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Indications for thoracic CT are similar for small animals as in humans, and will play an increasingly important role in evaluation of thoracic disease as multidetector CT becomes more widely available.

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Thoracic CT: More than Just a Pretty Picture

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THORACIC RADIOGRAPHY IS AN ESSENTIAL screening tool for pulmonary disease in human and veterinary patients, but has limited diagnostic accuracy. The poor sensitivity and specificity of radiography for interstitial disease and pulmonary nodules is well documented. Radiographic interpretation may also be compromised if pleural effusion is present. Furthermore, the paucity of histopathologic and radiographic correlation poses a diagnostic challenge for many radiologists and clinicians.

In humans, computed tomography (CT) is routinely used to examine pulmonary, tracheobronchial and mediastinal abnormalities, and is the standard screening test for pulmonary metastasis. CT is more sensitive and accurate than radiography for detecting interstitial disease and pulmonary nodules even in the presence of pleural effusion. CT has two primary advantages over radiography: elimination of anatomic superimposition, and superior contrast resolution which delineates aerated lung from soft tissue interfaces. Multidetector CT (MDCT) scanners are becoming increasingly available in veterinary hospitals and have two main advantages over single-slice helical CT scanners: rapid image acquisition and improved spatial resolution. Larger anatomic sections can be examined per tube rotation, resulting in faster image acquisition. Rapid image acquisition permits conduction of angiographic studies, minimizes respiratory motion artifacts and reduces the duration of general anesthesia. Some cases may be performed under heavy sedation. MDCT data can be reconstructed into submillimeter units with significantly improved spatial resolution and multiplanar image quality. This is particularly advantageous for examination of complex lesions and anatomy. As a screening tool, the primary disadvantage of CT is low specificity because small non-neoplastic and clinically insignificant nodules may be identified. Very small nodules may be difficult to differentiate from peripheral blood vessels, though this is usually not problematic when reviewing CT images in 'cine' mode on a computer workstation.

INDICATIONS

Thoracic CT is most useful when radiographs are equivocal or evaluation is limited by pleural effusion, pneumothorax, or multicompartmental disease. Multiplanar reformatted imaging and contrast administration are essential for examining complex lesions, differentiating pulmonary from mediastinal lesions and examination of tracheobronchial lymph nodes. Computed tomography is frequently recommended to determine the extent of thoracic lesions for surgical and therapeutic planning. CT permits examination of extrathoracic structures, pleura, mediastinum, lymph nodes and vasculature, and may provide information that changes the diagnosis, treatment plan, or prognosis. In a recent study of cats and dogs with indeterminate radiographs, CT findings altered the diagnosis in 48% of subjects.

In veterinary medicine, CT is most commonly utilized to detect pulmonary metastasis, determine the source of spontaneous pneumothorax, surgical planning for recurrent effusions, migrating foreign bodies, lung lobe torsion, and masses of the lung, mediastinum and thoracic wall. This article is a brief review of recent literature and describes CT features of some of the most common conditions.

PULMONARY METASTASIS

The lungs are predisposed to metastasis as a result of high perfusion rate and an extensive capillary network that reduces velocity of parenchymal blood flow. Conventional CT can detect metastases as small as 2-3mm whereas the threshold for radiographic detection

is approximately 7mm. A recent veterinary study with histopathologic correlation found that radiographs failed to detect 90% of nodules identified in CT images, and CT identified metastatic nodules in 39% of patients that had no radiographically detectable nodules. Comparable studies in humans report similar sensitivity and accuracy of thoracic radiography for metastasis detection.

Determining the likelihood that a nodule is benign or malignant is a common challenge for the radiologist, especially if a primary tumor site is known. Although the diagnosis cannot be determined without histopathology, some CT features may help improve diagnostic certainty. In a study of people with primary extrathoracic malignancy, single nodules and nodules <5mm were reported more likely to be benign, whereas multiple nodules and nodules between 5-10mm were more likely to be malignant. Lesions with little change over a prolonged period of time were also more likely to be benign. A nodule's morphology also determines its conspicuity. Nodules with uniform density and smooth, well-defined margins are typically more conspicuous than those with irregular or poorly defined margins regardless of lesion diameter. Subpleural nodules and those encircled by edema, hemorrhage, or necrosis are less conspicuous because of reduced contrast at the lung-lesion interface.

PULMONARY NEOPLASIA

Bronchoalveolar carcinoma is the most common primary lung tumor in small animals. Most primary tumors are bronchocentric, arising from the center or periphery of cranial or caudal lobar bronchi, and appear as solitary, solid or partially cavitated masses with defined margins. Larger tumors may be associated with bronchial deviation or obstruction. Internal cavitation or necrosis is reportedly more common than dystrophic mineralization. Malignant tumors tend to exhibit heterogeneous contrast enhancement as a result of compromised blood supply and may be associated with perilesional edema that has a 'ground glass' appearance on CT. The tracheobronchial lymph nodes (TBLN) drain the lungs and mediastinal structures, and are a frequent site of metastasis from pulmonary neoplasia. In the dog, lymph nodes >12mm in diameter were reported to have high sensitivity and specificity for metastasis. Even when not enlarged, lymph nodes that exhibit peripheral and/or heterogeneous contrast enhancement have also been significantly correlated with metastasis in dogs and humans.

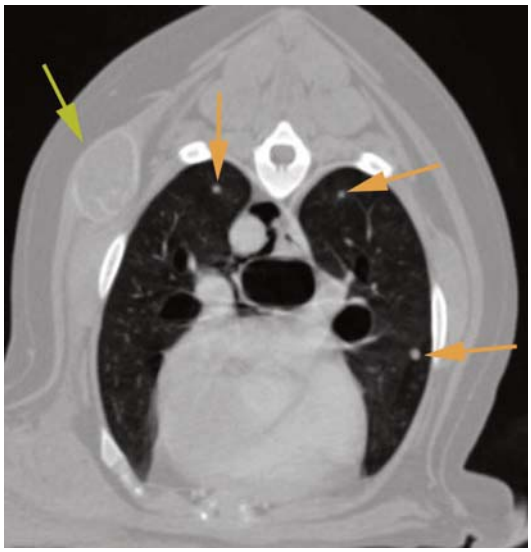

Figure 1: Axial CT image of the thorax at the level of the carina. Window width and level are optimized for assessing the pulmonary parenchyma. Small metastatic nodules are visible in both caudal lobes (orange arrows). An incidental metastatic lesion is also detected in the right thoracic wall (green arrow). None of these lesions were visible in survey thoracic radiographs.

PNEUMOTHORAX

The most common cause of spontaneous pneumothorax is the rupture of pulmonary bullae or blebs. In veterinary literature, a bulla is defined as a large air space within the pulmonary parenchyma, and a bleb is a smaller subpleural collection of air. Early surgical intervention is the treatment of choice to reduce morbidity and recurrence. Radiography is moderately sensitive for detecting pneumothorax but accuracy for detecting bullae is estimated to be <60% in humans and dogs. Radiography underestimates the number of, and poorly localizes, these lesions which may result in an inappropriate surgical approach. In humans, CT has an estimated 90% accuracy rate for determining number, location and dimension of lesions, though it is dependent on the presence and severity of accompanying pneumothorax.

In a recent study of dogs, 77% of surgically confirmed bullae were detected with CT compared to 23% with radiography. Atelectasis is the most common source of false negative findings in both modalities. As pneumothorax worsens, the pulmonary volume decreases and potentially ruptured bulla/blebs are obscured by atelectatic lung tissue. When scanning a patient with pneumothorax, pleural air should be completely evacuated prior to imaging. This may require continuous suction to reduce the degree of atelectasis and allows safe use of positive pressure ventilation.

LUNG LOBE TORSION

Lung lobe torsion (LLT) is a serious condition characterized by the axial rotation of a lobe around its

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Thoracic CT: More than just a pretty picture

Fig. 2a

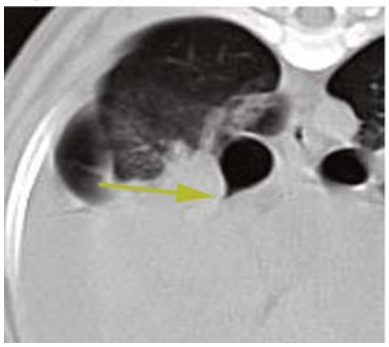

Fig. 2b

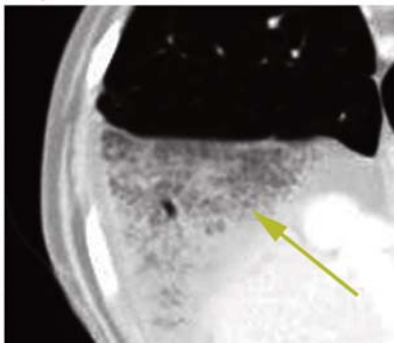

Figure a: Transverse CT image of a dog with torsion of the right middle lung lobe. Window level and width is optimized for examination of the bronchial tree. The image is centered at the bifurcation of the right middle bronchus. Note the bronchus has a tapered shape with occlusion of the lumen immediately adjacent to the consolidated lobe.

Figure 2b: Transverse CT image of the same dog, centered caudal to the heart. Window level and width is optimized for examination of the right middle lung lobe. There is abrupt demarcation between the normal right caudal lung lobe and torsed right middle lobe. Note the vesicular gas pattern within the affected lobe which is a common feature of this condition.

pedicle, resulting in airway obstruction and vascular hypertension. With LLT, arterial supply to the lobe is variably maintained but venous and lymphatic efferents are occluded, leading to parenchymal edema, infarction, necrosis and development of pleural effusion. This condition often occurs spontaneously but underlying pulmonary pathology, pleural effusion, thoracic conformation and prior lobectomy are also predisposing factors. The right middle and left cranial lobes are most commonly affected. Clinical signs, hematologic data and pleural fluid cytology are typically non-specific. Radiographic features can also vary with duration of the condition and interpretation may be complicated with the onset of pleural effusion. Because lobectomy is often necessary, a delayed diagnosis can result in patient mortality. CT imaging may be instrumental in obtaining a rapid and definitive diagnosis.

Computed tomography's primary advantage in the examination of complex pulmonary and airway disease is multiplanar image reformatting. The course of the bronchial tree can be examined using the 'paddle wheel' technique which involves pivoting the reformatting plane about the bronchial bifurcation, depicting the airways in different angles. Virtual bronchoscopy is another technique that can be used for non-invasive means of examining the bronchial tree. Virtual bronchoscopy is a high-resolution, 3D CT representation of the internal view of the trachea and bronchi that provides a simulated bronchoscopic exam, plus provides detailed information about peribronchial pathology that cannot be seen with bronchoscopy.

There are some imaging features that are shared by radiography and CT in animals and humans with LLT, including:

- Increased opacity/attenuation of the affected lobe.
- Displaced, obscured, or abruptly blunted bronchial lumen.
- Unilateral or bilateral pleural effusion.
- Vesicular emphysema, entrapped gas bubbles which contributes a sponge-like appearance to the parenchyma.

The diagnostic CT feature of LLT is a malpositioned bronchus with abruptly tapered lumen proximal to the occluded segment. Vesicular emphysema and tapered, attenuated bronchus are LLT-specific features that are visualized best with CT (fig. 2).

Other features that may be seen with LLT include mediastinal shift, rotation of the carina, and pneumomediastinum or pneumothorax if the bronchial wall is compromised. In virtual bronchoscopy, a torsed bronchus has a flattened lumen with a "fish mouth" appearance, whereas normal bronchi have a round lumen. By comparison, an infiltrative or compressive peribronchial mass can mimic the appearance of LLT. However, extraluminal lesions typically do not compromise arterial blood supply and exhibit some degree of contrast enhancement whereas torsed lung lobes exhibit poor contrast enhancement as a result of arterial thrombosis and/or parenchymal necrosis.

Indications for thoracic CT are similar for small animals as in humans, and will play an increasingly important role in evaluation of thoracic disease as multidetector CT becomes more widely available. The decision for CT examination may be multifactorial and is often dependent on a cost-benefit analysis as to information that would be potentially gained.

"Nice to Meet You": Introducing a New Cat to Household Pets

PROPER INTRODUCTION OF A NEW CAT to household pets can prevent a myriad of behavior issues in the future. If not conducted properly, problems such as inter-cat aggression, predatory aggression, fearfulness, anxiety and bullying can result. It is best to take this process slowly; rushing into it when a cat or other pets are not comfortable is asking for trouble.

Kathryn Wrubel, PhD

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PLANNING AHEAD

Owners should pick out a cat that will fit in well with their family. It is important that all household pets have a good quality of life. If owners have a dog that kills small animals and shows interest in cats that is worrisome (staring, stiffening, other predatory behavior), it is not fair to introduce a cat to the household. If owners are already in this situation, they should be prepared for a lifetime of avoidance, management and control measures to keep their cat safe. Cats should never be left unsupervised in the presence of a predatory dog. If a cat does not like other cats, or has a history of fighting with them, the owners may be in for more of the same. If a resident pet has behavior issues that require time-consuming fixes, the owners should attend to them prior to adopting a new cat.

Owners should decide what feline temperament or personality will fit best into their home. Some breeds of cats are stereotypically more bold, playful, laid-back, or affectionate. Information about cat breeds can be found here: http://animal.discovery.com/breedselector/catselectorindex.do or www.catster.com/breeds

When owners meet a kitten or cat for the first time they should notice its behavior. Are they gregarious or outgoing? Some resident pets will do best with a cat that stands its ground. Is the cat standoffish, fearful, or skittish? Owners should avoid the instinct to "rescue" a fearful cat if their resident pet(s) will have a field day terrorizing him or her.

If owners adopt a young kitten, it is best to introduce them to household pets during the sensitive period for socialization (prior to 9 weeks of age). If owners adopt an adult cat, it is a good idea to adopt a cat that has lived successfully with other cats or dogs.

Prior to bringing a new cat home, an existing family dog should be under good verbal control and know several commands ("Sit", "Down", "Come", and "Stay"). If the dog already knows these commands, refresh those skills in a distracting environment, as the new cat will be an exciting addition for a dog.

THE NEW CAT'S FIRST FEW DAYS:

Owners should provide a comfortable closed room for the cat to spend its first few days. It should have resting spots, a new litter box, scratching post, toys, and hiding spots (cardboards boxes or paper bags work great). The litter box should not be near the food or water dishes as cats do not like to eliminate where they eat.

When owners arrive home with the new cat they should take him or her directly to this room in a carrier. If the cat is nervous and won't come out, leave the room to give the new cat time to adjust to its new surroundings. If the cat has an item that smells like its previous home or owners, place that item in the room. Many cats hide when they come to a new house; this is normal behavior and the new owners should allow the cat time and space to acclimate. During this period owners should be upbeat and calm when visiting, sit on the floor, and see if the cat will come out for treats or petting. This period of isolation will give the cat time to explore its new environment without the stress or interruption

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"Nice to Meet You": Introducing a New Cat to Household Pets

Owners should be patient and give their new cat time to feel comfortable in his or her new environment

of existing family pets. During this time other pets may investigate the door area and owners may hear some vocalizations. Owners should keep their resident pet's schedule as close to normal as possible during this time. Cats in particular are creatures of habit and if the new cat disrupts their routine, they will be paying attention.

Cats' and dogs' senses of smell are finely tuned and provide them with lots of useful information. Owners should rub a clean washcloth on the cheeks of each family pet (one for each pet) and leave them out for the other animals to investigate.

CAT TO CAT INTRODUCTIONS

Owners should watch the cats to see how they behave around the scented washcloth to get a feel for how comfortable they are. This behavior should be observed for several days. If after the first few days, resident cats are not acting upset or unusual, and the new cat appears relaxed and comfortable in its new environment, owners can start switching territories.

The pets need to be separated during the territory switch so they don't interact yet. Since cats are territorial it is important that all of their smells are spread out throughout the home. The new cat can then explore freely without the interference of the other cats in the home. The new cat should leave the room on its own while the resident cat(s) is closed in a room or carrier. Once the new cat is in another room (preferably with a closed door) owners can bring the resident cat(s) to the new cat's former territory. Owners can switch territories a couple of times per day.

During this next phase owners should feed the new cat and the resident cats simultaneously near the door to the room where the new cat resides. Special treats and toys should also be given at these times. This will cause them to associate each other with positive experiences. Begin with the bowls at a comfortable distance from the door and gradually move them closer. Once the cats are on opposite sides of the door eating comfortably, owners can open the door a pinch using an eyehook or doorstop so the cats can see each other while eating, but cannot push the door open. Eventually owners can put up a double baby gate or screen to separate the cats at the door.

If this is progressing well the cats can be introduced in the same room. Treats and toys should be on hand to provide a distraction. Cats should have hiding places to retreat to if they become scared. Cats should only be introduced to the new cat one at a time (in order of suspected difficulty). Introductions should be brief and should end on a positive note if possible. Owners can do this for several sessions and gradually extend the time of exposure. If either cat becomes aggressive or appears frightened, owners should go back a few steps. Once the cats are comfortable with each other, they can have the run of the house together.

CAT TO DOG INTRODUCTIONS

After the new cat settles into its room and each pet appears comfortable around the scented washcloths, owners can start to switch territories so the pets can familiarize themselves with the other pet's smells, and the new cat can explore the rest of the house uninterrupted. The new cat should leave its room on its own while the dog is securely confined to prevent any interaction at this point. Once the cat is safely in another area (preferably with the door closed) owners can bring the dog to the cat's room on leash and close the door. Allow the dog to sniff around the room (remove the food and litter boxes to prevent the dog from eating the cat's food or stool). It is best to introduce one dog at a time to the newcomer's room. Owners can switch territories several times per day.

During the next phase, owners should feed the new cat and dog simultaneously near the door to the room where the new cat resides. This will allow both animals to associate the other with positive experiences, and should take the focus off any concerns they have about each other. Owners should begin with the bowls at a comfortable distance from the door and gradually move them closer. Once the pets are on opposite sides of the door eating comfortably, owners can open the door a pinch so they can see each other while eating (using a doorstop or eyehook, to ensure the door cannot be pushed open). If the dog is food aggressive this step may need to be omitted. Eventually a double baby gate or screen can be used to separate the pets at the door.

If things are going well, the owners can perform a formal introduction with the dog on leash. There should be two people on hand for this event, and high-value treats and toys should be available for both pets in case owners need to provide a distraction. Owners should only introduce one dog at a time to the cat (in order of suspected difficulty).

During the introduction, the dog should sit or lie down while the cat explores the area from a distance. Owners should do this for a brief time period and end on a positive note if possible. Gradually owners can extend the time of exposure. If the dog becomes too excited, or the cat becomes scared or aggressive, owners should end the session and go back a step or two in the introduction process. If the dog is intensely staring at the cat, stiffening, whining, pacing, salivating, or poking the cat with its nose and then backing up again (a predatory dog's way of saying "Just give me a reason") owners should stop the session entirely and consult with a behavior specialist. If the dog is calm and behaving well, owners should say "Good Dog" and reward him or her with treats. If this goes well after several daily sessions, owners can let the dog and cat interact with the dog moving freely on leash, and eventually with the leash dragging behind him or her. Then owners can start keeping them together while supervised. If things are going well after this point, owners can allow the cat and dog to interact freely in their home. Once the pets are living together, owners should keep the cat's food and litter boxes out of the dog's reach and provide the cat with hiding spaces or a baby gate they can jump over to escape the dog when they desire.

Prior to nine weeks of age, kittens are in a sensitive period for socialization. During this time, a kitten is like a little sponge and can form lasting bonds with other pets if they are willing partners.

IF THINGS GO BADLY

Owners should try to end all introduction sessions on a positive note. In the case that they cannot, or one of the pets becomes very fearful or aggressive, owners should separate them safely and go back a step or two in the process. Owners should progress slowly and not force anything. During introductions owners should be calm and upbeat.

NOTE FOR NEW KITTENS

If a new kitten is in the sensitive period for socialization (prior to nine weeks of age) owners can speed up the introduction process. During this time, a kitten is like a little sponge and can form lasting bonds with other pets if they are willing partners. If owners suspect the kitten may be injured by a large dog they should make sure to supervise them carefully. Also, just because a kitten is comfortable doesn't mean the other pets are, owners should not force, or accelerate the introduction period beyond the comfort level of each individual animal in the home.

Practical use of Minimally Invasive Techniques in Small Animal Soft Tissue Surgery

Kechia Davis, DVM, DACVS

RECENT INNOVATIONS IN MINIMALLY INVASIVE surgical technology are changing the face of veterinary soft tissue surgery. New minimally invasive surgical approaches have been developed to complement or replace traditional techniques. In many cases, a quicker recovery and superior visualization have also been demonstrated with some minimally invasive techniques. The purpose of this article is to describe some of the more practical and common uses of minimally invasive surgical procedures in small animal soft tissue surgery.

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Soft tissue minimally invasive procedures can be divided into two categories: thoracoscopic and laparoscopic. Thoracoscopic procedures describe all intrathoracic procedures. Laparoscopic procedures describe all intra-abdominal procedures. These two categories can be further divided into:

1) Purely thoracoscopic or laparoscopic procedures where all surgery is done within the body cavity (intracorporeal) under telescopic guidance.

2) Assisted procedures where some manipulations are done within the body cavity (intracorporeal) under telescopic guidance and others are done outside of the body cavity (extracorporeal).

Most procedures require at least two small incisions: one for a telescope and the other for an instrument.

More advanced procedures can require four to six ports for instrumentation. Patients are prepped for traditional surgery in case conversion is indicated, either due to an emergent situation during a scoping procedure, or if the minimally invasive procedure is unable to accomplish the desired surgical goal (fig. 1).

Fig. 1: Surgeon (left) and assistant (right) have patient draped for a traditional abdominal exploratory celiotomy, but are using laparoscopic instruments for the procedure. The laparoscopic telescope is on midline and the instrument is paramedian.

LAPAROSCOPIC ASSISTED OVARIOHYSTERECTOMY

Laparoscopic assisted ovariohysterectomy is one of the most common minimally invasive procedures performed in veterinary medicine. Ligation and transection of the ovarian pedicle are typically performed intracorporeally using a laparoscopic electrosurgical device (harmonic scalpel or LigaSure), whereas ligation and transection of the uterine vessels and body are typically done outside of the abdominal cavity through an enlarged instrument port using suture. Compared to traditional ovariohysterectomy, documented advantages include superior visualization of the ovary and pedicle, decreased postoperative pain and faster patient recovery. Complications are similar to traditional spays.

LAPAROSCOPIC OVARIECTOMY (LOVE)

Laparoscopic ovariectomy, also known as the L.O.V.E. procedure, describes laparoscopic removal of both ovaries. Typically the ovary is transected at the oviduct or uterine horn using a laparoscopic electrosurgical device and removed through an instrument port. The uterine horns and body are left within the pet. Ovariectomy complication rates and type are similar to traditional and laparoscopic ovariohysterectomy with no increase in incidence of postoperative pyometra. Ovariectomy is commonly performed in Europe, most notably the Netherlands. Postoperative pain is less in small dogs undergoing LOVE compared to a traditional ovariectomy (fig. 2).

Fig. 2: 12 hours postoperative laparoscopic ovariectomy.

LAPAROSCOPIC ASSISTED CRYPTORCHIDECTOMY

Excellent visibility and unobstructed exploration of the inguinal ring to determine if the retained testis has exited the abdomen are the benefits of laparoscopic assisted cryptorchidectomy (fig 3-6). Normal undescended testes removal with the laparoscope has been described as well as neoplastic intra-abdominal testes. Recovery is similar to that of a laparoscopic ovariectomy.

Fig. 3

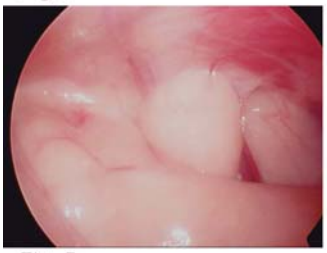

Fig. 4

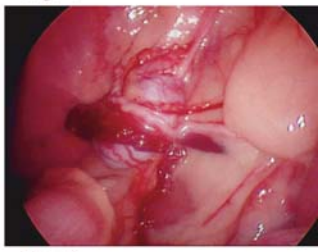

Fig. 5

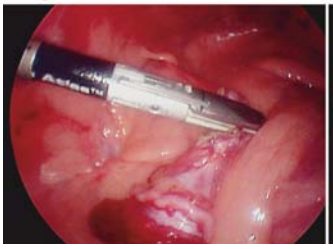

Fig. 6

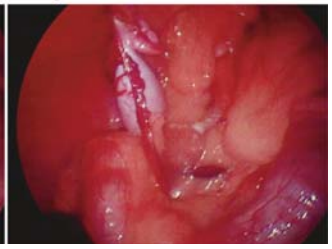

Fig. 3: Testicular vessels of descended testicle exiting inguinal ring. Fig. 4: Retained intra-abdominal testicle. Fig. 5: Laparoscopic sealing and transection of retained testicle. Fig. 6: Retained testicle exiting the abdomen through an enlarged instrument port.

LAPAROSCOPIC LIVER BIOPSY

Laparoscopic liver biopsy provides comparable diagnostic information to a traditional wedge biopsy (fig 7) with the added advantage of decreased morbidity and a faster recovery time. Laparoscopic liver biopsies have been shown to be superior to needle biopsies in retrieval of adequate tissue for analysis. Compared to a wedge biopsy obtained through an open mini-laparotomy centered over the xyphoid, laparoscopic liver examination provides superior visualization of all liver lobes, the biliary tree, and the surrounding organs (fig 8). The biopsy is obtained using cup forceps that compress lobar vessels for hemostasis and sample a 5mm section of tissue (fig 9).

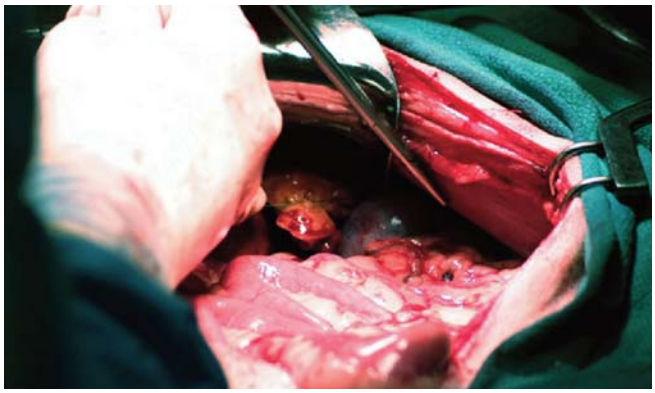

Fig. 7: Traditional wedge liver biopsy taken through a ventral midline celiotomy.

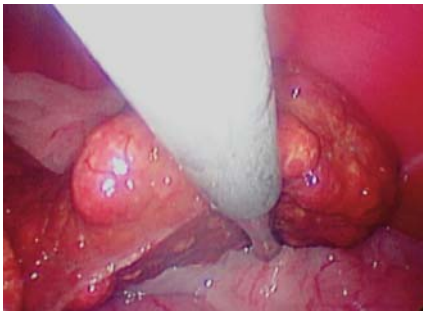

Fig. 8: Laparoscopic evaluation of abnormal liver tissue.

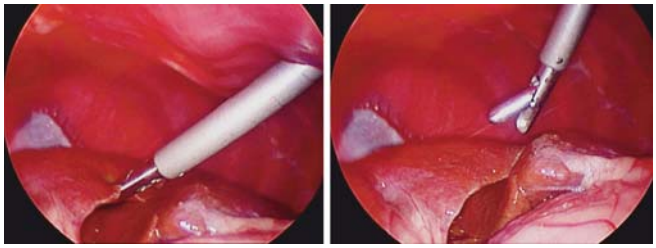

Fig. 9: Laparoscopic liver biopsy taken with 5mm oval cup forceps

Typically, all lobes are sampled and if focal lesions are present, these are sampled as well.

LAPAROSCOPIC ASSISTED GASTROPEXY (LAG)

Laparoscopic assisted gastropexy (LAG) has been shown to provide a persistent attachment of the stomach to the body wall and prevent gastric volvulus. Typically two ports are used, one for the telescope and one for an instrument (a pair of laparoscopic Babcock forceps). The instrument port is centered over the proposed site for the gastropexy. Once the stomach has been grasped (fig 10) and elevated to the port site (fig 11), the instrument port site is enlarged and the gastropexy is performed at this site extracorporeally (fig 12). Combined with either a laparoscopic spay or a traditional neuter, this procedure

Fig. 10

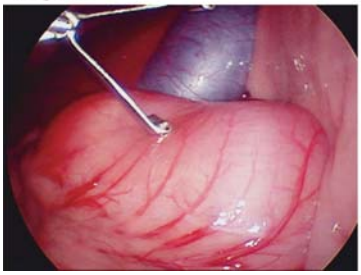

Fig. 11

Fig. 10: Selecting an appropriate incisional gastropexy site on the pylorus. Fig. 11: Elevating the desired pyloric site to the proposed gastropexy site on the body wall.

Practical use of Minimally Invasive Techniques in Small Animal Soft Tissue Surgery

Fig. 12

Fig. 13

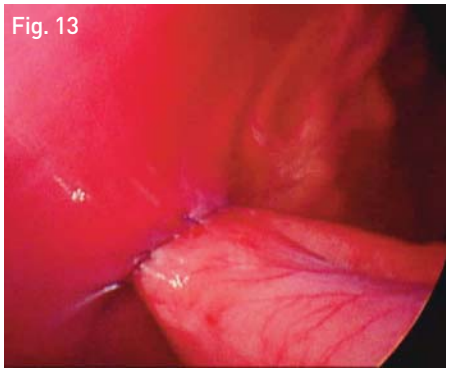

Fig 12: Extracorporeal suturing of the gastropexy site. A self retaining retractor (in green) is used to retract all abdominal wall muscles except for the transversus muscle which is then sutured to the gastric wall.

Fig. 13: Completed gastropexy.

Fig. 14

Fig. 14: 2 weeks postoperative laparoscopic assisted gastropexy (right paramedian incision) and laparoscopic assisted cryptorchidectomy (peri-preputial incision).

can be performed prophylactically in breeds that are at increased risk for . Client education is essential. Any high risk large breed dog that needs to be spayed or neutered can have a LAG performed at the same anesthetic episode. The spay can be performed with laparoscope as described above. LAG can also be performed successfully in dogs that have been diagnosed with gastric dilatation without volvulus (fig 13 - 14).

LAPAROSCOPIC GASTROPEXY

Laparoscopic gastropexy with all suturing performed intracorporeally has been recently described. Sited advantages include increased postoperative activity which would correspond with decreased postoperative pain compared to laparoscopic assisted gastropexy. The major disadvantage is surgical time (28 min for LAG vs 56 min laparoscopic gastropexy).

LAPAROSCOPIC ASSISTED CYSTOSCOPY

Bladder stone retrieval, bladder mass biopsy and bladder wall biopsy are only a few of the indications for laparoscopic assisted cystoscopy. The laparoscope is initially placed within the abdomen to identify and inspect the bladder. A laparoscopic Babcock forcep is introduced through a second port over the apex of the bladder. The bladder is elevated to the body wall and the instrument port is slightly enlarged. A small 5mm cystotomy is performed and the laparoscope is introduced into the bladder. Cystoscopic evaluation and intervention can be used to determine resectability of bladder masses, remove cystic calculi, inspect the ureters and intraluminally inspect the urethral lumen (fig 15-16). Cystic calculi

Fig. 15

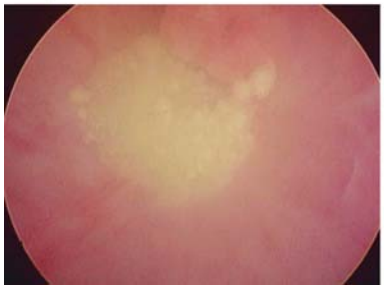

Fig. 16

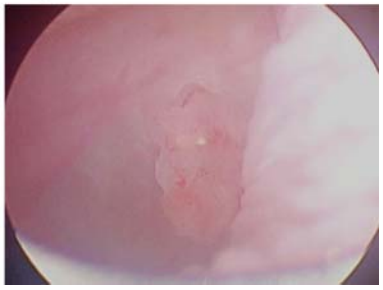

Fig. 15: Trigonal carcinoma surrounded by struvite calculi in a dog.
Fig. 16: Bladder polyp in a cat.

trapped within the urethral lumen can be identified and removed (fig 17). A recent retrospective study documented the incidence of incomplete cystolith removal as 20% following traditional cystotomy in dogs. Although unknown from this study, retained calculi within the urethra at the time of surgery undoubtedly accounts for some of these bladder stones left behind,

Fig. 17

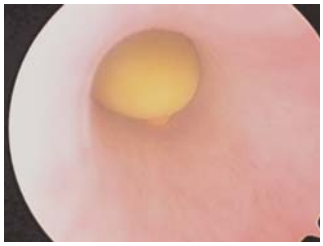

Fig. 18

Fig. 19

Fig. 17: Urethral calculus in the pelvic flexure of a dog. This dog had previously had a cystotomy and had never regained a normal urine stream after the cystotomy. Fig. 18: A 12 French red rubber catheter easily bypasses this urethral calculus. No resistance was felt when passing the catheter.. Fig. 19: Severe urethral narrowing just proximal to the papilla in a female dog. Two 1mm cystic calculi are adherent to the tissue.

highlighting the importance of complete urethral evaluation during surgery (fig 18). Cystoscopic evaluation including the urethra can be useful when evaluating urethral strictures to determine what, if any urinary diversion, is indicated (fig 19).

EXPLORATORY THORACOSCOPY

Exploratory thoracoscopy is emerging as one of the more useful and practical applications of minimally invasive surgery in small animal surgery. With the patient in dorsal recumbency, thoracoscopic exploration through a para-xyphoid transdiaphragmatic approach permits access to both hemithoraces. Small incisions between the ribs permit the introduction of instruments for organ manipulation and intracorporeal surgical access (fig 20). This access is invaluable and has transformed surgical management in cases that have traditionally required a lateral thoracotomy or splitting the sternum with a median sternotomy - a procedure that requires days in the hospital postoperatively for pain control and strict exercise restriction for 4-8 weeks while the sternum heals (fig 21). Exploratory thoracoscopy in dorsal recumbency is best for evaluating the medial, lateral and ventral aspect of the lungs. Exploratory thoracoscopy thorough a lateral approach with all ports placed between ribs permits ipsilateral access to the trachea, esophagus, heart base and hilus. Exploratory thoracoscopy with the patient in sternal recumbency provides stunning visualization of the dorsal mediastinum, great vessels and heart base. As such, magnified inspection of the thoracic duct is possible for patients with recurrent chylothorax. Some conditions where exploratory thoracoscopy is almost indispensable include spontaneous pneumothorax, acute pyothorax, penetrating thoracic wounds, recurrent pleural effusion, lung biopsy for diffuse pneumonia and pleural biopsy.

Fig. 20: Lifting emphysematous lung lobe with blunt probe for inspection.

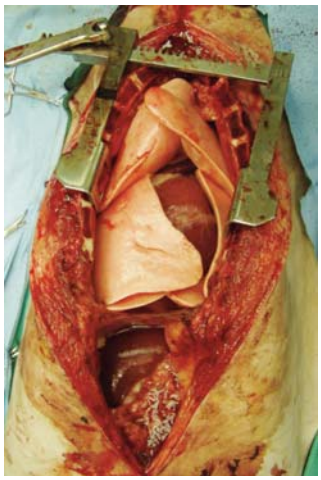

Fig. 21: Traditional median sternotomy combined with a cranial exploratory celiotomy in a dog.

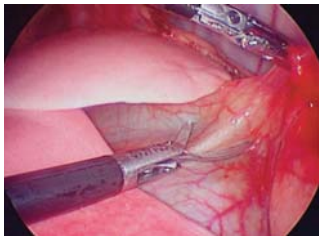

Fig. 22: Incising the pericardial sac.

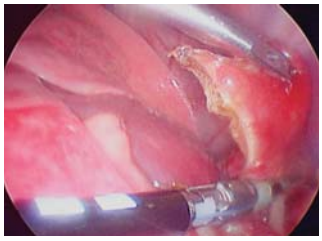

Fig. 23: Creating a pericardial window using thoracoscopic instruments. The heart is visible in the center of the image underneath the ragged edge of the pericardial sac.

THORACOSCOPIC PERICARDIECTOMY

Thoracoscopic pericardiectomy has transformed the surgical management of patients with recurrent idiopathic pericardial effusion. Traditionally this was performed through a lateral thoracotomy, cranial celiotomy with a radial incision in the diaphragm, or a median sternotomy. Through the para-xyphoid approach described above, a subphrenic pericardiectomy or pericardial window can be performed with a thoracoscope while providing excellent visualization of the surrounding vasculature and of the heart (fig 22). Decreased postoperative pain, fewer wound complications, and quicker return to function were all observed when dogs undergoing an open pericardiectomy were compared to dogs undergoing thoracoscopic pericardiectomy. Complications are rare and predictable (pneumothorax, hemorrhage). Once the pericardial sac is opened, the heart can be evaluated for evidence of neoplasia (fig 23).

The role of minimal invasive surgery in soft tissue surgery is growing rapidly. New procedures and techniques are developed every day. Below is a list of procedures currently performed by minimally invasive soft tissue surgeons.

- Laparoscopic Assisted Gastrotomy or Enterotomy for Foreign Body Removal
- Laparoscopic Assisted Cholecystectomy
- Laparoscopic Renal Biopsy
- Laparoscopic Pancreatic Biopsy
- Laparoscopic Exploratory Celiotomy
- Laparoscopic Gastrostomy and Enterostomy Tube Placement
- Laparoscopic Cystopexy for Retroflexed Bladder in Perineal Hernia
- Laparoscopic Colopexy for Recurrent Rectal Prolapse
- Laparoscopic Adrenalectomy
- Thoracoscopic Assisted Partial and Complete Lung Lobectomy
- Thoracoscopic Thoracic Duct Ligation and Cisterna Chyli Ablation

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