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EVALUATION OF AUTOLOGUS BLOOD PLEURODESIS FOR TREATMENT OF PERSISTENT PNEUMOTHORAX IN 23 DOGS AND 2 HORSES

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Abstract

The aim of this study is to describe the clinical course, outcome and success rate of 23 dogs and two horses with persistent pneumothorax treated with autologous blood pleurodesis. The cases included in the study consisted of unresolved pneumothorax through thoracostomy tube maintained for 1-3 days to remove pleural effusion and free air. In dogs, persistent pneumothorax was treated by pleurodesis after diaphragmatic hernia surgery (19) and four cases after traumatic chest injury. In the two horses, the persistent pneumothorax occurred after blunt trauma (traumatic accidents). Autologous blood pleurodesis was performed by intrapleural injection of 5 mL/kg of whole blood. The duration required for air leak to seal, chest drainage duration, length of hospital stay, and the incidence of complications were noted. In all dogs and in one horse the pneumothorax resolved within 12-72 hours after treatment. Minor complications occurred in other two dogs and resolved in both; one horse was euthanized. Blood pleurodesis may provide a simple, safe, and inexpensive medical treatment for resolution of persistent pneumothorax.

Key words*: dog, horse, persistent pneumothorax, blood pleurodesis.*

INTRODUCTION

Cases involving pneumothorax occur relatively frequently in clinical practice. In dogs pneumothorax occurs spontaneously caused by pulmonary blebs and bullae, after thoracic trauma or thoracic surgery (Puerto et al., 2002; Lipscomb et al., 2003; Lynch and Campos, 2018; Money, 2018). Horses developed pneumothorax secondary to pleuropneumonia, by open thoracic wounds, closed trauma, surgery involving the upper portion of the respiratory tract, and surgery involving the thoracic cavity (Boy and Sweeney, 2000; Hance and Robertson, 1992; Joswig and Hardy, 2013; Laverty et al., 1996).

Persistent air leak following traumatic or spontaneous pneumothorax in dogs can be managed conservatively via percutaneous thoracentesis, with thoracostomy tube placement or surgically by removing the affected lung lobes (Puerto et al., 2002; Lynch and Campos, 2018; Money, 2018)

Pleurodesis is another treatment method, commonly performed for recurrent or persistent pneumothorax or chronic pleural effusion more often in human medicine. Pleurodesis methods consist in talc slurry, instillation of various chemical sclerosing agents (Jeram et al., 1999), of whole blood and via thoracoscopic guided pleural scarification with either neodymium: yttrium-aluminum-garnet (Nd:YAG) laser or argon beam coagulator (Almind et al., 1989; Bresticker et al., 1993; Oppenheimer et al., 2014; Torre and Belloni, 1989; Wied et al., 1983). Although experimental pleurodesis in dogs has been reported in several studies (Bresticker et al., 1993), the therapeutic efficacy of pleurodesis in clinical cases of animals with pneumothorax is difficult to assess, with a limited number of clinical applications in dogs (Oppenheimer et al., 2014) and lacking data on horses.

The aim of this study is to describe the clinical course, outcome, and success rate of 23 dogs and two horses with persistent pneumothorax treated with autologous blood pleurodesis.

MATERIALS AND METHODS

Medical records from the Surgery clinic from 2000–2016 were reviewed to identify cases that

had persistent pneumothorax and/or unresolved pneumothorax through thoracostomy tube to remove pleural effusion and free air after 1-3 days of treatment and who were treated with autologous blood injected into the pleural cavity.
Autologous blood pleurodesis was performed using 5 mL/kg of non-coagulated aseptically collected whole blood.
The duration required for air leak to seal, chest drainage duration, length of hospital stay, and the incidence of complications were noted.

RESULTS AND DISCUSSIONS

Blood pleurodesis was used for resolution of pneumothorax in 19 dogs after correction of a diaphragmatic hernia and four dogs after traumatic chest injury and in two horses after traumatic pneumothorax from an axillary wound.
On admission, the dogs presented a marked increase in breathing effort, tachypnoea (respiratory rate, 64 breaths/min), decreased bronchovesicular sounds (bilateral), and muffled heart sounds. Thoracic radiographs revealed diffuse opacification of the thoracic cavity, the cardiac silhouettes and diaphragmatic contours were obscured by soft tissue opacity. The caudodorsal lung lobes were collapsed, and abdominal organs were identified in the thoracic cavity (Figure 1).

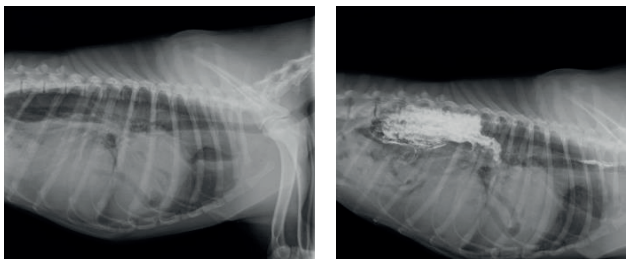

Figure 1. Radiographic views - diaphragmatic hernia in dogs

Based on the radiographic findings and anamnesis, in 19 dogs, a diagnosis of traumatic diaphragmatic hernia was stated.
Similar clinical findings were observed in 4 dogs after motor vehicle accidents and anamnesis and radiographic images led to the diagnosis of closed traumatic pneumothorax (Figure 2).

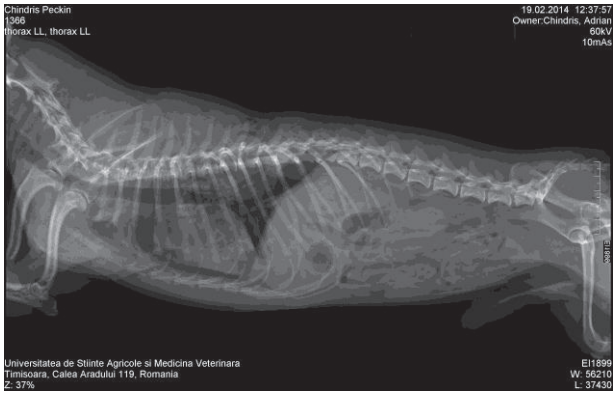

Figure 2. Closed traumatic pneumothorax in dog

Oxygen was initially administered to all 23 dogs. An IV catheter was inserted in the right cephalic vein and used to administer lactated Ringer's solution (5 mL/kg/h). Despite treatment, the clinical status of the all dogs continued to deteriorate (orthopnoea, dyspnoea, and marked discomfort).
Exploratory celiotomy and herniorrhaphy were performed within 3 and 72 hours after admission in dogs with diaphragmatic hernia. Premedication consisted in administration of diazepam (0.50 mg/kg, IV) in combination with ketamine hydrochloride (4-5 mg/kg, IV), for induction of general anaesthesia was used propofol (2 mg/kg, IV) and for maintenance 2% isoflurane and positive pressure ventilation. Celiotomy was performed via a ventral midline incision (Figure 3). The herniated abdominal organs (the liver lobes, intestinal loops and omentum) were reduced into the abdomen.

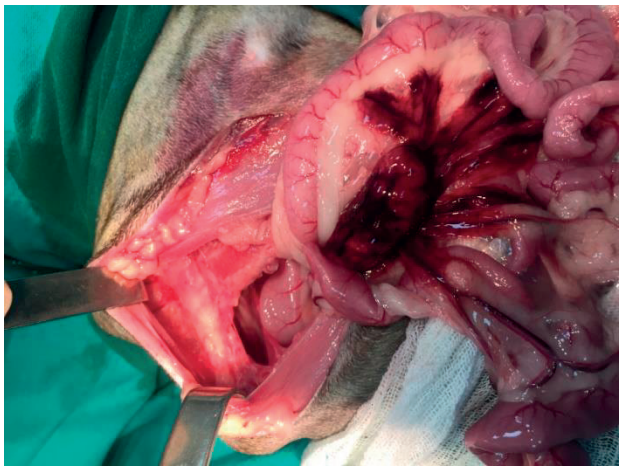

Figure 3. The herniated abdominal organs

In five dogs, due to multiple adhesions between the herniated organs and the lungs, sharp debridement was necessary. The thoracic cavities were filled with sterile saline solution

(0.9% NaCl), and no air leakage was detected from the lung adherence sites. In all 23 dogs (19 with surgery for diaphragmatic hernia and 4 dogs with closed traumatic pneumothorax) a thoracostomy tube (diameter, 8.0 mm; length, 40 cm) was inserted in intercostal space between ribs 8 and 9 (through the skin and musculature) into the thoracic cavity. Purse-string and finger-trap sutures were used to secure the thoracostomy tubes. The tube was hooked up to a suction and postoperative Heimlich valve was connected to it (Figure 4).

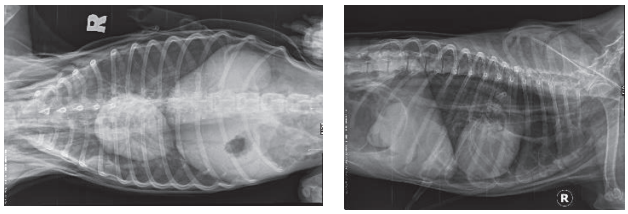

Figure 4. Pneumothorax - thoracostomy tube connected at Heimlich valve (radiographic views)

Postoperative, the rate of administration of lactated Ringer's solution was increased to 6-8 mL/kg/h during recovery from anaesthesia. Other postoperative treatments included administration of ketamine hydrochloride (0.12 mg/kg/h) or butorphanol (0.005 mg/kg q 12 h), and administration of ampicillin-sulbactam (20 mg/kg, IV, q 8 h). Pneumothorax resolution was obtained by intermittent (once a day) connection of thoracotomy's tube to a suction device. Clinical status of all dogs improved during the next 1-3 days, except for a non-resolving pneumothorax and mild pleural effusion (clinical and radiographic findings).

Blood pleurodesis was performed in all 23 dogs under aseptic conditions. Whole blood without anticoagulant was collected from the cephalic vein by use of a 50-mL syringes. The blood (5 mL/kg) was immediately instilled into the thoracic cavity via the thoracostomy tube, followed by flushing whit 10-20 mL of sterile saline solution. The drainage tube was clamped for at least 4 hours, after which the dogs were reconnected to the Heimlich valve. Following the pleurodesis procedure, the Heimlich valves remained connected for 24 hours; however, the valves appeared to be non-functional as a result of filled with fluid. The thoracostomy tube was then purposefully occluded because the breathing rate and pattern had remained stable in all dogs. The thoracostomy tube was removed 24 hours after the instillation of blood into the intrapleural space.

Rapid resolution of the pneumothorax was observed in 18 of the dogs, while the other 5 required additional treatments. Pleurodesis was repeated once in these dogs, after which air leak was not observed meaning pneumothorax resolution. Out of a total of 28 pleurodesis procedures performed in 23 dogs, 18 (78.2%) were successful after one procedure and the success rate increased to 100% after the second procedure. No significant modification of hemodynamic occurred after blood withdrawal with the exception of two dogs at which a mild hypotension was recorded and resolved after increasing the administration rate of lactated Ringer's solution. Thoracic radiographs after the procedure revealed lung re-expansion in all dogs, after 1-3 days from the pleurodesis procedures. All dogs were discharged 4 days after performing the pleurodesis.

In two horses with bilateral pneumothorax following axillary penetrating wounds (Figure 5) manifested by anxiety, distress and massive subcutaneous emphysema, after antisepsis and wounds sutures, pleurodesis with autologous blood (5 mL/kg) was performed, similar to the technique used in dogs. Rapid (after 48 hours) and complete resolution of the pneumothorax was observed in one horse. One horse was euthanized, because after 48 hours, its general condition deteriorated and the massive empyema obliterated the thoracostomy tube.

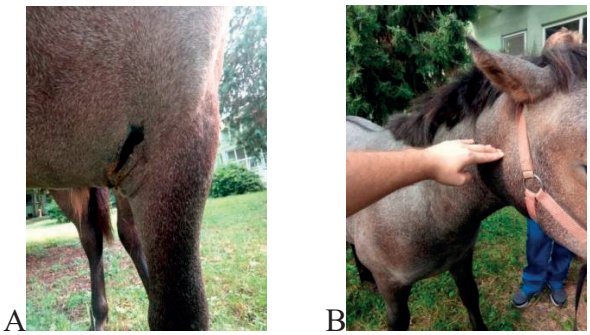

Figure 5. Bilateral pneumothorax following axillary penetrating wounds (A) with massive subcutaneous emphysema (B)

Pleurodesis, from the Greek pleura and desis (binding together), is intended to achieve a fusion of the parietal and visceral pleura, in order to prevent accumulation of either air (pneumothorax) or fluid (pleural effusion) in the pleural space. The mechanism of

pleurodesis is based on pleural irritation in order to create an inflammatory reaction leading to fibrinogenesis (Kroegel and Antony, 1997). The cellular and molecular mechanisms involved in pleurodesis include the activation of the coagulation cascade of the pleura; fibrin deposition; fibroblast recruitment, activation, and proliferation; and collagen deposition (Antony et al., 1992).

The mechanism responsible for the sealing effect of blood is likely multifactorial. Possible mechanisms, according to another study (Oppenheimer et al., 2014) include true pleurodesis that results in pleural adhesions; blood generates an inflammatory reaction in the pleural cavity that may contribute to the adhesion between the parietal and visceral pleura, or sealing the site of air leakage by blood clots.

In humans, pleurodesis with talc, insufflated or as a slurry, is controversial, there are reports showing that it can lead to the development of acute respiratory distress syndrome and even death (Light, 2000; Janssen et al., 2007). Pleurodesis by infusion of blood into the pleural cavity has been used in human medicine for the treatment of several conditions, which include primary and secondary pneumothorax, persistent postoperative air leakage, and chronic effusions refractory to chemical pleurodesis (Williams and Laing, 2005; Rinaldi et al., 2009).

In veterinary medicine (excluding laboratory animals) autologous blood pleurodesis was reported in 9 dogs' clinical cases (Oppenheimer et al., 2014; Merbl et al., 2010).

In laboratory animals, other authors compared the efficacy of pleurodesis by the infusion of blood or application of doxycycline or talc powder in rabbits. The application of doxycycline was effective, but caused severe local adverse effects.

The application of talc powder and doxycycline were both associated with histological changes in the contralateral lung lobes and increases in serum liver transaminase activity that suggest undesirable systemic effects (Mitchem et al., 1999). The pleurodesis with autologous blood in rabbits was ineffective over the short-term (Mitchem et al., 1999), although in human medicine there are some successful clinical reports of using autologous blood for pleurodesis (Dumire et al., 1992; Robinson, 1987).

Jerram et al., 1999 in an experimental 10-dog study on the efficacy of mechanical abrasion and talc slurry as methods of pleurodesis, showed that neither method of pleurodesis produced sufficient pleural adhesions to obliterate the pleural space.

Surgical intervention is seldom required in dogs with traumatic pneumothorax, healing occurs usually within 3 to 5 days after thoracentesis, thoracostomy and suction (Fossum, 1998; 2002; 2018). We report 4 dogs with unresolved traumatic pneumothorax after being managed with thoracentesis and thoracostomy tube and on which was obtained complete resolution only after management with blood autologous pleurodesis.

In a literature study, in total, 13 procedures of the blood pleurodesis were performed in 8 dogs, of which 5 (62.5%) were successful after one procedure and success rate increased to 87.5% after additional procedures (Oppenheimer et al., 2014).

In our study, 23 dogs (19 dogs had a history of pneumothorax secondary to diaphragmatic surgery and 4 dogs with closed traumatic pneumothorax) were initially treated with thoracentesis and placement of thoracostomy tubes with no reduction in the amount of air accumulation at 1-3 days after tube placement and healing occurred only when autologous blood pleurodesis was applied. The success rate was recorded in 78% of cases after one procedure and in 100% of cases after the second procedure.

Possible complications of blood pleurodesis described in humans include bacterial infection and tension pneumothorax. Bacterial infection is a result of the initial surgical procedure or unsterile conditions during the infusion of blood, which both sequentially cause empyema (Lang-Lazdunski and Coonar, 2004). Empyema is the complication most frequently reported with blood pleurodesis. Studies have revealed the incidence of empyema to be 9% (Williams and Laing, 2005). In our study, a fatal complication - massive empyema - in one horse with traumatic pneumothorax was reported.

The present article does not provide definitive proof that treatment with blood pleurodesis for the resolution of pneumothorax will be

successful in all dogs, observations that concords with another studies (Oppenheimer et al., 2014; Merbl et al., 2010).

To our knowledge, the horses reported in our study are the first ones in which the treatment of pneumothorax by blood pleurodesis has been reported.

Blood pleurodesis does not require advanced equipment or technical skills, and instillation of blood into the pleural space is likely to cause less pain and resolution of pneumothorax may be observed shortly after this.

CONCLUSIONS

The autologous blood pleurodesis may be considered as a medical alternative for the treatment of pneumothorax from unresolved air leakage, in dogs.

Blood pleurodesis may provide a simple, safe, and inexpensive treatment for resolution of persistent pneumothorax.

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