Widespread subcutaneous emphysema and barotrauma resulting from high pressure gas injection

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Abstract

Widespread subcutaneous emphysema is an unusual emergency presentation. We present a case of accidental high pressure insufflation, the pathophysiology and subsequent medical management in the acute setting. Such presentations are rare but dramatic and can have important life-threatening consequences that require immediate treatment.

Subcutaneous emphysema from work-related or iatrogenic high pressure gas injection can be a life-threatening condition. High pressure insufflation causing widespread subcutaneous emphysema has been described in previous case reports, and when the gas is under sufficient pressure can result in widespread dissipation of gas irrespective of the initial injection site.

Case report

We present an otherwise fit and well 49-year-old male truck driver, who fell 1 metre from the plate between the cab of his truck and its semi-trailer. His foot slipped from the plate and, as he fell, he broke the hose off a brass nipple connected to the compressed air reservoir powering the truck's brakes and punctured the subcutaneous tissue on the left posterior thigh (below the buttock crease) with an 8 cm outlet valve from the compressed air tank on the side of his truck. He was found approximately 3 minutes later semiconscious, having experienced continuous insufflation of compressed air through the open valve.

Hand brakes are activated from large trucks when stationary and kept locked on by compressed air held in a tank in an air-over-hydraulic brake system. This air is kept at a pressure within the tank of 120 psi (pounds per square inch; 827 Kilopascals, 6210 mmHg, or, 8.2 atmospheres) for release to activate the hand brake.

Upon arrival to Whakatane Hospital Emergency Department, Mr SM was tachypnoeic, with saturations of 93% and grossly distended with widespread subcutaneous emphysema from the entry point on his lower limb to his head and neck. His left eye was shut from the emphysema, and he had a goiterous neck with a hoarse voice. His only external injury was a small puncture wound on his left posterior thigh, which with digital exploration under local anaesthetic extended for 8 cm without puncture of the deep fascia of the thigh.

A chest X-ray (CXR) demonstrated a radiographic tension pneumothorax, free intra-abdominal gas, and widespread subcutaneous emphysema. A 28F intercostal drain (ICD) was immediately placed in his left pleural cavity. After incising the dermis, prior to placement of the intrathoracic ICD, there was rapid release and bubbling of gas through the wound—indicating that the subcutaneous emphysema was under pressure.
considerable pressure. (Placement of a subcutaneous intercostal drain has been recommended to augment the release of such high-pressure subcutaneous emphysema by other authors allowing a path of least resistance through the drain.\textsuperscript{7-9})

High flow oxygen via a non-rebreather mask was utilised to hasten the resolution of the subcutaneous emphysema by denitrogenating the patient as expeditiously as possible. This technique—coupled with the fact that the air (oxygen and nitrogen) in the tissues was under some pressure due to entrapment in the tissues—resulted in fairly rapid resorption in keeping with Henry’s Law (which states that the solubility of a gas in a liquid is proportional to the partial pressure of the gas above the liquid at equilibrium).

CT imaging showed extensive subcutaneous emphysema extending from the thigh through to the cervicofacial tissues with extensive pneumopericardium, pneumomediastinum and pneumoperitoneum.

Imaging defining the free air, subcutaneous emphysema within the abdominal, thoracic and cervicofacial planes.

**Figure 1. Axial CT- left; CT neck- showing extensive subcutaneous emphysema beneath the investing fascia and retropharyngeal spaces within the neck. Right; CT abdomen- subcutaneous, retroperitoneal emphysema with expensive pneumoperitoneum**

Over the subsequent 72 hours the subcutaneous emphysema resolved completely. Serial CXR confirmed persistent pneumoperitoneum. Mr MS was discharged on day 5 post injury. Further CXR showed a small persistent pneumoperitoneum on day 14 post injury, which had subsequently resorbed by day 30.
Discussion

This report shows the extensive and life-threatening process that can develop from complications of prolonged high pressure injection. Any gas—either medical or industrial—propelled by sufficient force can dissect through the subcutaneous/perivascular planes of least resistance, eventually creating enough pressure to overcome and perforate the fascia/pleura/peritoneum that envelops that potential space.

The passage of spread of gas was through the femoral sheath/canal to spread through retroperitoneum, dissecting up the crura of the diaphragm to surround the mediastinal structures and via the thoracic inlet to the pharyngeal spaces. The pneumothorax resolved over 24 hours, whilst the pneumoperitoneum took between 14 and 30 days to be completely resorbed.

As no hollow viscous had the direct forces of this within their lumen, no hollow viscous perforation was encountered. The subcutaneous emphysema visible resolved
remarkably rapid over the initial 72 hours, invariably due to the enormous surface area within the subcutaneous space relative to the peritoneal lining to facilitate diffusion of the gas. Although subcutaneous emphysema is benign per se, infection, necrosis, and perforation are potential catastrophic outcomes in extreme cases.

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