



## SUBCUTANEOUS EMPHYSEMA IN EQUINE DUE TO DIFFERENT ETIOLOGY WITH SUCCESSFUL TREATMENT PROTOCOLS

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### ABSTRACT

Three equine cases (a mare and 2 stallions) suffering from different degrees of subcutaneous (SC) emphysema were admitted to the Veterinary Teaching Hospital from July 2009 to August 2010. The common clinical signs included rapid respiration, dyspnea, stiffness and reluctance to move. Palpation revealed that the swelling was soft, painless, and crepitant. Clinical examination of the affected animals revealed the presence of internal wounds due to tracheal perforation in case 1 and external wound at the axillary and neck regions in cases 2 and 3, respectively. Ultrasonographic examination demonstrated the place of the tracheal perforation in case 1 and the SC infiltration of gas in cases 2 and 3. Hematological examination revealed leucocytosis, neutrophilia and lymphocytopenia in the mare affected with tracheal perforation, but no changes found in the other cases. Cases no 2 and 3 were resolved within 7-10 days after daily intramuscular administration of penicillin (20,000 iu/kg BW) and a single prophylactic dose (3000 iu/animal) of anti-tetanic serum. However, the mare affected with tracheal perforation required, in addition to the medicinal treatment, multiple skin incisions at different body areas to squeeze out the SC air and recovery extended to day 21. It was concluded that SC emphysema could occur in equine secondary to obvious external wounds or internal invisible wounds. The SC emphysema was successfully treated by medicinal and surgical intervention to avoid the fatal complications (pneumothorax and pulmonary emphysema). To the best of our knowledge, this is the first record of SC emphysema with different etiology.

Key words: Equine –SC Emphysema- tracheal perforation– treatment

### INTRODUCTION

SC Emphysema is relatively uncommon in large animal species<sup>1</sup>. Several causes of SC emphysema have been identified in both large and small animal species, including accidental and intentional skin wounds, thoracic trauma with lung perforation, cellulitis caused by gas-forming bacteria and as a sequel to pulmonary emphysema and perforating injuries of the

abdominal viscera<sup>2</sup>. SC emphysema is also a feature of tracheal perforation<sup>3</sup> and esophageal rupture<sup>4</sup>. The disease was also observed after endotracheal intubation during surgical interference in cats<sup>5</sup>. In the horse, penetrating wounds of the axilla commonly result in widespread SC emphysema<sup>6,23</sup>. SC emphysema was also detected most likely secondary to the tracheotomy<sup>7,8</sup>. More recently, extensive SC

emphysema has been observed as a sequelae to acute pulmonary emphysema in buffalos<sup>9</sup>.

Although SC emphysema is usually regarded as a temporary condition, it can lead to serious complications such as pneumothorax that is a life-threatening condition<sup>6</sup>. Therefore, horses with SC emphysema should be kept in confinement and monitored for the development of pneumothorax. Primary SC emphysema may lead to other serious conditions, such as pleural rupture and dyspnea.

We monitored the occurrence of SC emphysema throughout one year (July 2009 to Aug. 2010) at the Veterinary Teaching Hospital at the faculty of Veterinary Medicine, Benha University. We recorded three equine cases during this period to which we conducted a thorough clinical examination, recorded abnormal findings, and determined the haematological changes. Diagnosis was confirmed by using ultrasonography. We also described the result of treatment protocols for the affected cases.

## **MATERIALS AND METHODS**

### **Animals:**

Three equine cases with SC emphysema were admitted to the veterinary teaching hospital at the Faculty of Veterinary Medicine, Benha University from July 2009 to August 2010. The first case was a 3-year old mare suffered from generalized SC emphysema with history of non-penetrating trauma at the cervical tracheal region a week before. The second case was a 5-years old horse suffering from generalized SC emphysema with obvious wound at the axillary region. The third case was a 2-year old horse suffering from SC emphysema at the head, neck, shoulder and thorax with history of skin wound at the base of the neck. At the time of admission, the animals were subjected to general clinical examination and the pulse rate, respiratory rate and temperature were determined as previously described<sup>2</sup>.

### **Haematological changes**

Blood samples were collected from the jugular vein of affected animals into 4-ml Vacuette EDTA tubes (Greiner Bio-one GmbH, Kremsmünster, Austria). The samples were used to determine the total and differential white blood cells (WBCs), total red blood cells (RBCs)

count, packed cell volume (PCV%) and haemoglobin concentration (Hb)<sup>10</sup>.

### **Ultrasonographic examination**

Ultrasonographic examination was conducted to demonstrate the area of tracheal perforation in case 1 and the SC accumulation of gas in case 2 and 4. The area of trachea with tracheal wound (case 1) and the skin areas examined in case 2 and 3 were clipped cleaned and a coupling gel was applied. These areas were examined for ultrasonographic finding using a linear transducer (7.5 MHz) as previously described<sup>11</sup>.

### **Treatment protocols**

Case 1 with tracheal perforation and signs of dyspnea received a combination of 20,000 IU/kg procaine penicillin (daily dose) and 3000 iu of antitetanic serum (single dose) that were injected intramuscular (i.m.). In addition, multiple skin incisions of a proximately 10-cm length were applied on head, neck, thorax and abdomen of affected mare (case 1) to squeeze the hair out as previously demonstrated<sup>2</sup>. The skin incision were then disinfected with antiseptic solution (Betadine) and covered with gauze to prevent secondary bacterial infection. Skin squeezing was applied daily for 7 days.

Case 2 with axillary wound received i.m. daily dose (20,000 IU/kg) of procaine penicillin plus a single i.m. injection of antitetanic serum (3000 iu). In addition, movement was restricted by cross tying aiming to reduce gas entrance and minimize spread of air to SC tissue through axillary lesion.

Case 3 with neck wound received i.m. daily dose (20,000 IU/kg) of procaine penicillin plus a single i.m. injection of antitetanic serum (3000 iu).

## **RESULTS**

### **Clinical signs**

Case 1: The head and neck of the affected mare were diffusely swollen, most noticeably over both sides of the face. Palpation of the head and neck revealed non-painful, soft, easily indented, mobile and crepitant swelling; all consistent with SC emphysema. In addition to the head and neck, the emphysema extended ventrally to the level of both carpi, bilaterally

over the shoulders and thorax and as far caudal as the mammary gland (Figure 1). During examination, the affected horse was in good physical condition and was alert and responsive to manipulation. However, the animal was reluctant to walk and with minimal flexion of joint. Close examination of the upper respiratory tract revealed bilateral mucopurulent nasal discharge. There was no obvious lesion on the head or neck, although history revealed a trauma at the cervical tracheal region

Case 2: the affected horse had generalized SC emphysema at the head, neck, thorax, abdomen and back (Figure 3). There was a wound at the axillary region of 5-10 cm in diameter (Figure 4). The horse was suffering from depression and inappetance. Respiratory signs include increase in the respiratory rate with dilatation of nostrils. The affected horse had stiff gait with reluctance to move.

Case 3: The affected horse had SC emphysema at the head, neck, shoulder and thorax (Figure 5). Skin wound of about 3-5 cm in diameter was observed at the base of the neck. The horse appeared dull and depressed with increased respiratory rate and widening of nostrils.

#### **Clinical examination**

The rectal temperature, the pulse and respiratory rates were elevated in affected mare ad horse No. 3 compared to reference values. On the other hand, case 2 had increased respiratory rates only and the temperature and pulse rate were normal (Table 1).

#### **Haematology**

There was an increase in the total leucocytic count with neutrophilia and lymphopenia in affected mare (case1) as compared to reference values (Table 2). On the other hands, the other 2 stallions did not have a deviation from normal values. The RBCs count, the Hb content and PCV% of the three affected cases were within the reference values.

#### **Ultrasonography**

Ultrasonographic examination of the cervical trachea of case 1 (mare) showed a discontinuation (opening) of the tracheal wall which may occur as a result of external trauma with escape of the air to the SC tissue (Figure 6). After 7 days of treatment with penicillin and

antitetanic serum, the ultrasonographic examination revealed hyperechoic fibrous tissue formation at the site of tracheal injury with reduction of the amount of air escaped to SC tissues (Figure 7). The hyperechoic signals in cases 2 and 3 demonstrated the accumulation of air in the SC tissues (Figures 8 and 9).

#### **Treatment**

The affected animals were successfully treated with i.m injection of penicillin (20,000 iu/kg BW) and a single prophylactic dose of anti-tetanic serum (3000 iu/ animal). However, the mare affected with tracheal perforation required, in addition to the medicinal treatment, multiple skin incisions at different body areas to squeeze out the SC air. The SC swelling was restricted to the head and neck region within 8 days of treatment and complete recovery of SC emphysema occurred on day 21 after start of therapy (Figure 2).

### **DISCUSSION**

SC emphysema occurs in diseases in which there is a leakage of air from the lungs or airways into the SC space<sup>2</sup>. The etiology of SC emphysema is miscellaneous. It could results from air entering through a cutaneous wound made surgically or accidentally, air entering tissues through a discontinuity in the respiratory tract lining, e.g. in fracture of nasal bones; trauma to pharyngeal, laryngeal, tracheal mucosa caused by external or internal trauma as in lung puncture by a fractured rib; extension from a pulmonary emphysema and gas gangrene infection<sup>1,2,7</sup>. The disease can occurs also as a complication to tracheotomy, oesophageal perforation and after respiratory endoscopy<sup>12</sup>. All of the above mentioned types of SC emphysema occur as a secondary condition. However, SC emphysema was diagnosed as a primary condition in neonatal foal with respiratory abnormalities without any skin lesion<sup>13</sup>.

Tracheal traumas range from small puncture wounds to complete tracheal rupture<sup>14,15</sup> and can be induced by external injuries with or without disruption of the skin or by an internal insult, i.e., caused by foreign bodies. A special kind of trauma is the "contre coup" phenomenon, which occurs by a blow with a blunt object, leads to a sudden and severe

compression of the tracheal rings. In these cases the tip of the dorsal ends of the tracheal rings perforates the fibroelastic membrane in the airway. In such a blunt-object injury, the diagnosis of tracheal trauma may not be recognized until SC emphysema develops. Small tears can be treated conservatively while large tears should be managed surgically<sup>14,16</sup>.

We demonstrated 3 cases of SC emphysema in horses admitted to the veterinary teaching hospital with three different types of wounds. The first case was a mare with generalized SC emphysema including head, neck, thorax, abdomen and legs without obvious external wounds. However, the case history revealed exposure of the affected mare to external trauma. Since ultrasonography has been approved to assess the diseases and abnormalities of trachea<sup>17</sup>, it was used as confirmatory tool to locate and assess the tracheal wound. The ultrasound examination revealed a perforation in the tracheal ring near the base of the neck, which suggests exposure of the affected mare to external trauma. Extensive SC emphysema was demonstrated due to tracheal perforation in Quarterhorse mare with absence of a penetrating wound of the skin<sup>1</sup>. In addition, SC emphysema was documented in 12 horses out of 15 horses exposed to thoracic trauma<sup>18</sup>. Moreover, a filly developed SC emphysema and pneumothorax after an emergency tracheotomy was performed to alleviate dyspnoea that developed after surgery on the paranasal sinuses<sup>7</sup>. A case of SC emphysema reported in upper part of the neck and guttural pouches in a 16-year-old Thoroughbred gelding with a 1 cm longitudinal perforation of the dorsal tracheal membrane in the proximal cervical region<sup>19</sup>. Other studies demonstrated extensive SC emphysema in the head, neck and thorax region in a stallion due to tracheal perforation causing by kicking by another horse 2 days previously<sup>20</sup>. Moreover, it was also observed that SC emphysema in thoroughbred mare occurred secondary to tracheal intubation with perforation of trachea. The mechanism by which the air accumulates in the SC tissue following tracheal wound is well-described<sup>20</sup>. Additionally, SC emphysema and pneumothorax were demonstrated after

tracheotomy during excision of a cyst in right paranasal sinus<sup>7</sup>. They suggested that the powerful inspiratory movements caused by respiratory obstruction by the cyst, result in such high negative intrathoracic pressures that air is pulled through the cutaneous incision and cervical fascia into the mediastinum.

Treatment of SC emphysema is clinically important because the disease can lead to a life-threatening pneumothorax if the pressure is great enough to migrate through the mediastinum and into the pleural cavity<sup>6</sup>. Therefore, the affected mare was treated with penicillin and anti-tetanic serum as previously recommended<sup>1,21</sup>. Since the mare was suffering from signs of dyspnea, we additionally made superficial skin incisions of 10-cm length at different body areas to squeeze the air and release the intrathoracic pressure as previously described<sup>2</sup>. The SC emphysema was gradually resolved when the swelling was restrained to neck region after 8 days then the mare retains normal condition within 3 weeks of treatment. Ultrasonographic examination was used to monitor the healing process and revealed closure of the tracheal perforation by fibrin deposition. It has been demonstrated that fibrin seals form within 24 to 48 hours in small perforations<sup>16</sup>, but larger perforations involving herniation of soft tissue into the tracheal lumen may need suturing<sup>15</sup>. In our case, we did not interfere by surgery and the tracheal perforation was resolved spontaneously within 3 weeks of medicinal therapy and cutaneous incisions.

The increase in WBCs count with absolute neutrophilia and lymphocytopenia in the affected mare was comparable to those recorded by **Caron and Townsend**<sup>1</sup>. This result together with occurrence of fever and rapid pulse and respiration suggest that SC emphysema caused by tracheal perforation induced systemic changes, presumably because of the secondary bacterial infection.

The second case was suffering from generalized SC emphysema with old axillary wound. This finding coincided with those previously reported<sup>22</sup>, as SC emphysema can result from penetrating wounds of the axilla. In addition, some authors<sup>6</sup> examined a 5-year-old Thoroughbred gelding because of a small

axillary wound sustained 5 days earlier and had resulted in extensive SC emphysema. It has been demonstrated that horses with large axillary wounds should be closely observed for the development of SC emphysema and impending pneumothorax. The wounds of this area often expand deep into the axilla along the thoracic wall and tend to aspirate air into the wound and deeper structures<sup>23</sup>. To reduce the potential for SC emphysema, the horse was confined to a stall and cross tied to minimize movement of the limb as previously recommended<sup>6</sup>. This case was successfully responded to the treatment with penicillin and antitetanic serum with complete recovery of SC emphysema within a week of treatment.

The third case suffered from SC emphysema at the neck and thorax area due to a wound at the base of the neck. Similar observation was also recorded by other authors<sup>24</sup>. There was no change in the temp, pulse and respiratory rates, and the haematological parameters from reference values. The Ultrasonography demonstrated the hyperechoic signal representing air infiltration in the SC tissue of neck, thorax and abdomen. The exact cause of SC emphysema associated with neck wound is not well-known. However, *Clostridium perfringens* (genotype A) was isolated as gas-forming microorganisms from neck wound of gelding with SC emphysema<sup>24</sup>. This case was also successfully treated with penicillin and antitetanic serum.

In conclusion, the SC emphysema in horses may occur as a secondary disease to tracheal perforation without penetrating skin lesion. It can also occur secondary to untreated wounds, especially at the axilla and at the base of the neck with probable infection with gas-forming microorganisms. The prognosis of the condition is usually good as long as treatment starts immediately by daily i.m. injection of penicillin and antitetanic serum. Successful treatment is requires manual squeezing out the SC air through multiple skin incisions, otherwise serious complication by pneumothorax may follow. Ultrasonography can be used as a complementary tool for determination of the etiology and following up the recovery of tracheal perforation,

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**Table 1. The values of temp, pulse and respiratory rates in comparison to the reference range.**

<b>Cases Parameters</b>	<b>Reference range #</b>	<b>Case 1 (mare)</b>	<b>Case 2 (horse)</b>	<b>Case 3 (horse)</b>
Temp (°C)	36.5- 38.5	39.8	38.1	40.1
Pulse rate/min	28-36	66	32	55
Respiratory rate /min	6-18	33	25	28

# Reference range according to Caron and Townsend (1984)

**Table 2. Haematological changes in equine cases affected with SC emphysema**

<b>Cases Parameters</b>	<b>Reference range<sup>#</sup></b>	<b>Case 1 (mare)</b>	<b>Case 2 (horse)</b>	<b>Case 3 (horse)</b>
RBCs ul/10 <sup>6</sup>	6.9-10.7	8.5	7.2	7.6
HB (gm/dl)	11.3-17.9	12.3	11.8	13.5
PCV %	31-48	35	33	32
Total leucocytic count (10 <sup>3</sup> /ul)	4.9-10.0	14.1	5.6	8.9
Neutrophils (10 <sup>3</sup> / ul)	2.0-5.5	11.9	4.6	5.2
Monocytes (10 <sup>3</sup> /ul)	0-0.6	0.4	0.3	0.2
Lymphocytes (10 <sup>3</sup> /ul)	1.6-4.6	0.8	1.8	1.2
Basophils (10 <sup>3</sup> /ul)	0-0.1	0.06	0.06	0.04
Eosinophils (10 <sup>3</sup> /ul)	0-0.6	0.03	0.01	0.02

# Reference range according to Caron and Townsend (1984)



Figure 1a: A mare (case 1 before treatment) showing diffuse subcutaneous emphysema. Notice the abduction of forelimbs and the stiff attitude. The head collar is pressed out by the swollen emphysematous skin at the head (arrow) (side view)



Figure 1b: The same mare (case 1 before treatment) showing diffuse subcutaneous emphysema and swelling of the face (front view). Notice the bilateral mucopurulent nasal discharge.



Figure 2a: The same mare (case 1) after treatment. The emphysema is obviously relieved at the head and neck regions (side view)



Figure 2b: The same mare (case 1) after treatment. The emphysema is obviously relieved at the head and neck regions (front view). Notice the area of skin incisions (arrows)



Figure 3: A horse (case 2) showing generalized subcutaneous emphysema. The swelling is crepitant and pit under pressure at the neck region.



Figure 4: A horse (case 2) showing penetrating wound at the axillary region (arrow) with evident SC emphysema at shoulder, thorax and abdomen



Figure 5: A horse (case 3) showing subcutaneous emphysema at the thorax, shoulder, legs and abdomen. Notice the wound at the base of the neck (arrow)

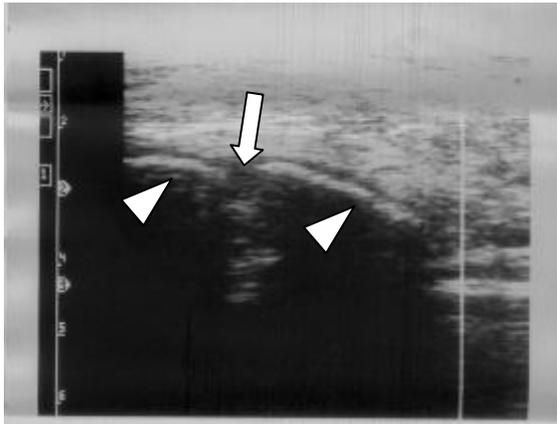


Figure 6: Ultrasonography of the trachea of case 1 taken in sagittal plane showing the site of tracheal perforation with discontinuation of tracheal cartilages (arrow) and escape of air to SC tissue. The arrow heads point to the normal tracheal cartilages.

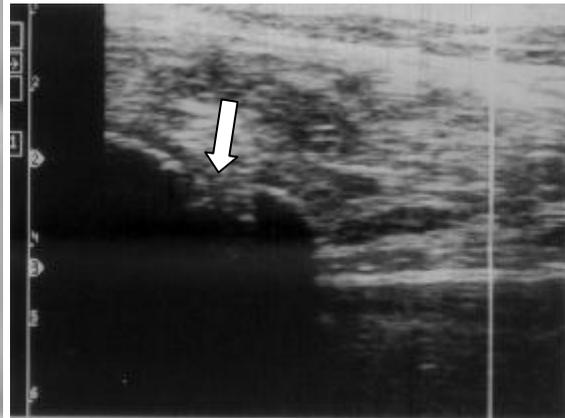


Figure 7: Ultrasonography of the trachea of case 1 capture in sagittal plane showing the start of healing of tracheal wound after 7 days of treatment with penicillin.



Figure 8: Ultrasonography of skin of case no 2 showing excessive accumulation of air (hyperechoic) in SC tissues of thorax.



9 Figure 9: Ultrasonography of skin of case no 3 showing hyperechoic areas representing accumulation of air in SC tissues of neck.

### الانتفاخ تحت الجلد فى الخيول لأسباب مختلفة مع أساليب علاجية ناجحة

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تم استقبال ثلاث حالات من الخيول (فرسة و ٢ حصان) يعانون من درجات مختلفة من انتفاخ تحت الجلد بالمستشفى التعليمي البيطري بكلية الطب البيطرى جامعة بنها من يوليو ٢٠٠٩ الى أغسطس ٢٠١٠. تم فحص الحيوانات إكلينيكيًا وفحص معدل التنفس والنبض ودرجة الحرارة. واشتملت العلامات المرضية على سرعة وضيق فى التنفس وتكتيف وعدم الرغبة فى التحرك و تورم فى منطقة الرأس والرقبة و تم جمع عينات دم لمعرفة التغيرات الدموية. كشفت دراسة الحيوانات المصابة عن وجود جروح داخلية بسبب ثقب القصبه الهوائية فى الحالة الاولى (فرسة ١) وجروح خارجية تحت الإبط ومنطقة العنق فى الحصان رقم ٢ و ٣ على التوالي. استخدم الفحص بالأشعة فوق الصوتية لتحديد مكان الثقب بالقصبه الهوائية فى حالة ١ و للتدليل على تسلل الهواء تحت الجلد فى الحالات ٢ و ٣. كشف فحص الدم زيادة فى كرات الدم البيضاء والمتعادلة ونقص فى الخلايا الليمفاوية فى الفرسة التى تعانى من ثقب القصبه الهوائية مقارنة مع المعدل الطبيعي، فى حين أن الحالات الأخرى لم تظهر تغيرات فى الدم. تم علاج الحالات رقم ٢ و ٣ فى غضون ٧-١٠ أيام بعد حقن البنسلين فى العضل يوميا (٢٠٠٠٠ وحدة دولية / كجم من وزن الجسم) ، وجرعة واحدة وقائية (٣٠٠٠ وحدة دولية / الحيوان) من المصل المضاد لمرض الكزاز. فى الفرسة المصابة بثقب بالقصبه الهوائية تم عمل شقوق متعددة فى الجلد فى مناطق الجسم المختلفة باستخدام المشروط لخراج الهواء وتم الشفاء تماما بعد ٢١ يوما. نستخلص من النتائج ان الانتفاخ الهوائى تحت الجلد يمكن أن يحدث فى الخيول نتيجة لجروح خارجية واضحة أو جروح داخلية غير ظاهرة. يمكن ان يتم علاج هذه الحالات عن طريق العلاج الطبى و التدخل الجراحي لتجنب مضاعفات مميتة مثل استرواح الصدر والنفخ الرئوي. إلى حد علمنا هذا هو السجل الأول عن مجموعة من الحالات المصابة بانتفاخ هوائى تحت الجلد فى الخيول لأسباب مختلفة فى مصر.