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THORACIC TRAUMA IN DOGS AND CATS.
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Thoracic injury is common in dogs and cats following trauma, mainly encounters with automobiles. Thoracic trauma seldom occurs as an isolated injury; patients are often in shock and may have other significant injuries: abdominal, spine-medullar and cranium-encephalic lesions. The goal of this lecture will be to outline some basics of thoracic anatomy and physiology, pathophysiology of thoracic trauma, general trauma management, and the diagnosis and management of specific traumatic thoracic injuries. The thorax is responsible for the vital cardiopulmonary physiology of delivering oxygenated blood to metabolically active tissues. Pathologic consequences of thoracic injury, either alone or in combination, are responsible for inadequate oxygen. Penetrating thoracic injuries (e.g., stab wounds, gunshot wounds, impalement on a foreign body) primarily injure the peripheral lung, producing both a hemothorax and pneumothorax. Blunt trauma can induce injury by three distinct mechanisms: a direct blow to the chest (e.g., rib fracture), deceleration injury (e.g., pulmonary or cardiac contusion and aortic tear), and compression injury (e.g., cardiac and diaphragm rupture). The "Golden period" defines the time following injury wherein effective therapy ensures a good chance of survival. A primary survey involves triage of major body systems that follows the ABC's of emergency care. Life-threatening problems are then treated immediately, according to their level of priority, utilizing a team-oriented approach. The first hour following trauma has classically been recognized in medicine as the "survival hour." It is within this time that most deaths occur as a result of major injury to the respiratory and cardiovascular system. The next 2-4 hours are what we as clinicians recognize as the "Golden period." This is the most common presentation in the veterinary hospital. Rapid and aggressive treatment determines survival. Most treatable cardiovascular and respiratory injuries are seen in this period. The initial step in managing any traumatized animal is obtaining a history of the incident, with specific reference to the kinetics of the injury. Encounters with automobiles, animal fights, traps, burns, weapons, and abuse are common traumatic injuries seen. Once the initial survey is completed, and the animal stabilized, the secondary survey takes place. This starts with detailed evaluation of potential life-threatening injuries in the thorax. In humans, fractures of the first and second rib are the hallmark of severe thoracic trauma. Although first rib fractures are rare in dogs and cats due to anatomic differences (forelimb musculature being more protective), cranial rib fractures may cause a mortality rate as high as 36% in small animals. Death is due to associated neurologic injuries, cardiac injuries (such as aortic and pulmonary artery transection), and pulmonary disease complicated by brachial plexus injury and subclavian artery injury. Pulmonary contusions are seen in 55% of all thoracic injury. Thoracic injury reveals a variety of clinic aspects. Subcutaneous emphysema may occur with trauma but in itself is usually of little significance. Crepidus may be an indication of SQ emphysema or isolated rib fractures. Rib fractures can interfere with ventilation if the animal splints to reduce pain or occasionally, rib fractures may injure a major vessel. The pattern of respiration can be diagnostic. Patients with pneumothorax, effusions, and diaphragmatic hernia tend to have a rapid, shallow pattern, whereas pulmonary injury generally results in slower, more labored (abdominal) respiration. Bear in mind, however, that pain may limit chest movements and cause a shallower pattern. Slow, shallow breathing and paradoxical respiration may occur with head or cervical spinal trauma or flail chest. Thoracic auscultation is performed to detect areas of dullness (hemothorax or diaphragmatic hernias), or harsh adventitious lung sounds (pulmonary contusions). Simultaneous auscultation and percussion can be used to diagnose pneumothorax; likewise, decreased lung sounds may indicate the same. Thoracic radiographs are not indicated for initial assessment. They provide little additional information for the risks involved. It is quicker and safer to perform needle thoracocentesis to detect the presence of air or fluid than to take radiographs in a compromised patient. When initial stabilization is obtained, radiographs can be performed. Thoracocentesis is usually performed in the seventh or eighth intercostal space, with the patient standing, in sternal or lateral recumbency. The dorsoventral location of the puncture within the intercostal space is influenced by whether fluid or air is to be aspirated. An 18-
20 gauge needle or a short plastic catheter (either intravenous or thoracic) is used. A 3-way stopcock and a 20-60 ml syringe are attached to the needle either directly or by a section of IV extension tubing. The neurovascular bundle is on the caudal edge of the rib. Sedation of valium and butorphanol IM or IV if the animal is extremely anxious or painful can be used. Pulse oximetry measures oxygen saturation but does not provide a measurement of acid-base or ventilatory status. Thus, the most important measures of tissue oxygenation are hemoglobin concentration and percent saturation. In this case, the pulse oximeter is indeed a useful monitor of tissue oxygen delivery given that the animal has normal hemoglobin concentration. If oxygenation or ventilation is impaired, a number of conditions should be initially considered: a.) airway obstruction; b.) pneumothorax; c.) flail chest or rib fractures; d.) hemothorax; e.) pulmonary contusions; f.) diaphragmatic hernia.

**Pneumothorax**
Closed pneumothorax may result from perforation of the lungs, airways, or esophagus. Most begin unilaterally but progress bilaterally. A tension pneumothorax develops from a closed pneumothorax and occurs when tissue acting as a one-way valve allows air to enter the pleural space during inspiration, but not to exit during expiration. The resulting supra-atmospheric pressure severely compromises ventilation as well as venous return, leading to death within minutes. Patients with pneumothorax have rapid, shallow, respirations. With tension pneumothorax, jugular and/or femoral venous distension is occasionally observed. Lung sounds are not only decreased, but often one can simultaneously percuss and auscultate ("ping") to hear an increased resonance.

Thoracic radiographs are not indicated for initial assessment. It is quicker and safer to perform needle thoracocentesis to rule out pneumothorax. If repeated thoracocentesis is required, a chest tube should be placed and continuous suction drainage used. Usually, these systems are used only with dogs because of the amounts of air being drained, apparatus size, and amount of required tubing.

**Open Chest Wounds**
These may be associated with extensive diffuse contamination of the chest cavity and pneumothorax. Wounds should be occluded immediately with Vaseline-impregnated gauze and a chest wrap. Antibiotics utilized to treat open chest wounds include enrofloxacin and metronidazole, the penicillins and the cephalosporins. These wounds may be explored, debrided, and closed under general anesthesia when the animal is cardio-respiratory stable a few days after.

**Hemothorax**
Pleural effusion, especially hemorrhagic, produces hypovolemic shock that generally precede respiratory distress. The internal thoracic vessels, intercostal vessels, or internal mammary vessels are often the source of hemothorax. Thoracic auscultation reveals dullness ventrally. Hemothorax should not be excluded based of a single negative thoracocentesis. How much blood to remove from a hemothorax is controversial. The accumulation of blood may increase intrapleural pressure enough to provide tamponade for cessation of bleeding, but a substantial hemorrhagic effusion may cause a significant decline in pulmonary function. It is generally recommended that blood be removed if it is causing a significant decrease in pulmonary function.

**Pulmonary Contusions**
Pulmonary contusions constitute the most common injuries following thoracic trauma. Hypoxemia occurs and pain induced hypoventilation. Hemothysis or the presence of blood or bloody fluid in the oropharynx and trachea indicates severe chest contusions. Thoracic auscultation may reveal moist rales, and/or bronchial sounds. Contusions may be confirmed on thoracic radiographs appearing as alveolar or interstitial infiltrates. Contusions may not appear or be evident for up to 6-12 hours post trauma. Treatments of pulmonary contusions do maintain adequate tissue oxygenation. Fluid therapy restores cardiac output and careful monitoring is used to avoid overload (CVP monitoring). Hypertonic saline solutions with dextrans are indicated for rapidly
restoring hemodynamic status avoiding pulmonary effects. Animals with dyspnea and hypoxemia require oxygen therapy. Nasal oxygen is most useful. Pain associated with thoracic trauma inhibits ventilation requiring analgesia with opioids. Pain also reduces cough, promotes atelectasis, and predisposes to pulmonary infection. Diuretics are not recommended unless fluid overload or pulmonary edema occurs.

**Trachea and Bronchus Injuries**

Blunt tracheal or bronchial injuries are often due to compression of the airway between the sternum and the vertebral column in decelerating steering wheel motor vehicle accidents with resultant shearing of the bronchus from the carina or transverse lacerations of the trachea. Alternatively, a blow-out injury to the membranous trachea may occur during chest wall trauma.

**Flail Chest and Rib Fractures**

Flail chest is the result of two or more rib fractures of two or more adjacent ribs. Rib fractures compromise respiration secondary to pain and often are indicative of much underlying lung lesions. Immediate stabilization is generally not required. Fractures of cranial ribs are often indicative of severe cardiovascular trauma, while fractures of the caudal ribs should arouse suspicion of possible cranial abdominal trauma. Placing the animal in sternal recumbency with flail side covered and down may limit pain and further injury, but wrapping the chest often decreases compliance instead of stabilizing fractures.

**Traumatic Myocarditis**

The pathogenesis of post-shock arrhythmias (traumatic myocarditis) is probably multifactorial. This appears to be much more common in dogs than in cats. Potential causes of this syndrome include blunt trauma of the heart, myocardial ischemia, and autonomic imbalance as a consequence of CNS injury. The arrhythmias commonly see are VPCs, idioventricular rhythm, and ventricular tachycardia. The first step in therapy of these arrhythmias should be identification and treatment of any metabolic disturbances predisposing to arrhythmias. Simply providing oxygen therapy assists in a more rapid resolve.

**Tamponade**

Cardiac tamponade is most frequently caused by penetrating thoracic injuries, but occasionally it is observed in blunt thoracic trauma from myocardial rupture or coronary artery laceration.

**Diaphragmatic Hernia**

Diaphragmatic hernia may cause varying degrees of respiratory compromise. Auscultation may detect diminished heart and lung sounds on the affected sides. Borborygmus may be heard on thoracic auscultation if the intestines or stomach are herniated. These findings may not be evident for days to weeks following injury. Radiograph diagnosis may be achieved if there is displacement of viscera into the thorax. Immediate surgical correction is contraindicated unless a rapidly expanding, gas filled viscus is present in the thorax. Only after hemodynamic stabilization surgical correction is warranted.

**Esophageal Rupture**

Esophageal leakage should be suspected in patients with a history of major chest trauma and a pleural effusion. Insidiously accumulating pneumothorax or a pleural effusion may be the only manifestation. Thoracocentesis is highly suggestive if it reveals an acidic exudative fluid, marked high amylase, or presence of rods. Extravasations of swallowed contrast material into the mediastinum (mediastinitis) or pleural space confirms the diagnosis. Immediate surgical repair and drainage are indicated.

**References:**