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Evaluation of thoracic trauma in dogs and cats: a review of seventeen cases

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Summary

The objective of this study was to assess the etiology, diagnosis, treatment methods, surgical findings, postoperative results and necropsy findings of seventeen cases of thoracic trauma by evaluating medical records. A car accident, falling down, stabbing and bites were identified as the causes of trauma. Diagnosed pathologies in the cases included pneumothorax, hemothorax, pulmonary contusion, lung lobe collapse or eventration, rib fractures, etc. The treatment methods employed in these cases were medical therapy, thoracocentesis, tube thoracostomy, lateral intercostal thoracotomy, median sternotomy and thoracic wall revisions. Atelectasis, rupture, laceration or contusion of the lung lobes, pulmonary artery rupture, rib fracture and etc. were the surgical findings. Overall, seven dogs and four cats recovered completely. Two dogs were euthanized due to other pathologies including multisegmental lumbar fracture, paraplegia and postpneumonectomy syndrome. Three dogs and a cat died during treatment management. The necropsies revealed that the animals had pulmonary artery and tracheobronchial ruptures. The cat also had sudden onset cardiac arrest during surgery. In conclusion, cases with thoracic trauma should be assessed closely and managed with the necessary emergency and surgical procedures.

Key words: Cat, Dog, Thoracic trauma

Introduction

Thoracic traumas cause serious and potentially life threatening injuries that are the result of blunt or penetrating conditions in dogs and cats (Hackner, 1995; Looney, 2001; de Laforcade, 2002; Fossum, 2002b; Kirpensteijn, 2002; Spreng, 2003; Tello, 2006; Pelosi *et al*., 2008). Traumatic thoracic injuries of dogs and cats are generally overlooked by practitioners (Hackner, 1995; Looney, 2001). Thoracic trauma causes shock as well as cardiovascular and respiratory system injuries. Pathologies that are commonly encountered due to thoracic trauma are tracheal trauma, pneumothorax, hemothorax, pulmonary contusion, rib fracture, flail chest, myocardial contusion or perforation (Kramek and Caywood, 1987; Hackner, 1995; Looney, 2001; de Laforcade, 2002; Kirpensteijn, 2002; Tello, 2006; Pelosi *et al*., 2008).

Since thoracic trauma can result in extensive organ damage, a global approach should be taken to manipulate vital thoracic organs and successfully manage the trauma (Looney, 2001; Fossum, 2002a; Kirpensteijn, 2002; Pelosi *et al*., 2008). Although previous studies (Kramek and Caywood, 1987; Hackner, 1995; Shahar *et al*., 1997; Looney, 2001; Brühl-Day, 2002; Kirpensteijn, 2002; Tello, 2006) have mentioned different management approaches, to the best of our knowledge, there is no short review about cases of thoracic trauma. Therefore, the aim of the present study was to assess the etiology, diagnosis, treatment methods, surgical findings, postoperative and necropsy results of twelve dogs and five cats with thoracic trauma by evaluating medical records.

Materials and Methods

Twelve dogs and five cats were reviewed in the study. All cases were presented to the Department of Surgery in Veterinary Medicine at Uludag University with a history of thoracic trauma for the years 2004-2006. The etiology, diagnosis, treatment methods, surgical findings, postoperative results and necropsy findings of the cases with thoracic trauma were reviewed based on the comprehensive medical record of each case.

Evaluation and stabilization of the cases

The history of each case included thoracic trauma, which was diagnosed with clinical examinations. Based on the clinical examination findings, all of the cases were managed in the following manner.

All animals that presented respiratory distress received mask oxygen therapy, and peripheral venous access was started. Routine arterial and venous blood samples were taken to assess the vital status of the animals. In the event of persistent respiratory distress, the animal was endotracheally intubated and ventilated manually or mechanically according to respiration status. Ventilation was monitored with a pulse-oximeter and capnography.

All of the cases were managed with the same medical protocol. Lactate ringer's solution (Vacoliter®, Baxter, Eczacibasi, Turkey) was infused, and pain was relieved with petihdine HCl (5 mg/kg, IV) (Aldolan®, Gerot Pharmacy, Austria). If intrathoracic hemorrhage was suspected, then tranexamic acid (10 mg/kg, IV) (Transamine®, Fako, Turkey) was administered. Ampicillin sulbactam (20 mg/kg, IV) (Combisid®, Bilim Ilac, Turkey) was used as an antibiotic agent.

In cases where the animal had a penetrated thoracic wall wound, a sterile and occlusive bandage was applied before surgery. Animals with suspected pneumothorax or hemothorax were given thoracocentesis to diagnose pleural pathology and to establish a negative intrapleural pressure.

If accumulation of air or fluid in the pleural cavity continued, a thoracostomy tube was inserted into the affected hemithorax under local anesthesia with prilocain (Citanest 2%, AstraZeneca, Turkey). Continued drainage (Heimlich valve) and intermittent aspirations were applied in dogs and cats, respectively, as reported previously (Salci, 2004; Salci *et al*., 2005; Salci *et al*., 2009a).

After the animals were stabilized, radiographical and ultrasonographical examinations were completed.

Anesthesia

The anesthetic for each of the cases was xylazine HCl (Alfazine® 2%, Alfasan/Egevet, Turkey) (1 mg/kg, IM) followed by thiopental Na (Pentothal Na® 1 g, Abbott, UK) (15 mg/kg, IV) and ketamine HCl (Alfamine® 10%, Alfasan/Egevet, Turkey) (10 mg/kg, IM) in dog and cats, respectively. General anesthesia was maintained with 2% isoflurane (Forane®, Abbott, UK). Respiration was maintained with mechanic ventilation (15 ml/kg tidal volume, respiration rate 15/min and 25 cm H_2O airway pressure). All of the cases were monitored with ECG, a pulse-oximeter and a capnograph.

Surgical procedures

Thoracostomy tubes were inserted between the eighth and tenth intercostal spaces and were placed ventro-cranially into the affected pleural cavity. A "Chinese finger trap" suture was placed in the skin to secure the tube in place (Fossum, 2002a; Salci, 2004; Salci *et al*., 2005; Salci *et al*., 2009a).

Any penetrating thoracic wounds were explored, and particular care was taken underneath the bandages. After routine preparation for surgery, the surgical procedures (thoracic wall revisions, repair of the rib fractures with cerclage wire, ligation of the bleeding blood vessels, lobectomy, pneumonectomy etc.) were performed as described previously (Shahar *et al*., 1997; Fossum, 2002a). At the end of the surgery, the pleural cavity was filled with warm sterile saline, and the lungs were inflated. Then the lung parenchyma and bronchi were checked for possible air leaks. If there was a

leakage, the leak sites were sutured and/or repaired before thoracic closure. After thoracostomy tube insertion, the thorax was closed routinely and a loose chest bandage was applied.

Postoperatively, each case received additional care. Fluid infusion, ampicillin sulbactam (20 mg/kg, i.v.) (Combisid® 1 g, Bilim Ilac, Istanbul) and pethidine HCl (5 mg/kg, i.v.), (Aldolan® ampoule 100 mg, Gerot Pharmacy, Vienna) were administered. Radiological and ultrasonographic real time examinations were conducted to compare the pre- and postoperative findings of both examinations in order to evaluate the thorax. The animals were closely monitored and when their vital parameters were normal, the animals were discharged.

Results

The detailed results of the cases are listed in Table 1. Car accidents were the cause of the thoracic trauma for four dogs and two cats (n = 6). Falling down was also observed in one dog and three cats (n = 4). Stab wounds were seen in one dog (n = 1) and thoracic bite wounds were seen in six dogs (n = 6).

The pathologies diagnosed in the animals included middle lung lobe eventration and open pneumothorax (n = 1), a penetrating thoracic wall wound, rib fracture and open pneumothorax (n = 4), open pneumothorax and hemothorax (n = 1). Tension pneumothorax was found in the lateral and ventrodorsal radiographs of four animals along with the dorsal displacement of the cardiac silhouette, a flattened diaphragm and a large radiolucent area containing no lung markings. The hemothorax (n = 4) diagnosed in the radiological exams included a widened, fluid-dense pleural space, obscuring of the cardiac and diaphragmatic silhouettes, as well as rounding of the lung lobe tips in the thoracic periphery. Moreover, pleural fluid (blood) in the thoracic cavity was easily detected and the character of the fluid was also evaluated ultrasonographically. Radiographs indicated a patchy density in the alveolar pattern of a case of first degree pulmonary contusion (n = 1). These radiological findings were severe and the radiographs also had an increased opacity in a lung lobe in a case with third degree pulmonary contusion and lung lobe collapse (n = 1). Another case had third degree pulmonary contusion and pleural effusion (n = 1), which was diagnosed by radiological examination (Fig. 1). Increased soft tissue opacity was also observed in addition to the pulmonary contusion findings.

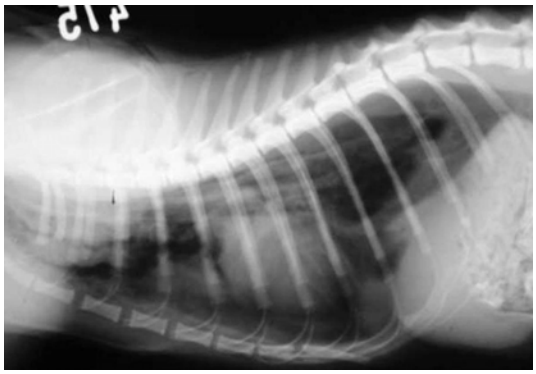

Fig. 1: This lateral radiogram demonstrates a third degree pulmonary contusion (increased opacity in lung lobes) and pleural effusion in a cat

One dog (n = 1) with first degree pulmonary contusion was treated medically. Two cats (n = 2) with hemothorax were treated with intermittent thoracocentesis and medical therapy. Tube thoracostomy was applied to treat the tension pneumothorax in two cats (n = 2). A thoracic operation was performed in seven dogs (n = 7) and one cat (n = 1). Lateral intercostal thoracotomy (n = 4) and median sternotomy (n = 1) were two of the surgical approaches. One dog (n = 1) underwent middle lung lobe lobectomy due to necrosis of and eventrated site of lung parenchyma. Left pneumonectomy was performed in two dogs (n = 2); one dog had atelectatic left lung lobes due to rupture, and the other had multiple stubbing lacerations on the left lung lobes. The thoracic wall wounds were revised in four dogs (n = 4). Fractured ribs were sutured with wire sutures, and all devitalized soft tissues (skin, subcutis and muscles) were debrided. Then the local wounds were managed.

During surgery, the injuries that were found included rupture of the middle lung parenchyma (n = 1), atelectasis of all left lung lobes (n = 1) due to rupture, middle

Table 1: Tabulation of the results of the cases

Case	Signalment	Etiology	Diagnosis	Treatment methods	Surgical findings	Postoperative results/necropsy findings
1	Dog, French Bracke crossbreed, 3-year-old, male	Bite	Middle lung lobe evantration and open pneumothorax	Left lateral intercostal thoracotomy, middle lung lobe lobectomy	Parenchymal rupture of left middle lung lobe	Recovered
2	Dog, English Setter, 9-month-old, male	Fall down	Tension pneumothorax	-	-	Euthanasia due to multisegmental lumbar fracture and paraplegia/Right cranial lung lobe burst
3	Dog, German shepherd, 5-month-old, female	Car accident	1st degree pulmonary contusion	Medical therapy	-	Recovered
4	Dog, English Setter, 2.5-year-old, male	Bite	3rd degree pulmonary contusion and lung lobe collapse	Left lateral intercostal thoracotomy pneumonectomy	Atelectasis and unexpansion of the left lung lobes due to rupture	Euthanasia due to postpneumonectomy syndrome
5	Dog, Anatolian crossbreed, 2-year-old, male	Car accident	Hemothorax	-	-	Died during stabilization due to hemorrhagic shock, pulmonary artery rupture
6	Dog, Pincher, 6-year-old, female	Car accident	Tension pneumothorax	-	-	Died during stabilization, right tracheobronchial rupture
7	Dog, Anatolian, 4-year-old, female	Car accident	Hemothorax	Lateral intercostal thoracotomy	Pulmonary artery rupture, excessive blood lost and myocardial ischemia	Died
8	Dog, Terrier, 1-year-old, male	Bite	Penetrate thoracic wall wound, rib fracture and open pneumothorax	Thoracic wall revision	-	Recovered
9	Dog, Boxer, 3-year-old, male	Stab	Open pneumothorax and hemothorax	Lateral intercostal thoracotomy left pneumonectomy	Multiple laceration of the lung parenchyma	Recovered
10	Dog, Anatolian crossbreed, 1.5-year-old, male	Bite	Penetrate thoracic wall wound, rib fracture and open pneumothorax	Thoracic wall revision	Middle lung lobe contusion, rib fracture	Recovered
11	Dog, Anatolian crossbreed, 3-year-old, male	Bite	Penetrate thoracic wall wound, rib fracture and open pneumothorax	Thoracic wall revision	Caudal lung lobe contusion	Recovered
12	Dog, Terrier, 8-year-old	Bite	Penetrate thoracic wall wound, rib fracture and open pneumothorax	Thoracic wall revision	Rip fracture	Recovered
13	Cat, Domestic shorthair, 2-month-old, female	Fall down	Hemothorax	Intermittent thoracocentesis and medical therapy	-	Recovered
14	Cat, Domestic shorthair, 9-month-old, male	Car accident	Tension pneumothorax	Tube thoracostomy	-	Recovered
15	Cat, Domestic shorthair, 2-year-old, female	Fall down	Hemothorax	Intermittent thoracocentesis and medical therapy	-	Recovered
16	Cat, Domestic shorthair, 1-year-old, male	Car accident	3rd degree pulmonary contusion and pleural effusion	Median sternotomy	Bloody chylous pleural effusion (suspected due to thoracic duct rupture) and air bubble under the visceral pleura of the left caudal lung lobe	Died due to postoperative sudden onset cardiac arrest
17	Cat, Domestic shorthair, 3-year-old, male	Fall down	Tension pneumothorax	Tube thoracostomy	-	Recovered

lung lobe contusion (n = 1), caudal lung lobe contusion (n = 1) and multiple lacerations of the left lung lobes (n = 1).

One dog that had a pulmonary artery rupture died during the operation due to excessive blood loss and myocardial ischemia. A cat died as well due to a pleural effusion in addition to a third degree pulmonary contusion. The characteristic of the pleural effusion in the cat was bloody chylous (likely due to a thoracic duct rupture) and an air bubble under the visceral pleura of the left caudal lung lobe, which revealed the severity of trauma. The cat died during the operation due to sudden onset cardiac arrest.

Seven dogs and four cats (n = 11) recovered completely. The vital parameters, including the clinical, radiological and ultrasonographic examination findings of the cases were all within the normal range within a median of 10 days (range, 5-12 days) after treatment.

Euthanasia was performed in two dogs (n = 2) because of additional pathologies. One dog had a multi-segmental lumbar fracture and paraplegia (n = 1). Necropsy of the dog also revealed the right cranial lung lobe burst. The other dog had unresponsive postoperative respiratory arrest (n = 1), which was thought to be post-pneumonectomy syndrome. The dyspnea was not resolved, and spontaneous ventilation was not obtained postoperatively in the dog.

Two dogs were not presented urgently, and they died during stabilization. One dog had hemothorax, and necropsy revealed pulmonary artery rupture (n = 1). The other dog had tension pneumothorax and a right tracheabronchial rupture (n = 1) which was revealed by the necropsy.

Discussion

Blunt or penetrating thoracic trauma typically results in catastrophic thoracic injuries in dogs and cats (Salci, 2003a; Pelosi *et al*., 2008). The most common causes of the trauma include car accidents, falling down, bites, fights, projectiles or bullets, stabbing and other forms of abuse by humans (Kramek and Caywood, 1987; Hackner, 1995; Shahar *et al*., 1997; Looney, 2001; Brühl-Day, 2002; Kirpensteijn, 2002; Salci, 2003a; Tello, 2006; Pelosi *et al*., 2008; Salci *et al*., 2009b). Similar causes were encountered in this study.

Thoracic trauma cases are always urgent due to damage in the cardiorespiratory system. Therefore, traumatic cases need immediate stabilization procedures (Tseng and Waddell, 2000; Looney, 2001; Brühl-Day, 2002; Kirpensteijn, 2002; Salci, 2003b; Tello, 2006; Pelosi *et al*., 2008). The presented cases were initially managed with oxygenization and medical procedures. Thoracocentesis is given to diagnose or treat the cases with pleural disease (Tseng and Waddell, 2000; Fossum, 2002b). We performed thoracocentesis to diagnose pleural pathologies, and intermittent thoracocentesis was also used as a therapy for two cats with pleural fluid.

Radiological and ultrasonographic examinations were a valuable step for diagnosing intrathoracic pathologies, even if the medical history, physical examination findings and laboratory results pointed to thoracic trauma (Kramek and Caywood, 1987; Hackner, 1995; Shahar *et al*., 1997; Brühl-Day, 2002; Kirpensteijn, 2002; Tello, 2006). In the present study, the physical examination findings and the laboratory results pointed to thoracic trauma, which was further characterized by radiological and ultrasonographic examinations.

Thoracostomy tube insertion is recommended if thoracocentesis fails to solve pneumothorax and if intrathoracal air accumulation is rapid (Kramek and Caywood, 1987; Tseng and Waddell, 2000; Fossum, 2002b; Salci, 2004). After tube thoracostomy, intermittent or continuous pleural drainage is used depending on the speed of air accumulation (Fossum, 2002b). In our cases, tube thoracostomy was performed to solve tension pneumothorax and postoperative pleural air after thoracotomy as recommended by Fossum (2002a).

Hypoxia and intrathoracal hemorrhage are the main causes of death in thoracic trauma. Therefore, shock and external bleeding or any blood accumulation in the pleural cavity should be assessed for these cases (Brühl-Day, 2002; de Laforcade, 2002; Tello, 2006). If there is intrapleural

hemorrhage, thoracocentesis (de Laforcade, 2002) or tube thoracostomy (Frendin and Obel, 1997) plus administration of medications (Tello, 2006) is recommended to alleviate respiratory distress and to stop bleeding. One dog with open pneumothorax and hemothorax (parenchymal bleeding due to stabbing) required a pneumonectomy operation, but two cats with hemothorax were treated with intermittent thoracocentesis plus medical therapy. The hemothorax in two dogs was severe, and the cause of the intrathoracal bleeding was pulmonary artery rupture. These dogs died due to hemorrhagic shock.

Traumatic pneumothorax (open and closed) is the most frequent type of traumatic thoracic injury (Kramek and Caywood, 1987; Fossum, 2002b; Salci *et al*., 2005; Salci *et al*., 2009b). The incidence of pneumothorax is 11-18% in dogs and cats with trauma (Kramek and Caywood, 1987). In this study, pneumothorax (open or tension) was the most common injury. In addition, a dog that was euthanized due to multi-segmental lumbar fractures and paraplegia had tension pneumothorax which was revealed in the necropsy.

The incidence of airway injury (tracheal and bronchial) is minimal in animals (Kramek and Caywood, 1987). Ruptures of the bronchial tree or the lung parenchyma occur when the thorax is forcefully compressed against a closed glottis. Then lung parenchymal tears occur from shearing forces at different rates (Kramek and Caywood, 1987; Fossum, 2002b; Salci, 2003a). This type of violence frequently results in a high incidence of closed pneumothorax. In many cases of traumatic pneumothorax, repair or resection of the traumatic lung lobe results in recovery (Kramek and Caywood, 1987). We performed a middle lung lobe lobectomy in one dog due to the necrosis of eventrated lung parenchyma. Furthermore, atelectasis of lung lobes due to rupture and lacerations in a dog were removed with pneumonectomy. The cause of the tension pneumothorax in the dog was right tracheobronchial rupture, which was revealed by the necropsy.

Pulmonary contusion occurs as a result of blunt thoracic trauma and is associated with other thoracic injuries such as pneumothorax, hemothorax, rib fractures, flail chest, diaphragmatic hernia, myocardial contusion or perforation and cardiac tamponade (Hackner, 1995; de Laforcade, 2002; Salci, 2003a; Tello, 2006; Pelosi *et al*., 2008). In total, three pulmonary contusions were encountered in this study. Successful treatment of a pulmonary contusion depends on the basic principles of trauma management and early recognition of the injuries (Hackner, 1995). Considering the advised treatment protocols in the literature (Hackner, 1995; de Laforcade, 2002; Fossum, 2002a; Salci, 2003b), first degree pulmonary contusion in one dog was treated medically. Pulmonary contusion in a dog with bite wounds that also had a collapsed lung was treated with an operation where the atalectatic left lung lobes were removed; however, the dog died postoperatively due to respiratory arrest, which was thought to be post-pneumonectomy syndrome. Chylous pleural effusion plus an air bubble under the visceral pleura of the left caudal lung lobe as well as a pulmonary contusion in a cat was also fatal.

Trauma causes serious injury in the thoracic wall and creates rib fractures (Tseng and Waddell, 2000; Tello, 2006; Salci *et al*., 2009b). Particularly, bite wounds penetrating the thoracic wall result in severe damage such as fractured ribs, pneumothorax and parenchymal rupture (Shahar *et al*., 1997; Salci *et al*., 2009b). This thoracic damage can be repaired with revision techniques including reconstruction of subcutis and muscle tears and fixing fractured ribs (Shahar *et al*., 1997; Fossum, 2002a; Kirpensteijn, 2002; Tello, 2006). Four dogs had bite wounds that required fixing fractured ribs, debridement of devitalized soft tissues and wound management.

Traumatic pneumothorax is rarely treated with surgery (Fossum, 2002b). If there is a perforation from the skin to the pleura, extensive flail chest, any sign of lung damage or uncontrollable hemorrhage, a surgical approach should be planned (Kramek and Caywood, 1987; Fossum, 2002b; Kirpensteijn, 2002; Pelosi *et al*., 2008). Thoracic surgical procedures include

either a right or left lateral thoracotomy or a median sternotomy (Kramek and Caywood, 1987; Fossum, 2002a; Kirpensteijn, 2002). The lateral thoracotomy is recommended in cases if a lesion has been localized only to a hemithorax. Median sternotomy allows for visualization of both hemithoraxes (Kramek and Caywood, 1987; Fossum, 2002b). Lateral intercostal thoracotomy and median sternotomy were the thoracic approaches employed for four dogs and one cat, respectively. The surgical findings in this study included ruptured lung parenchyma, atalectatic lung lobes, pulmonary artery rupture, lung lobe lacerations, bloody chylous pleural effusion and an air bubble under the visceral pleura.

Overall, seven dogs and four cats recovered completely. In conclusion, trauma can cause fatal thoracic pathologies. Therefore, cases of thoracic trauma should be assessed closely and managed with the necessary surgical procedures.

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