Successful Management of a Penetrating Thoracic Injury in a Pony Filly

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ABSTRACT

A 2.5-year old, pony filly, was referred to the Koret School of Veterinary Medicine – Veterinary Teaching Hospital (KSVM-VTH) with a traumatic open pneumothorax, hemothorax, large chest defect, minor lung laceration, and multiple rib fractures. The filly was initially stabilized via intravenous fluids, oxygen supplementation and blood transfusion and then went through standing surgical repair of the fractured ribs, followed by chest wall defect closure. Then, the thorax was evacuated from air and fluids by placing a ventral and dorsal thoracostomy tubes. The mare was hospitalized for fourteen days, during which time she received intensive medical care including; broad spectrum antimicrobials, non-steroidal anti-inflammatory drugs, prophylatic treatment for laminitis, thoracic lavage including intra-thoracic antibiotic administration and daily wound care. Upon follow up with the referring veterinarian, three years later, the filly returned to work showing no signs of exercise intolerance or any other clinical signs.

Keywords: Thoracic injury, Pneumothorax, Horse, Surgery.

INTRODUCTION

Thoracic injuries are relatively uncommon in horses and may follow blunt or penetrating trauma (1). The most common cause of trauma is collision with an inanimate object (2). Equine thoracic trauma may require rapid emergency measures in order to save the horse from life-threatening complications such as pneumothorax, hemothorax, pleuritis, diaphragmatic hernia, and damage to the lungs, heart or blood vessels. Patient stabilization is the primary objective prior to deciding upon the course of treatment. Thorough evaluation, and determination of location and depth of the wound, must be performed. One must keep in mind that extra-thoracic injuries (e.g. abdominal, spinal) may occur in association with thoracic trauma (1). Deep wounds and those caudal to the sixth rib are more likely to involve the abdomen; moreover, horses with axillary wounds should be monitored for delayed respiratory distress until the wound has completely healed (2). Clinical findings are variable and may be associated with external thoracic injuries, which may cause muscle damage, blood vessel laceration, rib fracture and spinal trauma that in turn may lead to pain, shock or neurological signs. Those horses with internal thoracic trauma often present with respiratory distress. In addition, horses with concurrent abdominal trauma or diaphragmatic herniation may develop signs of colic (1, 2). True penetrating wounds of the thorax and/or abdomen carry a guarded prognosis due to possible complications such as pneumothorax, septic pleuritis, etc. (3, 4). In contrast, it was previously stated that a distinction should be made between penetrating thoracic injuries occurring alone and those with an additional extra-thoracic injuries, since the former carries a favorable prognosis (2).

This report describes a case of a penetrating thoracic injury in a pony filly, the course of treatment and the long-term results.

CASE DETAILS

History

A 2.5-year old, 300 kg pony filly, was referred to the Koret School of Veterinary Medicine – Veterinary Teaching

Hospital (KSVM-VTH), with a left sided penetrating thoracic injury, following a direct collision with a paddock pole. Prior to arrival at the hospital, the filly was given non-steroidal anti-inflammatory drugs (NSAID's) (flunixin meglumine) and antibiotics (penicillin, gentamycin) by the referring veterinarian. The filly was routinely vaccinated for tetanus, rabies and influenza.

Clinical examination

The filly was depressed, showing signs of labored breathing, tachypnea (28 breaths/minute), tachycardia (92 beats/minute) with weak palpable pulse, and cold extremities. Her rectal temperature was 38.5°C. Mucus membranes were pale, and the capillary refill time (CRT) was prolonged (>2 sec); dehydration was estimated at 6-8%. At the left side of the thorax there was a 25 cm long, deep laceration oriented dorso-ventrally with fractured rib ends protruding from it. In addition, there was blood actively oozing out of the thoracic cavity. Moreover, careful inspection via strong illumination into the thoracic cavity revealed a collapsed lung. The diagnosis was open pneumothorax that seemed unilateral at this stage, fractured ribs, hemothorax, and shock (Figure 1). No extra-thoracic injuries were detected.

Clinical pathology

Initial laboratory data revealed: mild leukopenia (white blood cell count, WBC - 4.39×10^9/L, reference 5.40-14.3×10^9/L), mild anemia (red blood cell count, RBC - 7.07×10^{12}/L, reference 6.80-12.9×10^{12}/L, and packed cell volume, PCV = 27%, reference 32-52%), low total solids (TS - 5.2 g/dL, reference 5.7-7.9 g/dL), slightly high urea (urea – 41.1 mg/dL, reference 10-40 mg/dL), and serum creatinine was within range (Cr - 1.63 mg/dL, reference 0.9-2.0 mg/dL).

Treatment and hospitalization

An extended use intravenous (IV) catheter (Milacath®, MILA International, INC, Erlanger, KY, USA), 14 gauge, was inserted in the left jugular vein, IV fluids (Lactated Ringers solution, Teva Medical Ltd., Ashdod, Israel) were administered at a bolus flow rate, and nasal insufflation of oxygen, at a flow rate of 15 l/min, was initiated (Figure 1). Additional antibiotic coverage was provided by adding metronidazole (Metryl 100%, Vetmarket Ltd., Petach Tikva, Israel), and penicillin G sodium (Sandoz GmbH, Kundl, Austria). The filly was sedated, using a combination of detomidine hydrochloride (Domosedan® 1%, Orion Pharm, Turka, Finland) and butorphanol tartrate (Torbugesic® 1% Fort Dodge Laboratories, Fort Dodge, IA, USA) (0.01 mg/kg intravenously (IV)) given once and followed by constant rate IV infusion (CRI; 5mg/h) of both drugs. Regional analgesia was achieved by 2% mepivacaine hydrochloride (Mepivacaine, Ceva/Nature vet, NSW, Australia) injected into the subcutaneous tissue, muscle layers and exposed parietal pleura. The chest wound was thoroughly explored, irrigated gently, using sterile saline solution, and debrided. Three consecutive ribs were fractured (ribs 9-11) and access for repair was achieved by performing a 20 cm incision, 20 cm caudally to the original wound, oriented dorso-ventrally and extending through the skin and chest wall musculature. Two ribs (10 and 11) were amenable for reduction and stabilization using 1.25 mm thick cerclage wire. A 2mm hole was drilled near the rib ends and the two parts were wired together in a simple interrupted fashion (Figure 2). The third rib (9) suffered a comminuted fracture in which the bone fragments were removed, and rib edges were smoothed using rongeurs. Thoracostomy tubes (26 gauge), dorsal and ventral, were inserted into the thorax via a 1 cm skin incision made one intercostal space caudal to the intended portal of entry. The tube/trocar complex advanced under the skin and inserted into the thorax along the cranial edge of the rib, and once inside, the trocar was withdrawn. The dorsal tube was inserted at the 13 intercostal space, and the ventral one at the ninth intercostal space. A Heimlich valve (Becton, Dickinson and Company, New Jersey, FL, USA) was attached to the dorsal tube, while the ventral tube was just sealed with a

Figure 1: Image of the filly upon admission to the hospital.

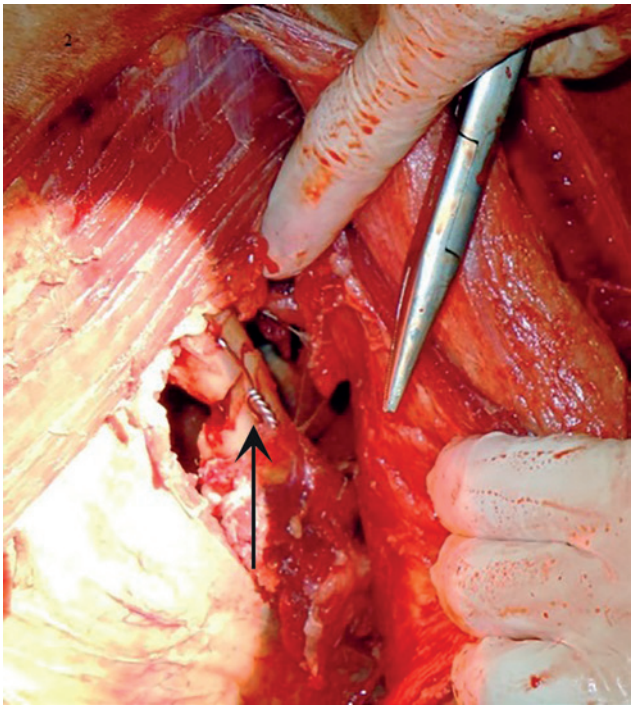

Figure 2: Intra-operative image of the stabilization of ribs ten and eleven using cerclage wire (black arrow).

catheter cup. Since there was evidence of continued thoracic bleeding which was considered significant according to the clinical signs of shock and the decrease in packed cell volume (PCV = 25%) and total solids (4.9 g/dL) during the surgical procedure, the filly received three litters of fresh whole blood from a cross matched donor. Both wounds, the original laceration and the surgical incision, were closed in 3 separate layers. The muscles were sutured using PDS 1 (Assucryl 1, Assut sutures, Switzerland) in a simple continuous pattern, (Figure 3) the subcutaneous tissue was closed using PDS 2-0 (Assucryl 1, Assut sutures, Switzerland) in the same pattern, while the skin was closed with Nylon 0 (Interlon 0, IntroMedix, Israel) in a simple interrupted pattern in the original wound and Ford interlocking pattern in the surgical incision. Moreover, a closed drainage system (a Jackson-Pratt drain with a container) was placed against the rib cage underneath the muscle layer during closure of the original wound (Figure 4).

Following wound closure and evacuation of air from the thorax, there was a significant improvement in the filly's clinical condition, her breathing pattern and rate improved and she seemed alert. Moreover, postoperative radiographs revealed both lungs to be properly inflated and the fractured ribs in good reduction.

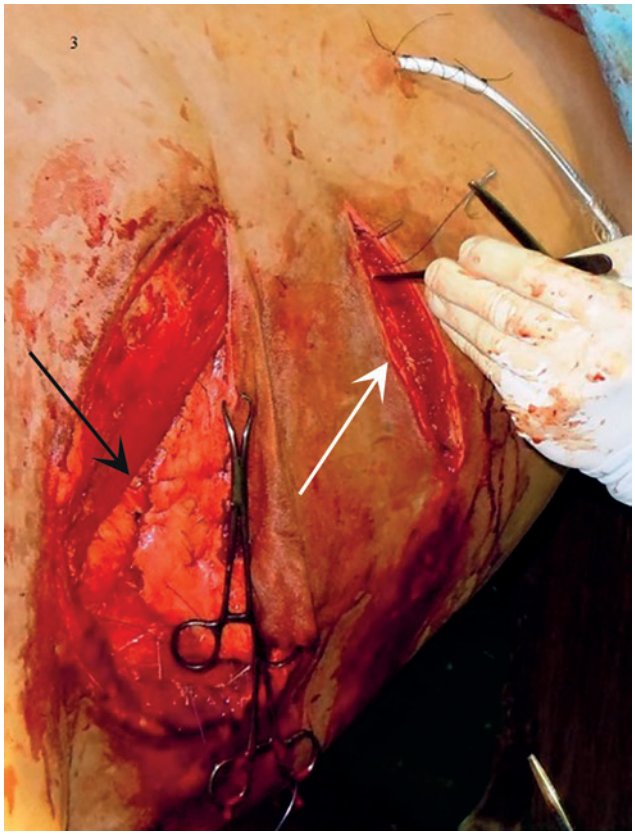

Figure 3: Intra-operative photograph demonstrating muscular layers closure using simple continuous pattern in both the primary wound (black arrow) and surgical incision (white arrow).

Postoperative care

During the first ten days following surgery, the filly was kept in strict stall rest, at which point short hand walking was allowed every day. Moreover, the filly was monitored frequently for vital signs, pain, demeanor, appetite, and intestinal activity. Special attention was given to the development of any sign of respiratory distress. In addition, wound appearance, type and quantity of secretions collected through the closed drainage system, were also monitored. The filly was given broad spectrum antibiotics; initial treatment included penicillin G sodium (25×10^3 U/kg BW, IV, QID), gentamycin (Gentaveto-5 pro injection, Biove Laboratories, Arendonk, Belgium, 6.6 mg/kg BW, IV, SID) and metronidazole (15mg/kg BW, PO, TID). The filly also received IV fluids (lactated Ringers solution) at a flow rate of 1l/hr, anti-inflammatory drugs flunixin meglumine (Meflosyl, Norbrook laboratories Ltd, Newry, Ireland, 1 mg/kg BW, IV, BID, six treatments), anti-endotoxemia medication - polymyxin B sulfate (Vi-Polyxin, Teva Ltd., Petach Tikva, Israel, 6000 iu/kg BW, slow IV, BID, four treatments), and

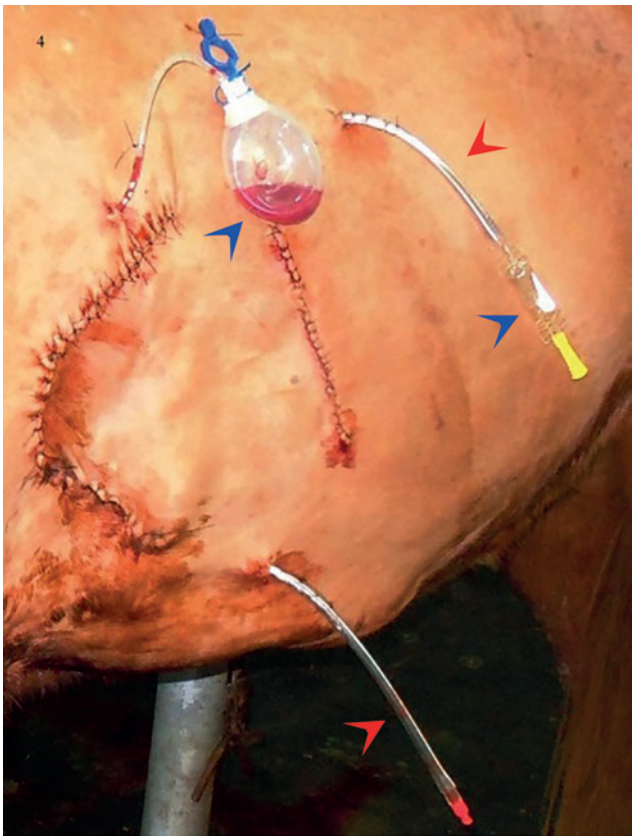

Figure 4: A post-operative image demonstrating the placement of the dorsal (red arrow) and ventral thoracostomy (red arrow head) tubes. A Heimlich valve is shown connected to the dorsal tube (blue arrow). A container is attached at the end of the Jackson – Pratt Drain (blue arrow head)

prophylactic laminitis treatment which included enoxaparin sodium (Clexane Forte, Sanofi Winthrop industries, France, 0.4 mg/kg BW, SC, SID, four treatments) and ice packs on all distal limbs for 72 hours. In addition, the thoracic cavity drained and lavaged once a day for two consecutive days, via the ventral thoracostomy tube, using 2L of warm saline and instilling 250 mg imipenem-cilastin sodium (Primaxin®, Merck Sharp & Dohme Corp., NJ, USA), into the thoracic cavity following drainage of all the lavage fluids. The ventral thoracostomy tube was removed after the second lavage, since only clear fluids were returned. The dorsal thoracostomy tube was removed after four days when repeated radiographs showed properly inflated lungs and well aligned rib fractures.

One week post-operatively the filly had an elevated body temperature (39.1˚C) and leukocytosis (WBC - 17×10^9/L, reference 5.40 - 14.3×10^9/L). The primary wound was clearly infected, sutures were starting to open and pus was oozing out. At that point, the wound was opened to the level of the muscle layer, the Jackson-Pratt drain was removed and sent for culture and sensitivity and the wound was debrided and thoroughly lavaged. Finally, a Penrose drain was placed at the most depended point and the systemic antibiotics (penicillin and gentamycin) were changed to cefquinom sulphate (Cobactan 25%, Intervet international, Germany, 1 mg/kg BW, IM, BID) coupled with metronidazole at the previously described dosage. The above described treatment continued for five days, during which the filly's temperature returned to normal level and her condition gradually improved. *Staphylococcus epidermidis* was cultured from the wound, which was resistant to most antibiotics with the exception of vacomycin and oxytetracycline. Thus, the filly's antibiotic regimen (cefquinom and metronidazole) was changed to oxytetracyclin (Terranycin®, Pfizer, NY, USA) at a loading dose of 9 mg/kg BW, IV, BID and continuing with 6 mg/kg BW, IV, BID for an additional fourteen days.

After two weeks of hospitalization and gradually decreasing intensity of care, the filly was discharged home, in good clinical condition. Owner was instructed to continue antibiotic therapy, using preplaced extended use intravenous catheter (Milacath®, MILA International, INC, Erlanger, KY, USA) inserted in the right jugular vein, for an additional of ten days, as well as performing daily cleaning of the wound.

Outcome

Follow-up information obtained approximately two weeks following discharge indicated that the filly was doing well, the wound was healing nicely and minimal daily exercise was initiated. Three years after discharge, the referring veterinarian reported that the filly was back to work showing no signs of exercise intolerance or any other clinical signs.

DISCUSSION

Penetrating thoracic injury represents an important cause of morbidity and mortality in horses (5). Quick, thorough assessment followed by prompt emergency management, temporary or permanent wound closure and restoring negative pressure within the thorax are the vital steps required for successful outcome of these patients (1, 4, 5, 6). In the present case, the filly was presented with respiratory distress, shock, fractured ribs, open pneumothorax and hemothorax. The filly was initially stabilized, then went through standing thoracic surgery and recovered completely.

In the horse, the two sides of the pleural cavity often communicate through a small fenestration in the caudal mediastinum (7), increasing the risk for unilateral open pneumothorax to become a life threatening bilateral pneumothorax (2). It is however, unclear how often do both sides of the equine thoracic cavity indeed communicate. In one study, healthy adult horses, went through unilateral standing thoracoscopy, and none of the horses developed any respiratory distress (8). Other authors assume frequent communication between the thoracic sides and relay the clinical phenomenon of unilateral pneumothorax to occlusion of the communication by exudates (2). In our case, the filly suffered from hemothorax, which could have occluded the communicating orifices and may explain the occurrence of unilateral pneumothorax.

Pneumothorax can be classified as; open, closed and tension (1, 2, 5, 6, 9, 10). Our filly suffered from a unilateral open pneumothorax which was treated by primary wound closure accompanied by placing a dorsal thoracostomy tube, connected to a Heimlich valve, which was used to evacuate air from the thorax. The use of a one-way valve for continuous air evacuation, or a Heimlich valve, decreases the chance for recurring pneumothorax (11).

Hemothorax in the present case was caused both, from an intercostal artery and from pulmonary parenchymal laceration. In the case presented here, serial laboratory results showed relatively low PCV (PCV = 25%) and TS (TS – 4.9g/dL) but stable over time, despite active bleeding. Nevertheless, the filly was weak; showing signs of shock and therefore received three liters of fresh whole blood from a cross matched donor. Moreover, hemostasis was achieved through wound closure and subsequent pulmonary re-inflation, which has been proven to be sufficient to stop bleeding from low pressure blood vessels (12).

In a previous study, it was stated that blood in the thorax associated with penetrating trauma should be removed, as it is an ideal medium for bacteria and it may facilitate the development of constrictive fibrothorax (12). Blood evacuation, in the present case, was facilitated by placing a ventral thoracostomy tube. Furthermore, complete evacuation and cleansing of the thoracic cavity was achieved by intra-thoracic lavage. We believe that the thoracic lavage aided in evacuating the hemothorax and contributed to the filly's rapid and complete recovery.

Fractured ribs are commonly associated with thoracic trauma (5). In the adult horse, it is accepted that simple rib fractures can be managed by strict confinement for 4-6 weeks and proper analgesia (2, 4, 5). In the present case, two ribs suffered simple fractures, which were stabilized using cerclage wire. Recently, rib fractures in foals, were repaired successfully by nylon strands tightened using a tension device, reconstruction plates, and cable ties (13, 14, 15), these methods may be considered; in adult horses as well. The third rib was shattered, leaving sharp ends and fragments, which were smoothened and removed respectively.

Pleuritis and pleuropneumonia are common complications of penetrating thoracic trauma. Moreover, it is accepted that horses that do develop these complication have a poor prognosis for survival (2, 4, 6). Therefore, in the case presented here, the filly received comprehensive therapy; including broad-spectrum antimicrobials (penicillin, gentamycin and metronidazole), NSAID's (flunixin meglumine), accumulated blood was evacuated from the thorax and thoracic lavage using sterile saline solution was performed. Furthermore, at the conclusion of each thoracic lavage, an intra-thoracic potent single agent broad-spectrum antimicrobial agent (imipenem-cilastin sodium) was infused. We firmly believe that the intensive post-operative therapy was instrumental to avoiding these potentially fatal complications.

In the present case, the only setback encountered was wound infection and dehiscence of the superficial tissue layers. It seemed probable that a highly resistant *S. epidermitis* that was cultured from the wound, was a nosocomial infection; since these bacteria commonly cause secondary wound infection in hospitalized patients (16).

In the current case, the entire surgical procedure was performed under standing sedation; and local anesthesia. The decision not to induce general anesthesia, was based upon the favorable response of the filly to initial stabilization, the left lung seemed to be functioning well, and the fact that the filly's condition did not appear to deteriorate. There is a considerable debate regarding the use of general anesthesia versus standing sedation when treating thoracic injuries in the horse. When selecting the appropriate type of anesthesia for treating penetrating thoracic injuries, it must be taken into consideration the patient status, response to initial treatment, location and extent of the injury and the need for intra-thoracic exploration and for aggressive thoracic lavage (17, 18, 2). Treatment of penetrating thoracic injuries in a sedated, standing horses has been previously described (2). Our report describes a filly with an extensive penetrating

thoracic injury, multiple rib fractures, and a unilateral open hemo-pneumothorax treated successfully using standing sedation and local anesthesia.

In summary, this case describes surgical treatment combined with aggressive post-operative medical management of a severe penetrating thoracic trauma that resulted in successful long-term outcome.

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