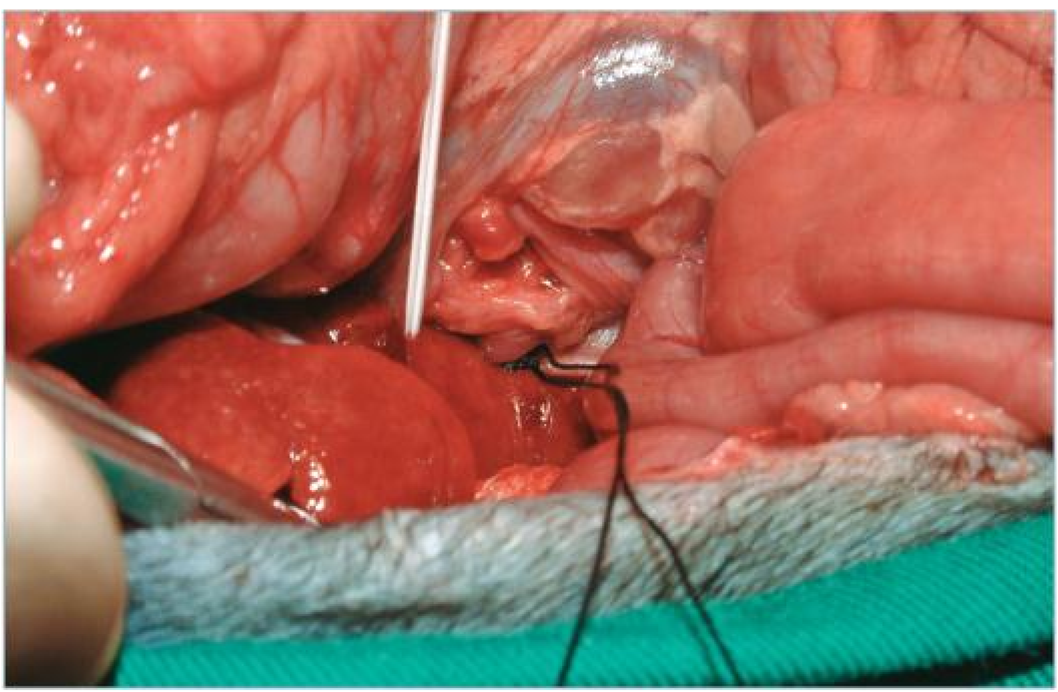

Fig. 12. After tying the ligature around the vessel and the catheter, the latter is removed. The incomplete closure of the ligature prevents immediate portal hypertension.

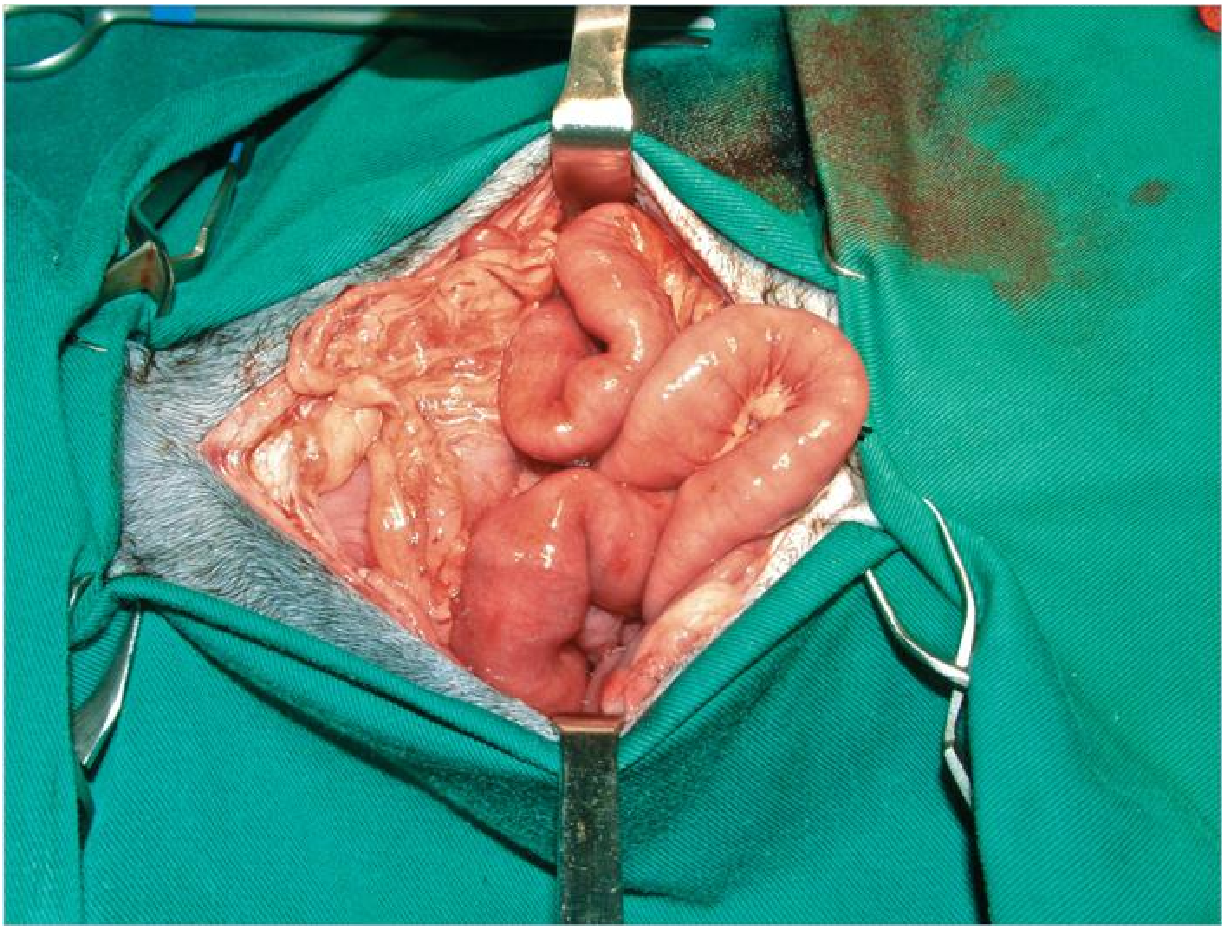

Fig. 13. The normal color of the bowel loops is an indicator for the absence of portal hypertension.

After the intervention, the bowel loops are checked for the absence of venous congestion (Fig. 13).

Complete ligation of the vascular anomaly often results in fatal portal hypertension.

This method cannot occlude the shunt completely, which is why a second operation is required to occlude it completely.

Other occlusion methods

Other methods for the closure of these congenital defects, such as coils or hydraulic occluders, have been developed.
Coils are made of thrombogenic material and are placed inside the shunt using interventional radiography. This minimally invasive technique is not without the risk of complications such as coil migration or sudden vessel occlusion.
Hydraulic occluders are rings that are placed around the vessels. Progressive occlusion is obtained by injecting saline into the system's reservoir, which is placed subcutaneously.

Portal hypertension Postoperative complication

Sudden closure of the portosystemic shunt as a result of the ligature or movement of the ameroid constrictor may cause portal hypertension and death of the patient within a few hours.
This is because the hepatoportal space is underdeveloped and incapable of receiving all the blood that was diverted through the shunt before, causing an increase of the venous pressure in the splanchnic area.
Portal hypertension causes congestion in the intestinal loops, the pancreas and the spleen. This leads to thrombosis of the veins due to blood stasis, followed by ascites, organ failure and death.

Case 1 / Extrahepatic shunt. Cellophane tape banding (right-sided approach)

José Rodríguez

Pincho is a Yorkshire Terrier pup who presented because it was much smaller than its littermates and occasionally vomited. The owner was most concerned by the pup's strange behavior after eating: walking in circles and pressing its head against the wall (Fig. 1).

Fig. 1. Pincho on the day of the operation.

Blood test results were compatible with a portosystemic vascular anomaly (table I). This was confirmed after abdominal ultrasound examination (Fig. 2).
In order to stabilise the patient, medical treatment was initiated which included the following:

- Specific diet for liver patients (Hill's l/d).
- Omeprazole 1 mg/kg once daily.
- Metronidazole 7.5 mg/kg twice daily.
- Lactulose 0.5 ml/kg PO twice daily.

After ten days, the digestive problems were corrected and no further crises due to hepatic encephalopathy were observed, so surgery was planned.

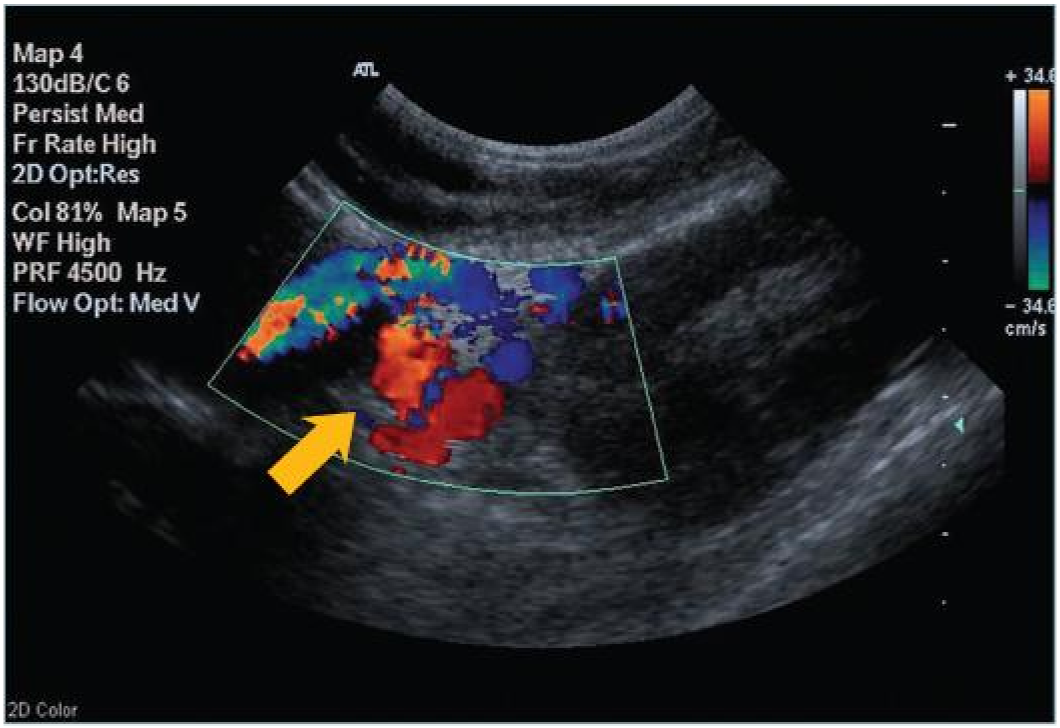

Fig. 2. Abdominal ultrasonography confirmed a vascular shunt (yellow arrow). Color Doppler revealed turbulence in the blood flow of the vena cava due to the extra blood supply through the shunt.

Table I.

Pincho's blood test results		
Hematology		
	Results	Normal range
Leukocytes	10.84 x 10^9/L	5.50-19.50
Lymphocytes	1.34 x 10^9/L	0.40-6.80
Monocytes	1.48 x 10^9/L	0.15-1.70
Neutrophils	7.65 x 10^9/L	2.50-12.50
Eosinophils	0.31 x 10^9/L	0.10-0.79
Basophiles	0.06 x 10^9/L	0.00-0.10
Hematocrit	0.346 %	0.30-0.45
RBC	5.60 x 10^{12}/L	5.00-10.00
Hemoglobin	108 g/L	90-151
Platelets	230 x 10^9/L	175-600
Blood chemistry		
	Results	Normal range
Total protein	**45 g/L**	54-82
Albumin	22 g/L	22-44
Globulins	15 g/L	15-57
Alkaline phosphatase	3.807 µkat/L	0.17-1.53
ALT	2.150 µkat/L	0.33-1.67
Total bilirubin	< 1.71 µmol/L	1.71-10.26
Glucose	5.5 mmol/L	3.88-8.32
BUN	**1.428 mmol/L**	3.57-10.71
Creatinine	17.68 µmol/L	26.52 -185.64
Ammonia (pre-prandial)	**66.331 µmol/L**	0-58.113
Ammonia (post-prandial)	**250.062 µmol/L**	0-58.113
Calcium	2.2 mmol/L	2.0-2.95
Phosphorus	1.905 mmol/L	1.09-2.74
Sodium	137 mmol/L	142-164
Potassium	4.7 mmol/L	3.7-5.8

Surgery

Technical difficulty

After general anesthesia and a supraumbilical laparotomy, the duodenum and the bowel loops are moved to the patient's left side to expose the vena cava.
After incising the mesentery, an abnormal vessel was located and dissected. It is usually found cranial to the right renal vein (Fig. 3).

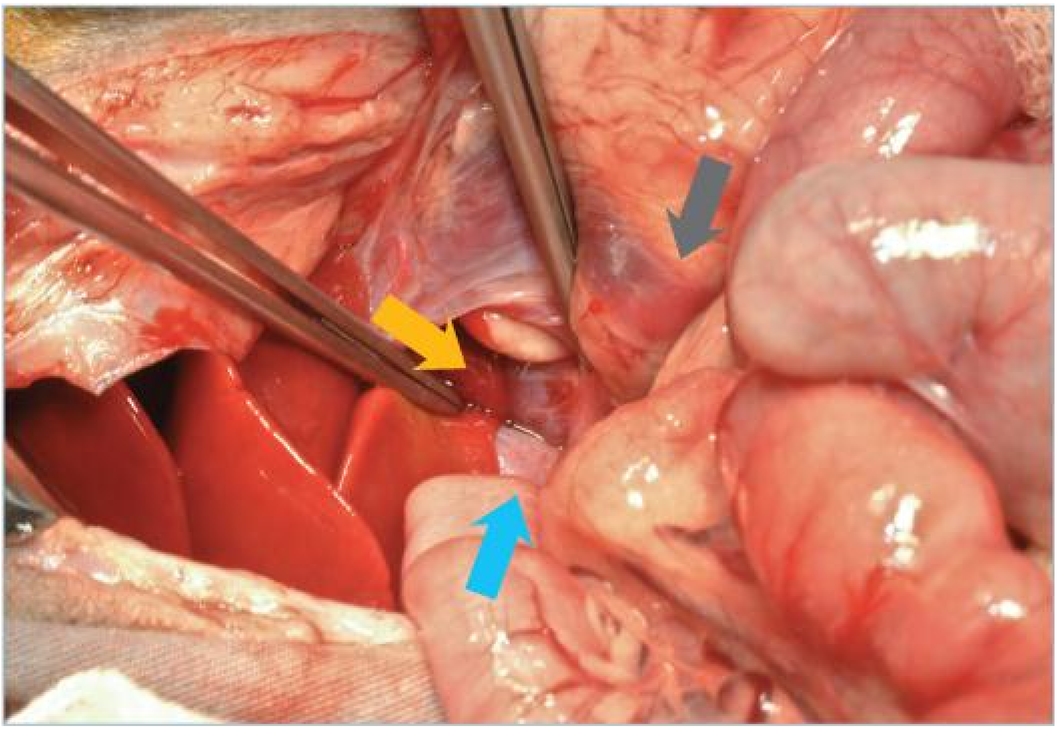

Fig. 3. This image shows the three vessels associated with this disorder: portal vein (grey arrow), vena cava (blue arrow) and the portocaval shunt (yellow arrow).

The portocaval shunt was dissected free (Fig. 4), and a cellophane tape was wrapped around it (Fig. 5).

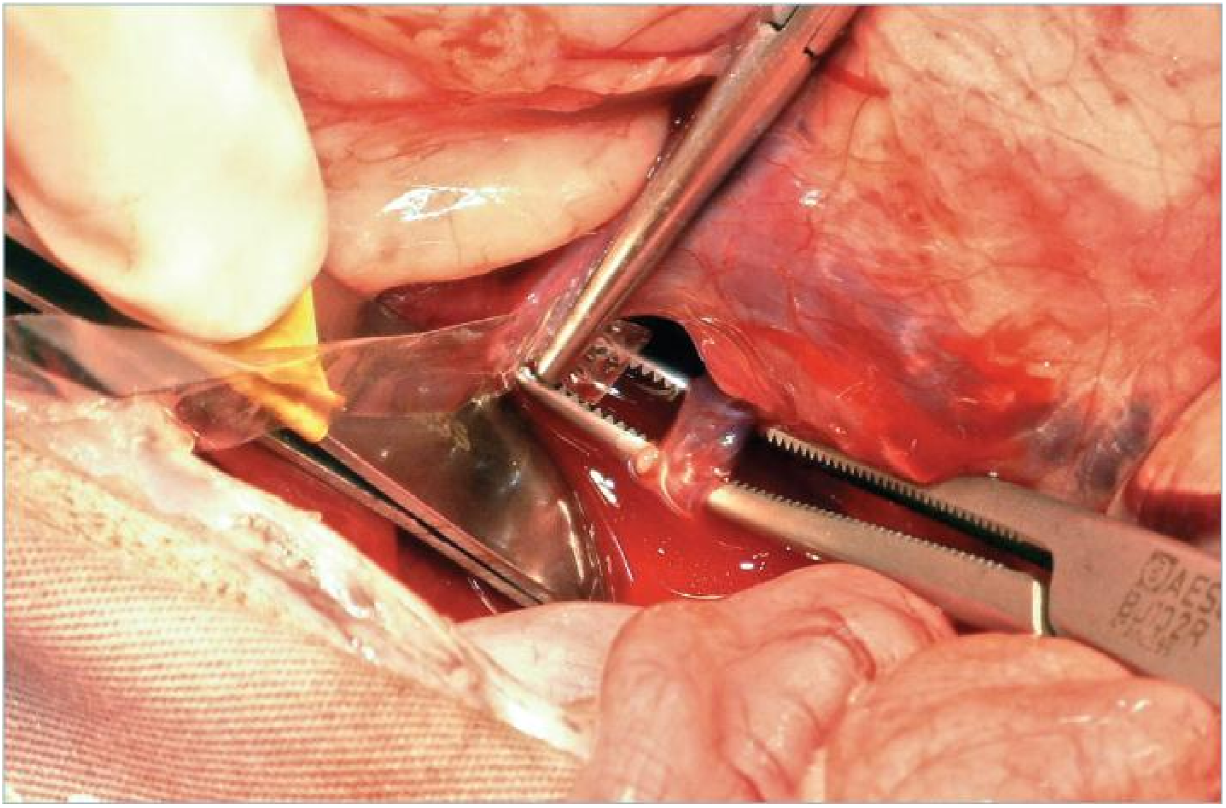

Fig. 4. After atraumatic dissection of the shunt, the cellophane strip is passed around the vessel.

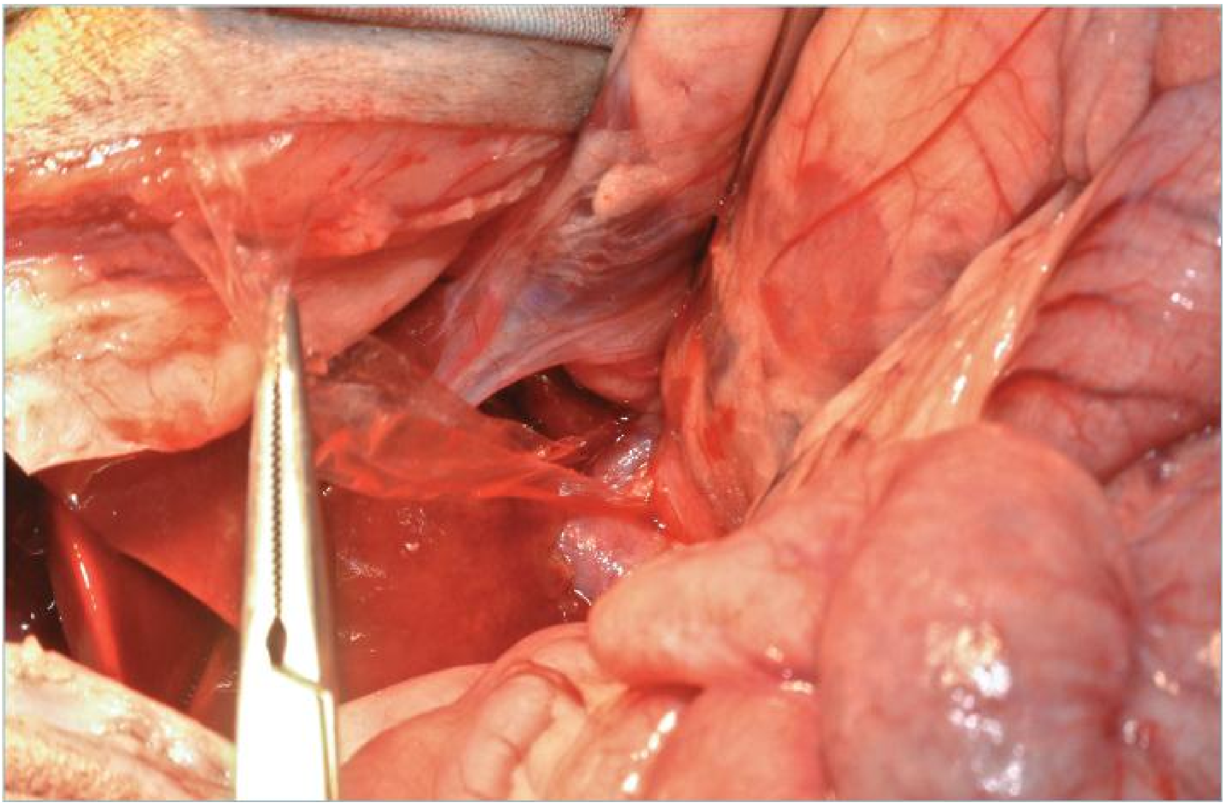

Fig. 5. This image shows the cellophane tape around the portocaval shunt.

To secure the cellophane tape around the vessel, one or two vascular staples are placed according to the diameter of the vessel to achieve constriction (Figs. 6 and 7).

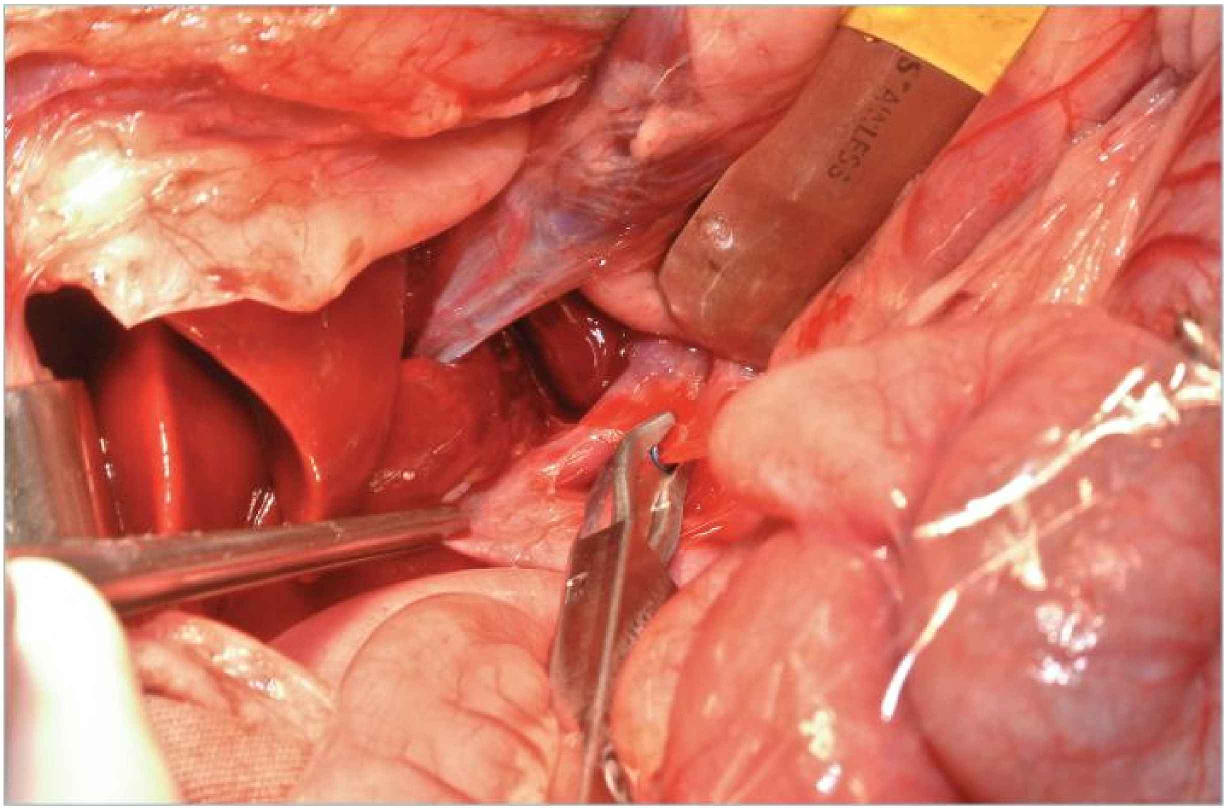

Fig. 6. Placement of a titanium vascular staple on the dorsal part of the cellophane strip around the shunt.

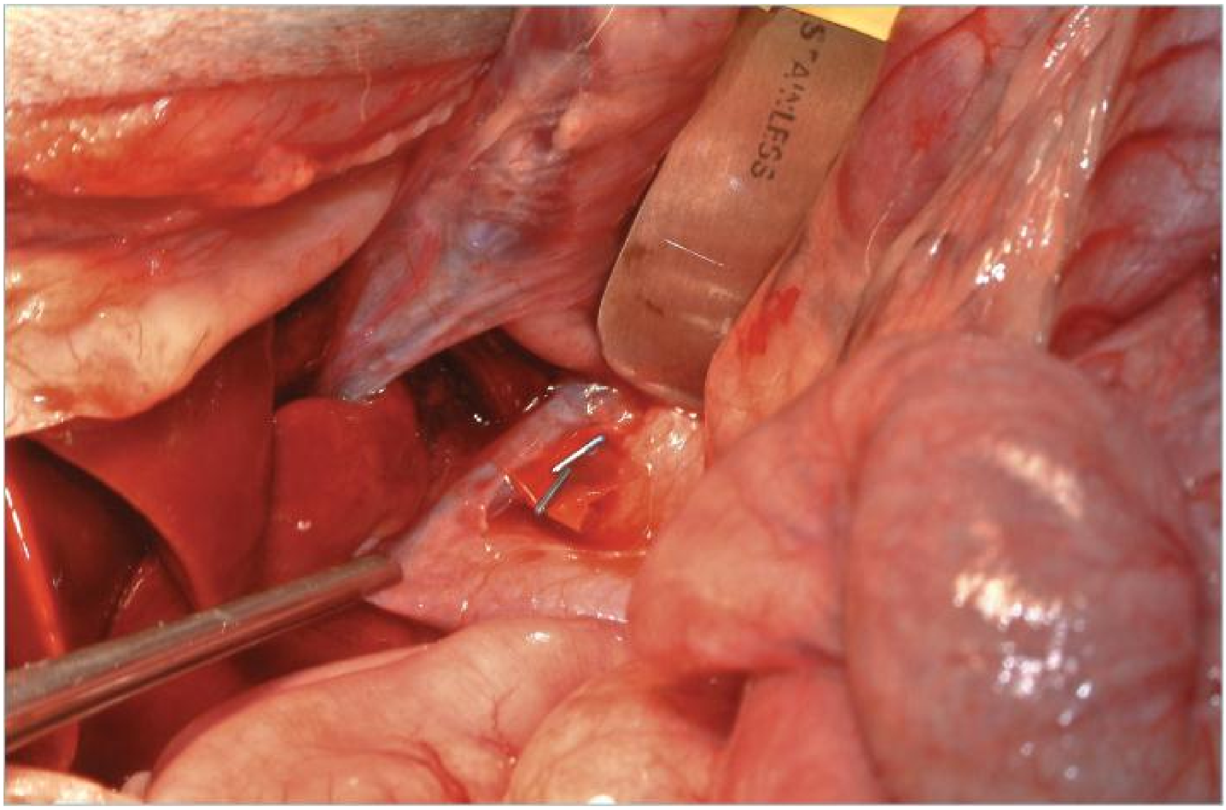

Fig. 7. This image shows the cellophane strip in place around the vessel; two vascular staples have been used and the end of the cellophane strip has been trimmed.

Postoperative follow-up

The patient recovered satisfactorily from the operation (Fig. 8). Medical therapy was maintained for three weeks and the special diet for a month and a half. Two months later, the owner came back because the dog was vomiting occasionally. An ultrasound check revealed that the vascular anomaly had not completely closed, although the portal blood flow to the liver was improved.

A second operation was proposed to close the vessel permanently, but the owner did not consent and the patient is currently being treated medically.

Fig. 8. Pincho recovered rapidly from his nervous problems and no longer showed signs of hepatic encephalopathy.

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Portosystemic shunt: occlusion with a cellophane strip

Case 2 / Extrahepatic shunt. Ameroid constrictor (left-sided approach)

José Rodríguez

Niko is an 8-year-old male Spanish Water Dog. His owners took him to their veterinarian because he was thin, vomiting and drinking a lot. The differential diagnosis included a portosystemic shunt.

Blood tests only showed a moderate leukocytosis: 18.06 x 10^9/L (5.50-19.50), an increase in alkaline phosphatase: 5.611 µkat/L (0.17-1.53), and a marked decrease of the BUN: 1.071 mmol/L (3.57-10.71).

Abdominal ultrasonography confirmed the existence of a shunt between the splanchnic area and the vena cava.
The patient was referred for surgery.

Surgery

Technical difficulty

Midline laparotomy was performed and the gastrointestinal parcel was moved to the right side of the patient by pulling on the duodenum (Fig. 1).
Portocaval shunts are typically located cranial to the phrenicoabdominal vein. The surgeon’s attention and dissection should therefore be focused on this area (Figs. 2-4).

Fig. 1. By moving the gastrointestinal parcel to the right, the left renal area is exposed, as well as the space between kidney and liver.

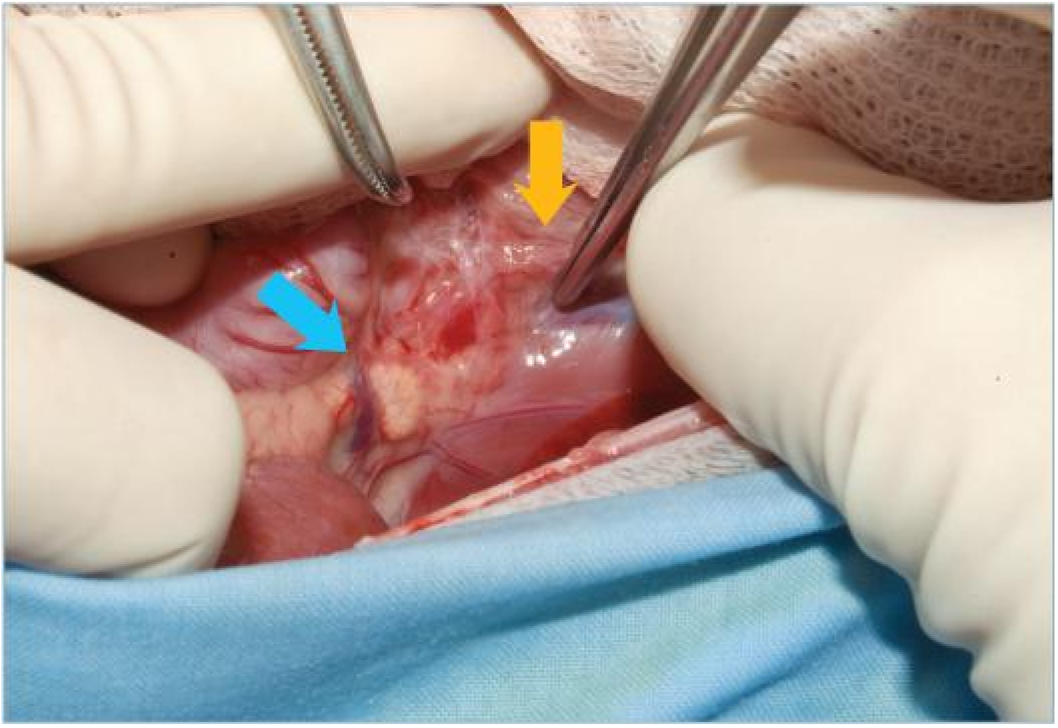

Fig. 2. In the left prerenal area, the phrenicoabdominal vein is identified (blue arrow) and, just cranial to this, the vascular malformation (yellow arrow).

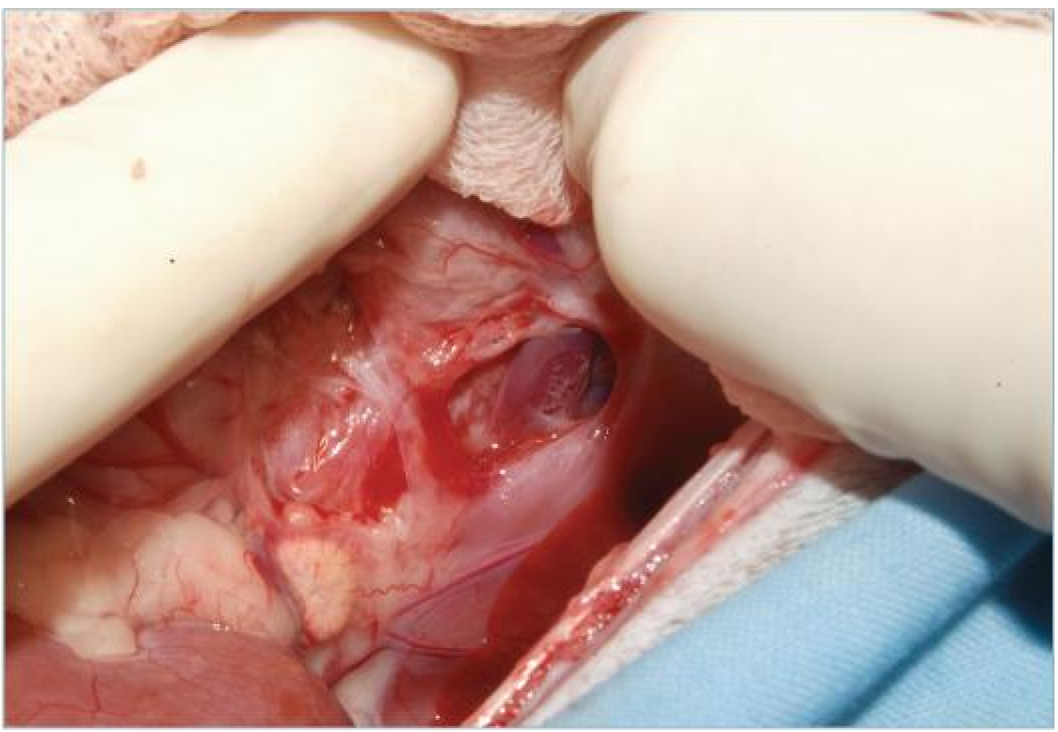

Fig. 3. Incision of the duodenal mesentery reveals the abnormality at its junction with the posterior vena cava.

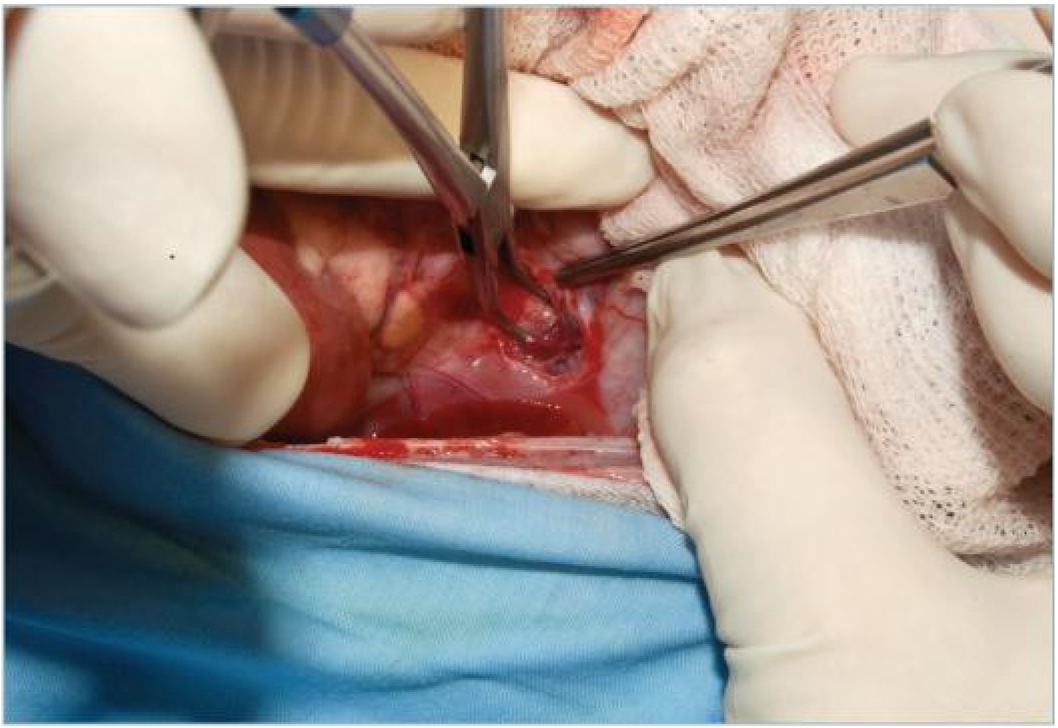

Fig. 4. Dissection of the shunt is carried out with great care and always lengthwise along the vein to prevent injury.

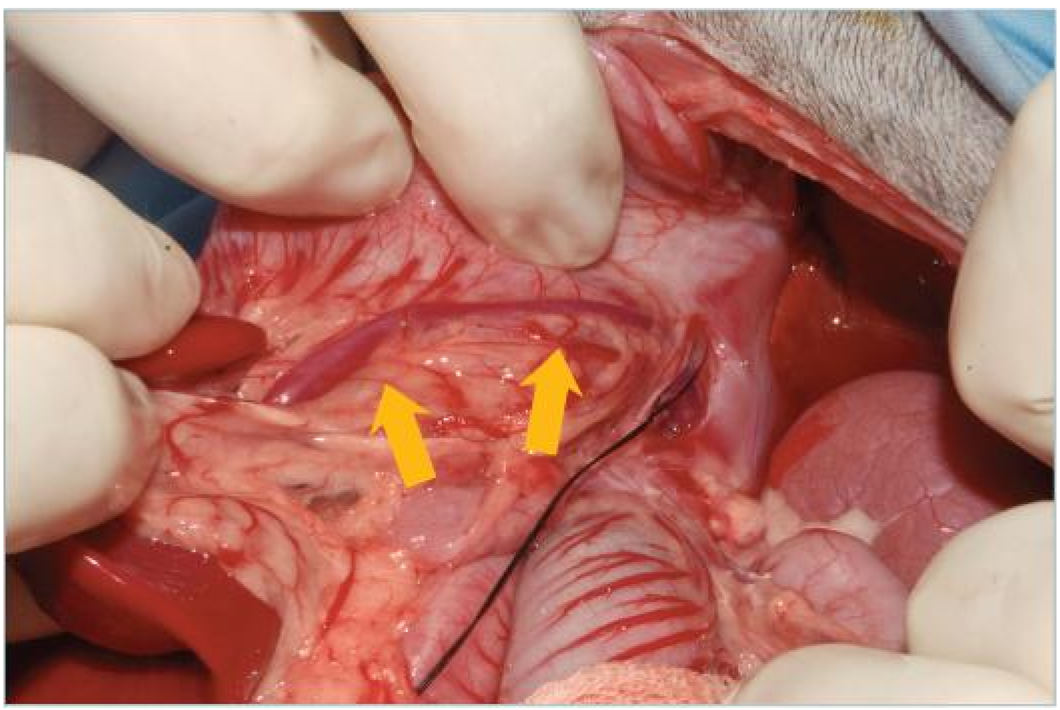

Fig. 5. Following the course of the abnormal vein, it is noted how it runs towards the greater curvature of the stomach (yellow arrows).

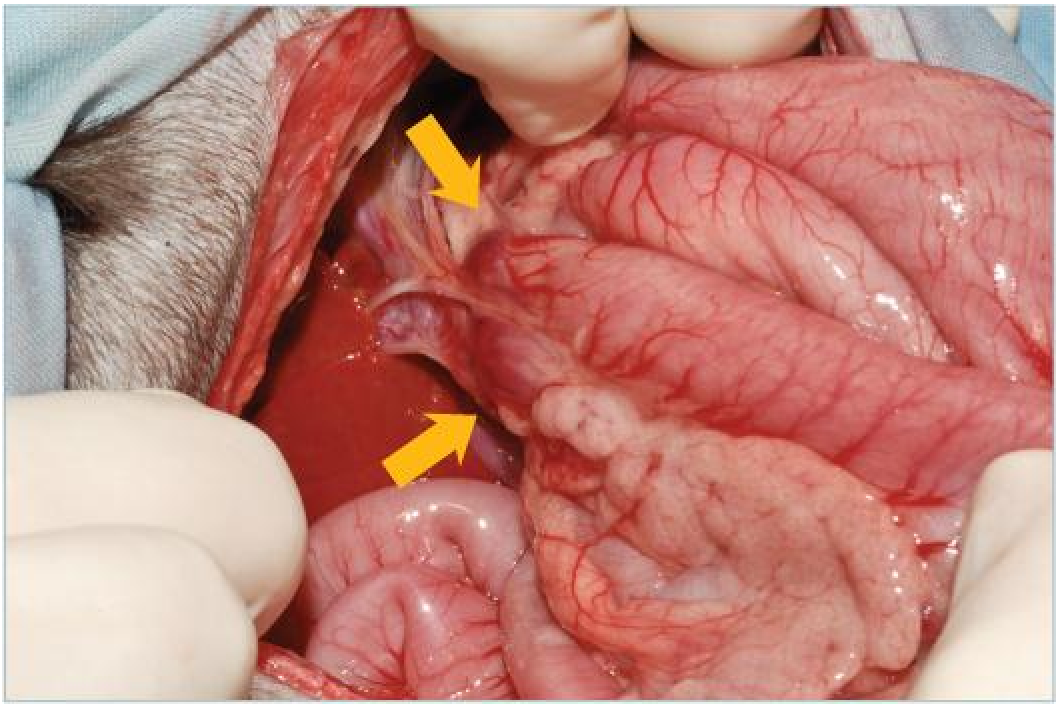

Fig. 6. It is then followed to its origin in the proximal part of the duodenum (yellow arrows). This was a gastroduodeno-caval shunt.

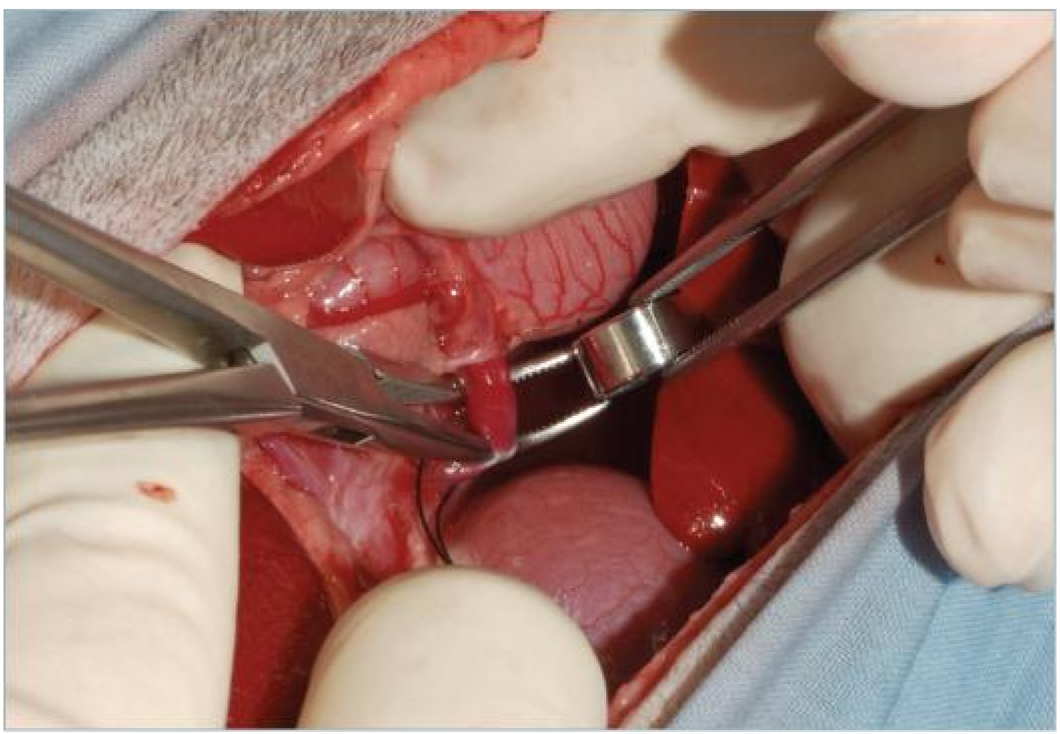

Fig. 7. Using forceps, the constrictor was passed around the vessel.

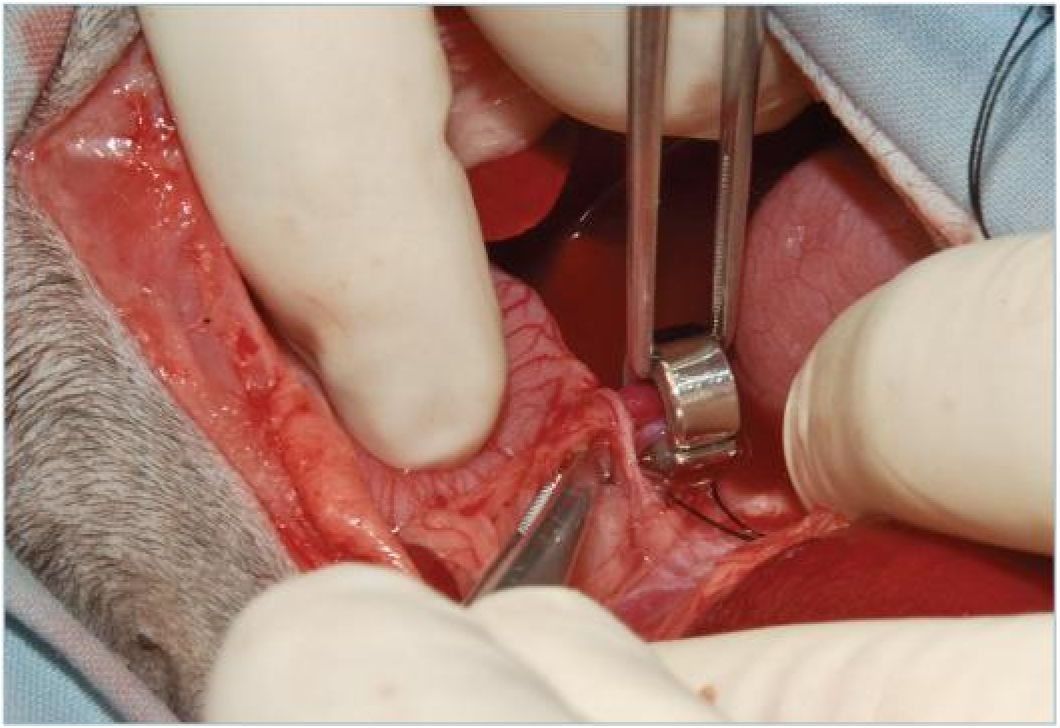

Fig. 8. The “key” locks the device.

During abdominal examination, the vascular anomaly was found to originate from the gastroduodenal vein (Figs. 5 and 6).
Returning to the left side of the patient, a 5-mm ameroid constrictor was placed around the shunt near the vena cava (Figs. 7 and 8).

Constrictors should be placed in areas where their movement is restricted. If excessive dissection occurred or if the area is relatively mobile, the constrictor may move, causing kinking of the vessel and subsequent portal hypertension.

Postoperative follow-up

Niko recovered satisfactorily from anesthesia and was returned to his owners the following day.
Subsequent ultrasound check-ups showed the progressive closure of the constrictor, with a final closure of the shunt two weeks after surgery.

Medical and dietary treatment, as described earlier, were maintained until complete recovery of portohepatic circulation.

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Portosystemic shunt: placement of an ameroid ring

Hepatic surgery: hepatic lobectomy

José Rodríguez, Carolina Serrano, Amaya de Torre, Cristina Bonastre, Ángel Ortillés

Partial hepatectomy

Partial hepatectomy is indicated in cases such as neoplasms, abscesses, rupture or hepatic torsion.
Up to 80 % of hepatic volume can be removed, as the patient can regenerate it in six weeks.

Hepatic tumor

The most common primary hepatic tumor in dogs is hepatocellular carcinoma. It can present in diffuse form (affecting the entire liver), nodular (several nodules spread across one or more hepatic lobes), or, most commonly of all, in mass form. The mass form presents as a large single tumor, which has a lower rate of metastasis than the other two forms.
Patients with hepatic neoplasms may be asymptomatic or show general clinical signs such as vomiting, anorexia, weight loss, abdominal distension, lethargy, polydypsia, polyuria or neurological symptoms such as weakness, confusion or tremor, among others.

If the patient presents coagulopathies or thrombocytopenia (<20,000 platelets/µl), a plasma or blood transfusion should be considered to improve hemostasis during surgery.

Coagulation tests must be performed to establish prothrombin time and partial activated thromboplastin time before and after the operation.

Animals with hepatic illnesses may bleed profusely during surgery. Coagulation must be assessed and measures put in place to control intraoperative bleeding.

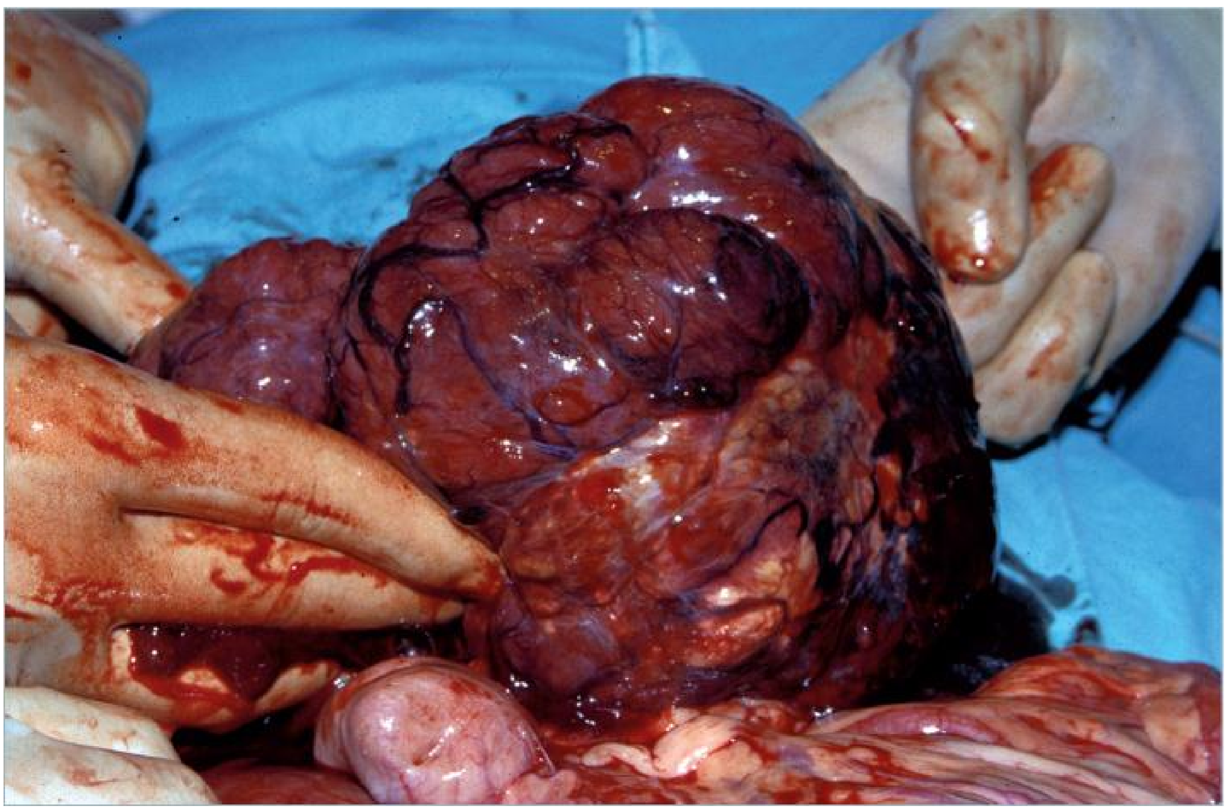

Fig. 1. The handling of neoplastic hepatic lobes must be done with extreme care to prevent rupture of the parenchyma and subsequent bleeding, which may be copious.

The treatment of choice is surgical, and can be very successful, even in the case of very large tumors.

Life expectancy in dogs with mass hepatocellular carcinoma after surgery increases notably.

The laparotomy is normally wide, and at the cranial part extreme care must be taken not to accidentally section the diaphragm and cause a pneumothorax.

During hepatic surgery, especially in the case of neoplasms, the hepatic lobes must be handled with care to prevent rupture of Glisson-capsule (Fig. 1).

During the dissection of the hilum, special care must be taken to prevent injury to the relevant arterial and portal vein branches. If uncontrollable bleeding occurs from the parenchyma during the operation, the Pringle maneuver must be used. This involves the surgeon using the thumb and index finger to compress both the hepatic artery and the portal vein at the hepatoduodenal ligament in the epiploical foramen.

Case / Hepatic lobectomy

José Rodríguez, Carolina Serrano, Amaya de Torre, Cristina Bonastre, Ángel Ortillés

This case deals with a 9-year-old male Cocker Spaniel with a hepatocellular carcinoma affecting both left lobes of the liver.

Hepatic lobectomy can be performed by dissection and ligation, or by using surgical staplers.

If despite careful handling of the hepatic lobe a rupture does occur, bleeding can be controlled by exerting direct pressure with a topical hemostatic agent, or by electrofulguration of the damaged tissue (Fig. 1).

All adhesions on the affected hepatic lobes are dissected and sectioned for easy removal (Fig. 2).

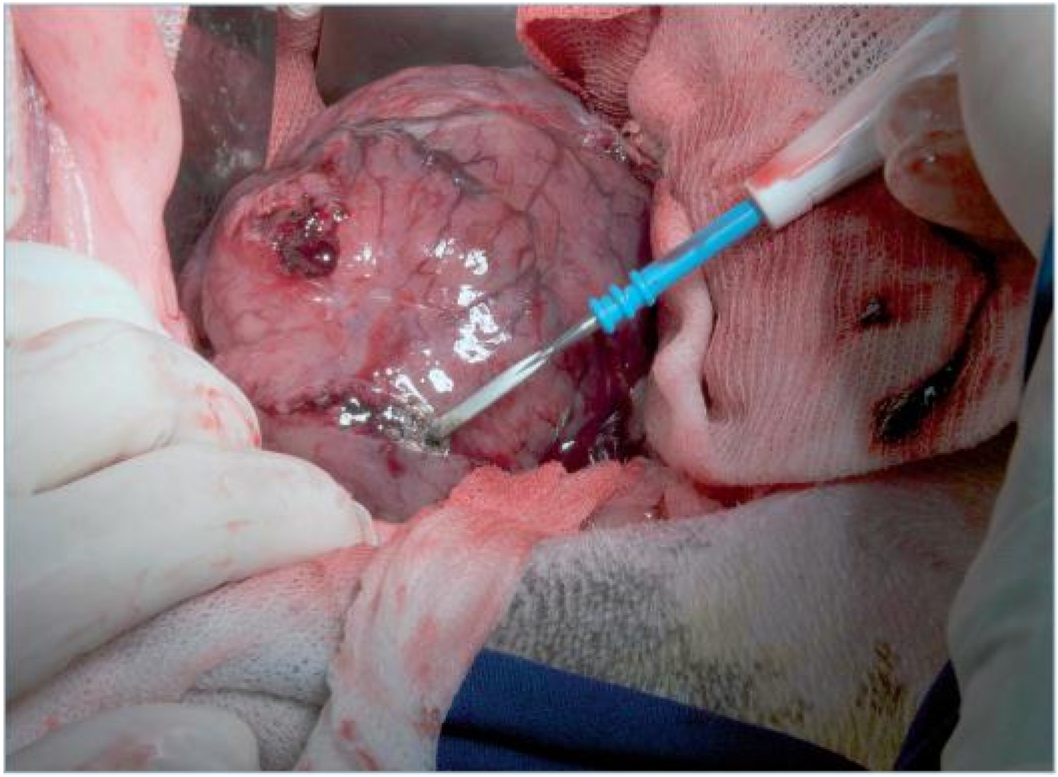

Fig. 1. Application of electrofulguration on the hepatic wound to control bleeding. In this case a larger amount of energy can be applied to increase the hemostatic effect.

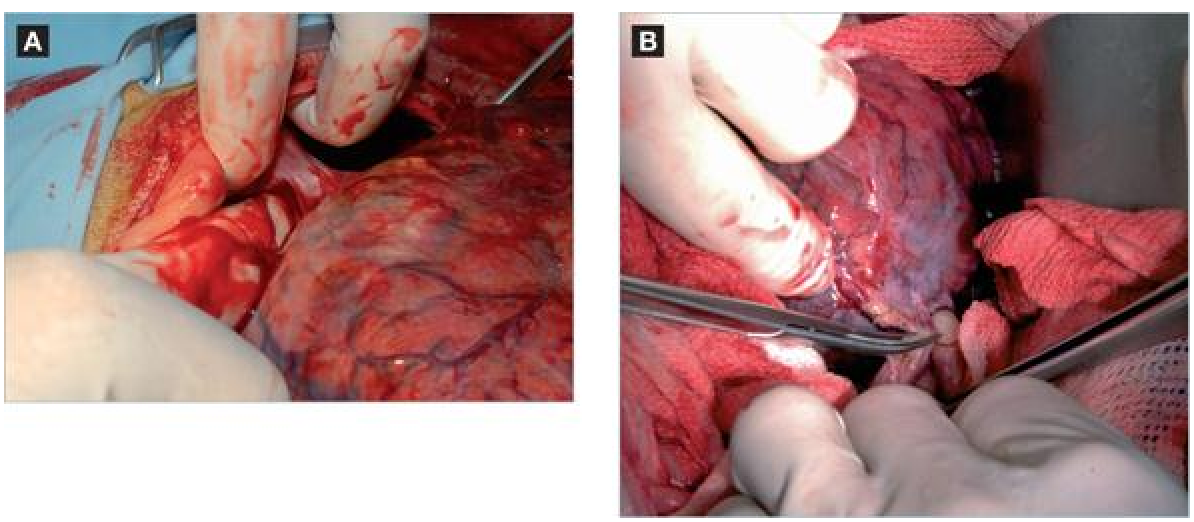

Fig. 2. It is common for neoplastic lobes to be adhered to other abdominal structures such as the diaphragm or segments of the intestines. These

adhesions must be located, dissected and sectioned before attempting to extract the affected hepatic lobes.

Surgical access to large, deep-chested dogs can be difficult. To simplify the process, the authors recommend inserting damp surgical swabs between the liver and the diaphragm. This lifts the liver up towards the laparotomy and makes the dissection of the damaged lobes easier (Figs. 3 and 4).

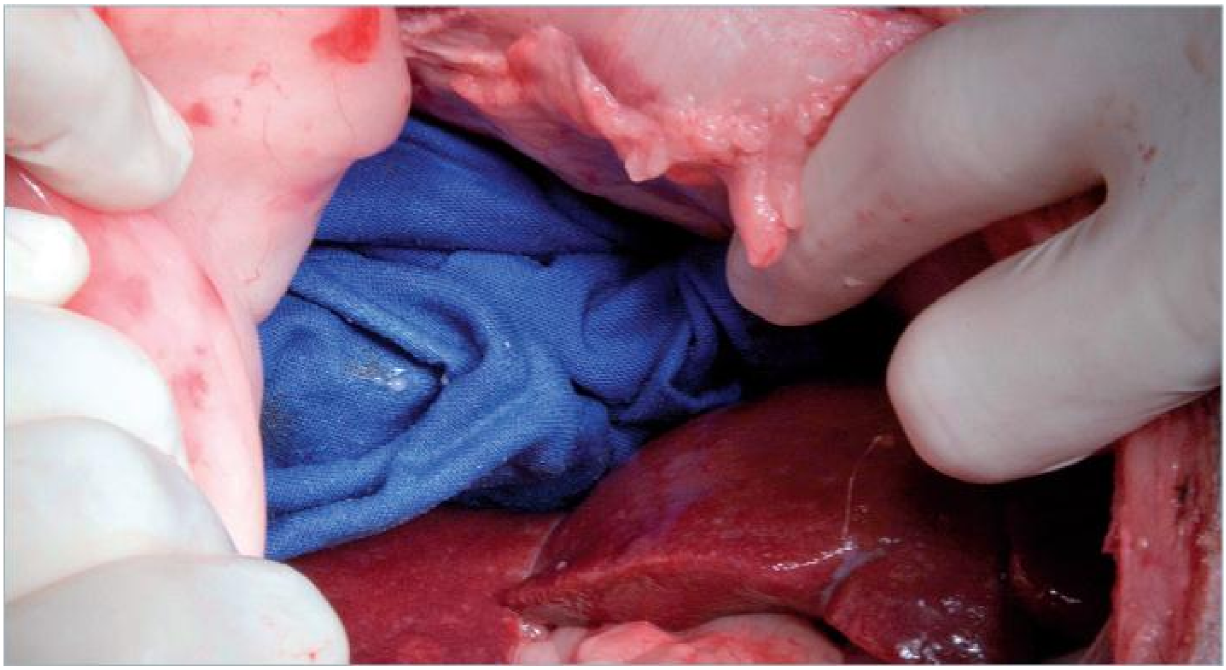

Fig. 3. To simplify access to the hepatic hilum the liver is moved close to the surgeon by inserting swabs soaked in saline between the liver and the diaphragm.

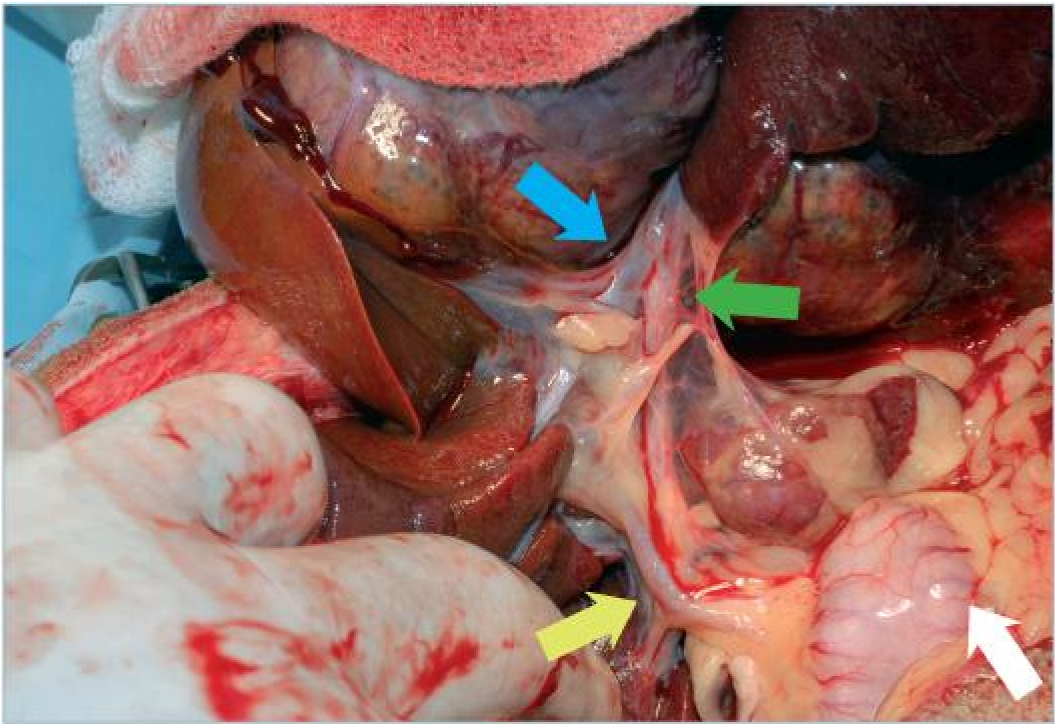

Fig. 4. By moving the liver outwards, it is easier to identify and dissect the different anatomical structures involved: duodenum (white arrow), common bile duct (yellow arrow), arterial branch (green arrow), portal branch (blue arrow).

Although mass ligature of the hepatic hilum has been documented, the authors recommend the separated dissection, ligature and sectioning of each of the structures entering and leaving the hepatic lobe (Figs. 5-10).

Preventative hemostasis is essential during all phases of àrtial hepatectomy.

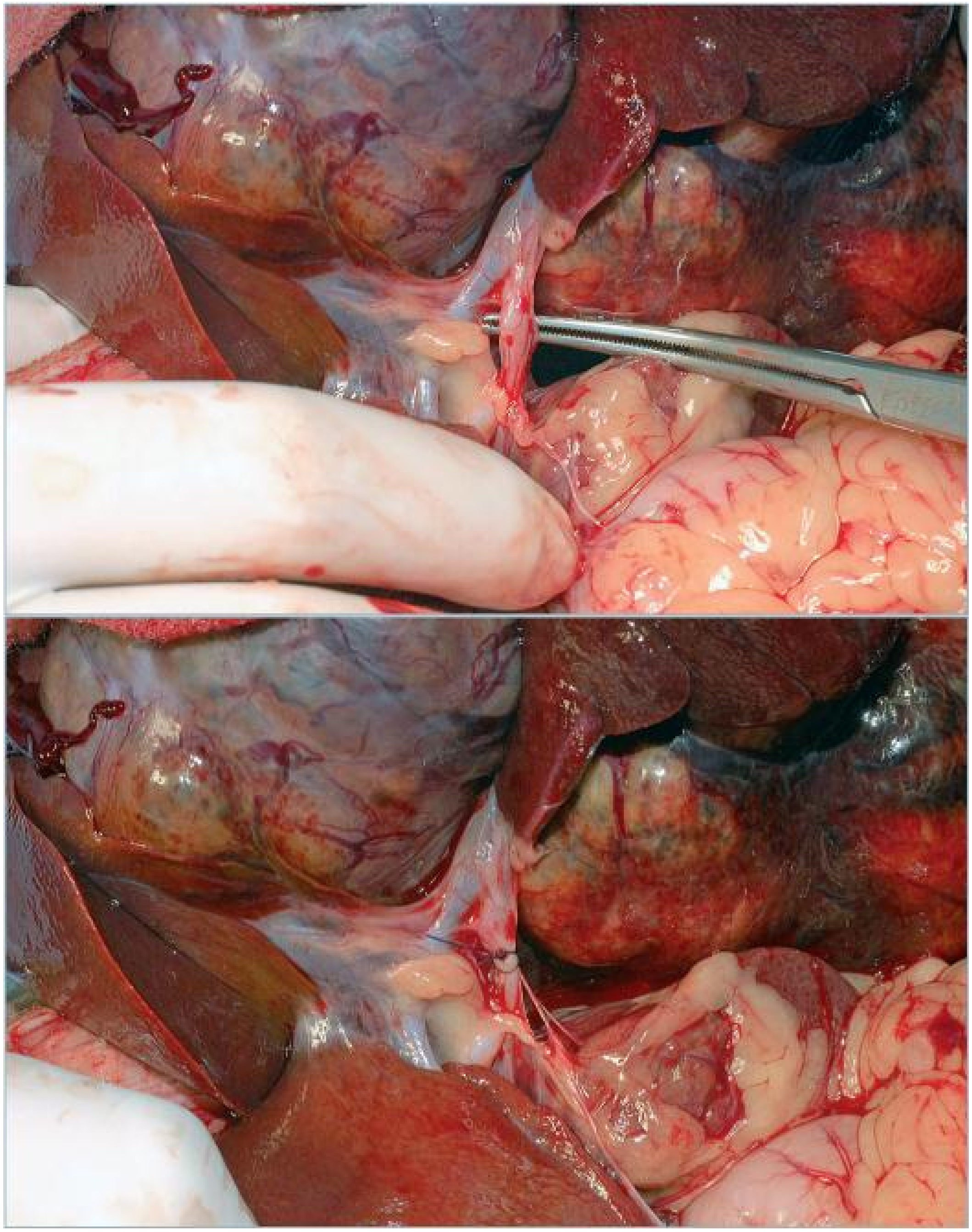

Fig. 5. Identification, dissection and closure with synthetic absorbable material of the hepatic arterial branch feeding the tumorous hepatic lobe.

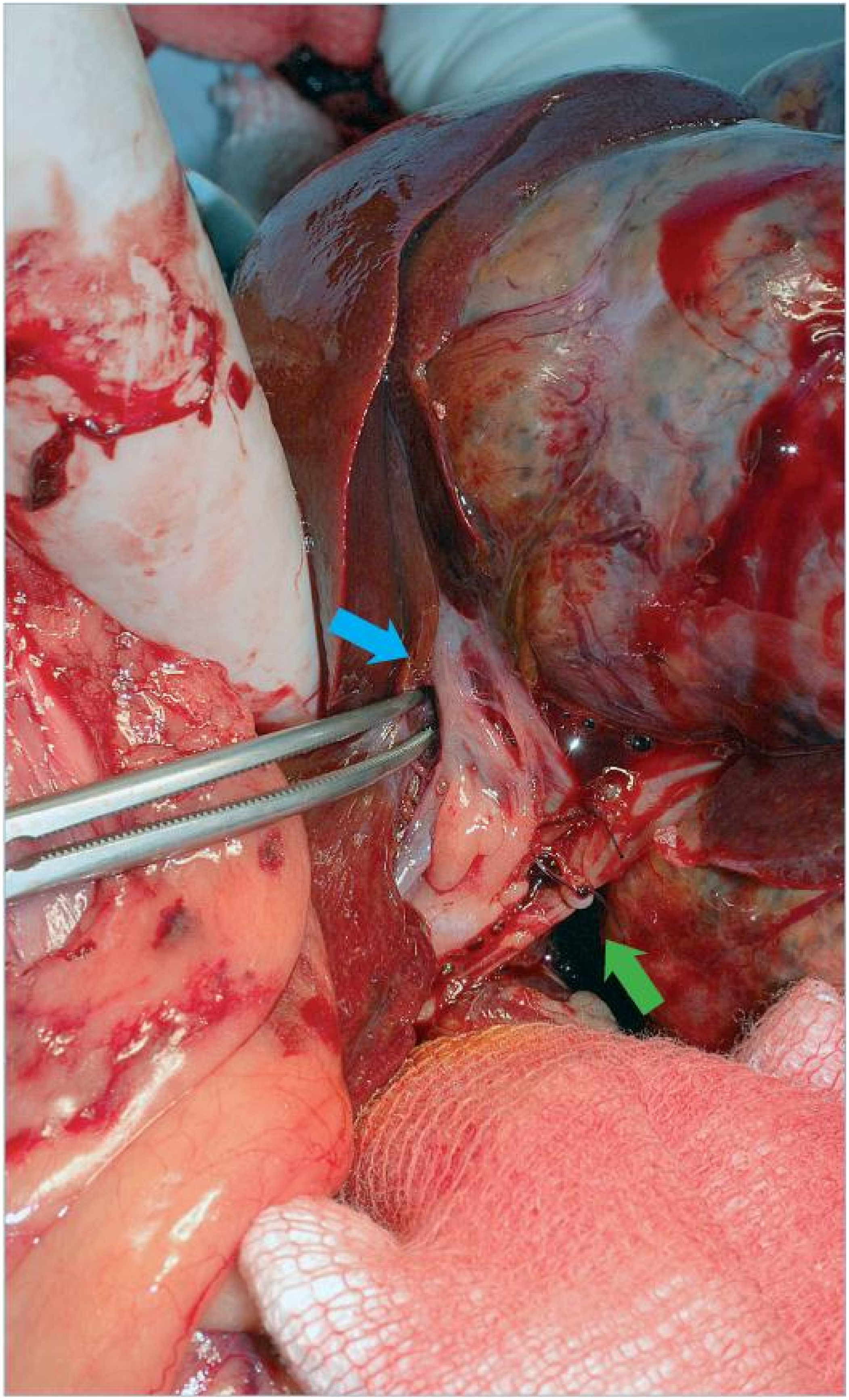

Fig. 6. This image shows the dissection of the branch of the portal vein running towards the left side of the liver (blue arrow). This is then ligated, as was done with the artery (green arrow).

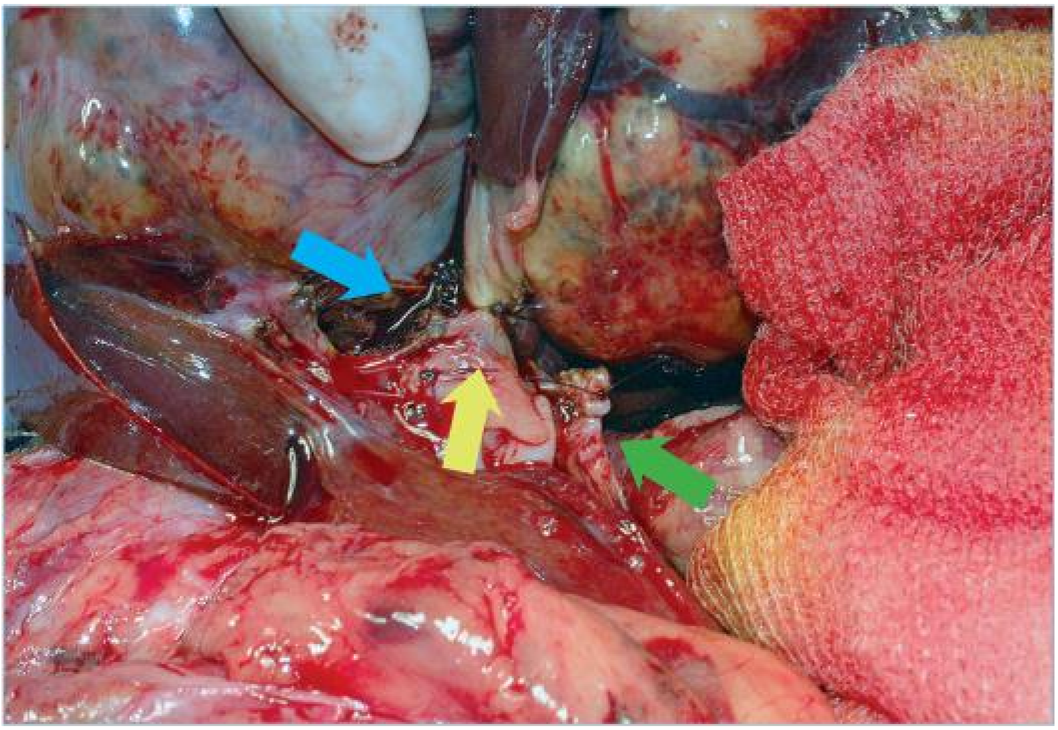

Fig. 7. Closure of the bile duct (yellow arrow), having closed and sectioned the arterial (green arrow) and portal (blue arrow) branches.

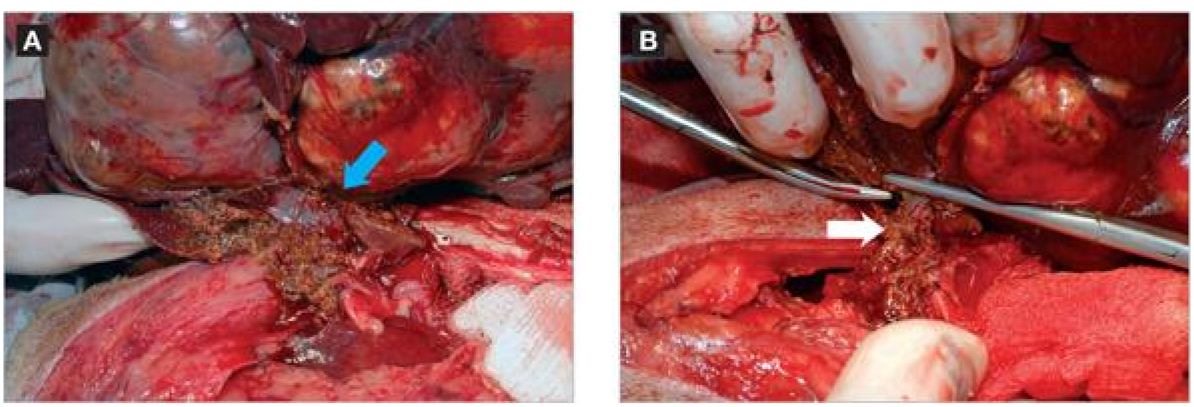

Fig. 8. After manual breakage of the hepatic parenchyma connecting the tumorous lobes to the rest of the liver, the relevant hepatic vein is revealed (blue arrow). It is then closed (white arrow) together with its section.

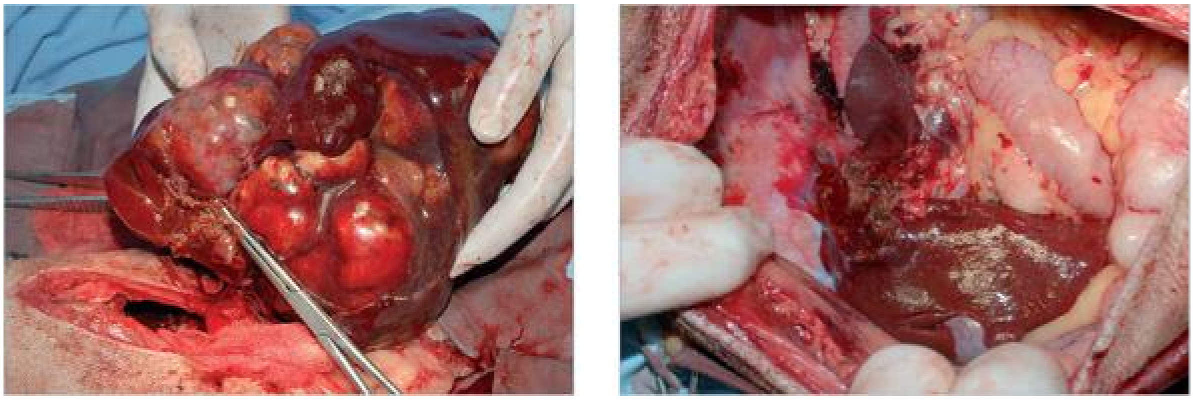

Fig. 9. After removal of the tumorous mass, hemostasis of the hepatic hilum must be checked.

Fig. 10. Preventative hemostasis of the parenchyma and hepatic vein can be performed using a surgical stapler. In this case a TA 90 stapler has been used. After the sectioning of the vein and parenchyma the area must be checked for bleeding. If bleeding is observed, it must be controlled using bipolar coagulation or topical hemostatic agents.

https://player.vimeo.com/video/180708275

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Hepatic lobectomy

The prognosis and evolution after hepatectomy in the case of mass hepatocellular carcinoma is satisfactory in terms of patient quality of life. Owners frequently remark that their dogs are more bright and active.

José Rodríguez

Intramural ureteral ectopy. Ureterocystostomy

Prevalence

Ureteral ectopy should always be considered in cases of urinary incontinence, in particular in young animals. The suspected diagnosis should be confirmed by excretory urography (Figs. 1-3).

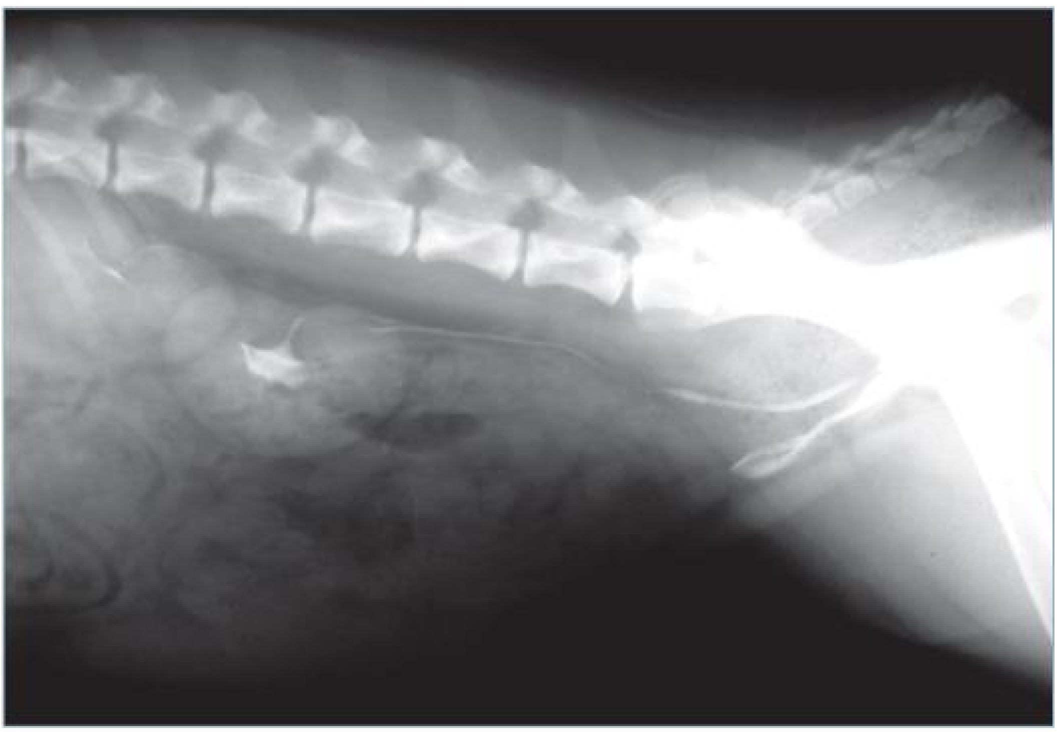

Fig. 1. In this case, the ureters do not terminate in the bladder, which does not contain any contrast medium.

Fig. 2. The contrast medium is directly eliminated via the urethra, while some of it flows back into the bladder. This explains the intermittent urinary incontinence in this patient.

It is very difficult to differentiate intramural from extramural ureteral ectopy with intravenous urography. The technique will only reveal an abnormality of ureteral implantation and the possible repercussions on the urinary system.

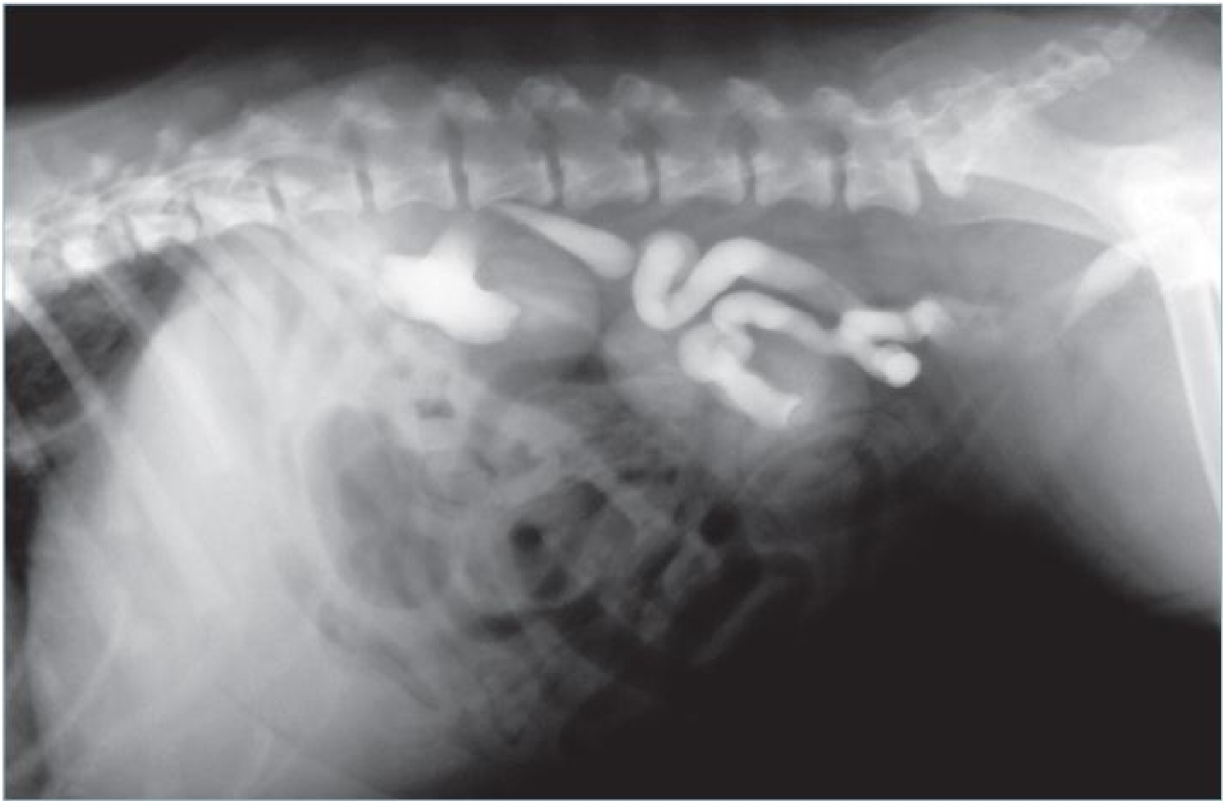

Fig. 3. This is another case in which the ureters do not terminate in the bladder. The image shows urinary retention, leading to hydroureters and distension of the renal pelvis.

Ureterocystostomy

Technical difficulty	■	■	■	□	□

Surgical technique

After performing an infraumbilical suprapubic laparotomy, the bladder is isolated and protected (Fig. 4). It is flipped caudally and held by a stay suture to display its dorsal surface. The distal pathway of the ureters and their insertion point in the bladder are then identified (Figs. 5-7).

The ureters should be dissected and manipulated with great care, as their blood supply runs in the periureteral fat. If this tissue is

damaged, this may cause ischemia and necrosis of the bladder, and surgical failure.

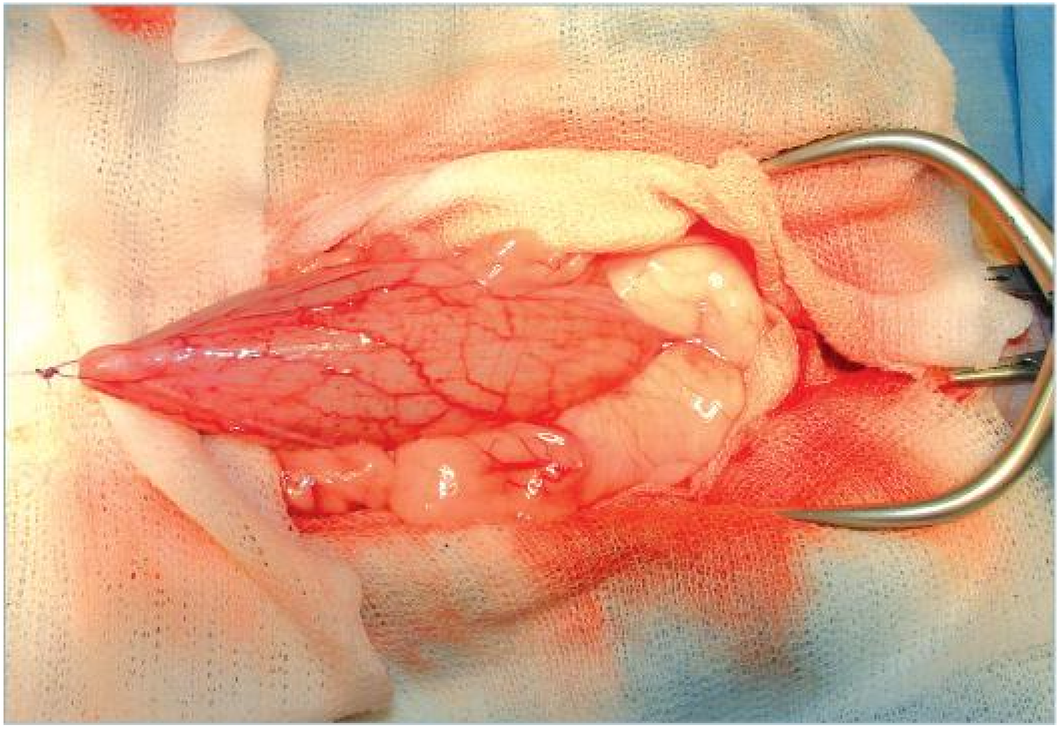

Fig. 4. For a clear view and dissection of the structures involved (bladder, ureters and urethra), Gelpi-type tissue retractors are used and a stay suture is placed in the apex of the bladder.

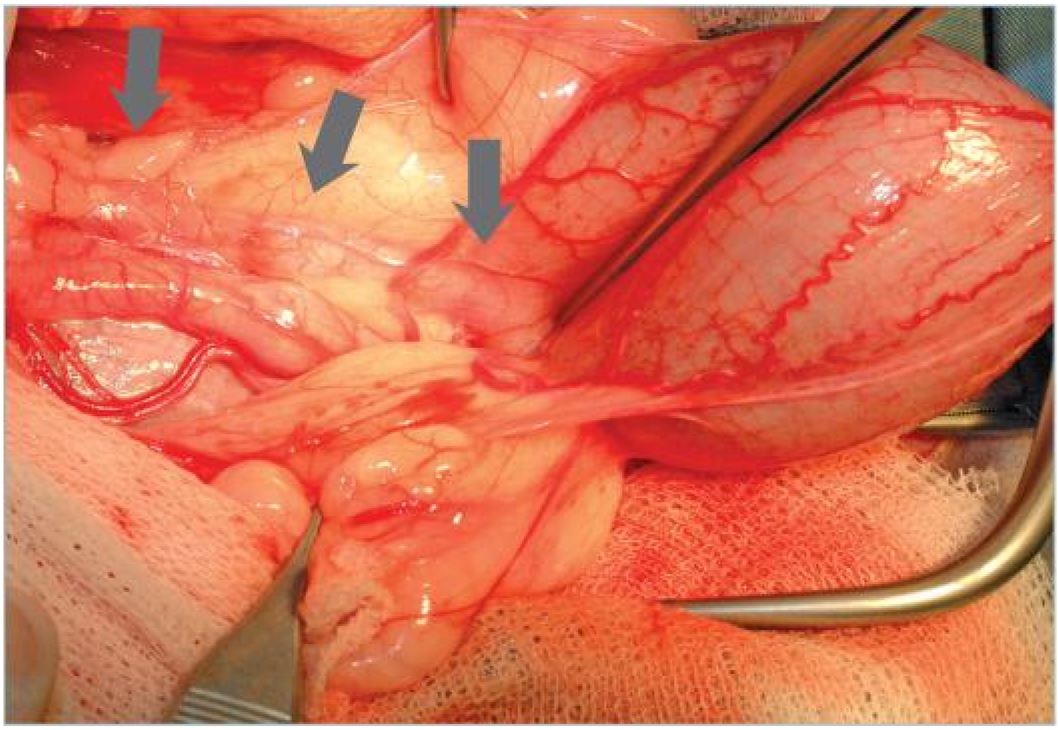

Fig. 5. Dorsal exposure of the bladder permits visualization of the pathway of the ureters and their insertion to the bladder. In the middle left, the distal pathway of the left ureter is visible (grey arrows).

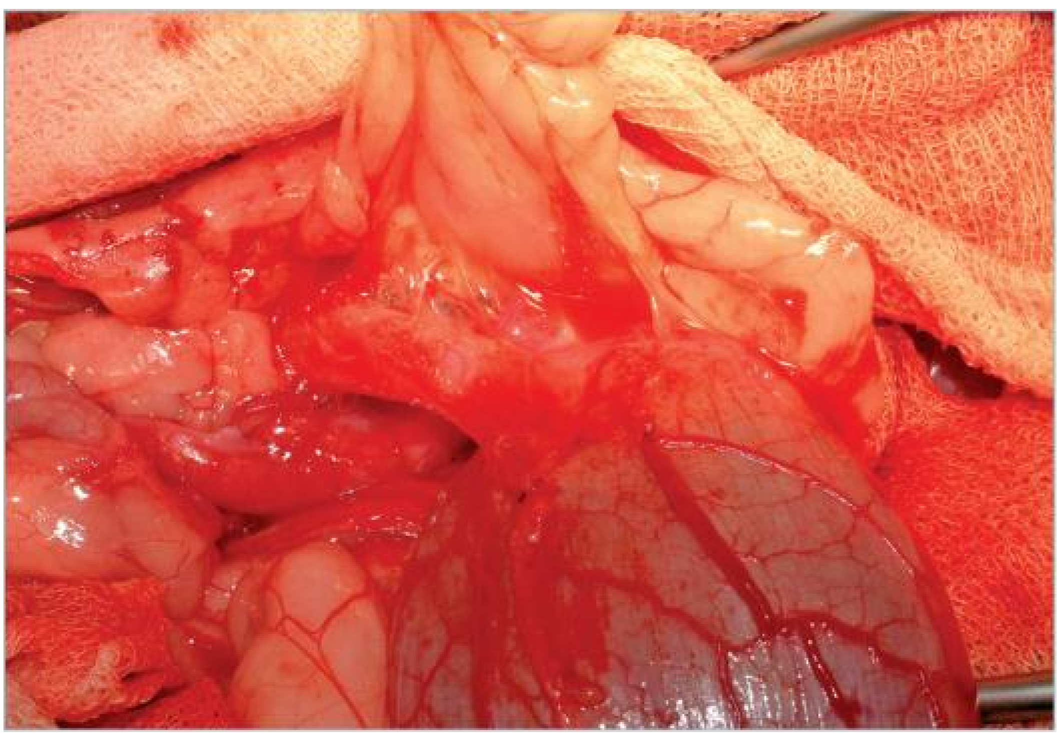

Fig. 6. Careful dissection of the distal part of the left ureter reveals that it enters the bladder wall. It is an intramural ectopic ureter.

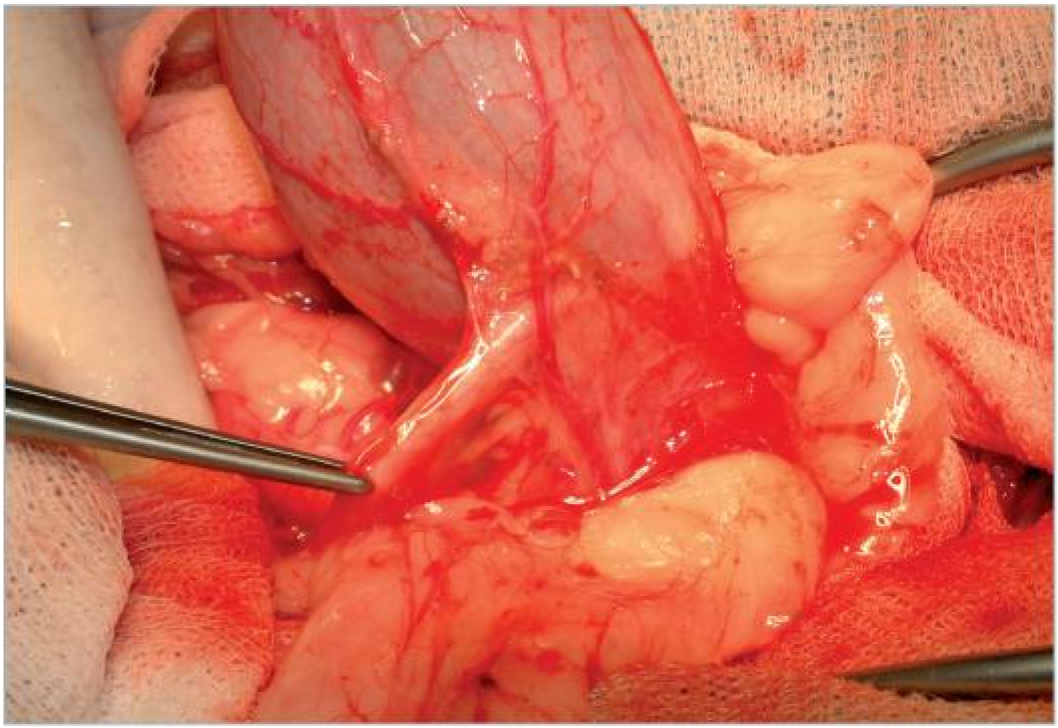

Fig. 7. The right ectopic ureter is also intramural. The ureter enters the bladder at the correct site, but does not open into it.

Next, the bladder is returned to its anatomical position and a cystotomy is performed to expose the trigone (region between the orifice of the ureters and the base of the urethra) (Figs. 8 and 9).

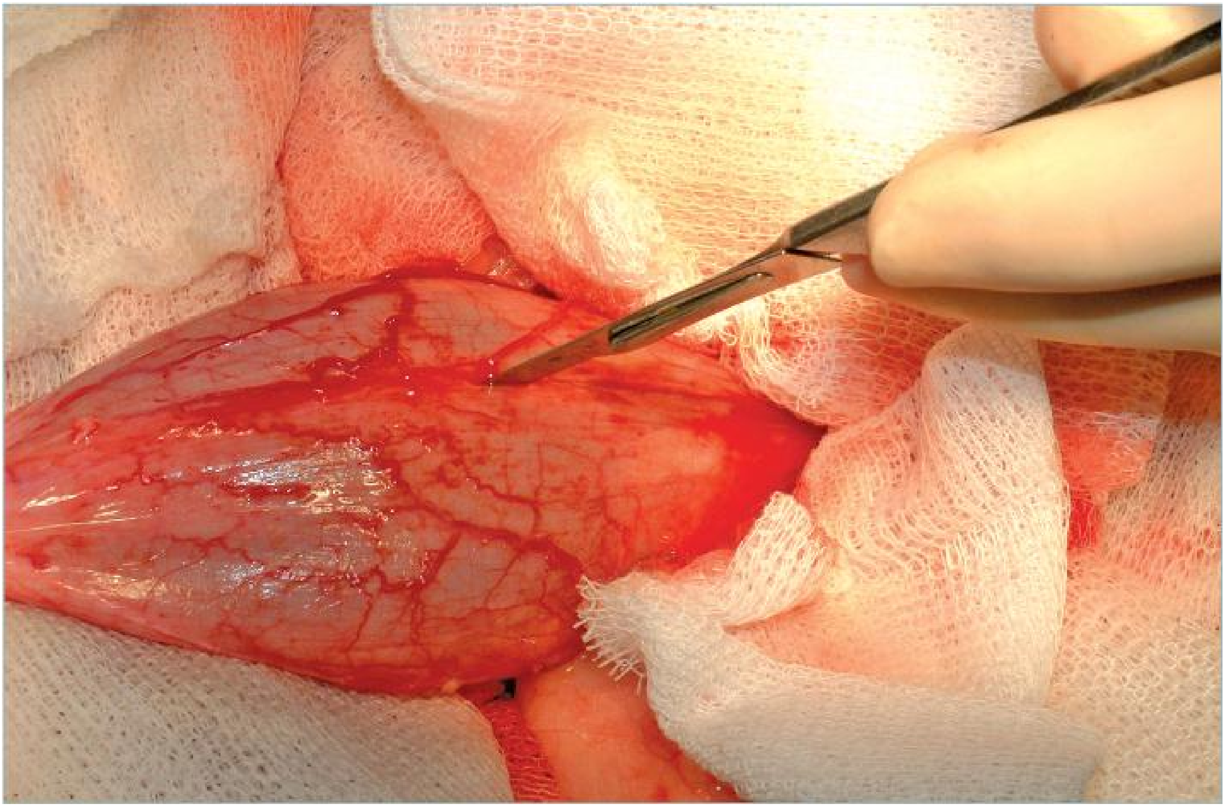

Fig. 8. Cystotomy is performed on the caudoventral region of the bladder, taking care not to damage its major blood vessels.

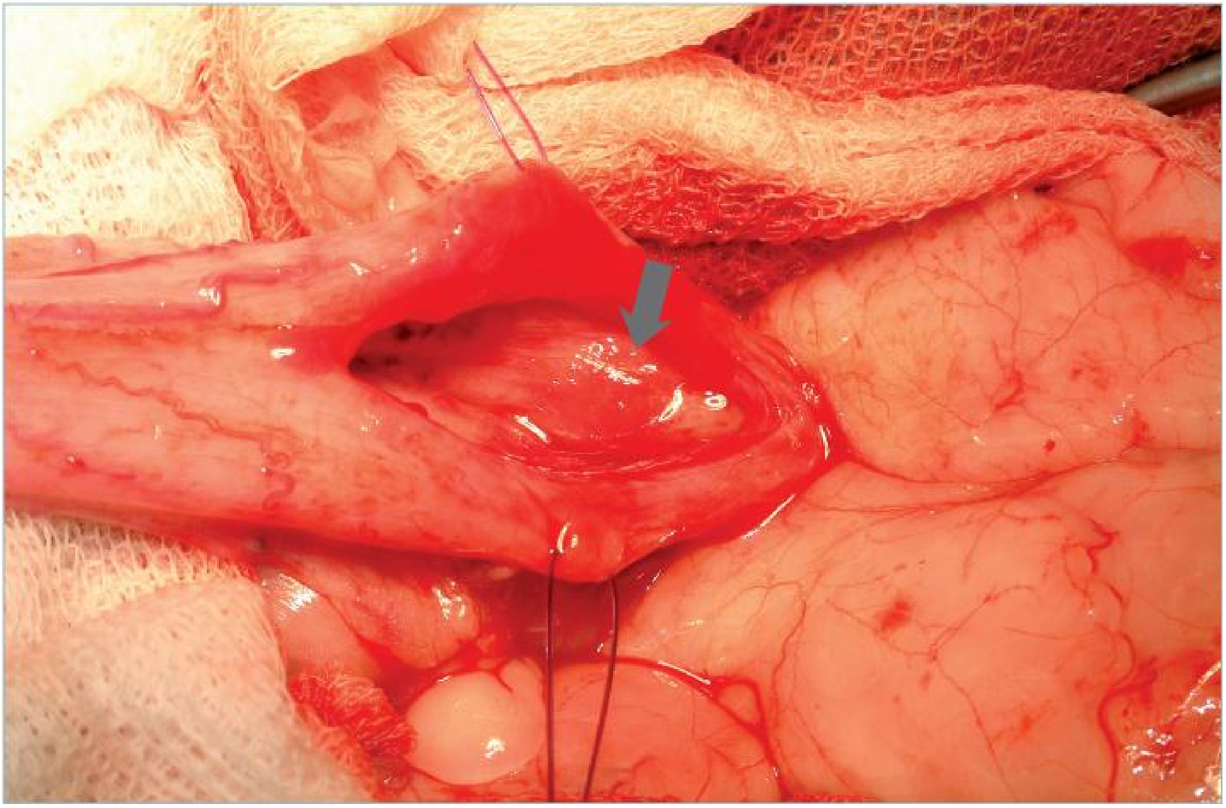

Fig. 9. To keep the cystotomy wound open, two stay sutures are placed, using 4/0 monofilament suture material, as shown on the photograph. In this region, the ureteral orifices should be visible, but they are not. The arrow indicates the area where the opening of the left ureter should be seen.

For easy identification of the points where the ureteral orifices should be, the urethra is tied off with a Penrose drain or is compressed manually (Fig. 10), so that their extravesical pathway is blocked and urine accumulates inside. Distension of the ureters facilitates identification of the site of the ureterostomy. Using a fine scalpel, the bladder mucosa is cut until the distended ureter is reached (Fig. 10).

Remember to flush the tissues regularly with lukewarm sterile saline.

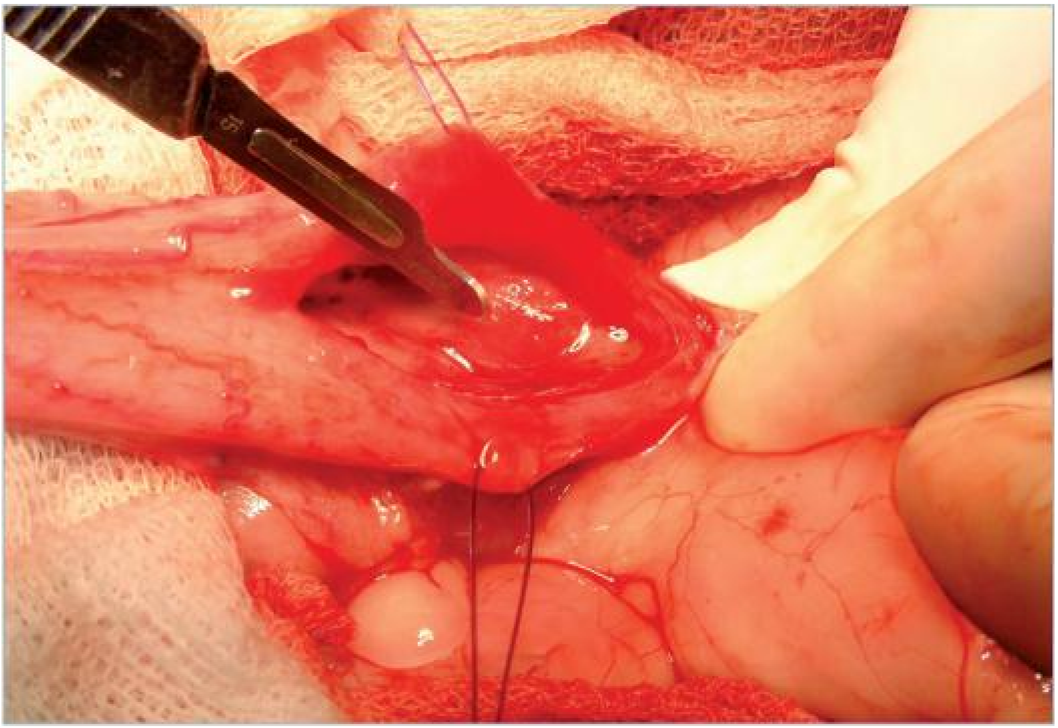

Fig. 10. Compression of the urethra leads to urinary retention in the ureters and helps to locate the region in the bladder mucosa where the incision should be made.

The ureteral mucosa is then sutured to that of the bladder with simple interrupted sutures, using 5/0 monofilament synthetic absorbable material (Figs. 11 and 12).

All suture material used in the urinary tract should be monofilament (to avoid the capillary effect with the risk of urine leakage and bacterial contamination), and absorbable (to prevent the formation of uroliths and foreign body tissue reactions that can lead to excessive fibrosis and abscesses).

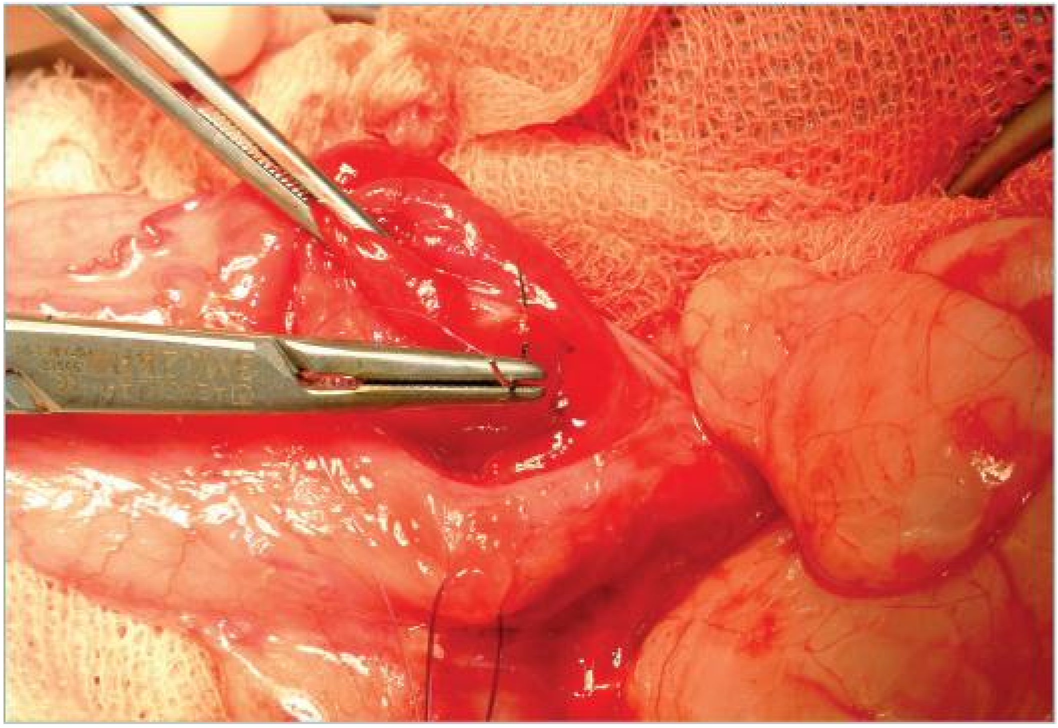

Fig. 11. After opening the left ureter, the ureteral and bladder mucosa are apposed with interrupted simple sutures, using very fine monofilament absorbable material.

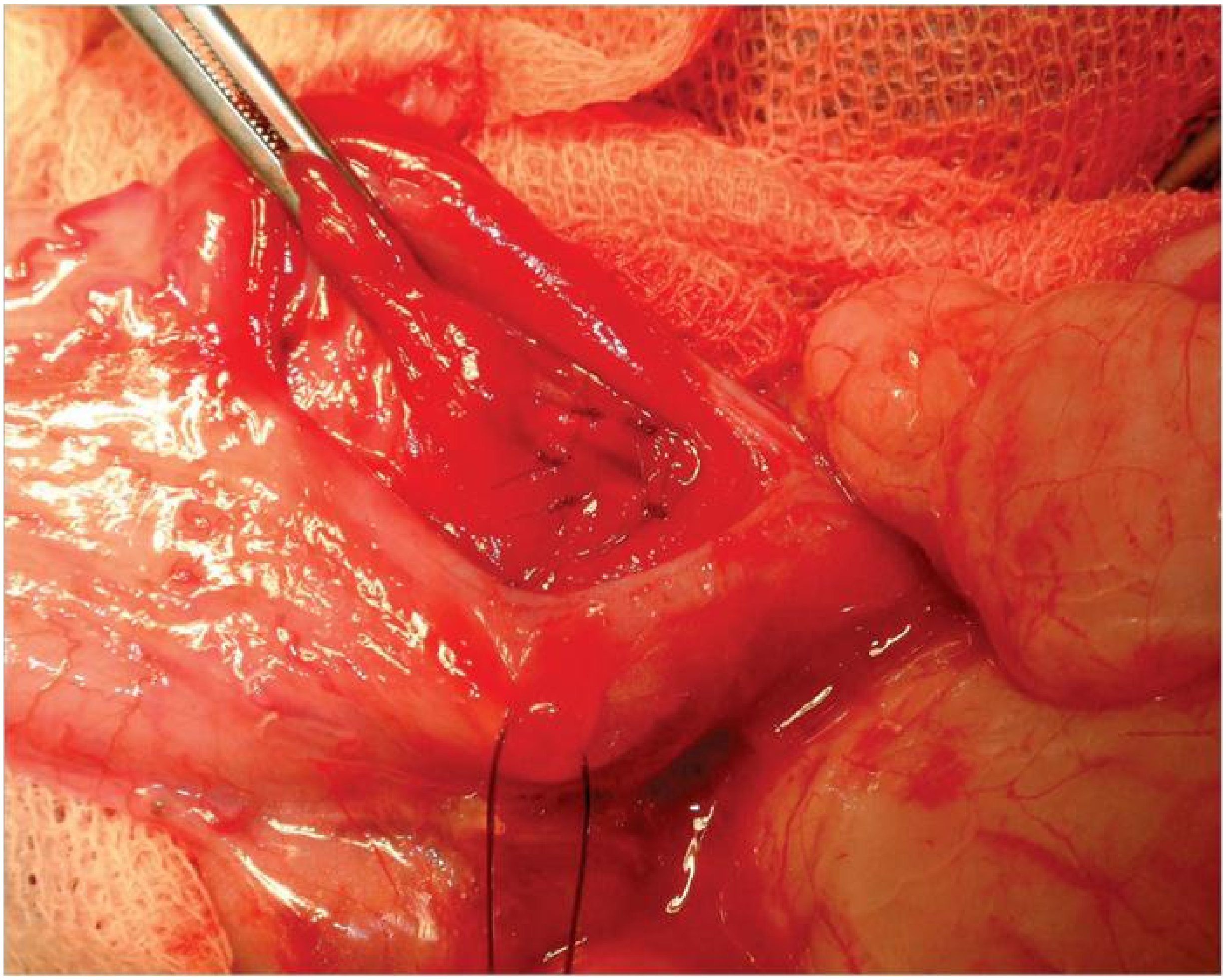

Fig. 12. Final appearance of the ureterostomy. Five interrupted sutures were placed, using 5/0 monofilament synthetic absorbable material.

After carrying out this procedure in both ureters, a short and rigid urinary catheter is inserted into the ureter through the ureterostomy in distal direction. This permits palpation of the extravesical ureteral segment (Fig. 13).

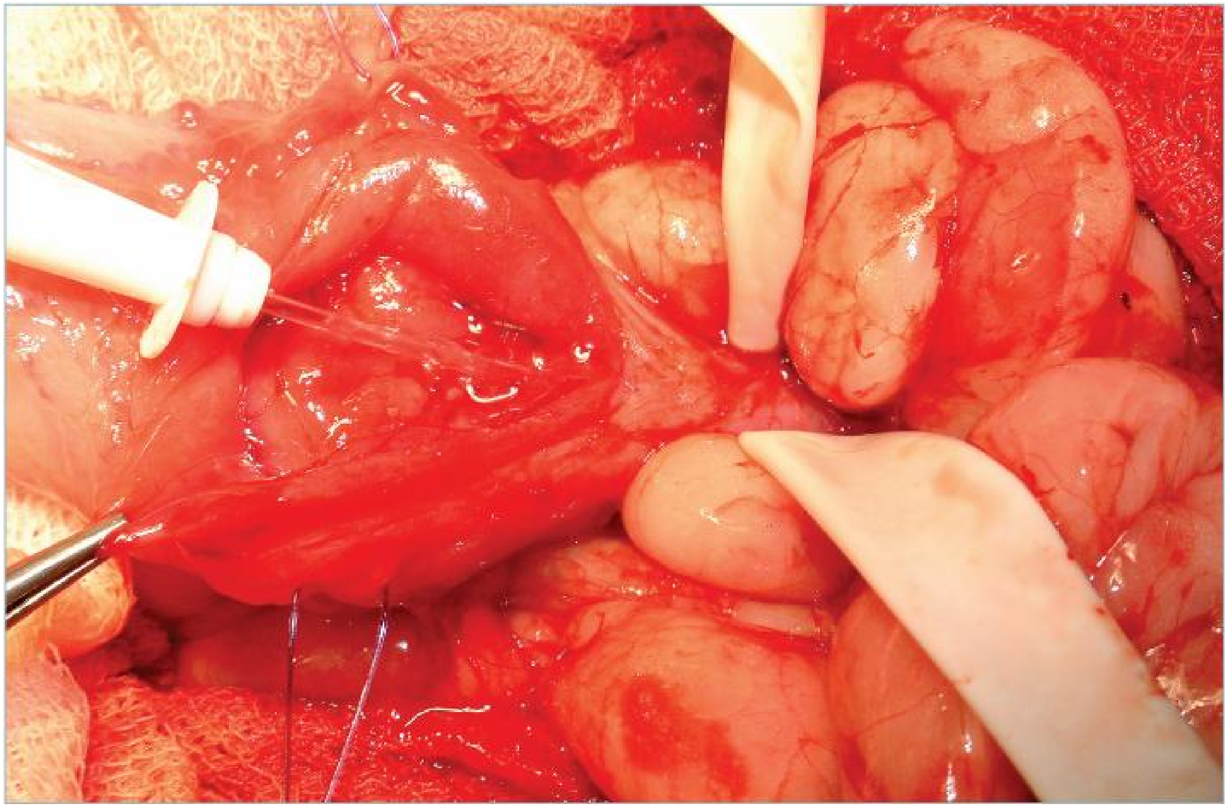

Fig. 13. As a next step, the ectopic part of the ureter should be tied off to avoid the passage of urine into the abdomen A urinary cat catheter is inserted through the ureterostomy to identify the pathway that runs along the urethra.

Urine flow from the bladder into the ectopic part of the ureter should then be prevented by placing a single suture with 4/0 synthetic non-absorbable suture around the extravesicaler part of the ureter. To simplify placement of this suture, and to ensure it does not involve the urethra, a thicker urinary catheter is inserted into the urethra (Fig. 14).

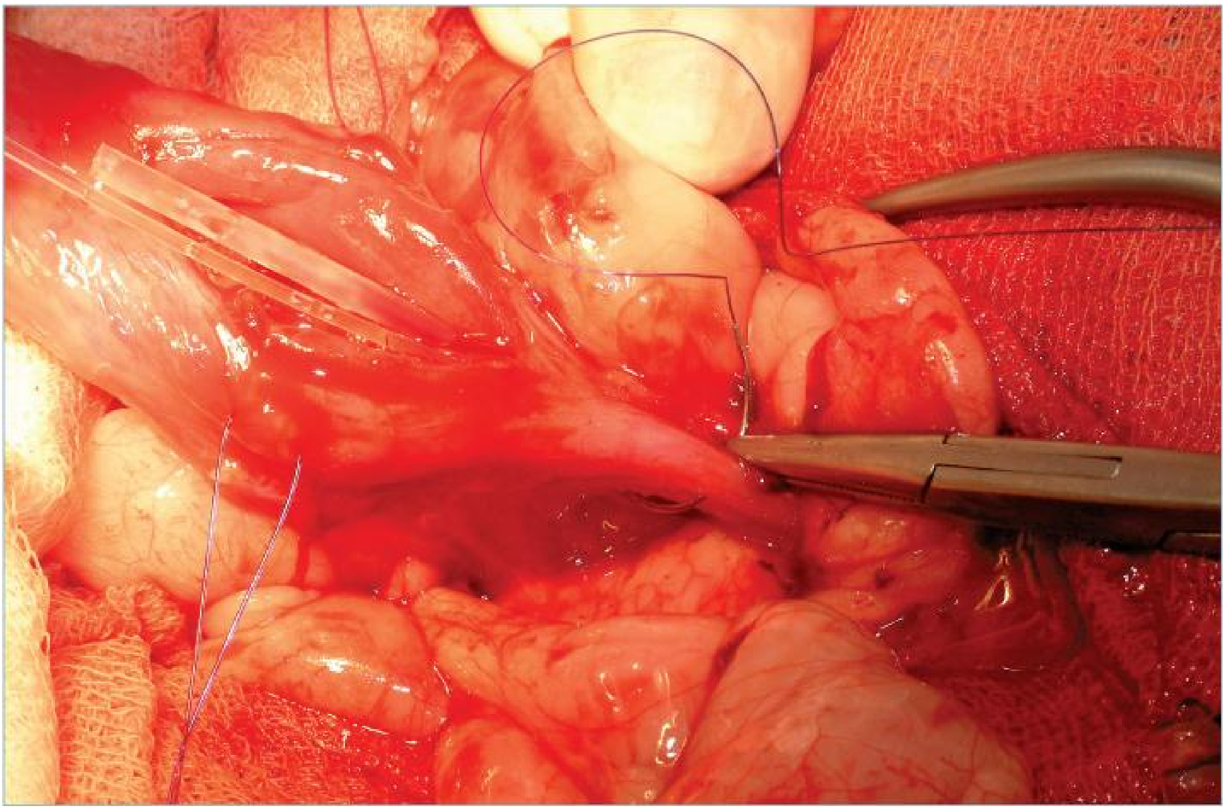

Fig. 14. The suture sealing off the extravesical segment that runs parallel to the urethra is placed blindly. To avoid including the urethra, both the ureter and the urethra must be identified, which is why a catheter is placed in both ducts. While the ureteral catheter is palpated, a simple suture is placed over it. Before tightening the knot, the catheter is removed.

For easy identification of the ureter that runs parallel to the urethra, a catheter is placed in both ducts.

After ligating the ectopic ureteral segments, the cystotomy incision is closed in two layers (Figs. 15-17).

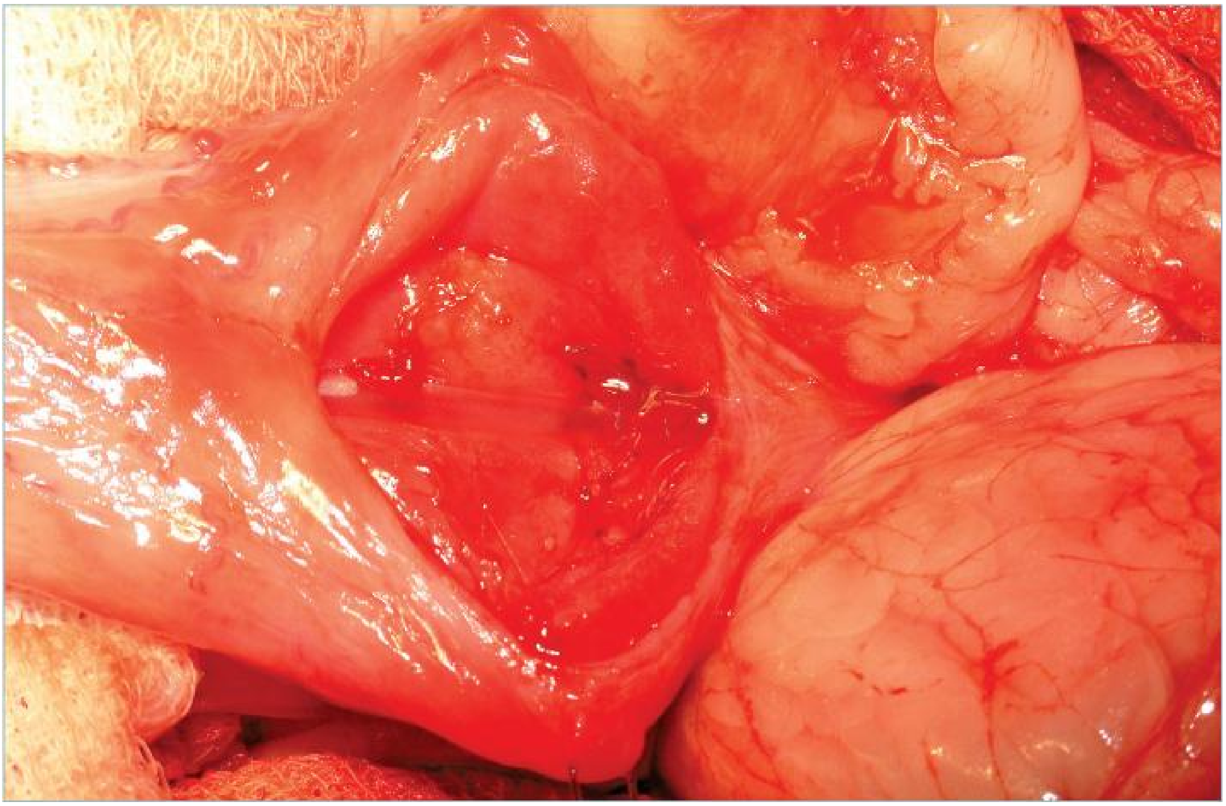

Fig. 15. The urethral catheter is left inside the bladder for the first 24 hours postoperatively.

✱

Omentalization of the bladder improves healing and reduces the risk of adhesions to adjacent organs.

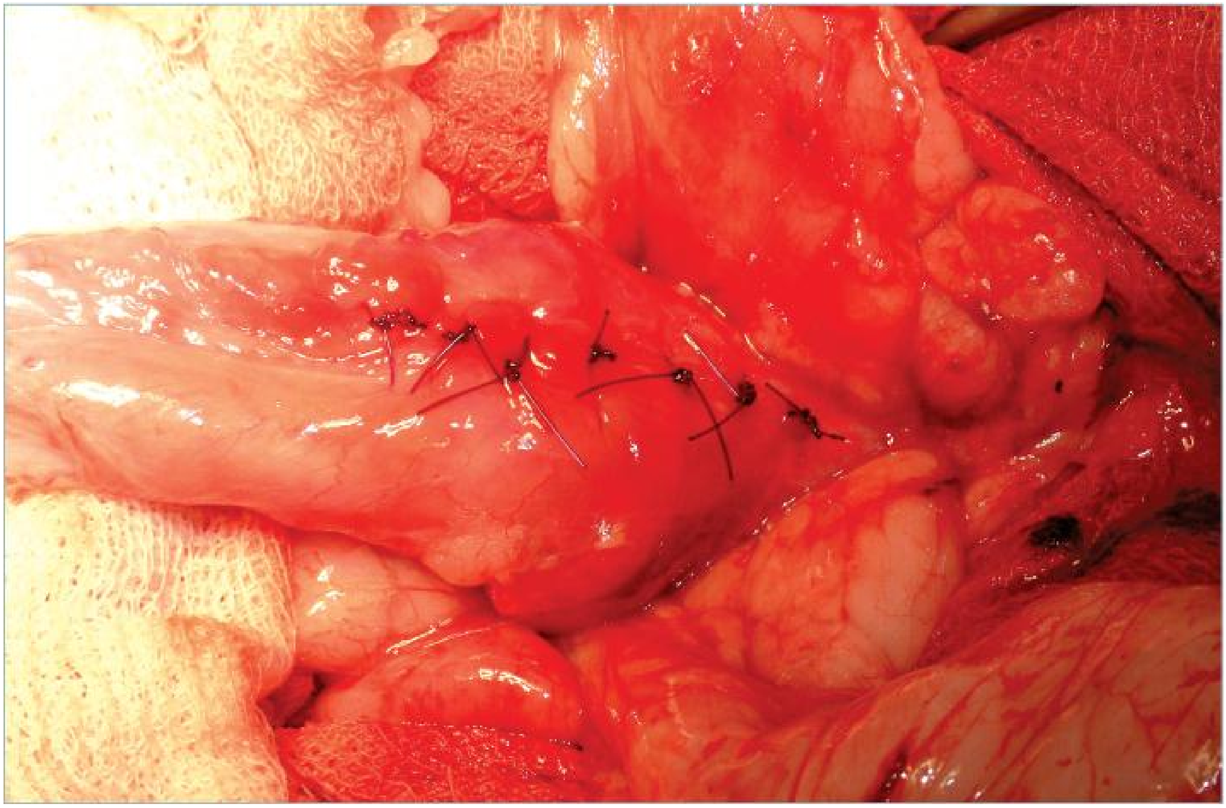

Fig. 16. The bladder is closed in the standard manner, using monofilament absorbable material.

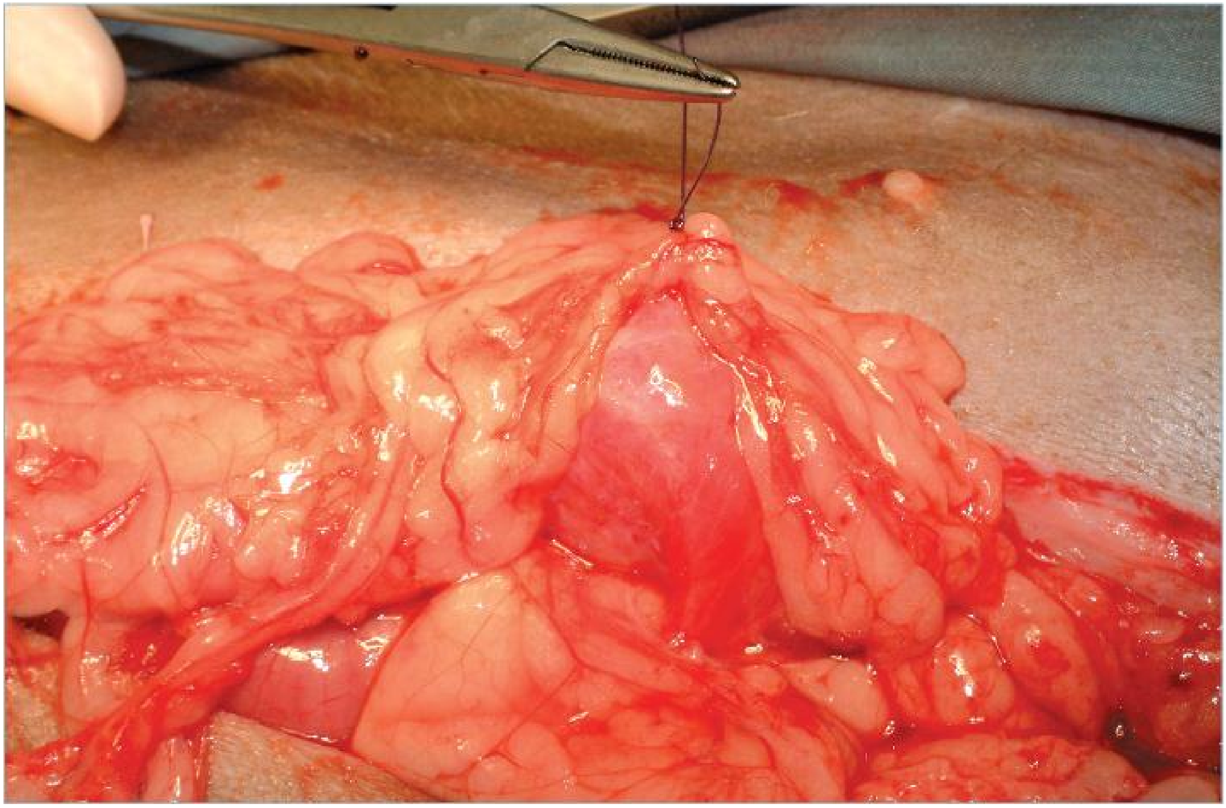

Fig. 17. As usual in surgery on hollow abdominal organs, the bladder is covered with omentum.

The urinary catheter is left in place for the first 24 hours postoperatively to avoid excessive distension of the bladder, causing a possible suture dehiscence.

The urinary catheter is removed the day after surgery and antibiotic treatment (based on culture and sensitivity testing) is continued for two weeks.

Patients will recover their urinary continence within the first few postoperative days. Nevertheless, a small number will remain incontinent, mainly due to neuromuscular failure of the bladder neck or bladder hypoplasia. In these cases, phenylpropanolamine should be administered.

https://player.vimeo.com/video/180708277

Watch this video

Case / Intramural ectopic ureter

José Rodríguez

Sara is a six-month-old female Bulldog. She was presented to the hospital by her owners who had noticed almost constant urinary incontinence since they bought her as a puppy. She had previously been treated with different antibiotics for recurrent urinary infections. Sara urinated normally during walks, but her perineal area was always wet with urine (Fig. 1).

Fig. 1. The patient on the day of first presentation at the hospital.

Physical examination and blood tests did not reveal any abnormalities. Examination of the perineal area showed a continuous drop-by-drop loss of urine, wetting the coat (Fig. 2).

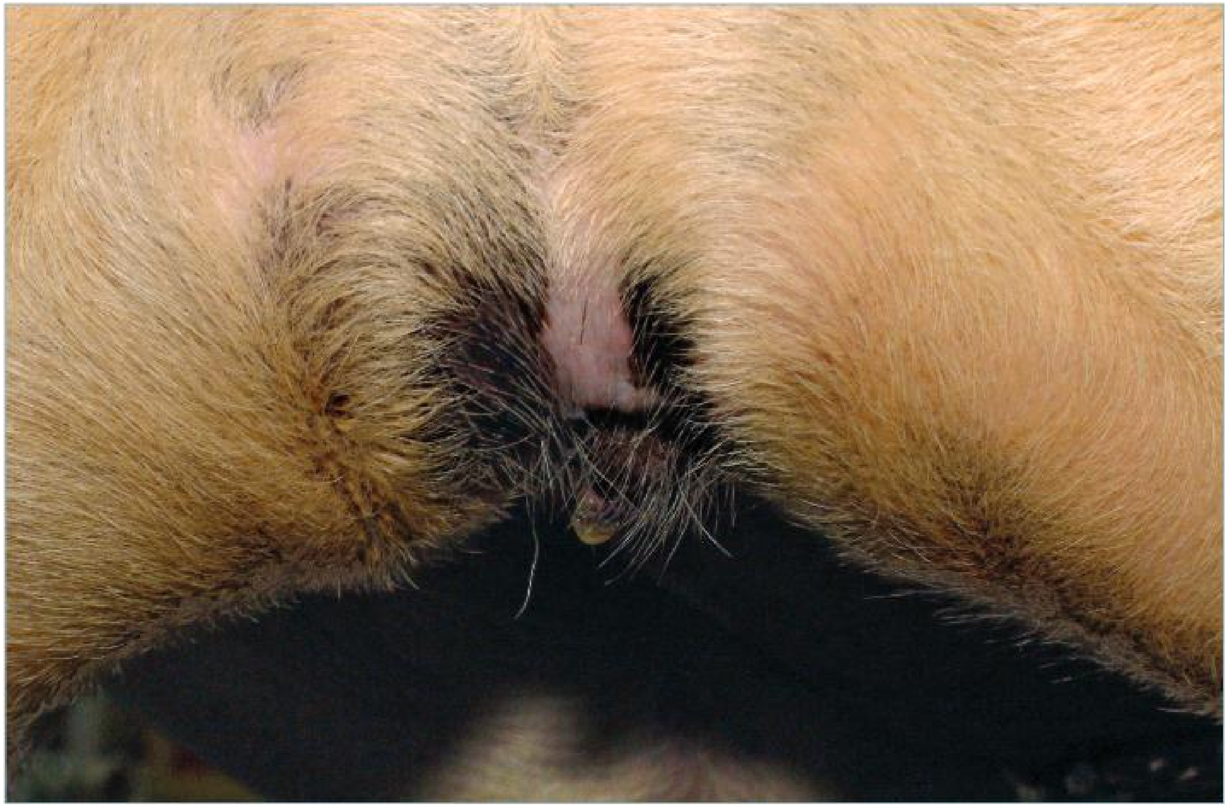

Fig. 2. This image shows urine loss from the patient. The coat of the perineal area was stained yellow by urine. The owners had to clean the area regularly due to the odor.

The signs were worse when the dog was lying down and during the night when sleeping (Fig. 3).

Fig. 3. The incontinence was worse when lying down, when the abdominal pressure on the bladder increased. Note the copious loss of urine when the patient was lying down in the hospital waiting room.

To confirm the suspected diagnosis of ectopic ureter, excretory urography was performed under general anesthesia (Figs. 4-7).

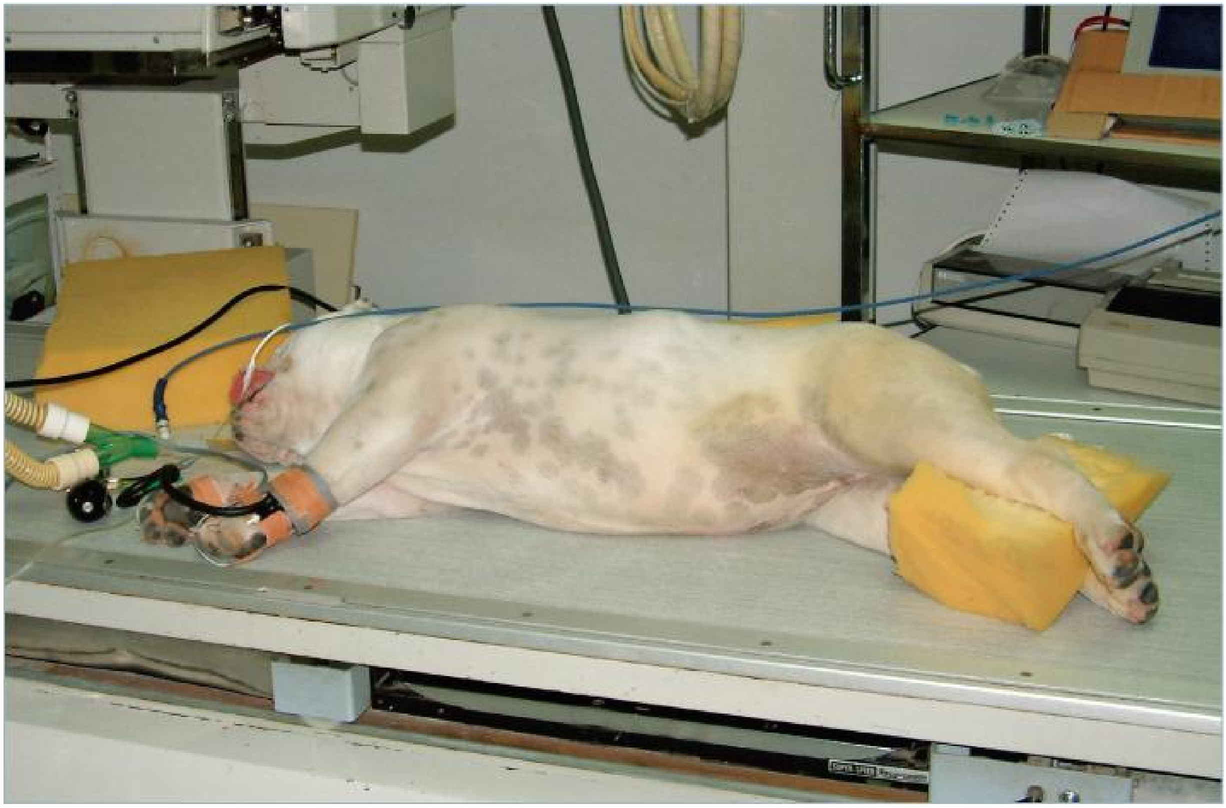

Fig. 4. Excretory urography carried out under general inhalation anesthesia to visualize the urinary tract and the ureteral insertion.

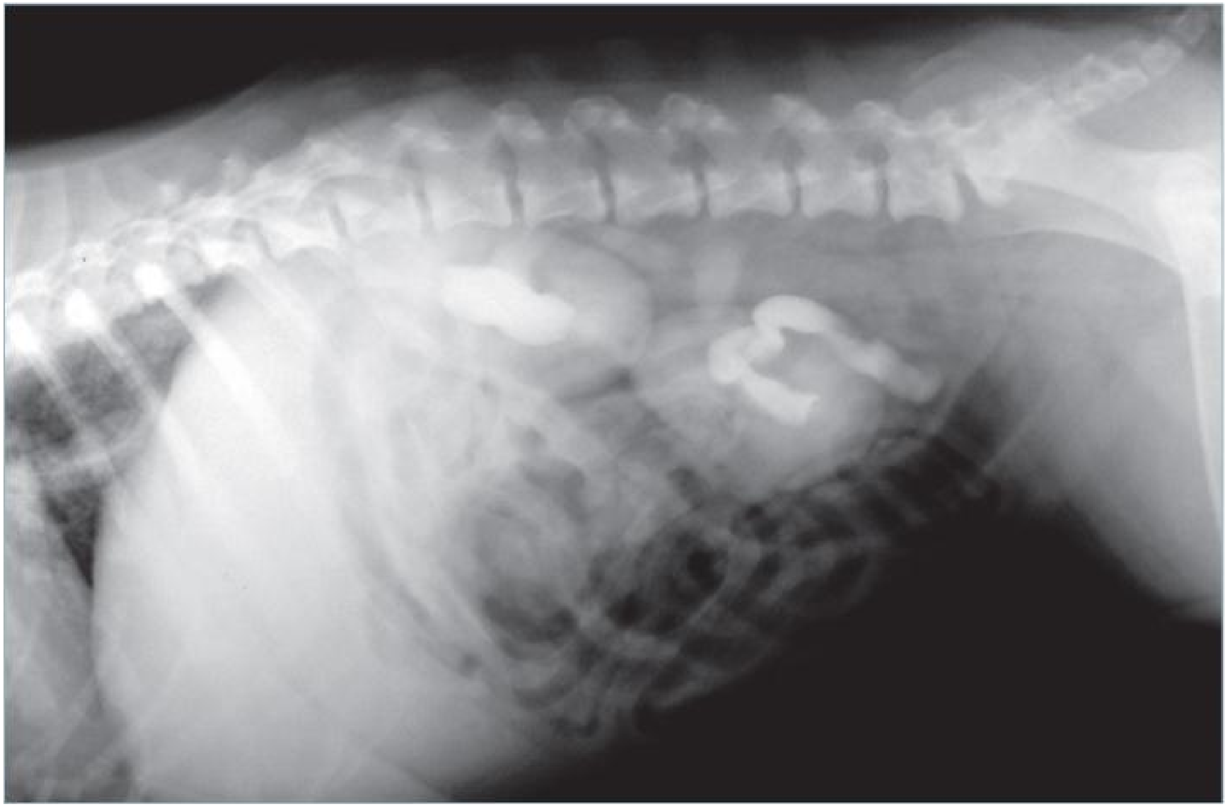

Fig. 5. Serial radiographs are obtained to observe the elimination of the contrast medium.

Fig. 6. A moderate ureteral distension is noted as well as some dilatation of the renal pelvis as a result of urinary stasis. The contrast medium does not accumulate in the bladder, but passes via retrograde flow into the vagina.

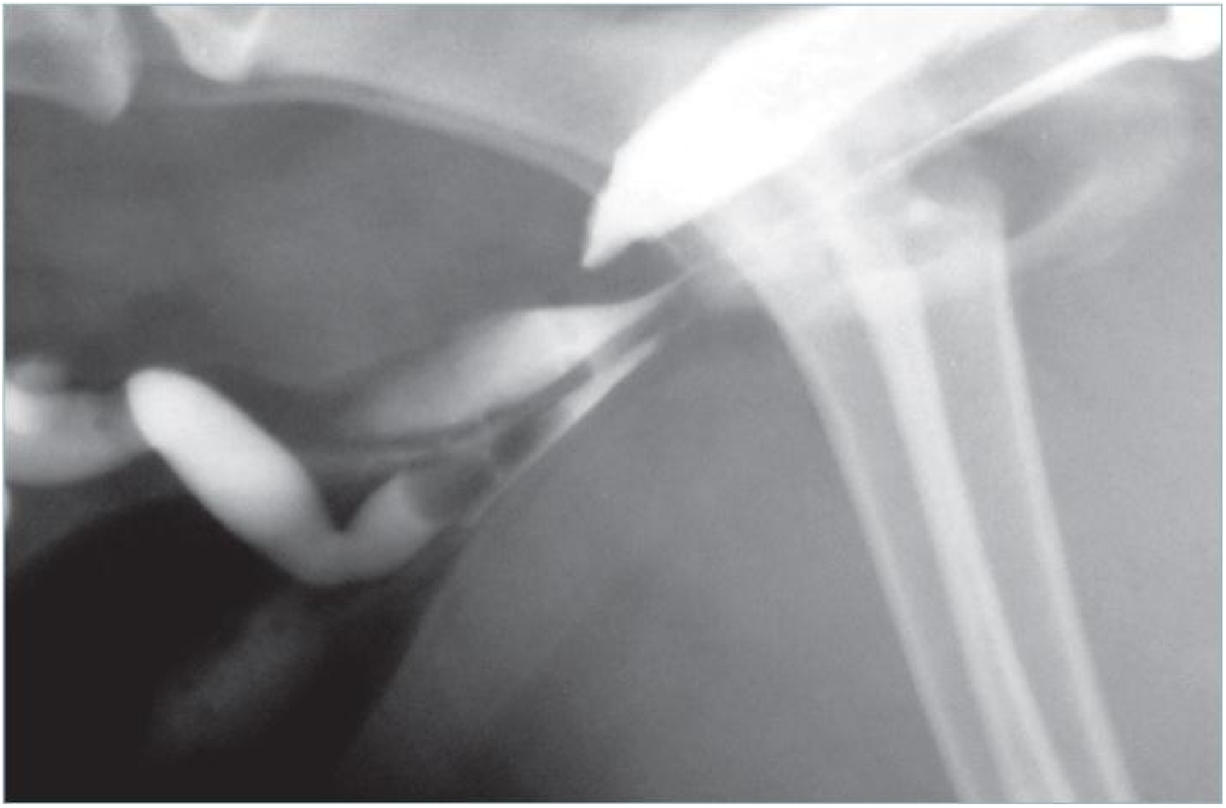

Fig. 7. Air is introduced into the bladder for better visualization of the structures in the region. This shows that the ureters terminate in the urethra. The vagina is full of contrast medium due to retrograde flow of urine.

Infraumbilical laparotomy is performed. After verifying that the ureteral ectopy is intramural, the ureters are opened in the trigone area of the bladder (Fig. 8).

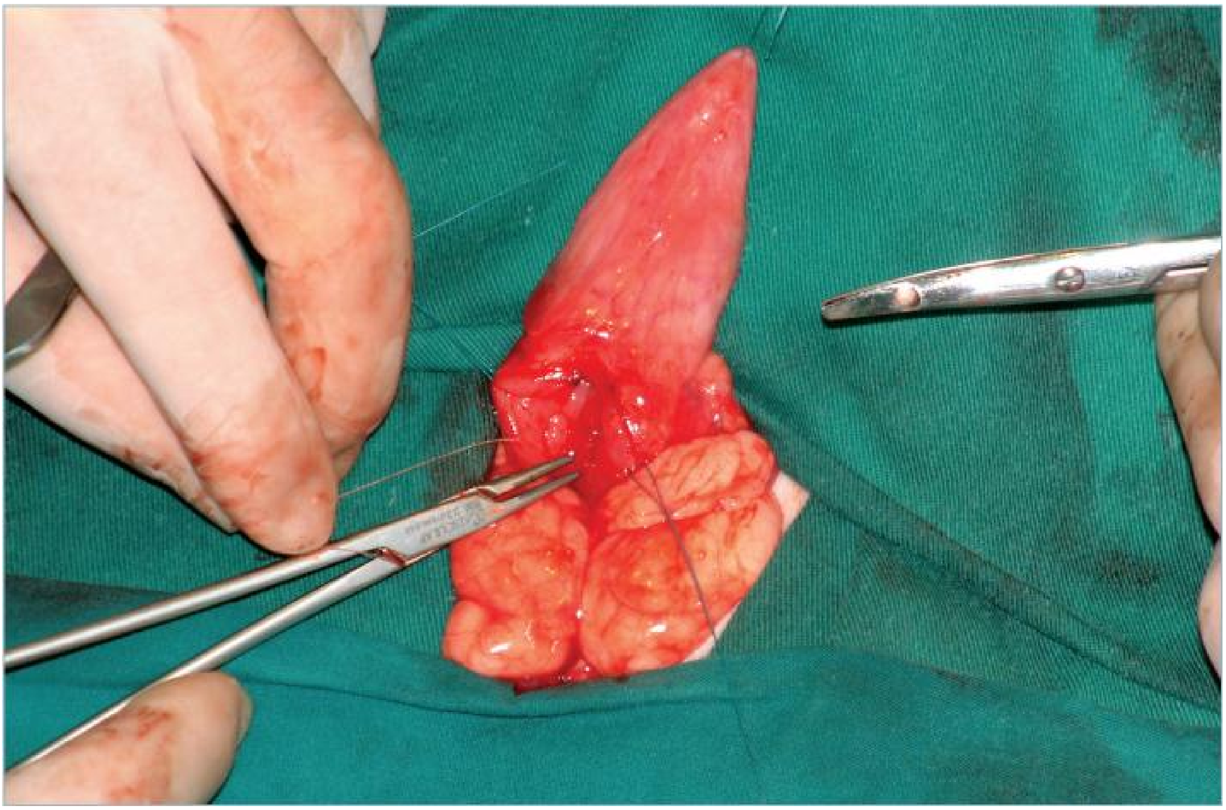

Fig. 8. After opening of the ureters in the trigone region of the bladder, 5/0 monofilament absorbable material is used for the sutures.

During the postoperative period, the patient was treated with amoxicillin / clavulanic acid (indicated following urinary culture and sensitivity testing), at a dose of 15 mg/kg/12 h, for 2 weeks.

Follow-up

From the first postoperative day, Sara became progressively urinary continent, and after seven days she was completely continent (Fig. 9). This has been maintained over the four years that her progress was monitored.

Fig. 9. Seven days after surgery, the patient had become fully urinary continent, even when the intraabdominal pressure increased.

Extramural ectopic ureter. Neo-ureterocystostomy

José Rodríguez

Technical difficulty ■■■■□

Surgical technique

After performing an infraumbilical suprapubic laparotomy, the bladder is identified and the ureters are located (Fig. 1).

https://player.vimeo.com/video/180708270

Watch this video

Neo-ureterocystostomy

> ***To facilitate manipulation of the bladder, a stay suture is placed at the apex of the bladder with monofilament material.***

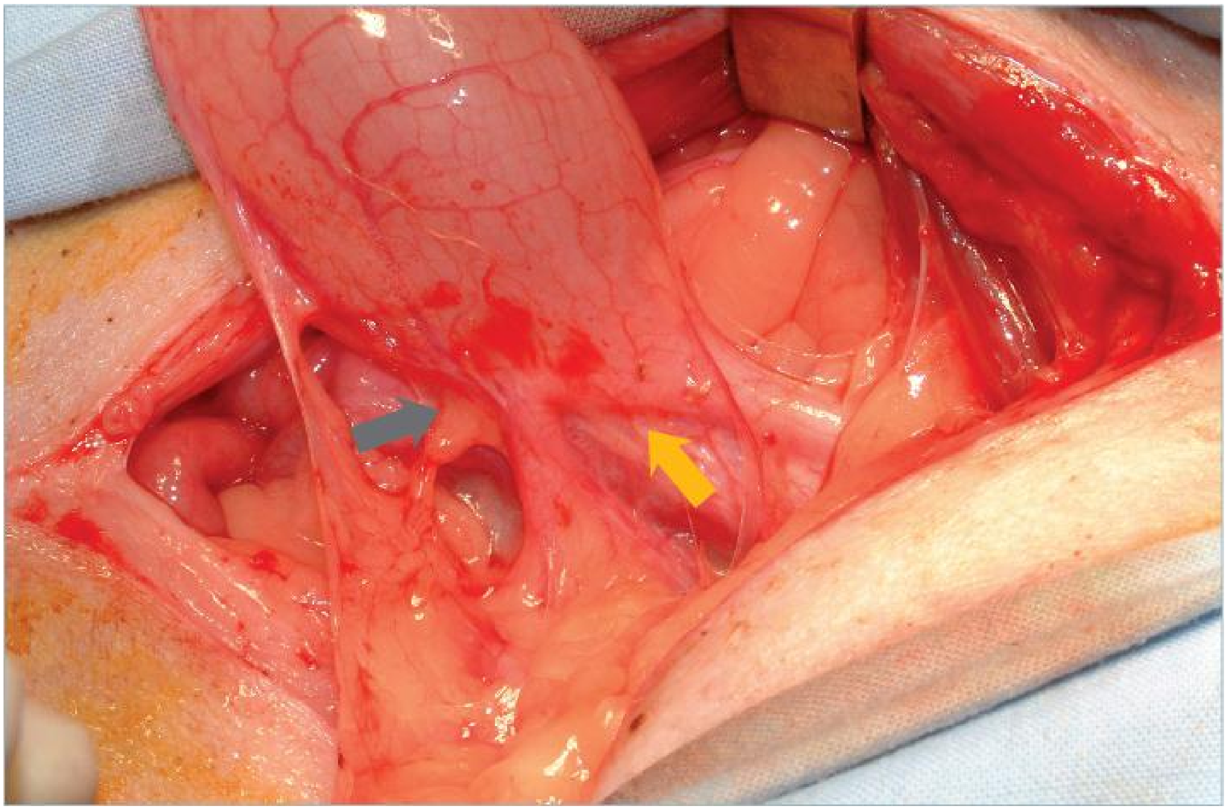

Fig. 1. The right ureter seems to enter the bladder in its correct anatomical position (grey arrow), but close observation reveals that it runs parallel to the bladder and ends in the urethra (orange arrow).

Once the ureters are located, their distal third is dissected to make moving them easier and identify their extravesical point of insertion (Fig. 2).

> ***Dissection of the ureter should be carried out with care to avoid trauma to the periureteral fatty tissue, which contains the blood***

vessels that perfuse the ureter.

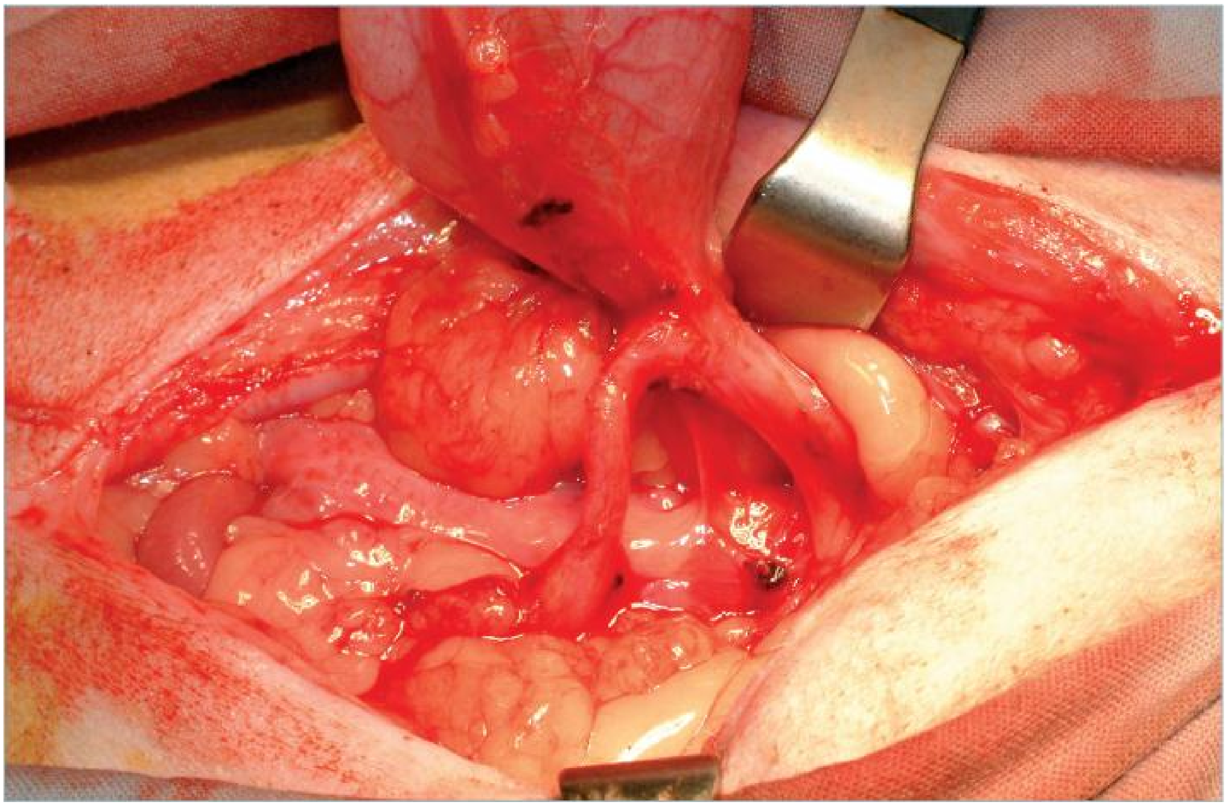

Fig. 2. Distal dissection of the right ureter permits identification of its termination in the proximal part of the urethra.

This is followed by the placement of two ligatures on its most distal part (one of the ends of the proximal ligature is kept longer), and the ureter is severed between the two (Figs. 3 and 4).

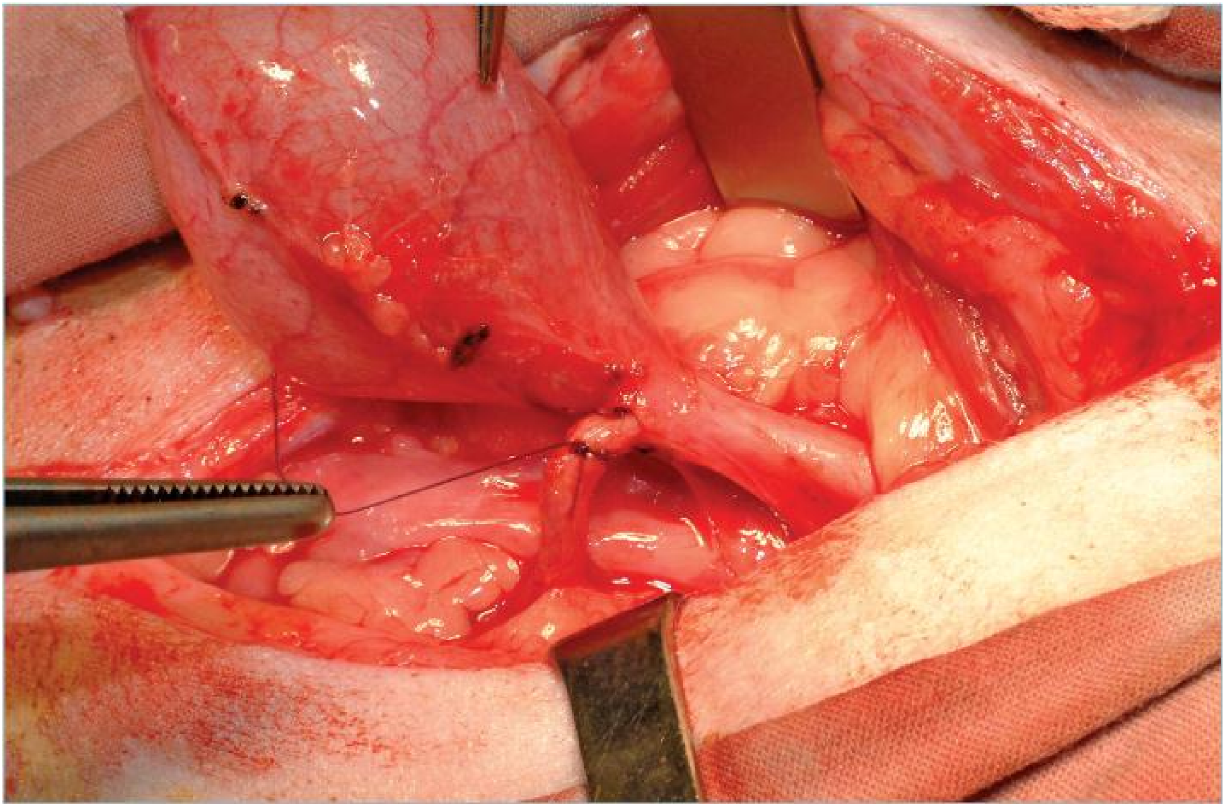

Fig. 3. The distal ligature is tied as closely as possible to the point of insertion of the ureter to avoid the ectopic ureteral segments filling with urine. One of the ends of the proximal ligature is kept long.

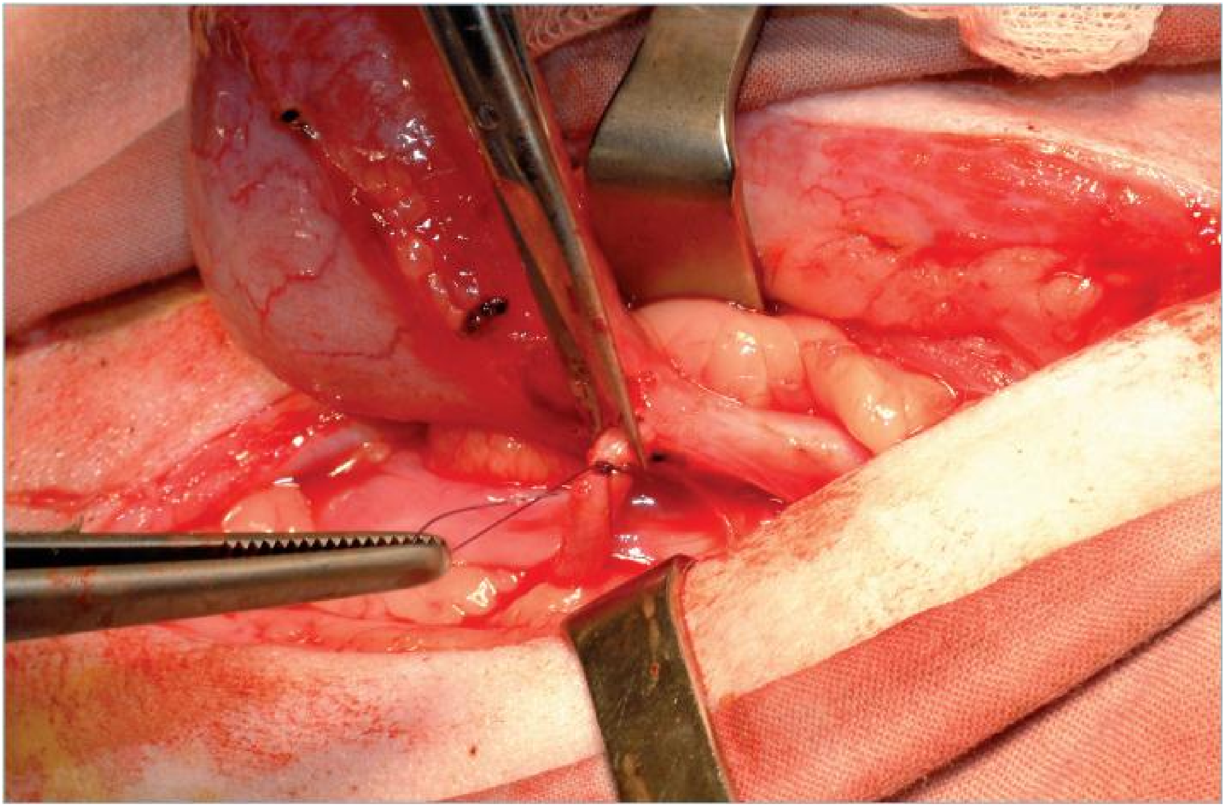

Fig. 4. The ureter is severed between the two ligatures.

If the ectopy is bilateral, the same procedure is performed on the other ureter (Fig. 5).

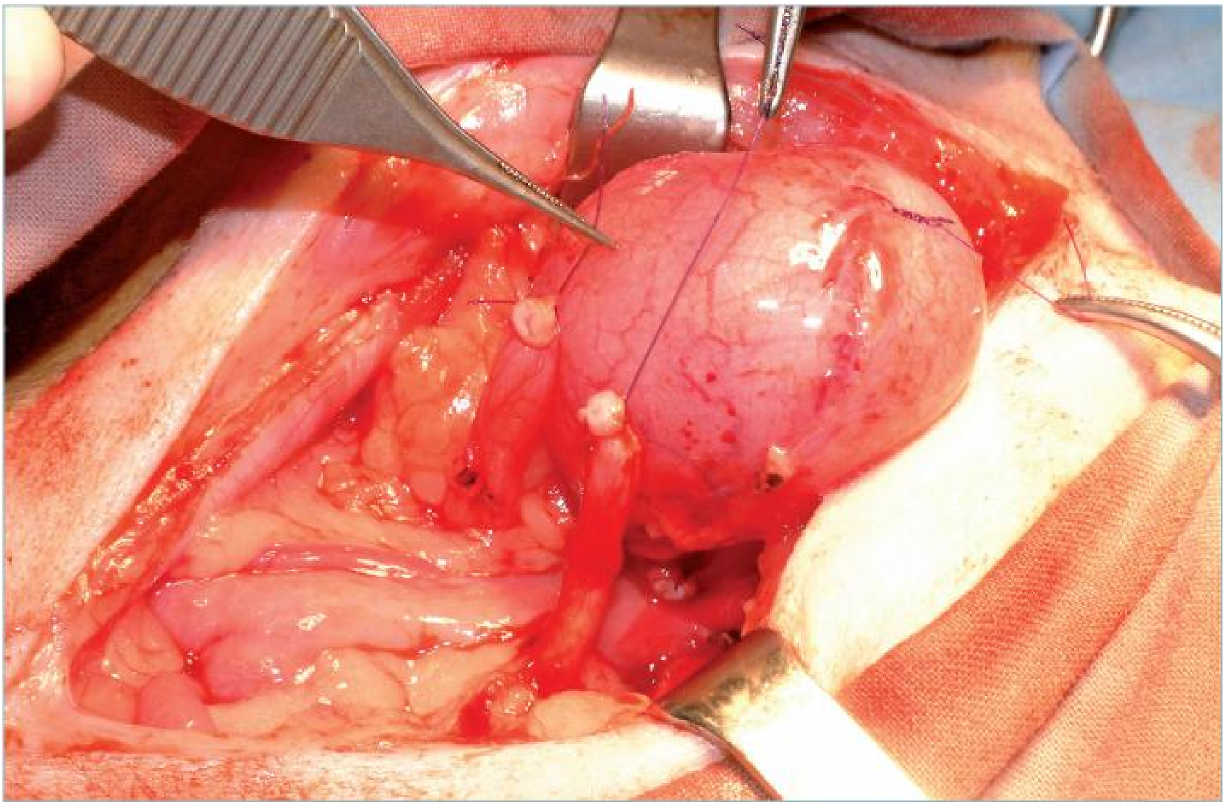

Fig. 5. This image shows both severed and ligated ureters before being implanted into the bladder. The left ureter is more dilated than the right.

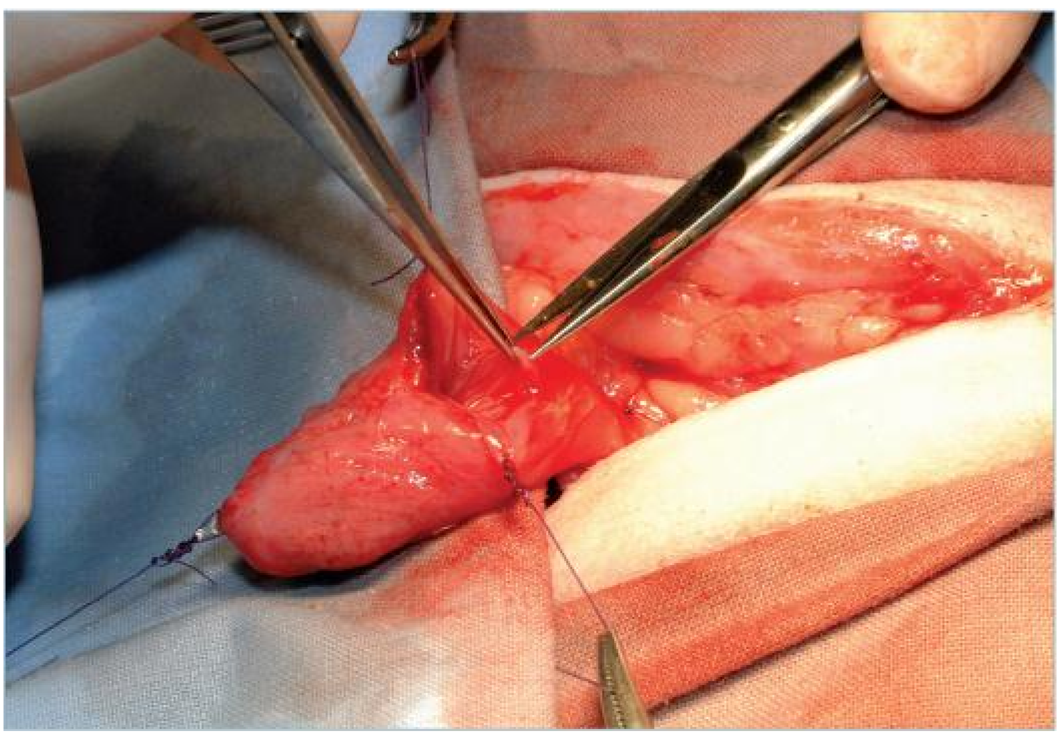

Fig. 6. The cystotomy is kept open with two stay sutures. At the sites of ureteral anastomosis, small pieces of the bladder mucosa are removed.

In the next phase of the operation, the bladder is emptied by cystocentesis, and a cystotomy is performed in the caudoventral bladder.
Stay sutures are placed in the wound edges to keep them apart. In the trigone region, two small circles are resected from the bladder mucosa, where the ureterovesical junction is planned (Figs. 6 and 7).

*

Cystotomy should be performed in an area with little vascularization.

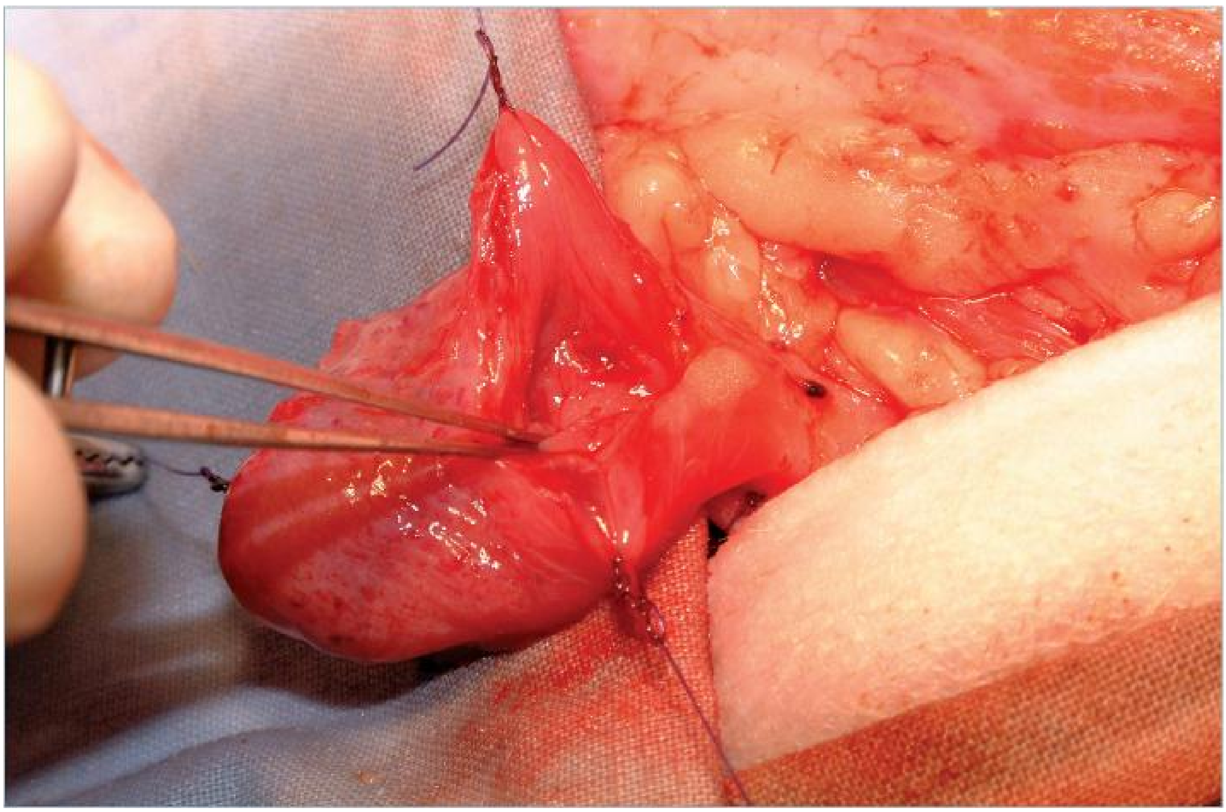

Fig. 7. Appearance after removal of a small piece of bladder mucosa on the left side of the bladder.

Through the defect created in the mucosa, an oblique tract is made in the bladder wall with fine hemostats, in a cranial direction (Fig. 8).

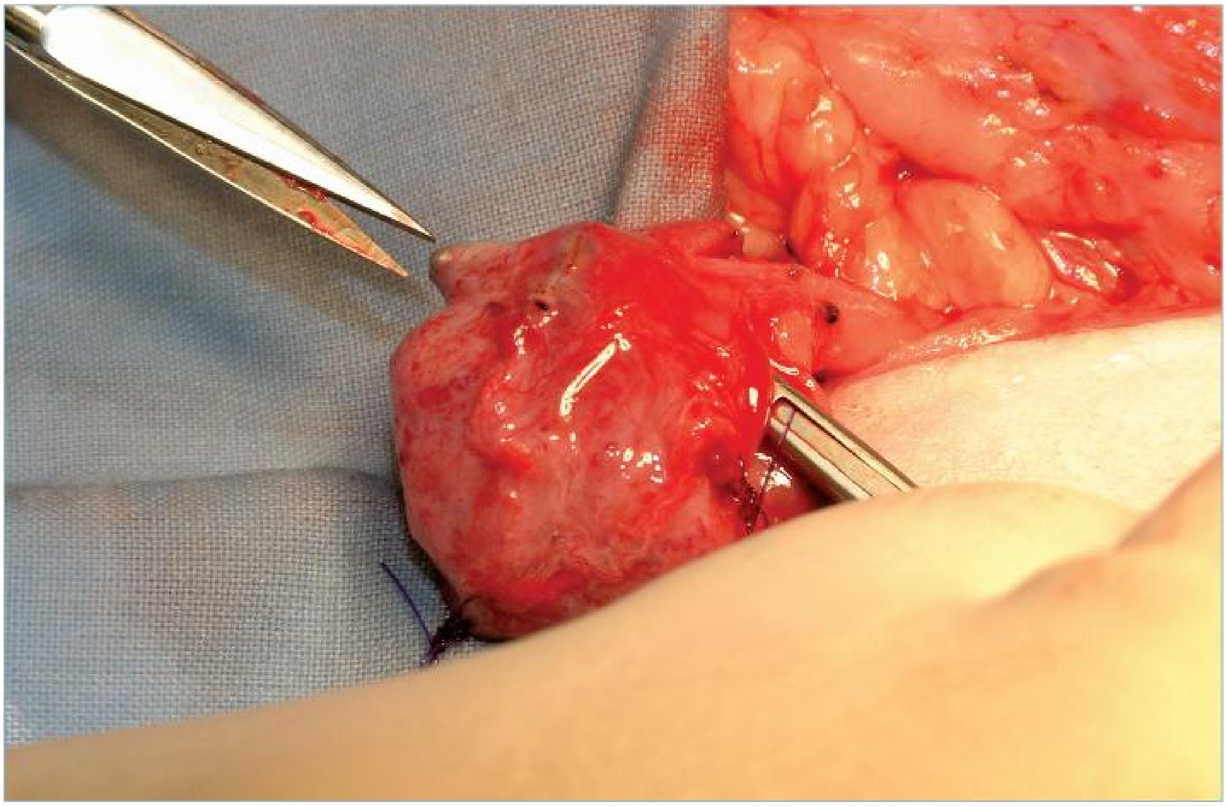

Fig. 8. Oblique introduction of fine forceps through the defect of the bladder mucosa, directed towards the apex of the bladder.

Then, the long end of the ligature on the ureter of the same side is grasped (Fig. 9) and pulled back to introduce the ureter into the bladder without tension (Fig. 10) and the ureter is cut close to the ligature.

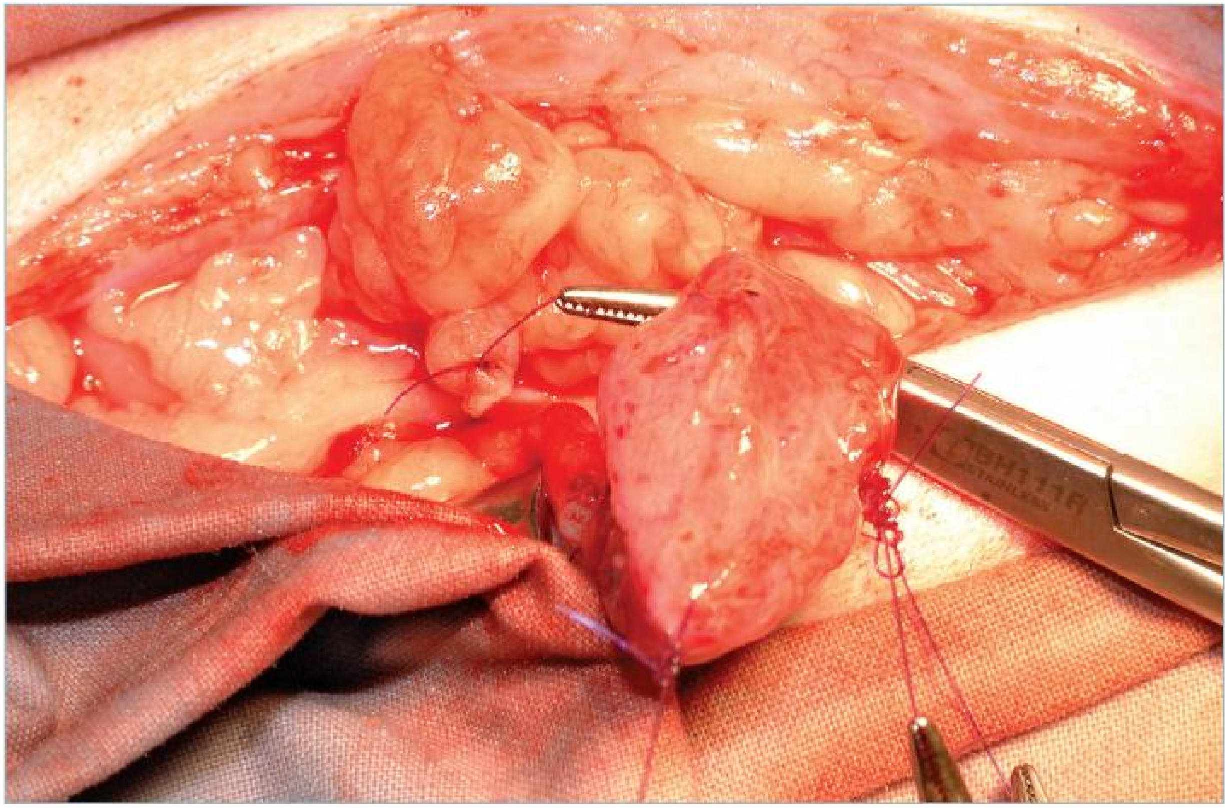

Fig. 9. After tunnelling an oblique tract through the bladder wall, the hemostatic forceps grasp the long end of the ligature on the ureter.

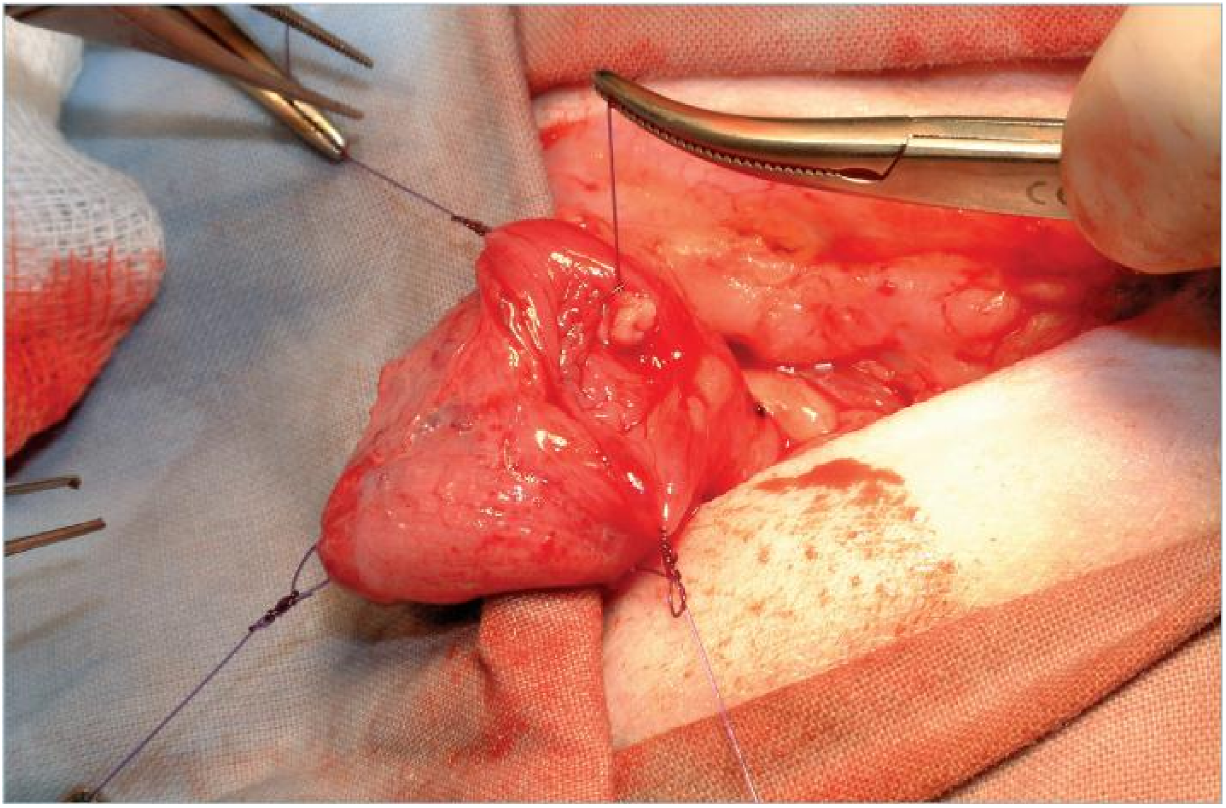

Fig. 10. By pulling back the forceps back, the ureter is introduced into the bladder. The distal ureteral segment tied off by the ligature is then resected.

The anastomosis between ureter and bladder is performed using simple interrupted sutures, of 5/0 or 6/0 monofilament synthetic absorbable material on a roundbodied atraumatic needle (Fig. 11).

*

There is no need to create a submucosal tunnel to prevent reflux of the urine towards the kidney.

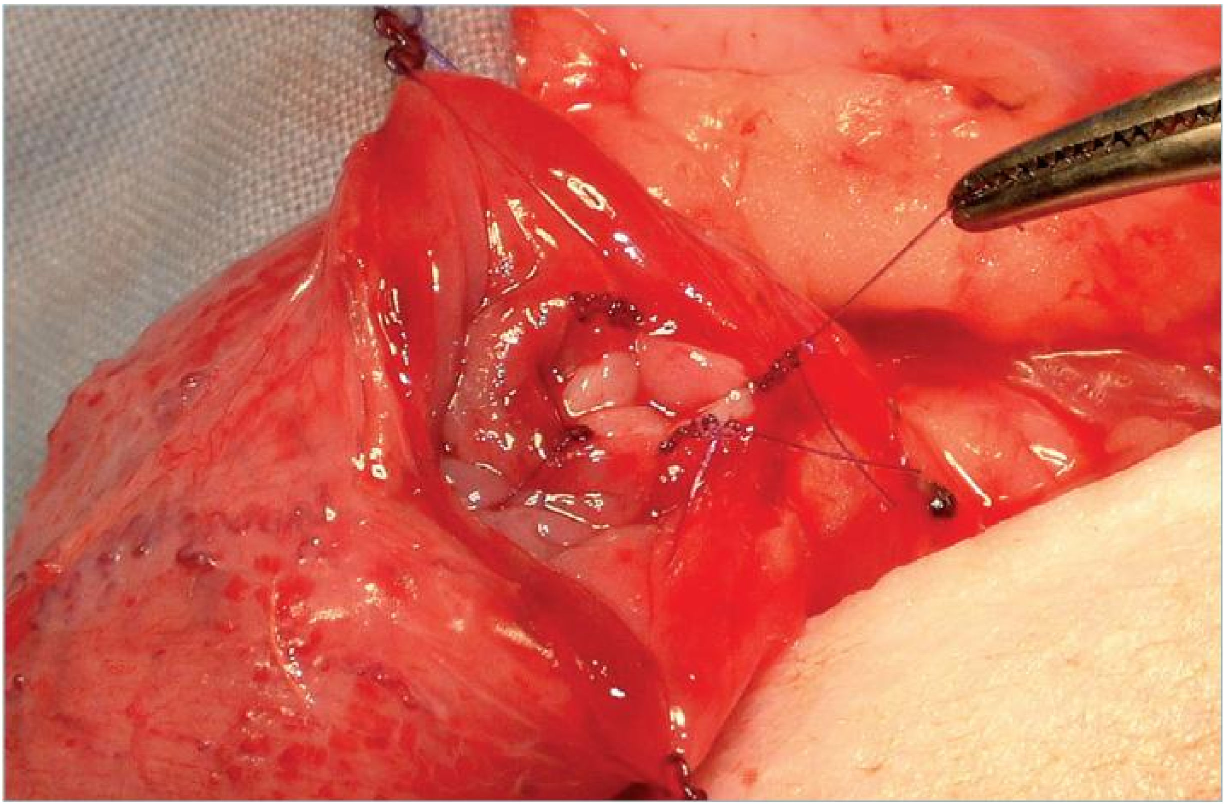

Fig. 11. Ureterovesical anastomosis with simple sutures using 6/0 monofilament synthetic absorbable material.

The same procedure for tunnelling and insertion of the ureter into the bladder is repeated on the other side. If the ureter is not distended and has a small diameter, the opening for the anastomosis can be widened by a longitudinal incision in its wall (Fig. 12). The ureterovesical anastomosis is then carried out as described above (Fig. 13).

If the ureter is distended due to urinary retention, its lumen is wide and it is easier to suture. If there is no hydroureter, the diameter is smaller. In this case, it is recommended to enlarge the distal end of the ureter by cutting it obliquely or by making a short longitudinal incision.

The ureters are attached to the outside of the bladder wall with two sutures using the same suture material, to reduce the risk of dehiscence of the anastomosis due to retrograde movement of the ureters (Fig. 14).

The bladder is closed as described on p. 400-403 and is covered with omentum to prevent possible leakage of urine or adhesions to other abdominal organs (Fig. 15).
Before closing the laparotomy wound, the abdominal cavity is flushed with lukewarm sterile saline to remove any urine that may have contaminated the peritoneum during surgery.
A urinary catheter is kept in the bladder for the first 24-36 hours after surgery to avoid excessive bladder distension.
Antibiotic cover is provided for at least two weeks after surgery.

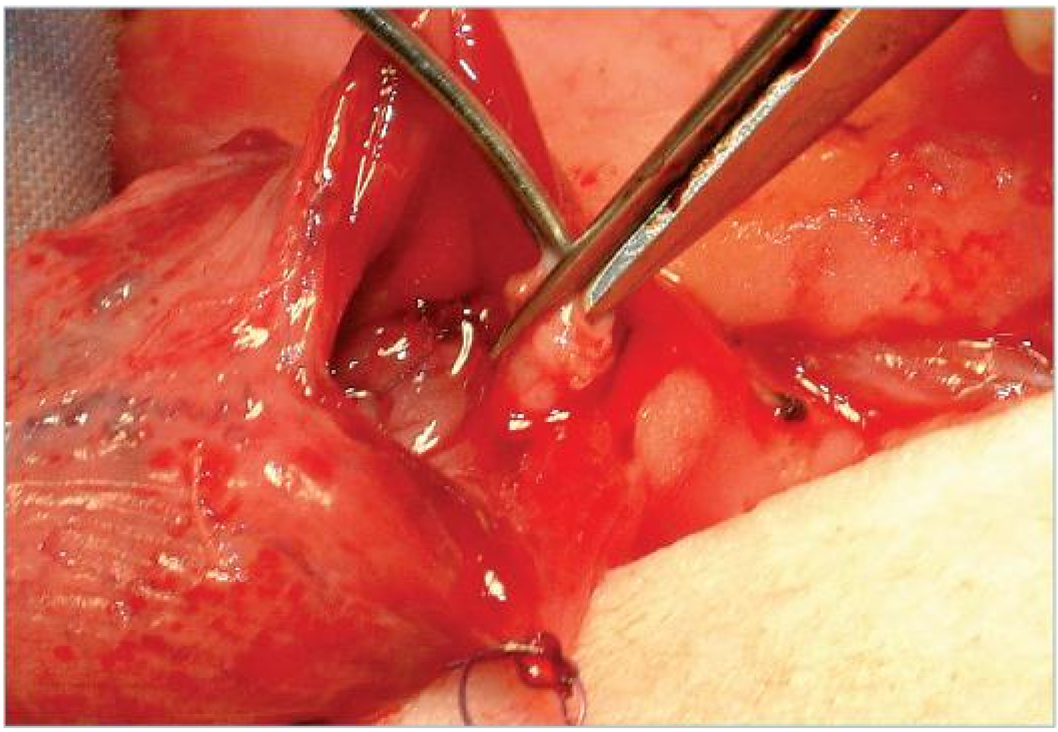

Fig. 12. To facilitate suturing the ureter to the bladder, its diameter can be enlarged by a short longitudinal incision of the ureteral wall.

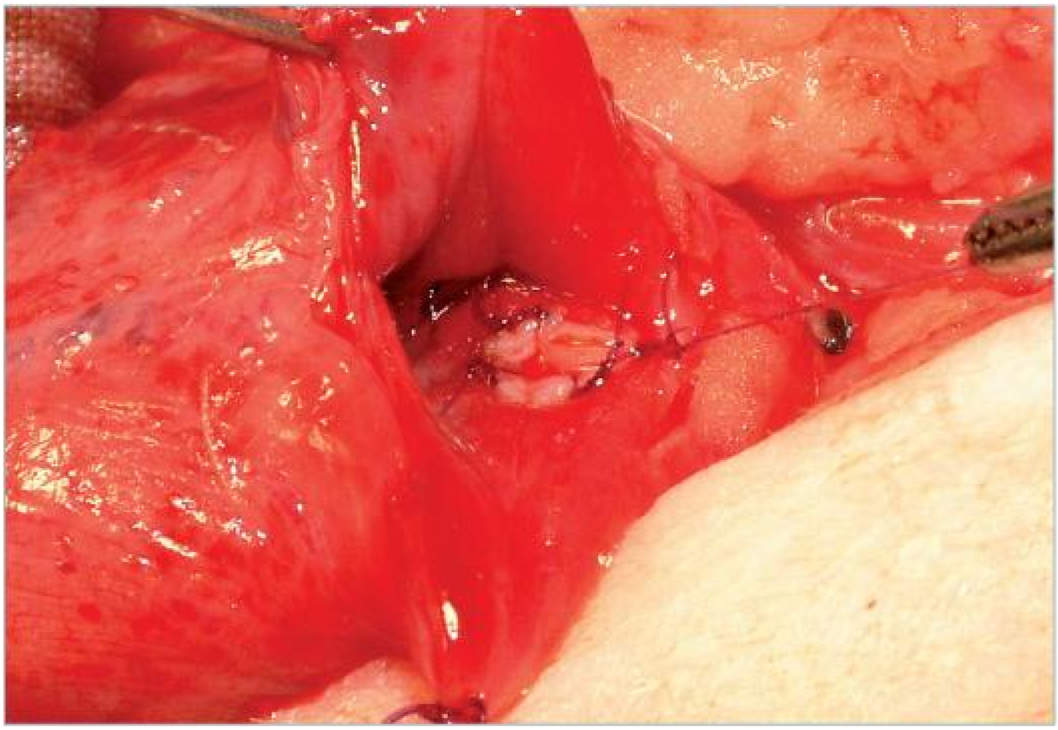

Fig. 13. Final appearance of the right new ureterovesical junction. Five to six sutures are needed, using 6/0 monofilament absorbable material.

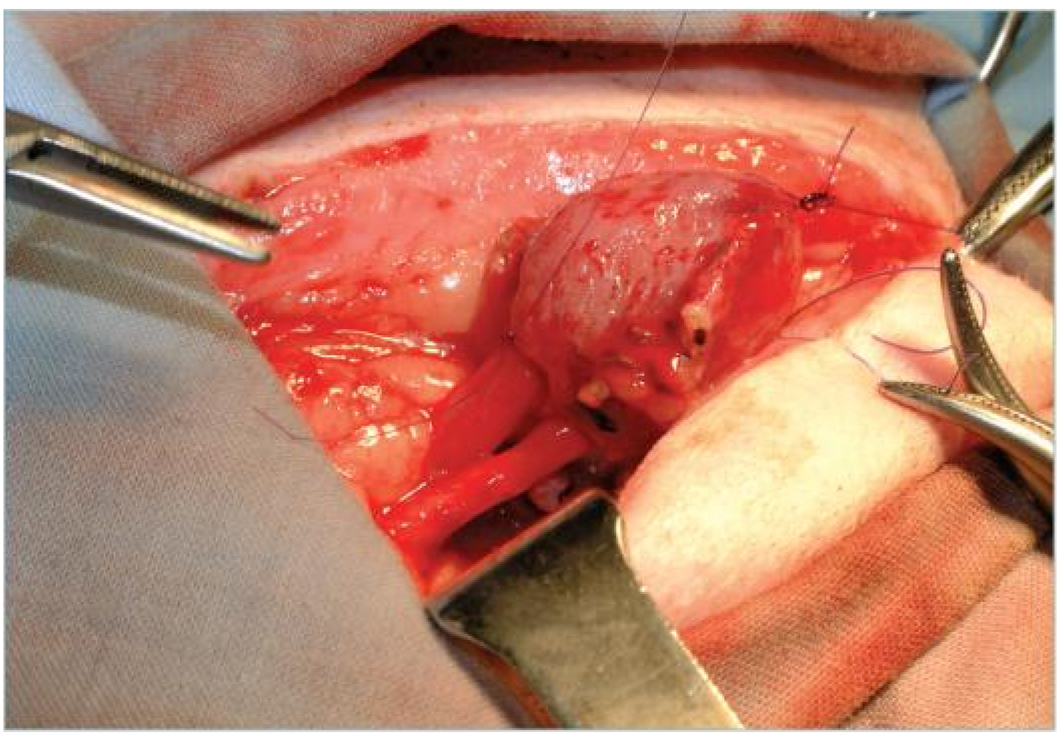

Fig. 14. The ureters are attached to the bladder wall to prevent retrograde slippage and dehiscence of the anastomoses.

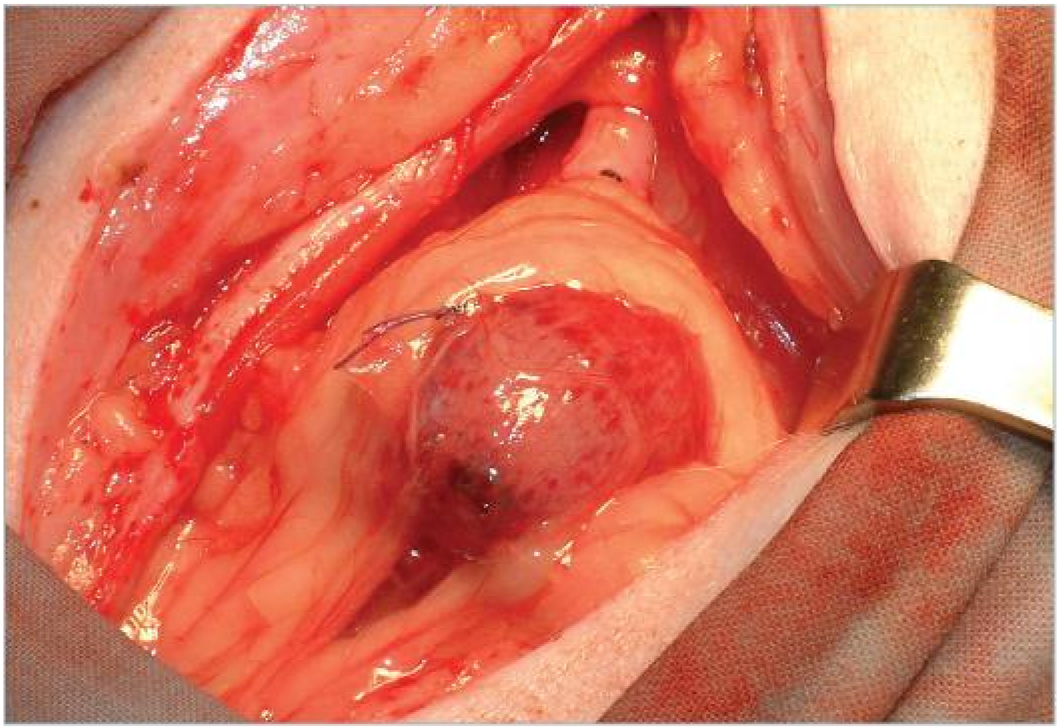

Fig. 15. Closure of the cystotomy wound using 3/0 monofilament synthetic absorbable material, followed by omentalization of the bladder to prevent urinary fistulas and abdominal adhesions.

Case / Extramural ectopic ureter

José Rodríguez

Pinchi is a one-year-old female Bichon Maltese with continuous urinary incontinence since she was a puppy. Apart from leaking small volumes of urine, she also urinates voluntarily when going out for walks (Figs. 1 and 2).

Her veterinarian suspected that the problem could be related to an ectopic ureter and referred her to the hospital for the necessary diagnostic work-up.
Ultrasonography of the urinary tract revealed that neither of the ureters ended in the bladder; one led to the proximal urethra and the other to a more distal point which could not be identified by ultrasound.
The left kidney and ureter were found to be distended due to urinary retention. Excretory urography was performed to confirm these findings and to locate the distal insertion points of the ureters (Figs. 3-7).

Fig. 1. Pinchi is a female dog with urinary incontinence since birth.

Fig. 2. The perineal area was always wet due to the constant dribbling of urine from the vulva.

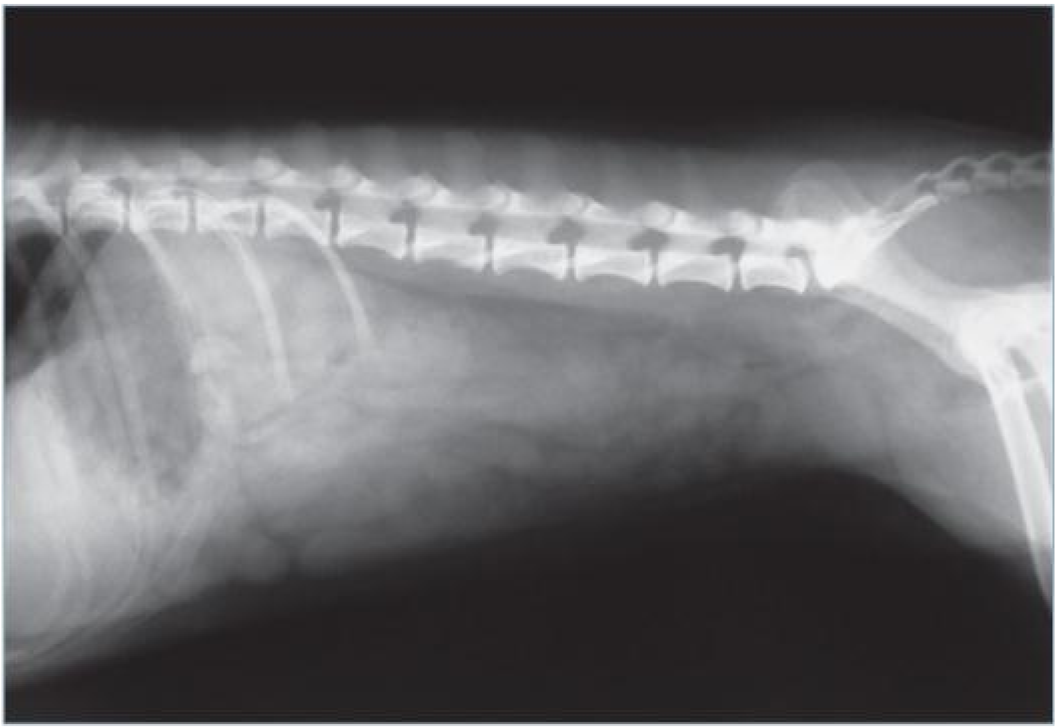

Fig. 3. Plain radiograph to locate the abdominal organs and to verify that there are no feces or gas rendering the radiological interpretation difficult.

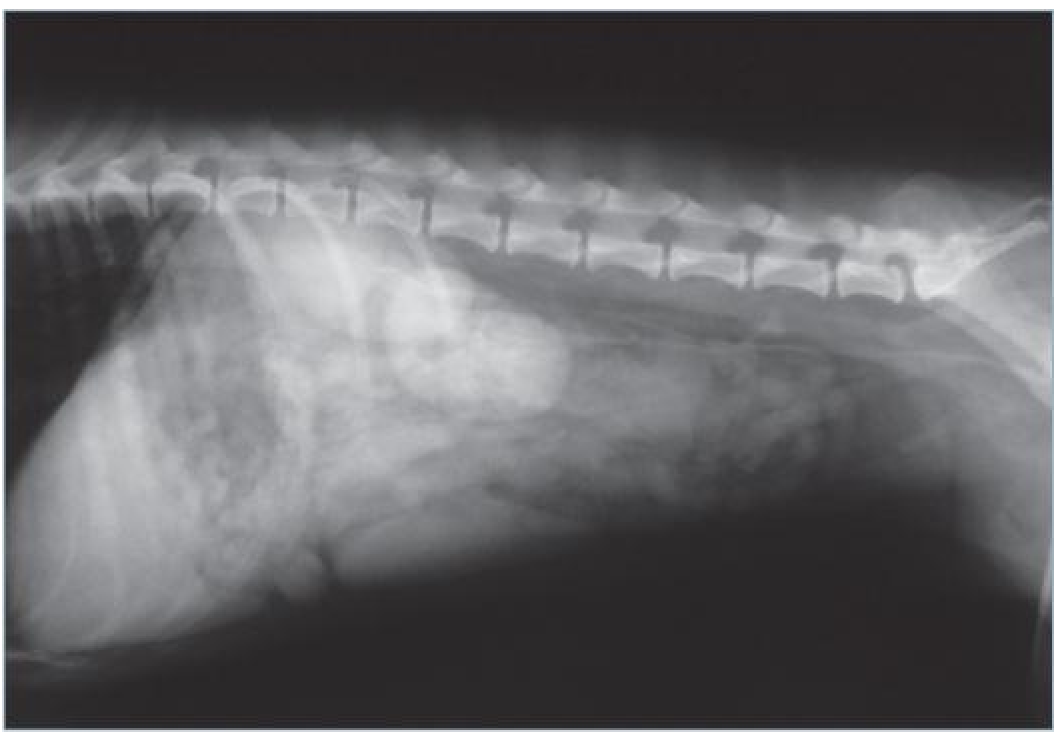

Fig. 4. Radiograph taken immediately after the IV iodinated contrast injection. The expected uptake of the contrast medium by the kidneys is

visible.

Fig. 5. The kidneys have a normal morphology and the ureters clearly end somewhere in the pelvic cavity.

Fig. 6. At a later stage, both ureters were found to bypass the bladder trigone and to insert in the urethra.

These results led to the diagnosis of urinary incontinence due to bilateral ectopic ureters, probably extramural in view of the image of the distal ureters.

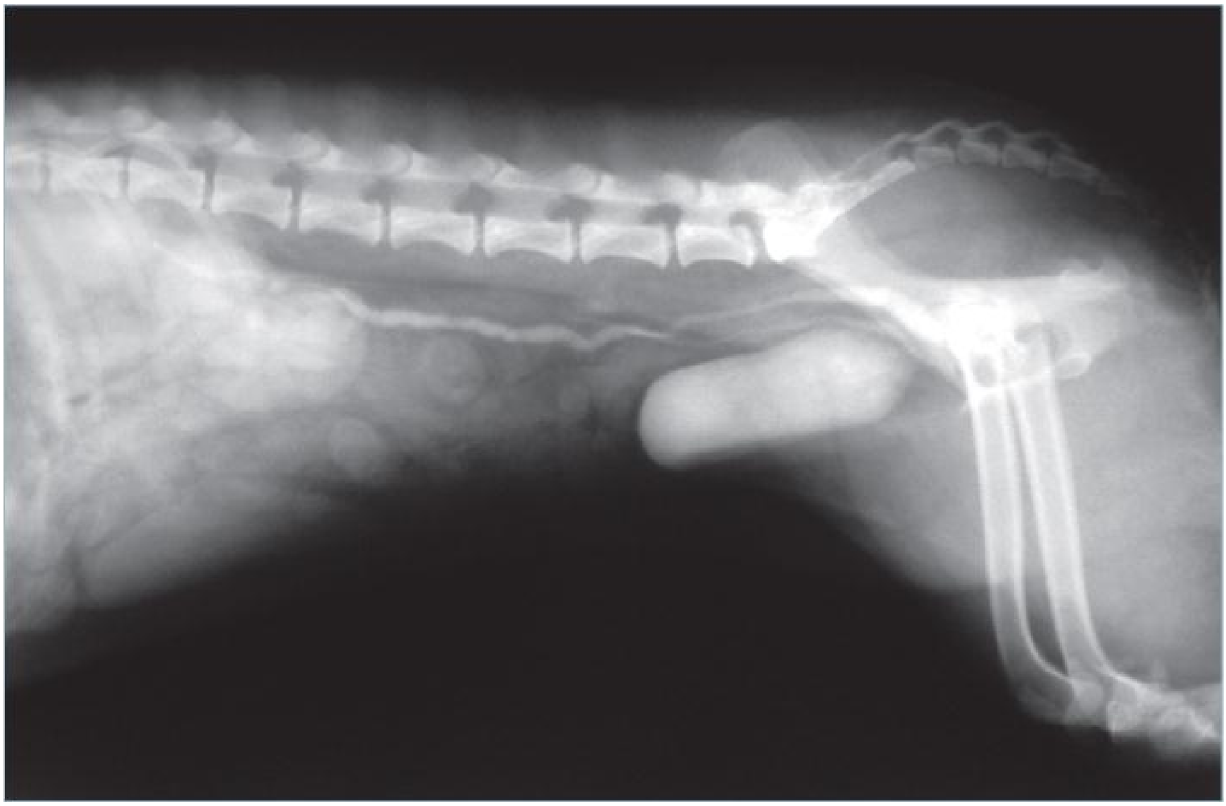

Fig. 7. This image clearly shows how the right ureter has its insertion point in the proximal area of the urethra and the left in a more distal part. There is also a moderate left hydroureter.

Surgical technique

Surgery starts with an infraumbilical midline laparotomy, followed by careful dissection of the distal ureters, taking care to preserve the periureteral fat that contains the blood vessels. After dissection, the insertion points of the ureters in the urethra became clearly visible (Fig. 8).

The ureteral ectopy was bilateral and extramural. The ureters were then implanted in the trigone area of the bladder (Figs. 9 and 10).

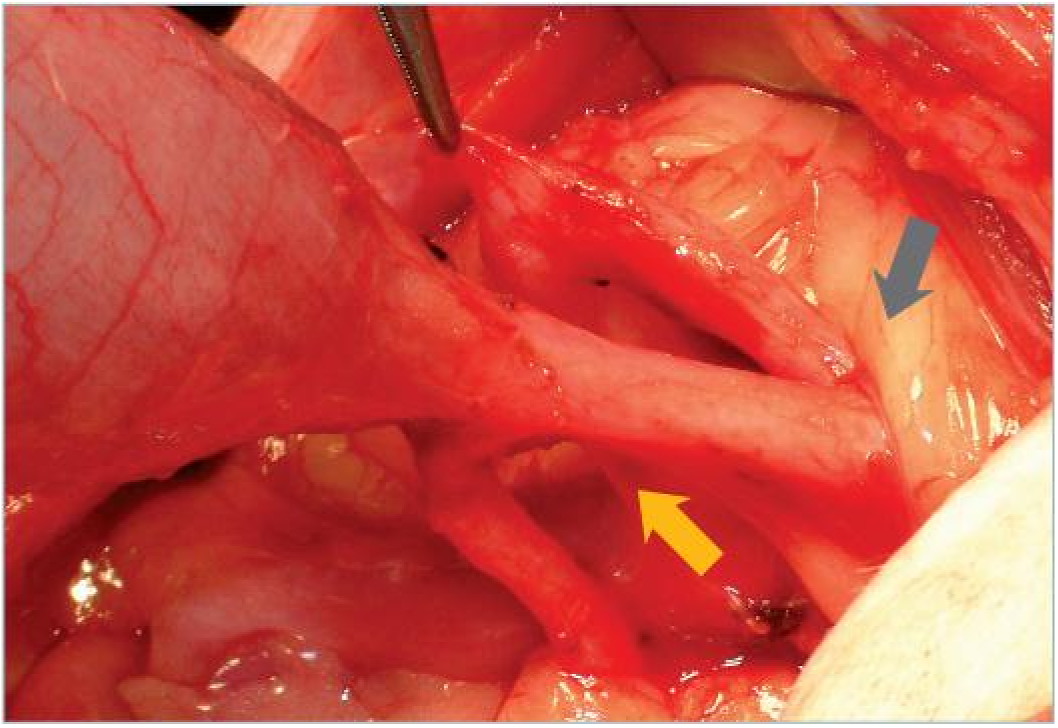

Fig. 8. The right ureter had its insertion point in the proximal urethra (orange arrow), while the left did so more distally (grey arrow).

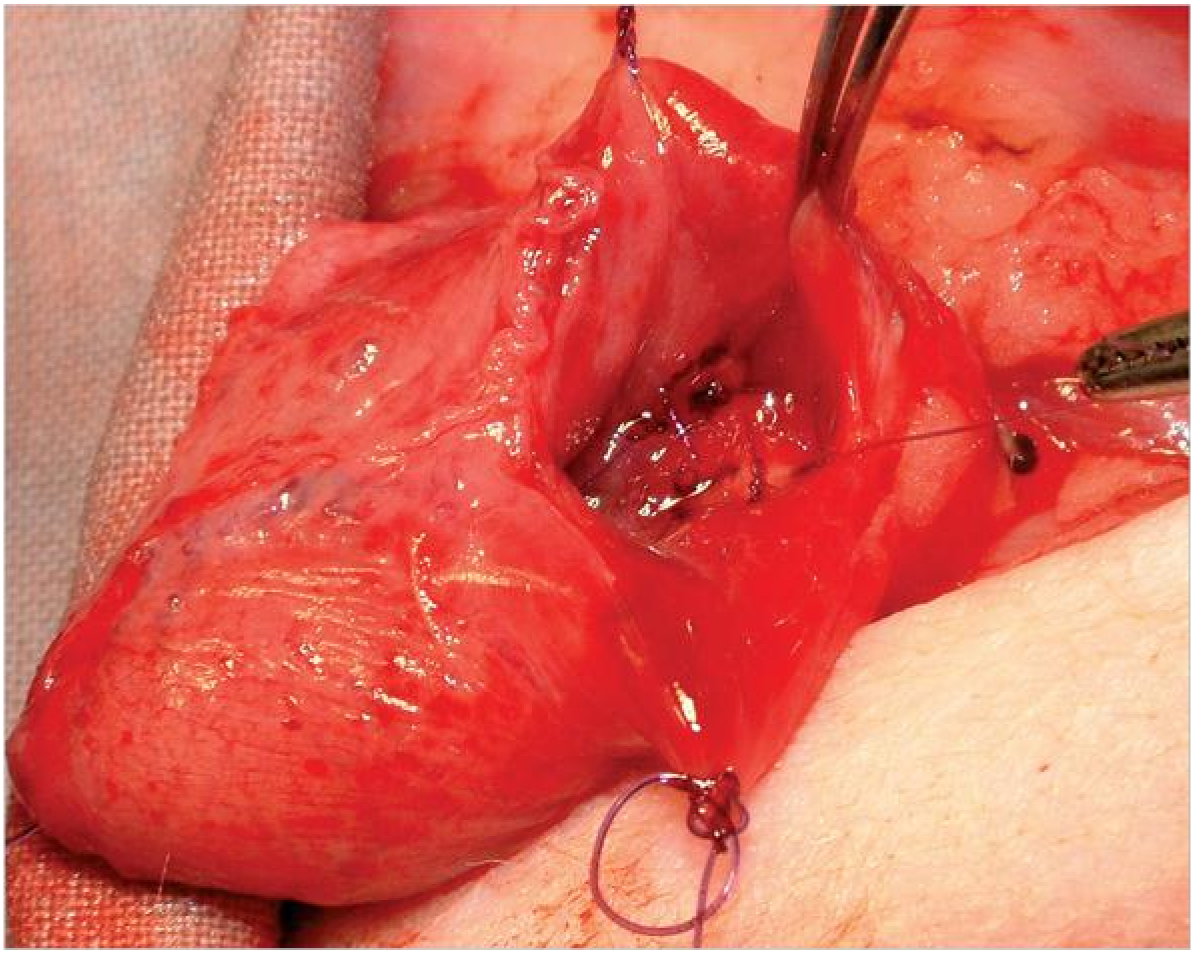

Fig. 9. Following introduction of the ureters through the corresponding oblique tunnels in the bladder wall, a ureterovesical anastomosis of the mucosa is performed with simple sutures using 6/0 monofilament synthetic absorbable material.

Fig. 10. During the first 24 postoperative hours, a urinary catheter was left in place to avoid excessive distension of the bladder.

Fig. 11. The perineal area was dry because urine dribbling had ceased.

Follow-up

Three days after surgery, the patient no longer showed signs of urinary incontinence, and the perineal region was dry (Fig. 11). However, the owner noted that the dog still leaked urine when lying down.

Healing progressed favorably, although the patient was brought back three weeks later for continued urine leakage when lying down.

Urine culture and sensitivity was performed on a sample obtained by cystocentesis, and treatment was prescribed accordingly. The incontinence improved notably but was not completely corrected.

Ultrasound examination of the abdomen revealed that the left ureter was significantly distended, with obvious signs of hydronephrosis. It was proposed to reimplant the ureter into the bladder or to remove the affected kidney, but the owner declined any further surgery.

In all cases of ectopic ureters, the client should be warned that despite the success of surgery, the patient may still show some degree of incontinence due to other abnormalities of the urinary tract, such as a lack of bladder distensibility or muscular tone of the bladder sphincter.

Esophageal hiatal hernia

José Rodríguez, Amaya de Torre Carolina Serrano, Rocío Fernández

Prevalence

Hiatal hernia is generally due to a congenital disorder of the esophageal hiatus, which allows the passage of the abdominal esophagus and the stomach into the thoracic cavity.

This reduces the tone in the lower esophageal sphincter, which may lead to esophageal reflux, esophagitis and possible secondary megaesophagus (Figs. 1 and 2).

Hiatal hernia may affect any dog breed, but in the authors' experience, most are found in the Shar Pei, English Bulldog and French Bulldog. It is much less common in cats.

The clinical signs appear before the patient is one year old. The most common sign is regurgitation, but other signs include:

- Vomiting.
- Dysphagia.
- Anorexia.
- Drooling.
- Respiratory signs.
- Weight loss, retarded growth, etc.

Fig. 1. Endoscopic image of the esophageal hiatus. Note the uncommon width of the hiatus, the folds of gastric mucosa in the esophagus and the esophagitis caused by gastric reflux. In this case, there is gastro-esophageal intussusception.

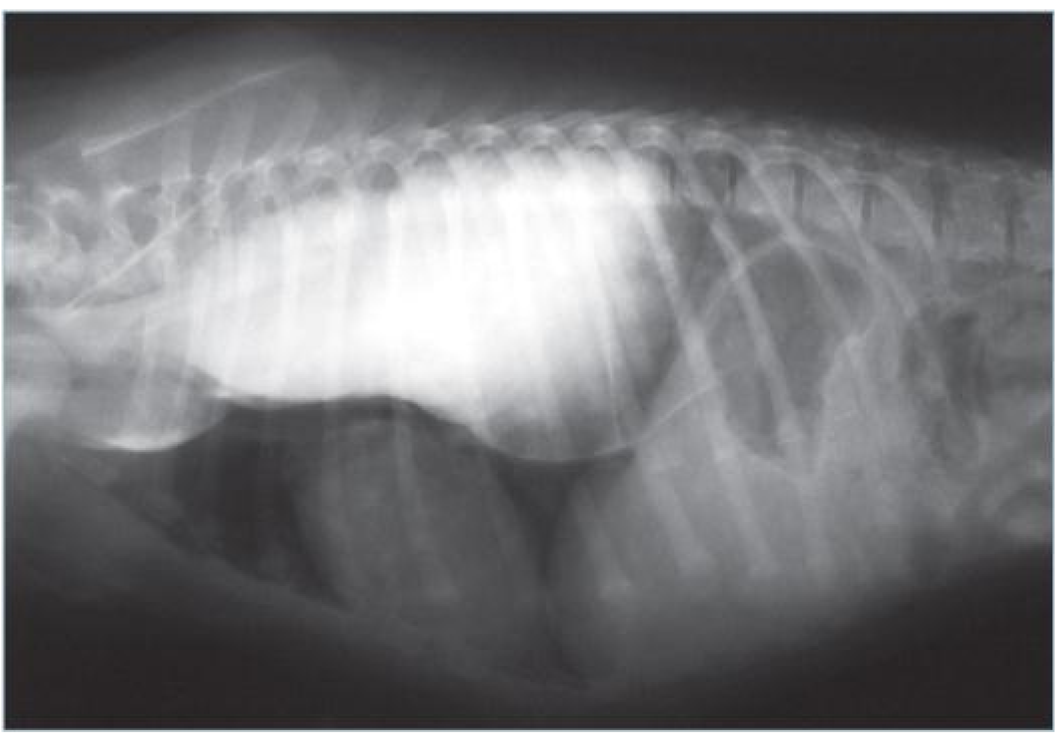

Fig. 2. Large megaesophagus in a patient with a large hiatal hernia. The megaesophagus may be primary, so an accurate diagnosis is required.

Diagnosis

It is not easy to recognise a hiatal hernia on a plain radiograph, because most are sliding, so that the abdominal viscera may be in their correct position when radiographs are taken. However, dilation or the presence of air in the distal esophagus may be signs of this disorder (Fig. 3).

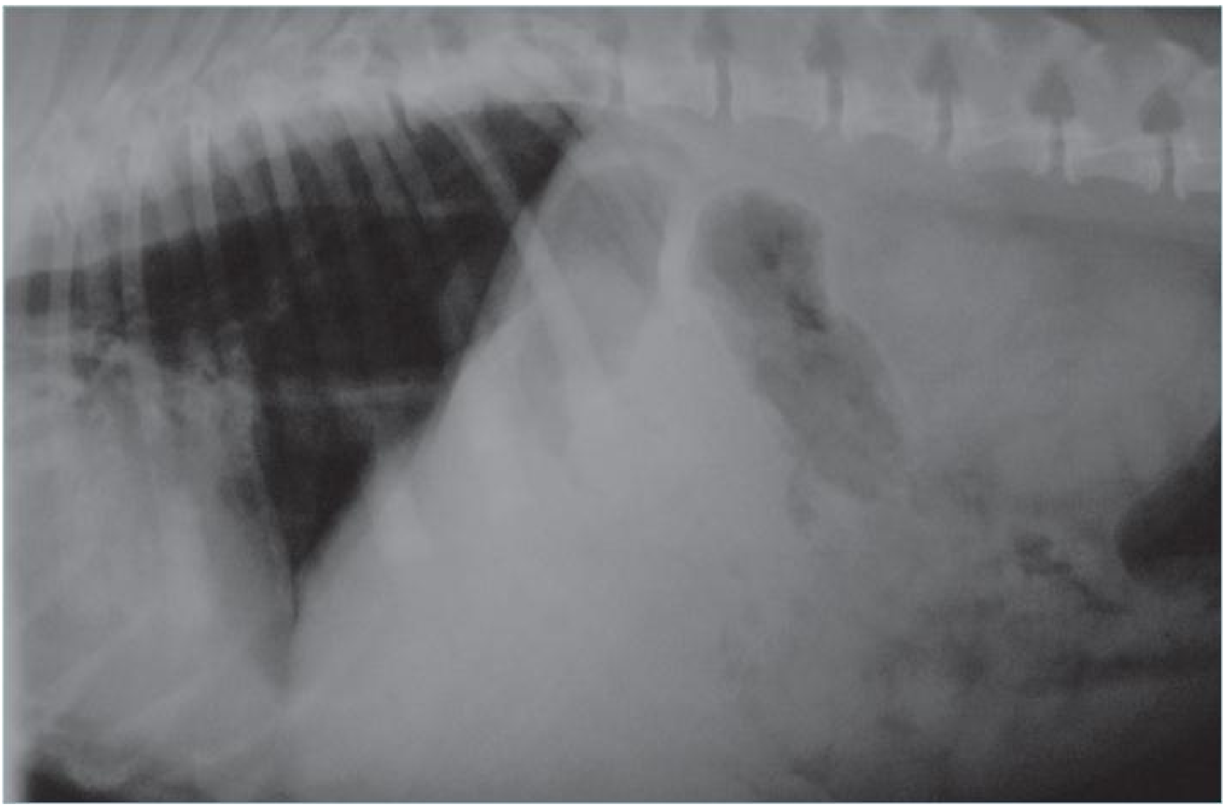

Fig. 3. Plain radiograph of a patient with hiatal hernia. Note the distension of the esophagus cranial to the diaphragm and the accumulated air in its lumen.

Positive contrast media help to achieve better visualization of the anatomical changes caused by the hernia (Figs. 4-6).

Fig. 4. After administration of a hydrosoluble contrast medium, dilation of the distal esophagus becomes visible, as well as the presence of folds of the gastric mucosa in the caudal esophageal sphincter.

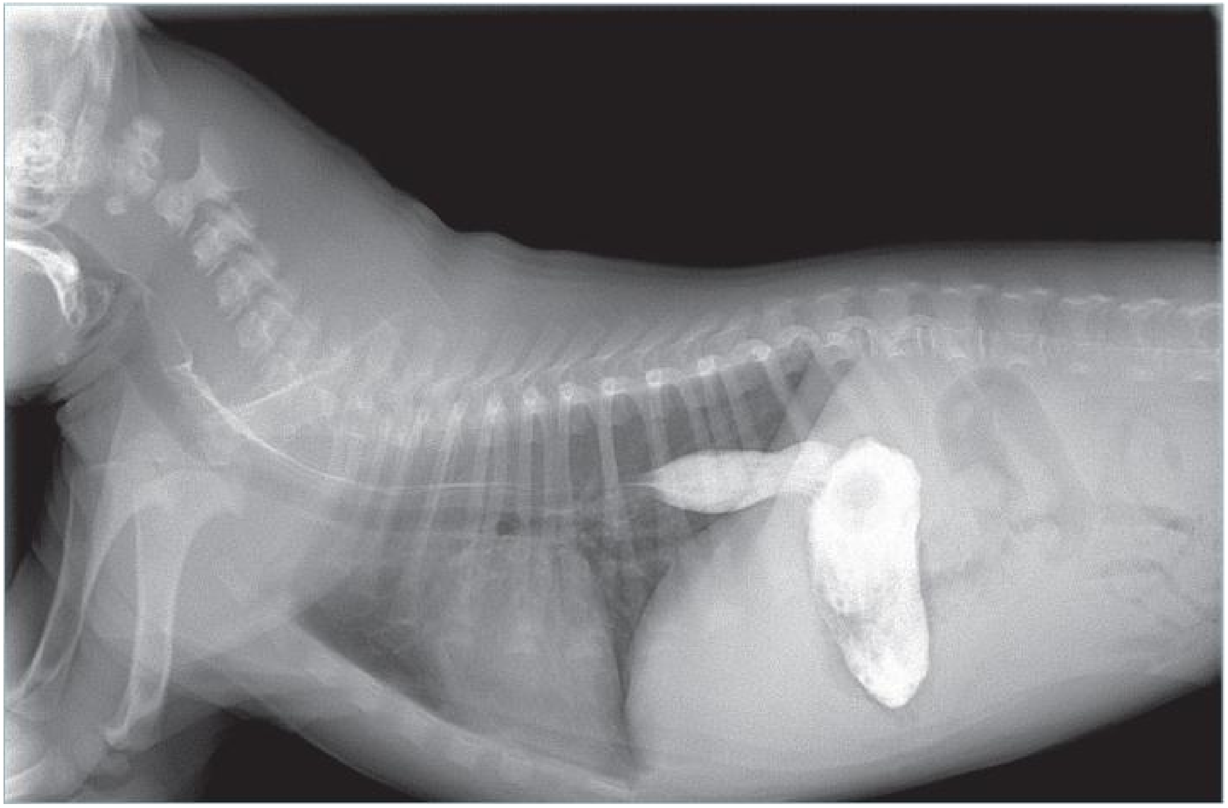

Fig. 5. Image of a hiatal hernia in a 5-month-old Bulldog. Note the prediaphragmatic esophageal dilation, the width of the esophageal hiatus and the presence of folds of the gastric mucosa in the hiatus.

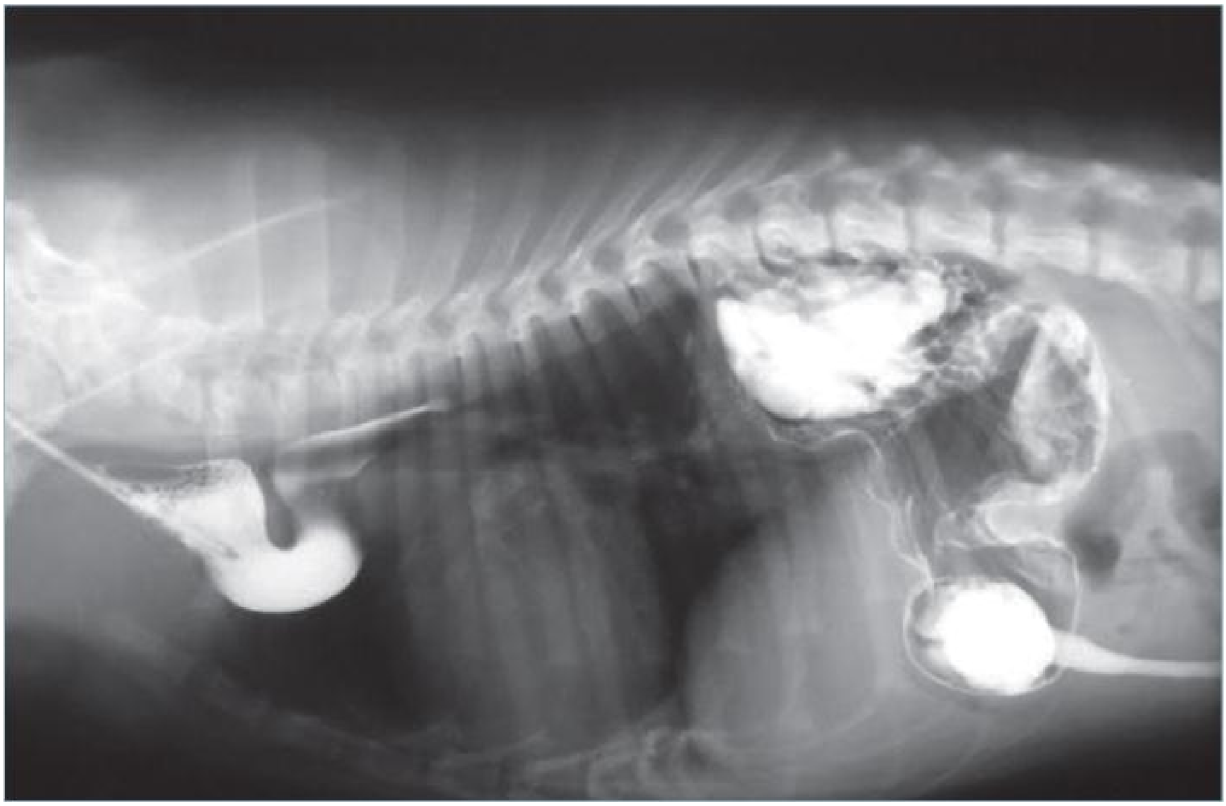

Fig. 6. In this patient, part of the stomach is located in the thoracic cavity, due to a large hiatal hernia.

Esophagogastroscopy (Figs. 7-9) is the most reliable diagnostic test, because it allows direct observation of:

- Esophagitis caused by gastric reflux.
- The width of the caudal esophageal sphincter.
- Folds of the gastric mucosa in the esophageal lumen.
- Inability of the cardia to close snugly around the endoscope when a retroversion maneuver is performed.

Fig. 7. Esophagoscopy in a patient with hiatal hernia showing esophagitis caused by gastric reflux and lateral displacement and poor muscle tone of the lower esophageal sphincter.

Fig. 8. Visualization of gastric mucosa folds in the esophageal lumen, a consequence of a hiatal hernia in a cat; there is also esophagitis all around the distal area of the esophagus.

Esophagitis of the distal esophagus is not always present.

Fig. 9. If a retroversion maneuver is performed inside the stomach to observe the cardia, it does not fit snugly around the endoscope. This is an unmistakable sign of hiatal hernia.

Treatment

The aims of the treatment are:

- To improve the signs caused by gastric reflux.
- To restore the function of the lower esophageal sphincter.
- To prevent complications due to esophagitis, aspiration pneumonia, ulcers, scar stenosis, etc.

Medical treatment should be started in all patients. When the response is not satisfactory, surgical treatment may be used.

Medical treatment is based on:

- A low-fat diet to improve muscle tone in the lower esophageal sphincter.
- Inhibitors of gastric acid secretion (omeprazole 1-1.5 mg/kg/24 h).
- Protection of the gastric mucosa (sucralfate 0.5-1 g/8 h).
- Reduction of the gastric emptying time (metoclopramide 0.2-0.5 mg/kg/8 h).
- Broad-spectrum antibiotic treatment in case of aspiration pneumonia.

> ***The lungs should be examined and, if aspiration pneumonia is detected, be treated immediately and always prior to any surgical intervention.***

If the signs and discomfort persist after a month of medical treatment, or if the patient suffers frequent relapses, surgery should be performed.

Technical difficulty ■■■■□

There are a number of surgical techniques that may be used to treat this problem. Usually, a combination of several techniques is used.
Among the surgical options to be considered are reduction and plication of the esophageal hiatus, esophagopexy, left-sided fundus gastropexy, as well as placing a feeding tube in the stomach to avoid the passage of food through the esophagus in cases of severe esophagitis.

> ***The anti-reflux techniques used in human medicine are not very efficacious in veterinary medicine.***

Approach

A supraumbilical laparotomy with a cranial extension to the left side of the xiphoid process is performed. The left liver lobes are displaced towards the medial area to access the esophageal hiatus (Fig. 10).

To facilitate displacement of the left lateral and medial liver lobes towards the right, it is advisable to cut the triangular ligament that attaches the cranial liver capsule to the diaphragm.

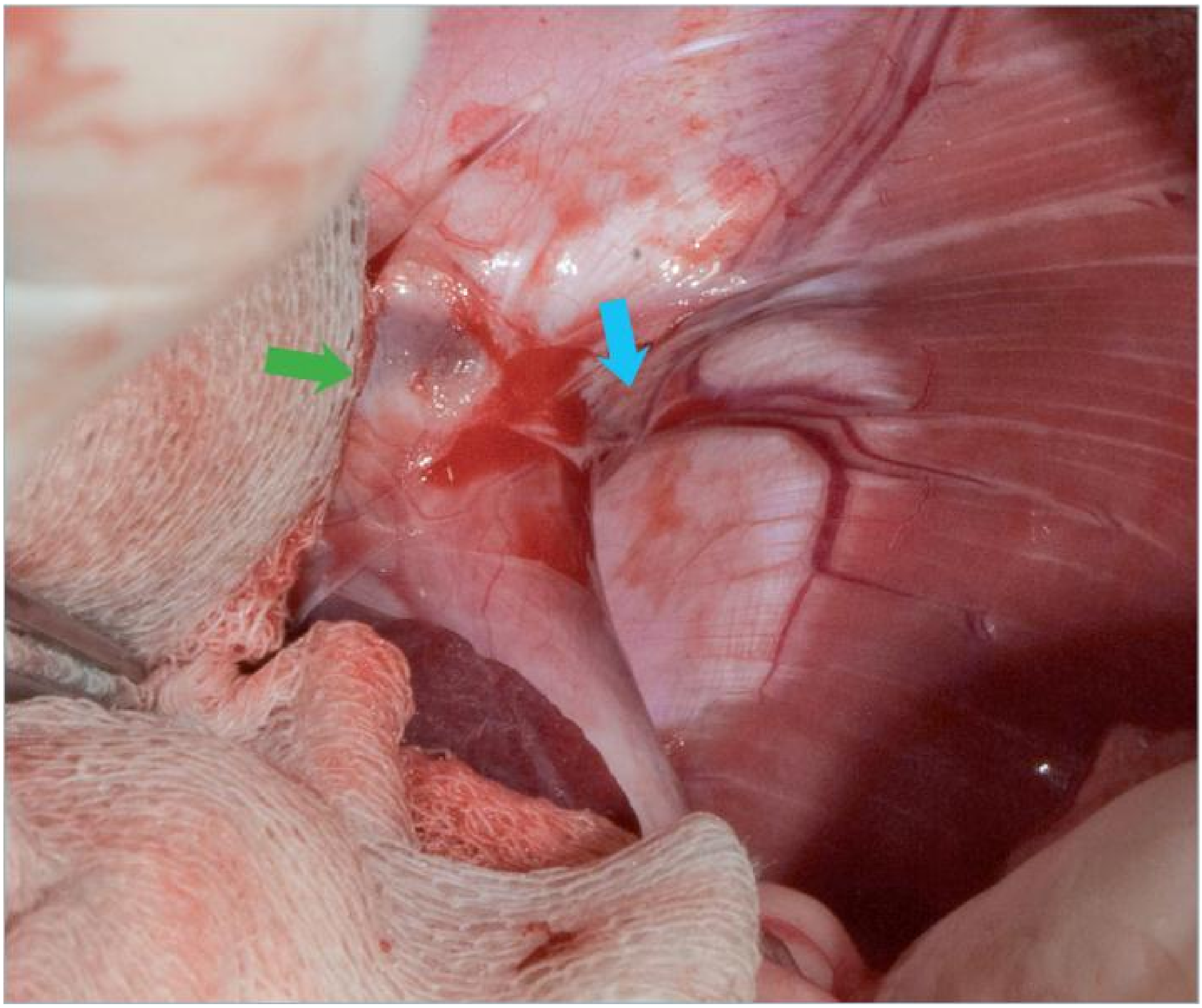

Fig. 10. To visualize the esophageal hiatus (green arrow), the liver lobes should be displaced to the right, immobilized and protected with compresses moistened in saline. The blue arrow indicates the diaphragmatic vessels.

A 6 to 12 mm stomach tube is introduced to facilitate the visualization and manipulation of the abdominal esophagus and stomach (Fig. 11).

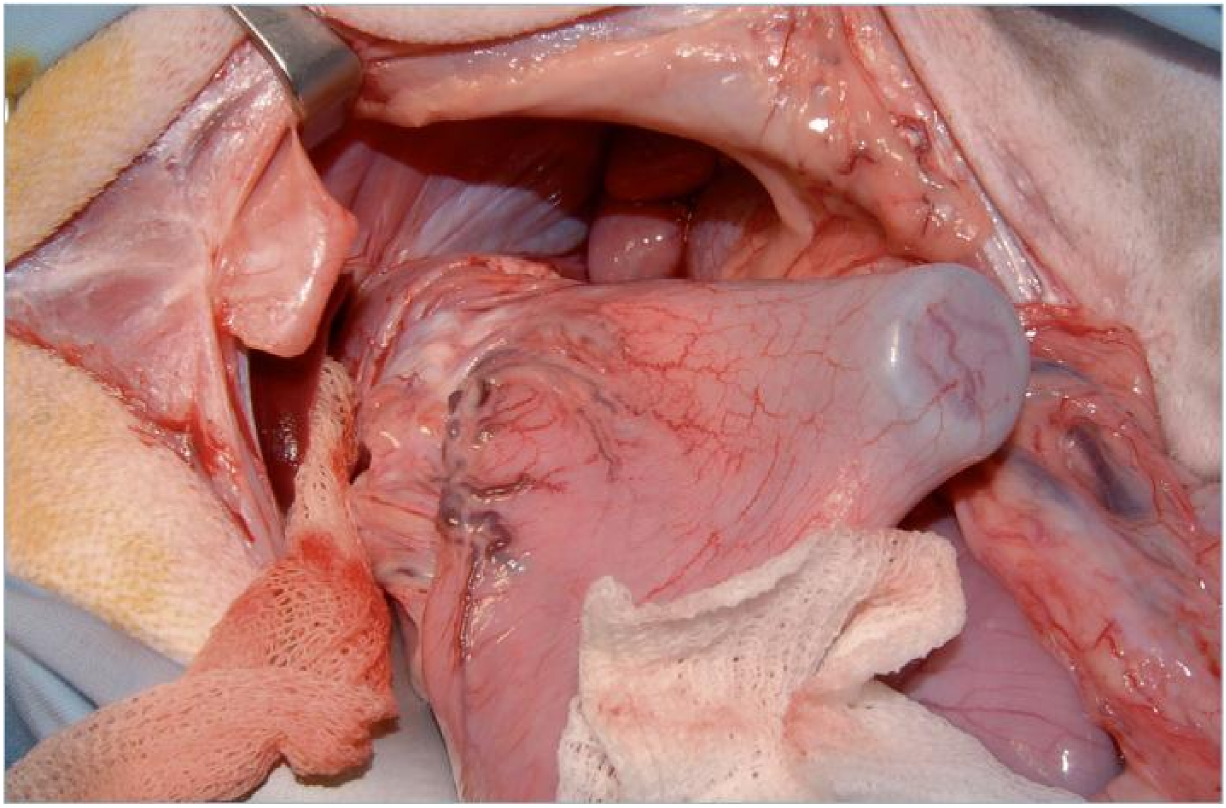

Fig. 11. Placement of a large-bore stomach tube helps to identify and manipulate the esophagus. In this French Bulldog, a 10 mm tube was used.

Reduction of the hiatal plication

Caudal traction is applied to the stomach to visualize and dissect the phreno-esophageal ligament. To assist in the manipulation of the stomach and prevent vascular and nervous injury in the area, a vascular tape or Penrose drain is placed around the abdominal esophagus (Fig. 12).

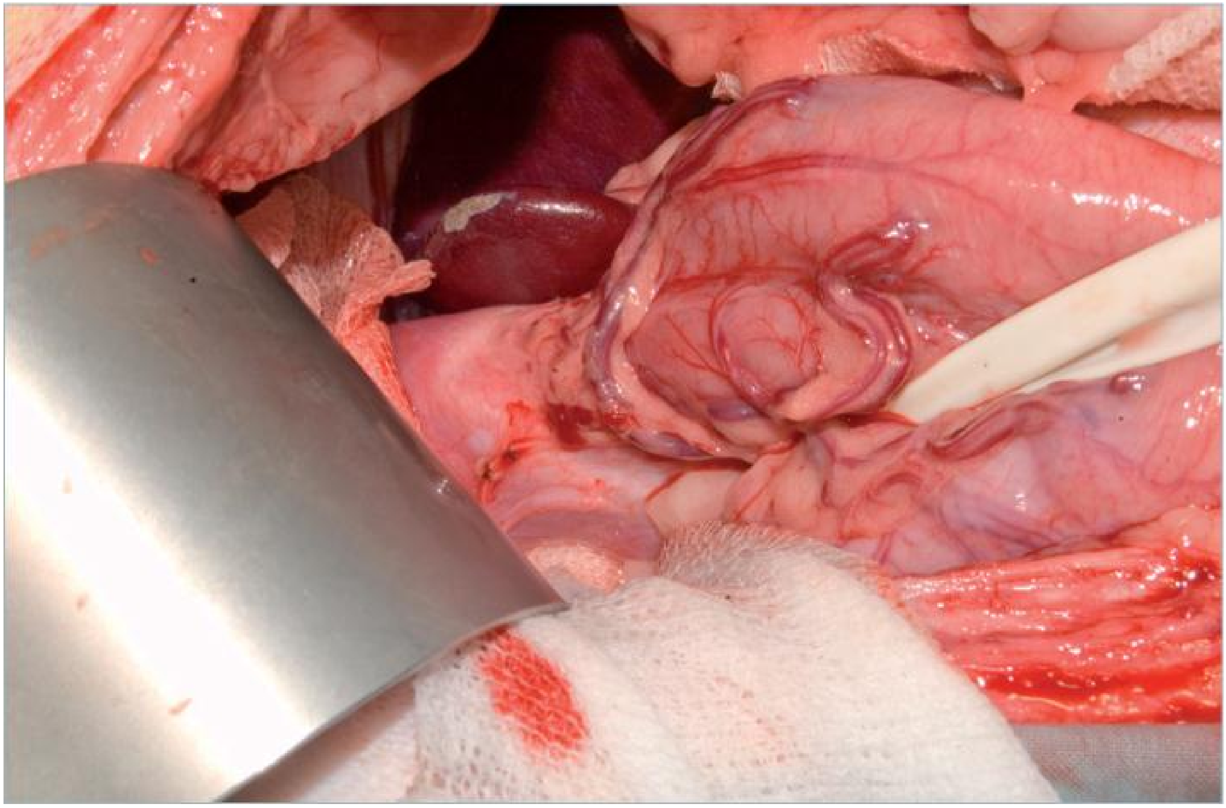

Fig. 12. To prevent vascular and nervous injury to the stomach and assist in its manipulation, a Penrose drain is placed around the abdominal esophagus.
This image shows the start of the dissection and section of the phreno-esophageal ligament.

Next, the ligament that attaches the esophagus to the diaphragm is cut over 180º of its ventral side (which is close to the surgeon); this results in an open thoracic cavity, so intermittent positive pressure should be initiated (Figs. 12 and 13).

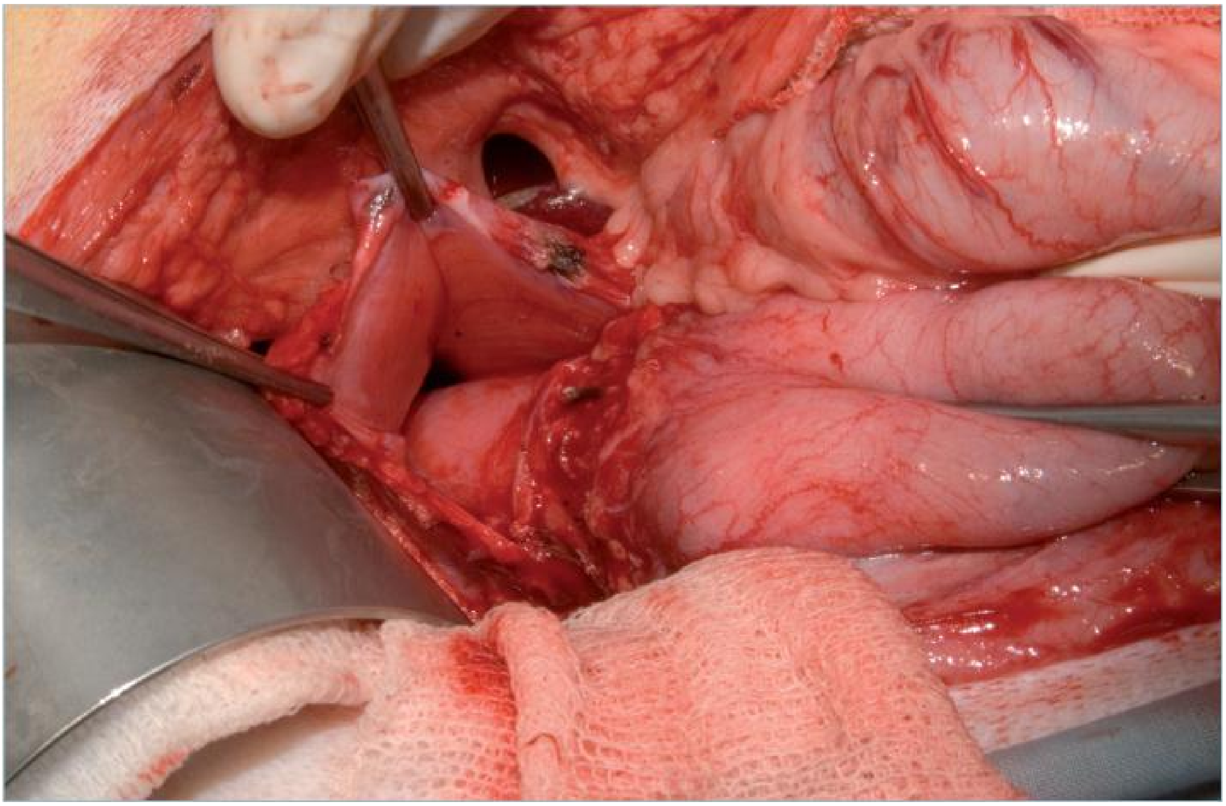

Fig. 13. Section of the phreno-esophageal ligament in the ventral area of the hiatus in order to return the esophagus to its correct position and reduce the esophageal hiatus to its normal size. Note the large size of the hiatus in this patient.

> ***Great care should be taken at this stage so as not to damage the vessels that supply the esophagus or the vagal trunks.***

The stomach is pulled caudally, the esophagus is placed in its dorsal position next to the vertebral column and the hiatus is plicated and reduced.

> ***Special care should be taken not to damage the dorsal and ventral vagal trunks that run along the esophagus.***

By pulling on the stomach, some 2 to 3 centimeters of the thoracic, esophagus enter the abdominal cavity. This increases the external pressure on the distal esophagus and the risk of gastro-esophageal reflux is reduced.

To reduce the size of the hiatus, several sutures are placed. Horizontal mattress sutures are made using a monofilament synthetic absorbable material mounted on an atraumatic cylindrical needle. Great care should be taken not to damage the phrenic vessels, vena cava or vagal trunks (Fig. 14).
The new diameter of the hiatus should be approximately 10 mm in cats and small dogs, and 10-15 mm in medium and large dogs.

The hiatus should be reduced around a stomach tube to avoid constriction.

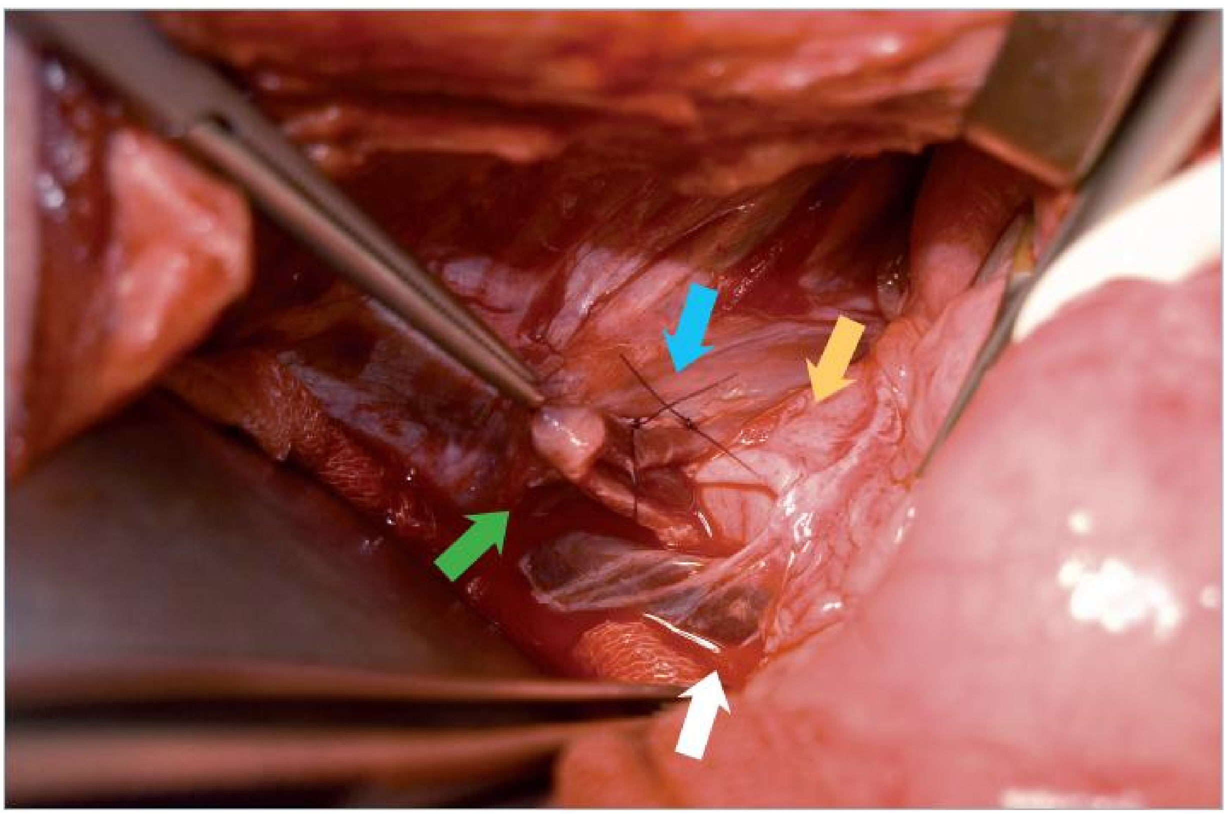

Fig. 14. Closure and plication of the ventral side of the esophageal hiatus (green arrow) with two horizontal mattress sutures in a 3/0 monofilament absorbable material (blue arrow).
Special care should be taken not to damage the vagal nerves that run along the esophagus (yellow arrow) or the vena cava, that may be close (white arrow).

Esophagopexy

Esophagopexy consists of placing several simple interrupted sutures around the esophagus to attach it to the hiatus. These sutures include all layers of the esophagus except the mucosa (Figs. 15 and 16).

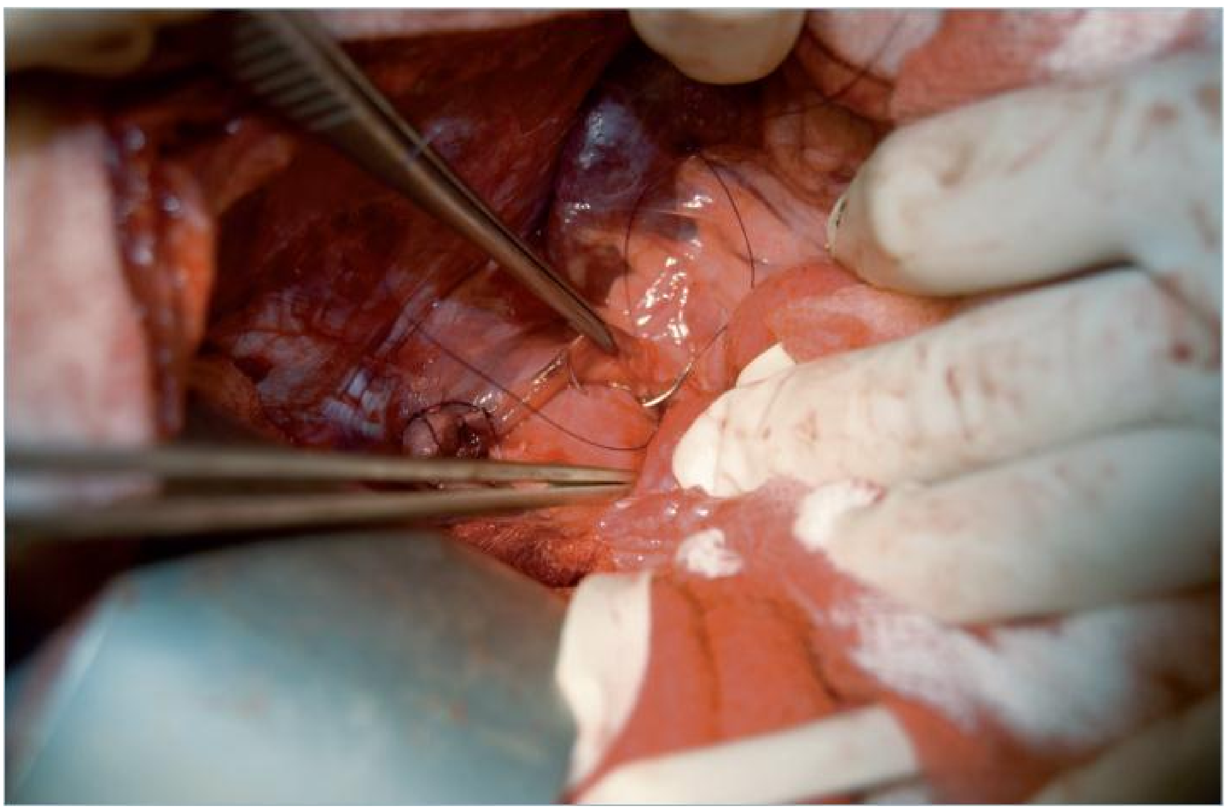

Fig. 15. The esophagus is attached to its hiatus using several simple sutures in the same material as used before. The sutures should not perforate the mucosa, to avoid infection complications.

Fig. 16. Final result of the diaphragmatic surgery. Note the length of the thoracic esophagus, part of which is now located in the abdominal cavity (approximately 8 mm).

Gastropexy

In an incisional gastropexy, the body of the stomach is fixed to the left abdominal wall. This technique impedes cranial movement of the esophagogastric junction, i.e. pressure of the junction on the hiatus and its passage into the thoracic cavity.

Two incisions are made with a scalpel: one in a poorly-vascularized area of the gastric body and the other in the abdominal wall. Next, the two incisions are joined with two continuous sutures in absorbable monofilament material to create a strong and permanent adhesion between the two sites (Figs. 17-19).

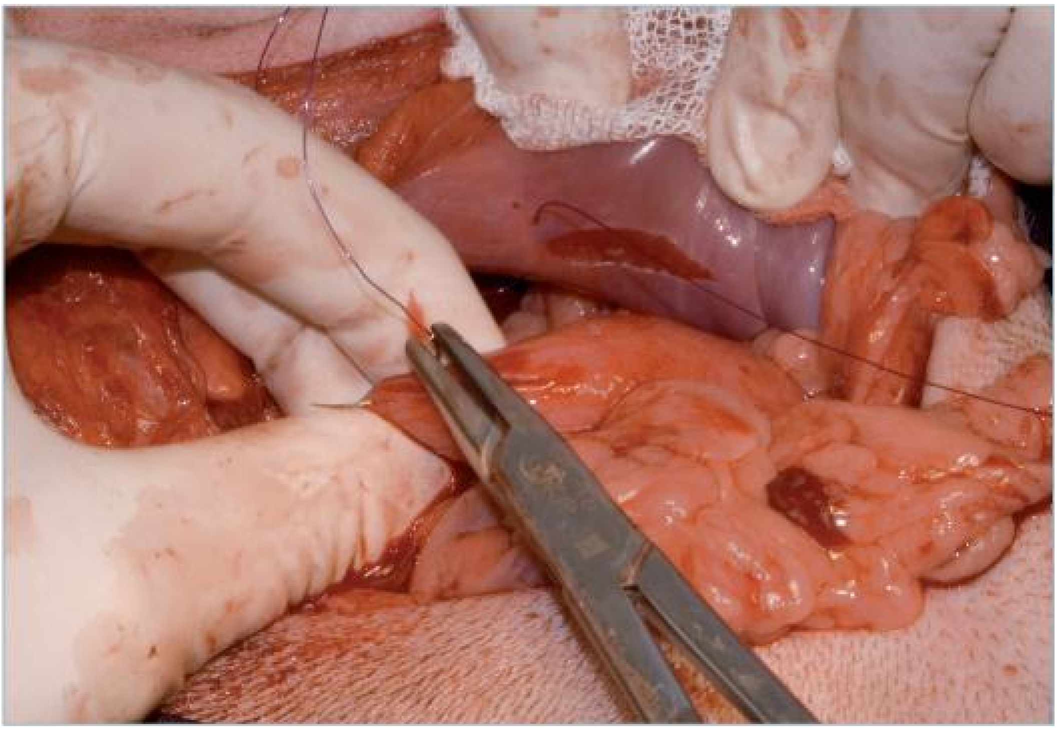

Fig. 17. To produce a strong gastropexy, two scalpel incisions are made: one in the left wall of the abdomen, the other in a little-vascularized cranial area of the gastric body.

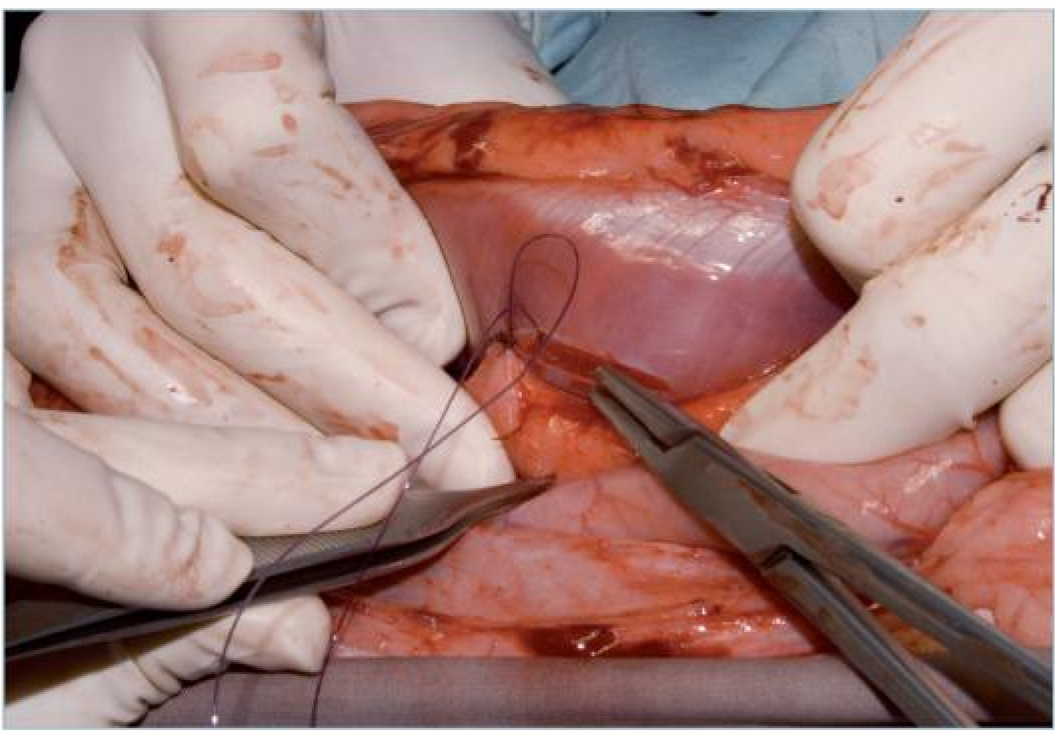

Fig. 18. Both incisions are joined with two continuous sutures in absorbable material. This image shows the suturing of the posterior edges.

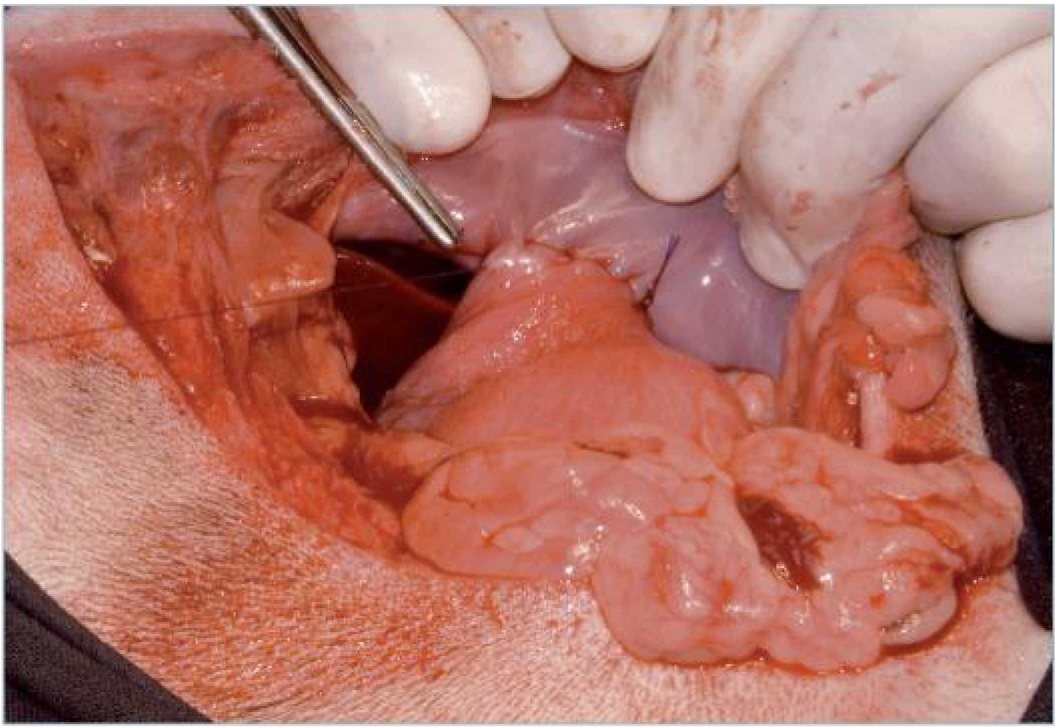

Fig. 19. Final appearance of the gastropexy. This technique stops the stomach from sliding forward, which reduces the pressure on the esophageal hiatus.

The gastropexy may also be performed around a feeding tube, which is used to administer food and water to the patient in case of severe esophagitis.

To finish the procedure

Air is extracted from the pleural space by forcing a sustained inspiration (pulmonary insufflation should not exceed 10-20 cm H_2O) while the last suture of the hiatal reduction or esophagopexy is tied, or using thoracocentesis.
The abdominal cavity is flushed and the sutures are checked for leaks (Fig. 20). The abdomen is closed in the standard manner.

See gastropexy in the book "The cranial abdomen".

https://player.vimeo.com/video/180708278

Watch this video

Hiatal hernia

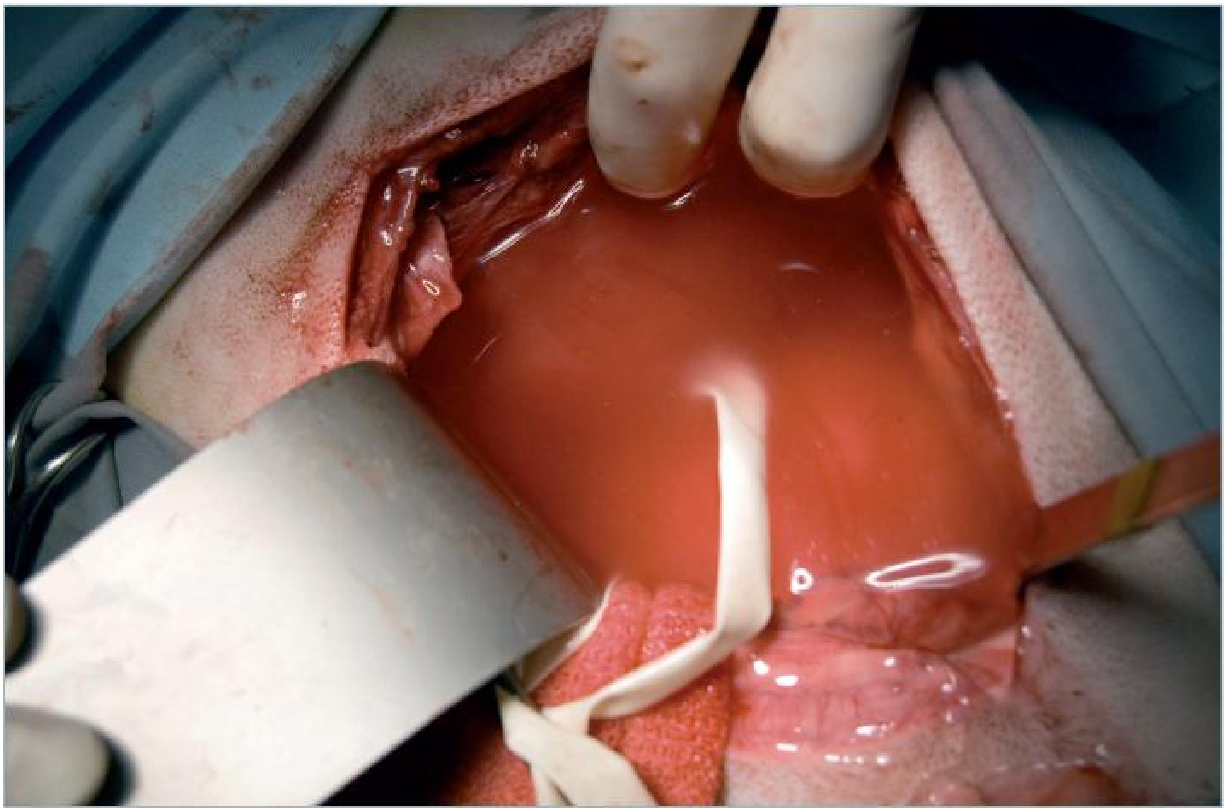

Fig. 20. To confirm that there are no leaks in the diaphragmatic sutures, the area is filled with lukewarm sterile saline and checked for bubbles when the patient inhales.

After surgery

These patients should be monitored during the postoperative period to detect dyspnea caused by pneumothorax; each case should be assessed to

see if thoracocentesis is required or if the air can be absorbed spontaneously.
Esophagitis treatment (antacids, H_2 receptor blockers, metoclopramide) should be continued for at least four weeks, as should the treatment for aspiration pneumonia, if present.

Some patients may continue to regurgitate after surgery, due to the existing unresolved esophagitis.

The diet should be low in fat, slightly mushy, and it should be fed in small frequent meals, placing the feeding bowl in a raised position if the patient suffers from esophageal distension.

Complications

The most common complication is esophageal stenosis, which produces dysphagia and regurgitation. The possible causes are secondary stenosis due to a poorly treated esophagitis, an excessive reduction of the esophageal hiatus or local infection if all layers of the esophagus have been penetrated (Fig. 21). To avoid these complications, it is advisable to use a large-bore stomach tube to mark the esophagus and not to penetrate the mucosa when the sutures are placed.

Complications arise when the esophageal hiatus cannot be visualized properly and when the sutures are not placed meticulously; this predisposes to recurrence of the problem or to strangulation of the esophagus.

Prognosis

In patients that respond well to the medical treatment, the prognosis is good and a surgical intervention is not required. However, patients that continue

to present with clinical symptoms and do not undergo surgery may develop esophagitis due to gastric reflux and significant stenosis.
Patients that have undergone a surgical intervention using the aforementioned techniques and precautions have a favorable prognosis.

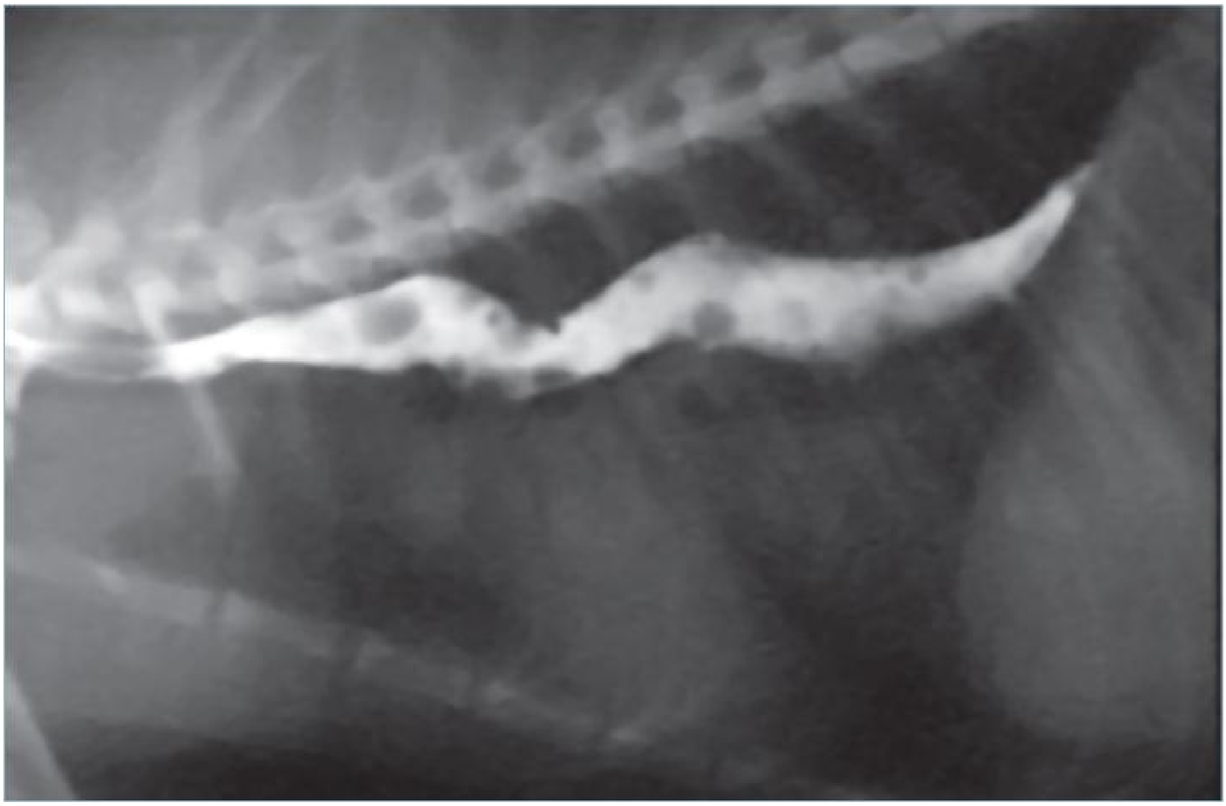

Fig. 21. Secondary esophageal dilation due to stenosis of the hiatus. This is an iatrogenic complication caused by an excessive reduction of the hiatus.

Megaesophagus

José Rodríguez, Patricio Torres

Prevalence	■	■	■		
Technical difficulty	■	■	■		

General considerations

At the moment of swallowing, the neurons in the nucleus of the solitary tract generate a nervous impulse that closes the glottis, relaxes the muscles of the upper esophagus and activates the “primary” peristaltic contraction that helps a food bolus progress down the esophagus. The distension of the esophagus by the presence of food generates a wave of “secondary” peristaltic contractions that ensures transit towards the gastro-esophageal sphincter.

The gastro-esophageal or cardiac sphincter is a functional sphincter rather than an anatomical one. The main objective of this high-pressure sphincter is to avoid gastro-esophageal reflux, since the esophageal mucosa lacks protection against gastric secretions. Regulation of the sphincter is mainly vagal, but its tone may be modified by hormones such as gastrin, the pH of the stomach, the type of food (the tone is decreased by fat and increased by protein) or many of anesthetic drugs.

Esophageal dilation may occur due to a stenosis that causes food retention and accumulation cranial to the obstruction and that normally affects only part of the esophagus. But it may also be due to a generalized muscular disorder along the full length of the esophagus, which is the subject of this chapter.

Megaesophagus is marked distension of the esophagus with insufficient muscular contractions to move the food bolus down the esophagus.

In all types of megaesophagus, there is an accumulation of food, liquid and air in the esophageal lumen that aggravates the passive dilation. The stasis of the food furthermore leads to fermentation of nutrients, producing inflammation of the wall (esophagitis), which, in turn, worsens the dilation and local circulation (ischemia).

Chronic dilation and inflammation form a vicious cycle that leads to progressive denervation due to compression of the submucosal and myenteric plexi. This explains the progressive deterioration of the affected esophagus, with signs that may range from a reduced amplitude of peristaltic contractions, minimal or no motor response to the stimulus generated by swallowing food, to complete paralysis of the esophagus.

Clinical signs

Patients have trouble moving food down the esophagus and present with frequent regurgitation.

The “cardinal” sign of megaesophagus is regurgitation.

Patients are usually in a poor nutritional state, or even cachectic if suffering from the congenital form. If there is no severe respiratory infection, they have a voracious appetite and often eat regurgitated food (Fig. 1).

Other common signs are fever, depression, cough and mucopurulent nasal discharge as a consequence of aspiration pneumonia, which is present in 60 % of patients (Fig. 2).

Fig. 1. Patients usually present with weight loss, dehydration, retarded growth in the case of pups, as well as listlessness or severe depression in the presence of respiratory infection, as is the case in the dog in this photograph.

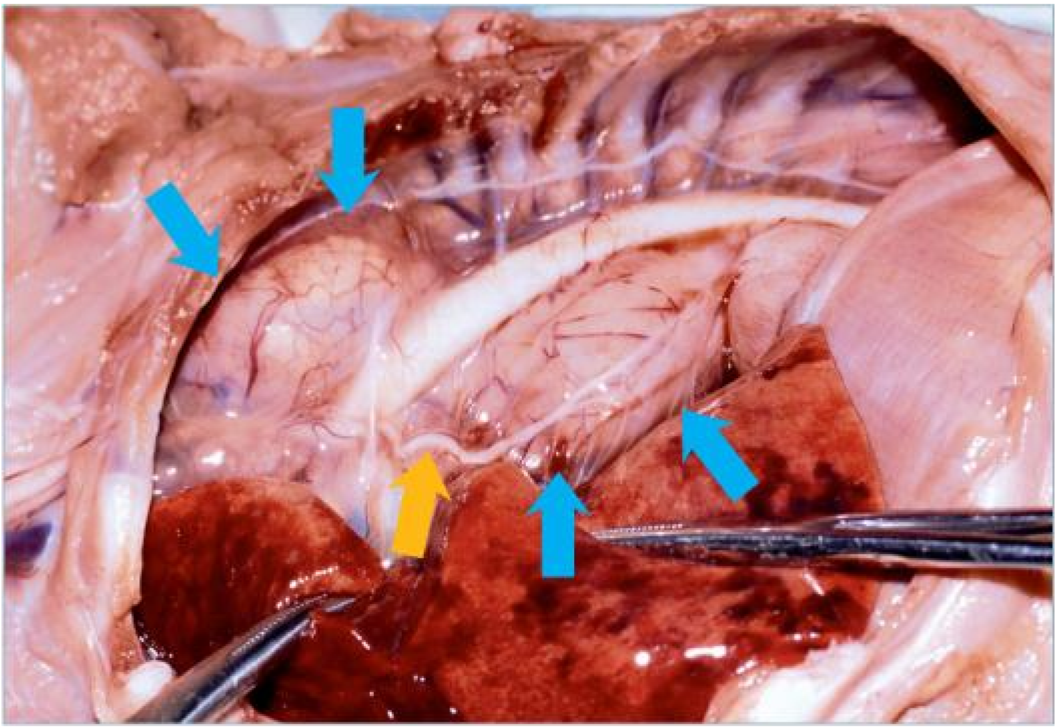

Fig. 2. Aspiration pneumonia is very common in animals with megaesophagus. This necropsy image shows generalized distension of the esophagus (blue arrows). The yellow arrow indicates the vagus nerve and there are foci of pneumonia distributed throughout the pulmonary parenchyma.

It is also possible to detect dilation and hydroaeric sounds in the neck and thorax region; the sounds are synchronous with the respiration and are caused by the accumulation of air and liquid in the dilated esophagus.

Diagnosis

A tentative diagnosis is based on the case history, a detailed clinical examination and a clear distinction between regurgitation and vomiting. The diagnosis is confirmed by radiography.

Regurgitation should never be mistaken for vomiting.

A plain thoracic radiograph shows retention of air and food in the lumen of the esophagus, which is distended and displaces neighboring structures (Fig. 3). Contrast radiography is used to enhance visualization of the degree and extent of the esophageal dilation (Fig. 4).

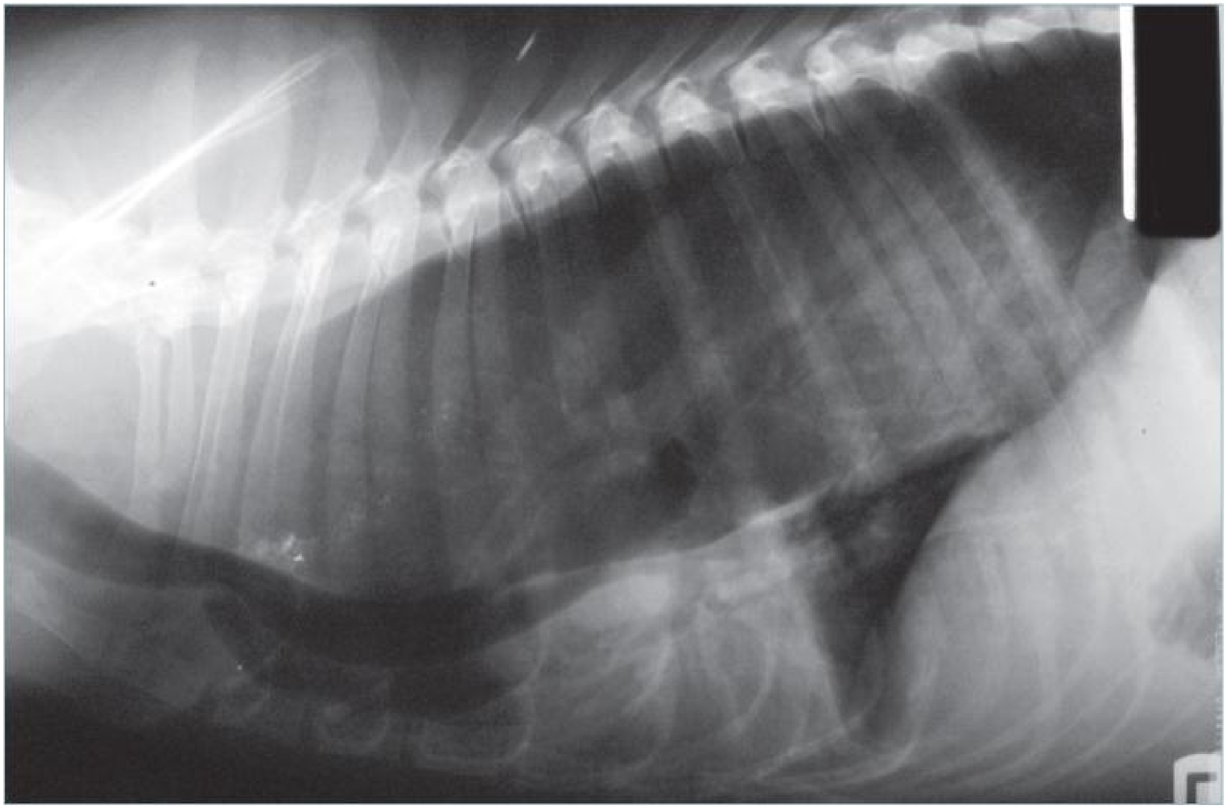

Fig. 3. Very advanced megaesophagus in an adult dog. Apart from the marked esophageal dilation, this radiograph shows ventral displacement of the trachea and heart and a severe bronchopneumonia.

Fig. 4. Using a radiopaque contrast medium, the shape of the esophagus is better defined, and the extent of the problem as well as the degree of distension can be visualized. This case corresponds to a congenital megaesophagus in a puppy.

In a good contrast radiograph, the contrast medium should be distributed along the full length of the esophagus to avoid any diagnostic error (Fig. 5); this can be achieved by lifting the animal up by its forelegs after barium administration.

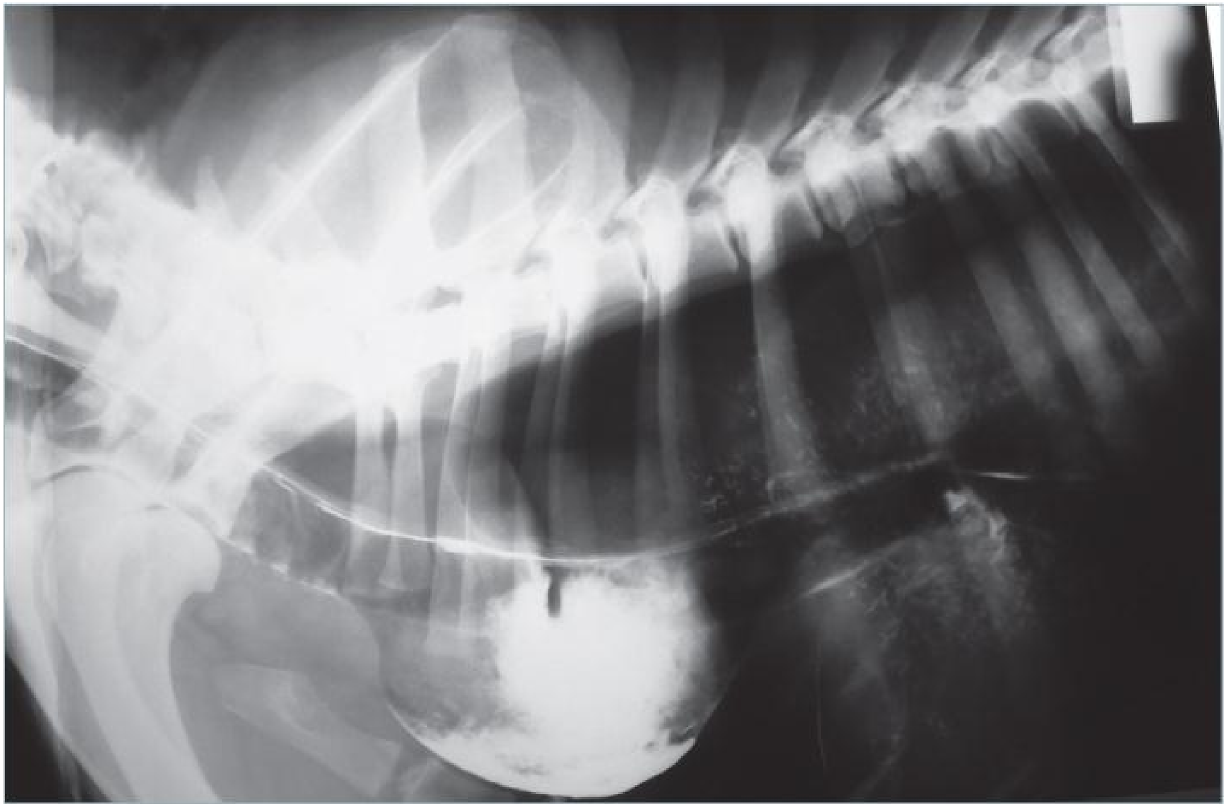

Fig. 5. If there is significant pre-cardiac dilation of the esophagus, the contrast medium tends to stay in that area and does not continue into the lower section; in this case, the radiographic image will be very similar to that of cranial esophageal dilation due to a persistent right aortic arch.

Congenital megaesophagus

The origin of congenital megaesophagus is unknown and it should not be compared with achalasia in humans. In dogs, the amplitude of the contractions after the swallowing stimulus is reduced or contractions are entirely absent, which means that there is paresis or complete paralysis of the esophagus, whereas the tone of the gastro-esophageal sphincter is normal.

A possible hypothesis is the immaturity of the nucleus of the solitary tract and the nucleus ambiguus, which are the control centers for esophageal motor function in the central nervous system. This hypothesis is supported by the fact that in some puppies esophageal function normalizes after the first six months of life. But it has also been postulated that the cause may lie in the immaturity or degeneration of the myenteric plexi in the esophageal wall.

The etiology of congenital megaesophagus is unknown.

Medical and dietary treatment

This treatment is based on the observation that some patients improve spontaneously with age.

Dietary treatment consists of feeding the dog with a semi-liquid food, divided into six to eight daily meals, and keeping it in an upright position for at least 15 to 20 minutes after feeding (Fig. 6).

Treatment with parasympathomimetic drugs such as bethanechol or neostigmine may increase the amplitude of the esophageal contractions, with partial clinical improvement.

Broad-spectrum antibiotics are indicated for the treatment of aspiration pneumonia.

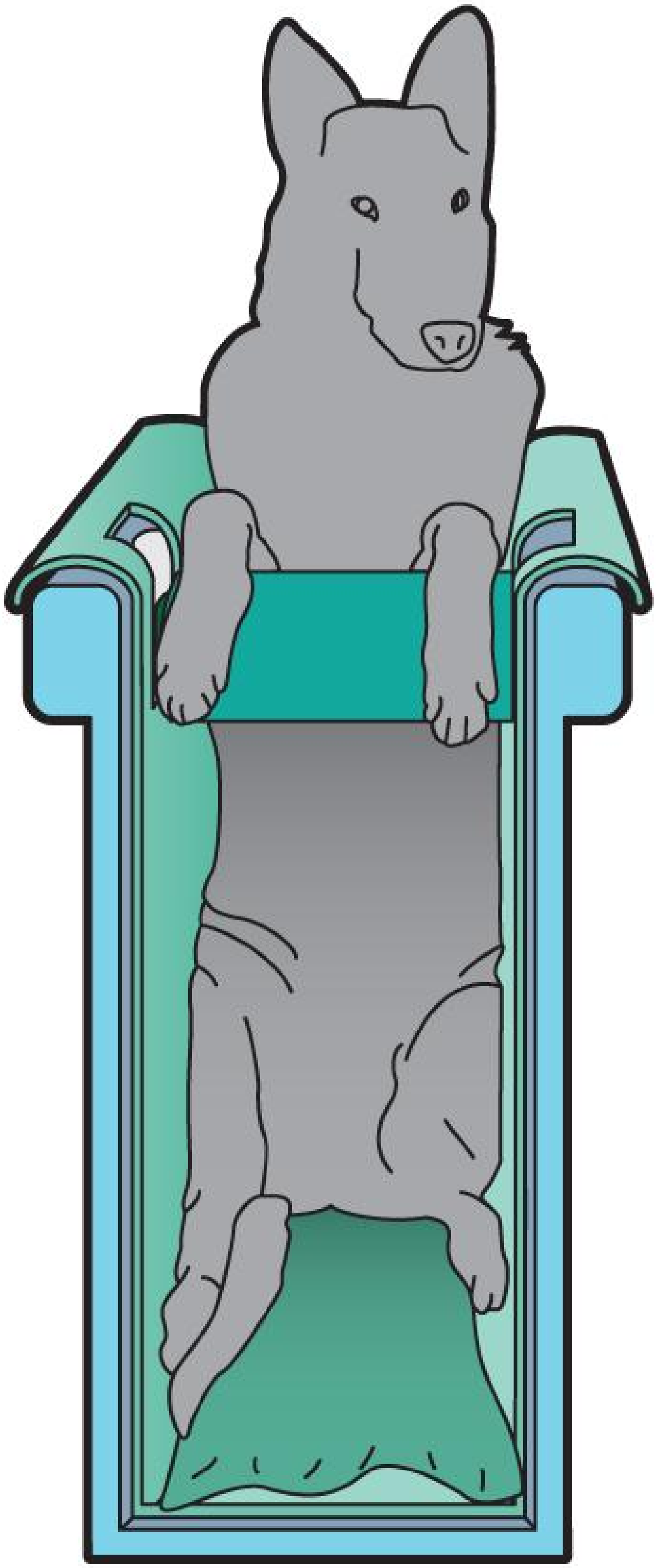

Fig. 6A. These patients should eat in an upright position. The Bailey Chair is a good system to keep the patient in this position while the food passes down the esophagus.

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Watch this video

Idiopathic megaesophagus (esophagus-diaphragmatic cardioplasty)

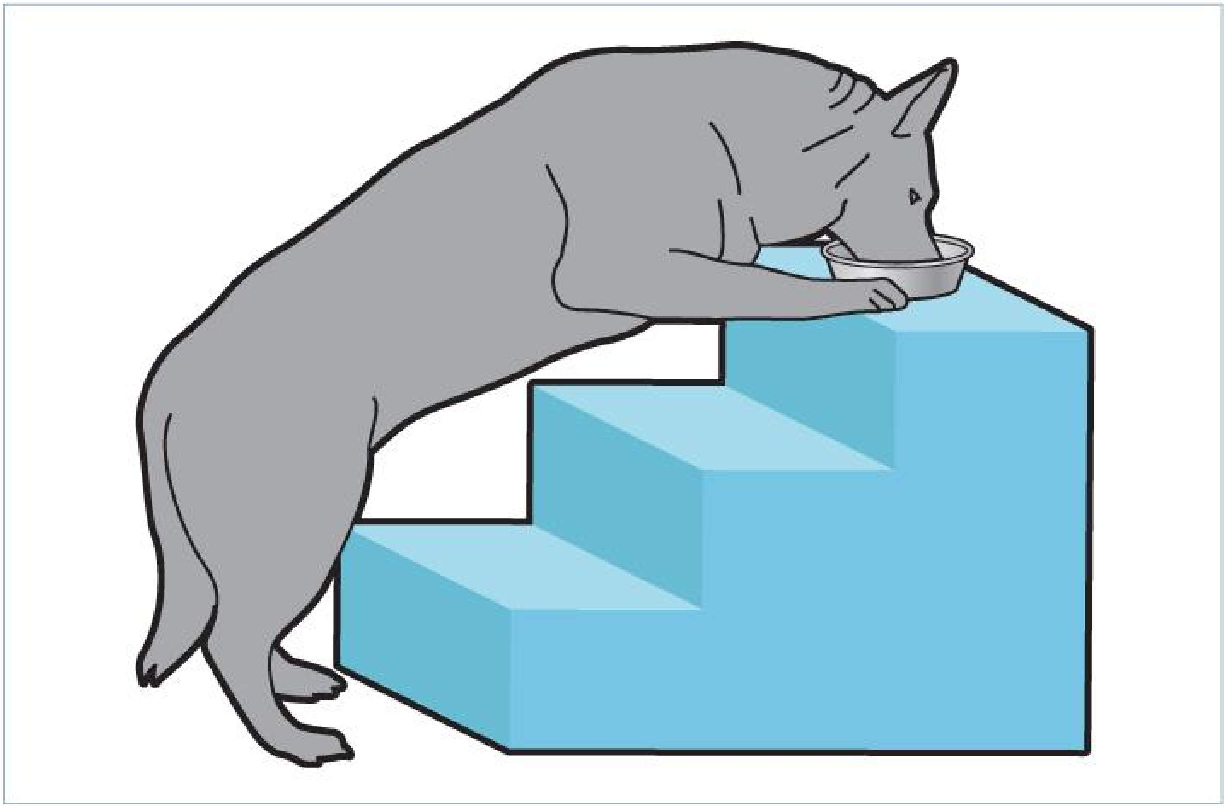

Fig. 6B. Feeding the dog with the forequarters in an elevated position, as shown here, will help to empty the esophagus.

Surgical treatment

The modified Heller esophagomyotomy, used in human achalasia, does not give good results in veterinary medicine, because continuing gastro-esophageal reflux and peptic esophagitis are very common after surgery.

The surgery described by Torres, esophagus-diaphragmatic cardioplasty, is the technique that gives the best results in this disorder.

Table I.

Most common systemic diseases that may include megaesophagus as a symptom	
Myasthenia gravis	
Immunological disorders	Disseminated lupus erythematosus Polymyositis Polyneuritis
Degenerative neuropathy	
Hormonal disturbances	Hypoadrenocorticism Hypothyroidism
Nutritional imbalances	Thiamine deficiency
Chronic heavy metal intoxication	Lead Thallium
Diseases of the central nervous system	Cranioencephalic trauma Distemper Cervical instability Cervical polyradiculoneuritis

Acquired megaesophagus

The origin of acquired megaesophagus in adult animals without any history of esophageal problems is unknown, as in puppies. The signs may appear suddenly after a severe episode of stress (road traffic accident, head trauma, etc.).

It may also be secondary to systemic illness (table I). The most common disease in dogs is myasthenia gravis. This is characterized by a deficiency of the acetylcholine receptors at the neuromuscular end-plate due to marked destruction of the receptors, resulting in the absence of muscle contraction.

> ***The main complication in patients with megaesophagus is aspiration pneumonia.***

The clinical signs are typical for megaesophagus and approximately 75 % of patients present with associated bronchitis or chronic pneumonia.

Treatment

In these patients, the origin of the problem should be treated first. The esophageal disorder should be addressed next, following the dietary recommendations that have been described earlier, and the respiratory disease should be brought under control.

Case / Megaesophagus

José Rodríguez, Patricio Torres, Amaya de Torre

Prevalence	■■■□□
Technical difficulty	■■■□□

Pepito is a male, 4-month-old German Shepherd pup. He was presented to the vet because he was smaller than his littermates, although he had been the largest pup in the litter at birth, and had been "vomiting" frequently for several weeks (Fig. 1).

In the clinical history, it appeared that the problem had started at weaning. When eating solid food, the pup regurgitated without previous retching. Usually, he would eat his "vomit" again. Liquids were well tolerated and not regurgitated.

Pepito walked, stopped, lowered his head and regurgitated. Sometimes he also regurgitated “white foam”.

A clinical history helps to differentiate vomiting from regurgitation.

Upon clinical examination, no significant abnormalities were found. Urinary and fecal findings were normal and the only alteration found in the hematology was leukocytosis: 22 x 10^9/L (5.5-16.9) and neutrophilia 16.2 x 10^9/L (3.0-12.0).
Radiographic examination showed a generalized dilation of the esophagus and a moderate bronchitis in the middle lung area (Figs. 2-4).

Fig. 1. Pepito on the day of presentation.

Fig. 2. Note the esophageal dilation and ventral displacement of the trachea in the cervical area.

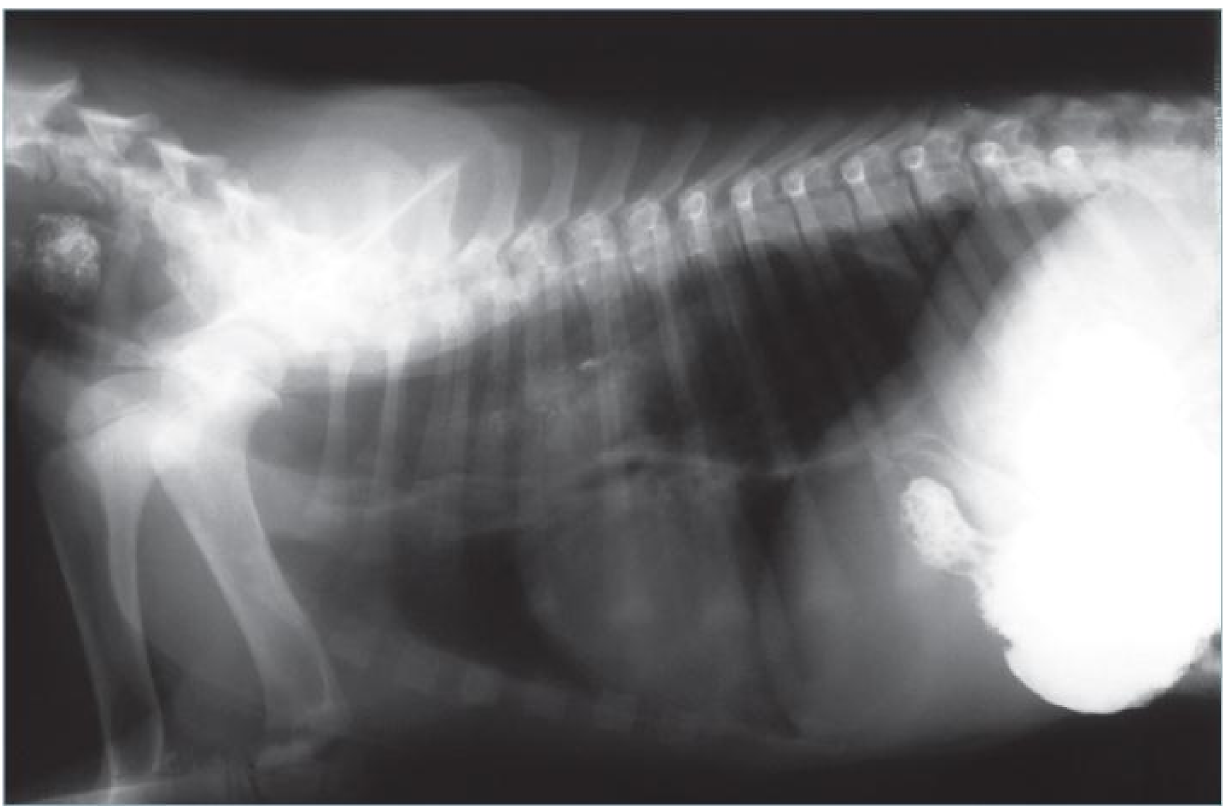

Fig. 3. A barium contrast radiograph shows that the esophagus is distended along its entire length. Note the rapid passage of the contrast medium into the stomach.

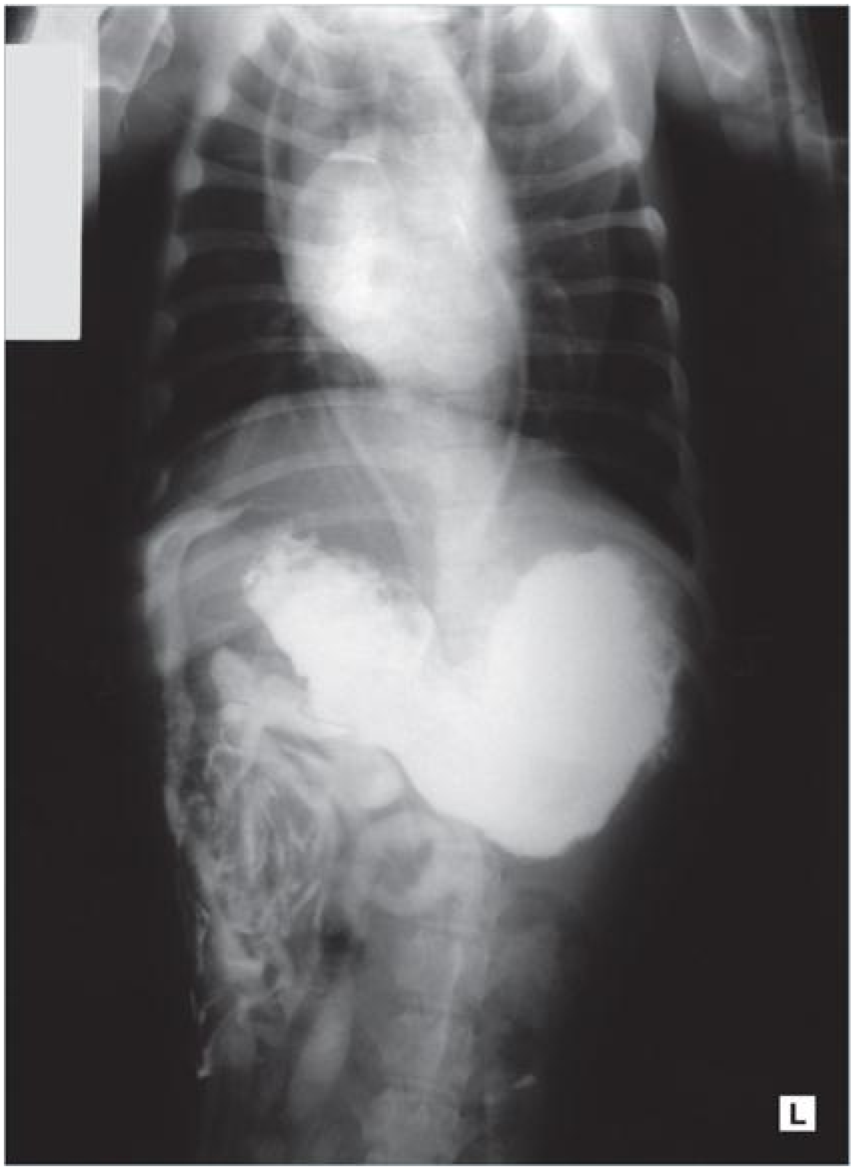

Fig. 4. A ventrodorsal radiograph offers a view of the esophageal dilation on both sides. The gastro-esophageal junction, one of the anatomical structures involved in the surgical procedure, can also be observed.

After treatment of the lung infection, the esophagus-diaphragmatic cardioplasty described in the previous section was performed (Figs. 5-11).

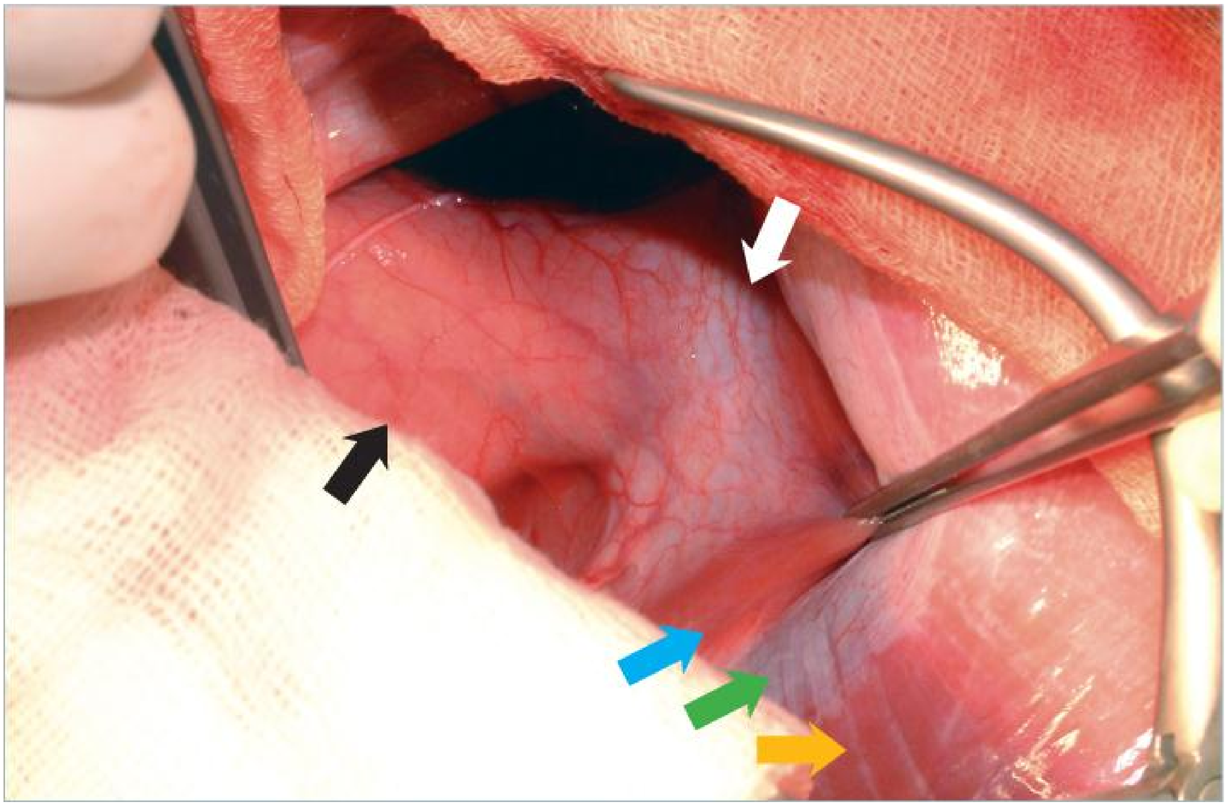

Fig. 5. Image of the esophageal hiatus after a thoracotomy through the left eighth intercostal space. Distended esophagus (black arrow). Phrenico-esophageal ligament (white arrow). Muscular part of the esophageal hiatus (blue arrow). Tendinous part of the diaphragm (green arrow). Peripheral muscular part of the diaphragm (yellow arrow).

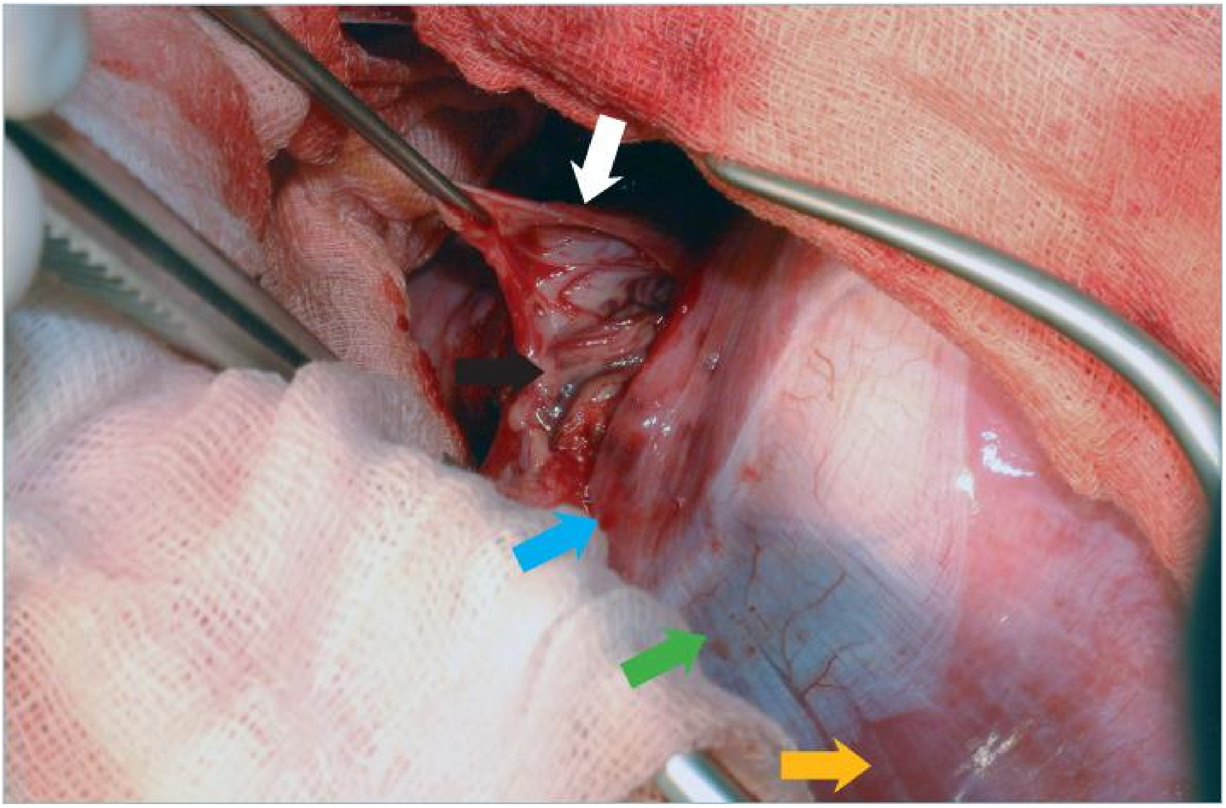

Fig. 6. Cutting the phrenico-esophageal ligament (white arrow) allowed mobilization of the esophagus and visualization of the stomach and its blood supply (black arrow). The muscular part of the esophageal hiatus (blue arrow) and a large part of the tendinous part of the diaphragm (green arrow) will be resected next. Peripheral muscular part of the diaphragm (yellow arrow).

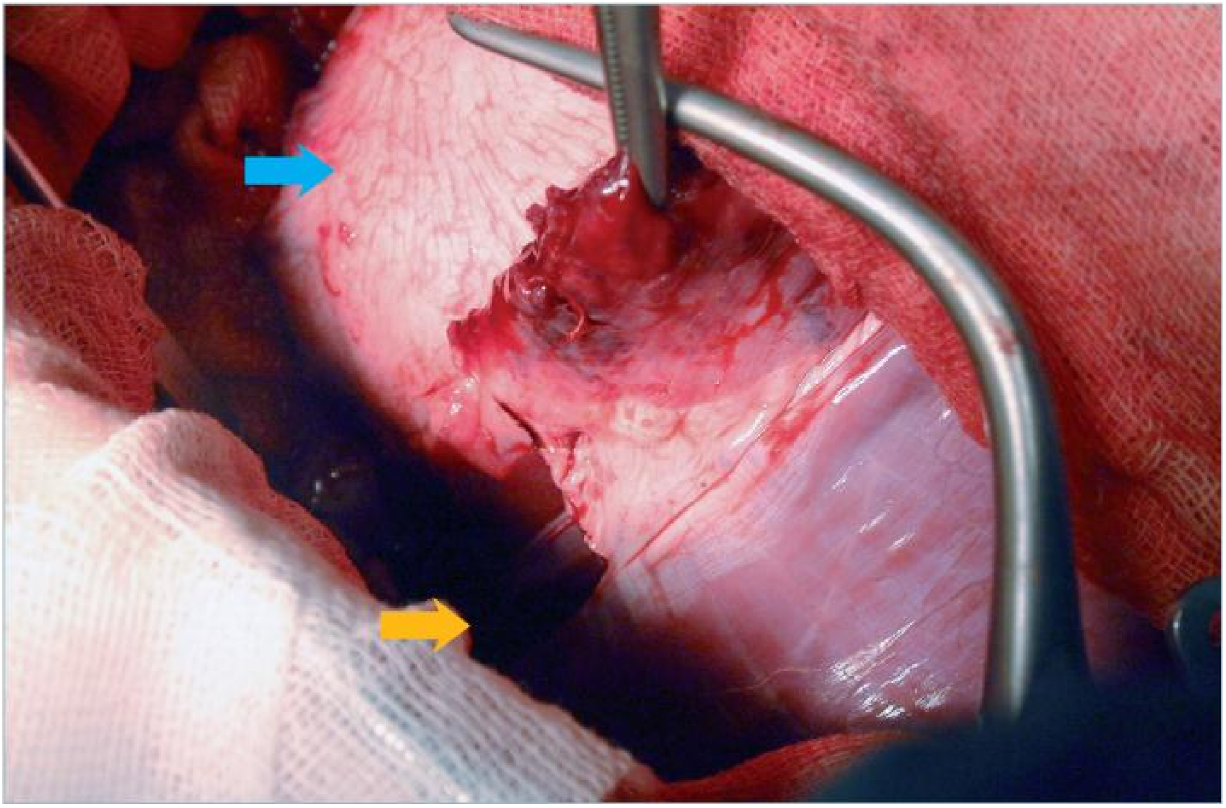

Fig. 7. By making a radial cut in the ventral and dorsal (yellow arrow) borders of the diaphragm, the esophageal hiatus was made much bigger, and the stomach herniated through it (blue arrow). Next, the left muscular area of the hiatus and a semicircular area of the tendinous part of the diaphragm were resected. Bleeding vessels were coagulated with bipolar forceps.

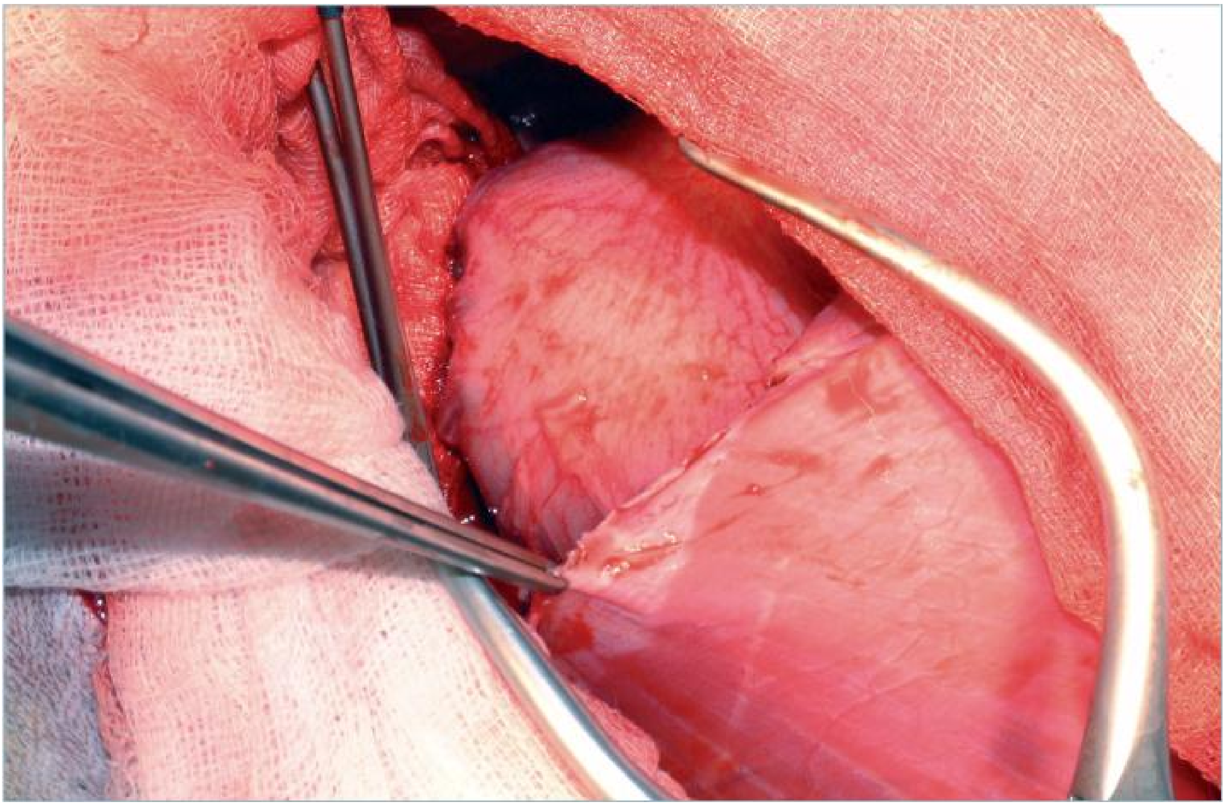

Fig. 8. Final appearance of the diaphragm after resection. In this case, the gaseous distension of the stomach hampered visualization of the esophagus. To solve this problem, the anesthetist introduced a tube in the stomach and aspirated the contents.

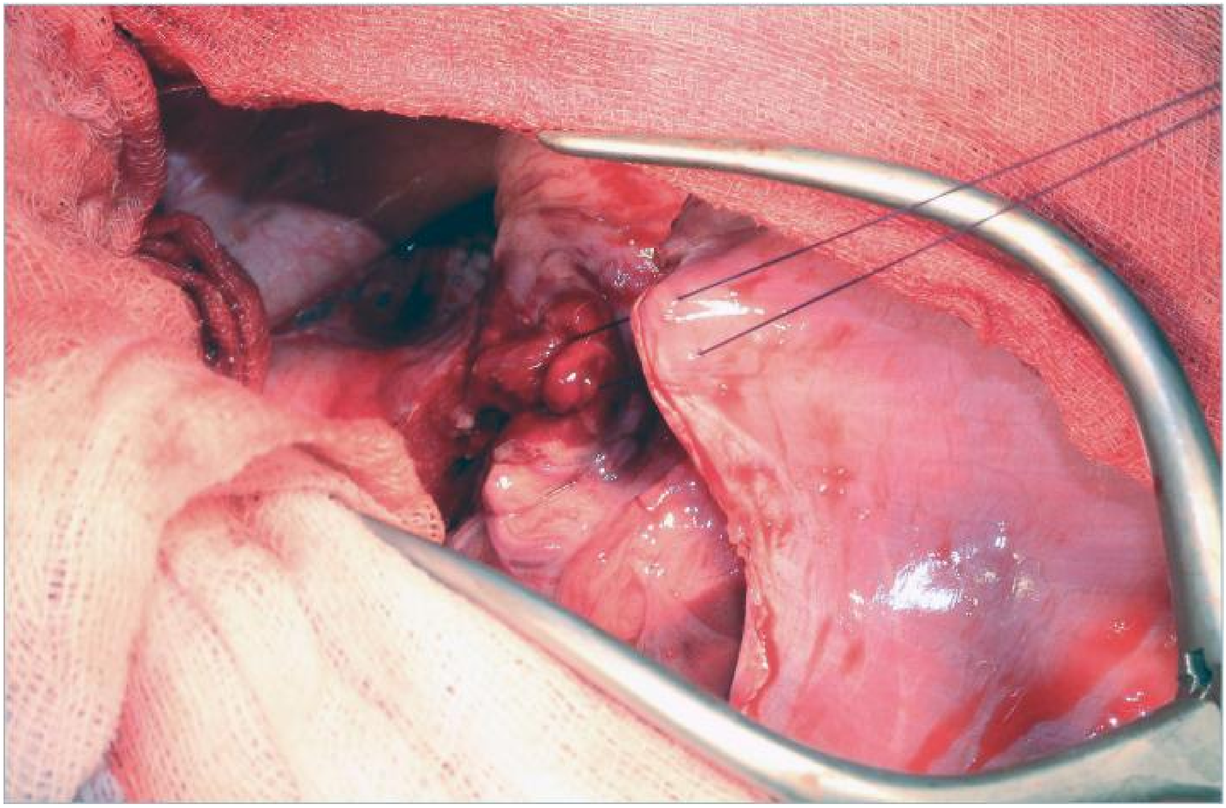

Fig. 9. The diaphragmatic defect was sutured to the gastro-esophageal junction with horizontal mattress sutures using 2/0 non-absorbable synthetic monofilament material.

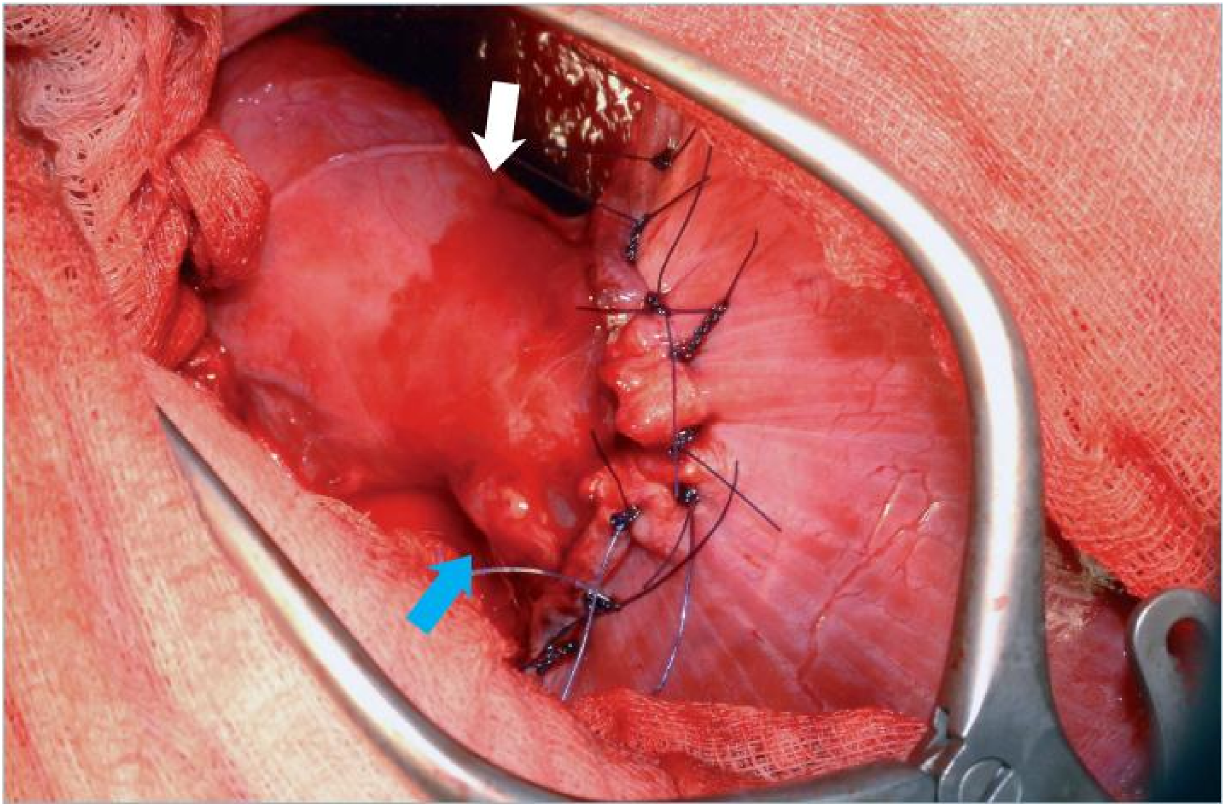

Fig. 10. Final appearance of the reconstructed diaphragmatic defect. The abdominal esophagus is now located in the thoracic cavity (blue arrow) and the diaphragm has been sutured to the cardia. The white arrow indicates the former esophageal-diaphragmatic junction.

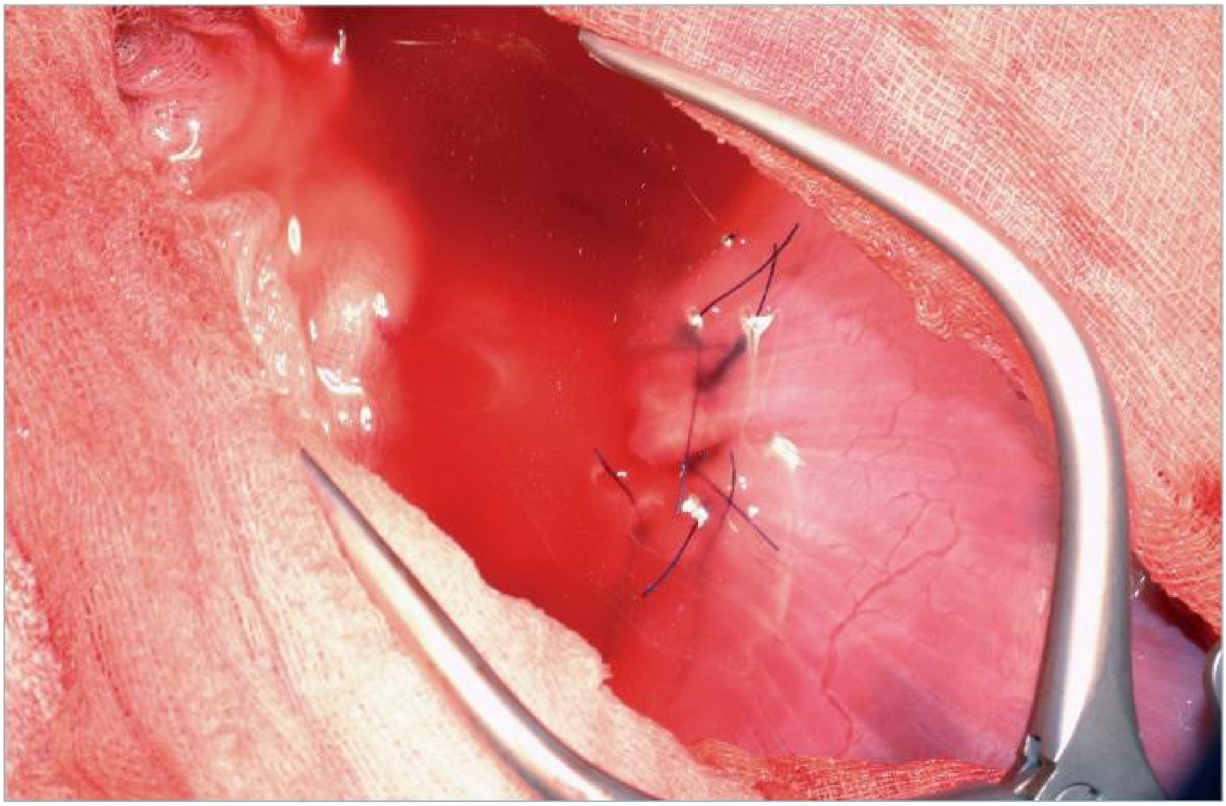

Fig. 11. The suture is checked for leaks by pouring lukewarm sterile saline into the caudal thorax and checking that there are no bubbles when the abdomen is compressed.

After surgery

Pepito recovered satisfactorily. After 24 hours, the chest drain was removed and the dog started to ingest a liquid recovery diet, fed in small portions several times a day. The food bowl was always raised to ease the passage of food down the esophagus (Fig. 12).

Fig. 12. In this image, taken two days after surgery, Pepito is waiting for one of his meals.

The patient progressed satisfactorily and was sent home after three days to continue the feeding protocol described in the previous section.

After six months, Pepito came back for re-evaluation. During this time, he had regurgitated sporadically and always related to situations of hyperactivity or nervousness. There had been no respiratory problems and he had grown normally (Fig. 13).

Fig. 13. Six months after surgery, the patient was almost completely recovered; he was leading a normal life, except for his feeding regime.

On the radiographic image, some improvement in the esophageal dilation was observed when compared with the preoperative X-rays (Figs. 3 and 14).

Pepito continues to eat dry food moistened with water to make it softer, divided into three daily meals. His feeding bowl is placed on a platform to elevate his forequarters during feeding.

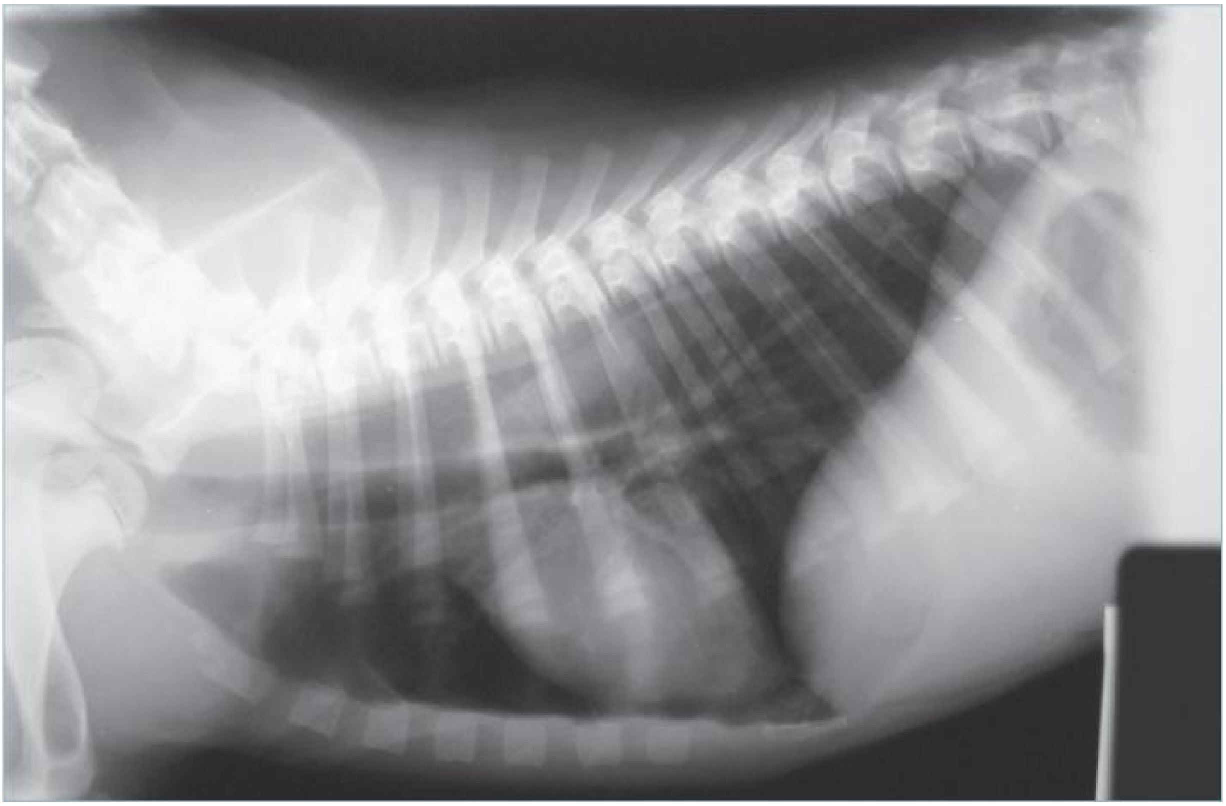

Fig. 14. The radiographic study at six months after surgery. There is still esophageal distension, but less than there was before surgery.

Adrenal gland surgery. Adrenalectomy

José Rodríguez, Amaya de Torre, Carolina Serrano, Cristina Bonastre, Ángel Ortillés

Prevalence	■	■			
Technical difficulty	■	■	■	■	

Adrenalectomy

The surgical resection of the adrenal glands is not simple, especially on the right side due to its close connection with the vena cava. There is a high risk of hemorrhage and tromboembolism. This type of surgery should only be performed by an experienced surgical team.

The indications for adrenalectomy are:

- *Hyperadrenocorticism secondary to neoplasms in the adrenal cortex (adenoma or carcinoma).*
- *Neoplasms of the adrenal medulla, such as pheochromocytoma.*

Neoplasms of the adrenal glands

Table I provides a summary of the clinical signs associated with each of these tumor types.

Before, during and after surgery on adrenal neoplasms, different parameters must be quantified and controlled:

- In adrenal cortical neoplasms:
  - Hypoglycemia.
  - Hypokalemia.
  - Hemorrhage.
  - Thromboembolism.
  - Postoperative replacement of mineralocorticoids and glucocorticoides.
- In medular neoplasms:
  - Cardia arrhythmias.
  - Systemic hypertension.

In order to reduce the risk of thromboembolism, intraoperative IV administration of heparin at a dose of 35-100 UI/kg should be considered. Postoperatively it should be administered subcutaneously every 12 hours at a dose of 35 UI/kg. It is also recommended that the patient starts taking moderate exercise as soon as possible (short walks on a lead).

Table I.

Clinical signs associated with neoplasms of the adrenal glands	
Cortical neoplasms	**Medular neoplasms**
■ Polydypsia/polyuria ■ Pendulous abdomen ■ Skin alterations ■ Hair loss ■ Muscle weakness ■ Anestrous ■ Obesity ■ Muscular atrophy ■ Excessive panting ■ Testicular atrophy ■ Thromboembolism ■ Diabetes mellitus	■ Hypertension (hemorrhage, convulsions, etc.) ■ Panting ■ Dyspnea ■ Tremors ■ Polydypsia/polyuria ■ Anorexia ■ Tachycardia ■ Arrhythmias ■ Mydriasis ■ Signs of partial obstruction of the vena cava (ascitis, edema in rear limbs, etc.)

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Meticulous adrenalectomy

Case / Adrenalectomy

José Rodríguez, Amaya de Torre, Carolina Serrano, Cristina Bonastre, Ángel Ortillés

This case presents a patient suffering from Cushing's syndrome as a result of a neoplasm of the left adrenal gland.
This surgery is highly delicate and must be performed meticulously.

A supra umbilical laparotomy is performed for exploration of the liver and regional lymphatic glands to search for tumor metastases.

Intestinal loops are moved and the adrenal area is isolated with moistened compresses and gauze (Fig. 1).
The delicate and precise dissection of the periglandular area is completed, avoiding injury to the large blood vessels close to the vena cava or renal vessels (Fig. 2).
The phrenicoabdominal vein is located, dissected and ligated, on its path through the adrenal gland. The purpose is to avoid the vasoactive substances released upon manipulation of the gland entering into systemic circulation (Figs. 3 and 4).

Preventative hemostasis of the phrenicoabdominal vein is performed using synthetic long-term absorbable ligatures or vascular clips.

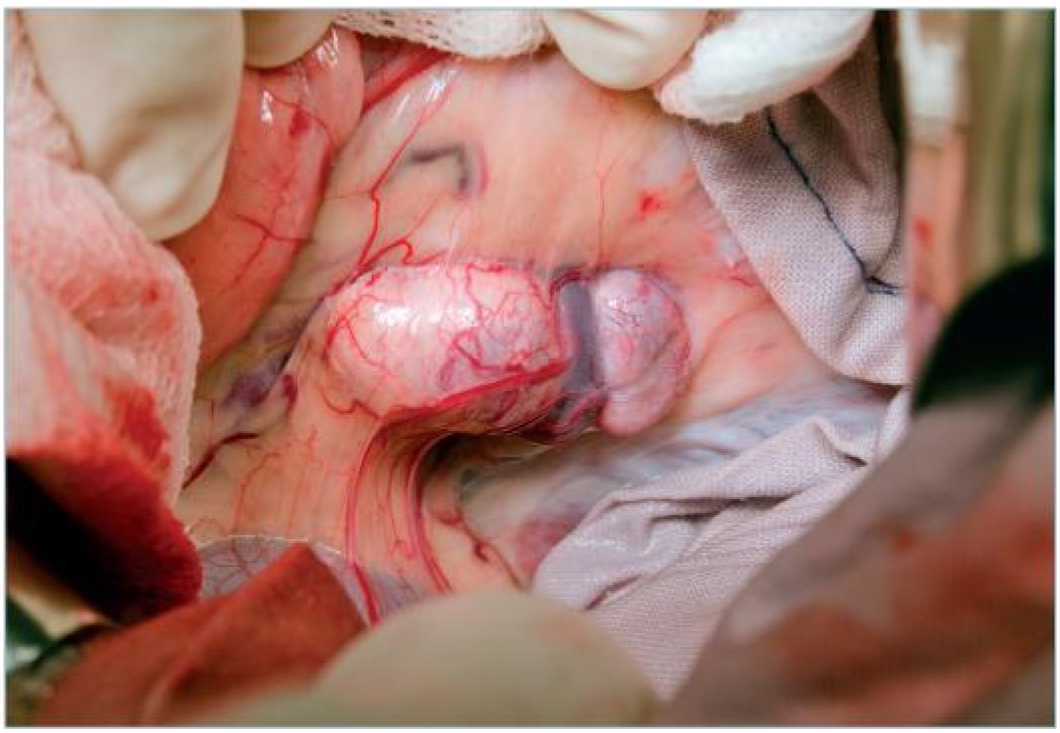

Fig. 1. Preparation of the surgical field by displacing intestinal loops and hepatic lobes close to the tumorous gland. The stability of this preparation is very important in order to simplify the surgical technique and control the dissection, ligation and hemostasis processes as well as possible.

Fig. 2. The dissection of the periglandular tissue should be performed meticulously and with great care, so as not to damage major nearby blood vessels, such as the left renal vein, if the affected gland is on this side, or the vena cava, if the tumorous gland is on the right.

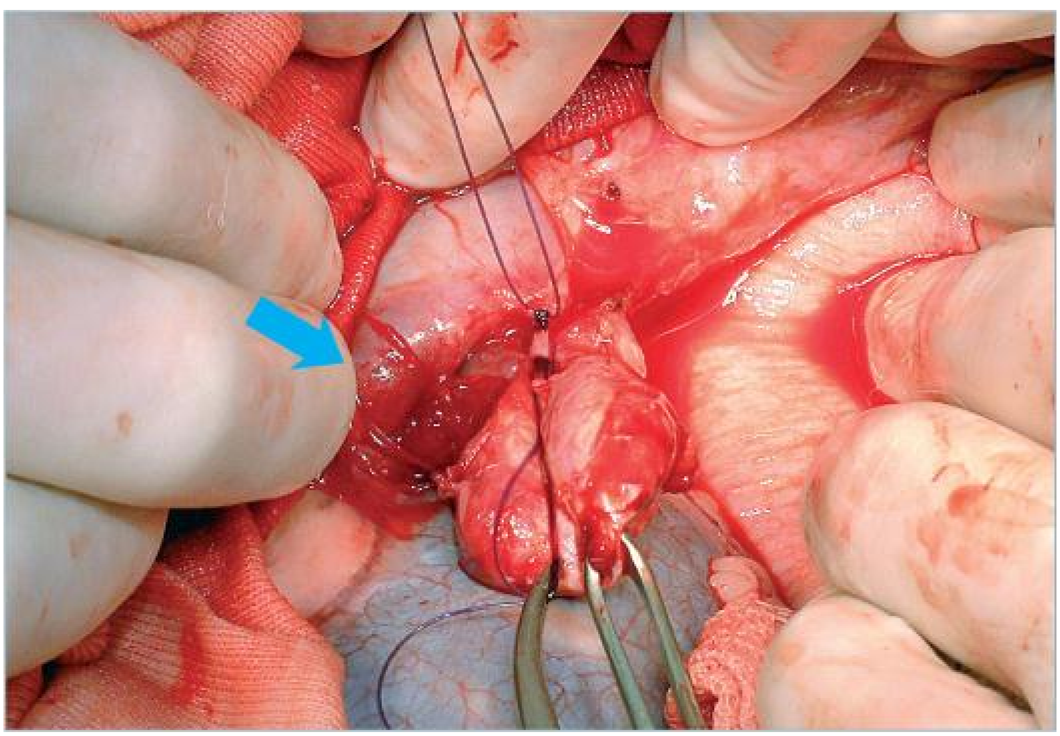

Fig. 3. In this case, the gland was firmly adhered to the left renal vein (arrow). After release, the phrenicoabdominal vein is dissected and closed to prevent vasoactive substances or tumor cells from entering systemic circulation.

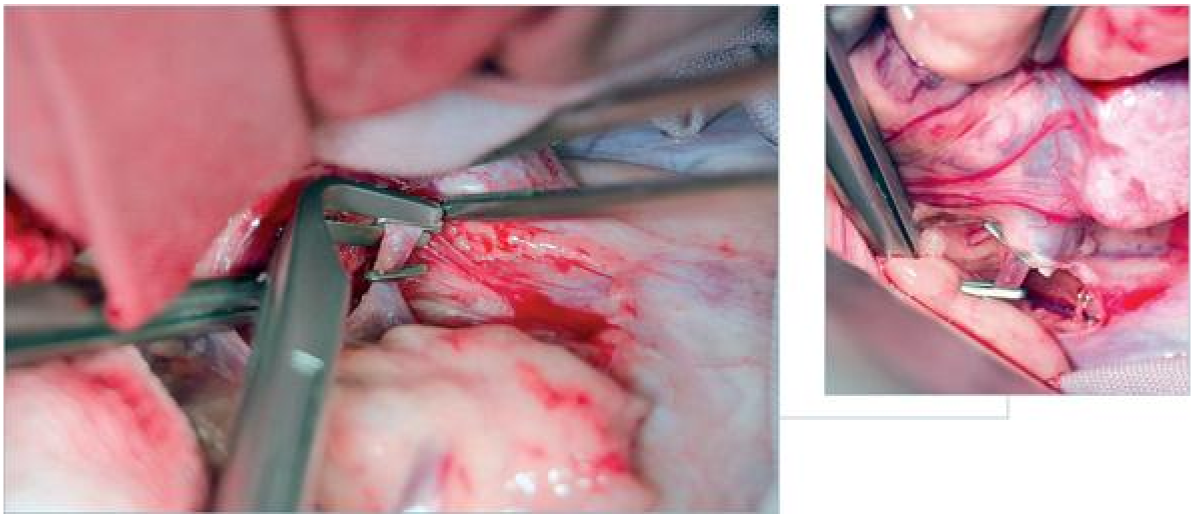

Fig. 4. Preventative hemostasis of the phrenicoabdominal vein is easily achieved using vascular clips as observed in this image.

All the small vessels around the gland are dissected and coagulated using bipolar clamps to prevent bleeding (Fig. 5).

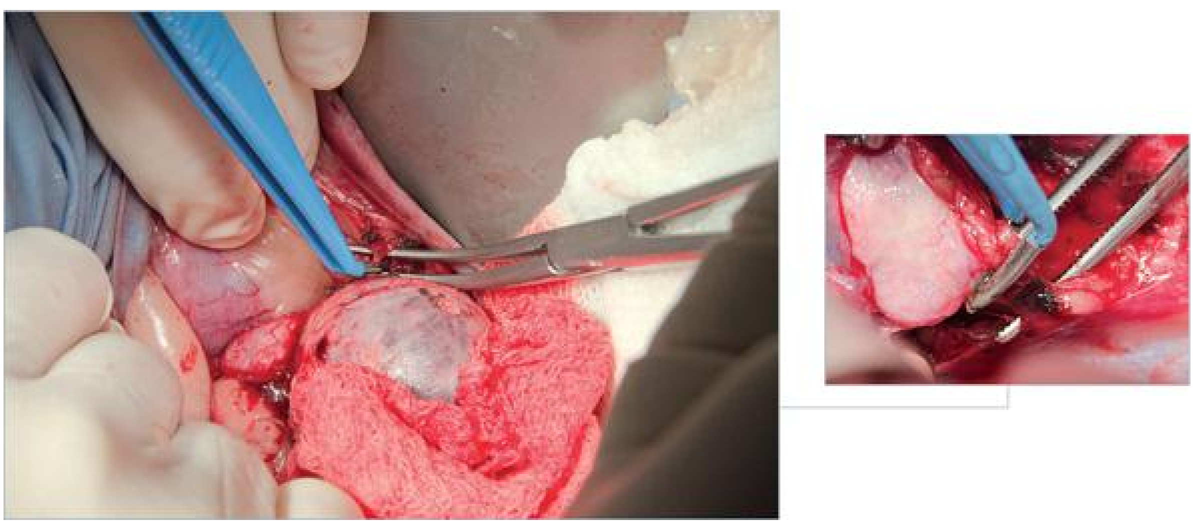

Fig. 5. The adrenal gland has a large number of peripheral blood vessels. Preventative hemostasis should be performed using bipolar clamps before sectioning.

After removal of the neoplasm and prior to replacing the abdominal organs and closing the wound, successful hemostasis of the affected area must be confirmed (Fig. 6).

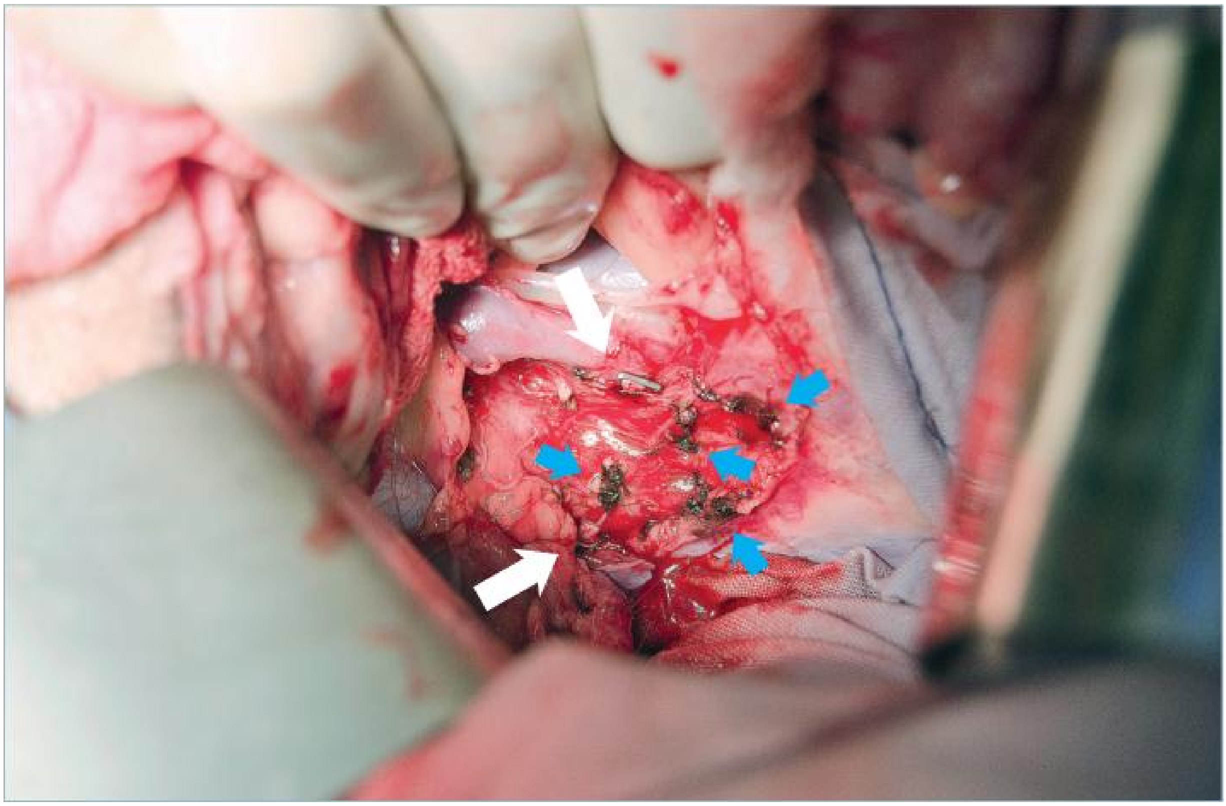

Fig. 6. Before completing the procedure, it must be checked that hemostasis has been successful during the surgery. This image shows the vascular clips used to close the phrenicoabdominal vein (white arrows) and the numerous coagulated arterial vessels (blue arrows).

In some cases a tumorous thrombus can be identified inside the vena cava (Fig. 7). In this situation the vena cava can be clamped in order to perform a venotomy to remove the clot.

Intraoperative or immediate postoperative mortality can be high, caused by uncontrolled bleeding, thromboembolism, peritonitis, renal failure, infection and pancreatitis. For this reason, the surgical technique must be impeccable and thromboembolism must be avoided.

In these patients it is advisable to close the abdominal cavity with non-absorbable material.

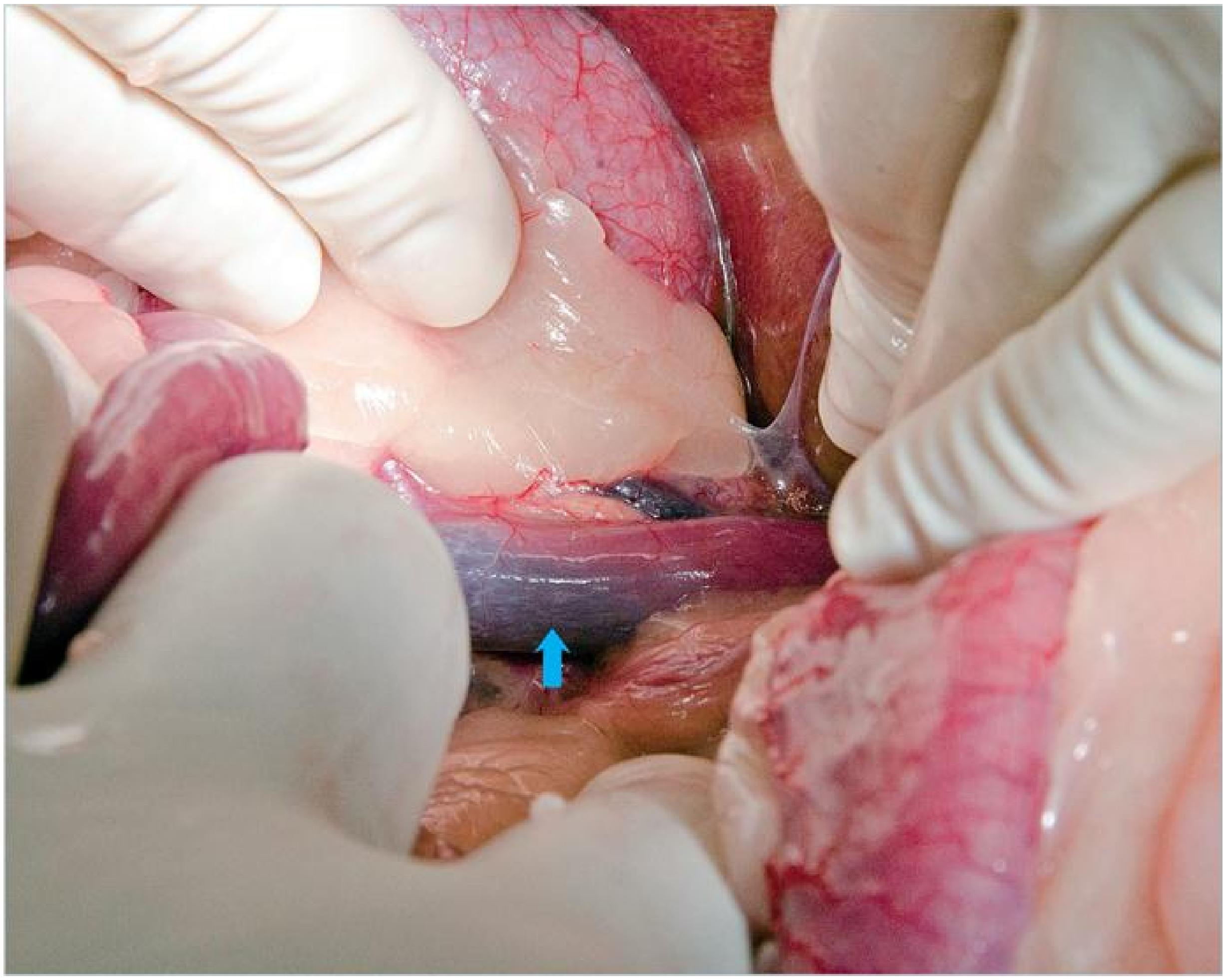

Fig. 7. If the neoplasm of the adrenal gland has invaded the vena cava the tumorous thrombus can be observed (arrow) through the venous wall.

Pheochromocytoma

José Rodríguez, María José Martínez

Prevalence	■	□	□	□	□
Technical difficulty	■	■	■	□	□

Pheochromocytoma is a tumor that affects the adrenal medulla; it produces vasoactive catecholamines that may produce hypertension, venous congestion, cardiomyopathy, congestive heart failure, collapse and sudden death.
This case concerns a 9-year-old female Boxer that presented with coughing, panting, weakness, anorexia and dyspnea as the main symptoms. The arterial pressure was 190 mm Hg.

These patients should be closely monitored during anesthesia to correct any hemodynamic changes that may occur.

Ultrasonography of the abdomen revealed a tumor of the left adrenal gland; it had a mixed echogenic pattern (that may also be present in other adrenocortical tumors).
The hematology and blood chemistry results were completely normal. The owner was advised to have the tumor removed, because the patient was at risk of sudden death as a result of cardiac arrhythmias and high blood pressure. The patient also presented with tachycardia and a cardiac arrhythmia. Medical treatment was used to try to correct these disorders before surgery.

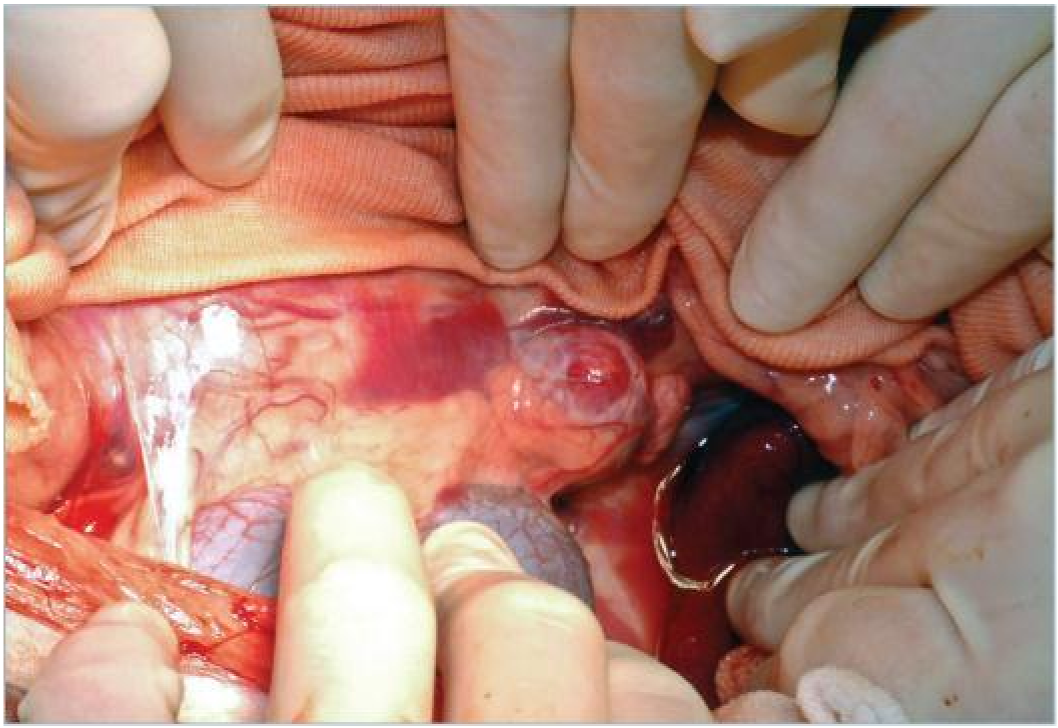

Fig. 1. After a long midline laparotomy, the intestines are displaced towards the right of the patient and protected with surgical compresses moistened in sterile saline. Note that the renal area is clearly visible in this image.

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Pheochromocytoma

Anesthetic complications, such as wide variations of heart rate or blood pressure, are common in these patients.

Prior to surgery

To control the cardiovascular disorder, the patient was started on phenoxybenzamine at a dose rate of 0.3 mg/kg/12 h; the aim was to lower the blood pressure and keep it under control. Next, the tachycardia was controlled with propanolol (0.05-0.1 mg/kg IV).

In these patients, the use of anticholinergics, ketamine and xylazine should be avoided.

Phaeochromocytomas are highly vascularized tumors; in combination with high blood pressure, this may lead to significant intraoperative hemorrhage.

Surgery starts with a long midline laparotomy to achieve good visualization of the left renal fossa and the rest of the abdomen (Fig. 1).
Next, the peritoneum is incised over the neoplasm to make careful dissection possible (Fig. 2).

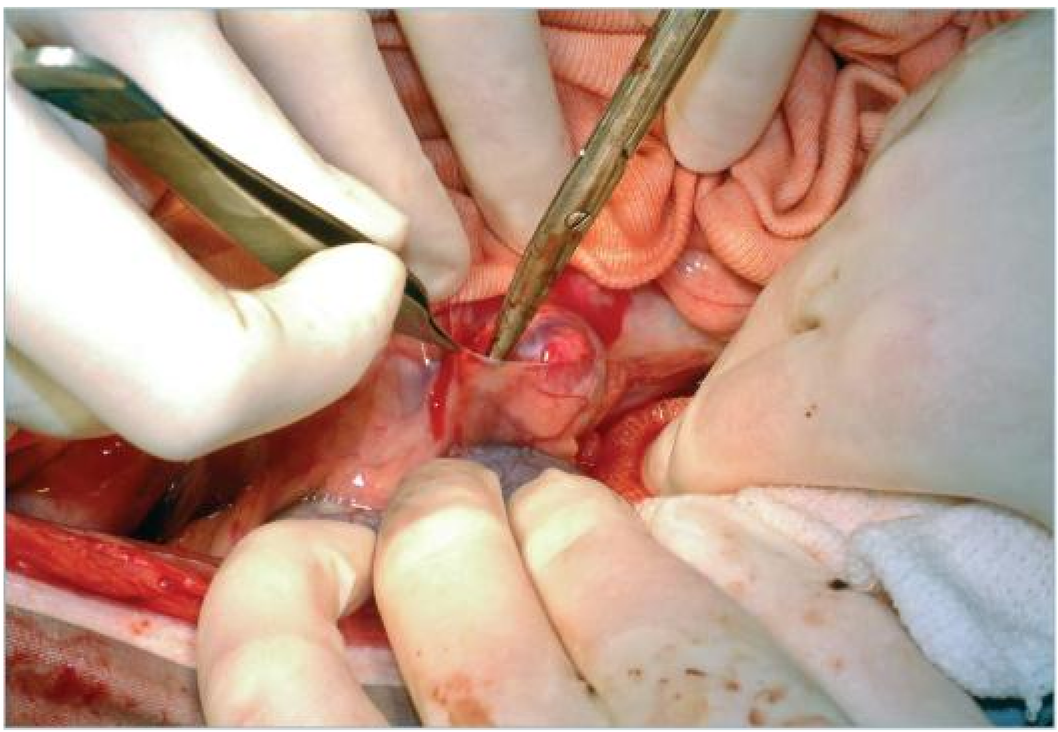

Fig. 2. Incision and dissection of the peritoneum over the adrenal gland to achieve access to the gland and its blood vessels.

In pheochromocytomas it is best to first ligate the phrenicoabdominal vein, to prevent the release of catecholamines

during handling of the gland.

The periadrenal blood supply was abundant and numerous small hemorrhages were detected; these were controlled with bipolar coagulation (Fig. 3) before dissection of the phrenicoabdominal vein.

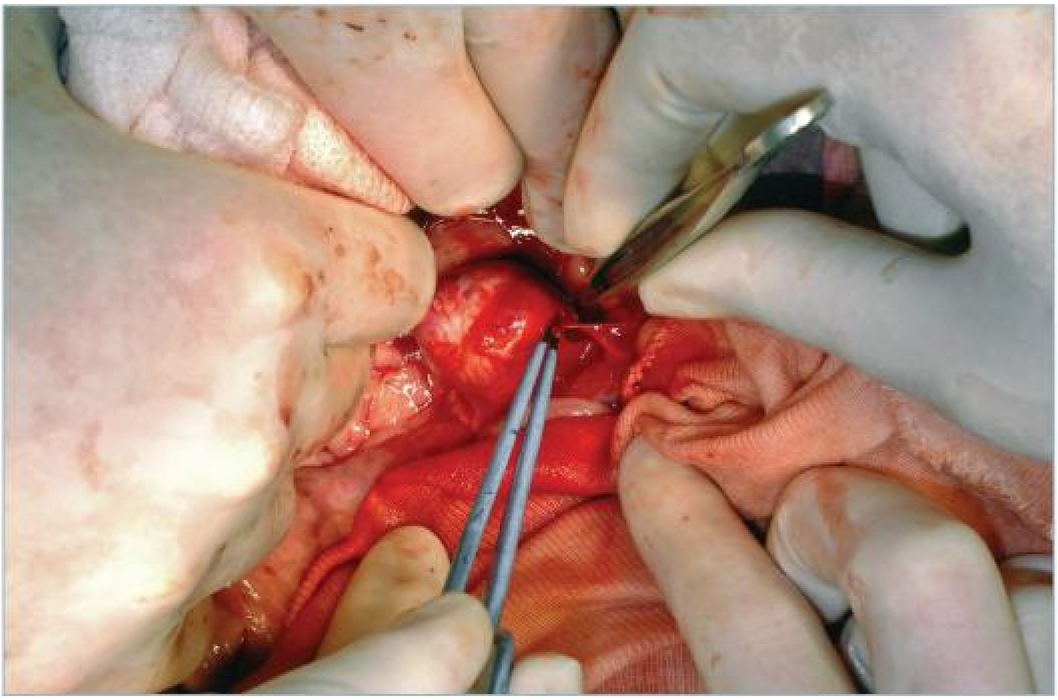

Fig. 3. There were numerous small arteries around the gland. Each of the small hemorrhages was coagulated with the bipolar forceps to achieve good hemostasis.

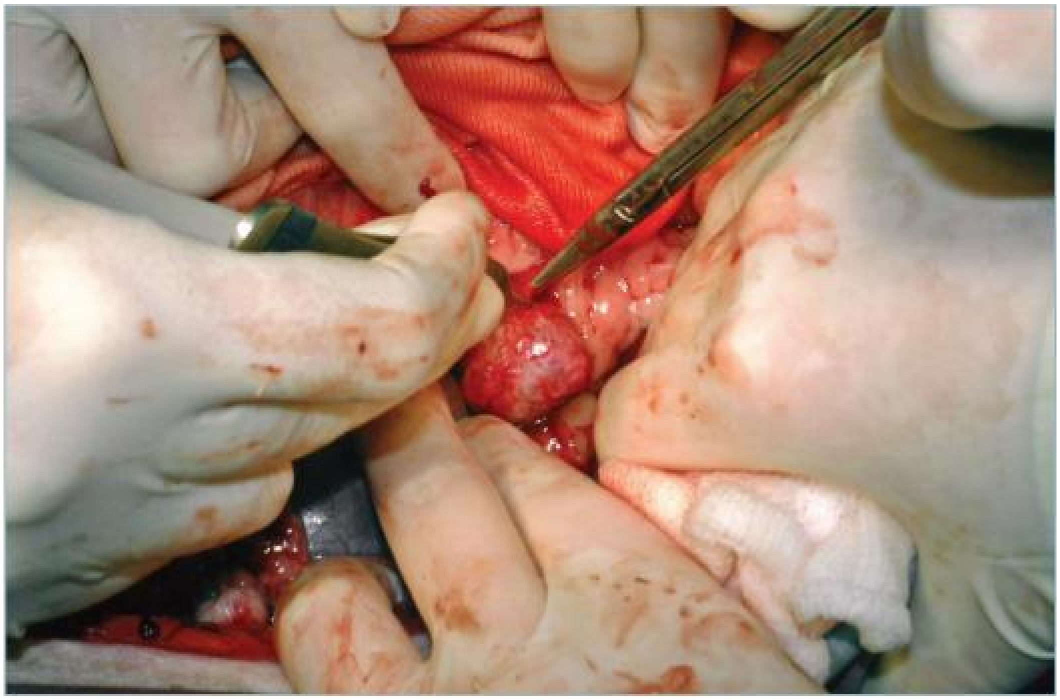

Fig. 4. Dissection of the course of the phrenicoabdominal vein between the adrenal gland and the caudal vena cava.

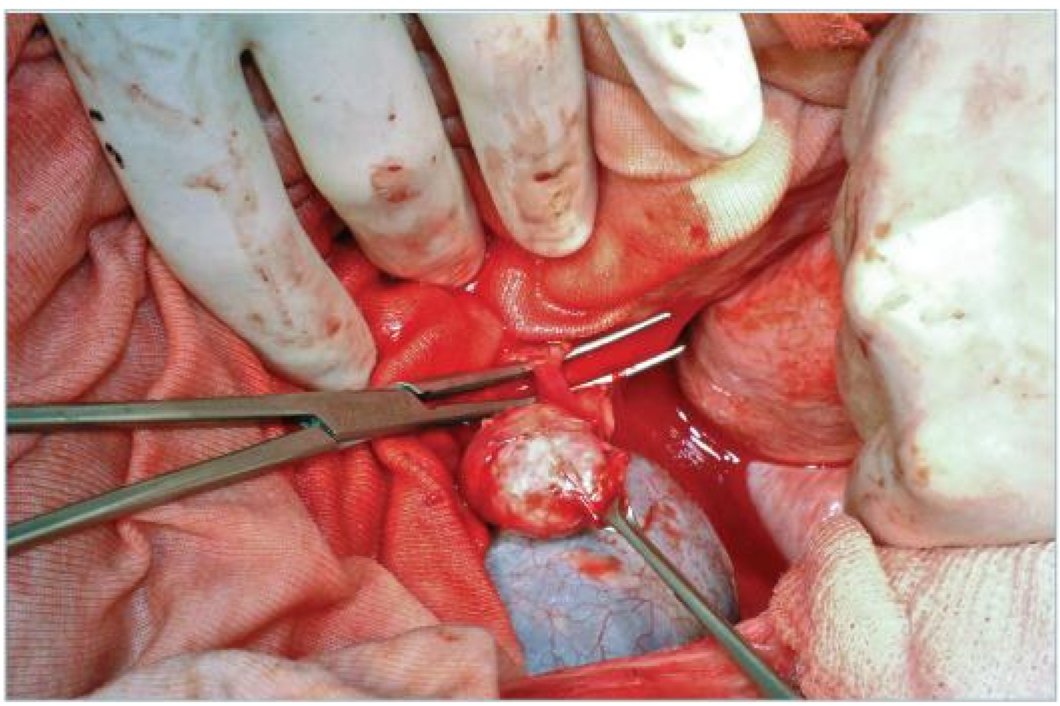

Fig. 5. Dissection was finished with a a pair of Overholt® dissecting forceps which was also used to pass the ligatures around the vessels.

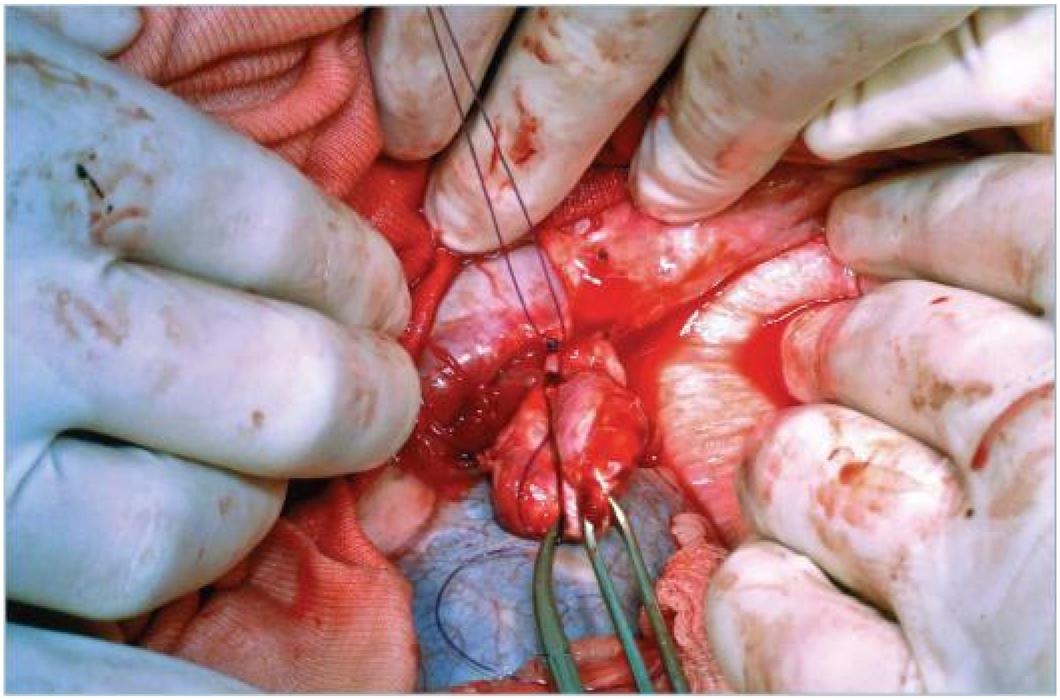

Fig. 6. Hemostasis of the vein was assured with two non-absorbable ligatures, placed prior to cutting the vein.

Next, the phrenicoabdominal vein was dissected, ligated and cut (Figs. 4-7) before isolating and removing the tumor (Figs. 8 and 9).

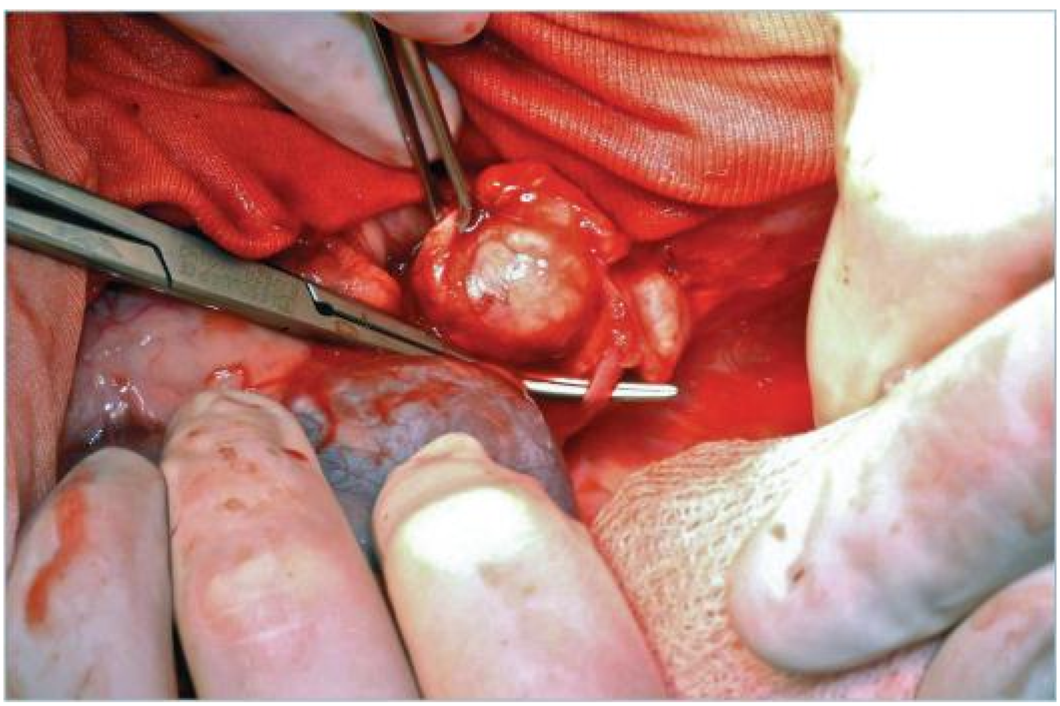

Fig. 7. Next, the afferent part of the vein was dissected, ligated and cut. The vein starts at the abdominal wall and runs through the glands.

Careful hemostasis is a priority in these patients to prevent postoperative bleeding.

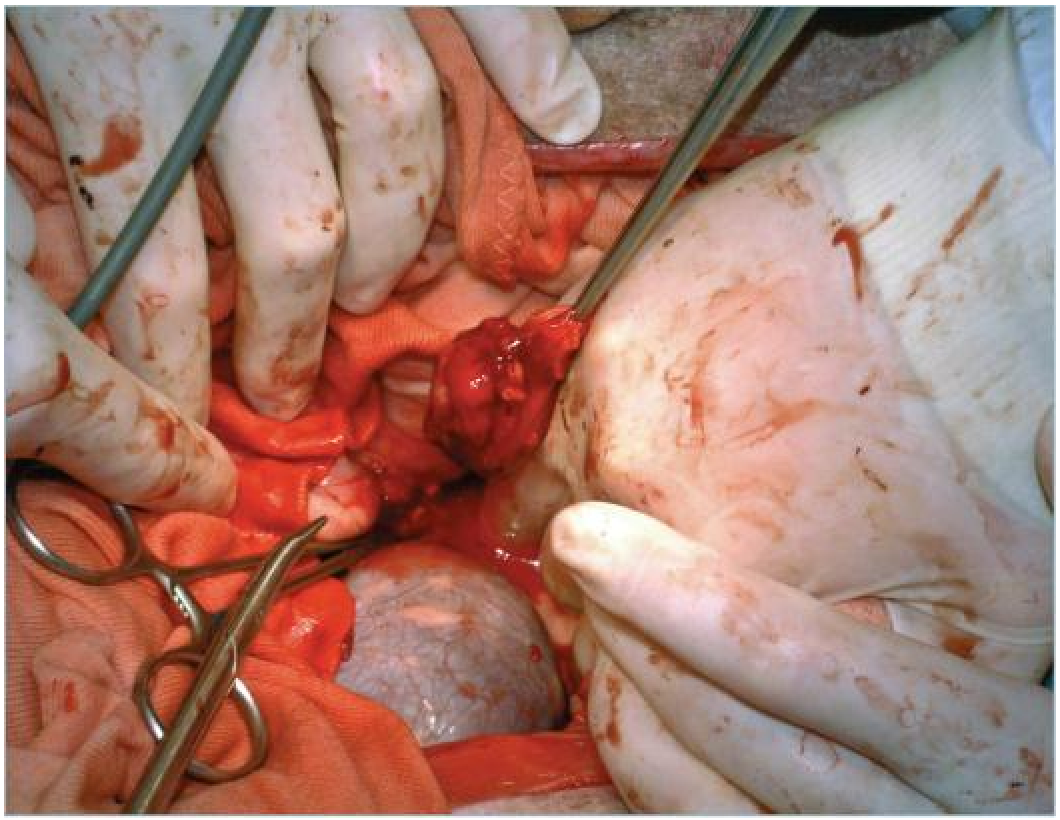

Fig. 8. Removal of the tumor after coagulation and ligation of all the blood vessels.

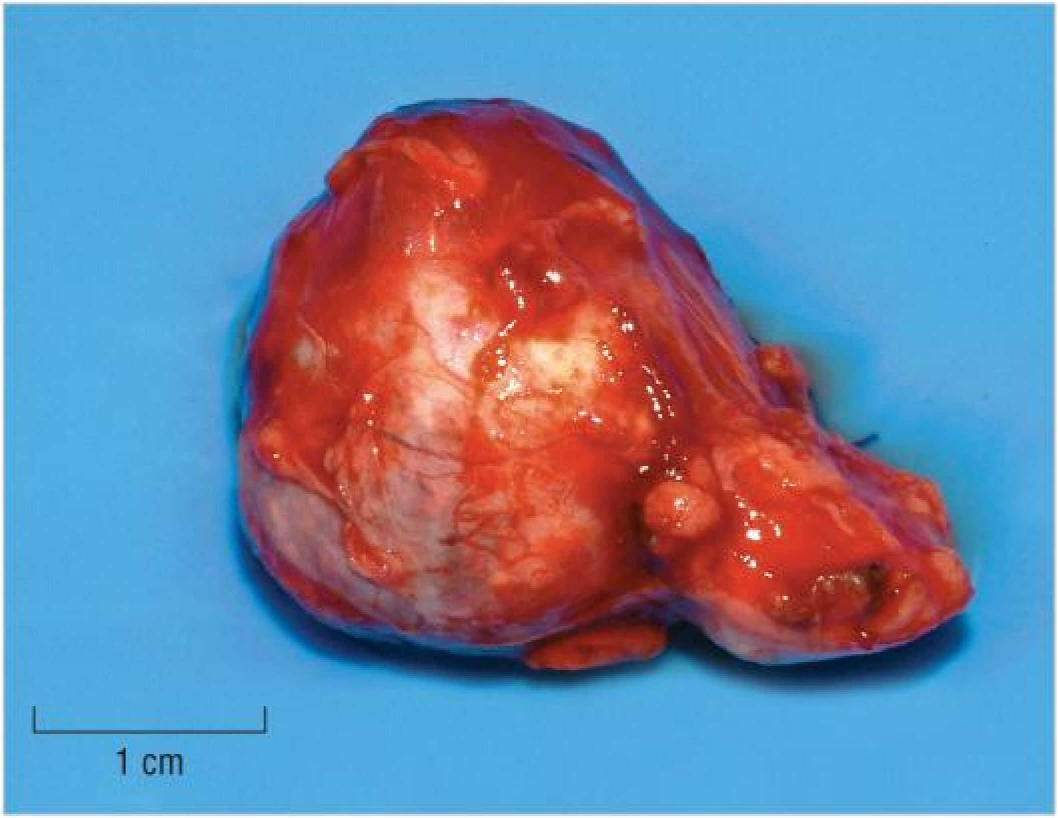

Fig. 9. Size of the neoplasm. Histopathology confirmed that it was a pheochromocytoma.

When the intervention is finished and before closing the abdominal cavity, the area is checked for bleeding (Fig. 10).
In this patient, it was decided to start the dissection at the adrenal arteries because there was insufficient space and the gland had to be mobilized to gain access to the phrenicoabdominal vein.

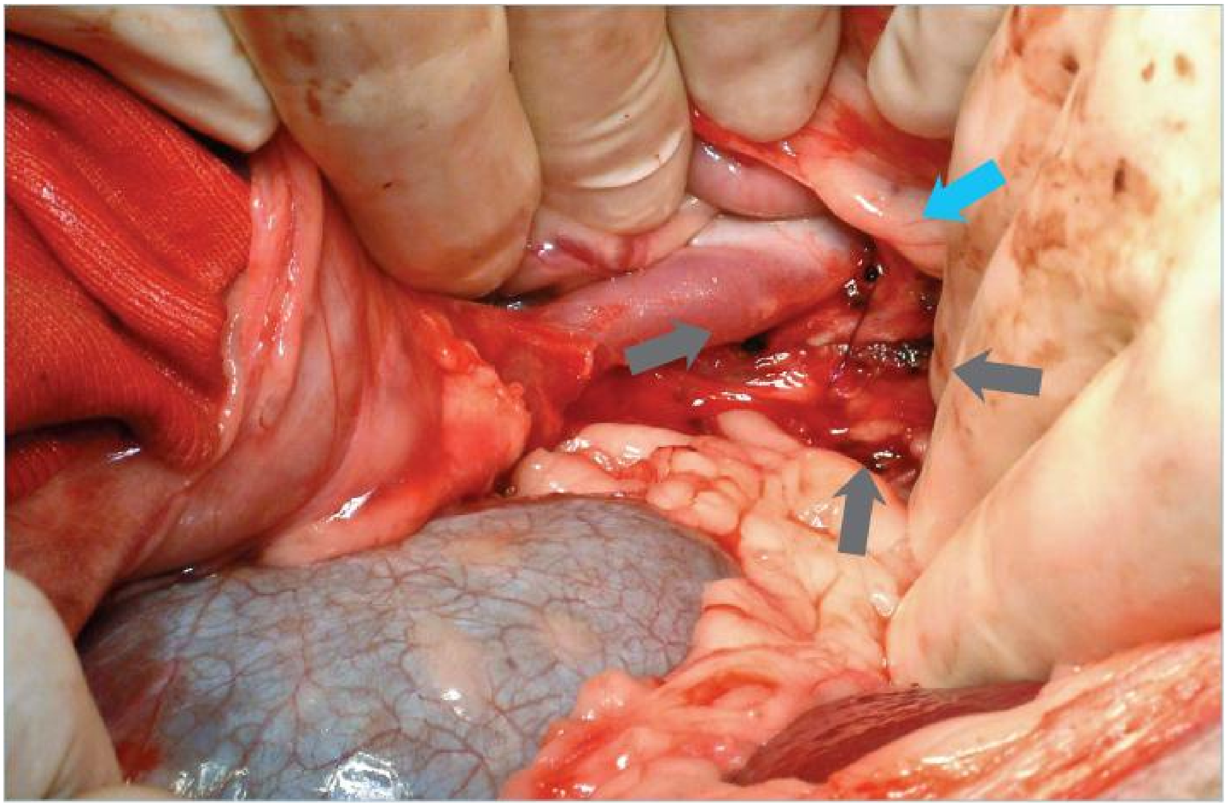

Fig. 10. At the end of the surgery, the area was carefully checked for bleeding, even if minor, to prevent postoperative complications. Ligation of the vein (blue arrow) and the coagulated adrenal arteries (grey arrows).

After surgery

The patient recovered satisfactorily from the surgery and did not develop any cardiac anomalies or hypertension, or the slightest sign of postoperative hypoadrenocorticism.
The antibiotic treatment that had been started before surgery was maintained for five more days.
The cardiology unit took over the follow-up of the patient and she was still stable 16 months after the operation.

Pheochromocytomas are tumors of the adrenal medulla that secrete large quantities of catecholamines and other vasoactive peptides, leading to cardiovascular, respiratory or neurological changes.

Cardiac tamponade. Pericardiectomy

José Rodríguez, Amaya de Torre, Carolina Serrano, Rocío Fernández

Prevalence	■	■	□	□	□

Overview

Increased pressure in the pericardium as a result of an effusion or hemorrhage leads to a cardiac tamponade, causing a decrease in cardiac output and right-sided congestive heart failure (impaired cardiac compliance, reduced diastolic filling, decreased output volume). This is compensated by tachycardia, which may further compromise the cardiac output, trigger cardiac arrhythmia and decrease the coronary blood flow.

Cardiac tamponade is mainly caused by:

- Heart base tumors.
- Hemangiosarcomas of the right atrium.
- Idiopathic pericardial effusion.

Clinical signs

Clinical signs in these patients are mainly secondary to the cardiac insufficiency described above. The principle clinical signs are:

- Tachycardia.
- Muffled heart sounds.
- Weak arterial pulse.
- Increased jugular pulse.
- Reduced capillary refill time.
- Hepatomegaly.
- Ascites (moderate to high protein content).

Diagnosis

Diagnosis is based on clinical signs and thoracic radiographs, in which a large, round cardiac silhouette is seen (Fig. 1).
Ultrasonography confirms the diagnosis of pericardial effusion and is of great help when performing pericardiocentesis to relieve the pericardial pressure (Fig. 2).
A pericardial fine-needle aspirate may be of help to determine the etiology of the tamponade. Serous effusion is suggestive of a neoplastic or inflammatory origin, while hemorrhagic effusion may indicate a hemangiosarcoma of the right atrium or idiopathic pericardial bleeding.

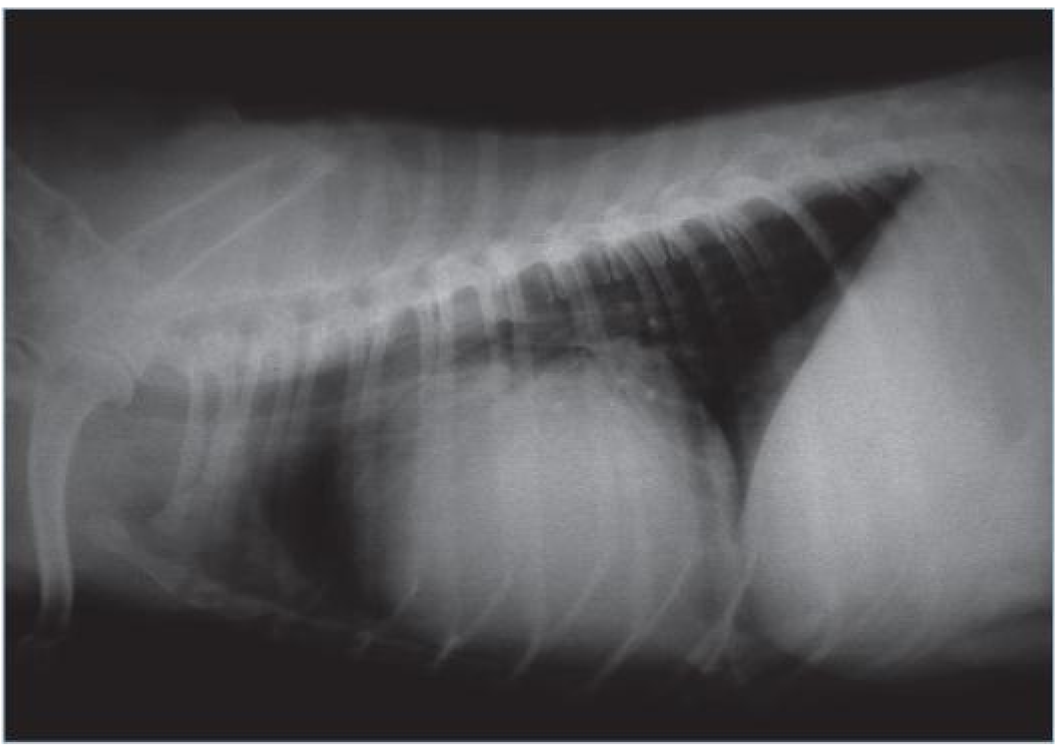

Fig. 1. Lateral radiograph of a 5-year-old Boxer with an idiopathic cardiac effusion.

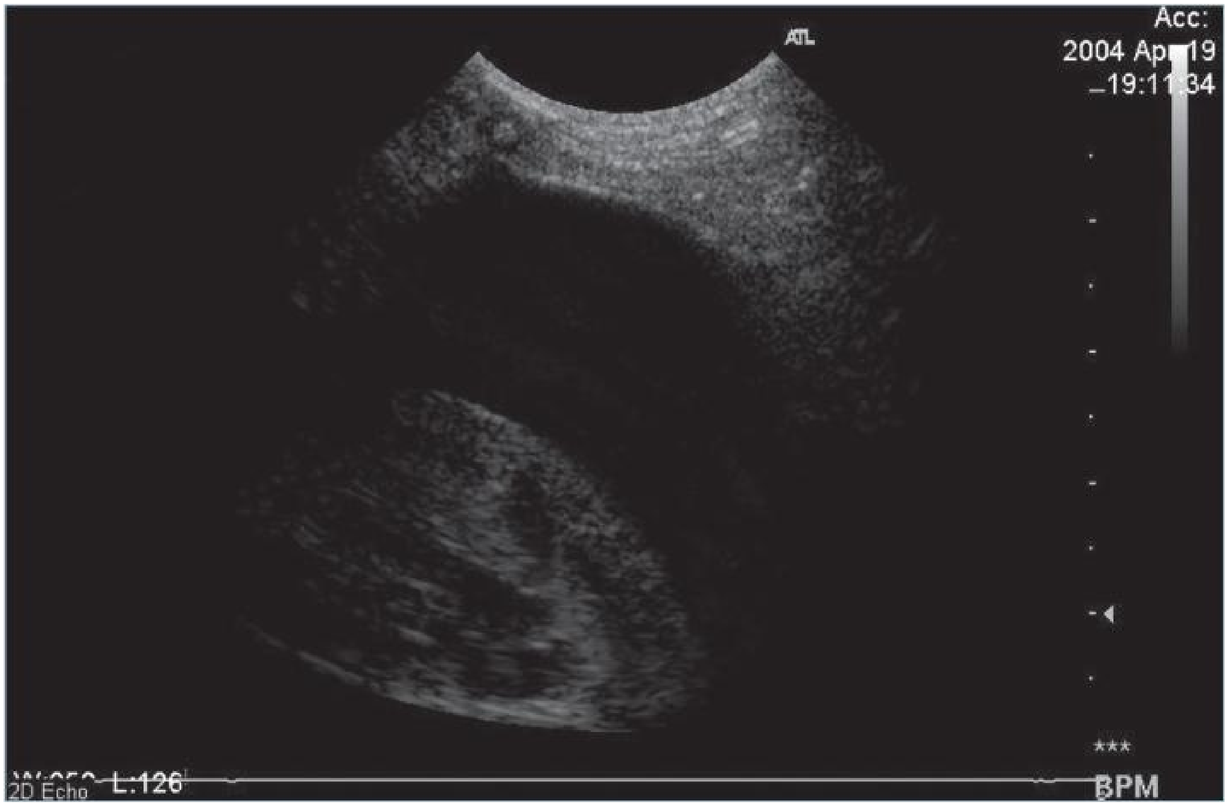

Fig. 2. Pericardial effusion in a patient with a hemangiosarcoma located in the right atrium.

Surgical procedure. Pericardial decompression.

Pericardiocentesis

Technical difficulty

The pericardium can be drained percutaneously in a straightforward manner, using a needle or catheter. It is best done on the right side, to avoid the coronary arteries, and under ultrasound guidance, through the fourth or fifth intercostal space (Fig. 3).

Removal of the pericardial contents will rapidly improve the heart rate, the arterial pulses and peripheral perfusion.

In case of emergency, a blind pericardial aspirate can be performed on the right side.

Pericardiectomy

Technical difficulty	■	■	■	□	□

Pericardiectomy is performed to prevent the accumulation of fluid or blood in the pericardium, thus preventing right-sided congestive heart failure and low cardiac output.
Currently, subtotal pericardiectomy is performed by removing the pericardium from underneath the phrenic nerve. This technique can be performed via thoracotomy or thoracoscopy.

Open surgical pericardiectomy

Lateral thoracotomy is performed through the fifth intercostal space, on the right, to examine the right atrium or from the left to examine the base of the heart (Fig. 4).

Fig. 3. Ultrasound-guided aspiration to drain the blood-filled pericardium in a patient with a hemangiosarcoma in the right atrium.

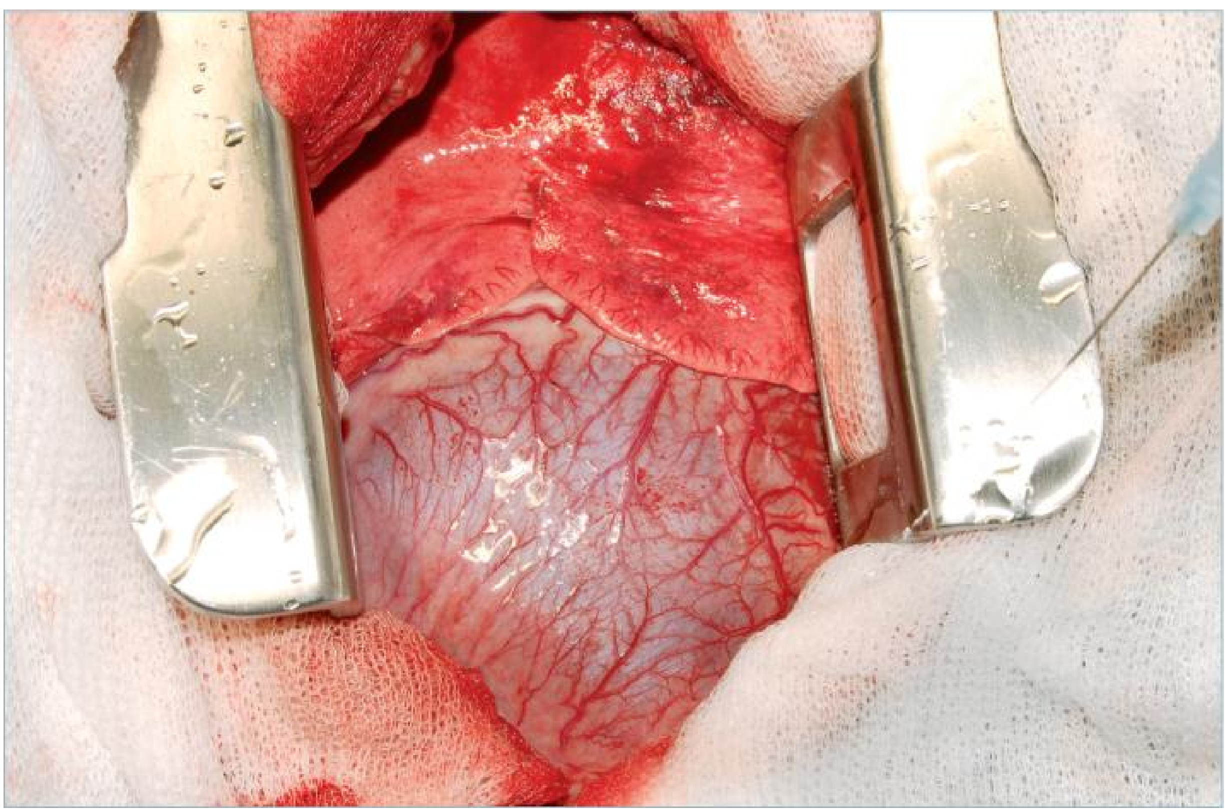

Fig. 4. Preparation of the operating field after a lateral thoracotomy through the left fifth intercostal space.

The pericardium is distended and often thickened. A small incision is made ventral to the phrenic nerve through which the contents of the pericardial sac are aspirated (Figs. 5 and 6).

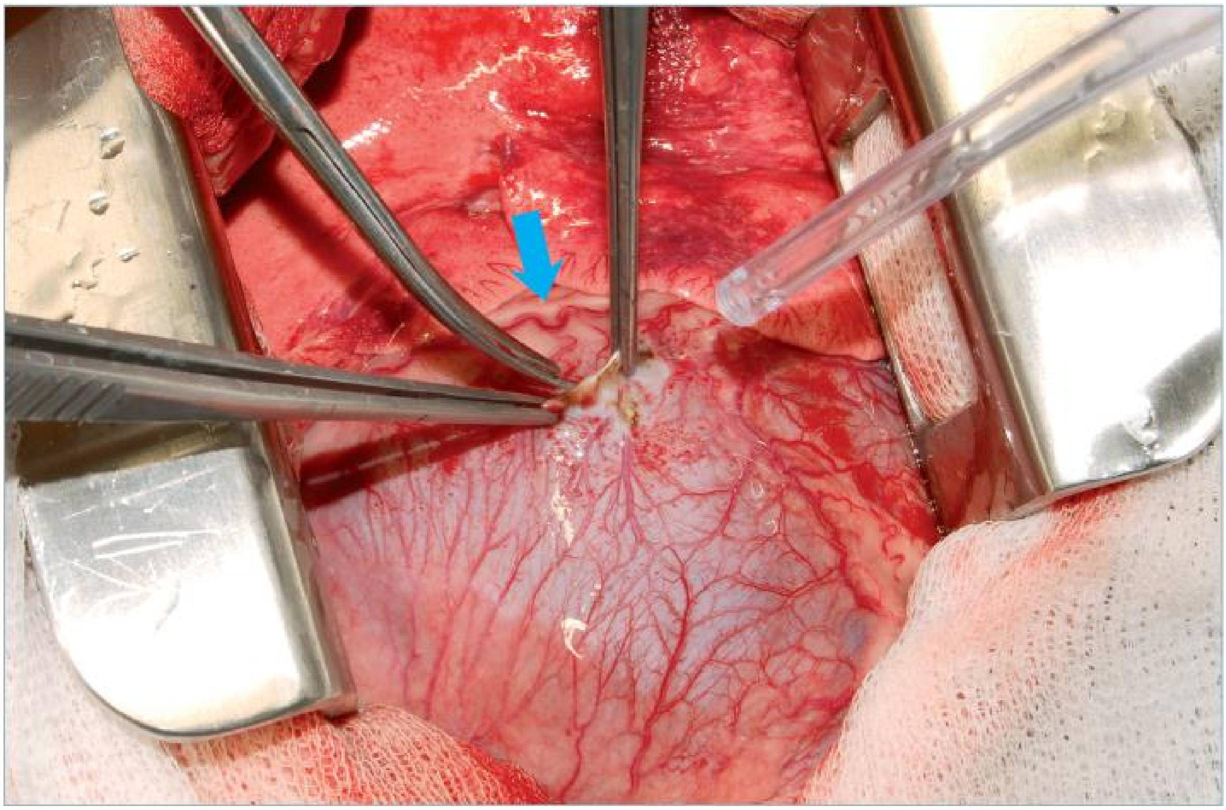

Fig. 5. The pericardium is incised ventral to the phrenic nerve (arrow). In this case, preventive hemostasis of the vessels was performed with bipolar coagulation.

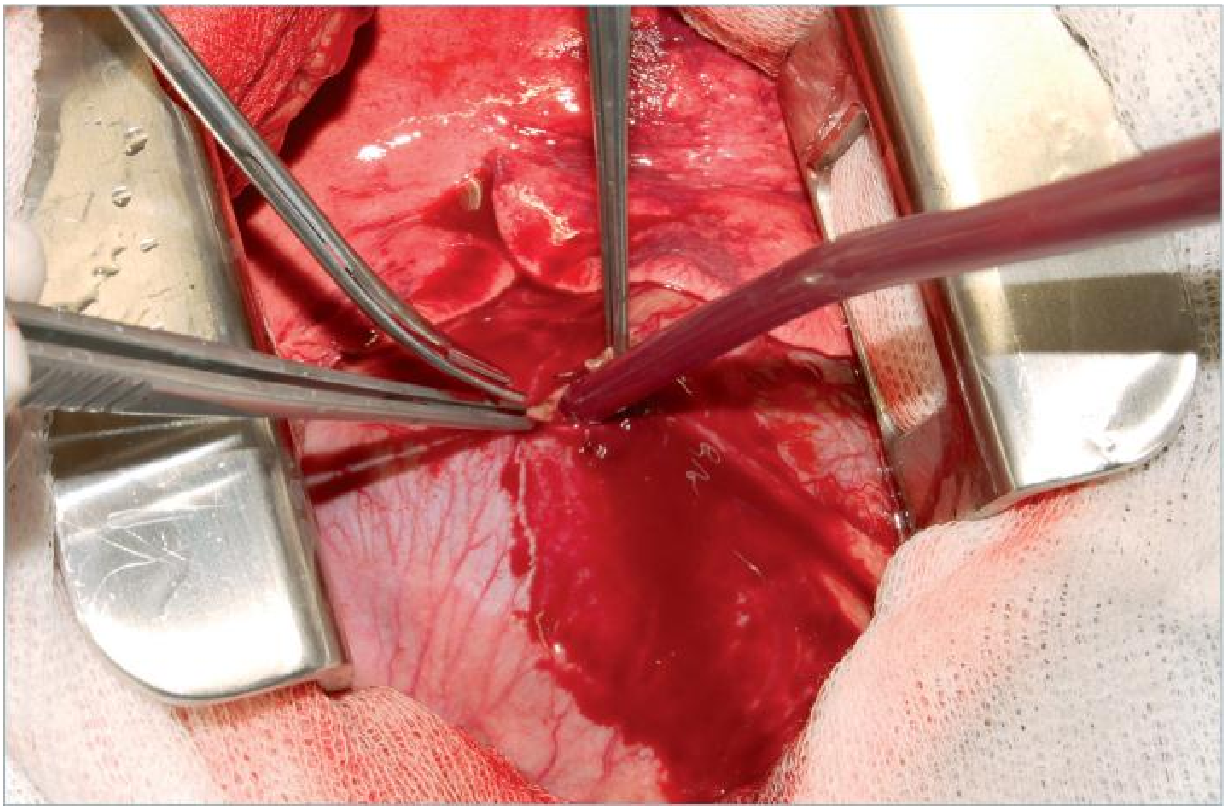

Fig. 6. Fluid is aspirated from the pericardial sac as soon as the incision is made.

Before incising, the anesthetist should be alerted as this may induce hemodynamic alterations.

The incision is then extended in cranial and caudal direction, using electrocautery or bipolar coagulation and scissors (Figs. 7 and 8).

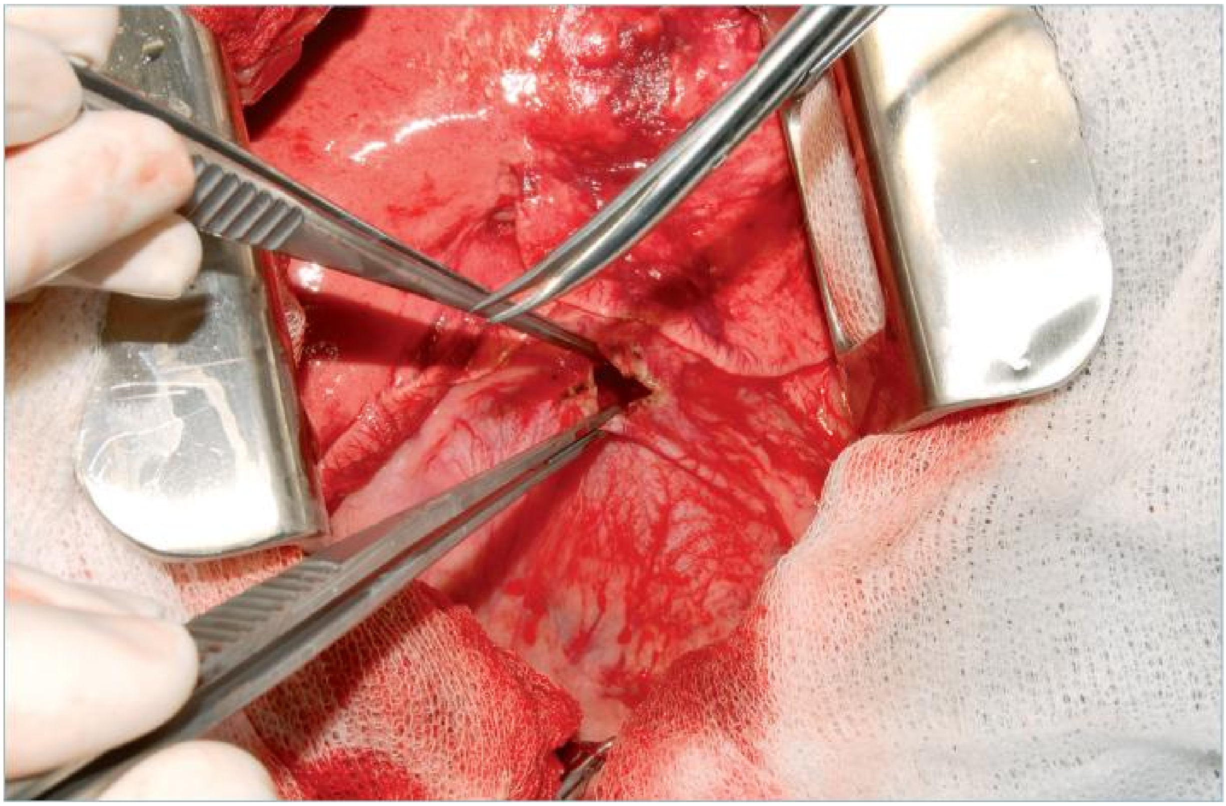

Fig. 7. The pericardium is incised below the phrenic nerve, and the incision is extended in a cranial and caudal direction.

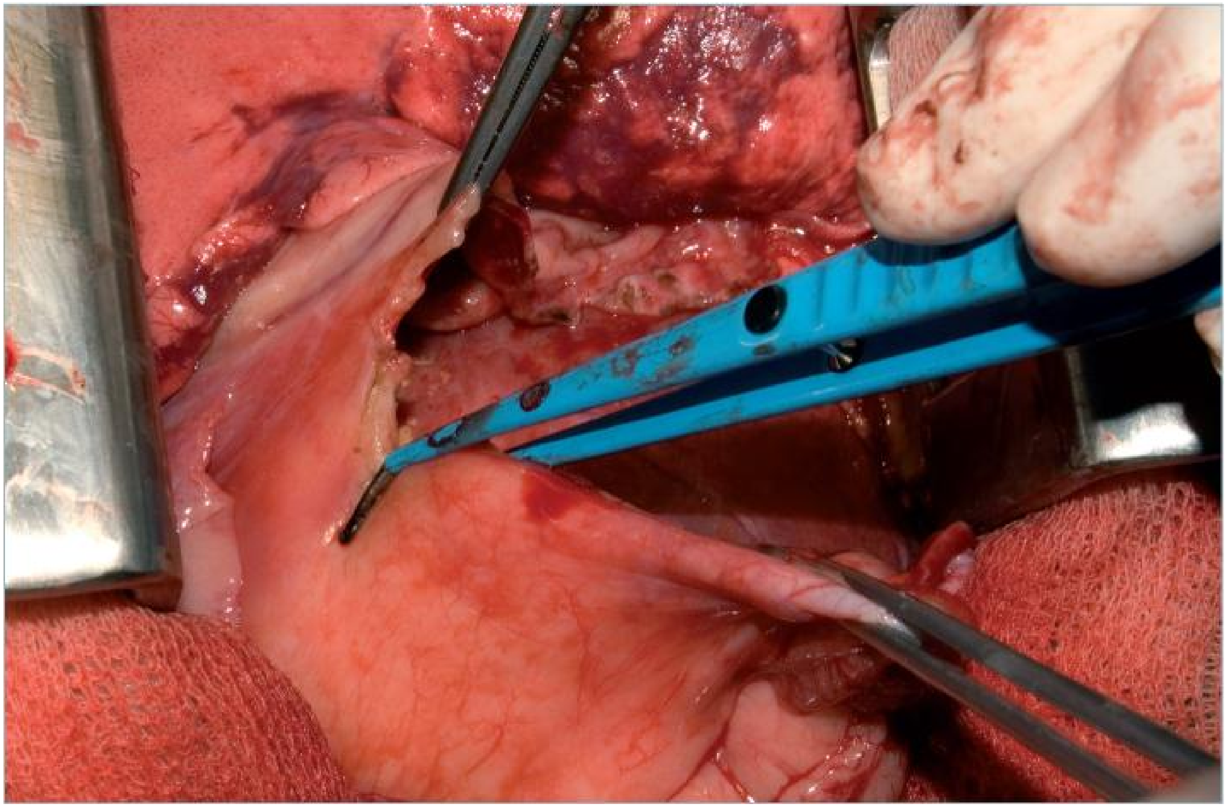

Fig. 8. To ensure hemostasis of the pericardial vessels, bipolar coagulation is performed before cutting them. Note the thickened pericardium in this patient.

If monopolar electrocautery is used, keep the tip well away from the myocardium; preferably using a wooden tongue depressor.

The other side of the pericardium is incised with the help from an assistant who gently lifts the heart. During this maneuver, take care not to damage the phrenic nerve on the other side, and bear in mind that cardiac and hemodynamic changes may occur.

If the anesthetist observes any cardiac changes, the surgeon should interrupt the procedure and wait until the patient has stabilized.

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Pericardiectomy

By lifting up the pericardium and withdrawing the lung lobes and the thymus, approximately 60-70 % of the pericardial surface can be resected (Figs. 9-11).

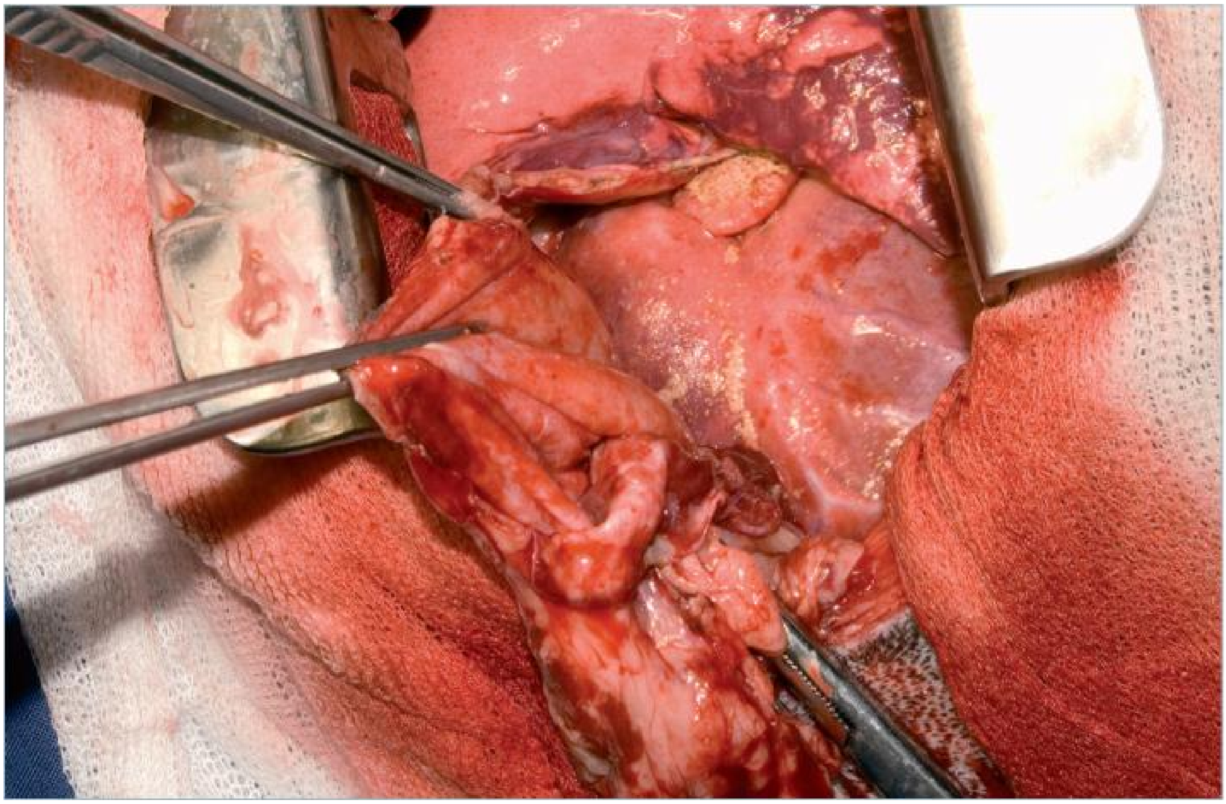


Fig. 9. Image showing how, after incising the pericardium caudally and extending the incision to the left and to the right, it can be pulled cranially for easy removal.

During this procedure, several blood vessels may be accidentally severed as they are hidden in the mediastinal fat and are difficult to see. Good preventive hemostasis is therefore essential.

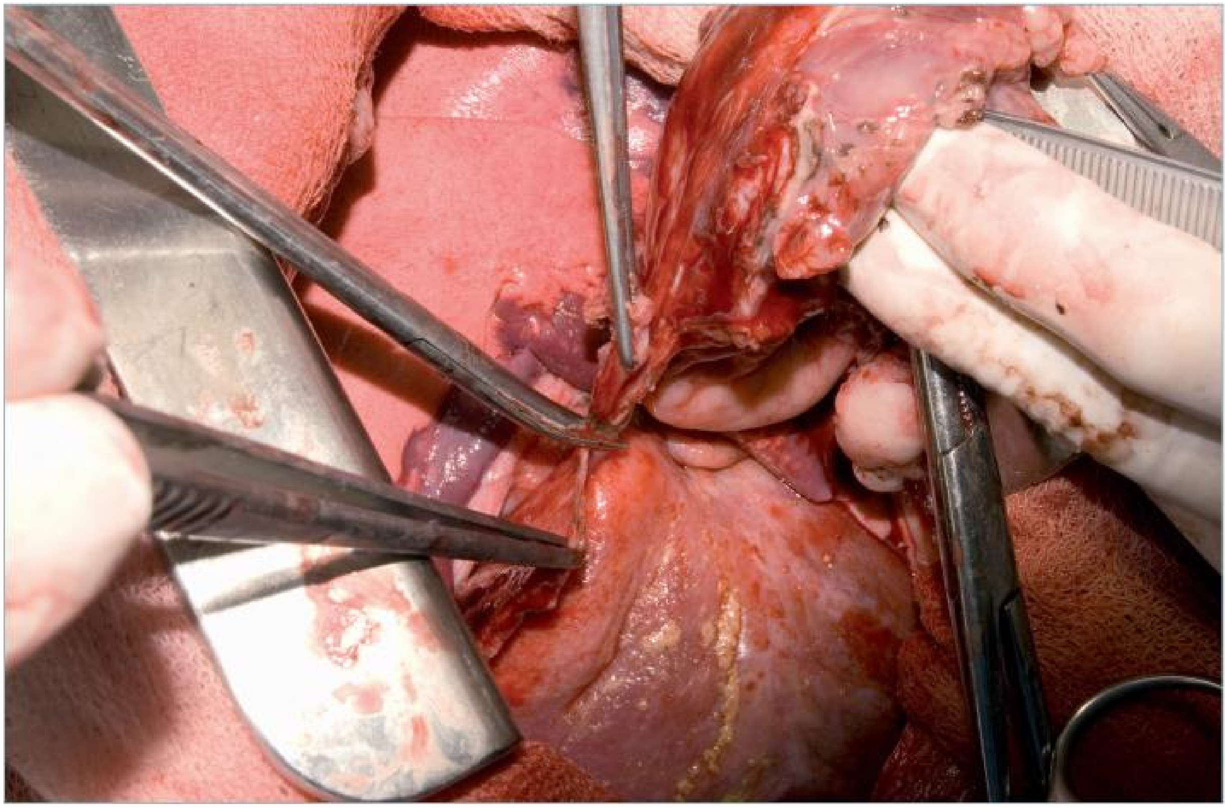


Fig. 10. Image showing the final appearance after pericardiectomy.

If it is not possible to visualize and identify the origin of the bleeding, several surgical swabs or compresses can be placed, using moderate pressure. Wait several minutes until it coagulates.

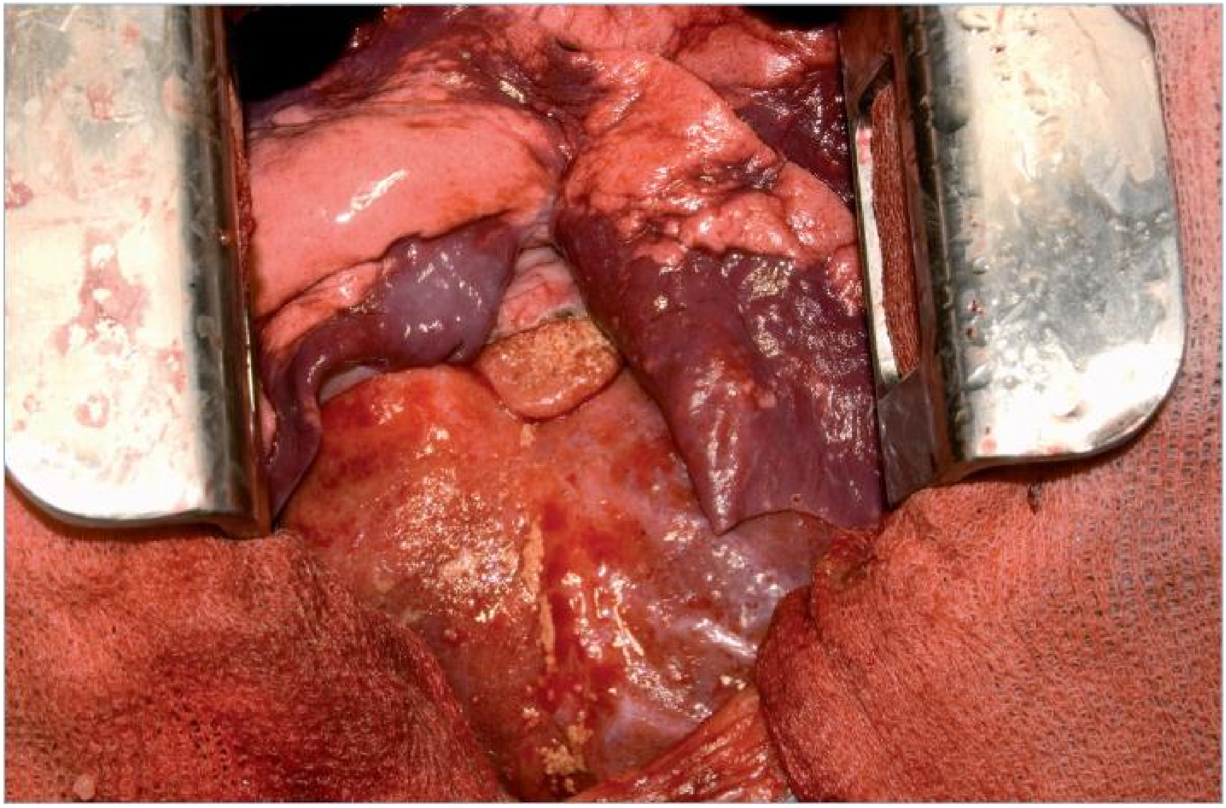


Fig. 11. End of the pericardiectomy. Following this technique, over 60 % of the pericardial surface is removed.

After this, the thoracic cavity is flushed and aspirated with lukewarm saline (Fig. 12).
A chest drain is placed and the thoracotomy is closed in the standard manner.
These patients often develop thoracic effusion, so expect to extract hemorrhagic fluids for the first three to four days postoperatively.

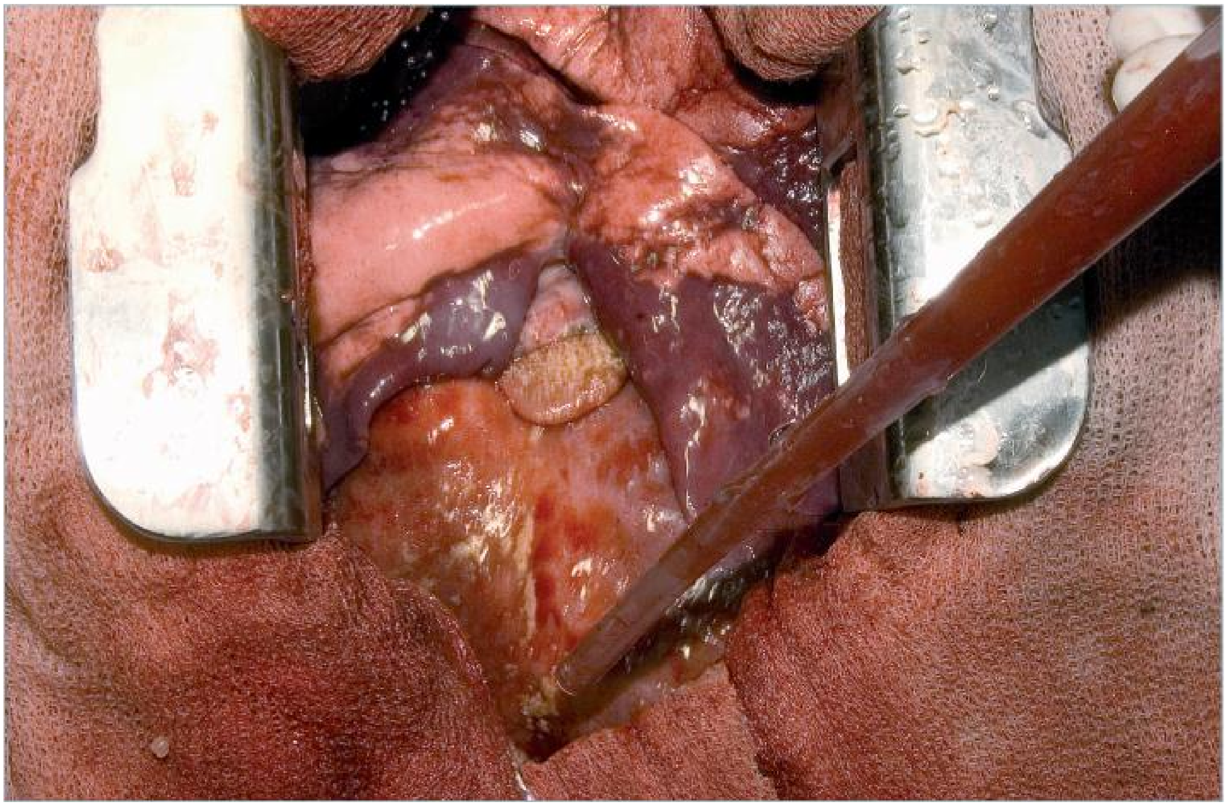


Fig. 12. Aspiration of the thorax after flushing. A low blood content confirms hemostasis of the mediastinum.

Patent ductus arteriosus (PDA)

José Rodríguez, Amaya de Torre, Carolina Serrano, Rocío Fernández

Prevalence

Patent ductus arteriosus (PDA) is a very common congenital cardiac abnormality in pets (between 25 and 30 % of all congenital heart defects); it is the consequence of the embryonic ductus artery which connects the descending aorta with the common pulmonary artery failing to close (Fig. 1).

During fetal development, the ductus arteriosus connects the main pulmonary artery with the descending aorta, thus diverting the blood that flows towards the lungs (collapsed) into the aorta (right-to-left flow) and to the umbilical arteries, for oxygenation in the placenta. At birth, the lungs expand, their vascular resistance decreases and the direction of the blood flow in the ductus is reversed (left-to-right flow); the wall of the ductus contracts, with complete closure 72 hours after birth.

What is the mechanism of ductus closure?

The ductus arteriosus closes by constriction of the circumferential smooth muscle in its wall in response to increased oxygen tension.

Why does it sometimes fail to close?

Because the amount of normal muscular fibers is smaller than normal, with a predominance of elastic fibers.

If the ductus fails to close, the left-right shunt between the aorta and the pulmonary artery will persist, which will result in cardiac volume overload and a typical continuous "machinery" murmur.

Clinical signs

The incidence is higher in females than in males.

The clinical signs vary considerably in relation to the diameter of the ductus arteriosus, the amount of blood that flows through it and how long it has been present. The clinical signs include:

- Retarded growth compared to littermates.
- Exercise intolerance.
- Cough.
- Anorexia.
- Weight loss.

Most patients with PDA will develop severe signs of heart failure before twelve months of age.

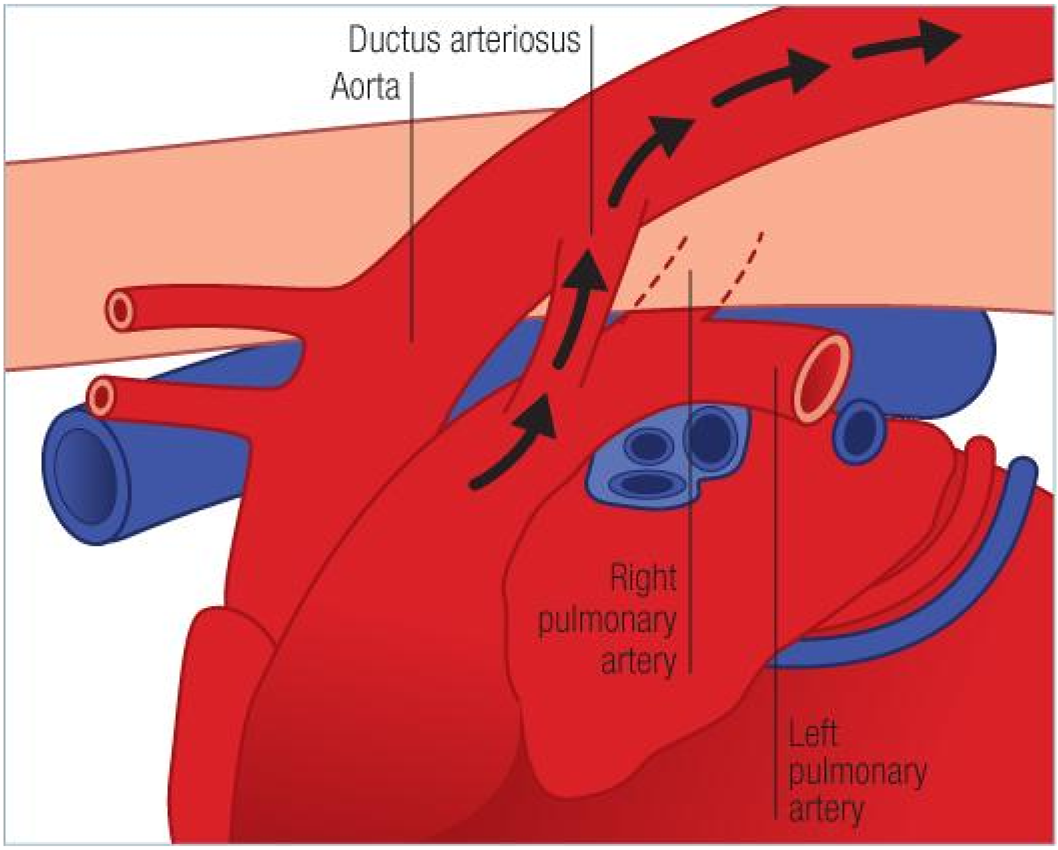


Fig. 1. Schematic drawing of the embryonic ductus arteriosus that connects the main pulmonary artery with the aorta during fetal development.

However, it may also be an incidental finding in adult dogs without any signs of heart failure during a routine examination or when assessing another disorder. In these animals, the size of the PDA is small, and the hemodynamic changes are not very significant.

Pathophysiology of PDA

PDA causes a volume overload in the left side of the heart, which in the long term leads to alterations and injuries such as:

- Progressive dilatation and hypertrophy of the left ventricle.
- Distension of the mitral valve, with secondary regurgitation.
- Left congestive heart failure.
- Pulmonary edema.

- Atrial fibrillation due to the excessive dilatation.
- Dilatation and weakening of the wall of the aorta or the pulmonary arteries.

Over time, and due to left heart failure, the direction of the blood flow through the PDA changes to a right-to-left flow (reverse flow). Cyanosis appears, as non-oxygenated blood from the pulmonary artery mixes with the oxygenated blood in the aorta.
The machinery murmur may disappear and become a diastolic murmur, which may be impossible to auscultate if there is equilibration of the aortic and pulmonary blood pressure.

Most patients with untreated PDA die of progressive heart failure during the first year of life.

Diagnosis

Thoracic radiographs show enlargement of the left atrium and ventricle, dilatation of the pulmonary vessels and bulging of the aorta on ventrodorsal view (Figs. 2 and 3).

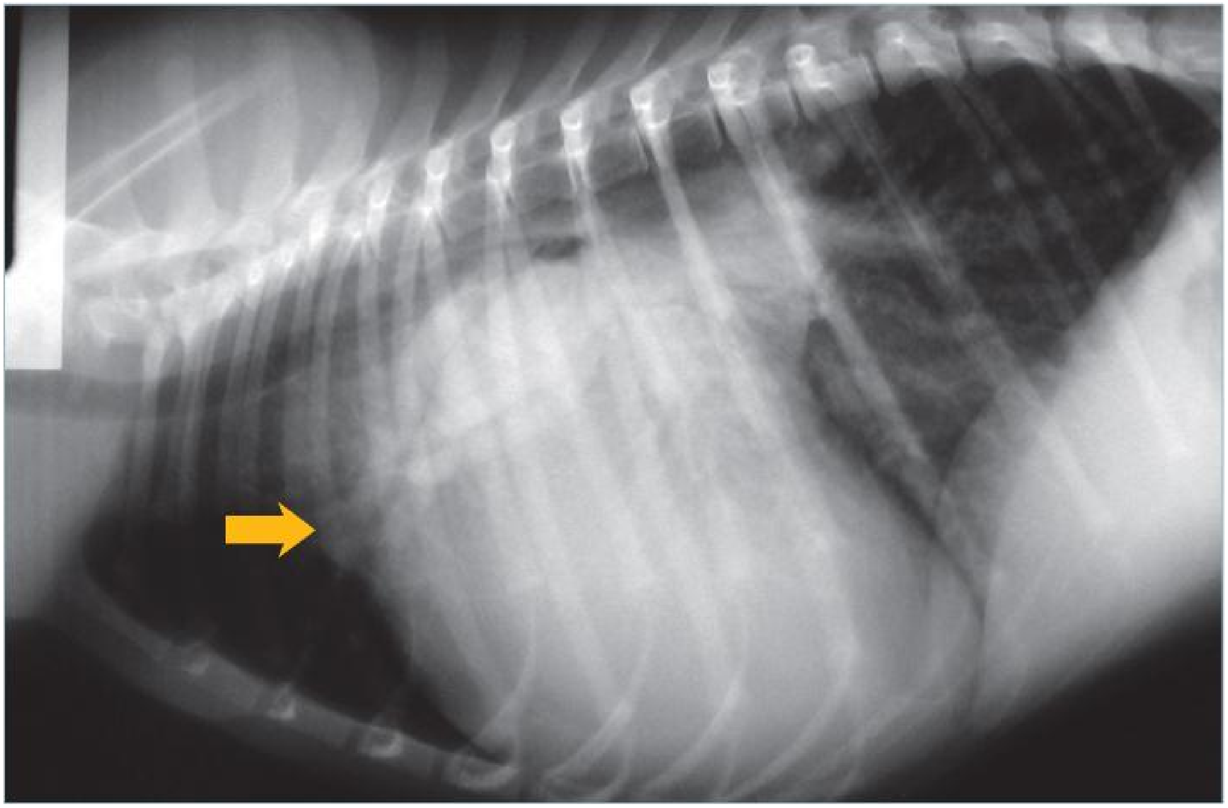


Fig. 2. Lateral view. Note the dilatation of the heart and the arterial branches that accompany the bronchi (arrows), as well as edema in the pulmonary hilum.

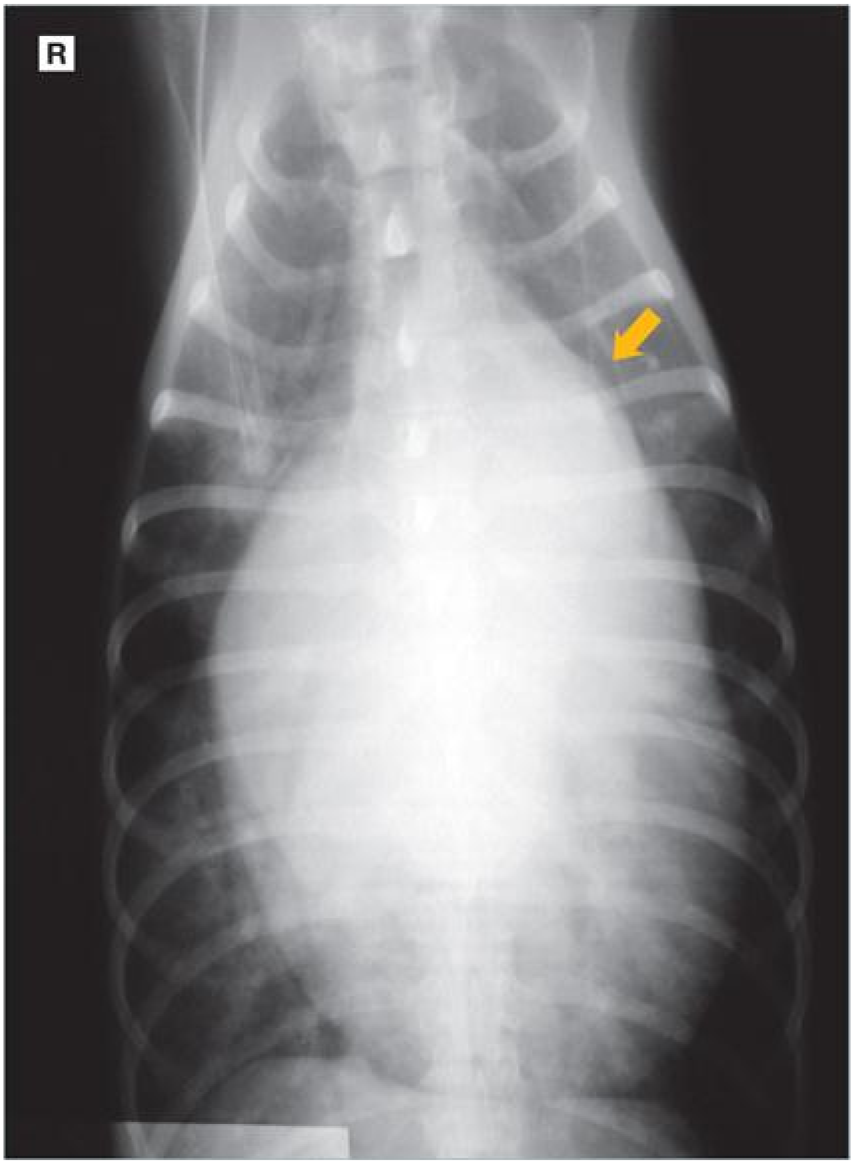


Fig. 3. On the ventrodorsal view, dilatation and bulging of the cranial aorta can be seen (arrow).

The diagnosis is confirmed by echocardiography, which shows dilatation and hypertrophy of the left ventricle, a dilated pulmonary artery, increased aortic ejection flow velocity and on Doppler sonography, turbulence in the pulmonary artery (Fig. 4).

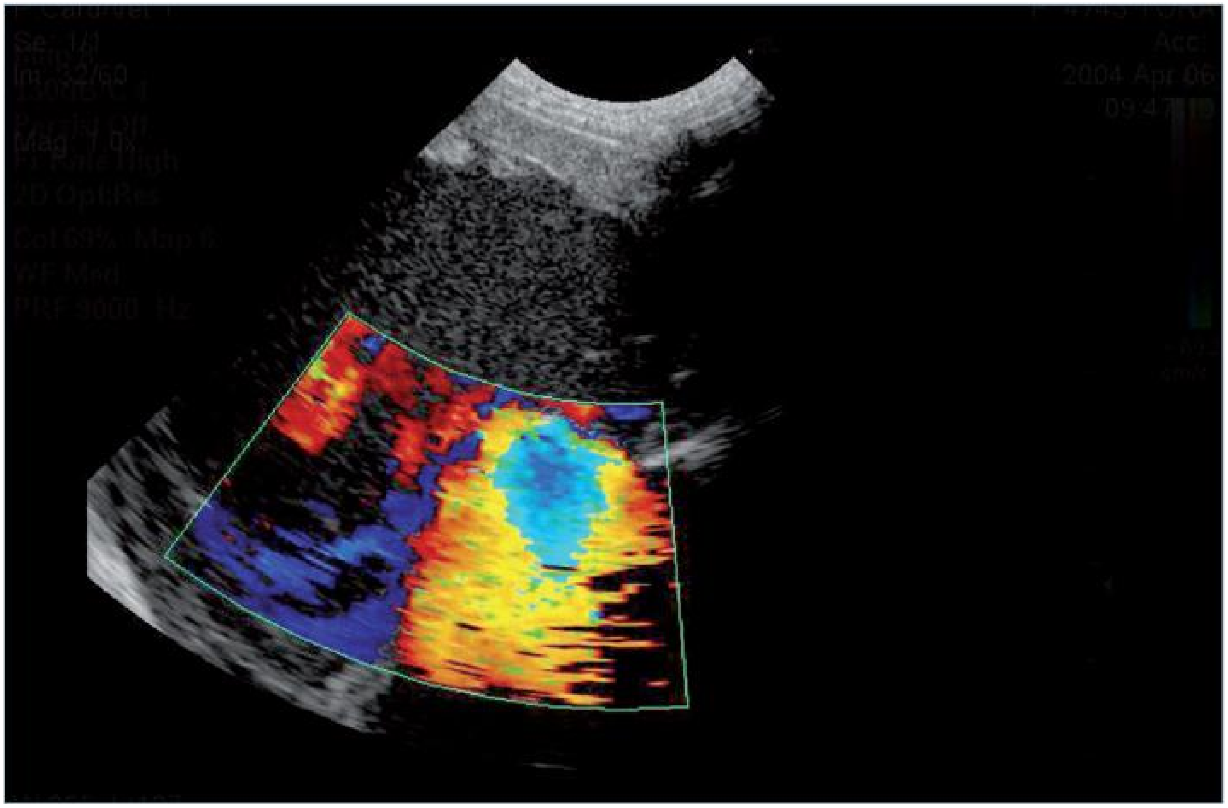


Fig. 4. Turbulent flow in the pulmonary artery, as seen with color Doppler ultrasonography.

On the electrocardiogram, the lead II may show tall R waves (>2.5 mV) or wide P waves, but these are not always present.

Treatment

In general terms, it is recommended to close the PDA as soon as possible after diagnosis, using either conventional or minimally invasive techniques.

Surgical intervention is contraindicated in patients with a right-to-left flow through the PDA (reverse flow). In this case, PDA closure will cause pulmonary hypertension that is incompatible with life.

The mean survival time after surgery is 14 years. This period is reduced to 9 years if the patient does not undergo surgery.

Patients presenting with congestive heart failure should be treated prior to the intervention with diuretics (furosemide 2-4 mg/kg/6h), digoxin (0.005-0.0011 mg/kg/12h) and vasodilator drugs (enalapril 0.1-0.3 mg/kg/12h).

Excessive diuresis or vasodilatation should be avoided, as they produce undesirable hypotension.

Surgical options

Minimally invasive surgery:

- Thoracoscopy and PDA closure with endoclips.
- Image-guided minimally invasive surgery, also called interventional radiology (Fig. 5), in which the PDA is first catheterized, followed by the placement of a self-expanding occluder (Amplatzer).

Fig. 5. Arteriograph performed prior to occlusion of the PDA shows the aorta (yellow arrow), common pulmonary artery (blue arrow) and patent ductus arteriosus (white arrow).

These techniques are minimally invasive and reduce iatrogenic lesions to a minimum; recovery of the patient is also better and faster. They require special equipment and specialist training and the procedure is complex in small patients (less than 7 kilos).

Conventional surgery

The standard correction of a PDA is by ligation with non-absorbable multifilament material. The approach to the PDA is by thoracotomy through

the left fourth intercostal space.
The vagus nerve crosses the ductus arteriosus and may be used as a reference point to find the ductus (Fig. 6).
After identification and isolation, the PDA may be dissected and ligated using the techniques presented in the following chapter.
During closure of the PDA, a Branham reflex may occur, which is characterized by severe bradycardia as a consequence of the rapid increase in aortic flow.

The rapid closure of a PDA may lead to a vagal reflex due to stimulation of the mechanoreceptors[1] of the left atrium.

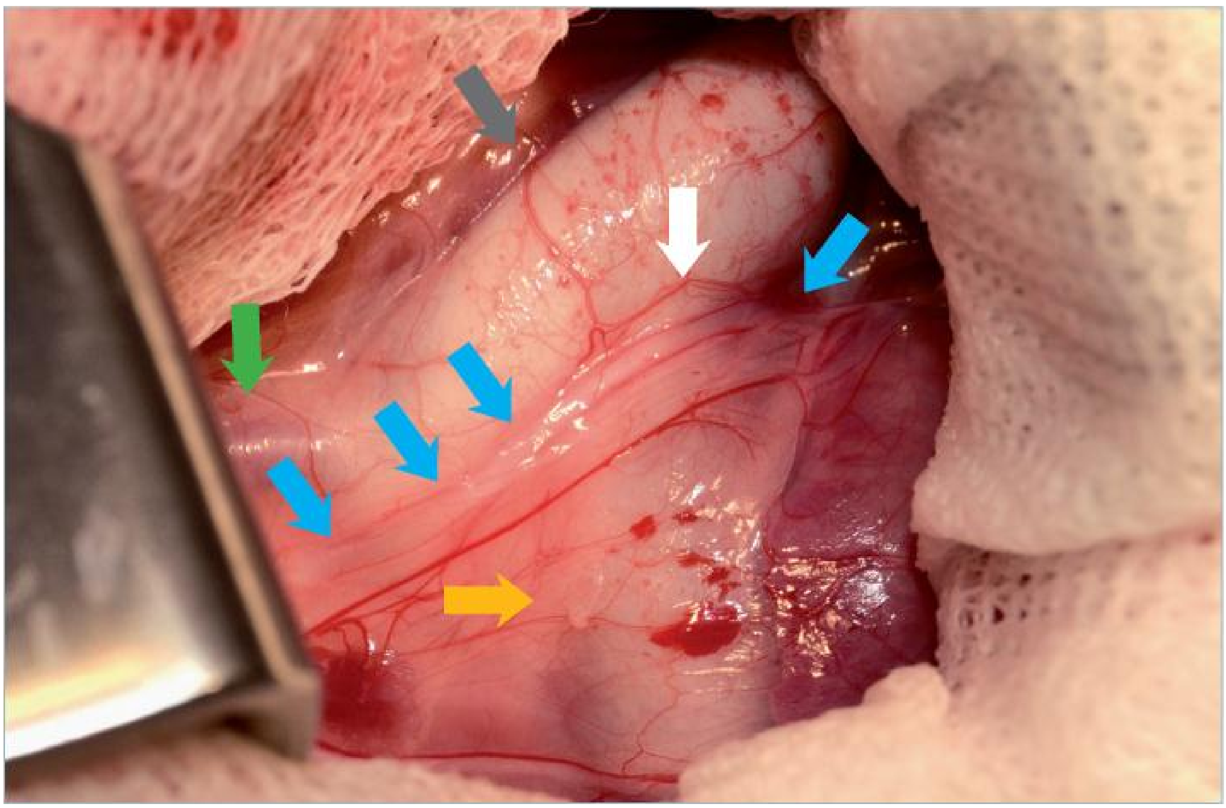


Fig. 6. Image of the base of the heart, on which the following structures may be observed: left subclavian artery (green arrow); descending aorta (grey arrow); pulmonary artery (yellow arrow); vagus nerve (blue arrows); patent ductus arteriosus (white arrow).

Results and complications

Occlusion of the PDA will cure the condition in the majority of patients if performed in young animals (under 6 months of age). In these patients, the mitral regurgitation and heart failure are reversible.

During the postoperative period, treatment with angiotensin II receptor blockers may be indicated in animals with mitral insufficiency or heart failure.

Mortality due to intraoperative complications is minimal if the operation is performed by an experienced surgeon (0-2 %).
The most important and severe intraoperative complication is rupture of the PDA or the right pulmonary artery. This risk increases if the animal is over two years of age.

Small ruptures of the posterior (right) side of the PDA during dissection can be controlled quite well by pressing swabs on the area, but during further dissection they may become bigger, with increasing blood loss. If there is a larger rupture, the hemorrhage should be controlled with vascular clamps on the PDA or aorta and pulmonary trunk (outflow vascular occlusion technique), after which a surgical technique should be selected to solve the problem. The options are:

- Altering the dissection plane and using the Henderson-Jackson technique.
- Placing a continuous suture on the PDA, using wide resistant bites.
- Resection of the PDA between the clamps and oversewing of the free ends.

[1] A mechanoreceptor is a sensory receptor that responds to mechanical pressure or distortion.

Prevalence	■	■	■	□	□
Technical difficulty	■	■	■	■	□

The patient is placed in right lateral recumbency and a thoracotomy is performed through the fourth intercostal space to gain access to the base of the heart.

The left cranial lung lobe is displaced caudally and immobilized with moistened compresses to get a clear view of the phrenic and vagus nerves, the aorta, the pulmonary artery and the patent ductus arteriosus (PDA) (Fig. 1).

The left vagus nerve always crosses over the PDA. First, this nerve should be carefully dissected and marked with a thread or vascular tape in order to keep it identifiable at all times and avoid accidental damage (Fig. 2). The recurrent laryngeal nerve, which runs along the caudal side of the PDA, should also be identified (Fig. 2, white arrow).

The left recurrent laryngeal nerve bends around the PDA and continues in a cranial direction. It can often be identified (Fig. 2), but if not, it should be kept in mind during dissection of this area.

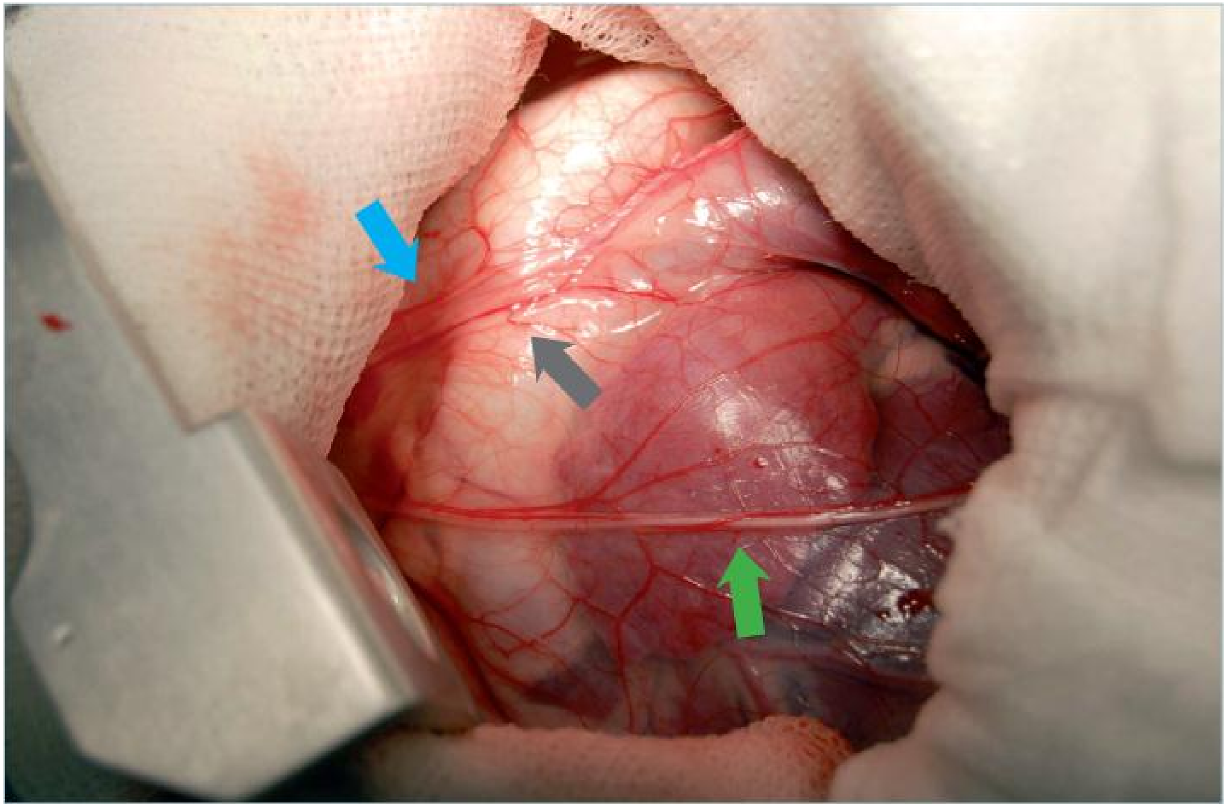


Fig. 1. Image of the base of the heart. Note the vagus nerve (blue arrow), the patent ductus arteriosus between the pulmonary artery and the aorta (grey arrow) and the phrenic nerve (green arrow).

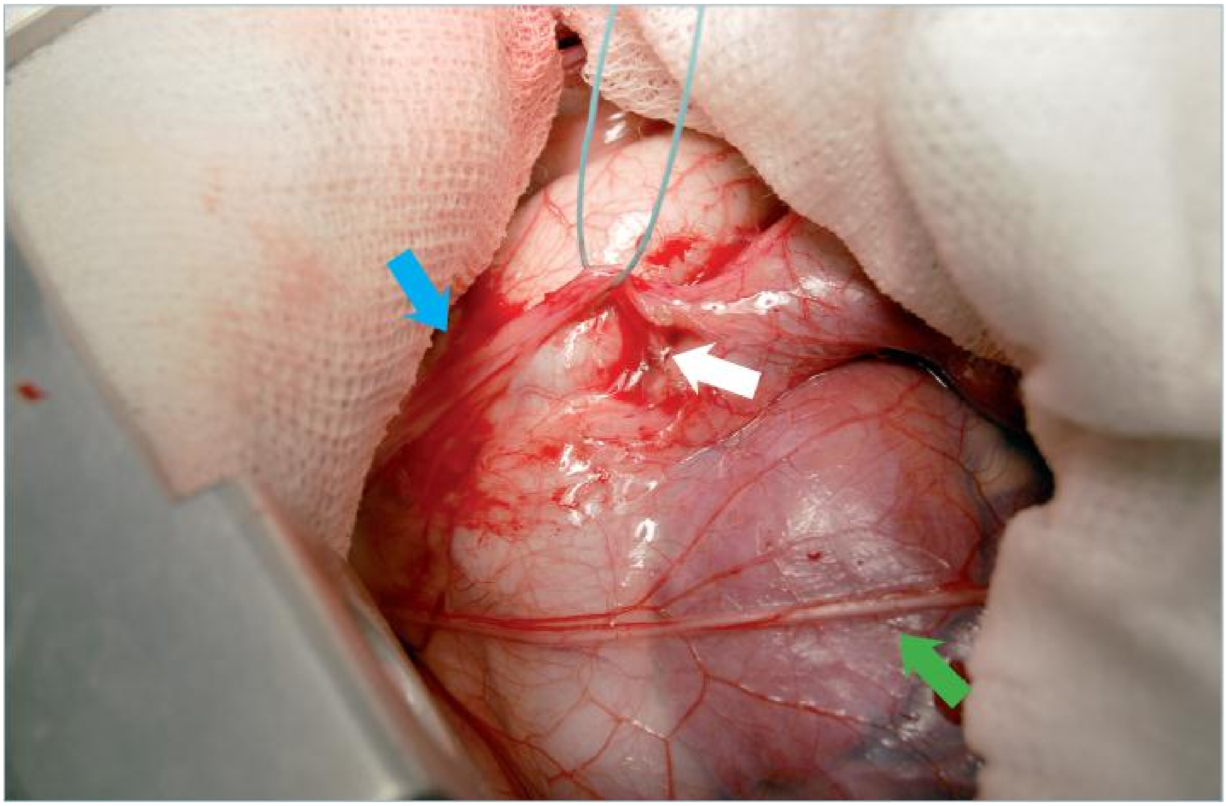


Fig. 2. Dissection of the vagus nerve to keep it identifiable at all times and avoid accidental damage. Nerves: vagus (blue arrow), left recurrent laryngeal nerve (white arrow) and left phrenic nerve (green arrow).

Next, the cranial and caudal sides of the PDA are dissected free in preparation for the placement of two ligatures of a non-absorbable multifilament material around the ductus (Figs. 3-5).

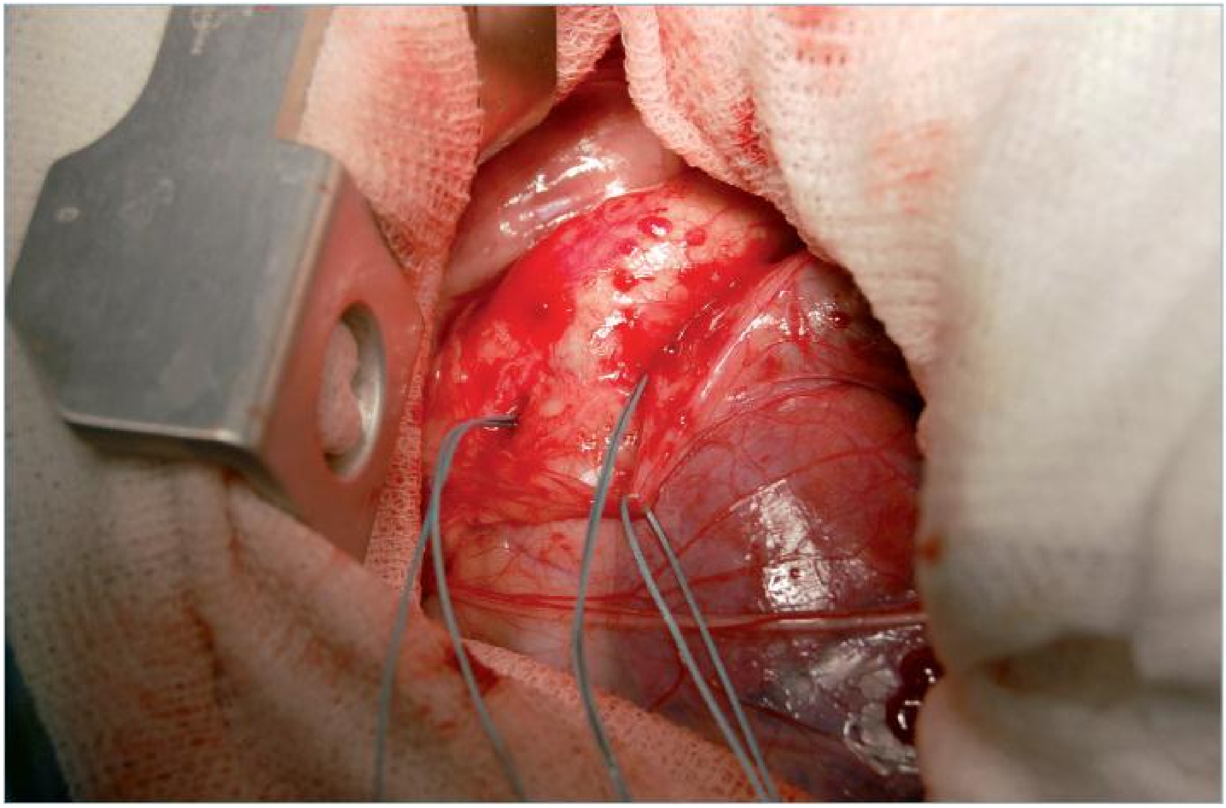


Fig. 3. After ventral retraction of the vagus nerve and dissection of the PDA, two ligatures of a non-absorbable multifilament material are placed.

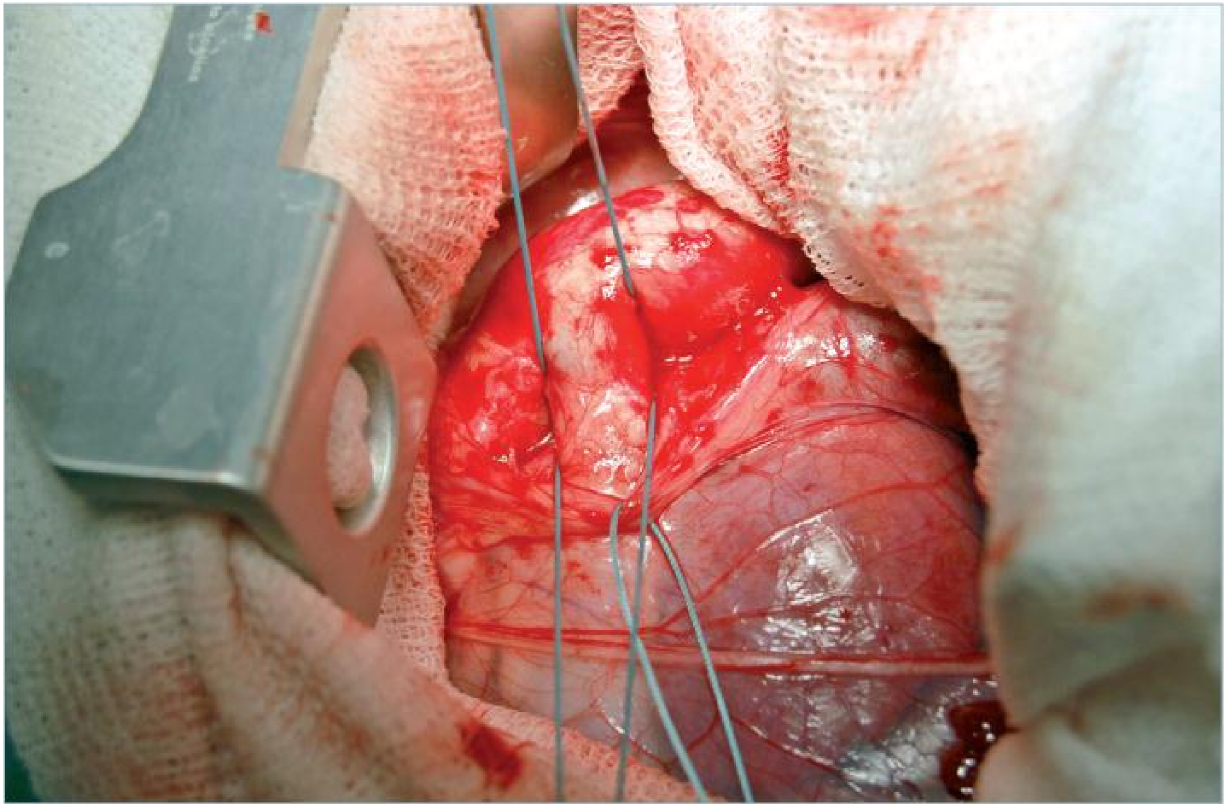


Fig. 4. The ligatures should be kept apart and not cross on the right side of the PDA. They should remain independent and as far from each other as possible.

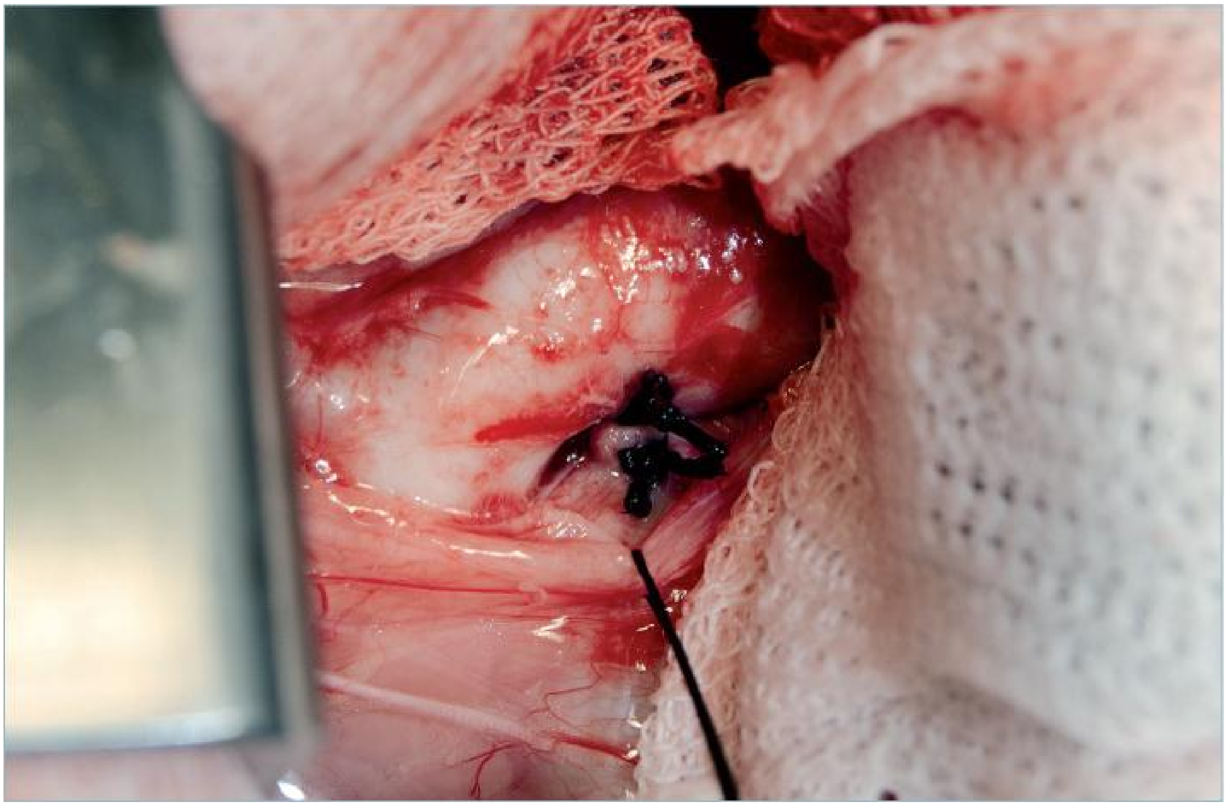
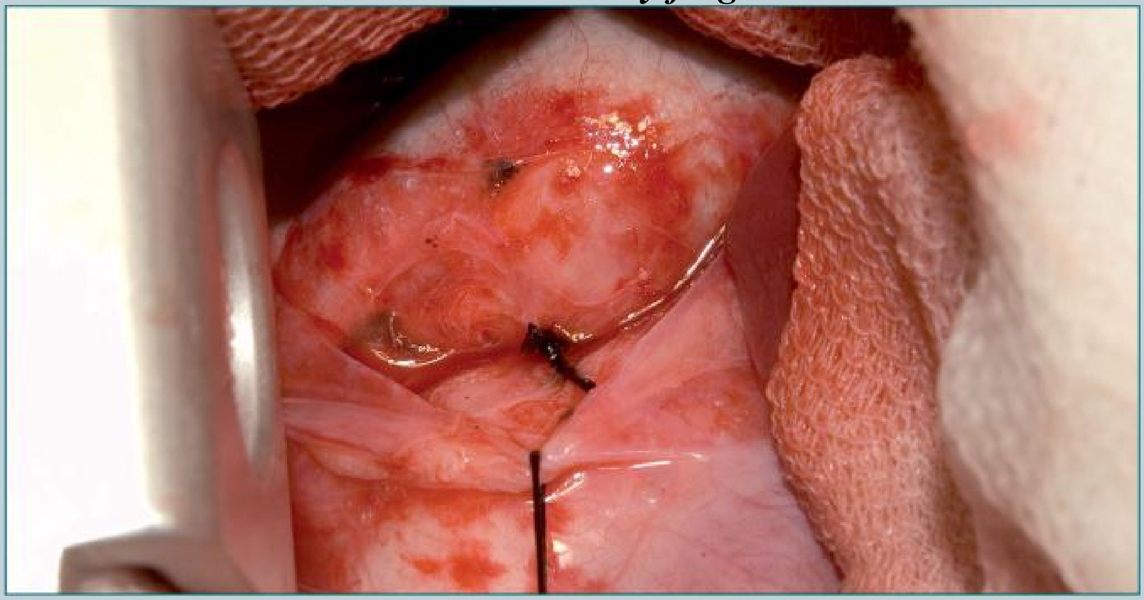


Fig. 5. Ligated ductus. The ligature closest to the aorta is tied first, and the second ligature is tied as far away as possible from the first.

In some patients, the ductus is very short and only a single ligature can be placed. In this case, the surgeon should be extremely careful,

because the vascular structures are very fragile.



If the ligature provokes a Branham reflex, it should be loosened, then re-tied more gradually. An alternative is the use of atraumatic forceps to clamp the PDA prior to tying the ligature.

To place ligatures around the PDA, either of the techniques that will be described below may be chosen. They both have advantages and disadvantages that the surgeon should understand and assess for each case.

Circumferential ligature

Without opening the pericardial sac, the cranial side of the PDA between the aorta and the pulmonary trunk, and the caudal side between the aorta and the left pulmonary artery are dissected (Figs. 6 and 7).

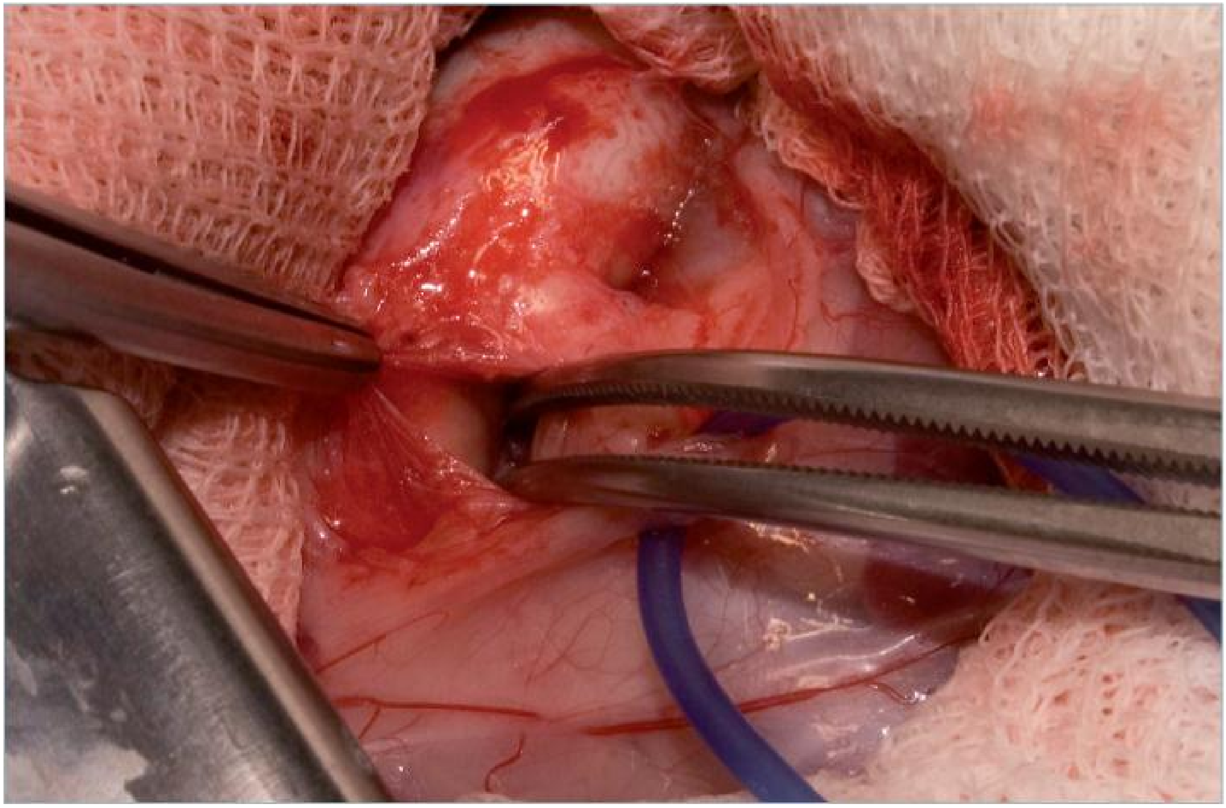


Fig. 6. Cranial dissection of the PDA with right-angle forceps. From this position, the cranial aspect of the ductus is dissected, angling the forceps over 45º in a caudal direction.

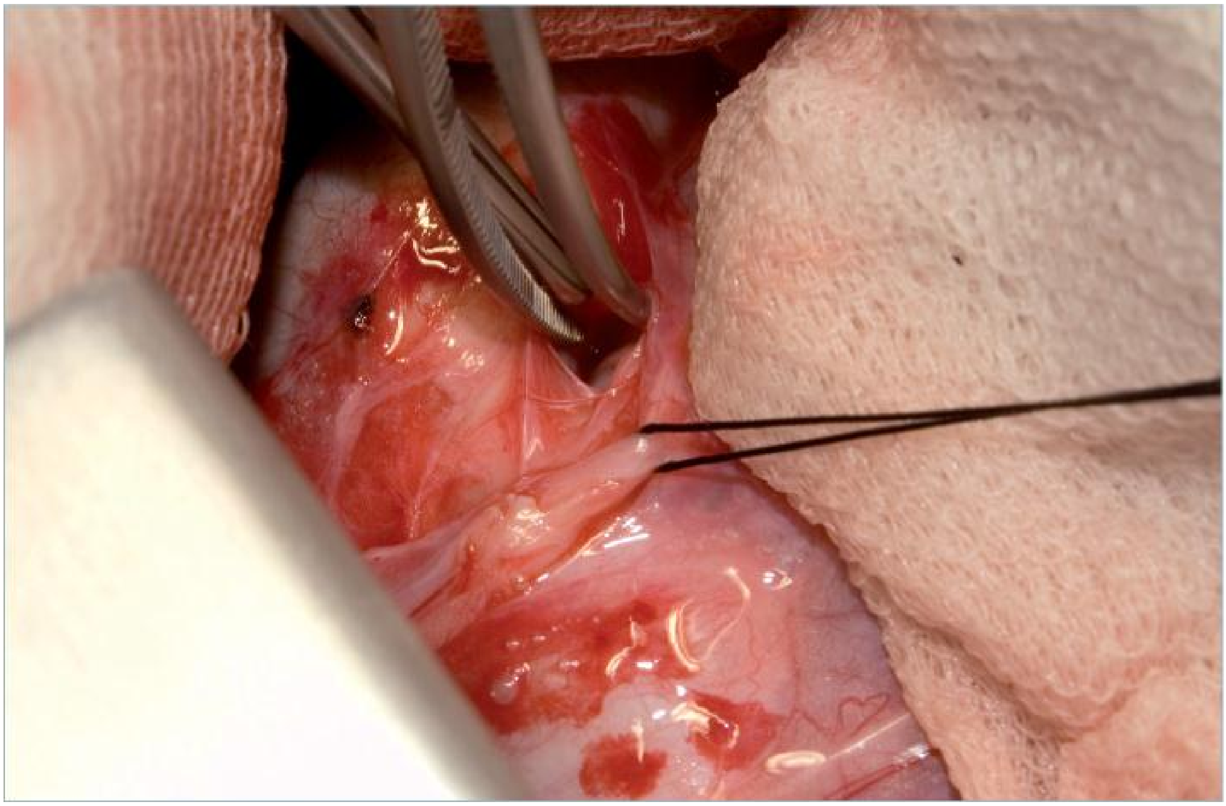


Fig. 7. A careful dissection between the PDA and the pulmonary artery is performed, with special attention so as not to damage the left recurrent laryngeal nerve that runs behind the PDA, or the right pulmonary artery (not visible in this figure).

As much as possible of the fibrous tissue that surrounds the ductus should be dissected away to ensure ligature stability and complete closure of the PDA.

Using angled forceps, the PDA is dissected carefully and gradually from the caudal side towards the cranial side, until the tip of the forceps can be palpated and observed on the cranial side (Fig. 8). Dissection is achieved by opening the jaws of the forceps no more than a few millimeters (2 or 3 mm) in order to avoid tearing the wall of the PDA, the aorta or the right pulmonary artery.

Great care should be taken when dissecting the right side of the PDA, because it is done blindly around vessels that may have weakened walls that rupture easily.

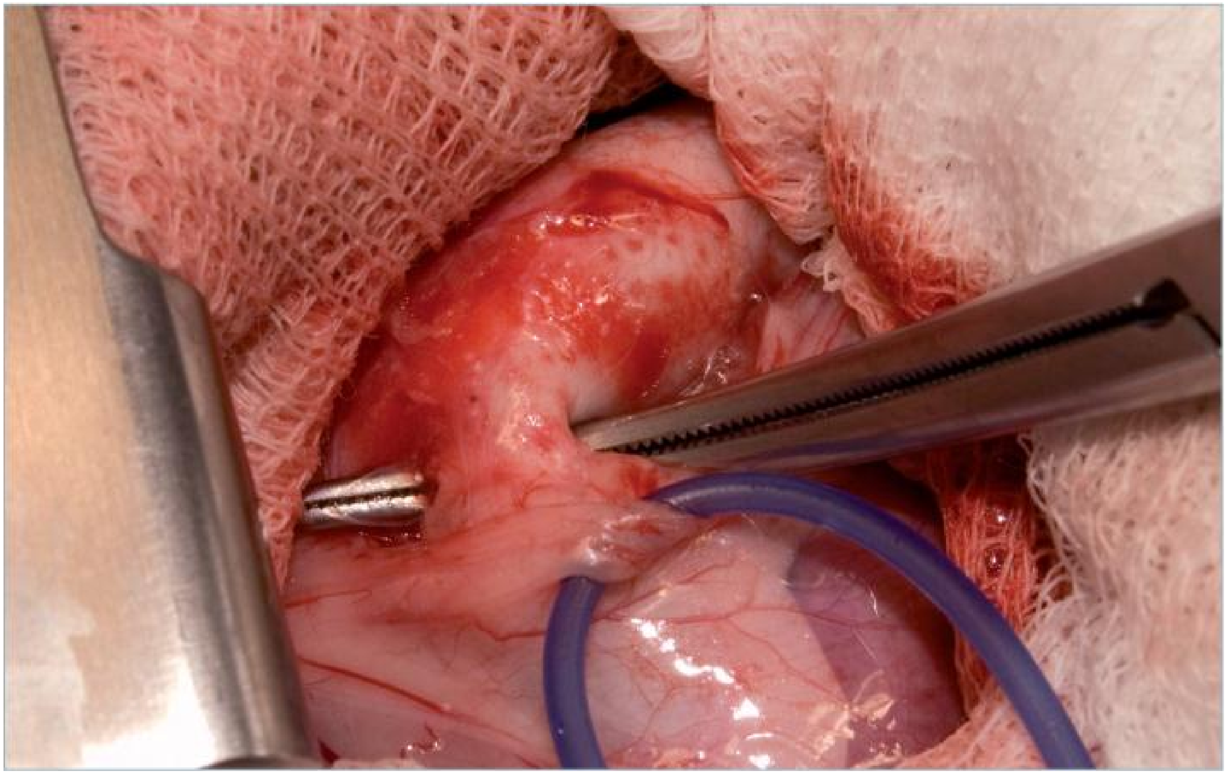


Fig. 8. The medial side of the PDA is dissected slowly and carefully, passing the forceps from caudal to cranial. This should be done with extreme care to avoid tearing the walls of the vessels.

The ligatures should be independent; they should not cross on the medial side of the PDA.

The ligature closest to the aorta should be tightened slowly and carefully, but firmly, followed by the ligature close to the pulmonary artery (Fig. 9).

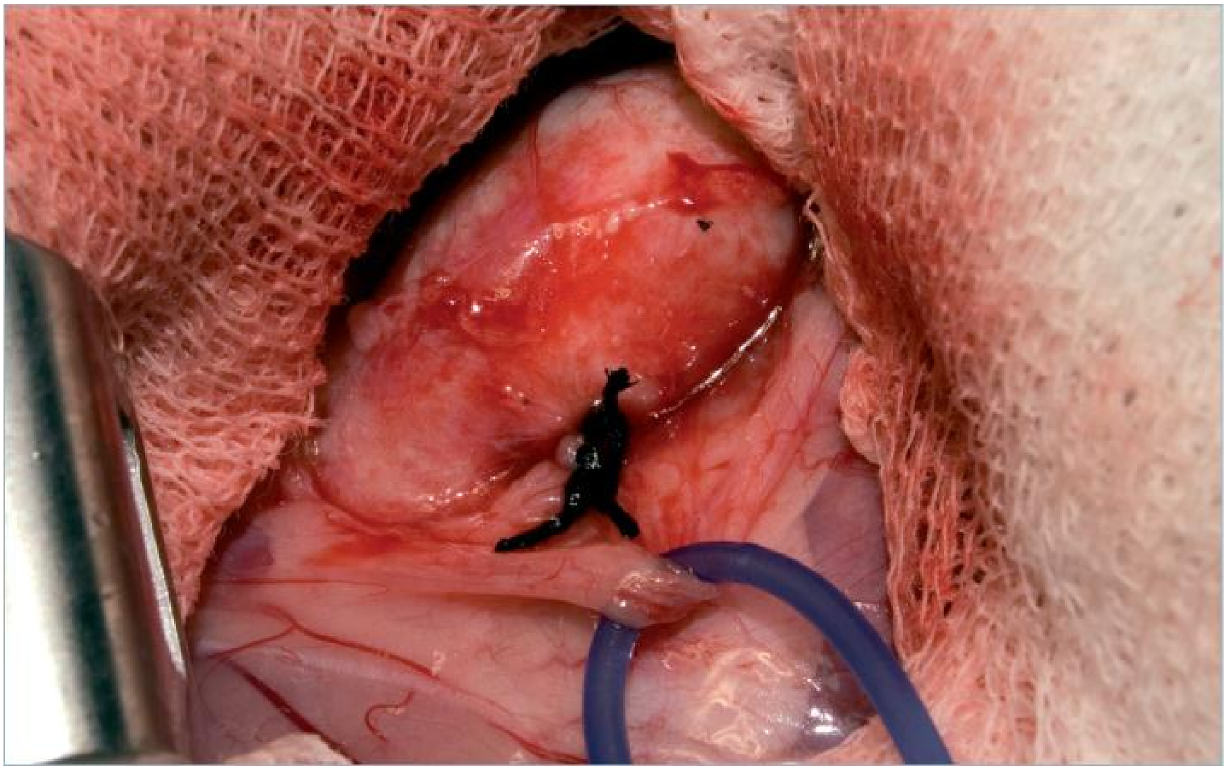


Fig. 9. The PDA has been occluded with two ligatures of 0 silk.

Next, the suture is picked up with the forceps and passed behind the PDA; this should be done slowly to avoid the sawing effect of multifilament material (Figs. 3 and 4).

To avoid the sawing effect of multifilament thread, it should be moistened in saline or impregnated with coagulated blood.

If the forceps do not pass smoothly through the tissue, the mediastinum has been clamped; do not use force or pull, but open the jaws and repeat the procedure as many times as necessary until the forceps slide through correctly.

The same procedure is used to pass a second ligature. As an alternative, a loop of suture material may be passed that is then cut to obtain two sutures (Fig. 4).

Jackson-Henderson technique

This technique was invented as an alternative to the circumferential ligature that has been described, to avoid the blind dissection of the medial side of the PDA that might lead to the rupture of the ductus arteriosus, its union with the common pulmonary trunk or the right pulmonary artery.

Intraoperative hemorrhage occurs in 6-10 % of cases.

The dorsal pleura is incised and dissected alongside the aorta from the left subclavian artery to the first aortic intercostal artery. If the latter is not visible, it may be identified by passing the forceps in a caudal direction starting at the aortic arch (Fig. 10).

Dorsal dissection of the aorta should be performed with care to avoid damage to the thoracic duct that runs very close to its medial side.

The medial side of the aorta should always be dissected with great care and precision, using the fingers or a blunt instrument.

Careful dissection of the medial side of the aorta is essential to ensure that the ligatures are positioned freely and do not enclose mediastinal tissue when tied, which might hamper closure of the ligature.

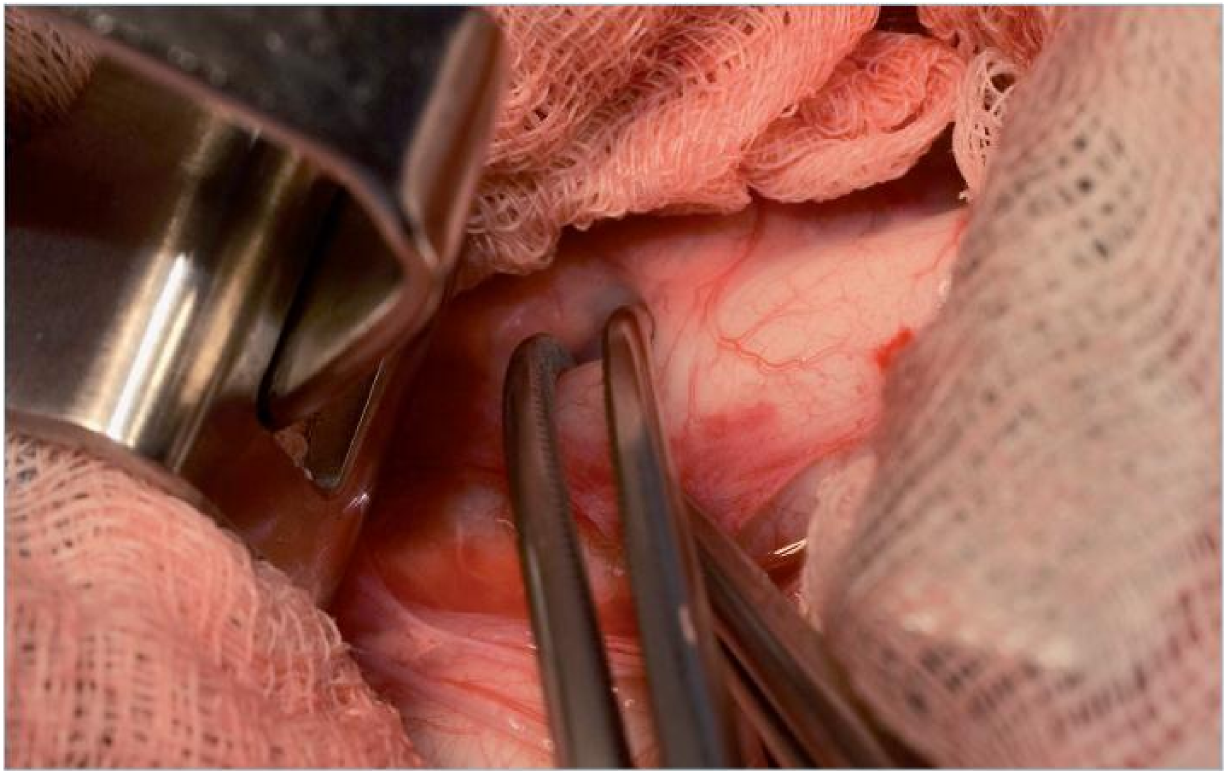


Fig. 10. Dissection of the dorsal and cranial side of the aorta. It should be dissected along the portion that lies between the subclavian artery and the first aortic intercostal branch.

Next, the cranial and caudal sides of the PDA are carefully dissected. The angled forceps are passed from the cranial side of the ductus to the dorsal side of the aorta. The two ends of a loop of suture material are clamped and pulled through carefully (Figs. 11 and 12).

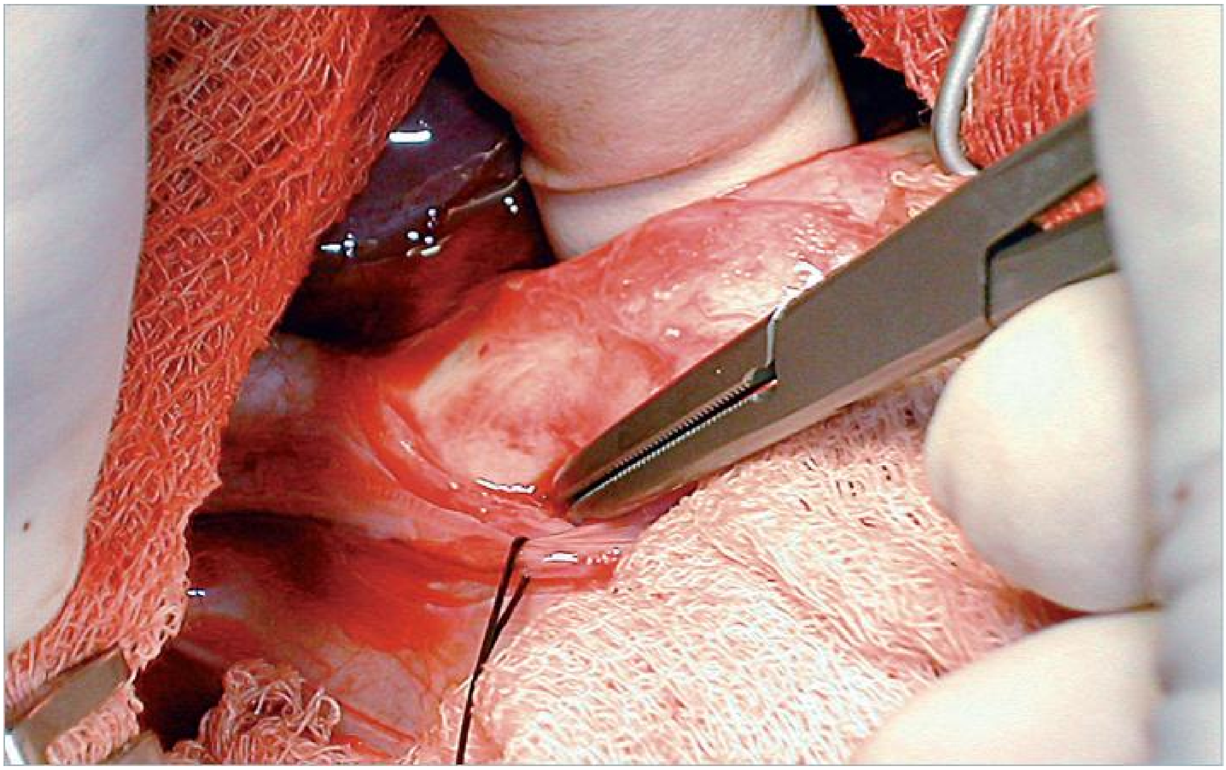


Fig. 11. Manual blunt dissection of the medial side of the aorta works very well. The passage of angled forceps under the ventral side of the aorta towards the right dorsal area is made easier by direct palpation, as shown in this image.

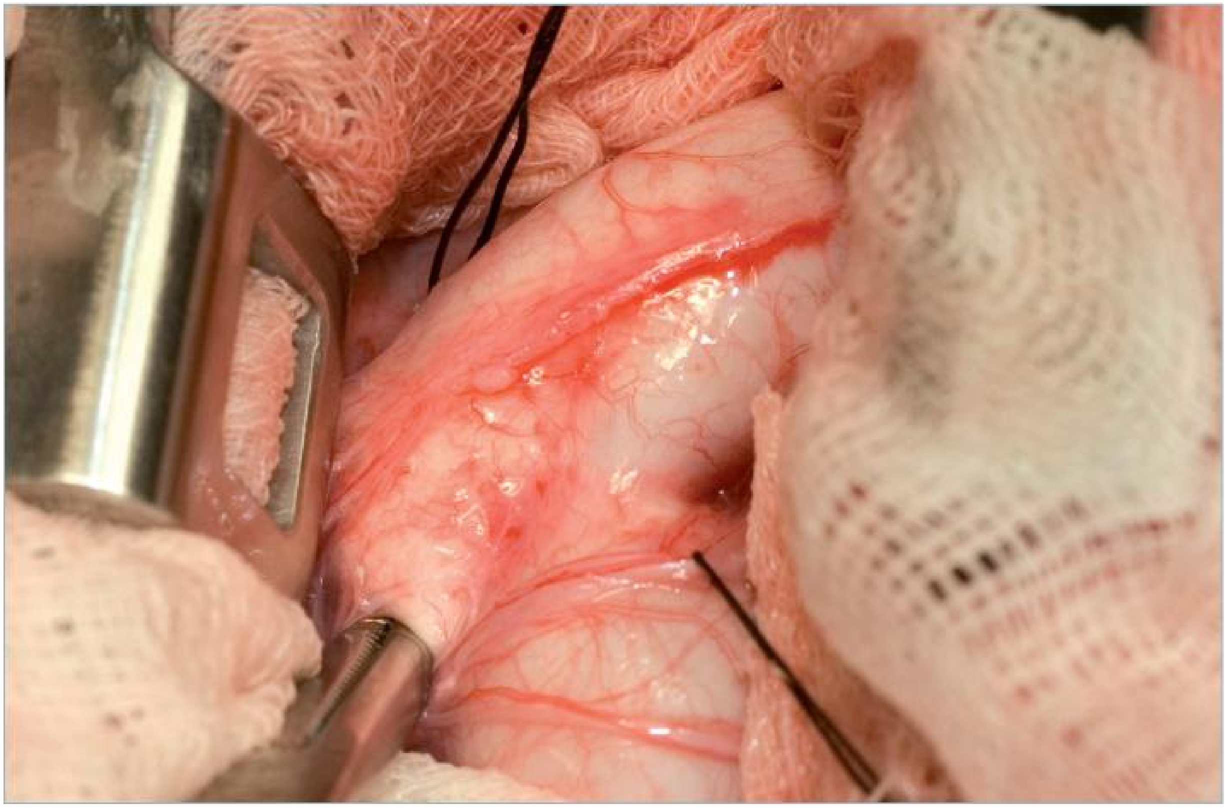


Fig. 12. The loop of a double strand is clamped and passed carefully around the aorta, without pulling hard, to avoid friction between the thread and the vessel.

The same procedure is repeated in the caudal area of the PDA (Fig. 13) then the loop is cut to obtain two independent ligatures.

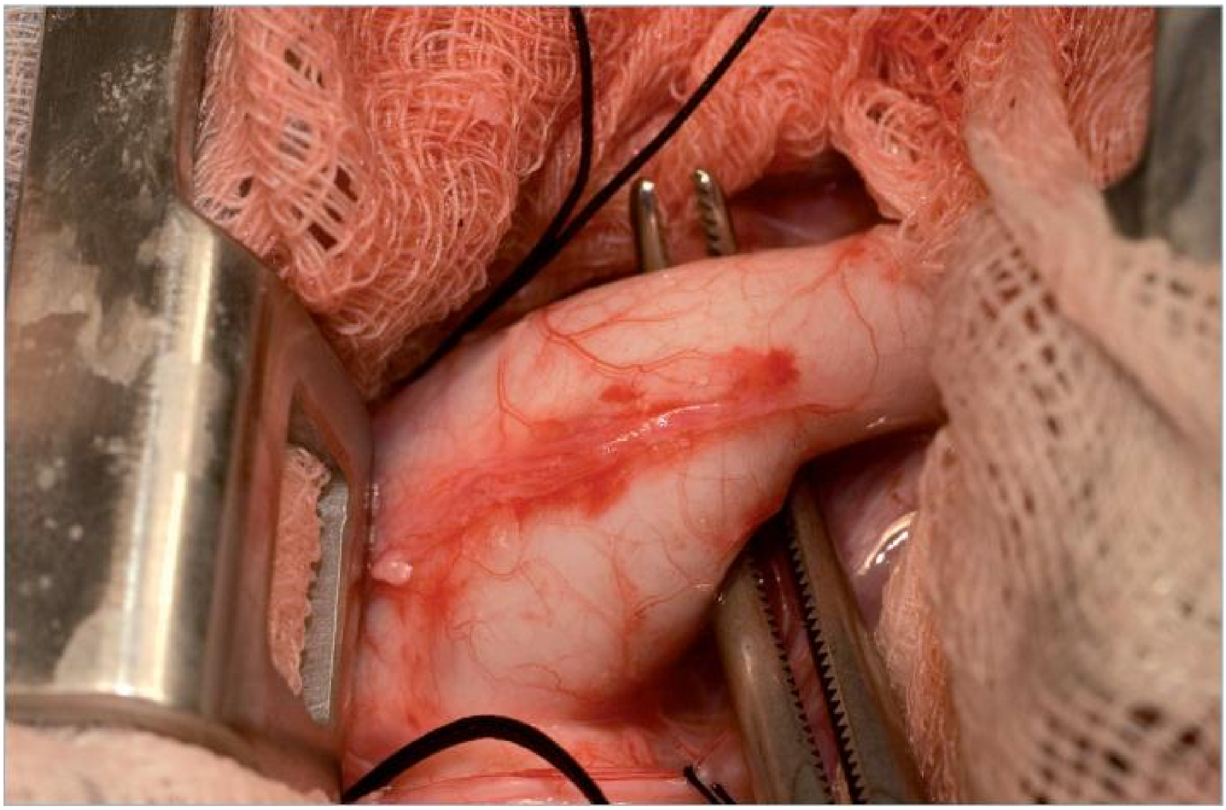


Fig. 13. The angled forceps are inserted from the caudal side of the PDA towards the dorsal area of the aorta to pass the remaining strands.

The ligatures are moved to a position in which they are independent and do not cross on the medial side of the ductus (Fig. 14).

The strands should be carefully pulled into place; they should pass from the dorsomedial side of the aorta to the medial side of the PDA.

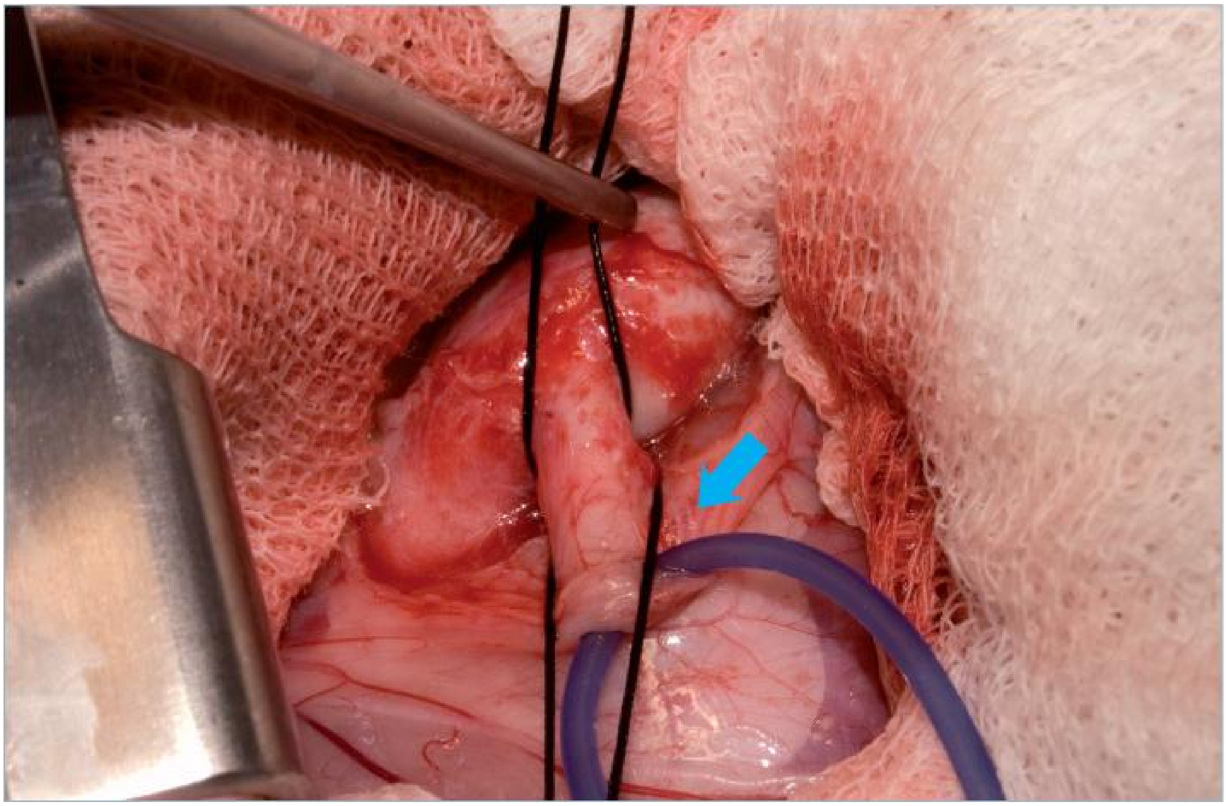


Fig. 14. It is very important that the ligatures are independent and do not cross; the closure should be as secure and complete as possible. Avoid damage to the recurrent laryngeal nerve in this procedure (arrow).

The ligatures are firmly tied; usually, the ligature closest to the aorta is tied first and the two ligatures are separated as much as possible (Fig. 15).

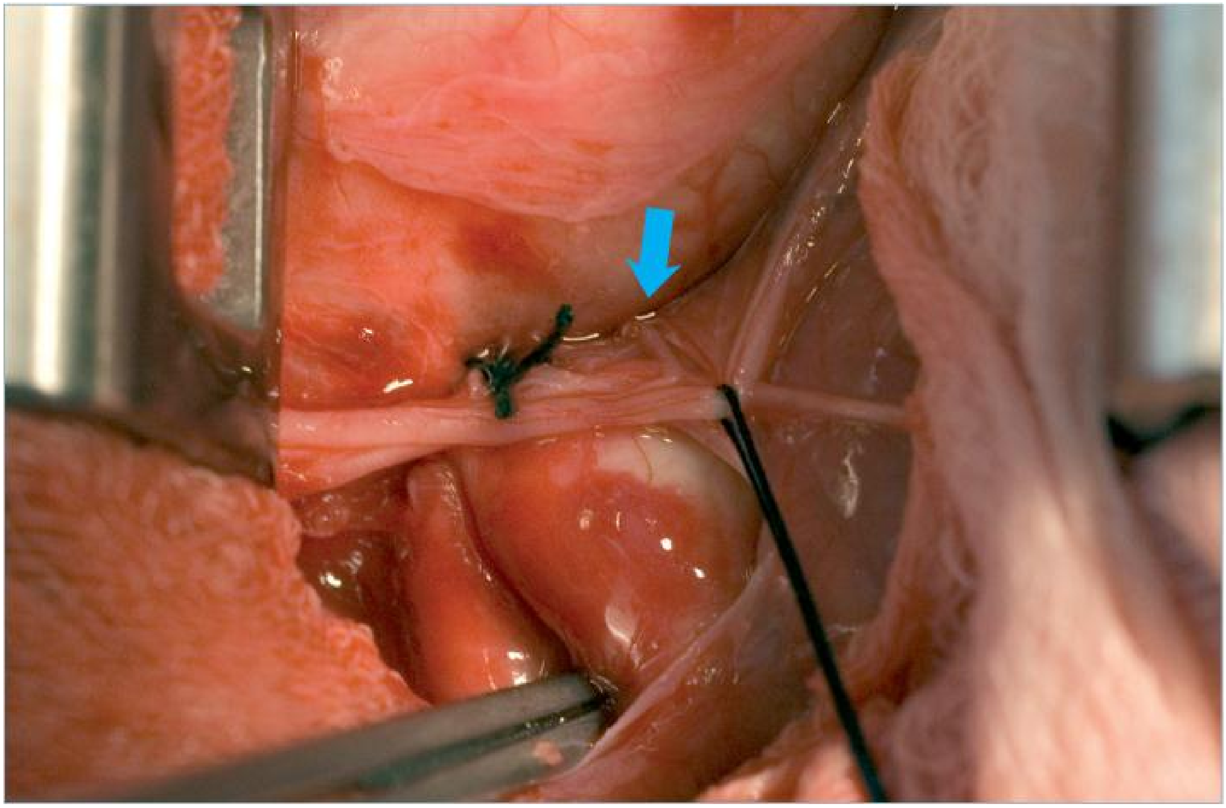


Fig. 15. Final result after tying the ligatures. There is little space and the ligatures are very close, but an attempt should be made to separate them as much as possible. The arrow indicates the recurrent laryngeal nerve.

The vessels and the PDA are visually checked for problems and palpated to confirm the absence of a turbulent thrill.

The surgeon should be familiar with both techniques and use the appropriate one in each case.

Persistent flow in the ductus is due to incomplete occlusion, but its clinical repercussion is usually insignificant.

Intraoperative complications are reduced if the surgeon has experience, dissection is done carefully and the tissues are handled with care.

Special care should be taken in adult large breed dogs, because the vessels are less elastic and the PDA is more fragile than in

younger, smaller dogs.

Recanalization of the PDA occurs in about 1-2 % of surgical cases. The risk is increased in complicated cases or if the surgeon is inexperienced.

The thoracotomy is closed in the standard manner. A chest drain is not routinely placed, unless there is a surgical complication involving the loss of blood, other fluids or air. In that case, the chest drain is normally removed after 12-24 hours.

Table I.

Possible complications of the two techniques[1]		
	Standard technique	Jackson-Henderson technique
Intraoperative hemorrhage	++	++
Rupture of the thoracic duct and secondary chylothorax	-	++
Dysphonia due to iatrogenic lesion of the recurrent laryngeal nerve	+	+
Residual flow through the PDA	++	+++[2]

[1] There is a significant reduction in complications with increasing experience of the surgeon.

[2] This may be due to inclusion in the ligature of too much mediastinal tissue of the medial side of the aorta, or to badly-tied ligatures.

Surgical results

In young dogs, the size of the heart returns to normal three months after the operation. The pulmonary vessels achieve their normal size after seven days, but aneurysmatic dilatations do not disappear, since the laxity of the vessel wall is irreversible.
In the absence of intraoperative complications, the prognosis is very good. The patient recovers completely from his heart defect.

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Patent ductus arteriosus

Perineal hernia

José Rodríguez

Prevalence

Perineal hernias almost exclusively appear in middle-aged or old, intact male dogs. They occur only anecdotally in the cat and female dogs. The breeds that are most commonly affected are: Boxer, Boston Te-rrier, Pekingese, Collie, Dachshund and the Old English Sheepdog. They are also common in small mixed breeds of the Terrier type.
Hernias originate from deterioration of the pelvic diaphragm due to weakening of the muscles. Perineal atrophy or degeneration is often multifactorial. Those that should be highlighted include: neurogenic atrophy caused by the stretching of the motor neurons of the perineal area in patients with chronic constipation and tenesmus, senile atrophy, atrophy of the coccygeal muscles in dogs with docked tails, myopathies due to endocrine disorders of the sex hormones and prostatic disease. In all cases, the result is reduced support of the rectal wall, so that the terminal portion of the digestive tract is pushed sideways, forming a pouch or a diverticulum.
The herniation is usually located lateral to the external anal sphincter. The herniated contents can slip between the sphincter and the levator ani muscle. Often, the levator ani is atrophied, leaving space for the contents to

slip out of the abdomen between the anal sphincter and the coccygeus muscle (Fig. 1).

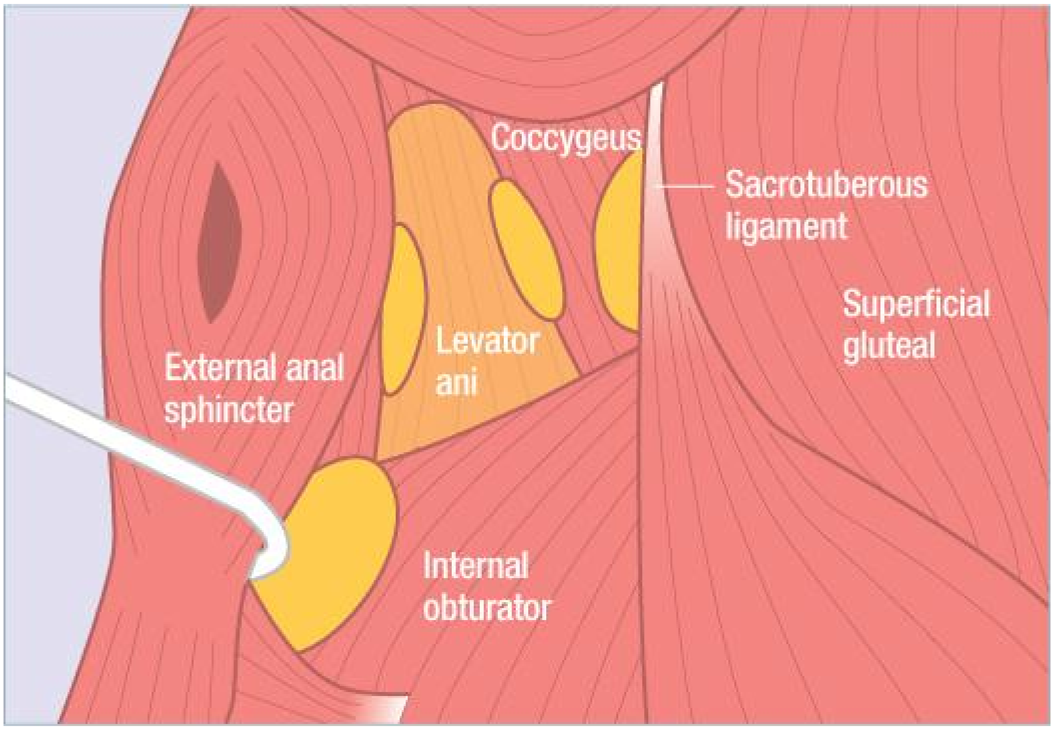

Fig. 1. Anatomical diagram of the perineum showing the possible sites of herniation.

Fig. 2. Lateral radiograph of the abdomen, showing a unilateral perineal hernia. The content of the hernia is a rectal pouch filled with feces.

Fig. 3. Ventrodorsal contrast radiograph of the abdomen, showing a unilateral perineal hernia, containing the deviated rectum.

The most common content of a perineal hernia is intestines or fatty tissues of abdominal origin. As a result of the defective muscular function of the pelvic diaphragm, the rectum is often deviated laterally, forming a loop in the herniated content. In some cases, a rectal pouch is formed following chronic constipation, and it is the pressure exerted on the perineum the retained feces that produces the hernia (Figs. 2 and 3).

The bladder and/or the prostate can also herniate. Sometimes, the bladder retroflexes and herniates on its own, and sometimes it is dragged along with the prostate. (Figs. 4 and 5).

Clinical signs include swelling, generally reducible, of the perineum on one or both sides of the anus, depending on whether the hernia is bilateral or not (Fig. 6). Other signs include constipation, tenesmus and dyschezia, sometimes alternating with diarrhea or fecal incontinence. If the bladder is included in the hernia and is retroflexed, the clinical picture can worsen to the point when urination becomes impossible, which in turn leads to postrenal azotemia.

A complete diagnostic approach should include the identification of the anatomical structures included in the hernia, based on radiography and rectal palpation. The findings of these diagnostic tests will aid in selecting the course of treatment and aid in identification of posible surgical difficulties. For this reason, a radiograph should be taken with or without contrast media in the bladder and/or the rectum.

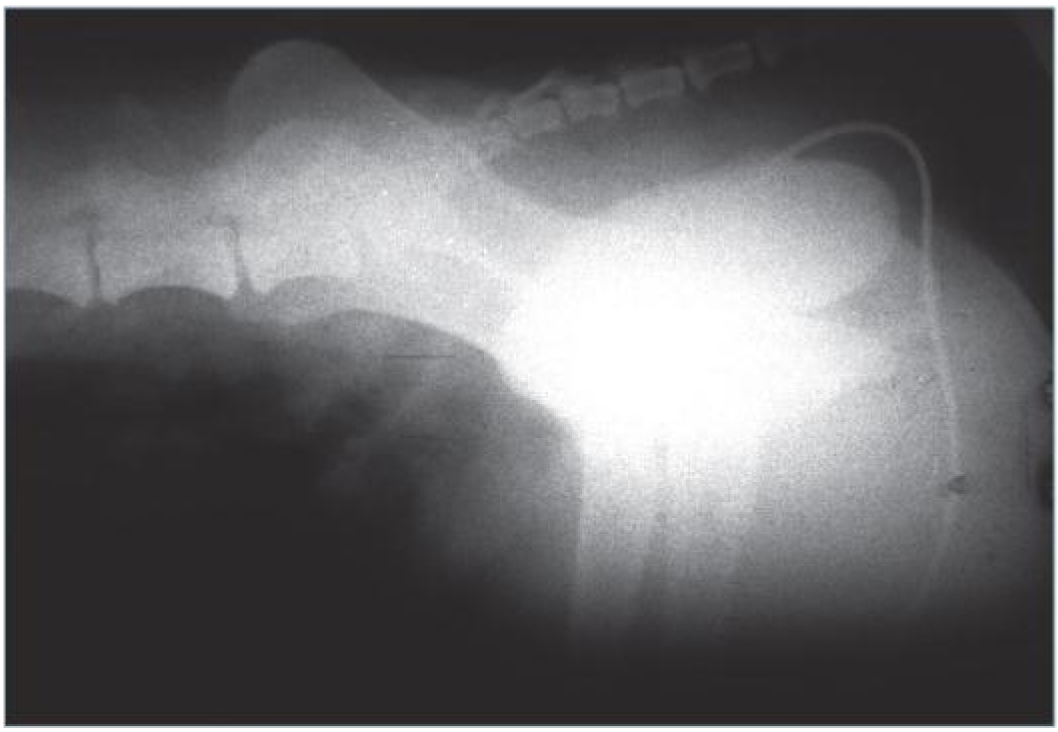

Fig. 4. Contrast radiograph, using an iodinated medium, of a cystocele with the bladder located in the perineal area.

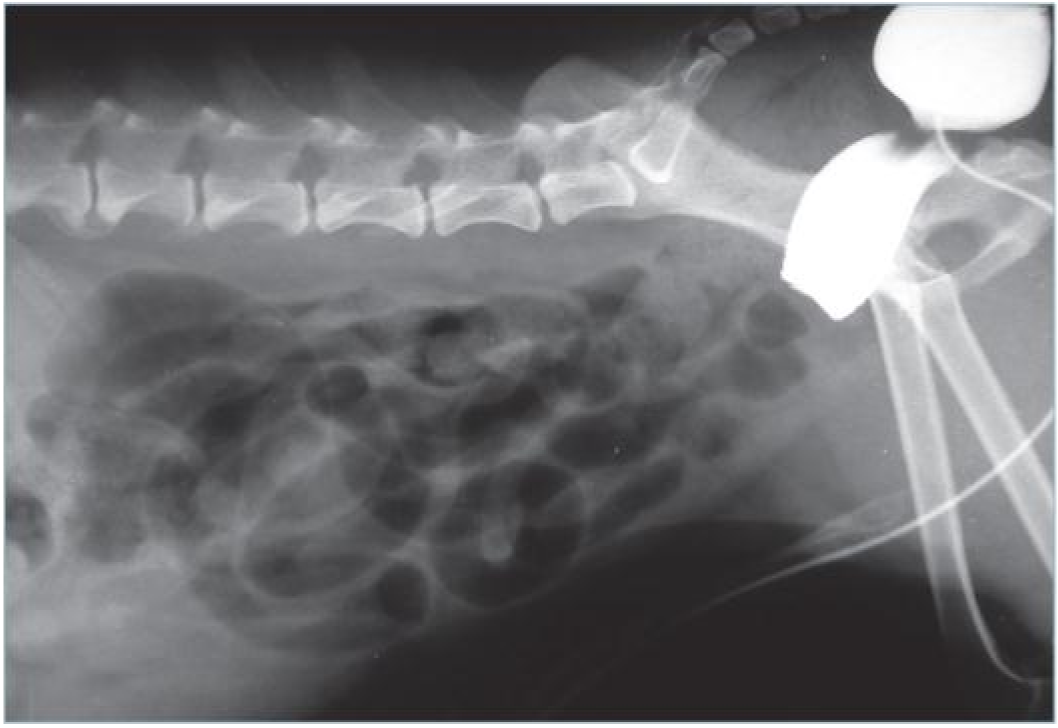

Fig. 5. This cystogram shows a caudally displaced bladder. Part of it is located in the pelvic canal, part in the hernia.

Fig. 6. Swelling of the perineal area corresponding to a unilateral perineal hernia. Note that the animal has a docked tail.

Medical and dietary treatment is aimed at defecation and the production of soft feces. It is based on the combination of a moist diet high in fiber and bulk-producing laxatives and/or stool softeners. It is recommended that all dogs be castrated. The outcome of these treatments is relatively poor and it is generally necessary to perform surgery in order to solve the problem.

If the radiological examination has shown that the bladder is included in the hernia, surgery must be performed as soon as possible. There is a risk that urine retention will lead to postrenal azotemia.

Fig. 7. Incision line for a simple herniorraphy.

Fig. 8. Extension and side incision in order to carry out a muscular transposition of the superficial gluteal and/or internal obturator muscle.

Fig. 9. Landmarks used for the approach to a perineal hernia.

Prior to surgery

- Withhold food from the patient for 24 hours to ensure emptying of the digestive tract in order to avoid contamination of the operative field.
- Administer an enema with the same objective.
- If the hernia includes the bladder, urine should be removed using a catheter or cystocentesis.
- Patients with dehydration or uremia due to urine retention should be stabilized prior to surgery.
- Prepare the surgical field and position the patient as for any other operation of the perineal area.

The perineal hernia can be repaired surgically by a number of techniques. The most suitable approach for each case depends on:

- The state of the perineal musculature (size and location of the hernia, degree of muscular atrophy…)
- The herniated content (intestines, bladder…)
- The surgeon's experience with each technique.

Surgical techniques for the repair of perineal hernias include:

- Simple herniorraphy.
- Elevation or transposition of the internal obturator muscle.

- Transposition of the superficial gluteal muscle.
- Transposition of the semintendinosus muscle.
- Placement of a mesh prosthesis.
- Cystopexy.
- Deferensopexy.
- Colopexy.

The skin incision will vary depending on the surgical technique used for repairing the hernia. For a simple herniorraphy or for the placement of a mesh, it is sufficient to make an incision lateral to the anus, over the herniated pouch, extending from the base of the tail in a ventral direction to the ischium (Fig. 7). If transposition of the superficial gluteal muscle is required, the incision should be prolonged dorsally and/or a second incision, perpendicular to the first, should extend towards the major trochanter of the femur (Fig. 8). The ischiatic tuberosity, the greater trochanter of the femur and the iliac wing are the landmarks for these approaches (Fig. 9).

After surgery

- Fit the patient with an Elizabethan collar and leave it on during the entire postoperative period.
- Administer laxatives in order to avoid straining during defecation.
- Prescribe a soft diet in order to avoid constipation.
- Advise the owner about the importance of good hygiene of the area (which should be cleaned every time the animal defecates).

Complications are rare. They include: wound infection, fecal incontinence, dysuria, tenesmus, rectal prolapse and paralysis of the sciatic nerve.
On the other hand, recurrences are relatively common, with an incidence varying between 10 and 40 % according to the literature. This percentage is largely dependent on the experience of the surgeon and the technique used. Some studies indicate that castration reduces these figures by a third, and also reduces the occurrence of a contralateral hernia.

If a hernia of this type is repaired surgically, simultaneous castration of the dog should always be recommended to the owner.

Case 1 / Simple herniorraphy

Technical difficulty	■	■	■	□	□

Fig. 1. The patient on the day of the first consultation.

Fig. 2. Ventrodorsal contrast radiograph showing that, in this case, the rectum is not included in the hernia.

Whenever it is possible to perform a simple herniorraphy, this technique is preferable as it is the easiest, and consists of closing the hernial ring with interrupted sutures. The success of the technique depends on the state of the perineal muscles adjacent to the hernial ring, which will need to support the tension of the sutures. Another determining factor is the size of the hernial ring, which will dictate the tension on the sutures.

A male, 10-year-old Poodle is presented with a swelling in the perineal area (Fig. 1). The patient shows no signs of tenesmus or fecal retention. A bilateral perineal hernia is diagnosed by rectal exploration. The rectum is not affected, which is confirmed by a contrast radiograph (Fig. 2). Surgical repair is elected.

Fig. 3. Surgical field prepared in the usual way, showing the swelling on both sides of the anus.

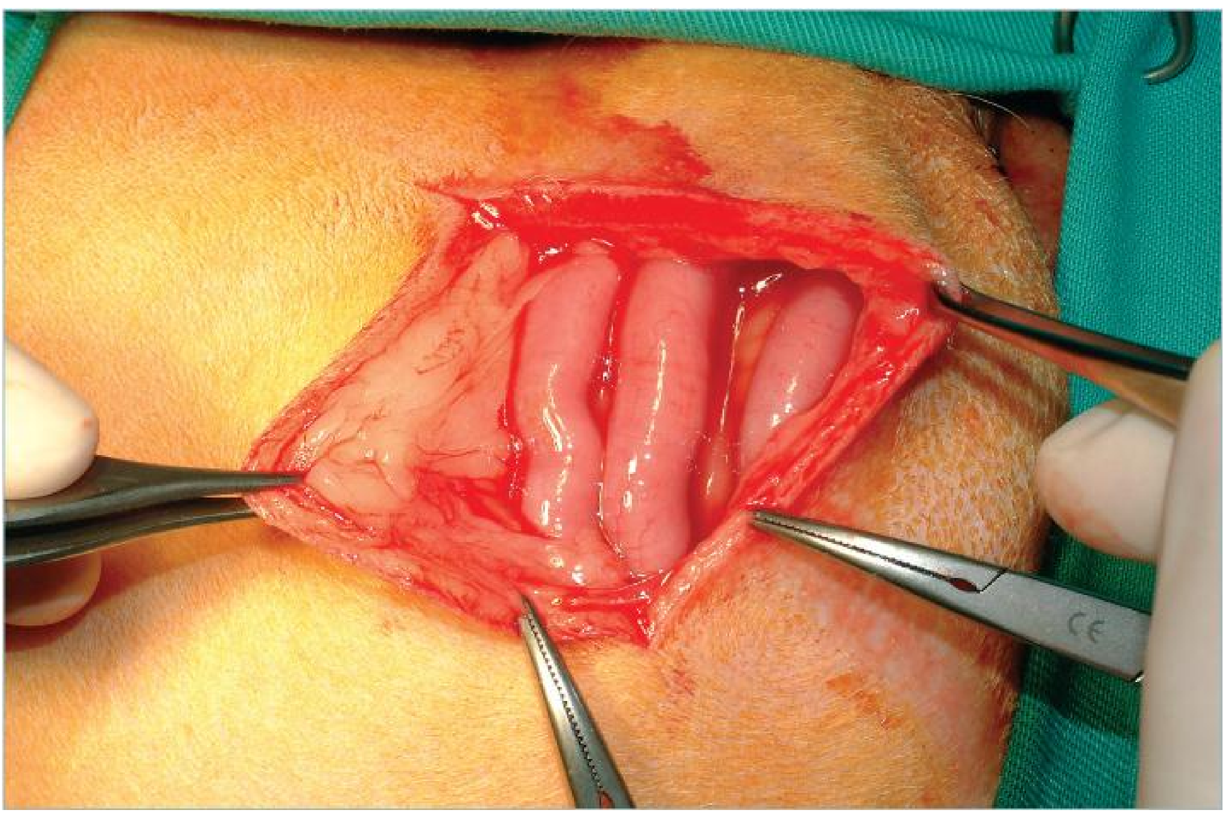

Fig. 4. After opening the hernial pouch, its contents consisting of healthy intestinal loops, can be seen.

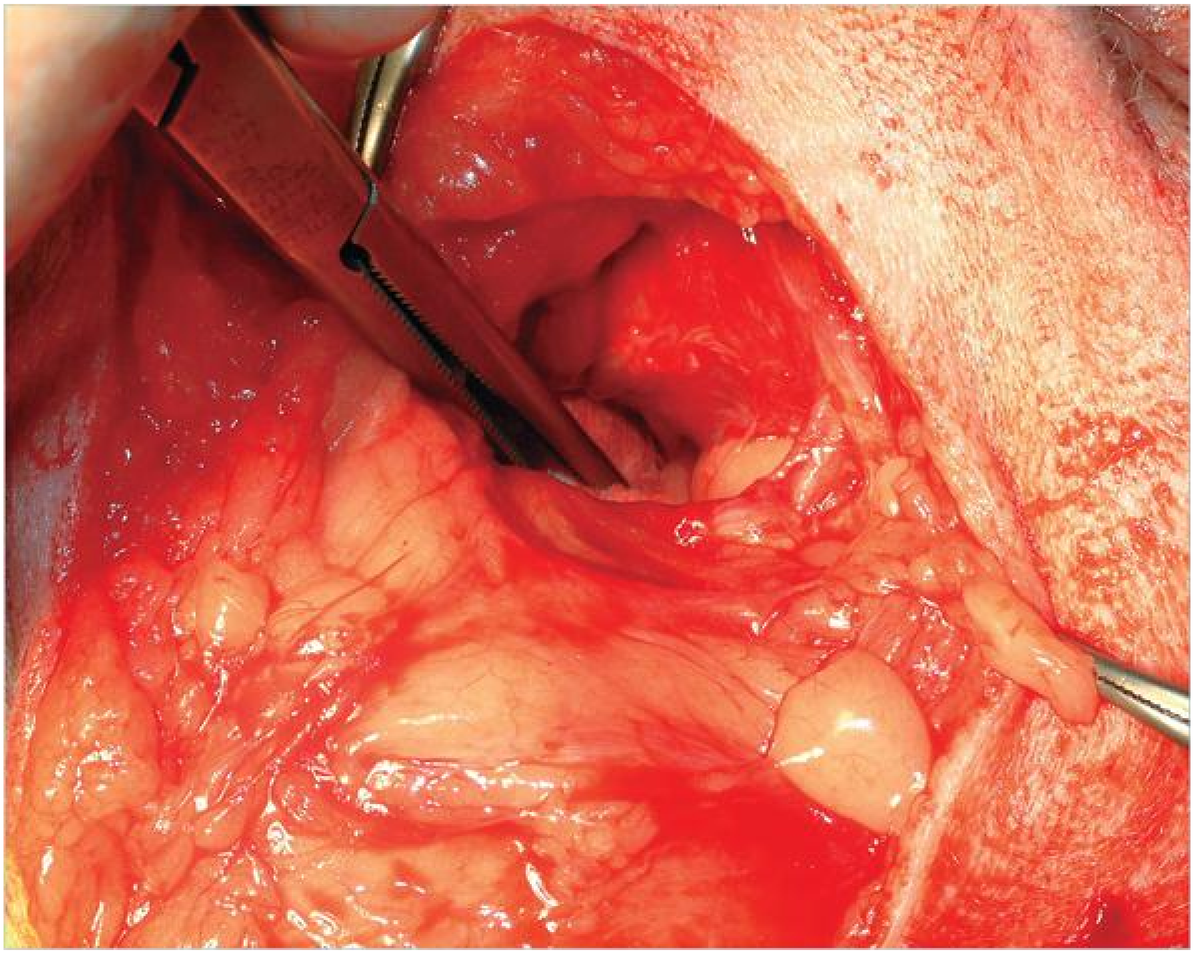

Fig. 5. The content of the hernia is reduced using gauze swabs held in long forceps, which help to keep it in place during suture placement. The photograph shows that the defect is not too large, with good integrity of the coccygeus and the external anal sphincter, surrounding the hernia. It was therefore decided to perform a simple herniorraphy.

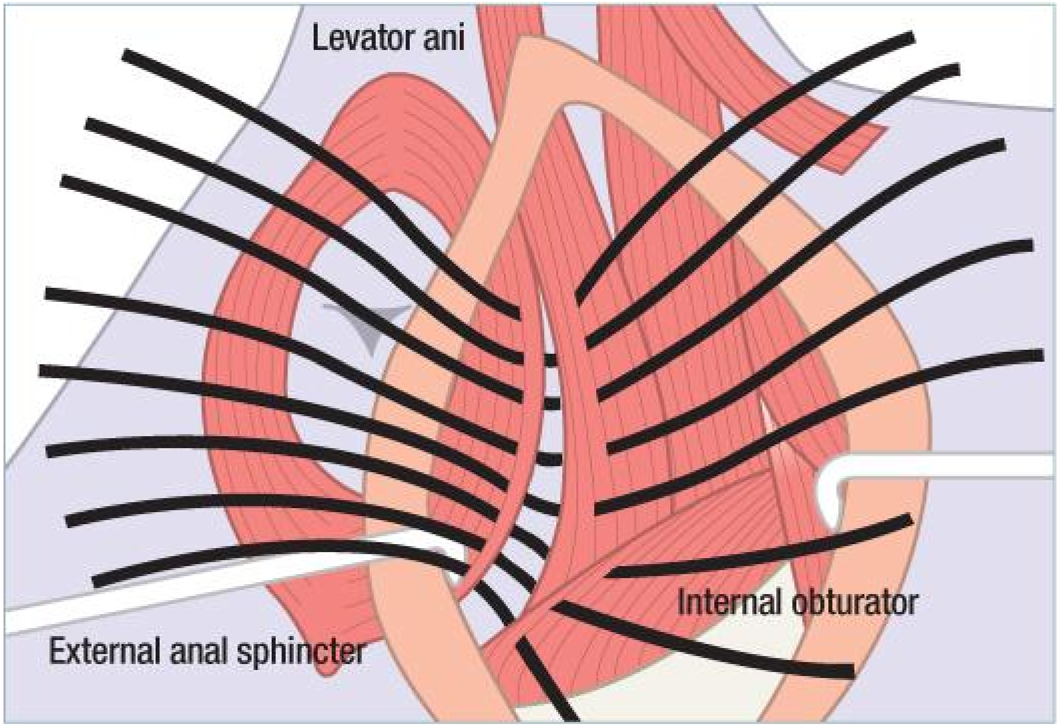

Fig. 6. Schematic drawing of a perineal hernia, showing the position of the interrupted sutures between the anal sphincter and the levator ani and coccygeus muscles and the sutures between those muscles and the internal obturator.

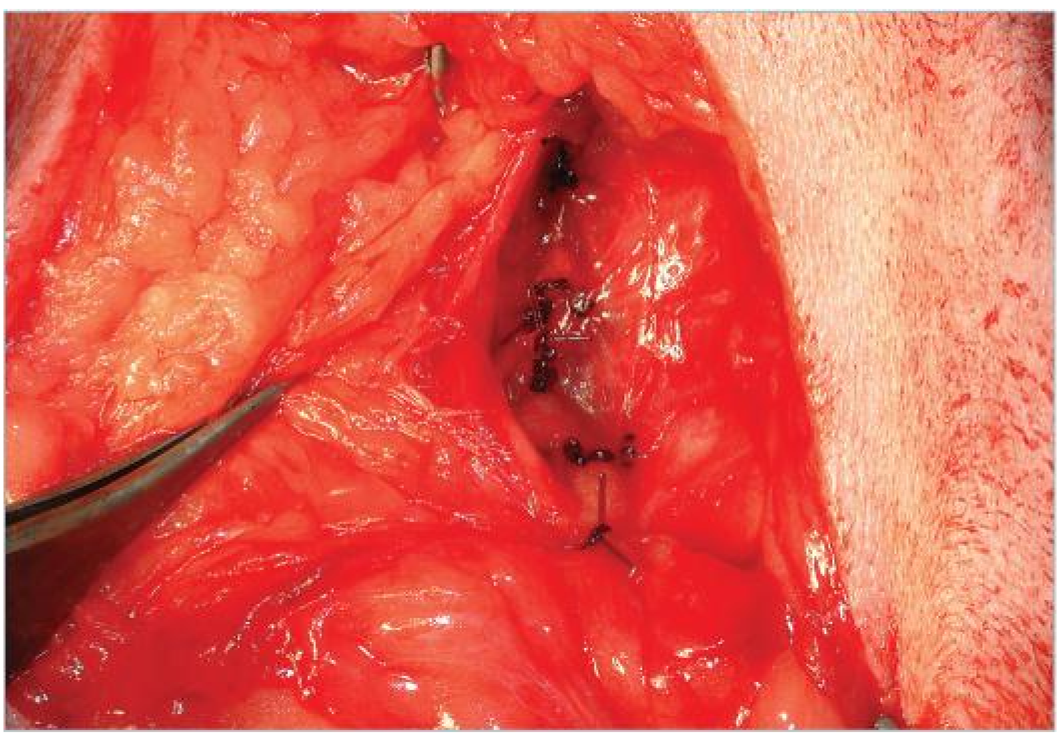

Fig. 7. Note the hernial ring after closure with simple absorbable sutures.

Fig. 8. After the herniorraphy, it is important to suture the subcutaneous tissue with care, to obtain the best possible apposition of a tissue that has been stretched by the hernia.

Fig. 9. Final appearance of the wound after subcutaneous suturing. During the same operation, contralateral herniorraphy was performed, as well as compulsory castration.

Fig. 10. Surgical result at the time of suture removal. Note the normal appearance of the perineum and the disappearance of the postoperative inflammation common in this area.

If the state of the perineal muscles allows it, and the hernial defect is not too big, simple herniorraphy is the technique of choice because of its simplicity.

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Simple herniorraphy

Case 2 / Mesh implant

Technical difficulty ■■□□□

If the perineal muscles are not strong enough to support sutures under tension, an alternative to simple herniorraphy is to implant a surgical polypropylene mesh. The disadvantage of this technique is the cost of the mesh.

Do not forget to place a purse string suture around the anal sphincter and to remove it at the end of the surgery!

Fig. 1. Ventrodorsal radiograph of a dog showing a large perineal hernia on the left, which includes a rectal pouch.

Fig. 2. Preparation of the surgical field. The patient is placed in sternal recumbency, with a raised pelvis and the tail fixed to the back. The incision is made as for the simple herniorraphy, oblique and over the herniated pouch.

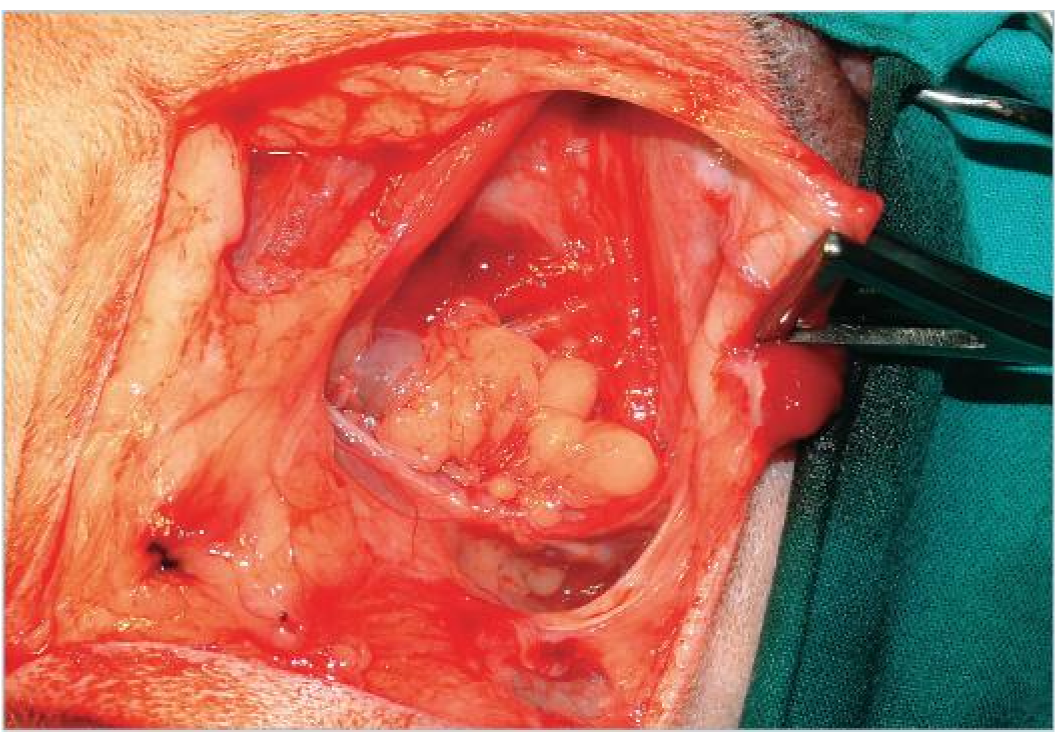

Fig. 3. Once the hernia is reduced and the hernial ring is dissected, the size of the defect and the muscular weakness can be appreciated. For this reason, it was decided to place a surgical mesh implant.

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Mesh implant

When choosing a mesh for the repair of a perineal hernia, cone–shaped meshes are the most appropriate.

Fig. 4. The surgical mesh is made of polypropylene, a non-absorbable material that serves as a support for the scar tissue. This consists of fibroblasts which invade the mesh.

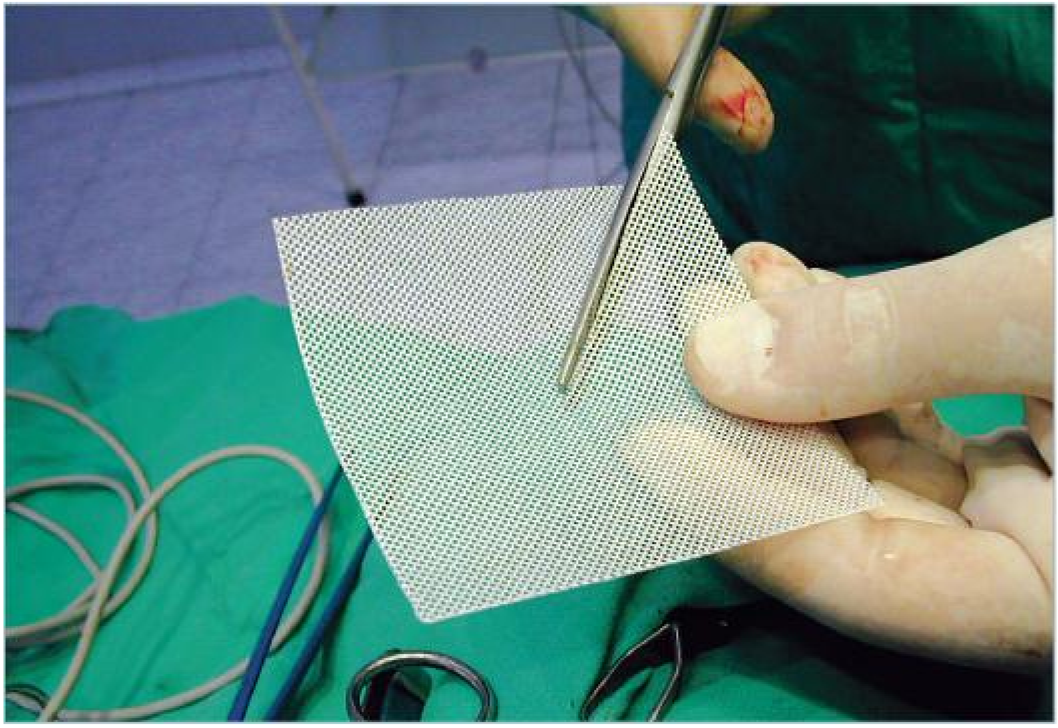

Fig. 5. Considering the depth of the anatomical defect causing the perineal hernia, it is practical to create a cone shape with the mesh, as shown in the picture.

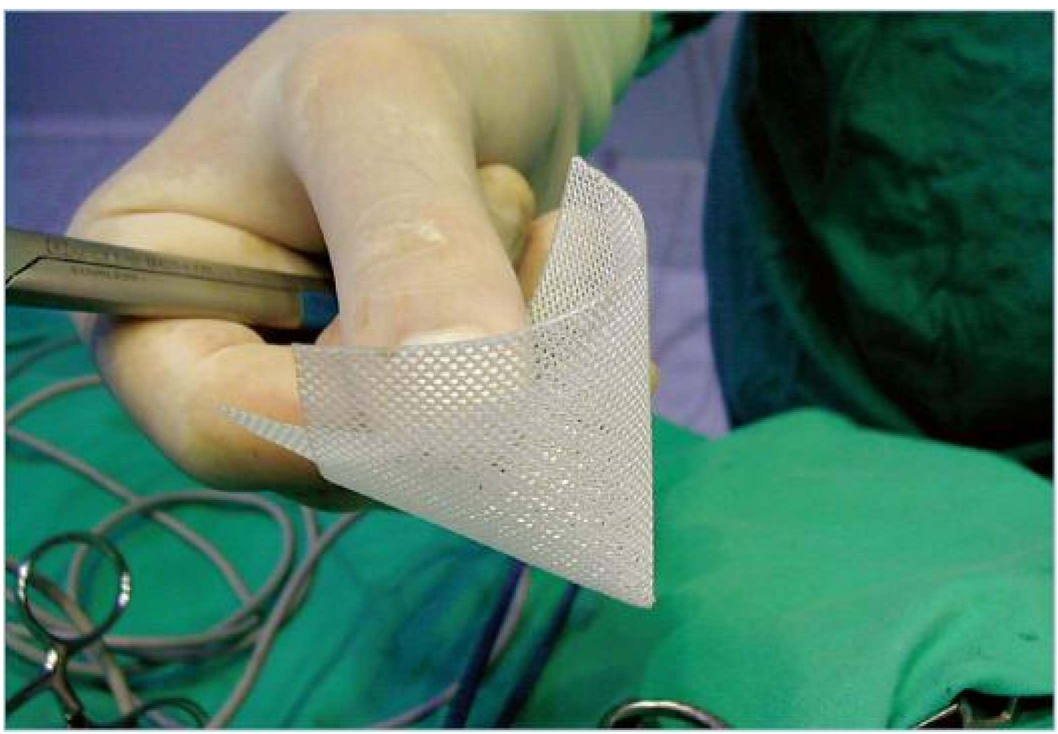

Fig. 6. Once the cone has been made, it is placed with the vertex in the deepest part of the defect.

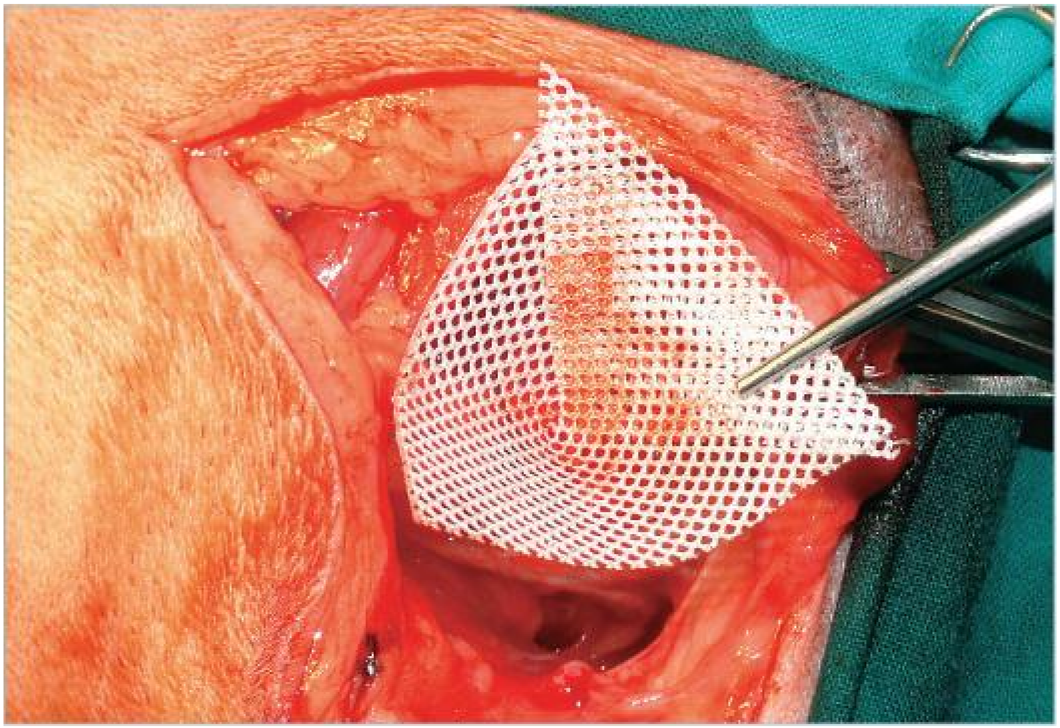

Fig. 7. The mesh cone is placed over the defect and its size adjusted, until the base of the cone covers the hernial ring.

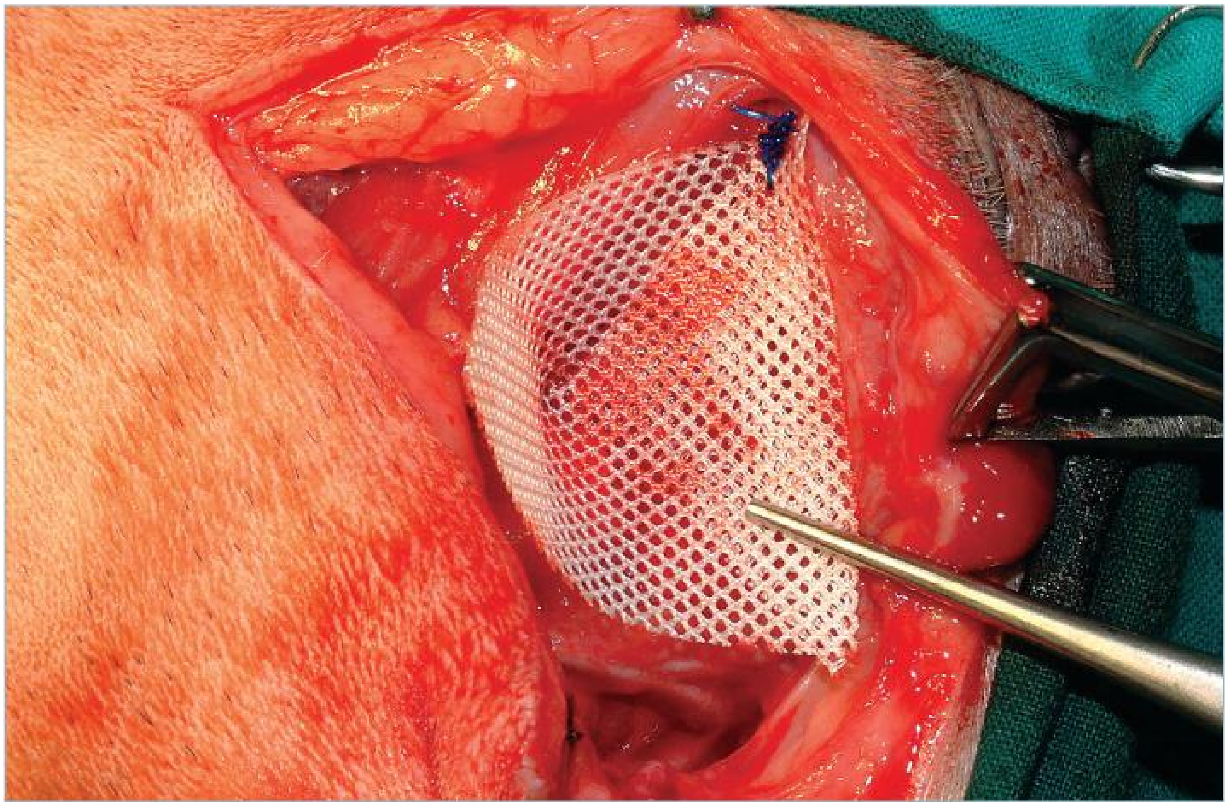

Fig. 8. Next, the circumference of the cone base is sutured to the muscles that delineate the hernial ring. Ensure that the sutures are placed in healthy muscle and take care to avoid excessive tension on the sutures.

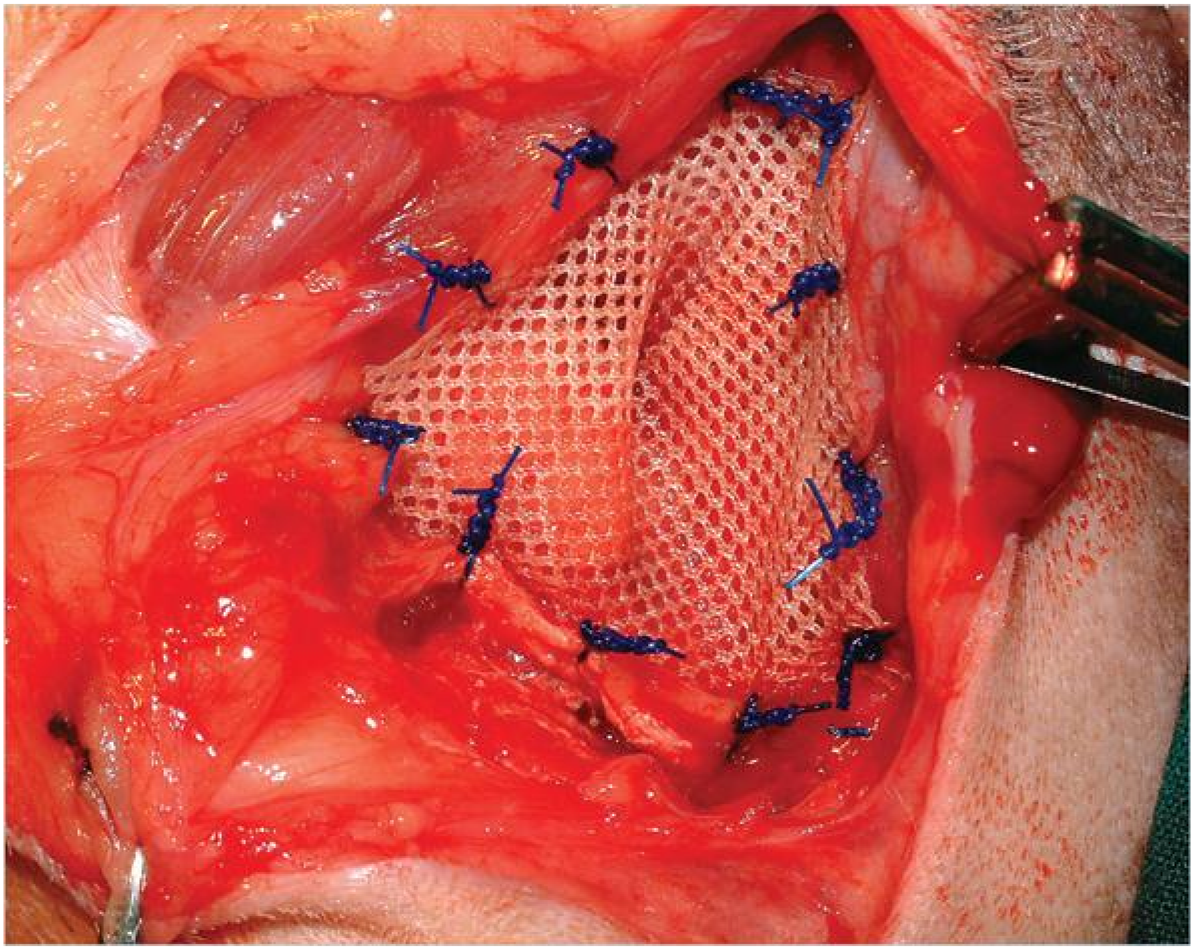

Fig. 9. To fix the mesh, simple, interrupted sutures of non-absorbable monofilament material are placed around the circumference.

Case 3 / Deferensopexy

Technical difficulty	■	■	■	□	□

Hypertrophy of the prostate, a common finding in older intact dogs, can be a mechanical hindrance to defecation when it is displaced into the pelvis by abdominal straining. As a result, the patient shows tenesmus and chronic constipation. The prostate acts like a battering ram on the pelvic diaphragm during defecation efforts, thereby contributing, along with other causes already mentioned, to the weakening of the perineal muscles, leading to herniation.

In these cases, the prostate moves into the pelvic canal, dragging the bladder along, a reason why both structures can be contained in the hernia (Fig. 1). Reduction of the hernia and repair of the hernial ring are insufficient in these cases to fully prevent recurrence.

On the next pages, the technique of deferensopexy is described. The aim of this technique is to fix the prostate and the bladder in the abdominal cavity, thus preventing their displacement towards the pelvis and recurrence of the hernia.

This technique is complementary to the earlier described techniques of herniorraphy, mesh implantation and muscular transpositions.

Fig. 1. Lateral radiograph of the abdomen of the patient, showing that the herniated content includes the prostate, which has dragged the bladder in a caudal direction into the pelvic canal. Radiographic examination includes a barium enema and a pneumocystogram.

Deferensopexy is a complementary surgical technique, particularly indicated for perineal hernias that involve the bladder and/or the prostrate.

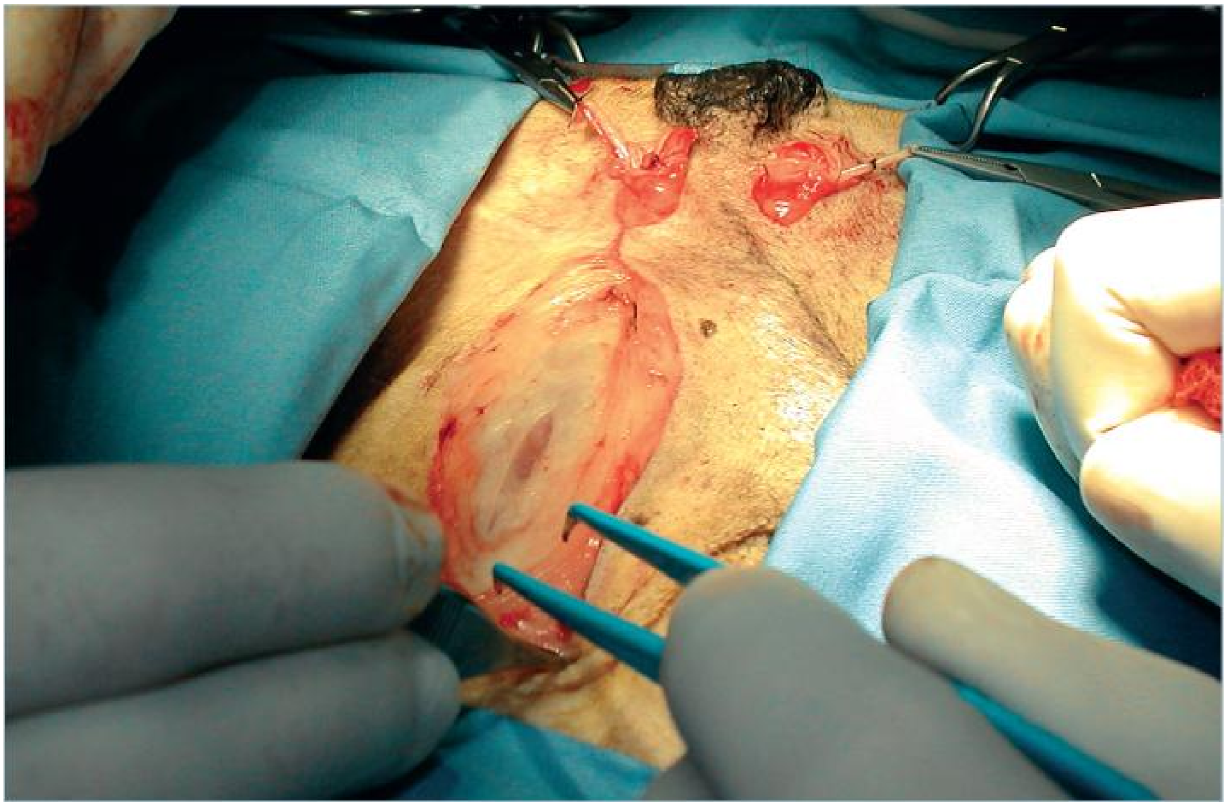

Fig. 2. First, castration is performed, leaving the patient with forceps on the vasa deferentia. Both incisions are left momentarily without sutures. Next, a parapenile laparotomy is performed.

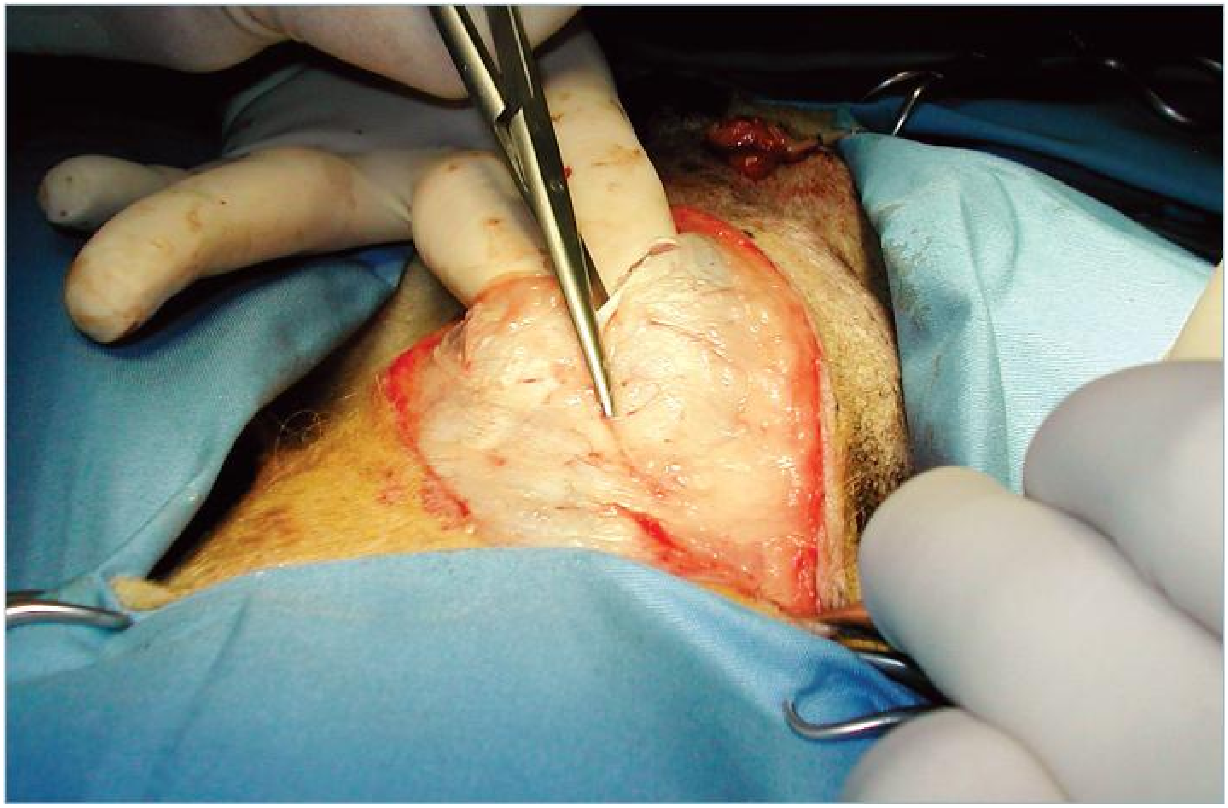

Fig. 3. Laparotomy is performed in the usual way after lateralization of the penis: via the linea alba and taking care to protect the abdominal organs.

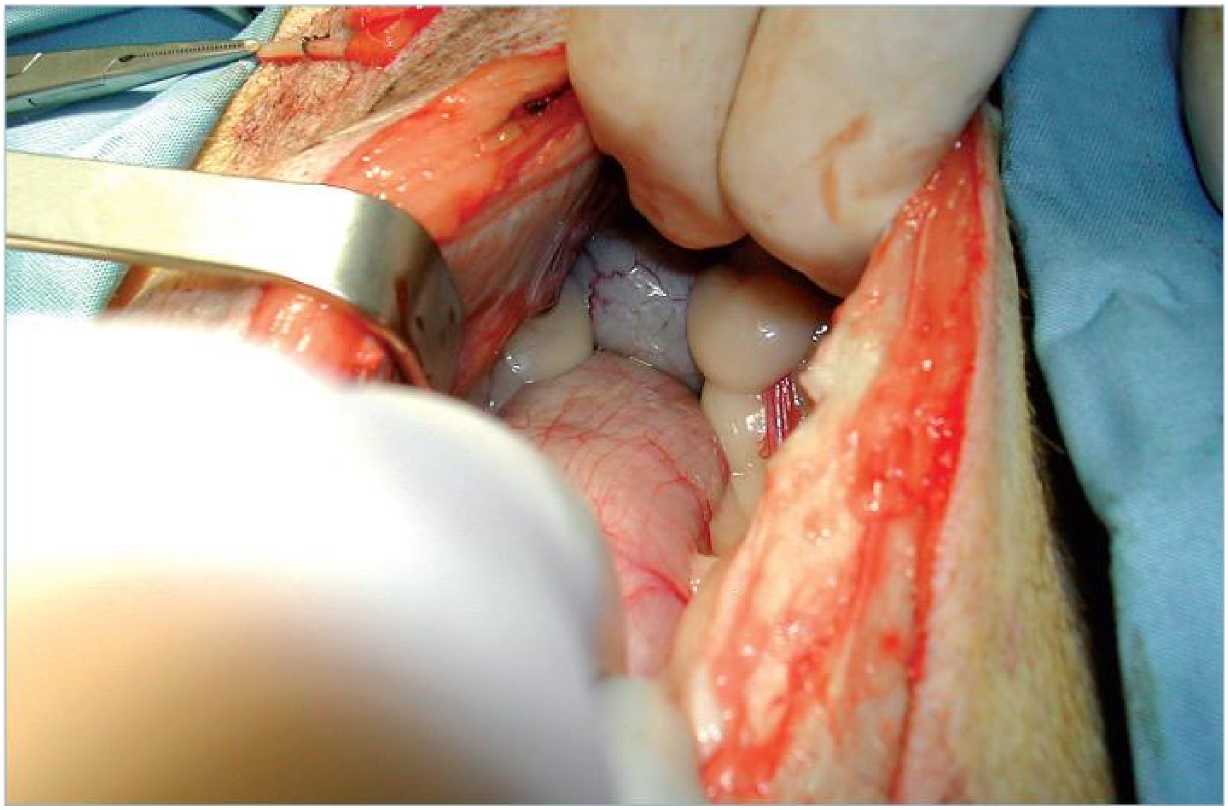

Fig. 4. Once the abdomen is opened, the bladder can be seen. After moving the intestines cranially, the colon can be identified.

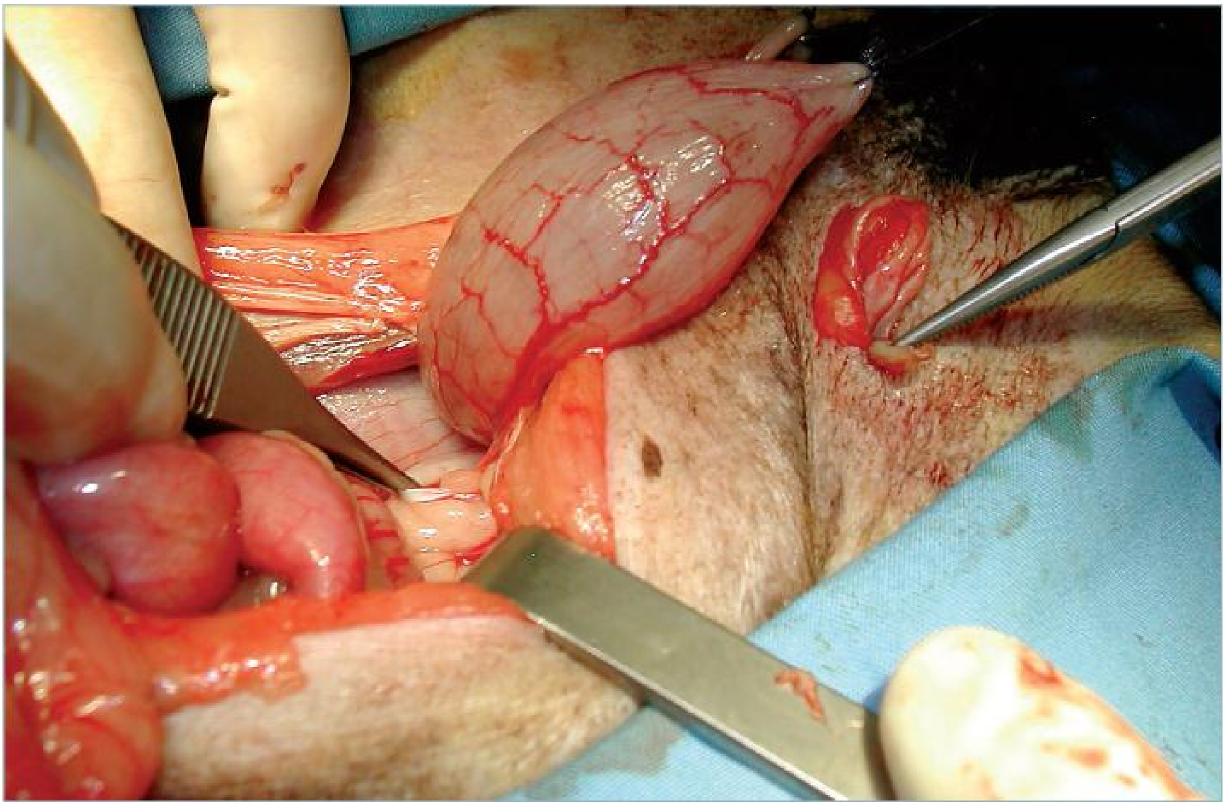

Fig. 5. The bladder is moved caudally in order to locate the vasa deferentia leading to the prostate, crossing the ureters.

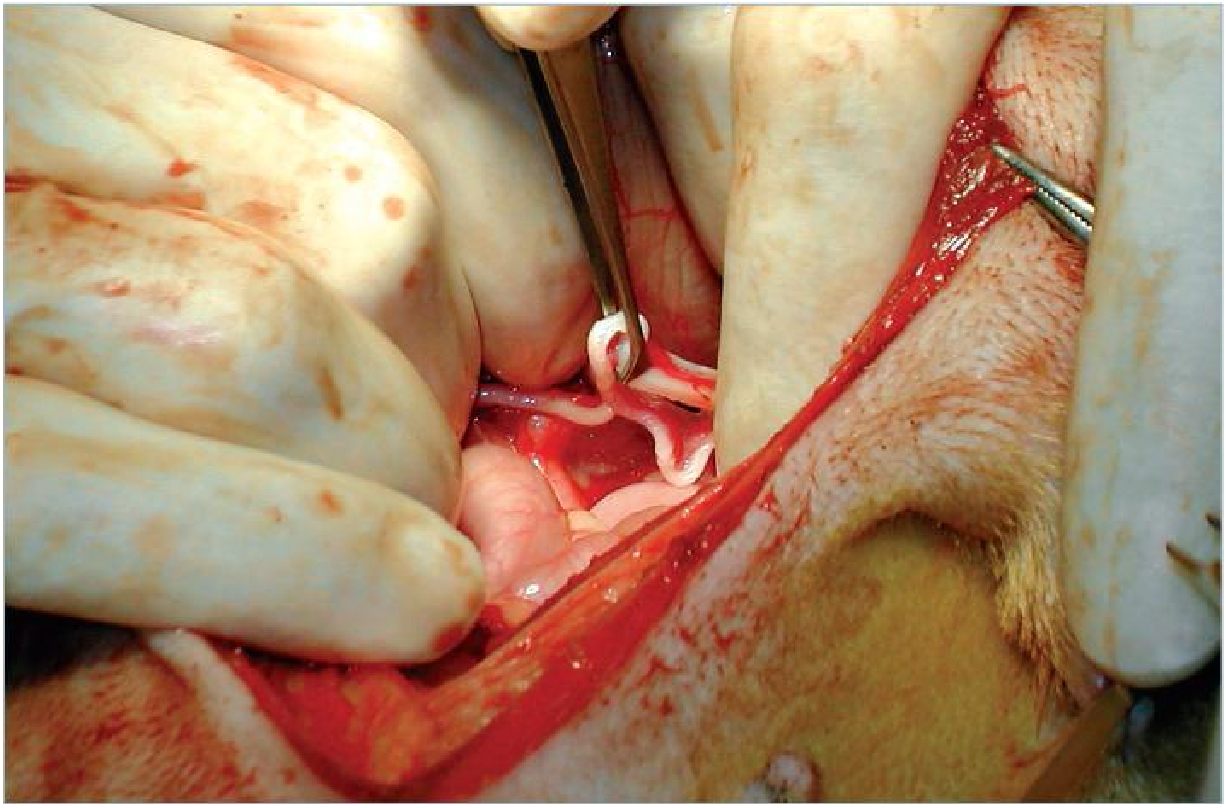

Fig. 6. Once the vasa deferentia are located, the forceps placed during castration are loosened, and one of the ducts is pulled back into the abdominal cavity through the inguinal ring.

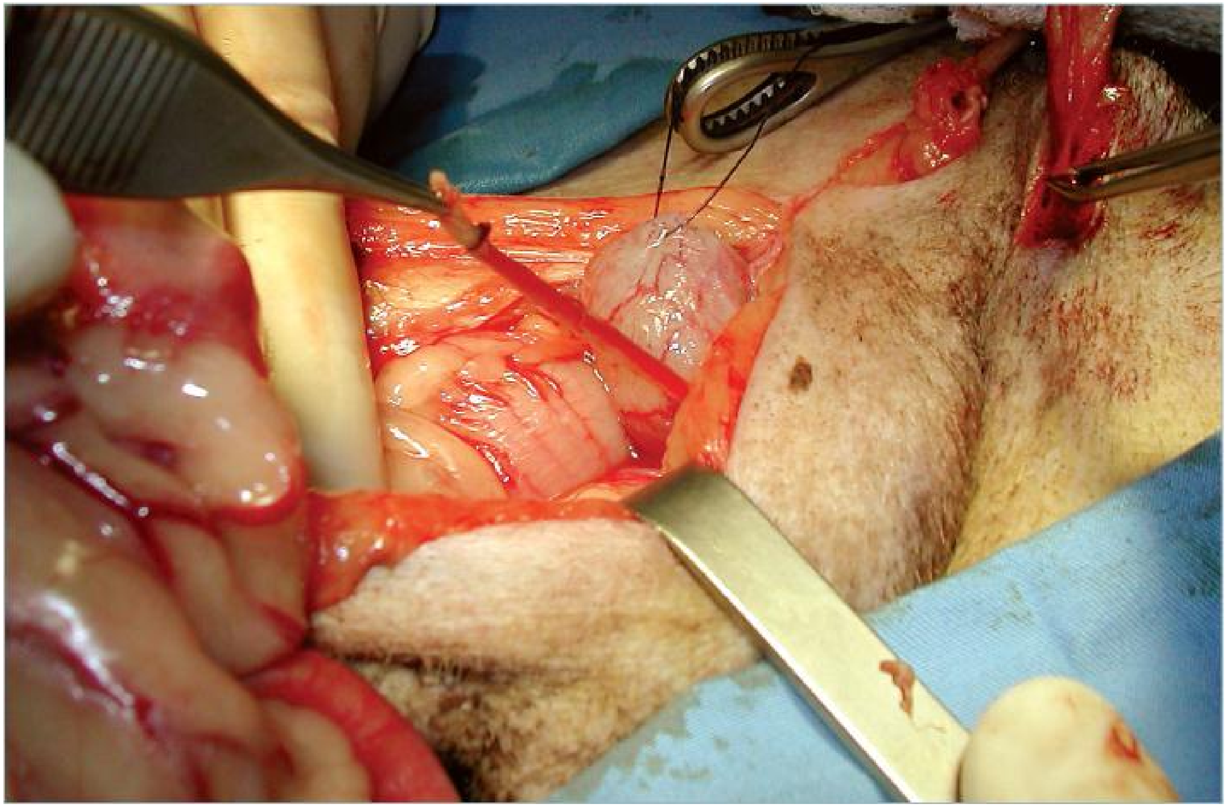

Fig. 7. This picture shows one of the vasa deferentia back in the abdominal cavity. The bladder is kept back with the help of a holding suture and an atraumatic clamp.

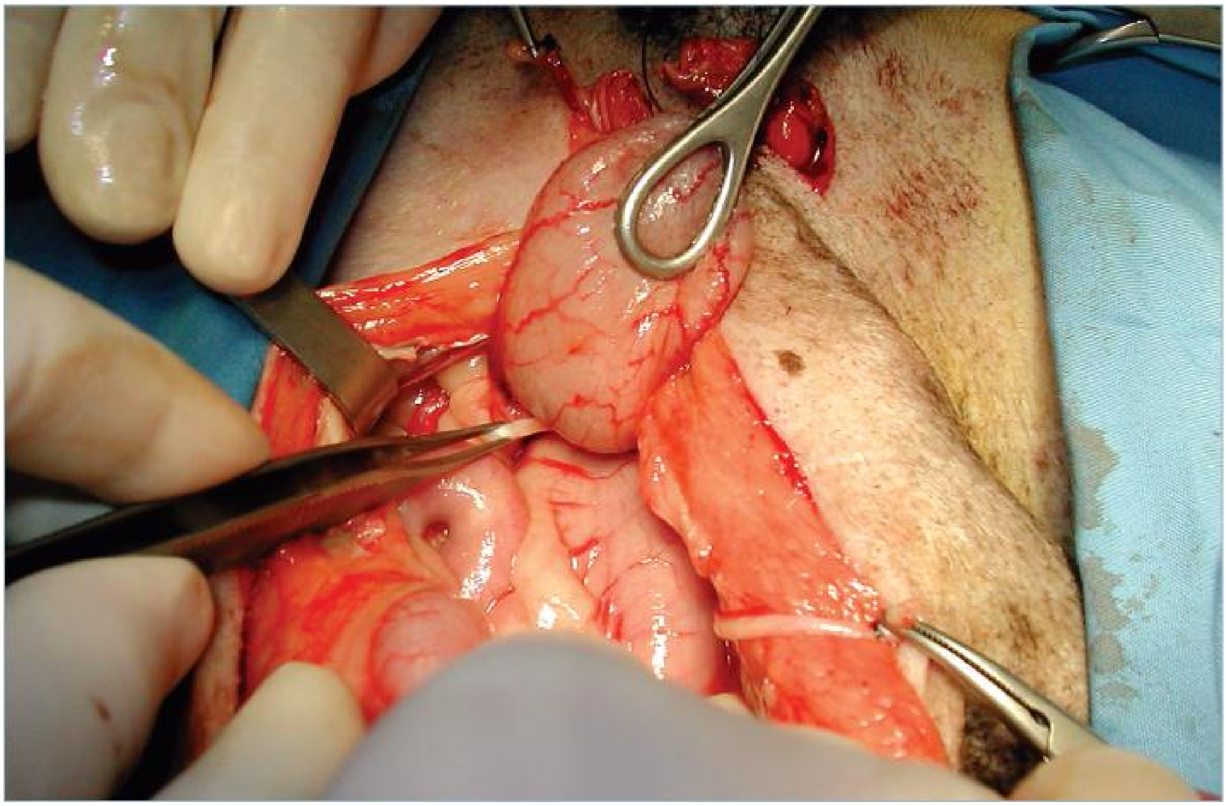

Fig. 8. The first duct is held by forceps to check its location. The same is done with the other duct.

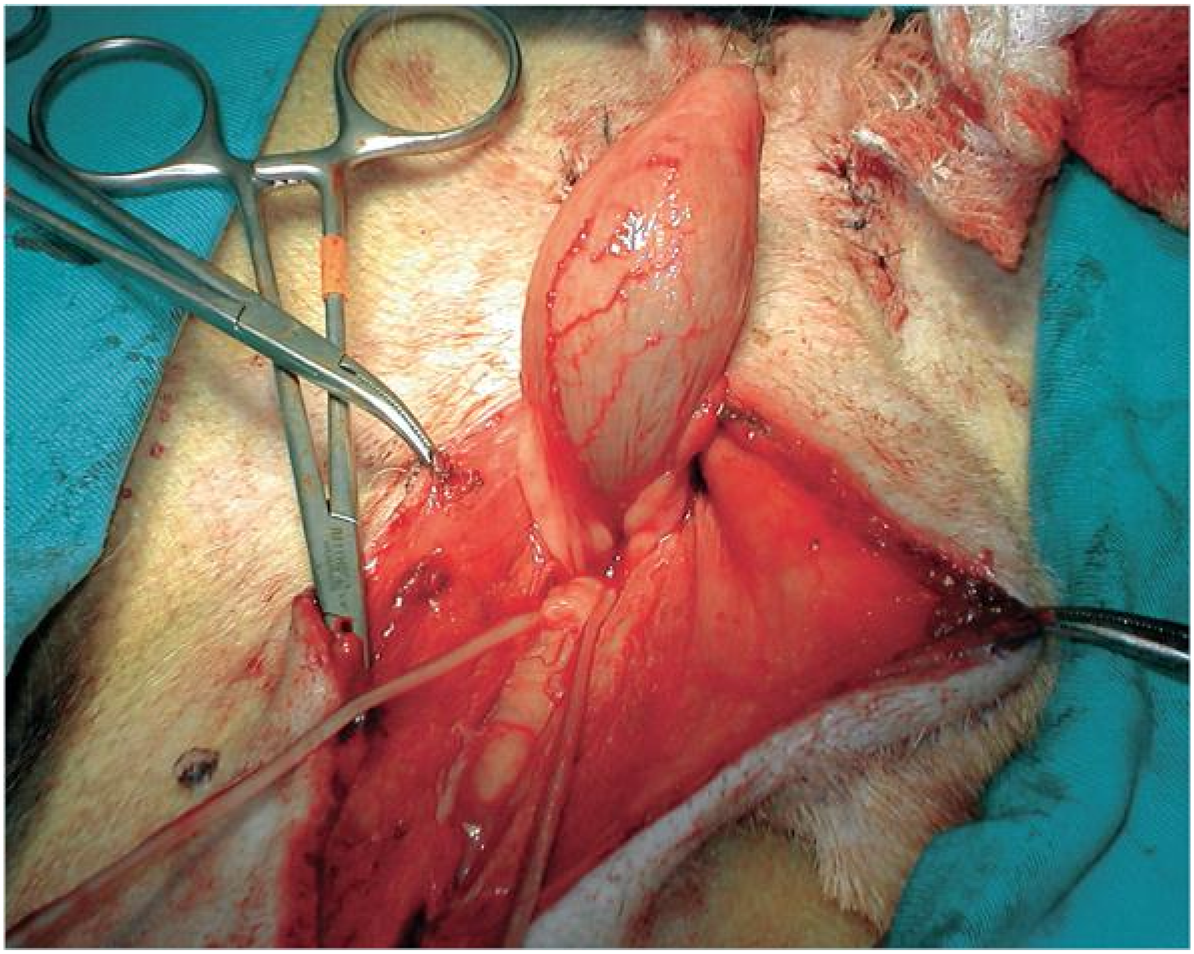

Fig. 9. Both vasa deferentia are clearly visible in the abdomen, attached to the prostate.

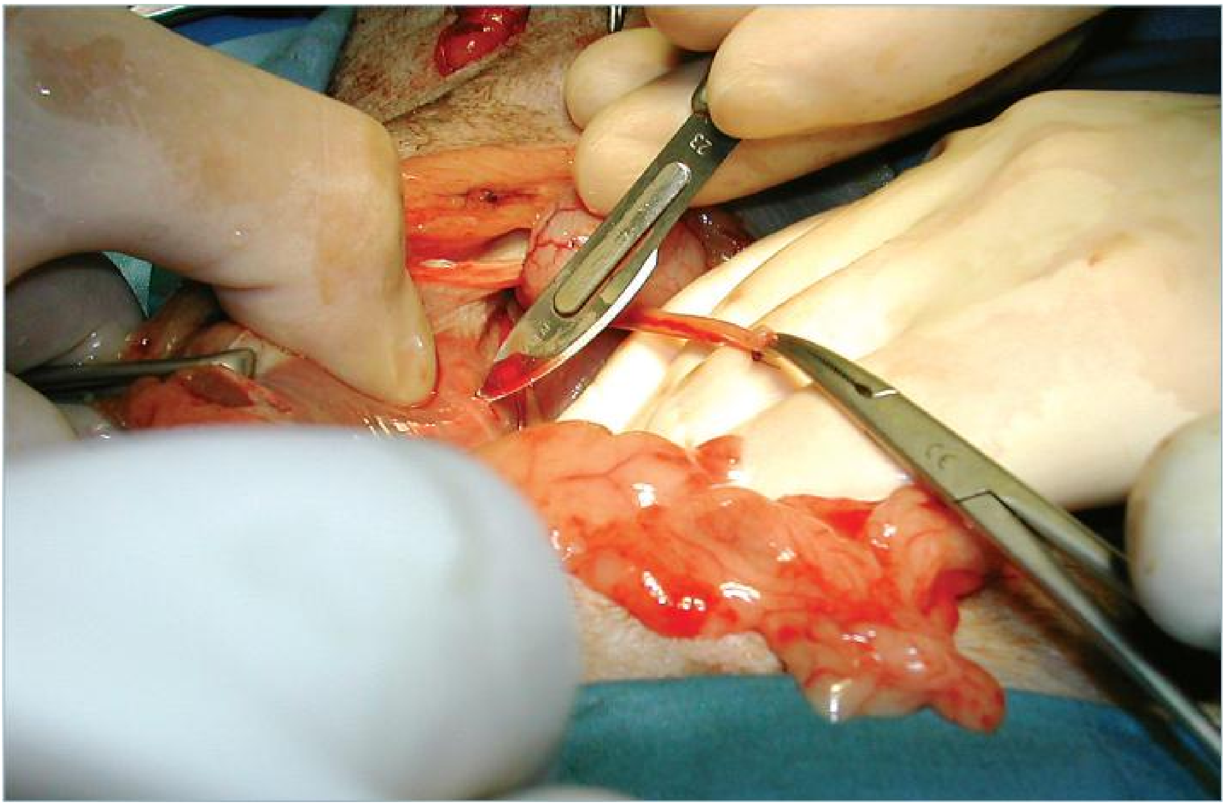

Fig. 10. The aim is to use the two vasa deferentia to fix the prostate in the abdomen, by anchoring them in a tunnel in the abdominal wall. In order to do so, a small incision is made in the lateral abdominal wall, cranial to the bladder.

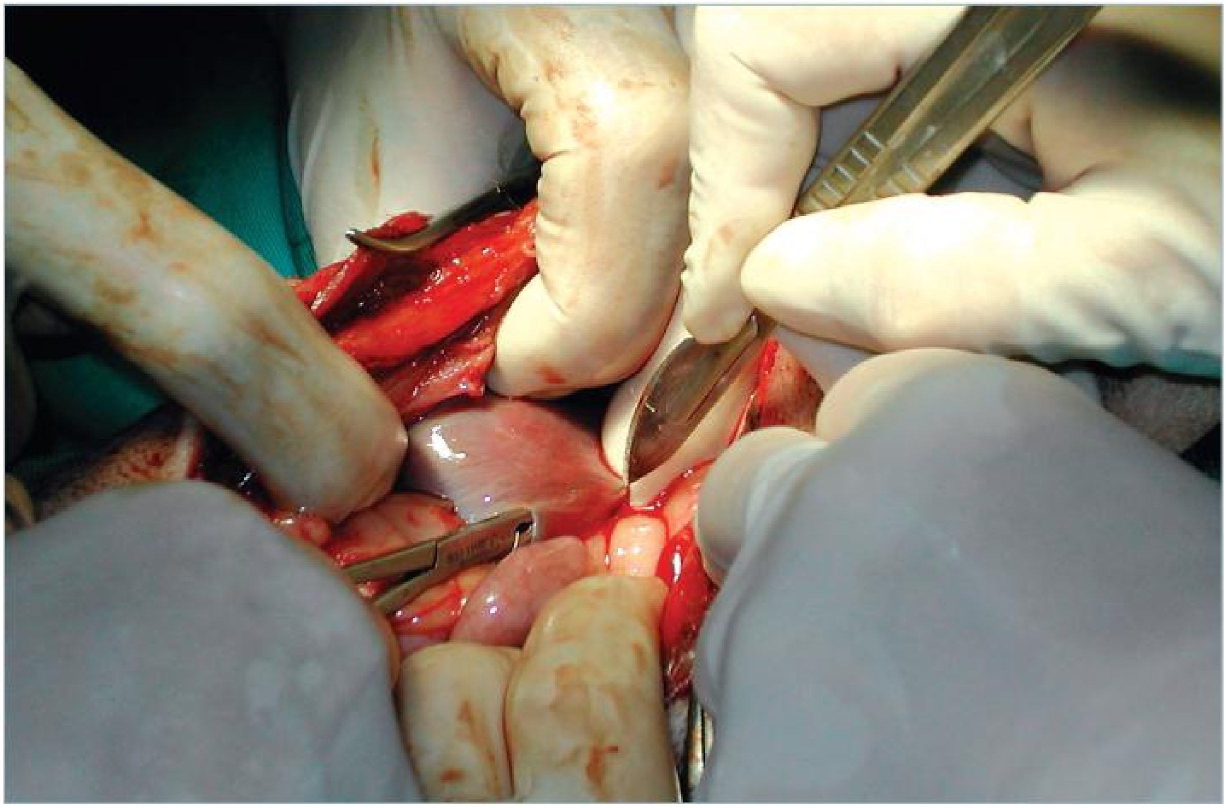

Fig. 11. Mosquito forceps are passed through the incision, thus creating a 1-cm-long tunnel, just under the fascia of the transverse abdominal muscle. The exit point of the mosquito forceps is opened using a scalpel.

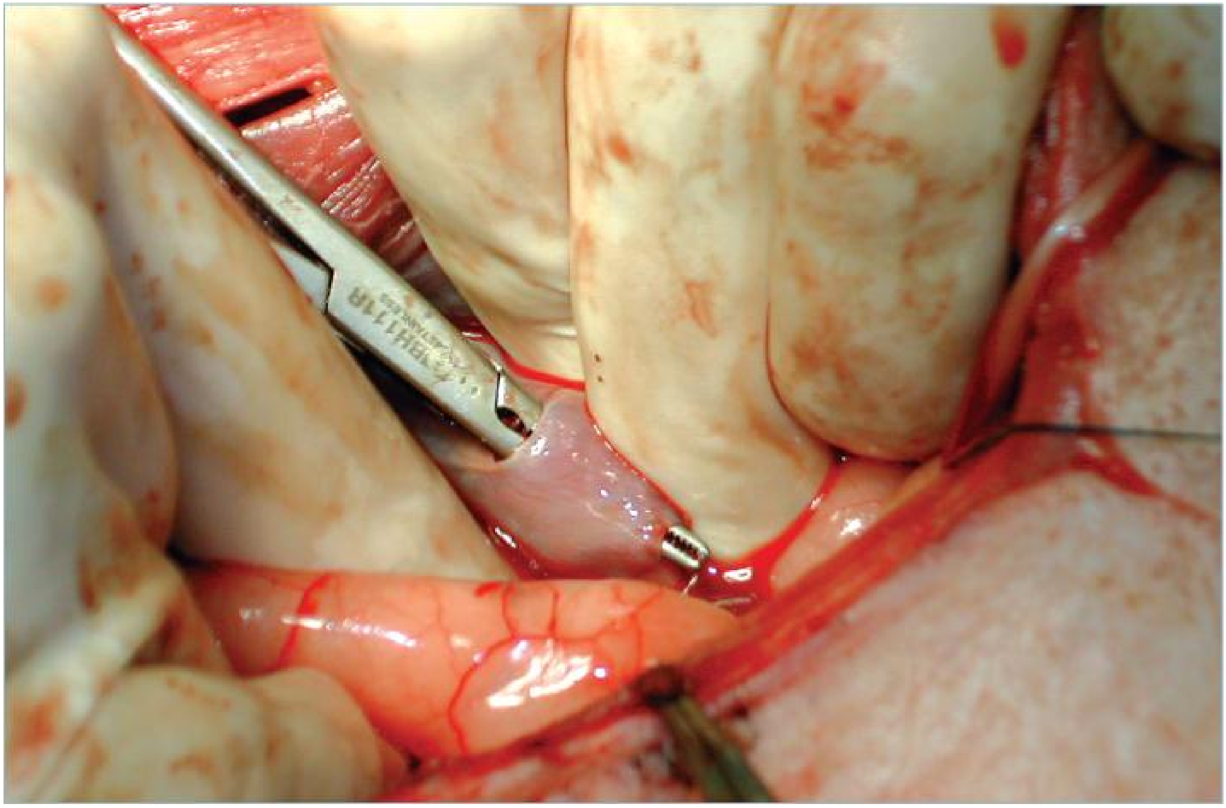

Fig. 12. This picture shows the tunnel, prepared for passage of the vas deferens.

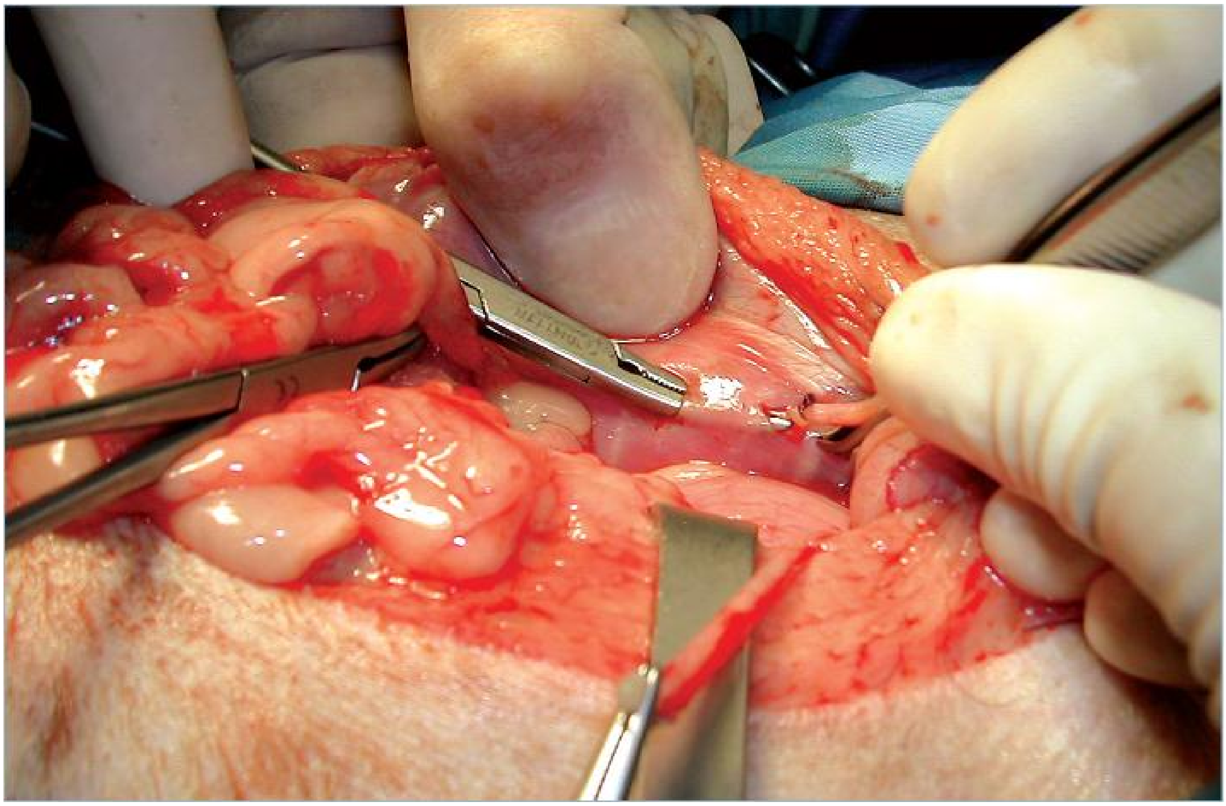

Fig. 13. Using a second pair of mosquito forceps, the vas deferens is passed through the tunnel.

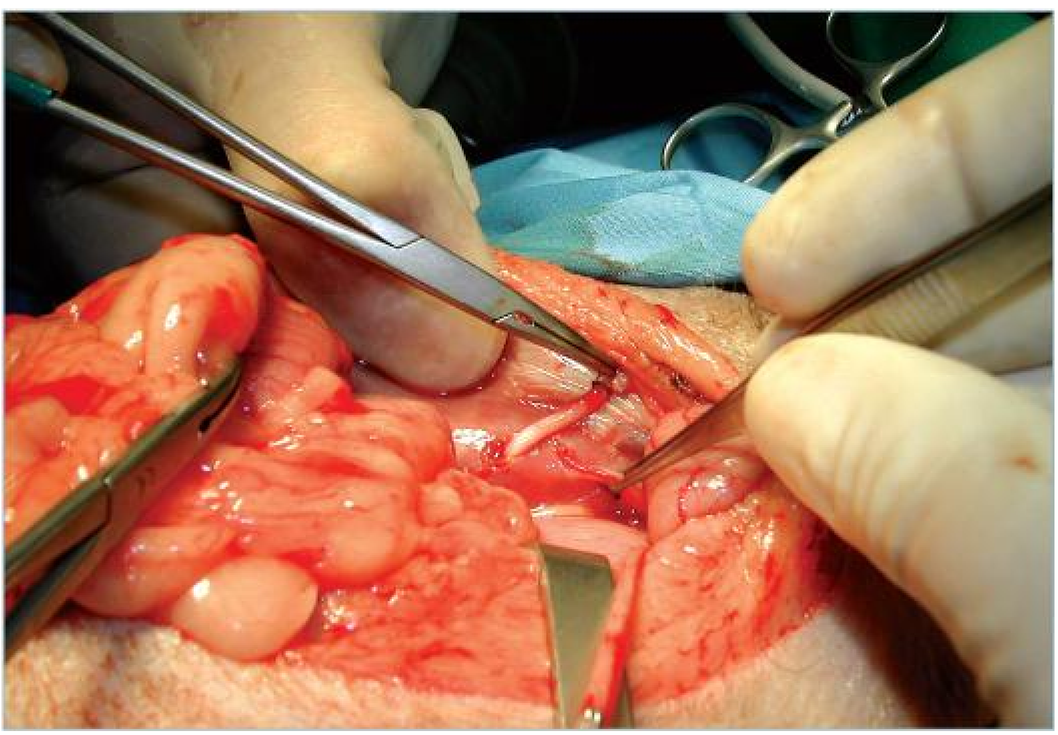

Fig. 14. The vas deferens is pulled in a cranial direction and tightened until the prostate is fixed in the abdominal cavity. Then, the duct is folded back on itself and is attached with a suture.

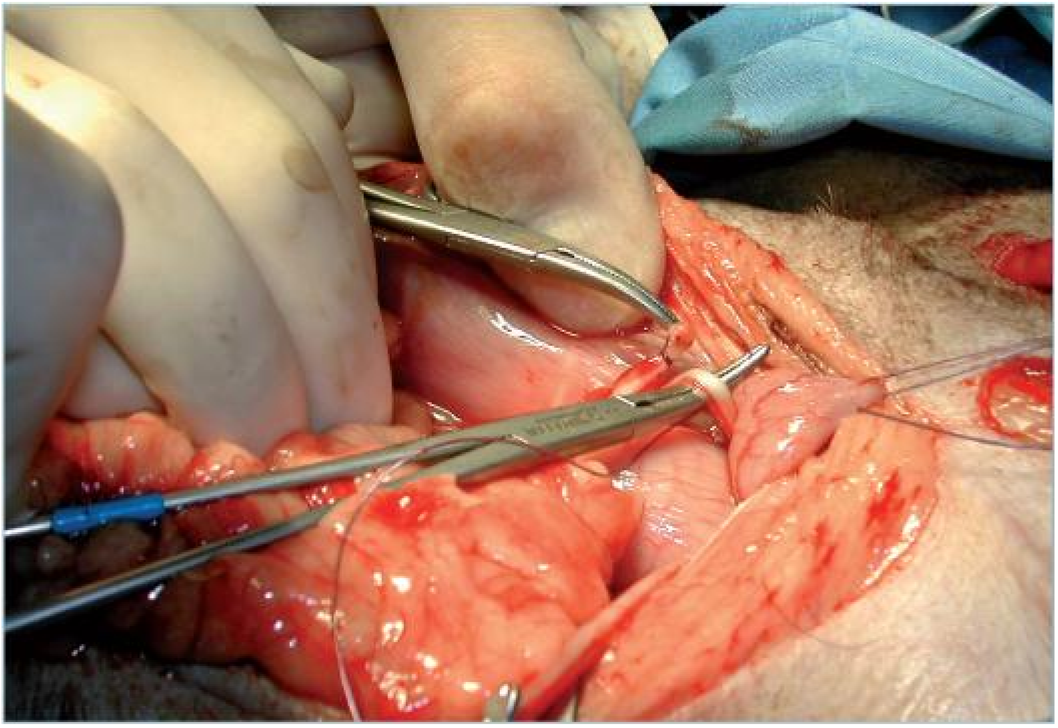

Fig. 15. After folding and fixing the vas deferens, another suture is tied around both segments.

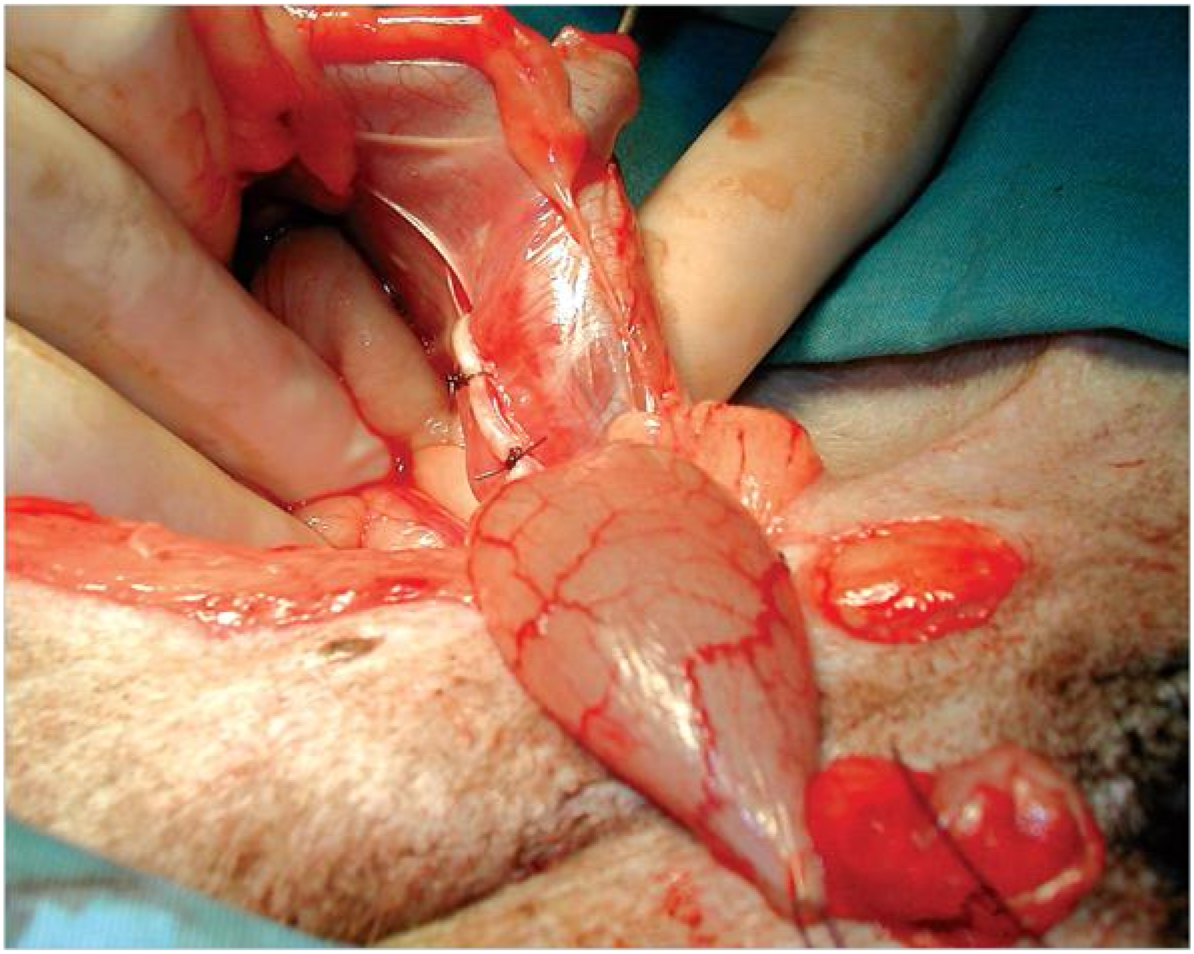

Fig. 16. View of the vas deferens fastened on itself with two sutures. The same technique is used for the duct on the other side.

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Deferensopexy

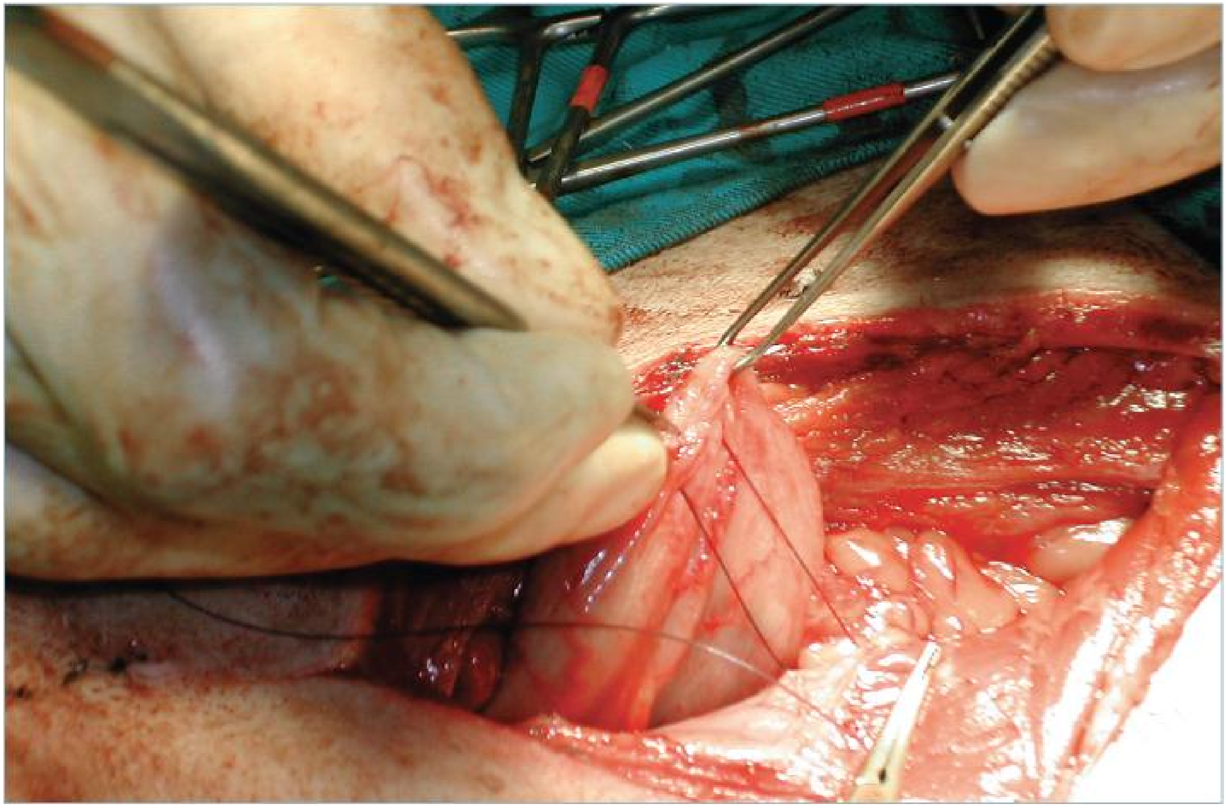

Fig. 17. Deferensopexy ensures that the prostate cannot be displaced into the pelvic canal or drag the bladder with it, but it does not prevent the bladder from retroflexing. To avoid this possibility, a cystopexy can be performed.

To complement deferensopexy, it may be advisable to perform a cystopexy, which fixes the bladder in its anatomical position and prevents retroflexion.

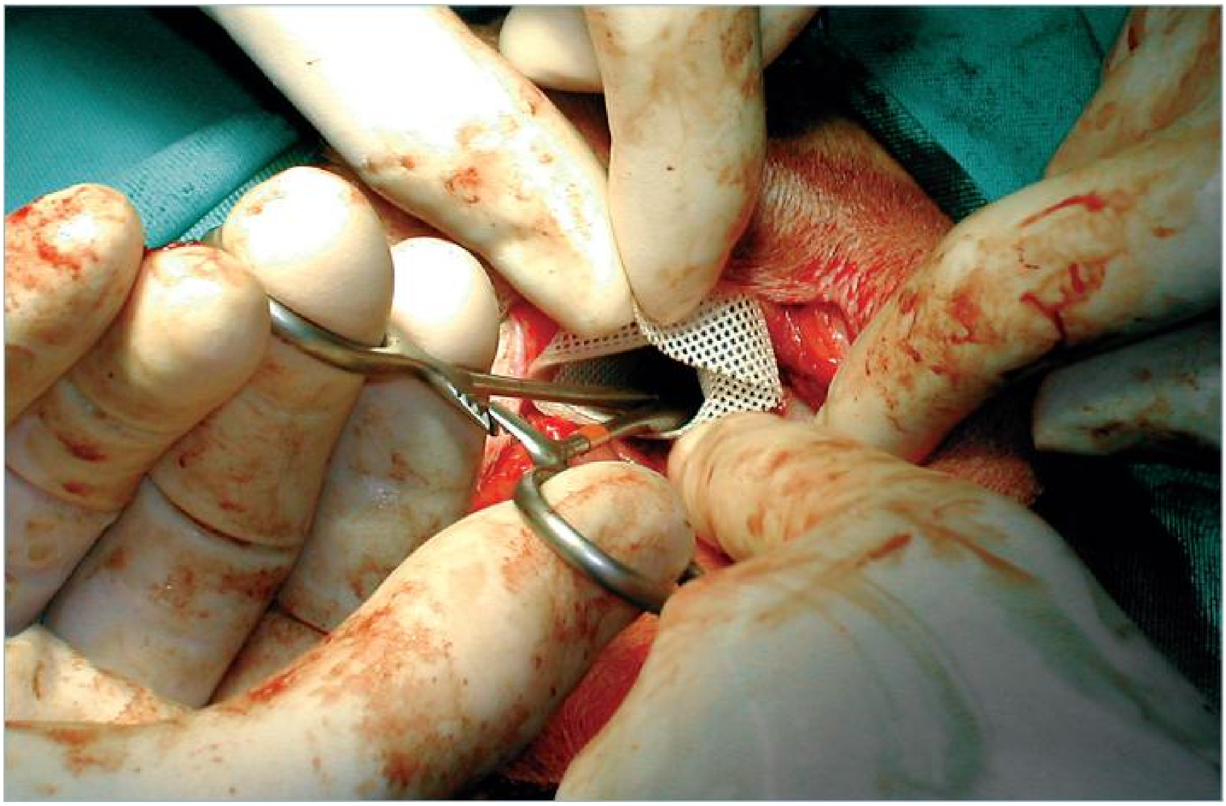

Fig. 18. Once the abdominal cavity is closed, the patient is placed in sternal recumbency, with the rear end elevated in order to close the hernial ring with one of the techniques described.
In this case, it was decided to use a cone-shaped polypropylene mesh implant.

Perianal fistulas

José Rodríguez

Prevalence

Perianal fistulas are characterized by a chronic inflammatory, purulent ulcerated lesion with multiple interconnecting fistular canals and a severe infection around the anus (Fig. 1). It mainly affects male dogs of certain breeds like the German Shepherd and the Irish Setter.

Clinical history

- Pain in the perianal area.
- Foul smell.
- Constant licking of the perineal area.
- Digestive problems (constipation, diarrhea, tenesmus, dyschezia…).
- Ulceration, hemorrhagic or purulent discharge.

Clinical signs

- Very intense pain of the area, becoming worse when an attempt is made to lift the tail.
- Fistulas around the anus (Figs. 2 and 3).
- Ulcerations and necrotic tissue around the anus (Figs. 4-6).
- Anal stenosis due to excessive post-inflammatory fibrosis.

> ***Caution when examining the perineal area; a calm animal can become aggressive due to pain.***

Fig. 1. Image showing the perianal fistulas of a 6-year-old male German Shepherd. The patient had intense pain in the area and difficulty defecating.

Fig. 2. Small fistulous openings in a German Shepherd bitch on the left side of the anus.

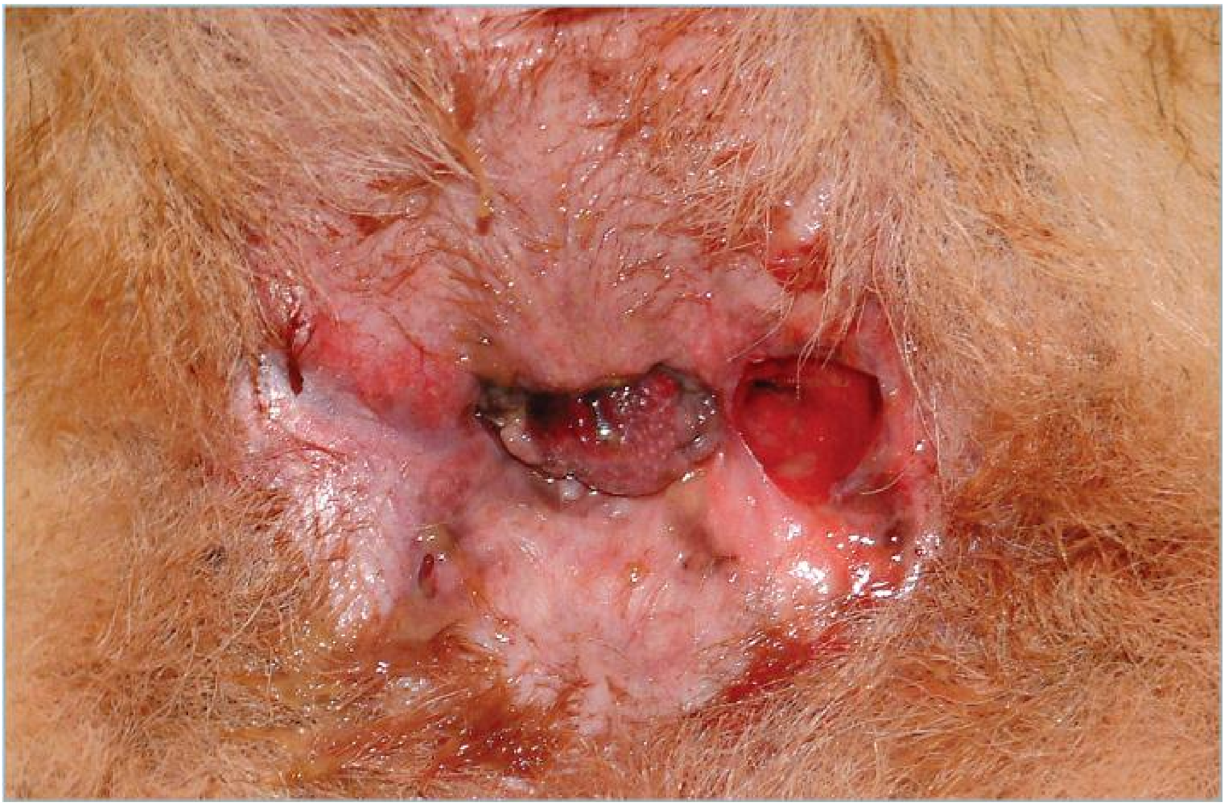

Fig. 3. Patient with recurring perianal fistulas. Note the small fistulous openings on the left and the ulceration on the right.
Secondary anal stenosis is also present in this case.

Some patients need to be sedated or even anesthetized to permit examination of the perineal area.

Fig. 4. Large ulcerated areas appear when several fistulous tracts coalesce. There is intense pain and a considerable local infection.

The owner should be informed about the severity of the condition, the treatment to be carried out, the expected results and, most importantly, the need for cooperation and long-term commitment during the postoperative period.

*

Recurrence is common, irrespective of the treatment.

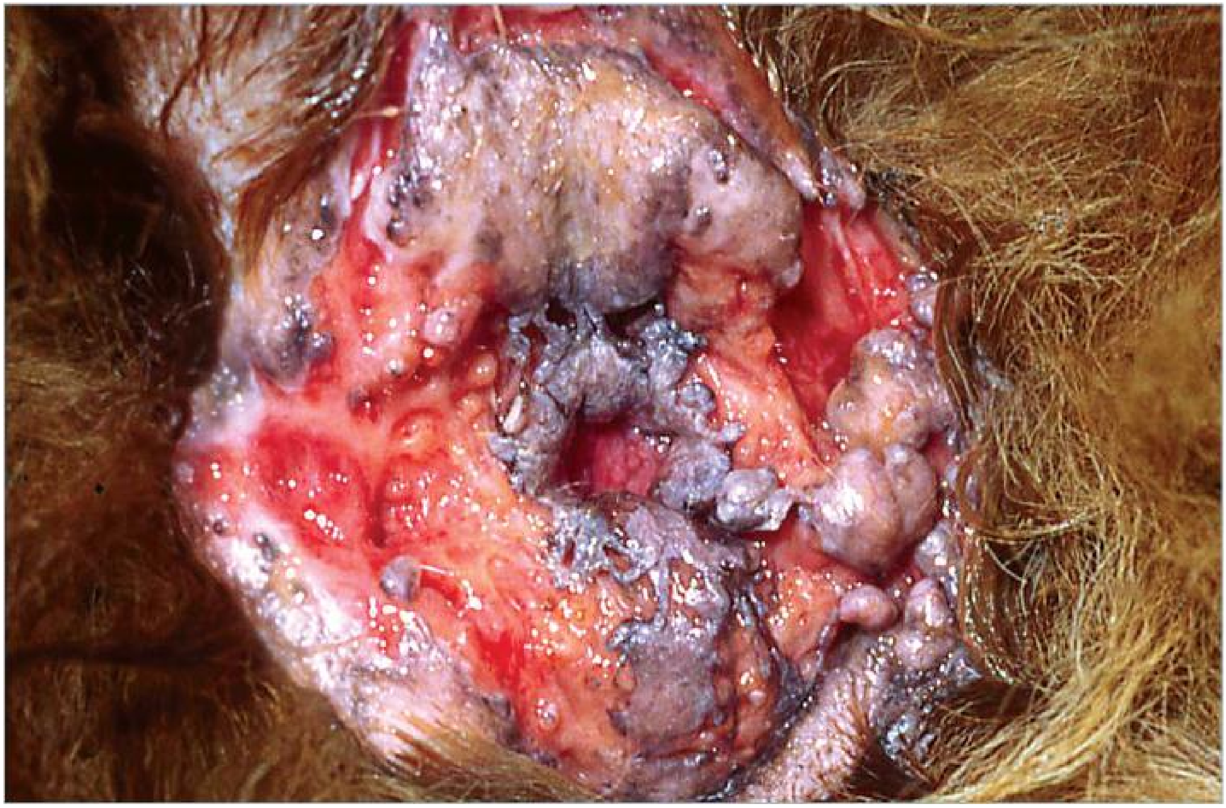

Fig. 5. Perianal fistulas in an 8-years-old German Shepherd. Together, they have affected the entire circumference of the anus.

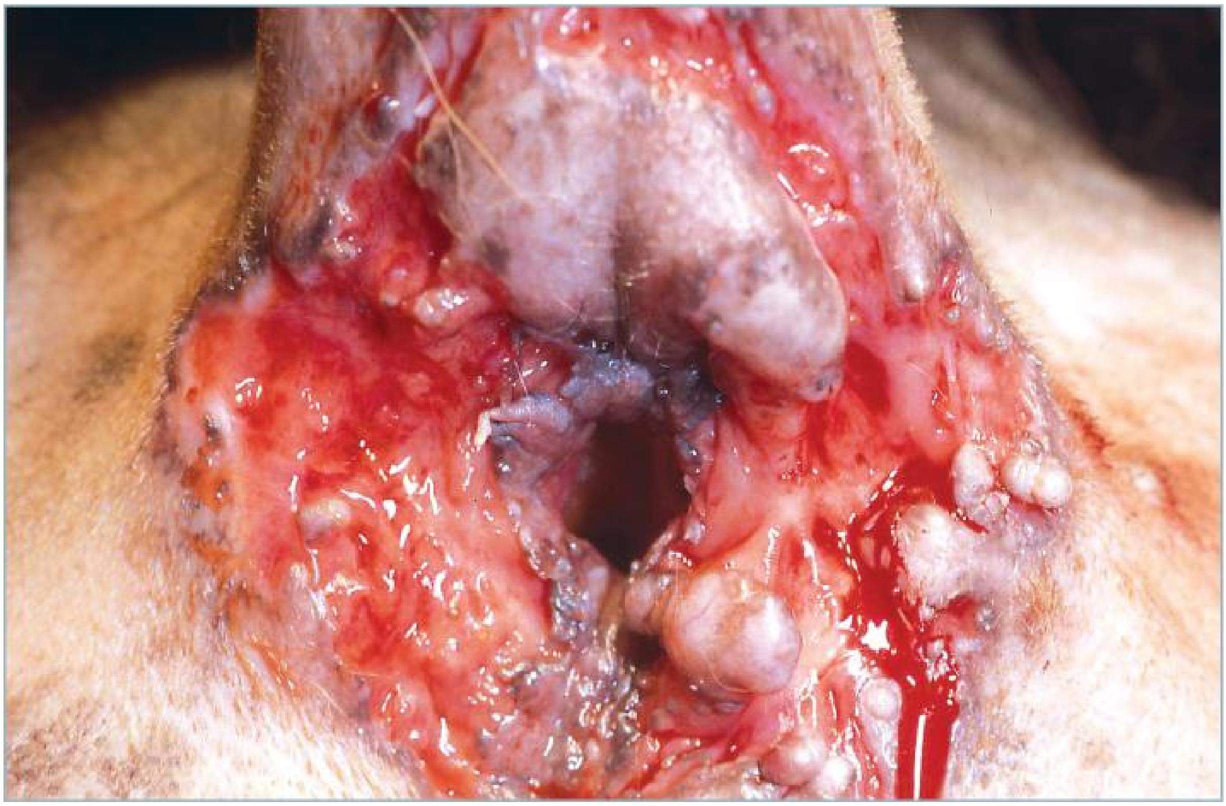

Fig. 6. The perianal lesions are extensive, the patient is in great pain, has problems defecating, is licking the area and it is bleeding. This patient will undergo surgical treatment.

Case / Radical surgical resection

Technical difficulty	■	■	■	■	■

Fig. 1. The perianal lesions are severe, and affect 360° of the area. Medical treatment has improved the clinical signs and has reduced the lesions, but

has not achieved complete healing.

Radical resection is based on the excision of the entire affected perianal area, eliminating the fistulous and ulcerated tissue.

“Kaiser” is an 8-year-old male German Shepherd with severe clinical signs of perianal fistulas that do not respond well to medical treatment (Fig. 1). The owner is informed about surgical intervention, as well as the possible complications that may arise. The owner accepts these warnings and is committed to giving the immediate and long-term postoperative care that “Kaiser” will need.

Before surgery

- Mild laxatives for several days before the operation.
- Rectal enema 48 hours before.
- Thorough cleaning with antiseptic soap and water.
- Antibiotic prophylaxis (against Gram negative and anaerobic bacteria).

Do not use enemas in the 24 hours prior to surgery. The feces may become very liquid and contaminate the surgical field.

Try to preserve the anal sphincter as much as possible to reduce the risk of fecal incontinence.

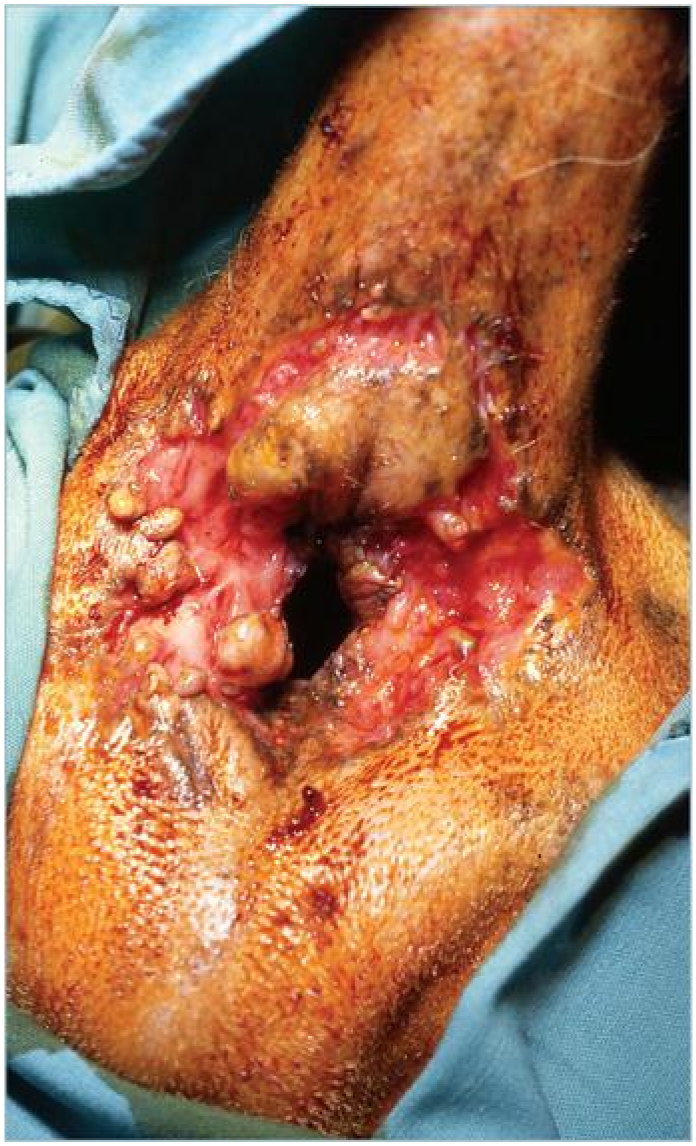

Fig. 2. Note the large area of affected tissue, which includes the anal sphincter. Using a scalpel, incise the skin on the outside and the anal sphincter on the inside. Resect the entire affected area: skin, subcutaneous tissue, muscle, fascia and the majority of the anus.

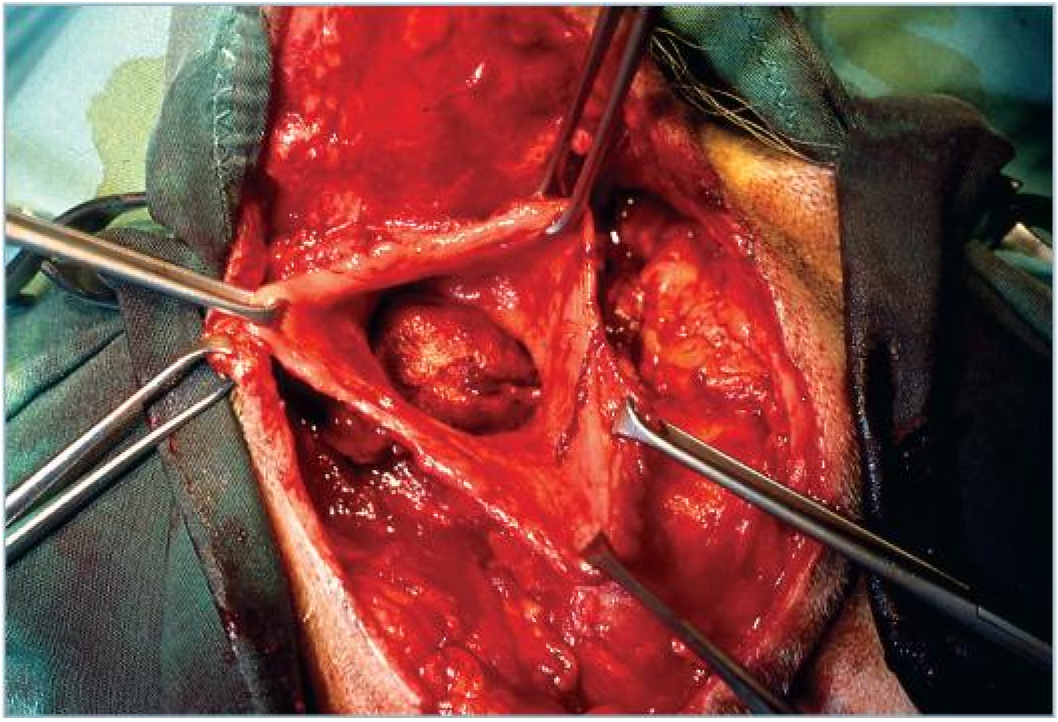

Fig. 3. After resection of all affected tissue, the rectum is sutured to the skin. Keep the rectal plug in place to avoid fecal contamination of the surgical field.

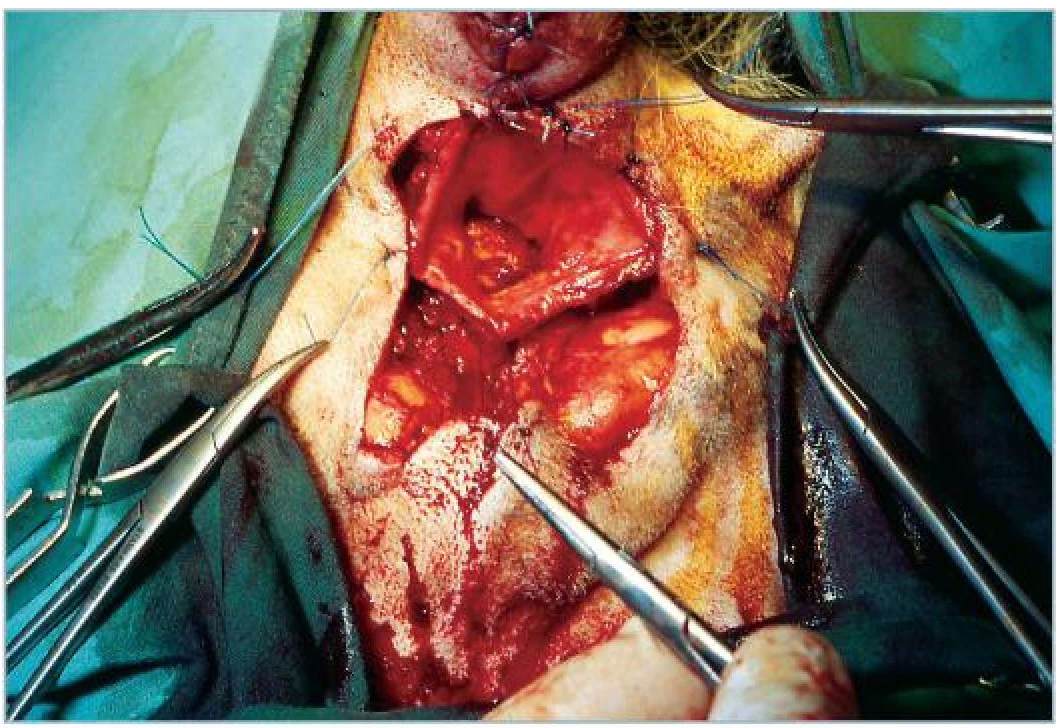

Fig. 4. Interrupted simple sutures are placed, using non absorbable monofilament material.

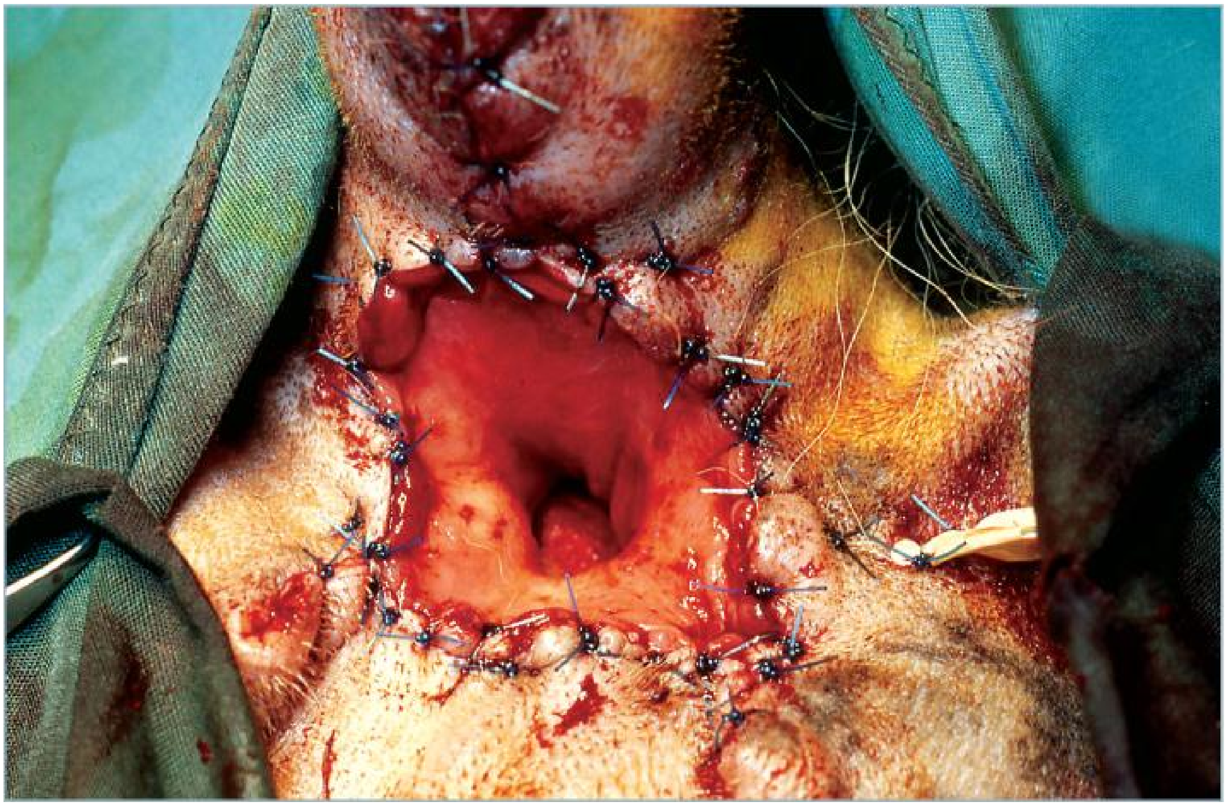

Fig. 5. Before finishing suturing, place one or two Penrose drains to avoid seromas forming postoperatively.

After surgery

- Elizabethan collar.
- Systemic analgesics.
- Cleaning of the anal area several times a day, particularly after defecation.
- Mild laxatives for 3 to 4 weeks. Feces should be eliminated easily, but should not become excessively pasty.
- Systemic antibiotics.
- Check-up every 2 days until complete healing, then once a month.
- Medical management of perianal fistulas.

Possible complications

- Fecal incontinence (24-28 %).
- Recurrence (17-33 %).
- Anal stenosis (14 %).
- Diarrhea.
- Tenesmus.
- Dyschezia.
- Constipation.

Postoperatively

Regular check-ups are required to asses the progress of the patient.

Fig. 6. The evolution after 36 hours is satisfactory.
It is very important that the patient wears an Elizabethan collar at all times.

Fig. 7. Four days after the operation, the surgical area is healing satisfactorily, apart from the small dehiscence of a suture in the lateral area. The drains are removed and their exit wounds are allowed to heal by second intention.

Fig. 8. Fifteen days after the operation, healing is progressing well. “Kaiser” is defecating normally and shows no pain in the area. During initial postoperative period, no infection has been observed as the wound edges have progressively retracted.

From now on, monthly check-ups are recommended to monitor for recurrence. If any lesions appear, they should be dealt with promptly with cauterizing substances.

Cauterizing substances

- Silver nitrate.
- Phenol (5 % solution).
- Iodine (7 % solution).

Fig. 9. After three months, the patient has regained weight, leads a completely normal life and there are no signs of recurrence of the perianal fistulas. Scar tissue contraction does not cause stenosis or defecation problems.

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Watch this video

Fecal incontinence is the most common postoperative complication of this kind of surgery.

This case was supplied by Dr. Cairó, of the Canis Veterinary Clinic, Girona (Spain).