Thoracoscopy in Dogs and Cats

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Introduction

There are several diagnostic options to evaluate dogs and cats with thoracic disease, including radiographs, ultrasonography, bronchoscopy, and exploratory thoracotomy. These methods have limitations in evaluating the gross appearance and histopathologic features of pulmonary parenchyma in a minimally invasive fashion. Thoracoscopy overcomes many of these limitations, allowing direct visualization of the thoracic cavity, including pulmonary parenchyma, mediastinum, pleura, pericardium, heart, and major blood vessels. In many cases, the view obtained during thoracoscopy is superior to that obtained during open thoracotomy due to the ability to get the tip of the scope near thoracic structures, magnification, and ability to get the scope in places that are inaccessible to a surgeon during open thoracotomy. In addition, thoracoscopy allows directed biopsies of many of these structures, and allows therapeutic intervention. In human medicine, thoracoscopy has replaced many diagnostic and therapeutic procedures previously applied in open thoracotomy. Advances have occurred due to improvement in video technology and in manufacture of instruments that allow a versatile array of procedures similar to those performed in open thoracotomy. A thorough knowledge of the anatomy, appropriate preoperative assessment, and experience with equipment are all necessary to complete a successful procedure.

Instrumentation

Most of the equipment used in abdominal laparoscopy can be used for thoracoscopy. A rigid scope ("telescope") is used to visualize the thoracic viscera. Smaller scopes have a smaller image with less field of view. In addition, a greater light intensity is needed for smaller scopes. Scopes are also available in various degrees of field of view, including zero-degree (direct forward viewing) up to 70°. The zero-degree angle is easier to use, and generally preferred for most procedures. Angled scopes are more difficult for inexperienced operators. Most scopes have no biopsy channel. Operating scopes have a 5- or 6-mm channel, with an eyepiece extending from the proximal end at a 45° angle. These scopes allow introduction of instruments through the same puncture as the scope. Some operators believe them to be technically easier because the tip of the instrument is always in the field of view, without the need for "triangulation" to locate the tip of the instrument when they are introduced through accessory or secondary puncture sites. Operating scopes are generally slightly longer, so instruments must be long enough to protrude through the channel. The disadvantage of operating scopes is the limited ability to manipulate instruments passing through the channel. Usually the accessory or secondary puncture technique is preferred.

Scopes and instruments are introduced with a trocar/cannula system. The inner diameter of the cannula must be large enough to allow insertion of the scope or instrument intended to be introduced into the thorax. Unlike laparoscopic cannulas, thoracoscopic cannulas are shorter to minimize trauma to thoracic viscera and allow protrusion of instruments closer to the thoracic wall, thus permitting work on the surface of the lungs or other structures in the near field. Cannulas are also available in straight or threaded shafts. I prefer the latter because they are more secure and tend not to inadvertently come out during the procedure.

Insufflation with carbon dioxide is commonly used during laparoscopy to create a pneumoperitoneum and allow better visualization of the abdominal viscera. Occasionally carbon dioxide insufflation is helpful during thoracoscopy, especially in obese patients or when the pleural space is small. In these situations, care must be taken to not infuse too much gas, which could subsequently result in hypoxemia. Monitoring with pulse oximetry and end tidal CO_2 is essential in these situations. A carbon dioxide insufflation device is helpful, but the amount infused is not limited by pressure (as in laparoscopy), but by oxygenation/ventilation and anesthetic status of the patient.

A bright light source (usually 150 to 300 Watts) is required to adequately illuminate the thorax. A small hand held high resolution CCD video camera attached to the eyepiece of the scope is also necessary to allow visualization by multiple operators. These can be kept sterile with a plastic sleeve, or the camera can be gas-sterilized or sterilized by soaking in antiseptic solution (such as Cidex®).

Numerous accessory instruments are available, usually similar to those that are used in open thoracic surgery. They include biopsy forceps (“spoon/clamshell” style), grasping forceps (straight, curved, serrated, toothed, etc.), scissors, suction devices, retractors, suturing and stapling devices, blunt probes, and pre-tied suture loops (Endoloop®). Most of these instruments are made with electrocautery capability.

Anesthetic Management

Preoperative evaluation should consider metabolic and cardiopulmonary status. If there is significant pleural or pericardial effusion, withdrawal of the fluid is often helpful to stabilize the patient and simplify the procedure. Pre-anesthetic administration of narcotics (such as hydromorphone or buprenorphine) is followed by induction with propofol. Prior to induction, oxygen is delivered by facemask for five to ten minutes if the patient is at increased risk for hypoxemia. Standard endotracheal intubation for administration of isoflurane anesthesia can be used, or when a lateral approach to the thorax is planned, a double lumen endobronchial tube is used to administer anesthetic gases. These tubes allow selective intubation of the mainstem bronchus on the operative side to permit collapse of the lung on that side. A tracheal lumen is used to ventilate the opposite side. In general, hypoxemia is uncommon with single lung ventilation. Once the thorax is entered, positive pressure ventilation must be started. A mechanical ventilator can be used, or an assistant can manually ventilate the patient. I prefer the latter approach to allow moment-to-moment short pauses in ventilation during operative procedures on or near the lung.

Technique for Examination

Once the scope is introduced into the thorax, the video camera is attached to allow visualization of the thoracic viscera. With the transdiaphragmatic paraxiphoid approach, the ventral mediastinum often hangs down to obscure the view. This is removed with a combination of sharp and blunt dissection with scissors attached to the cutting setting of an electrocautery unit. With any of the approaches, carbon dioxide insufflation is occasionally helpful to expand the pleural space and improve visualization. Care must be taken to prevent instillation of too much gas, which could cause respiratory compromise. A drop in oxygen saturation determined by pulse oximetry usually detects this. Once a clear view of thoracic structures is obtained, the scope is slowly moved to completely evaluate all surfaces visible. Blunt probes and retractors can be introduced at secondary puncture sites to facilitate examination. The technique for introducing accessory instruments involves careful planning of where the tip of the instrument is desired. The puncture site is determined by estimating the course of the instrument, and locating the puncture site by visualizing with the scope a finger jabbing the intercostal space at the desired accessory entry site. The trocar/cannula assembly is then introduced under direct visualization to prevent injury to thoracic viscera. The visual examination of the thorax is completed, and biopsy sample procurement or therapeutic interventions performed (such as pericardiectomy). Once it has been determined that there is no significant residual hemorrhage or air leakage, the accessory instruments and cannulas are removed. The puncture sites are sutured, usually with single sutures in the muscle, subcutis, and skin. The scope is then withdrawn and a no. 18 French red rubber catheter inserted through the cannula into the thorax. The cannula is removed and a purse-string suture placed around the red rubber catheter. Gas/air is manually evacuated with a 60-cc syringe until negative pressure is obtained. Local anesthetic is instilled into the pleural space to provide postoperative analgesia. A total of 1.5 to 2.0 mg/kg each of lidocaine and bupivacaine is instilled. The tube is then gradually removed with the syringe attached to provide negative pressure. Once the tube exits the thorax, the purse-string suture is tightened. A single suture is then placed in the subcutis and skin to complete the procedure. Most animals are discharged the following day.

Potential complications include inadvertent lung trauma with a trocar or instrument, extra puncture sites from initially entering at the wrong location, pneumothorax following pulmonary resection or biopsy, uncontrolled bleeding from vascular injury, bleeding in a patient with a coagulopathy, inadvertent cutting of thoracic nerves (vagal or phrenic), penetrating abdominal viscera from a diaphragmatic hernia, and excessive postoperative pain.

Abnormalities detected by thoracoscopy include pleural or pericardial effusion, pleural irregularity or thickening, pulmonary mass lesions, pulmonary bullae, lung lobe torsion, mediastinal masses or branchial cysts, and hilar lymphadenopathy.