Pneumoperitoneum from Subcutaneous Emphysema after Blunt Chest Injury

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Introduction

Pneumoperitoneum following blunt force trauma usually indicates the need for an emergency laparotomy. However, 5~15% of pneumoperitoneum cases do not require surgical management, because the air comes from sources other than the hollow viscus [1]. Pneumothorax or pneumomediastinum could lead to non-surgical pneumoperitoneum, and several hypotheses have been proposed on how the air passes from the thorax to the abdomen. Air could also directly pass through the diaphragm via diaphragmatic defects [2]. Moreover, Lantsberg and Rosenzweig [3] suggested that communication between the thorax and abdominal cavity could exist through a weak site in the diaphragm (corresponding to Bochdalek and Morgagni hernia). Romero and Trujillo [4] demonstrated that the air from the alveoli travels through the perivascular connective tissue in the mediastinum to the retroperitoneum and peritoneum.

In massive subcutaneous emphysema, air could travel through the tissue from the face to the buttocks and scrotum [5]. However, subcutaneous emphysema in the scalp was rarely reported. Here, we report subcutaneous emphysema in the scalp and pneumoperitoneum caused by a blunt chest injury. This case also suggests the existence of a new passageway via which air passes between the thorax and the abdomen exist.

Case Report

A 46-year-old man, who had been beaten mainly in the chest region, visited a local clinic. Despite being intoxicated, he could follow the doctor’s instructions. Initial oxygen saturation was 65% and dyspnea soon developed. After intubation, he was transferred to the trauma center. On arrival, his vital signs were as follows:
blood pressure of 135/92 mm Hg, heart rate of 121 beats/min, oxygen saturation of 99%, and body temperature of 35.9°C. Crackling sensation of subcutaneous emphysema was palpated from the head to the lower legs, and abrasions were seen on both knees and on the right elbow. Some bruising was observed on the chest and back; however, the abdomen wall was clear. The abdomen was soft and presented with no muscle guarding. A chest radiograph showed pneumothorax, with multiple rib fractures on both sides of the chest and extensive subcutaneous emphysema. A small amount of hemothorax was also found on the chest radiograph. Pneumomediastinum was detected on a chest computed tomography (CT) (Fig. 1). An abdominal CT revealed pneumoperitoneum in the liver dome and upper abdomen (Fig. 2A). Air was dissected between the external and internal oblique muscles, and some air was present behind the rectus muscle. In the lower abdomen, much air was seen around both the psoas muscle and erector spinae muscles. The region filled with air was bigger than for the perivascular plane in the diaphragm level.

Fig. 1. Chest computed tomography revealed pneumothorax (white arrow), pneumomediastinum and rib fracture (black arrow) from blunt thoracic injury. Collapsed lung and subcutaneous emphysema were shown.

Fig. 2. (A) Pneumoperitoneum (black arrows) and small retroperitoneal air in perivascular space (posterior black arrow) were present. Subcutaneous emphysema was shown (white arrows). (B) Air existed behind rectus muscle (anterior black arrows) and around psoas muscle (posterior black arrows). Air dissected intermuscular layer (white arrows).

Fig. 3. Brain computed tomography revealed subcutaneous emphysema in scalp and air in temporalis muscle (white arrows).
Fig. 4. (A) Follow up abdominal computed tomography revealed improved pneumoperitoneum (black arrow) and subcutaneous emphysema (white arrows). (B) New pneumoperitoneum was appeared (black arrow) and subcutaneous emphysema was improved (white arrow). Air around psoas muscle was disappeared.

(Fig. 2B). Brain CT revealed that subcutaneous emphysema was present throughout the scalp and that there was air inside the right temporalis muscle; however, pneumocephalus was not seen (Fig. 3). A 28-Fr chest tube was inserted into both sides, and the patient was admitted to the intensive care unit (ICU). In the ICU, he was stable and extubation was performed the following day. Two days after admission, a follow-up CT was performed, which revealed that the extent of subcutaneous emphysema and pneumoperitoneum had decreased (Fig. 4A). However, the pneumoperitoneum was newly developed in the lower abdomen (Fig. 4B). A brain CT revealed that subcutaneous emphysema had also improved, and air had disappeared from inside the temporalis muscle. Due to a lack of signs of peritonitis, the patient was started on a diet of soft foods and was moved to the general ward. He was discharged nine days following admission.

Discussion

We demonstrated that extensive subcutaneous emphysema and pneumoperitoneum caused by traumatic pneumothorax were cured successfully by conservative care methods.

Laparotomy is a difficult choice when pneumoperitoneum and pneumothorax exist after blunt injury. Hoover et al.[6] suggested an algorithm that was composed of chest radiograph for free air, body temperature, leukocyte count, and physical examination. If a patient is stable and non-surgical causes of pneumothorax or pneumomediastinum exist, the patient can be observed. Marek et al.[7] demonstrated that pneumoperitoneum in CT scan was not sufficient for laparotomy, but additional findings were necessary (e.g., free fluid, bowel wall thickening, bowel wall discontinuity, solid organ injury, mesenteric injury, diaphragmatic rupture). However, both algorithms emphasized the importance of physical examination or a patient’s complaint. Indeed, in patients with multiple trauma, vital signs or laboratory findings can easily deteriorate. Even a physical examination or complaint could be inaccurate due to a distracting injury. Therefore, examination should be followed up frequently and the physician should always consider an emergency laparotomy if it is suspected to be necessary. In this case, the patient was admitted to the ICU and was monitored by an intensivist throughout the day. Since he was stable and did not develop any other symptoms, we continued conservative care, even though a follow-up CT scan revealed that pneumoperitoneum had newly developed.

There were several mechanisms proposed for the development of pneumoperitoneum from thoracic injury; however, these were only focused on diaphragm [2-4]. In our case, air was dissected in the inter-muscular space in the abdominal wall and erector spinae muscle, and air was shown behind the rectus muscle and around the psoas muscle. We proposed that the newly developed
pneumoperitoneum originated from these spaces for several reasons. First, the location of the pneumoperitoneum was near the rectus muscle, where air had been detected previously. Second, on abdominal CT, pneumoperitoneum was associated with the air located between the extraperitoneal space and the abdominal wall. Third, the patient was bed-ridden in the ICU; hence, the pneumoperitoneum could not translocate and the air over the liver could not travel to the lower abdomen. Fourth, there was much more air in the lower abdominal wall and psoas muscle than perivascular space at the diaphragmatic level. Therefore, air passed over the diaphragm and penetrated the intraperitoneum through the abdominal wall.

Intraabdominal pressure is usually greater than intrathoracic pressure; however, intrathoracic pressure may be higher than intra-abdominal pressure in cases of pneumothorax or pneumomediastinum [1]. Grosfeld et al. [8] reported that in animal models, intratracheal pressures exceeding 40 cm H\textsubscript{2}O develop into interstitial emphysema, pressures exceeding 50 cm H\textsubscript{2}O develop into pneumomediastinum, and pressures exceeding 60 cm H\textsubscript{2}O develop into subcutaneous emphysema. Barotrauma, which is usually aggravated by mechanical ventilation, can cause subcutaneous emphysema and air can subsequently dissect into various spaces such as the epidural space, the cervicofacial space and scrotum [5,9]. The mechanism of epidural emphysema is that air in the pneumomediastinum dissects the fascia plane and reaches the epidural space [9]. Coincidentally, with this mechanism, air could dissect the abdominal wall and reach the peritoneum. It is not certain whether air could pass through the peritoneum. Pneumoperitoneum is often observed in laparoscopic totally extraperitoneal surgery. However, peritoneal injury is always suspected in cases of pneumoperitoneum. Levinson et al. [10] reported that case of pneumoperitoneum with subcutaneous emphysema but no thoracic cause was detected. That maybe the clue of connection between intraperitoneal and extraperitoneal, but more studies are needed. In the current case, the patient did not have bruising or pain of the abdominal wall; hence, accidental peritoneal injury was not suspected. However, extensive subcutaneous emphysema was found, and in such a condition, the high pressure of air could possibly tear the peritoneum. Therefore, air may not pass the peritoneum in classic subcutaneous emphysema.

Air from thoracic injury could directly pass through the abdominal wall and cause pneumoperitoneum. Surgical intervention is not needed in such a case.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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