An Unusual Pattern Of Post-Traumatic Subcutaneous Emphysema Of The Neck, Chest And Abdominal Wall

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Abstract
Motor vehicle accidents are a major health concern in both developed and developing countries. These result in varying degrees of morbidity and even death. There are many causes of subcutaneous emphysema. Most cases of subcutaneous emphysema encountered in clinical practice are iatrogenic. These are usually secondary to procedures. Traumatic causes as a result of blunt or penetrating injuries is a known aetiology. An unusual case of massive subcutaneous emphysema involving the neck, chest, and abdominal wall following traumatic rib fracture, with associated pneumothorax, pneumomediastinum, and prevertebral soft tissue air, is presented. Chest x-ray examination alone may not be sufficient in investigating these patients, as other associated conditions may not be shown with this imaging modality. The importance of computed tomography (CT) in evaluating this condition is highlighted. The prompt CT examination established the extent of the soft tissue air and the other associated abnormalities; and this contributed remarkably to the favourable outcome in this case presented.

INTRODUCTION
Subcutaneous emphysema can be caused by a variety of conditions. These include high-pressure water injury to the hand [1], ulcerative colitis [2], and perforated diverticulitis [3]. It may also be iatrogenic following procedures like colonoscopy [4], colectomy [5], endoscopic retrograde cholangiopancreatography (ERCP) [6], thyroidectomy [7], tonsillectomy [8], continuous positive airways pressure (CPAP) ventilation [9], and ventriculopleural shunt [10]. This may be associated with pneumomediastinum. Pneumomediastinum presents with subcutaneous emphysema in 70% to 90% of cases [11]. Blunt or penetrating chest injuries with rib fractures is a traumatic cause of air in the subcutaneous tissues [12]. A case of massive subcutaneous emphysema from post-traumatic rib fractures is presented, which involved the neck, chest, and abdominal wall. This case is reported for two reasons. Firstly, there are reported cases of post-traumatic subcutaneous emphysema in the medical literature, but there are few cases as extensive as presented by this patient, who also had pneumothorax and pneumomediastinum. Secondly, no overt pneumothorax was shown on the chest radiograph, but this was well demonstrated on computed tomography (CT), which also outlined the associated pneumomediastinum. These associated findings are valuable in the management; and this illustrates the importance of further imaging with CT in patients with rib fractures and subcutaneous emphysema.

CASE REPORT
Mr TK is a 45 year-old man who was the driver of a salon car involved in a motor vehicle accident. The car was said to have somersaulted. There was no loss of consciousness. He was immediately taken to the hospital, where he was reviewed by the Casualty Officer. His complaints were chest pain which was worsened by breathing, and abdominal pain. His vital signs were pulse rate 110 beats/minute, respiratory rate 22 breaths/minute, blood pressure 138/84 mmHg, and oxygen saturation 96%. There was mild respiratory distress, widespread tenderness and crepitus of the neck and anterior chest wall, with a positive Hamman sign. The abdomen was moderately tender all over, but there was no rebound tenderness or guarding. The x-ray examination of the cervical spine showed no spinal injury. The brain computed tomography (CT) scan was normal. The chest radiograph revealed multiple fractures of the right ribs, subcutaneous emphysema of the neck and chest wall, intramuscular emphysema with the fibres of the pectoralis major muscle well outlined by air. The fibres of the muscles of the posterior axillary wall were also outlined by soft tissue air. The right costophrenic sulcus was blunted, in keeping with haemothorax. No overt pneumothorax was shown on the chest radiograph (Figures 1-3). The CT of the chest and
abdomen showed multiple rib fractures, subcutaneous emphysema of the neck, chest and abdominal wall, right haemothorax, right pneumothorax, and pneumomediastinum. Air was also seen in the prevertebral soft tissue around the descending thoracic aorta. There was a laceration in the spleen. The liver and both kidneys were normal, with no evidence of haemoperitoneum (Figures 4-11). He had chest tube insertion for his right haemothorax and pneumothorax before positive pressure ventilation. This chest tube insertion was both therapeutic and precautionary prior to abdominal surgery (which required intubation with positive pressure ventilation, to avert worsening of the pneumothorax and subcutaneous emphysema). He had an emergency abdominal surgery with suturing of the splenic laceration. The widespread subcutaneous emphysema and pneumomediastinum resolved with conservative management. He did well on analgesics and was discharged home after two weeks of hospital admission.

Figure 1
Figure 1: Posteroanterior chest radiograph showing multiple right rib fractures (down arrow), subcutaneous emphysema (left arrow) and blunted right costophrenic sulcus (up arrow).

Figure 2
Figure 2: Posteroanterior chest radiograph showing air outlining the fibres of the pectoralis major muscle (down arrows). Air is also seen in the soft tissues of the lower neck (up arrow).
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**Figure 3**
Figure 3: Posteroanterior chest radiograph showing air outlining the fibres of muscles of the posterior axillary wall (arrows).

**Figure 4**
Figure 4: Axial contrast-enhanced computed tomography (CECT) of the chest showing air in the muscles of the posterior chest wall (arrows).

**Figure 5**
Figure 5: Axial CECT of the chest showing air in the muscles of the anterior chest wall (arrows).

**Figure 6**
Figure 6: Axial CECT of the chest showing pneumothorax (up arrow) and pneumomediastinum (right arrow).
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Figure 7
Figure 7: Axial CECT of the chest showing pneumothorax (up arrow), pneumomediastinum (down arrow), and air separating the fibres of pectoralis major muscle (left arrow).

Figure 9
Figure 9: Axial CECT of the chest showing pneumothorax (up arrow), air in the lateral chest wall (left arrow), posterior chest wall (down arrow), and prevertebral air (right arrow).

Figure 8
Figure 8: Axial CECT of the chest showing pneumothorax (up arrow) and air in the lateral chest wall (left arrow).

Figure 10
Figure 10: Axial CECT of the chest showing pneumothorax (up arrow), haemothorax (down arrow), air in the posterior chest wall (left arrow), and prevertebral air (right arrow).
DISCUSSION

The pathophysiology of free air in the soft tissues has been well described in the literature. This sequence of events is known as the Macklin effect. It involves firstly alveolar rupture; secondly dissection of air along the bronchovascular sheath and; thirdly free air reaching the mediastinum, which may then track to the pleural, peritoneal, or pericardial spaces, and also to the fascial planes of the neck and chest wall resulting in subcutaneous emphysema [12]. Regardless of the cause of the free air in the soft tissues, this is the general sequence of events. It is not a surprise therefore to have free air in multiple soft tissue planes, as presented by this patient. Following their experience of subcutaneous emphysema of the neck after colectomy in a patient, Koop K and colleagues postulated that the borders between the mediastinum, pleural, and abdominal cavity are not always air tight. They described subcutaneous emphysema as a symptom of serious underlying causes like pneumothorax, trachea, and oesophageal injuries [5]. It is these underlying causes of subcutaneous emphysema that may be life threatening if not promptly diagnosed and managed, as further demonstrated in the management of the patient presented.

Pneumothorax is usually seen at the apex in an erect chest radiograph. It is possible that the pneumothorax was obscured on the chest film by the extensive subcutaneous emphysema in this patient. The absence of overt pneumothorax on chest radiograph in a patient with subcutaneous emphysema should not exclude the need for surgical decompression if required by the patient’s condition [12]. The right hemidiaphragm was not depressed and there was no mediastinal shift in the patient presented, thus precluding tension pneumothorax. The extent of free air was demonstrated on the CT examination of the patient. Although this patient required no surgical decompression, but the knowledge of the presence or absence of pneumothorax was also important in the management of the patient. A chest tube had to be inserted in this patient with pneumothorax associated with subcutaneous emphysema before intubation with positive pressure ventilation as a precautionary measure to avert catastrophic worsening of the condition. This may arise as a precarious vicious cycle of hyperinflation of the subcutaneous tissues and the iatrogenic establishment of a tension pneumothorax [12]. The patient was successfully managed conservatively. Some other patients may require surgical drains to decompress the emphysema [13]. The patient did not require surgical decompression despite the extensive nature of the emphysema, probably because a prompt diagnosis was established with the CT examination, and an early and appropriate treatment was instituted. Furthermore, the underlying causes of the subcutaneous emphysema were promptly addressed in the course of the management of this patient.

Mechanical ventilation in itself can cause massive subcutaneous emphysema. This was not the case in this patient presented, because he had radiological evaluation (which confirmed massive subcutaneous emphysema) prior to mechanical ventilation.

CONCLUSION

Massive subcutaneous emphysema is a relatively common complication following several invasive procedures. However the extensive involvement of the neck, chest and abdominal wall as presented in this patient following rib fracture, with the associated pneumothorax, pneumomediastinum and prevertebral soft tissue air, is rare. Early CT examination confirmed the extent of the soft tissue air and the other associated abnormalities; and this contributed significantly to the favourable outcome in this case. Subcutaneous emphysema should be seen as a symptom of more serious underlying causes like pneumothorax and pneumomediastinum, and should be addressed accordingly.

References

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