More Soft Tissue Surgery Case Challenges for Advanced Practitioners Mini Series

Session 2: Abdominal Surgery

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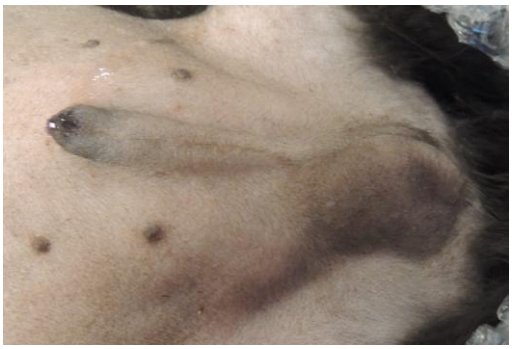


In this episode, I have presented a single long case that had an unusual presentation and two linked diseases, then a series of abdominal hernias. By working through the cases, I will consider the problem solving involved and demonstrate relevant facts. I will present how I approached the cases and made decisions and give my opinions, and these should be supported by independent learning of relevant book chapters.

CASE 1 – Urinary disease

A 2-year-old male neutered Poodle presented with a history of urinary obstruction two days prior to referral that had been relieved with catheterization. Review of his clinical notes showed that the referring vet had difficulty passing the catheter before his bladder was lavaged, and he then didn't pass any more urine at home The assumption is his obstruction was not relieved, as it is sometimes possible to push a catheter past an obstruction. He developed marked abdominal pain and anuria 24 hours later but was not presented to his vet for a further 24 hours. Blood tests at that time showed increased urea and creatinine, increased PCV/TP consistent with hypovolaemia/dehydration, hyperkalaemia (consistent with urinary tract obstruction or uroabdomen) and normal lactate (normal perfusion). He was treated with methadone and lactated Ringer's at 4ml/kg/h.

Triage and Problem List

A brief summary of the physical examination findings is as follows:

Cardiovascular system:
- Tacky mucous membranes, CRT reduced
- Weak femoral pulses
- Bradycardia
- Skin tenting
- Estimated 5% dehydration

Respiratory system:
- Normal

Neurological system:
- Depressed
- Normal cranial and peripheral nerves

Abdomen:
- Abdominal pain
- Distension

Orthopaedic – normal

Skin – normal

Rectal temperature - normal

Problem List & Differential Diagnoses

A brief problem list and differentials list are as follows. There are more potential differentials that can be considered, but these are the most likely.

- Azotaemia, hyperkalaemia, bradycardia

Primary renal disease e.g. AKI
Urinary tract obstruction
Uroabdomen

- Weak pulses, tacky mucous membranes

Hypovolaemia

- Abdominal pain/distension

Urine

Infection
Abdominal mass

Initial stabilization

10ml/kg bolus lactated Ringer's over 10 minutes followed by maintenance at 4-6mlkg/h with 2 further boluses over next 60 minutes.

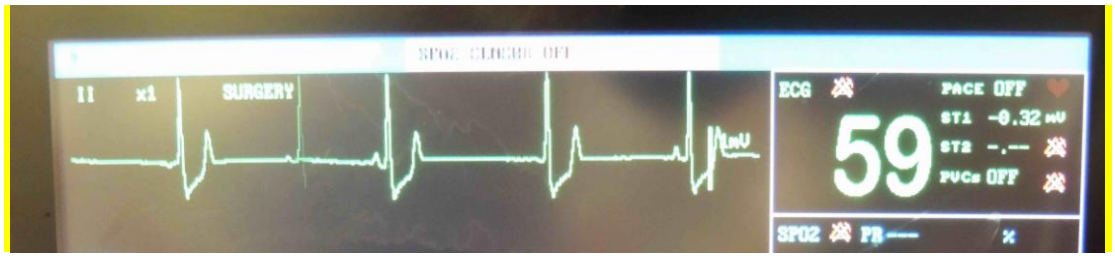
Diagnostic Tests

Blood tests:

Full biochemistry and haeamtology were performed. Abnormal parameters are below.

Urea	46.2	2.5-9.6 mmol/l
Creatinine	263	44-159 umol/l
Albumin	43	23-40 g/l
AST	113	0-50 U/l
Creatine kinase	1975	10-200 U/l
Chloride	106	109-22 mol/l
PCV	59%	
TS	84 g/l	

ECG: bradycardia, missing P waves



Blood pressure: 117/76 mean 88

Abdominal FAST scan:

- Free abdominal fluid
- Bladder rupture

Abdominocentesis and fluid analysis:

Fluid was obtained from the abdomen and looked grossly like urine. Most blood analysis machines will allow the analysis of other fluids. As urea is a small molecule it can move between the abdominal cavity and serum and will quickly equalize, so that serum and free abdominal urine will have a similar urea concentration. However, creatinine is a larger molecule that cannot move freely into the serum, so free abdominal urine will have a much higher concentration that a serum sample. If fluid is obviously urine I will not run any further tests, but it is useful to send fluid for culture in animals where pre-leakage urine may have been infected e.g. an animal with previous urinary tract signs. In a dog with rupture secondary to road traffic accident, where urine is expected to be sterile, I would not consider culture necessary.

	Blood	Abdominal fluid	
Potassium	4.7	>9.0	3.5-5.8 mmol/l
Urea	46.2	43.5	2.5-9.6 mmol/l
Creatinine	263	>1700	44-159 umol/l

If there is suspicion of fluid other than urine, other tests may be necessary, e.g. cytology to assess for infection, bilirubin if fluid looks like bile.

Revised Problem List/ Diagnosis

Uroabdomen

- Urinary tract rupture
    - Bladder – most common source of uroabdomen
        - Secondary to urethral obstruction e.g. urolith
            - ? types of urolith – see below
                - Ammonium urate – consider portosystemic shunt
                - Struvite – consider infection
                - Calcium oxalate
                - Cysteine
                - Xanthine
                - Silica
                - (other rare uroliths)
        - Cystitis (inflammatory, infectious) - unlikely with no history of urinary tract signs
        - Neoplasia (benign, malignant)– unlikely given young age
        - Trauma - unlikely with no history
    - Urethra, ureter, kidney – unlikely with no history of trauma

Suspected hyperkalaemia (at cellular level)
Ongoing hypovolaemia – not yet resolved

Urolith composition – urolithiasis in young dogs is unusual. Poodles are a breed predisposed to congenital portosystemic shunts and subsequent urate urolith formation can cause urinary tract signs. Some dogs with shunts have only urinary tract signs, therefore portosystemic shunt must be considered in any young dog with urinary tract signs, especially if of a predisposed breed. Typically biochemistry of dogs with shunts show low urea, which couldn't be assessed in this dog as he had high urea from uroabdomen. Bile acid is an externally run test and usually requires a post-prandial sample to make a diagnosis of reduced liver function, so wasn't performed on initial presentation. An abdominal ultrasound could have been performed to look for a shunt, but may have been difficult in the presence of uroabdomen. As this dog presented as an out of hours emergency detailed abdominal ultrasound would have led to a delay in surgery. Therefore we treated the dog (especially with anaesthesia and analgesia drugs) as though he had a shunt.

Further Diagnostic Tests

It is difficult to fully stabilise an animal with uroabdomen for as long as there is urine in the abdominal cavity. I have placed urinary catheters in dogs with rupture during fluid stabilization, as this will successfully drain urine produced from the ureters assuming there is a small rupture only. However many ruptures are large and fluid from the ureters empties directly into the abdominal cavity, with catheters being ineffective. Similarly placement of an abdominal drain has not proven to be particularly effective as urine tends not to drain well from drains that are not well fenestrated (such as a Jackson-Pratt drain). Most practices don't have access to peritoneal dialysis.

Therefore fluid therapy is used to stabilise the animal as much as possible priory to anaesthesia. Whilst we recognize that an animal with uroabdomen will be unstable, it is important to ensure that sufficient fluid resuscitation is performed to minimise risks. Failure to resolve hypovolaemia and hypotension will increase risk of peri- and post-operative death. As

with the bleeding dog in the first lecture, fluid boluses are given (10ml/kg/5-10 minutes) and the response assessed. When the blood pressure and mucous membranes respond appropriately, the dog is maintained with a constant rate of fluids (based on clinical parameters, high rates will be needed initially) with the option to bolus again if the dog becomes hypovolaemia again. In this case, the dog was bolused 3 times before being maintained on 6 ml/kg/h.

Potassium was normal on our blood tests but he had been hyperkalaemia at his vets and, most importantly, the ECG was consistent with hyperkalaemia. We therefore assumed that his cells were under the influence of high potassium, and that the serum potassium would likely increase when hypovolaemia was successfully treated, which is indeed what happened. Presumptive cellular hyperkalaemia was treated with glucose 50% and calcium gluconate 10% was given to stablise cardiac cells.

He was premedicated with methadone before induction with midazolam and propofol. He received fentanyl during surgery and dopamine to maintain normal blood pressure as it could not be maintained with fluids alone.

Abdominal radiography:

Plain orthogonal radiographs were taken to rule out radio-opaque uroliths and to check exposures prior to contrast radiography. Other radiographic changes are not expected given the uroabdomen, as detail cannot be seen in the presence of fluids.

Positive contrast urethrocystography is performed to confirm that the rupture is from the bladder. Should the urethra and bladder be intact, intravenous urography would be necessary, but I don't perform this initially as spontaneous bladder/ureter rupture is very rare, and IVU can be time consuming to perform, so it is an unnecessary additional financial cost and would prolong anaesthesia in an unstable dog. Negative or double contrast studies are of no benefit in investigation of uroabdomen. I use a 50:50 dilution of contrast although some imagers prefer a 100% concentration of contrast. Using a diluted solution can avoid contrast masking the presence of uroliths, but a non-diluted sample can make urethral visualization better.

A dog urinary catheter (of large enough size to avoid leakage from the penis) is prefilled with contrast via a 3-way tap, to avoid injection of air bubbles that can be confused with uroliths. It is lubricated and placed a few centimetres into the urethra and the penis is clamped with a tongue clamp (available from Veterinary Instrumentation) adjacent to the urethra to stop urine leakage. By placing the catheter just within the penis the entire urethra can be visualized for uroliths (as rupture may have occurred secondary to obstruction from urethral urolithiasis), other urethral disease or urethral rupture (as a proximal rupture will leak urine into the abdominal cavity causing uroabdomen).

The study showed no evidence of urolithiasis or other urethral disease, confirming the rupture was not from the urethra. There was a large volume of free contrast in the abdomen, consistent with bladder rupture. In the presence of bladder rupture, contrast radiography is of no use in investigating bladder disease, as the bladder cannot be filled. As the diagnosis was achieved, there was no need for IVU.

Epidural analgesia

An epidural was performed using preservative free morphine.

Surgical exploration

Suction is very useful for removing large volumes of fluid from the abdominal cavity. A small rupture was found on the dorsal aspect of the bladder cranial to the trigone. The bladder wall was thickened and erythematous, consistent with trauma (of which there was no history), previous distension or bladder disease e.g. inflammatory cystitis. The most likely differential diagnosis was secondary to urolithiasis, so examination of the urinary tract was performed to

locate a urolith. Uroliths that have caused urethral obstruction tend to be located in the proximal urethra when dogs are in dorsal recumbancy, and cannot be seen from the bladder. If they are not removed, they may pass back to the urethra and cause re-obstruction.

The rupture was used to visualise the trigone, but the rupture could have been converted to a cystotomy if necessary, or the rupture could have been repaired and a ventral cystotomy performed. A urinary catheter placed in the penis was used to flush saline into the trigone of the bladder. It is important to visualise the bladder during flushing as often uroliths are flushed into the trigone and fall back into the urethra when flushing ends. Therefore if the urethra is flushed without being visualised and then the trigone is checked afterwards, a urolith can be missed. In this case two uroliths were flushed into the bladder from the urethra but despite repeated flushing no other uroliths were found. The uroliths were small enough to have passed into the proximal urethra but were too large to pass through the urethra where it narrows distally at the caudal os penis.

It is important to evaluate the location of the ureters when suturing the dorso-caudal bladder. The ureters enter the dorsal wall of the midline dorsolaterally and travel for 1-2 cm (depending on dog size and bladder filling) to open at the trigone. There is variability in individual dogs as to how dorsal the ureters are. The ureters can be seen entering the bladder in the lateral ligaments and can be palpated within the bladder wall, although palpation can be difficult in smaller animals. In this dog the rupture was very close to one of the ureters and careful suturing using small bites with a small gauge suture was needed to avoid penetrating the ureter.

Post-operatively swelling can occur and could lead to obstruction of urine outflow from the adjacent ureter. However, swelling is usually transient and a partial (or even complete) obstruction for a few days is unlikely to have a detrimental effect. However, scar tissue forming upon wound healing could interfere with ureteral flow, and eventually lead to hydroureter and hydronephrosis, so the dog was followed up with ultrasound a few weeks after surgery, and no complications were noted.

In this dog, the assumption was made that the urolith had caused a complete urethral obstruction, leading to bladder distension and eventual bladder rupture. It is rare for the bladder to rupture as it has a large capacity for distension. Most animals will complete obstruction will present with dysuria, vomiting or collapse and will have a very distended bladder, and so this dog has an unusual presentation.

The uroliths were submitted for urolith composition analysis and aerobic/anaerobic bacteriological culture and sensitivity.

Post-operative care and recovery

He was continued with fluids at 4ml/kg/h. dopamine was continued for 6 hours by which time he was able to maintain normal blood pressure. Urea and creatinine remained high at the end of surgery but had normalized 12 hours later following fluid therapy and normal urine flow. He had a urinary catheter for 12 hours following surgery (mainly to assess urine output for evaluating hypovolaemia). He was treated with methadone for 48 hours followed by buprenorphine and then Tramadol. He was treated with intravenous antibiotics pre- and intra-operatively and then oral antibiotics as he had suspected portosystemic shunt.

Follow-up

The dog made a good recovery. Culture of a urolith was negative. Urolith composition was 100% ammonium urate, suggesting the dog had a portosystemic shunt.

Ultrasound of the abdomen two weeks later showed no abnormalities of the ureters. There were no other uroliths within the urinary tract, other than multiple sediment in the bladder that seemed to be small uroliths of <1mm in diameter – these would not have been visible at surgery or may have formed subsequently, as flushing the bladder and urethra should have got rid of most uroliths. The liver was small. The portal vein was seen entering the liver but

was small. A portosystemic shunt was identified, leaving the splenic vein (or a tributary), coursing into the mid-dorsal abdomen alongside the oesophagus. It could not be followed due to overlying lung and so it could not be followed to its communication with the systemic vascular circulation. Blood tests showed high pre- and post-prandial bile acids (pre 15 and post 25 [0.1-10 umol/l)). Many dogs with shunts have much higher bile acids but it is variable. Ammonia was normal.

He was treated with antibiotics (typically we use amoxicillin or clavulanate-amoxicillin) to reduce production of ammonia from bacteria, lactulose (to decrease bacterial load) and a diet for dogs with liver disease (options include Hills L/D and Royal Canin Hepatic). These diets are not suitable for young dogs as they are too protein restricted. Medical treatment is continued for two weeks before surgical treatment to reduce the levels of circulating neurotransmitters. They also pre-treated with levetiracetam to reduce the risk of post-operative seizures.

Portosystemic Shunt – Medical vs. Surgical Treatment

In a population of dogs, there will be longer survival in dogs treated surgically. Death rates are not high with surgery, although some dogs will suffer seizures, which can be fatal. Whilst some owners will choose medical therapy due to the fear of post-operative mortality, dogs that have medical treatment will have shorter survival before death from liver failure.

The abstract below is from a recent paper on survival times with medical and surgical treatment.

J Am Vet Med Assoc. 2014 Sep 1;245(5):527-33. doi: 10.2460/javma.245.5.527.

Long-term survival and quality of life in dogs with clinical signs associate with a congenital portosystemic shunt after surgical or medical treatment.

reenhalgh SN(1), Reeve JA, Johnstone T, Goodfellow MR, Dunning MD, O'Neill EJ, Hall EJ, Watson PJ, Jeffery ND.

OBJECTIVE: To compare long-term survival and quality of life data in dogs with clinical signs associated with a congenital portosystemic shunt (CPSS) that underwent medical or surgical treatment.
DESIGN: Prospective cohort study.
ANIMALS: 124 client-owned dogs with CPSS.
PROCEDURES: Dogs received medical or surgical treatment without regard to signalment, clinical signs, or clinicopathologic results. Survival data were analyzed with a Cox regression model. Quality of life information, obtained from owner questionnaires, included frequency of CPSS-associated clinical signs (from which a clinical score was derived), whether owners considered their dog normal, and (for surgically treated dogs) any ongoing medical treatment for CPSS. A Mann-Whitney U test was used to compare mean clinical score data between surgically and medically managed dogs during predetermined follow-up intervals.
RESULTS: 97 dogs underwent surgical treatment; 27 were managed medically. Median follow-up time for all dogs was 1,936 days. Forty-five dogs (24 medically managed and 21 surgically managed) died or were euthanized during the follow-up period. **Survival rate was significantly improved in dogs that underwent surgical treatment** (hazard ratio, 8.11; 95% CI, 4.20 to 15.66) **than in those treated medically** for CPSS. Neither age at diagnosis nor shunt type affected survival rate. Frequency of clinical signs was lower in surgically versus medically managed dogs for all follow-up intervals, with a significant difference between groups at 4 to 7 years after study entry.
CONCLUSIONS AND CLINICAL RELEVANCE: **Surgical treatment of CPSS in dogs resulted in significantly improved survival rate and lower frequency of ongoing clinical signs, compared with medical management.** Age at diagnosis did not affect survival rate and should not influence treatment choice.

Some surgeons perform CT angiography prior to surgery. Without a doubt it will be helpful as the shunting vessel is clearly seen, and studies have shown that shunt dogs can safely have the procedure. However it adds expense, and additional diagnostic procedures should not be performed if there is then not enough money for treatment. An experienced imager can determine on ultrasound if the shunt is entering the vena cava caudal to the liver, in which case I am happy to operate without CT. An imager may recommend CT if they think the shunt is going to be difficult, and in those cases I find it very useful to have the same imager in theatre directing me if the shunt can't be found, as it can sometimes be hidden in fascia or other tissues, and dissection can be guided to find it.

Portosystemic Shunt Surgery

Shunt surgery is difficult without experience, and anaesthesia is usually very unstable. I perform surgery with the use of intra-operative fluoroscopy. Most shunts in dogs enter the caudal vena cava at the epiploic foramen, cranial to the hepatic artery. Others are located cranial to the stomach as branches of the gastric veins, and may pass through the diaphragm. There are some shunts with very strange morphology that can be difficult to find and to interpret what vascular anatomy is normal and what is abnormal. In this dog the shunt was found caudal to the stomach arising from the splenic vein, that travelled cranially and dorsally to enter the dorsocaudal diaphragm near to the oesophageal hiatus. This was a difficult shunt location that was found based on the ultrasound report.

When I have found the shunt, I catheterize a jejunal vein and perform portovenography with fluoroscopy to determine I have recognized the shunt. I do this before shunt dissection, as shunt spasm can prevent blood flow through it. I then dissect around the shunt, usually as it enters the vena cava if this is possible, or close to the diaphragm. This is a difficult skill as there is often little space and if the shunt tears it is likely to be fatal. The shunt is temporarily ligated with a Rumel tourniquet before repeating fluoroscopy, to determine if the shunt vessel has been occluded and to assess blood flow through the liver. If there is no liver blood flow it is important to determine if the portal vein is present, as the shunt cannot be ligated without a portal vein, but this is rare. Within a population of dogs, the extent of portal vein branching seen on post-attenuation portovenography is associated with prognosis, but it cannot be used to determine outcome in individual dogs. If full ligation is tolerated, determined by normal intestinal colour, I ligate the shunt completely. If intestines become congested or purple, this is an indication of portal hypertension, showing that the liver is unable to tolerate portal flow. Ligating this type of shunt would lead to fatal portal hypertension. Therefore shunt attenuation is performed more slowly – I use a cellophane band around the shunt but other authors use partial ligation (with a view to repeat surgery to ligate it fully) or an Ameroid constrictor. Liver biopsies are taken. Animals can be neutered if the anaesthetic is stable – I often perform ovariectomies or castration while my imaging colleague is interpreting the fluoroscopy, to make good use of time.

Anaesthetic complications include hypotension, hypoglycaemia and hypothermia and anaesthesia can be very challenging. Post-operative complications include portal hypertension and seizures.

This is a very long topic with lots of new literature available, and only a small part of it has been covered in these notes. There are some excellent chapters in Tobias with more information about anatomy, investigation, treatment and prognosis.

Follow-up after shunt surgery

The dog made a good recovery, with no seizures or portal hypertension. He ate slowly on recovery and was discharged after 48 hours with ongoing levetiracetam (20mg/kg tid 2 weeks), ranitidine (2mg/kg tid 2 weeks, as dogs with shunt can have GI ulceration), potentiated amoxicillin and lactulose.

Hernias

Congenital hernias in young animals may be hereditary, especially inguinal and umbilical hernias, and therefore young animals with hernias should not be used for breeding. Acquired hernias can occur in older dogs and may be precipitated by trauma – these animals may have had an anatomical weakness already. Acquired inguinal hernias may occur with oestrus or pregnancy, related to oestrogen production.

Not all hernias need immediate surgery. Small umbilical hernias (<2-3mm) will often close as an animal grows and those that don't can typically be left until the animal is neutered. Umbilical hernias can close by 12 weeks of age.

Hernias may contain reducible abdominal contents and animals do not tend to suffer consequences or morbidity with this scenario. Most hernias just contain fat. Incarceration of abdominal contents is less common and strangulation is uncommon. The organs that become incarcerated will depend on hernia type and size. Inguinal hernias can contain intestine, bladder and the female reproductive tract. The latter is unlikely to cause a problem unless there is pyometra or pregnancy. Intestines can pass through a scrotal hernia into the scrotum. Strangulation occurs when hernia contents start to become devitalized. Generally incarceration and strangulation will only occur through a hernia that is approximately the size of intestine, as intestine will pass easily though the hernia but tends to swell when venous circulation is interrupted and cannot move back out again. For larger hernias, intestine is likely to pass in and out of the hernia without becoming incarcerated. The exception is traumatic hernias where scarring can lead to narrowing of the hernia ring and can incarcerate and strangulate abdominal contents over time.

Palpation of a swelling can often identify a hernia ring and abdominal contents can often be reduced into the hernia. Inguinal hernias can be bilateral so both should be assessed. It can be difficult to palpate the edge of large hernias e.g. large incisional hernias. It can also be difficult to distinguish an acquired hernia from other causes of swellings, especially in mature animals. Diagnostic imaging is therefore necessary. Radiography may not be helpful in distinguishing a hernia from a mass and cannot determine the contents of a hernia. Ultrasound is useful to look for loss of continuity of the abdominal wall and for abdominal organs within the hernia.

Many congenital hernias, especially umbilical hernias, can be left for a while before being surgically repaired, although inguinal hernias should not be delayed for too long in case it leads to complications. More prompt surgery is recommended for a hernia that is the size of small intestine, especially if it has an inelastic ring (as may be seen with umbilical hernias), as there is increased risk of intestinal incarceration, and for scrotal hernias where incarceration is more likely within the narrow vaginal process. Strangulated hernias require immediate surgery after medical stabilization. Without prompt treatment it is likely that irreversible damage will have occurred and resection will be required.

The goal of hernia repair is to check the hernia contents are viable, to resect them if they are not, reduce hernia contents, remove redundant hernia sac tissue and to achieve primary closure of the hernia defect. If the latter cannot be achieved, prosthetic meshes can be used, but they are rarely needed. Midline approach may be better to some hernias e.g. inguinal hernias, especially if they are bilateral or if incarceration or strangulation are suspected.

Inguinal and Scrotal hernias

Any hernia passing though the inguinal ring is an inguinal hernia; a scrotal hernia is a specific type of inguinal hernia. The inguinal canal is a potential space between the internal and external inguinal rings. The internal inguinal ring is the space between the caudal edge of the internal abdominal oblique muscle cranially, the rectus abdominus muscle medially and the inguinal ligament laterally and caudally. The external inguinal ring is a slit within the aponeurosis of the caudal external abdominal oblique muscle. The rings allow passage of the genital branch of the genitofemoral artery, vein and nerve and the external pudendal vessels

caudomedially. Hernias are more common in females as the inguinal canal is shorter and wider.

If the hernia occurs adjacent to the vaginal process the hernia is termed direct – this is less common in dogs than indirect hernias. If the hernia contents enter the vaginal process the hernia is termed indirect, therefore a scrotal hernia is an example of an indirect hernia as the hernia contents pass into the vaginal process. Scrotal hernias tend to be described separately in the literature. In scrotal hernias, herniated contents may be confined to the inguinal region or they can be palpated in the scrotum adjacent to the testes.

Unilateral inguinal hernias are usually approached via an inguinal incision. The hernia is palpated and its contents are reduced if possible. If this is not possible, the hernia sac can be incised and the inguinal canal can be incised craniomedially. Residual hernia sac is ligated and transected. Sutures are placed in the cranial inguinal ring to reduce its size, leaving sufficient room caudally for passage of neurovascular structures. A midline approach is preferred if there are bilateral hernias, developed mammary tissue, if the hernia contains a gravid uterus or pyometra or if there is organ strangulation, as examination of the tissues will be needed and resection is probable.

Scotal hernias are less easy to reduce than the other inguinal hernias prior to surgery. This can be aided by pushing scrotal contents externally from the scrotum towards the inguinal region. However it is more likely that reduction will be needed at surgery. Surgery is performed promptly as incarceration can easily occur. Castration is recommended as inguinal hernias may be hereditary, it is easier to get a good closure of the inguinal canal if the dog is castrated therefore reducing the risk of reherniation, scrotal swelling can occur if there is venous or lymphatic occlusion when the inguinal ring is reduced in an entire dog, and there is increased risk of testicular tumours in dogs with scrotal hernias. An inguinal approach is used for a unilateral non-strangulated hernia. The hernia sac is opened and castration is performed by disrupting the ligament of the tail of the epididymis and ligating and transecting the spermatic cord. Hernia contents are reduced, the residual hernia sac is ligated and transected and the inguinal canal is reduced in size as for other inguinal hernias. There will be parietal vaginal tunic present distal to the hernia sac and this is left intact as it involves too much trauma to try to remove it, and it is unnecessary. Midline abdominal approach is needed if there is strangulation, followed by closure of the inguinal ring external to the abdominal musculature.

Incisional Hernia

The risk of incisional hernia should be lower than in previous decades due to improvement in suture materials. However, technical error is considered the most common cause of acute incisional hernias. Dehiscence can occur if wrong suture material or size is chosen. A continuous suture should only be performed if a suture with prolonged tensile strength is available e.g. polydioxanone. If this is not available, simple interrupted sutures are recommended, even though this will take longer. Studies in people show it is the tissue that is more likely to fail than the sutures, and failure is more likely due to inclusion of too little tissue. There is no need to engage all of the muscle and doing so may lead to strangulation of tissues. Only the external rectus fascia needs to be engaged with the suture, as this is strength-holding layer, but at least 5mm of healthy tissue is needed. The knot is an important part of the strength of the suture.

Incisional hernia is likely to occur within the first seven days of surgery, although owners may not notice it. Chronic incisional hernia has been reported and is most likely to be due to local wound factors e.g. infection. Evisceration is rare but will occur if there is failure of both the muscle and the skin/subcutaneous repair.