Urinary and Perineal Surgery

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DAY 1

Urinary surgery
Basic urinary tract surgery techniques

Nephrotomy – Nephrectomy

Nephrotomies are almost exclusively performed for removal of nephrolithiases. Nephrectomies are performed in cases of renal tumours, irreversible kidney damage or intractable kidney abscesses.

The kidneys are located in the retroperitoneal space, ventral to the lumbar spine and epaxial musculature. The right kidney is more cranially located than the left one, and is in close vicinity of the caudate process of the caudate lobe of the liver.

Whether it be for nephrotomy or nephrectomy, a critical step of surgery is the identification and isolation of the renal artery (or arteries) and vein. This is best accomplished by elevating the kidneys and pivoting them around their hilar border, in order to expose their dorsal aspect. To achieve this, the kidney is bluntly dissected free of its attachments to the sublumbar tissues and pivoted medially. Care must be taken to visualise the hilar vessels well, especially with the left kidney as it has been shown to have multiple renal arteries in 10 to 15% of cases.

For nephrotomy, the renal vessels are identified and reversibly occluded with bulldog clamps or Rummel tourniquets. Failure to occlude all branches of these vessels results in profuse haemorrhage on incision of the renal parenchyma. After vascular occlusion, the kidney is held with its convex surface up and its parenchyma is incised over one half to two thirds of its length. The incision is extended in depth sharply or by blunt separation of the renal parenchyma with small haemostats, until the pelvis is reached. The pelvis is then inspected and calculi are removed with forceps and gentle suction. Some of them are kept for bacteriology. An IV catheter can be used to flush the pelvic diverticula to remove any potential lithiases entrapped in them. If there is any doubt as to the presence of ureteral stones or engagement of a renal calculus into the proximal ureter, retrograde catheterisation of the ureter from the bladder is performed and the ureter is flushed. When no more calculi are present, the two halves of the kidney are apposed and held pressed against one another. The vascular occlusion duration is kept to a minimum, and as soon as the pelvic exploration is finished, the 2 halves of the kidney are brought together and the temporary vascular occlusion is relieved. Manual moderate compression of the two halves of the kidneys is maintained for 3 to 10 minutes. It is usually sufficient to stop any haemorrhage which showed on vascular repermeation. The renal capsule is then sutured in a simple continuous pattern with a small diameter monofilament absorbable suture. As little renal parenchyma is taken in this suture. The kidney is then placed back in its anatomical position and fixed by either a few sutures between its capsule and the sublumbar tissues, or by making a sling of sublumbar connective tissues to hold it. In either case, it must be fixed firmly enough to prevent dislodgement and kinking or twisting of its vascular pedicle when the animal is no longer recumbent and moves again after surgery.

For nephrectomy, the kidney is elevated and its vessels are identified as above. They are permanently occluded by placement of ligatures or vascular clips, or by use of a vessel sealing device if their size makes them amenable to it. As a precaution, all ligatures and clips placed on the portion of the vessel remaining
in the patient are doubled. When ligatures are used, the second ligature is transfixing to make sure it will not slip. Once the kidney is isolated, the ureter is ligated as close as possible from the bladder wall. It is then severed and the kidney and ureter are removed en bloc (Figure 1).

Figure 1: Nephrectomy (from Tobias and Johnston, Veterinary Surgery: Small Animal, 2012)
Cystotomy

The bladder is approached through a median umbilicopubic coeliotomy. It is isolated from the rest of the abdominal cavity by appropriate placement of moist swabs. A stay suture is placed at its apex, allowing gentle cranial traction and full exposition of the bladder. A longitudinal stab incision is made on its ventral aspect in an area as devoid of vessels as possible. A suction tip is introduced in the lumen of the bladder through this incision and its contents are suctioned. The longitudinal incision is extended as necessary, potentially down to the proximal urethra. Efforts are made to sever as few bladder wall vessels as possible. Stay sutures can be placed on both edges of the cystotomy incision to open the bladder wound with minimal trauma. The bladder lumen is inspected. If appropriate, the ureteral stomas are identified and examined for abnormalities. A full-thickness sample of the bladder wall can be obtained from one of the cystotomy edges for pathology. In all cases, a urine sample and a fragment of the bladder mucosa are taken for bacteriology. If bladder stones are present, some of them are also collected for bacteriology. The rest can be used for analysis of their composition.

When the cystotomy is performed for removal of bladder stones, the lithiases in the bladder are removed. The distal portion urethra is catheterised, and the tip of the penis is squeezed around the urethral catheter. The assistant then prepares to flush the urethra with a 5 or 10-ml syringe of isotonic crystalloid. The surgeon then places one finger in the bladder neck to occlude it. The assistant pushes on the syringe and the surgeon opposes the pressure at the bladder neck. When the pressure is judged sufficient, the surgeon removes his finger abruptly. In most cases, several such attempts allow retro-flushing of all urethral stones. In my experience, even stones which resisted to non-invasive retro-flushing can be pushed back in the bladder with this method.

Closure of the bladder can almost always be performed in one layer of appositional sutures. A simple continuous suture using an absorbable monofilament on a round or tapercut needle is appropriate. Care is taken to include the submucosa in all sutures, but efforts are made not to place sutures in the bladder lumen (i.e. to perforate the mucosa), as sutures are lithogenic. However, if the bladder wall is very thin and inclusion of the submucosa can only be ascertained at the cost of perforation of the mucosa, it is safer to perforate it, especially if absorbable sutures are used.

Dorsal cystotomies are not recommended. The bladder trigone is located dorsally and is a triangle area delimited but the 2 ureteral openings in the bladder caudally and the bladder neck cranially. It is the area where the autonomic nerves responsible for bladder continence and voiding, coming from the pelvic plexus, enter the bladder. A dorsal incision increases the risk of damaging these structures.

Urethrotomy

In dogs with penile urethral obstruction by urolithiases, a urethrotomy is sometimes preferred to definitive urethrostomy, if the suspected composition of the stones is amenable to medical prevention. In such cases, the obstruction is relieved and recurrence is prevented medically through diet and adjuvant medication, as needed. The medical management of urolithiases is beyond the scope of this course. A urethrotomy is performed at the level of the obstruction, localised by retrograde catheterisation. It consists of approaching and incising the urethra over the site of obstruction, and removing the lithiases.
The surgical wound and urethra can either be primarily closed with a small monofilament absorbable suture or left to heal by second intention, at the surgeon’s discretion. If the urethra is left unsutured, an indwelling urethral catheter is left in place for 2 to 8 days to minimise leakage of urine in the surgical wound.

During the procedure, care must be taken to manipulate the urethra and surrounding tissues gently, to traumatise them as little as possible and reduce the likelihood of postoperative stricture.

Urethrostomy

Depending on the species and the obstruction site, several types of urethrostomies exist. Mainly, a urethrostomy can be ante-scrotal, scrotal or perineal in the dog and perineal, trans-pubic, subpubic and antepubic (or prepubic) in the cat.

As a rule, the urethral portion proximal to the urethrostomy site should be left as long as possible to minimize the likelihood of postoperative incontinence and UTI. The only exception is in the dog, where scrotal urethrostomies tend to be preferred to antescrotal ones, as they tend to bleed less postoperatively.

Feline perineal urethrostomy (Figure 2)

In cats, the perineal urethrostomy is the technique of choice in first intention. The cat is placed is sternal recumbency with the hindlimbs hanging over the edge of the table. The entire perineal area is clipped and prepared for aseptic surgery. If possible, a sterile urethral catheter is placed. An elliptical or rectangular incision is made around the penis and scrotum. If the cat is entire, its testicles are exteriorised and it is castrated. The penis is dissected free of its attachments of the pelvis: the dorsally located retractor penis muscle is severed and elevated, and the ischiocavernous muscles are identified. Each of these muscles is transected along the caudal edge of the ischium. Use of a unipolar cautery can be helpful as moderate haemorrhage can result from these sections. The ischiocavernous muscles are left as intact as possible, attached to the penis. Dissection of the penis is carried out up to the bulbourethral glands, which mark the point where the urethral diameter increases from 1mm caudally to 3-4 mm cranially. To be able to bring the bulbourethral glands caudally to the level of the skin, the penis must be completely freed from its pelvic attachments. Efforts are made not to dissect dorsally to the urethra beyond the bulbourethral glands, as this increases the risk of damage to the nerves supplying the urethra. On the contrary, the ventral attachments of the penis are severed or bluntly ruptured until it can be clearly felt that the penis can be brought caudally by 1 to 2 cm. Blunt digital dissection of the pelvic urethra can be performed by inserting the index between the pelvic floor and the urethra and gently rupturing their attachments. The urethra is then opened by sharp incision with a scalpel blade or fine blunt-tipped iridectomy scissors. If urethral catheterisation was impossible, the distal portion of the penis can be amputated. The urethra is then identified within this penile section plan and catheterised. The urethra is opened up to the bulbourethral glands. If not already done, the distal portion of the penis is amputated, leaving 1 to 2 cm of open urethra. Sutures are placed between the bulbourethral glands and subcutaneous tissues, bringing the cranial-most open portion of the urethra flush with the skin edges. These sutures will decrease the tension placed on the future mucocutaneous anastomosis. Similarly, sutures can be placed between the ischiocavernous muscles and subcutaneous tissues or caudal femoral muscles (semitendinosus or
semimembranosus muscles), to decrease even more the tension on the future mucocutaneous anastomosis. Several simple interrupted sutures of monofilament material are then placed between the urethra and the skin around the dorsal aspect of the open portion of the urethra, at 12 o’clock, then 11 and 1 o’clock, then 10 and 2 o’clock. Starting at 9 and 3 o’clock, the mucocutaneous anastomosis is continued in either interrupted or continuous patterns.

Figure 2: Feline perineal urethrostomy (from Tobias and Johnston, Veterinary Surgery: Small Animal, 2012)
The size of the new urethral stoma is controlled by introduction of a haemostat or a large-bore urinary catheter. In most instances, placement of an indwelling catheter is unnecessary. Clean petroleum ointment can be applied over the exposed urethral mucosa and surrounding skin to protect it from desiccation and ease subsequent removal of blood clots.

To avoid complications, 3 points are critical:

- **The urethra must be opened up to the bulbourethral glands.** Failure to do so is the most common reason for middle and long-term failure of the procedure by urethral obstruction or stenosis.

- **Tension on the mucocutaneous anastomosis must be kept to a minimum.** If not, the occurrence of a stenosis of the ostomy will be favoured;

- **The mucocutaneous apposition must be precise.** If not, urine may infiltrate the surrounding tissues, at best promoting scarring stenosis, at worse leading to extensive necrosis of perineal and inguinal tissues.

Should these principles and atraumatic proper technique be adhered to, urethrostomies are straightforward procedures associated with few complications and a good prognosis.

**Canine scrotal urethrostomy (Figure 2)**

The dog is placed in dorsal recumbency and the inguinal area is prepared for aseptic surgery. If possible, a retrograde urethral catheter is placed. An elliptic incision is made around the base of the scrotum. If the dog is entire, it is castrated routinely. The scrotum is then excised, leaving an elliptical wound above the penile urethra. The latter is approached ventrally by dissection and retraction of the retractor penis muscle. If a urethral catheter is placed, the urethra can be palpated. Otherwise, it usually is quite easily identified as being a rather darkish longitudinal structure (the corpus spongiosum) lying between two broader and brighter longitudinal structures, the corpora cavernosa. It is incised longitudinally on the midline over a few centimetres (2 to 5 depending on the patient's size). Moderate haemorrhage is usually encountered at this stage, but no efforts should be made to stop it other than by applying manual pressure on the wound for several minutes if it is judged excessive. In particular, the use of cautery is discouraged. A few sutures are placed between the subcutaneous tissues and the periurethral tissues, to bring the urethral opening flush with the skin wound. The mucocutaneous apposition is then performed in a simple interrupted or 2 simple continuous pattern(s) using a 1.5 or 2 metric absorbable monofilament suture swaged on a round or tapercut needle. The urethrostomy site can be covered by clean petroleum ointment to protect it from desiccation and ease the subsequent removal of blood clots from it.

The main complication from canine urethrostomies are postoperative haemorrhage. Typically, it waxes and wanes and can be observed for several days. In my experience, keeping the dog well sedated (e.g. with acepromazine) helps minimise these haemorrhagic episodes. Although they can be quite significant, they rarely become life-threatening or of significant clinical consequence.
Like for feline urethrostomies, keeping the tension on the mucocutaneous anastomosis to a minimum is very important to prevent future stenosis of the stoma. Also, precise mucocutaneous apposition is required to prevent urine leakage in, and scalding of, the surrounding tissues.

*Figure 3: Canine scrotal urethrostomy (from Tobias and Johnston, Veterinary Surgery: Small Animal, 2012)*
DAY 2

Perineal surgery
Surgery of the large intestine

Surgery of the colon

Anatomical and physiological considerations

The colon is a part of the large intestine, which also comprises the caecum and the rectum. Anatomically, it can be divided in *ascending*, *transverse* and *descending* colon.

The large intestine differs from the small intestine in several respects. Its main roles in the digestive physiology are to **reabsorb water and electrolytes** from the digesta, to be a **reservoir for faeces** and propel them towards the anal canal in due course. These roles imply that the large intestine contents are more solid than that of the more oral portions of the digestive tract, and also imply that it is larger. Besides, the large intestine has the **highest bacterial content** in the entire digestive tract ($10^{10}-10^{12}$ bacteria per ml of intestinal content). The presence of bacteria in the large intestinal is beneficial to the host, as they produce vitamins and help digest part of the indigestible substances contained in the digesta.

The large intestine also differs anatomically from the small intestine. For the surgeon, the main differences concern the mobility and vascularization. The mesenteries of the large intestine (mesocolon, mesorectum) are short and allow limited range of mobilisation of the corresponding intestinal portions. This has to be kept in mind when planning extensive colic resections to avoid excessive tension on the anastomosis. Finally, the blood supply of the large intestine mainly depends on the ileocolic artery and caudal mesenteric artery, which supply 3 vascular arcades, the right colic, middle colic and left colic arteries. Small arteries (vasa recta) originate from these arcades and segmentally supply the colon. The length of colon depending on each on of these arcades is variable and is the greatest for the left colic artery, supplying most of the descending colon. Preservation of these main arteries during colic surgery is therefore paramount to success.

General surgical considerations

Preparation for colic surgery

Because of the high bacterial content in the large intestine, septic complications are a greater risk after colic surgery than after many other types of surgery. In an effort to minimise such complications, several recommendations are commonly made.

Preparation of the patient undergoing colic surgery is twofold and consists of systemic prophylactic antibiotic administration, combined, as deemed necessary, with preparation of the colon itself.

The colon can be prepared in several ways. The choice in the preparation method depends on the patient’s clinical condition, on the type of surgery planned and on the surgeon’s preferences. Feeding the animal **hyperdigestible food** for 2 to 4 days prior to surgery decreases the amount of faecal material and bacteria present in the colon. Additionally, whenever possible, food should be withheld 24 hours before surgery.
Enemas are commonly given to clean the colon before surgery or coloscopy. Warm water or 10% povidone iodine can be used. Enemas decrease the amount of faeces in the large intestine but do not decrease, or only temporarily, its bacterial content. Furthermore, enemas soften and liquefy the stools, which make them more likely to spill on entering the colic lumen. To the contrary, when the colic contents are harder, they are more easily controlled and any potential peritoneal contamination is easier to address. For this reason, many surgeons do not give enemas before colic surgery. In any case, should enema be given prior to surgery, this should not be within 24 to 48 hours of the procedure.

Finally, preparation of the colon can be efficiently achieved by use of electrolyte solutions (Golytely, Colyte), unless the colon is obstructed. Like enemas, they result in liquid colic contents to be evacuated, and should therefore be administered long enough before surgery: usually, several administrations, between 48h and 24h before surgery are recommended.

Administration of non-absorbable antibiotics (e.g., neomycin, aminoglycosides), aiming at lowering the intraluminal bacterial content, is controversial and sometimes advocated. They temporarily reduce the bacterial population, but tend to select the most resistant strains of bacteria.

Colic surgery is considered contaminated (class III surgical procedure in the Altemeier classification). As such, it benefits from the perioperative administration of intravenous antibiotics. Classically, these are administered at the time of induction and repeated after every additional 90 to 120 minutes of operating time. As the bacterial flora of the colon is mainly composed of anaerobes and gram-negative aerobes, the drug of choice must have a documented efficacy against such germs. The most commonly used antibiotics for this purpose are various combinations of second-generation cephalosporins (cefmetazole, cefoxitin, cefotetan), amoxicillin clavulanate, metronidazole, ampicillin and amikacin. I almost invariably use metronidazole, combined with a broad-spectrum antibiotic such as a first- or second-generation cephalosporin.

To summarise, preparing the colon is especially useful when the surgery planned involves significant access or contact with the intraluminal aspect of the colon/rectum. Although off topic here, this is the case for pull-through rectal excisions, in which anastomoses are made intraluminally, with little means of preventing the colic contents to contaminate the surgical field. For intra-abdominal colic surgery, the colic contents can be milked away form the section sites and intestinal forceps (e.g. Doyen forceps) can be used to prevent subsequent spilling. The colic contents will then be more easily contained if they are rather solid and not altered. Preparation of the colon is therefore, for these surgeries, of lesser importance.

With regards to antibiotics, systemic prophylactic antibiotic administration is the only clear recommendation. Should the intervention be uneventful, protracting the administration beyond the immediate perioperative period is not recommended. The use of non-absorbable oral antibiotics is not believed to be of significant benefit.

Very importantly, as in most procedures not addressing a sepsis-based disease, antibiotics should not be regarded as the mainstay of infection prevention. Antibiotics are only adjuvant and seldom are the limiting factor in the occurrence of infection. The surgeon is the limiting factor, and adhering to the fundamental principles of atraumatic surgery is the best warrant of the absence of septic complications.
In other words, minimal and well-addressed (cleaning, rinsing, suctioning) faecal contamination during surgery is seldom a problem in a well-isolated surgical field, if tissues manipulated during surgery are left as little traumatised as possible, non-hypoxic, in a healthy environment. To the contrary, even in the absence of contamination whilst using the most potent antibiotics, roughly handled tissues in a hypoxic environment will not handle the high bacterial contents of the colon and a septic complication will then be likely.

**Approach and exposure**

The colon is almost invariably approached through a midline umbilicopubic coeliotomy. In some instances, when the portion of colon to access is very caudal, the pelvis can be partially elevated by means of bilateral pubic and ischial osteotomies to increase exposure.

Efforts should be made to isolate the involved portion of colon from the rest of the abdominal cavity. Moist abdominal swabs are packed around the colon and additional drapes can be used to further isolate the surgical field. Ideally, drapes, instruments and gloves are changed after the septic step of the procedure.

**Healing**

The colon is classically known to heal more slowly than the more oral parts of the digestive tract. Several reasons have been proposed, such as the solid contents, the high bacterial population, the less developed collateral vascular network and the collagenolytic activity of the large intestine. During the first few days of wound healing of the large intestine, the collagen lysis is greater than its synthesis, leading to a maximal risk of wound dehiscence around the 3rd and 4th postoperative days.

**Suturing**

The same layers compose the colic wall as in the rest of the digestive tract. From the lumen to the external surface the mucosa, the submucosa, the muscularis and the serosa are successively encountered. Among these, as in the other hollow organs, the submucosa is the layer of main mechanical resistance and should always be taken in the sutures. As long as each suture incorporates the submucosa, other considerations are of lesser relevance. Because of the abovementioned concerns about healing of the colon, efforts should be made not to hamper wound healing any further: sutures should not be too many or excessively tight, tension on the suture line should be as little as possible and reinforcement techniques should be used as appropriate.

**Specific surgical techniques**

**Colotomy**

The colotomy technique is very similar to the enterotomy technique: the colon is incised longitudinally on its antimesenteric border. It is sutured in one perforating layer, preferentially in an interrupted pattern, with monofilament slowly-absorbable sutures. Swaged-on round or tapercut needles should be used. Reinforcement techniques of the colic wound, such as omentisation or serosal patches, are used as appropriate.
Colectomy

A colectomy can be segmental, subtotal or total, depending on the underlying disease. A segmental colectomy involves excision of a portion of colon followed by end-to-end anastomosis (colocolostomy). Subtotal and total colectomies are performed in case of diffuse colic disease (feline idiopathic megacolon mainly) and extend from the ascending colon (colocolostomy) and from the ileum (ileocolostomy) respectively, to the last centimetres of the descending colon.

For segmental colectomies, the vascularization is better preserved by only cautering or ligating the vasa recta of the portion to excise. For subtotal colectomies, ligation of the colic arteries supplying the portion to excise can be ligated, provided the vascularization of the remaining portion is identified and clearly preserved. Subtotal and total colectomies are most commonly performed in cats for treatment of idiopathic megacolon. In such an indication, it is preferable to preserve the ileocolic sphincter whenever possible (i.e. opt for a subtotal colectomy). The only indications for colectomies with excision of the ileocolic sphincters (total colectomy) are recurrence of megacolon after subtotal colectomy and excessive tension on the anastomosis site. Unlike what was proposed by some authors, recurrences of megacolon are not more frequent after subtotal colectomies than after total colectomies. In addition, adverse side-effects are less common after subtotal colectomies than after total colectomies.

The section lines are isolated between intestinal clamps. Great care must be taken to use atraumatic forceps on the portions of intestine which are conserved. The colon is transected and the portion to excise is removed. The portions to anastomose are brought together and sutured in one layer of appositional interrupted or continuous sutures. Although a two-layer appositional closure is described (the first layer incorporating the mucosa and submucosa, and the second incorporating the muscularis and serosa), in most cases, a single layer is appropriate and less traumatic. Perforating sutures are used.

The anastomosis is performed in a simple interrupted or 2 simple continuous patterns using a slowly-absorbable monofilament suture on a round or tapercut needle. When using continuous patterns, a minimum of two sutures is placed to avoid a stenosis purse-string suture effect (figure 1). It is best to initially place the mesenteric and antimesenteric stitches (Figure 1a, Figure 1b). Then the first continuous suture is placed starting at the antimesenteric side (Figure 1c), so that intraluminal control of the anastomosis at the mesenteric side is possible (Figure 1d). Then the second continuous suture is placed (Figure 1e). If necessary, the mesocolon is sutured with great care not to damage the colic vasculature (Figure 1f). Reinforcement techniques (omentalisation especially) are used as appropriate.
Colopexy

A colopexy involves fixing the descending colon to the left abdominal wall. It is indicated in case of rectal prolapse or severe perineal hernia. Two techniques have been described: incisional or non-incisional. In both cases, after a conventional midline approach, the descending colon is gently tracted cranially and brought to the left side of the abdominal wall. In the non incisional technique, two lines of sutures are placed between the descending colon (incorporating the submucosa) and the left side of the abdominal wall. In the incisional technique, an incision is made through the seromuscular layer of the descending
colon and a corresponding incision is made through the transverse abdominal muscle (Figure 2a). The ventral edges of both incisions are sutured together in a continuous pattern with slowly absorbable sutures (Figure 2b-d), followed by the two dorsal edges (Figure 2e, Figure 2f). In both techniques, care must be taken not penetrate the colic lumen when placing the sutures. Subjectively, this is more easily achieved with the incisional technique.

Surgery of the rectum

The surgical treatment of colorectal tumours aims at their wide excision, while limiting short-term and long-term complications.
Resections of the colon generally are straightforward for the surgeon of sufficient experience. In addition, the colon can be widely resected without clinically relevant functional consequence on the volume and consistency of stools or faecal continence in the long term. For concision purposes, the specificities of wound healing and surgery of the colon will not be detailed here. For the same reason, the description of colic resection and anastomosis (sutures, staples, biofragmentable rings, etc.) and associated potential complications have been discussed elsewhere. Briefly, when sutures are used for colocolostomy (end-to-end colic anastomosis), the anastomosis is most often performed using a 1-layer, full-thickness continuous or interrupted pattern using a slowly-absorbable monofilament on a blunt or tapered swaged needle.

Conversely, rectal or colorectal (as including portions of both colon and rectum) resections often are more technically challenging and can have greater functional consequences.

Technically, as the rectum is mostly located within the pelvic canal, its approach is hindered by the pelvis. Its cranial-most and caudal-most portions are however accessible through an abdominal or a perineal (dorsal, lateral, by pull-out or pull-through) approach, respectively. The approach of it middle portion requires to either go through the pelvis by osteotomy (ventral approach) or to displace this portion caudally so that it can be approach from the perineum (pull-through technique).

The **ventral approach** to the rectum is performed either by splitting-distraction of the pelvic symphysis or by ischiopubic osteotomy and elevation of the pelvic floor (Figure 1). The former is quicker and is associated with fewer complications of bone wound healing, but provides a rather narrow exposure. The ischiopubic osteotomy is a more invasive approach, but provides a greater exposure and is in effect associated with few complications.
To perform an ischiopubic osteotomy, the patient is placed in dorsal recumbency and a caudal median coeliotomy is performed. The cutaneous incision is extended caudally to the ischium. The adductor muscles covering the obturator foramen (e.g. gracilis, external obturator) are elevated to expose the ventral aspect of the pubis and ischium. On the side opposite to the surgeon, this dissection is kept to a minimum allowing osteotomy without disinserting the muscles excessively to preserve the vascularisation of the bone. The chosen osteotomy lines are initially only marked by biting in the bones with an oscillating saw. Holes are then made on both side of each osteotomy line with a Jacob’s chuck and a pin or drill-bit, in view of future fixation of the repositioned pelvic floor. Great care is taken when drilling holes in or sawing the bones not to damage any pelvic structures, such as the urethra. Placement of a protective instrument into the pelvis, either through the obturator foramen or through the abdomen and pelvic inlet is recommended. Once the holes are made, the pubis and ischium are sawed and the pelvic floor is gently elevated. Once the intrapelvic step of the procedure is completed, the pelvic floor is repositioned and stabilised by placement of sutures or wire through the holes made previously.

The **dorsal approach** to the rectum is performed from the perineum, through an “inversed-U” incision located dorsally to and around the anus. The rectococcygeal muscle is incised close to its insertion on the caudal vertebrae. Its retraction exposes the pararectal fossae, peritoneal reflections located between the cranial-most caudal vertebrae and the rectum. Their identification is important as it is at their level that nerves of the pelvic plexus, responsible for the autonomous innervation of the organs contained in the pelvic canal, may be identified. One study suggested that when these nerves are preserved (experimental
resections of 4 cm of rectum), faecal continence is maintained whereas when they are damaged
(resections of 6 cm or more), faecal continence is impaired.

Figure 7: Dorsal approach to the rectum (from Tobias and Johnston, Veterinary Surgery: Small Animal, 2012)

This approach provides limited exposure, particularly to the ventral portion of the rectum. It is indicated
for tumours of the middle third of the rectum, located dorsally, especially when anatomical structures
dorsal to the rectum are involved. It is not suitable for the most caudal resections of the rectum as the
presence of the external anal sphincter muscle hinders the visibility of the rectum, which complicates the
performance of a colic anastomosis.

The lateral approach to the rectum is similar to the approach of the perineum for repair of a perineal
hernia. To expose the rectum, the pelvic diaphragm is open by blunt dissection between the levator ani
and external anal sphincter muscles. The limited exposure can be extended by blunt dissection and caudal
retraction of the rectum. This approach has overall few indications.

The “pull-out” technique consists of the eversion of the rectum to expose its luminal surface through the
anus (Figure 3). In this transanal approach the portion of rectum to expose is progressively exteriorised by
placement of successive intraluminal stay sutures in a “walking” fashion (i.e. placed more and more
cranially in the rectum, as the rectum is progressively everted). Therefore, this approach is only indicated
for resection of benign tumours or ADK in situ, as the resection is limited to the mucosal and submucosal
layers of the rectum. In this indication, the technique is associated with good results. In one study on 23 dogs, the excision appeared incomplete in just 1 case and only 2 dogs had a recurrence of the tumour.

Figure 8: Pull-out approach to the rectum (from Fossum, Small animal surgery, 2007)

The “pull-through” technique consists of incising the anal canal or the rectum on 360°, before dissecting the rectum along the external surface of its wall. The external anal sphincter muscle is preserved. The rectum is retracted caudally through the initial circumferential incision. When the portion of rectum to excise is exteriorised, it is resected and the remaining portion of rectum or colon is Anastomosed to this circumferential incision (Figure 4).

This approach allows resection of long portions of the rectum, sometimes up to the colon. If a more extensive resection is required, a combined approach is indicated (see below) to ascertain that the caudal mesenteric vessels will not be damaged par excessive traction on the rectocolon. When these vessels are ruptured during a pull-through procedure, it is not always apparent in the surgical field and can lead to significant, potentially fatal perioperative haemorrhage.
This technique is associated with a high complication rate, although most complications can be managed and do not necessarily impact significantly on the patient’s survival or quality of life. In one study of 74 dogs, complications included temporary faecal incontinence (n=58; 78.4%), permanent faecal incontinence (n=23; 31.1%), diarrhoea (n=32; 43.2%), tenesmus (n=23; 31.1%), stricture formation (n=16; 21.6%), rectal bleeding (n=8; 10.8%), constipation (n=7; 9.5%), dehiscence (n=6; 8.1%) and infection (n=4; 5.4%).

The combined (abdominoperineal) approach to the rectum (Swenson technique) is indicated for colorectal resections extending cranially. It is a two-step procedure. In a first step, the abdomen is approached by caudal median coeliotomy. The ascending colon is transected at the level of the rostral limit of the portion to excise and both ends are sutured. It is then ascertained that the oral ("cranial" or "proximal") portion of the colon can be brought through the pelvic canal into the perineum without tension and that its vasculature will be preserved. The two sectioned portions of colon are attached together and the abdomen is closed routinely. In a second step, a pull-through technique is used to exteriorise the rectum from a perineal approach. The two transected portions of colon, attached together are then exteriorised and the aboral end of the portion of colon to preserve is brought to the pull-through circumferential incision, which is the caudal limit of resection. The colorectal or coloanal anastomosis is then performed.

This approach is very invasive and has been reported to be associated with a high rate of immediate postoperative mortality (50%) in a recent study.
The choice of the approach mainly depends on the localisation and extension of the tumour to resect. In addition, the concomitancy of abdominal lesions or lymphadenopathies may necessitate an abdominal approach, combined or not with another rectal approach.

Potential complications combine complications from colorectal surgery (suture dehiscence, infection, stenosis and incontinence) with those of oncologic surgery (recurrence mainly). However, the good knowledge of colorectal anatomy and physiology, together with an atraumatic technique, lowers the risk of such complications.

As much of the rectum as possible should be preserved to limit the risks of postoperative faecal incontinence. The preservation of the external anal sphincter is not sufficient for a normal faecal continence. The sensitivity of the 1 to 2 caudal-most centimetres of rectal mucosa is essential for the function of faecal continence and defaecation reflexes. On the contrary, the preservation of the internal anal sphincter is not mandatory, as its role can be taken over by the smooth muscles of the remaining rectum. In a retrospective study of 10 cases of rectal resection by pull-through, 4 animals remained faecally incontinent and 2 were euthanased for this reason. The caudal limit of resection was not reported and it could not be determined whether the animals which remained incontinent had very caudal resections or not. In a more recent study on 11 dogs, only one required a very caudal resection extending to the anorectal margin. All others could have at least 1 cm of caudal rectum preserved. Only 2 dogs had temporary faecal incontinence, lasting 1 and 5 months after surgery. A recent study of 74 dogs undergoing rectal pull-through showed temporary incontinence in 58 dogs (78.4%) and permanent incontinence in 23 dogs (31.1%).

Another aspect of faecal continence is “reservoir” continence. In humans, even limited resections of the rectum can have serious consequences of faecal continence by loss of this reservoir effect of the rectum. In dogs, the importance of this reservoir effect is not as clear and it seems that dogs can remain faecally continent even after resection of most of the rectum, provided a sufficient portion of the colon is preserved.
Perineal hernias

Perineal hernia (PH) results from rupture of muscles of the pelvic diaphragm. It occurs most likely in older male dogs but has also been described in cats. It rarely occurs in female dog.

Clinical signs include straining to defecate and less frequently straining to urinate. Some other signs such as faecal incontinence, urinary incontinence, and flatulence have also been reported.

The clinical diagnosis is based on appearance of a perineal swelling, most often right sided or bilateral. A rectal examination demonstrates the presence of accumulated faeces in an abnormally enlarged rectum. When the rectum is empty, the hernia may be difficult to diagnose. In these cases, the ability to push the finger through an enlarged rectum towards the sacrotuberous ligament demonstrates the loss of muscular support to the rectum wall and is therefore diagnostic for perineal hernia.

Pathogenesis

Perineal hernia occurs most commonly in dogs from 7 to 9 years of age. Whether the age is associated with muscle weakness, prostatic disease, or any other underlying disease remains unknown.

Among different studies, 60% of the perineal hernia were unilateral and 40% bilateral. Among the unilateral ones, almost 70% are right-sided. Studies have failed to demonstrate a relative weakness of the pelvic diaphragm muscles of the right side. On rectal examination of unilateral hernias, a contralateral weakness is often encountered. Failure to identify this weakness and to support this contralateral side adequately makes it prone to future hernia.

Chronic constipation due to bad feeding habits is usually associated with increased defaecating efforts, in return can increasing abdominal and perineal pressure. In cats, most cases are bilateral and associated with chronic constipation, megacolon, stranguria or perineal urethrostomy surgery.

Perineal herniation commonly occurs between the external anal sphincter and the levator ani muscles, and more rarely between the levator ani and the coccygeal muscles. Frequently, the cranial remnants of the levator ani can be found close to the external anal sphincter or the external coccygeal muscles. In severe cases, muscle atrophy will not only involve the levator ani muscle but also the external coccygeus, internal obturator and the external anal sphincter muscles. Biopsies of the muscle fibres of the levator ani muscle in dogs suffering of perineal hernia show atrophy of neurologic origin but it remains unclear whether this atrophy is an expression of aging, neurologic disease or excessive pressure exerted on this muscle.

Perineal hernias have been frequently associated with testicular tumours (2% of sertolinomas, 15% of interstitial tumours, 19% of seminomas et 11% of mixed tumours), which suggests an association between hormonal imbalance and atrophy of the muscles of the pelvic diaphragm. In one study, the recurrence rate was 2.7 times lower in castrated dogs than in intact ones. This is one of the reasons why castration is recommended as an adjunct therapy for perineal hernia.
Relaxin was found in the canine prostate and the hypothesis that it could be involved in perineal hernia formation in male dogs was tested. Based on preliminary results, relaxin of prostatic origin, leaking from periprostatic cysts commonly seen in the perineum of affected dogs, is a possible factor in local connective tissue weakening and subsequent development of perineal hernia.

Several studies have shown dogs with perineal hernia frequently suffer from concurrent prostatic disease (10 to 51% of cases). One study, in which ultra-sonographic prostatic assessment was performed before any perineal surgery, found that prostatic lesions were present in 17 dogs (41%), and in 8 dogs (19.5%) prostatic disease had to be specifically treated surgically. In another study on 41 bilateral or complicated hernias, 9 prostatic surgeries (omentumisation or perineal cyst resection) were performed. Given the high frequency of prostatic disease associated with perineal hernia, its ultrasonographic evaluation is recommended prior to surgery. Whether both diseases occur in the same type of patients (breed, age and sex) or whether a significant correlation does exist between them remains unclear.

Pathogenesis

Deterioration of the levator ani muscle results in a progressive loss of rectal wall support. The fissure between the external anal sphincter muscle and the caudal pubic portion of the levator ani muscle progressively widens. Retroperitoneal fat naturally progresses through this fissure. The loss of muscular support and the progression of defaecating efforts increase the likelihood that the rectum progressively fills this new space into the perineal cavity. The consequent malalignment of the rectum with the anus hinders elimination of faeces and increase defaecating efforts. A secondary rectal dilatation therefore progressively develops, gradually worsening defaecation straining and further enlarging the rectal dilatation and weakening the pelvic diaphragm muscles. Persistent straining associated with large rectal dilatation and hernia can even promote secondary herniation of the prostate and retroflexion of the bladder into the perineal cavity.

Rectal abnormalities associated with perineal hernia have previously been differentiated as deviation (a change in rectal orientation from the midline), sacculation (enlargement not associated with tearing of the muscular wall) or diverticulum (protrusion of rectal mucosa through the muscular layers of the rectal wall). Because differentiation between rectal deviation, sacculation, and diverticulum can be difficult clinically or radiographically, a grading for the rectal dilatation was proposed: a simple deviation with no dilatation corresponds to grade 1, a mild rectal dilatation (asymmetric dilatation with faecal accumulation without visible perineal deformation) corresponds to grade 2, and severe rectal dilatation (asymmetric dilatation with a visible bulge of the perineum and a large amount of faecal accumulation and impaction) corresponds to grade 3.

Bladder retroflexion (engagement of the flipped bladder through the hernia) occurred in 12 to 29% of dogs. In cases of retroflexion, the bladder rotates at least 180° around its neck. Although this finding was not statistically significant in all studies, perineal hernias with bladder retroflexion seem to be associated with higher mortality rates (30%) and a worse prognosis than those without.6,10,12 Following retroflexion, several complications can be encountered: acute renal failure secondary to complete urethral occlusion, bladder necrosis due to occlusion of the urogenital arteries and partial or total, temporary or definitive loss of urinary continence.
To propose guidelines for surgical treatment, some authors have graded perineal hernias as unilateral, bilateral and complicated. A perineal hernia was defined as complicated if it met the following criteria: recurrent PH, unilateral PH with a severe (grade 3) rectal dilatation, PH with a concurrent surgical prostatic disease, and PH with retroflexed bladder.

Considerations for Treatment

Closure of the pelvic diaphragm

Current approaches to treatment of perineal hernia rely on closure of the pelvic diaphragm. Since muscle appositional techniques resulted in excessive tension on the external anal sphincter, muscle transposition techniques were developed using the superficial gluteal muscle, internal obturator muscle (Figure 7), semitendinosus muscle flap or a combination of internal obturator muscle and superficial gluteal muscle transpositions. Filling the defect with stainless steel, polypropylene mesh, porcine intestinal submucosa and fascia lata have been reported. Currently, the internal obturator muscle tenotomy and transposition is the most popular, and seemingly the most appropriate, technique for treatment of PH.

Figure 10: Perineal hernia repair by internal obturator muscle transposition
(from Tobias and Johnston, Veterinary Surgery: Small Animal, 2012)

Laparotomy in the treatment of perineal hernia

Rectal disease, bladder retroflexion, and prostatic disease often occur concurrently with PH. They contribute to its severity and may contribute to treatment failure. The incidences of rectal, prostatic, and bladder diseases associated with perineal hernia were studied and a 2-stage treatment, combining an abdominal step with the classic perineal step, was designed. This 2-step treatment is reportedly indicated for bilateral or complicated perineal hernias (recurrent, unilateral with grade-3 rectal dilatation, with concurrent surgical prostatic disease, or with retroflexed bladder). The abdominal step can include colopexy, cystopexy, vas-deferens pexy and, if needed, prostatic surgery. The perineal steps, performed either concomitantly or 2 to 7 days later, remains classic, consisting of perineal hernia repair using an
internal obturator muscle transposition. In some studies, results of this staged treatment have compared favourably with earlier reports. Satisfactory results using colopexy, cystopexy or vas deferens pexy as sole or adjunctive treatment for perineal hernia have also been reported.

Rationale for a two-step protocol
Colopexy improves or resolves the rectal dilatation or deviation, vas deferens pexy stabilises the prostate and cystopexy prevents bladder retroflexion so that the hernia is mostly empty of viscerza. When the perineal step is later performed, the perineal inflammation has decreased and the hernia is empty, both allowing improved observation of the important local anatomic structures, such as the pelvic diaphragm muscles, pudendal and caudal rectal nerves and artery, internal obturator muscle and tendon, and rectal wall. The abdominal steps therefore facilitates hernia repair during the perineal step.

Prognosis, complication rates and causes
The prognosis and complication rates of PH depend on the severity of the hernia and associated diseases, on the surgeon’s experience and on the chosen surgical techniques.

Colorecto-anal abnormalities
Preoperatively, external anal sphincter mechanism incompetence is rare. However, chronic distension of the rectal wall and chronic straining may weaken the external sphincter fibres. Whenever incompetence is suspected, electromyography of the external sphincter should be recommended prior to surgery. Although postoperative faecal incontinence and rectal prolapse have been described respectively in 3-15% and 7-42% of dogs with PH, they were not observed in dogs treated in 2 steps. When recorded, persistent postoperative tenesmus has been reported to occur in to 2 to 50 % of dogs. Causes have not been determined, but rectal deformation associated with persistent recto-colitis has been suggested. Colonic or rectal motility disorders can also be associated with long-term straining. This could explain poor rectal emptying in some patients with good perineal reconstruction.

Urinary dribbling
Postoperative urinary incontinence has been described in 4 to 8% of dogs with perineal hernia. Suggested mechanisms involve acute traction on the hypogastric and pelvic nerves, or secondary deterioration of the detrusor muscle due to bladder retroflexion. In one study, 15 dogs (36%) presented with urine dribbling after surgery; 8 resolved within the first 6 months but 7 had permanent dribbling. Possible associations between urinary incontinence and prostatic disease, bladder malposition and vas deferens pexy or cystopexy remain to be elucidated.

Perineal wound infection
Perineal wound infection is the most common complication described after perineal hernia repair, occurring in 5 to 45% of cases. Absorbable monofilament suture material, perioperative antibiotics and anal purse-string suture occlusion are used to decrease the risk of postoperative infection. Although laparoscopic colopexy and vas deferens pexy were initially proposed, they have since been deemed inappropriate by some authors given their high rate of septic complications at the colopexy site.
Anal sacculectomy

For treatment of inflammatory and infectious diseases

Anal sacculectomy is often performed for definitive treatment of recurrent inflammatory or infectious diseases of the anal sacs. In such cases, acute episodes should be managed medically (typically with combinations of surgical debridement of any non-ruptured abscesses, and anti-inflammatories and antibiotics) and surgery only performed when perianal tissues have become (near) normal again.

Two main techniques exist: an open and closed technique. The closed technique has our preference and will be the only one described here (Figure 1). In the closed technique, the anal sacs are excised without intentional penetration of their lumen. Circumferential cutaneous incisions are performed centred over the “8 o’clock” and “4 o’clock” positions of the anal circumference, sufficiently far from the anal mucosa to be on normal skin. The anal sacs can be difficult to identify in dogs and several techniques can be used to facilitate their recognition and dissection, including filling them with self-hardening materials or Foley tubes. These techniques are not mandatory and anal sacs can equally be dissected while empty.

![Figure 1: Closed anal sacculectomy (from Tobias and Johnston, Veterinary Surgery: Small Animal, 2012)](image)

In any case, the dissection must be carried out as closely to the anal sac as possible, to preserve as much fibres of the external anal sphincter muscle as possible. In our experience, this is best achieved by using small, precise and delicate scissors such as curved, sharp-tipped iridectomy scissors. Once identified, the anal sac is grabbed with tissue forceps (e.g. Allis) and dissection is carried out from its lateral aspect in a cranial direction, until the cranial boundary of the anal sac is reached. The anal sac is then progressively retracted caudally, gradually exposing its medial aspect and allowing dissection of the fine layer of connective tissue between the anal sac and the internal anal sphincter around the rectum. Dissection is complete when the anal sac is free except from its ductal attachment. Depending on its size the duct is
either ligated and cut, cut and is opening sewed or cut and its opening left open. In any case, the duct is resected as entirely as possible, which required transecting it very close to the anal mucosa. The wound is then closed routinely.

For tumour resection

Anal sac carcinoma (ASC) is a fairly common tumour in dogs and rare tumours in cats. Whenever technically possible, surgical removal of the tumour is the cornerstone of ASC treatment. Metastatic lymph nodes should also be removed to decrease the tumour burden as much as possible, especially in hypercalcaemic patients.

Bilateral disease is uncommon (approximately 10% of cases), but some surgeons will also remove unaffected anal sacs during this step. Excisions of ASCs are essentially marginal, as anal sacs are partially surrounded by loose connective tissues, preventing en-bloc excisions. The sac is resected with only a thin layer of muscle fibres from the external anal sphincter muscle. The dissection progresses cranially along the lateral aspect of the sac until its cranial border is reached. The sac is then progressively retracted caudally, until it is only attached along its contact with the internal anal sphincter muscle and rectal wall. In most cases, a dissection plane can be found between the rectal wall and the sac, allowing preservation of the wall. In rare cases, the rectal wall is invaded and must be partially resected with the tumour. Once the tumour is excised, the caudal border of any enlarged lateral sacral lymph nodes is dissected and these nodes are excised.

Complications are uncommon and most commonly involve wound complications. Persistent faecal incontinence should not occur if proper technique is used, unless most of the external anal sphincter is resected.