Original Article

Axillary wounds in horses and the development of subcutaneous emphysema, pneumomediastinum and pneumothorax

A. Joswig* and J. Hardy

Department of Large Animal Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Texas A&M University, Texas, USA.
*Corresponding author email: amandajo.joswig@gmail.com

Keywords: horse; axillary wound; subcutaneous emphysema; pneumomediastinum; pneumothorax

Summary

Equine axillary wounds are common in horses. Severe and potentially life-threatening complications that can result from axillary wounds include subcutaneous emphysema, pneumomediastinum and pneumothorax. This report describes the occurrence of these complications and appropriate treatment. Case records of 7 horses after sustaining an axillary wound are reviewed. Of these cases, all 7 developed subcutaneous emphysema, 5 developed a pneumomediastinum and 4 developed a pneumothorax. The time between the wound occurrence and the development of subcutaneous emphysema was able to be determined in 5 of the 7 cases. The mean ± s.d. time for the development of subcutaneous emphysema following initial injury was 3.2 ± 0.84 days (range 2–4 days). Resolution of subcutaneous emphysema was not achieved until the treatment included packing the wound to stop it from acting as a one-way valve. Horses with a pneumothorax in respiratory distress were managed with thoracocentesis or placement of thoracic drains. Horses with a pneumothorax but without respiratory distress were treated with conservative management. All horses survived to discharge.

Introduction

Axillary wounds are common in horses and often result from traumatic insults that may include: running into a stationary object or being impaled by a sharp object, such as a fence post or stick; or kick injuries from other horses (Hassel 2007). At first, these wounds may appear to be relatively minor; however, they need to be monitored carefully as they can result in severe complications. The most common complication is the development of subcutaneous emphysema. Other complications include pneumomediastinum, pneumothorax and infection (Barber 2008). In the veterinary literature, there has been one case report detailing subcutaneous emphysema, pneumomediastinum and pneumothorax as a result of an axillary wound (Hance and Robertson 1992). There have been 2 additional retrospective studies that acknowledge axillary wounds as the cause of subcutaneous emphysema, pneumomediastinum and pneumothorax. The focus of one of these studies was on penetrating wounds of the chest (Laverty et al. 1996) while the other focused on the causes of pneumothorax in horses (Boy and Sweeney 2000). There have been no studies specifically aimed at investigating the clinical progression, treatment and outcome of axillary wounds in horses.

The purposes of the study reported here were to characterise the clinical progression of axillary wounds and their secondary complications, including subcutaneous emphysema, pneumomediastinum and pneumothorax, and to describe clinical signs, treatment, and outcome of a series of 7 horses with axillary wounds.

Materials and methods

Medical records from the Texas A&M University Veterinary Medical Teaching Hospital (TAMU VMTH) from August 2004 to May 2010 were reviewed to identify horses with a diagnosis of an axillary wound. Other criteria for selection included a concurrent diagnosis of subcutaneous emphysema, pneumomediastinum or pneumothorax. Case details, duration of injury before examination, clinical signs, radiographic findings, treatment, complications and outcome were studied. The outcome was considered successful if the horse was discharged from the hospital.

Results

Seven horses, age 8 months to 16 years, with a diagnosis of an axillary wound were identified. Details of the 7 horses are summarised in Table 1. The mean ± s.d. time between the occurrence of the axillary wound and presentation at the TAMU VMTH was 8.57 ± 1.4 days (range 5–12 days). On presentation, the temperature was recorded in 5 of the 7 cases. Only Case 6 had a temperature (38.7°C) that was out of reference range (rr 36.9–38.6°C). All cases except Case 3 and 6 had an elevated heart rate (rr 24–40 beats/min). The heart rate of Case 3 could not be determined due to the amount of subcutaneous emphysema and the heart rate of Case 6 was 30 beats/min. Cases 1, 2 and 4 had elevated respiratory rates (rr 12–20 breaths/min). In Cases 1, 3, 4 and 6 auscultation of the heart and lung sounds was performed. The heart and lung sounds were clear in all cases. Case 3 was discharged after 12 days with a diagnosis of pneumomediastinum and pneumothorax.

Four of the 7 horses developed subcutaneous emphysema. The time between the wound occurrence and the development of subcutaneous emphysema was able to be determined in 5 of the 7 cases (3.2 ± 0.84 days, range 2–4 days). In Cases 2 and 7, the development of subcutaneous emphysema was recorded as ‘progressive’. They were...
referred to the VMTH after the subcutaneous emphysema became 'extensive,' 7 and 10 days after initial occurrence of the wound, respectively.

Radiographs were taken in Cases 1, 2, 4, 5 and 6. Pneumomediastinum was diagnosed in Cases 1, 2 and 6 (Fig 2). Pneumomediastinum was suspected in Cases 4 and 5. A bilateral pneumothorax (Fig 3) was diagnosed in Cases 1, 2 and 4. Case 6 was diagnosed with a unilateral pneumothorax (Fig 4). All pneumomediastinum and pneumothorax were diagnosed on the day of admission.

All cases were initially treated by referring veterinarians. Treatment consisted of anti-inflammatory and antibiotics in all cases and Cases 2, 5 and 6 received a tetanus toxoid. In Case 1, the wound was left open and draining and the referring veterinarian performed fenestrations in the skin to relieve severe subcutaneous emphysema. In Case 2, the wound was lavaged, but additional treatment by the referring veterinarian was not recorded. In Case 3, the referring veterinarian sutured the wound at the time of injury. No complications were evident until 4 days after treatment when subcutaneous emphysema began to develop. In Case 4, the referring veterinarian stapled the edges of the wound, but left the central portion open to drain. In Case 5, the referring veterinarian sutured the wound and granulation tissue was present at the time of presentation. It was not recorded how the referring veterinarian treated the wound in Cases 6 and 7.

Treatment at the VMTH was similar across all cases. All wounds were initially cleaned, explored, packed and bandaged. Huck towel stents were used to maintain the position of the packing. Bandages were changed daily. In Cases 3 and 6, scarlet oil (a mixture of mineral oil, isopropyl alcohol [30%], methyl salicylate, benzyl alcohol [3%], pine oil, eucalyptus oil, parachlorometaxylenol and biebrich scarlet red), an agent used to stimulate granulation tissue formation, was used to soak the bandages before they were packed into the wound. In Case 2, silver sulphadiazine ointment was packed into the wound. Additional treatment to relieve subcutaneous emphysema was performed in Cases 2 and 3.

In Case 2, incisions were made lateral to the withers 3 days after presentation in order to allow air to escape from the subcutaneous space. In Case 3, 14 gauge hypodermic needles were inserted subcutaneously over the shoulders bilaterally in order to release air. All cases received broad spectrum antibiotics and nonsteroidal anti-inflammatory drugs (NSAIDs). The antibiotics that were used included trimethoprim sulpha, procaine penicillin G in combination with gentamicin and chloramphenicol. Phenylbutazone and flunixin meglumine were the NSAIDs chosen for pain management.

Pneumothorax present in Cases 1, 2 and 4 were treated by aspiration of the air from the pleural cavity. In Case 1, bilateral thoracic aspiration of air was performed with two 14 gauge 133 mm intravenous catheters inserted dorsally at the level of the ventral aspect of the tuber coxae at approximately the 14th intercostal space in both hemi-thoraces. Four days later, the mare’s respiratory rate and effort were increased and thoracocentesis was performed again. One week after presentation, additional radiographs were taken. Due to the continued presence of a bilateral pneumothorax, two 24 French thoracic drains with one-way valves attached were placed bilaterally at the dorsal aspect of the 14th intercostal space and left in place. Repeat radiographs 2 days after placement of the thoracic drains revealed resolution of the pneumothorax. The thoracic drains were removed after an additional 2 days. The skin incisions were closed with nonabsorbable suture material. In Case 2, size 28 thoracic drains were placed bilaterally in the caudodorsal thorax. The intercostal space was not specified. Suction was initially applied and then one-way valves were left in place. The thoracic drains were removed 4 days later and the skin incisions were closed with nonabsorbable suture material. In Case 4, bilateral thoracic drains were placed in the caudodorsal thorax on the day of admission and were removed one week later. The skin incisions were closed with nonabsorbable suture material. The size of the thoracic drains was not recorded. Pneumothorax was present in Case 6, but was not severe enough to warrant thoracocentesis.

Discussion

An important finding of this study is recognising that there is a repeatable association between equine axillary wounds and the development of secondary complications. These complications include the development of subcutaneous emphysema, pneumomediastinum and pneumothorax. Based on the results of this study, subcutaneous emphysema develops to a clinically significant extent approximately 3 days post injury and progresses extensively if the primary cause is not treated. Another important finding of this study is that optimal treatment of axillary wounds should include packing and sealing the wound with a sterile laparotomy sponge or gauze that is changed daily until healing by second intention occurs. Primary closure is insufficient to prevent secondary complications. Restriction of movement and close monitoring are necessary to limit the occurrence and severity of complications. Finally, it is an important finding that all patients survived to discharge.
When subcutaneous air dissects through the muscle layers and fascial planes into the mediastinum, pneumomediastinum ensues. Pneumomediastinum has been reported in cases of axillary wounds (Hance and Robertson 1992; Laverty et al. 1996). Pneumomediastinum is diagnosed based on radiographic evaluation. Diagnostic radiographic features of pneumomediastinum include delineation of the oesophagus, great vessels, cardiac borders and outer margins of the trachea (Hassel 2007). In the current study, 3 of 7 horses with an axillary wound had a definitively diagnosed pneumomediastinum. An additional 2 horses had a suspected pneumomediastinum based on radiographs. In Case 4, there was increased definition of the oesophagus and in Case 5 there was evidence of periaortic air. However, since additional radiographic features of pneumomediastinum were not pronounced in either case, a definitive diagnosis of pneumomediastinum was precluded. Additional support for a pneumomediastinum in Case 4 is that this horse had a pneumothorax. Since other causes of pneumothorax in horses, for example, thoracic trauma, pleuropneumonia, or diaphragmatic hæmía, were not present, this horse’s pneumothorax was probably secondary to a pneumomediastinum. Pneumomediastinum cannot be entirely
ruled out in the 2 cases in which it was not diagnosed because radiographic evaluation was not performed in these cases. Since not every case that suffers from an axillary wound has radiographic evaluation performed, a true incidence of pneumomediastinum resulting from an axillary wound and subsequent subcutaneous emphysema is difficult to determine. However, these data point to the conclusion that pneumomediastinum is a common complication of axillary wounds. If pneumomediastinum progresses, it can result in pneumothorax and specifically tension pneumothorax. Tension pneumothorax occurs when a flap of skin or soft tissue acts as a one-way valve, allowing air into the pleural cavity on inspiration but preventing its escape on expiration. This is a rapidly progressive form of pneumothorax that classically consists of progressive respiratory distress, tachycardia, hypotension and absent lung sounds. In Cases 1 and 4 and in the one published case report on axillary wounds and secondary pneumothorax, the respiratory rate dramatically increased as pneumothorax became severe. The delay in worsening of clinical signs of pneumothorax was associated with it probably being due to a tension pneumothorax where the development was insidious in onset (Hance and Robertson 1992). Pneumothorax can be diagnosed with radiographs, ultrasonography, auscultation (Boy and Sweeney 2000). In the current study, pneumothorax was diagnosed on radiographs in 4 of 7 cases, all of which had subcutaneous emphysema, and 3 of which had a definitive pneumomediastinum and one with a suspected pneumomediastinum. Pneumothorax in horses can be unilateral or bilateral (Boy and Sweeney 2000). The development of bilateral pneumothorax should be considered because the mediastinum of horses is generally described as incomplete, having small fenestrations in the caudal and ventral portions of it (Hassel 2007). Diagnostic radiographic features of bilateral pneumothorax include complete absence of pulmonary parenchyma and hyperlucency in the caudodorsal lung fields and retracted dorsal margins of both the right and left lung lobes (Hassel 2007). Diagnostic features of unilateral pneumothorax include retraction of one lung margin and visualisation of the vessels in the contralateral lung (Butler et al. 2008). Ultrasonographic examination is not useful in the presence of subcutaneous emphysema because the ultrasound waves do not penetrate through the air. Based on clinical signs and progression of the cases, it is unlikely that the 2 cases that were not radiographed had a pneumothorax, even though it cannot be definitively ruled out.

Initial management of axillary wounds can affect what complications may develop. In cases where the wounds are not fully sealed, air continues to enter the subcutaneous tissue and potentially the mediastinum and pleural space, resulting in pneumomediastinum and pneumothorax, respectively. Wounds that are left open to drain or are sutured and either do not granulate in fully or dehisce are likely to develop these consequences. Initial examination of an axillary wound should evaluate the direction and depth of the wound. Potential involvement of the elbow joint, cranial mediastinum and cranial thorax should be evaluated. Once the extent of the wound has been determined, it should be cleaned, debrided and lavaged. The overuse of high-pressure lavage should be avoided to prevent further dissemination of contaminants into deep fascial planes (Barber 2008). After the wound is cleaned, it should be packed and sealed with a sterile laparotomy sponge or gauze. A stent and thoracic bandage should be placed to hold the packing in place. The sterile dressing should be changed every 24–48 h. Resolution of subcutaneous emphysema and pneumomediastinum were not achieved in the reported series until the treatment included packing the wound to stop it from acting as a one-way valve. To help avoid progressive accumulation of air within the soft tissues, limiting movement is indicated. Cross-tying the horse in a stall is helpful in limiting movement. These data suggest that optimal therapy for an axillary wound is to clean and debride it, pack it with a sterile dressing and allow secondary healing by granulation tissue (Fig 5). Once the source of subcutaneous emphysema has been addressed, residual subcutaneous emphysema is usually self-limiting and rarely requires additional treatment. However, if the subcutaneous emphysema is extensive, and the risk of complications from the amount of subcutaneous emphysema is high, small intravenous catheters may be inserted subcutaneously in order to aspirate some of the air (Marble et al. 1996). Examples of complications that have been reported in addition to pneumomediastinum and pneumothorax include retropharyngeal emphysema with acute respiratory distress and inadequate cardiac output attributable to decreased venous return (Marble et al. 1996). Additionally, the subcutaneous emphysema has an insulation-like effect. At warmer times of the year or in warm climates, horses suffering from axillary wounds should be placed in climate controlled environments to avoid the potential for serious hyperthermia. Primary hyperthermia was not seen in any of these patients but has been seen in the authors’ previous experience. Inserting subcutaneous catheters is not without its own potential complications; therefore this technique should only be done when deemed necessary to prevent complications from subcutaneous emphysema. Such complications include ischaemia of overlying skin and infection from bacteria migrating along the catheter. Sterile techniques and close monitoring of catheters should be used (Barber 2008). In this study, the cases treated with subcutaneous catheters did not develop ischaemia or infections.
Horses should be kept on broad-spectrum antibiotics, NSAIDs, and given a tetanus toxoid vaccination. If additional analgesic medications are needed in addition to NSAIDs, butorphanol may be administered. As in small animal species (Biller and Larson 2010), pneumomediastinum in the horse is often clinically silent and there is no specific treatment beyond treatment of the underlying cause. Pneumomediastinum as a result of tracheal perforation is reported to have resolved on its own and without complications within 7–10 days (Caron and Townsend 1984; Fubini et al. 1985). Cases should be monitored for complications including pneumonia, impairment of venous return to the heart and rupture of the mediastinal pleura, which has been reported in man but is yet to be reported in horses (Evans and Smallidon 1950).

Delays in the development of pneumothorax are commonly encountered; therefore, serial evaluations should be performed to identify progressive changes in pulmonary function. Pneumothorax that is causing respiratory distress or is severe on radiographs should be treated. Aspiration of air from a dorsally located thoracic drain in the 12th to 14th intercostal space is therapeutic for pneumothorax. The thoracic drain is placed midway between 2 adjacent ribs at the level of the ventral aspect of the tuber coxae; alternatively, placement of thoracic drain can be determined by placing radiopaque markers on the skin while taking radiographs. Intravenous catheters (14 gauge, 133 mm) may also be used to aspirate air from the thorax. The decision to use a catheter vs. a thoracic drain is based on the clinician’s expectation of the pneumothorax resolution. A catheter is appropriate if the clinician expects the pneumothorax to resolve after aspirating the air once, but if not, a thoracic drain is more appropriate because it can be left in place and used for repeat or continuous aspirations. Furthermore, if the pneumothorax does not resolve with passive aspiration of air through a thoracic drain, suction may be applied. Removal of the thoracic drain is based on the clinical condition of the horse and radiographic evidence of pneumothorax resolution. Horses in this study and in the few case reports in the literature responded favourably to treatment that included thoracocentesis and placement of thoracic drains. Pneumothorax may be treated conservatively if the horse is not showing signs of respiratory distress (Laverty et al. 1996) and there is mild pneumothorax on radiographic evaluation, which was also documented in this study (Case 6).

In order to enhance the understanding of this condition, it would be beneficial to determine the incidence of axillary wounds that do not develop subcutaneous emphysema, pneumomediastinum or pneumothorax. All of the cases that presented to the TAMU VMTH had a degree of subcutaneous emphysema and this clinical finding was often referred to as a reason for referral. Therefore, these cases cannot be used to calculate a true incidence of the occurrence of complications secondary to an axillary wound.

Authors’ declaration of interests

No conflicts of interest have been declared.

References


