

CASE REPORT

Tube obstruction after surgery in a prone position

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Abstract - Mechanical ventilation with an endotracheal tube is frequently used in the ICU setting (including paediatric ICUs, or PICUs). Although complications seldom occur, they can be life-threatening. We report on the case of a 10-year-old boy who developed pneumomediastinum and extensive subcutaneous emphysema due to severe tube obstruction caused by kinking of the endotracheal tube. The kinking probably occurred while positioning the patient in the prone position for surgical intervention. We describe the mechanism that possibly underlies the emergence of the air leak, and emphasize the importance of correct tube fixation and the avoidance of tube rotation while positioning a patient from a supine to a prone position and vice versa. Moreover, we would like to stress the importance of addressing seemingly trivial clinical signs promptly and properly to prevent further complications.

Keywords - prone position, pneumomediastinum, subcutaneous emphysema, tube obstruction

Introduction

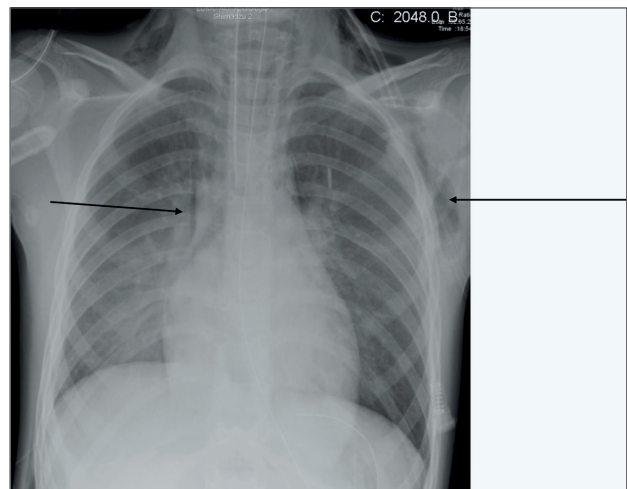
Invasive respiratory support with an endotracheal tube has been proven safe and is in common use in the (P)ICU setting. However, complications sometimes occur and are related to a variety of causes. Well-known complications are those related to respiratory settings, the tube itself (position, patency), the condition of the lungs, or the interaction between patient and machine. To prevent complications, most ICUs have protocols, for example, for handling intubated patients who are turned from supine to prone positions and vice versa. In 2006, a multi-centre, randomized, controlled clinical trial showed that prone positioning can also be safely accomplished in critically ill infants, and that complications are relatively rare [1]. Although mechanical complications of invasive respiratory support are infrequent, they can be life-threatening. To emphasize the importance of correct tube fixation and tube patency, we describe the case of a 10-year-old boy who developed a severe air leak while on respiratory support.

Case report

A 10-year-old boy presented at the emergency department of our hospital because of acute-onset headache and subsequent loss of consciousness. He was coughing up foamy pink sputum. On arrival the boy was haemodynamically unstable. On physical examination he had a Glasgow Coma Scale of 3 (eyes: 1, motor: 1, verbal: 1) and he was immediately intubated. After haemodynamic stabilization, a CT scan of the cerebrum was performed, revealing substantial intracranial haemorrhage based on an arterial-venous (AV) malformation, which required emergency surgical intervention. Post-operatively, the patient was admitted to the paediatric intensive care unit (PICU), sedated, and mechanically

ventilated. He was haemodynamically stable. However, unusually high ventilatory pressures (inspiratory pressure: 28-30 mBar, positive end-expiratory pressure: 12-15 mBar, inspiratory oxygen fraction: 0.35) were required to achieve normal ventilation of the lungs. It also proved quite difficult to advance a suction catheter through the endotracheal tube. The high ventilatory pressures were primarily attributed to neurogenic pulmonary oedema, which was confirmed by the foamy pink sputum and chest X-ray. On the second day following surgery, physical examination showed an increase in the patient's neck diameter. Moreover, crepitations were palpable on the anterior chest wall and abdomen in both axillae and the neck, indicating widespread subcutaneous emphysema.

Figure 1. X-thorax: pulmonary oedema, subcutaneous emphysema (right arrow), and signs of pneumomediastinum (left arrow).



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Confronted with the subcutaneous emphysema, we first had to rule out the most obvious causes. To rule out a pneumothorax, a chest X-ray was performed (Figure 1) that proved negative for pneumothorax. However, signs of mediastinal and subcutaneous emphysema were obvious and pulmonary oedema was present. At this moment, the problem of suspected partial tube obstruction was reconsidered. The suction catheter could still be advanced only halfway, at which point resistance was felt. In view of the high ventilatory pressures, we decided to consult the ENT specialist, preferring flexible bronchoscopy instead of direct reintubation. Bronchoscopy proved impossible, as the bronchoscope could not be passed down the entire length of the endotracheal tube. The tube itself seemed to be flattened. A CT scan of the neck and thorax was made, and there was no evidence of compression of the tube by surrounding tissues or any tracheal lesions (Figure 2). The extensive subcutaneous emphysema and pneumomediastinum were confirmed. On palpation of the tube inside the pharynx, a sharp twist could be felt in the tube. This kinked part of the tube proved to be at the same location as the tube obstruction that had been encountered during bronchoscopy. Because of this proven partial tube obstruction, we decided to reintubate the patient in cooperation with the ENT specialist and anaesthesiologist. Removal of the tube confirmed the kinking halfway (Figure 3). After reintubation, ventilatory pressures could be tapered down. The subcutaneous emphysema diminished, and disappeared within a week. After three days the patient was extubated without any complications, and he was discharged from the PICU after seven days. The patient developed a pseudobulbar paralysis from which he recovered completely after seven months of rehabilitation. A follow-up CT scan after eight months confirmed the AV malformation, which was corrected surgically. The post-operative course was uneventful. After nine months, the patient had recovered completely.

Discussion

In the case described, the endotracheal tube had been inadvertently twisted, most probably while positioning the patient from a supine to a prone position, which was necessary for the neurosurgical

procedure. The kinking caused tube obstruction, which ultimately led to pneumomediastinum and subcutaneous emphysema. We present this case to show the consequences that can result when a problem that seems of only minor importance (e.g. difficulty in advancing a suction catheter through the endotracheal tube) is not addressed properly. In addition, we want to emphasize the importance of correct tube fixation and attention to inadvertent kinking of the tube when positioning a patient in the prone position.

During the operation, the anaesthesiologist encountered the same respiratory problems that we did in the PICU. Observing the data in the patient data management system (PDMS) demonstrated that high inspiratory pressures were also needed during the surgical intervention to achieve adequate tidal volumes and to maintain end-tidal CO₂ values in the normal range (peak inspiratory pressures: 40-42 mbar, plateau inspiratory pressures: 37-40 mbar, respiratory frequency: 18-22/min, end-tidal CO₂ pressures: 4-4.5 kPa). In the presence of airway obstruction, forced inspiration with high pressures enables inflation of the lung. The mechanism is comparable with the ball-valve mechanism as described by JH Russomanno et al. in 1992 [2]. The obstructed expiration causes hyperinflation of the lung and an increase in the intrapulmonary alveolar pressure with the potential risk of air leakage (barotrauma). Air in the pulmonary interstitium can easily spread through the connective tissue into the mediastinum and subcutaneous tissue of the neck as described by A Schulman et al. and R Schumann et al. [3,4]. This explains the subcutaneous emphysema. Although subcutaneous emphysema rarely leads to severe complications, it can be a source of great discomfort to the patient. Only a massive amount of pneumomediastinal and subcutaneous air may lead to decreased venous return and subsequent hypotension.

Although we were able to ensure adequate ventilation by adjusting the ventilatory pressures, expiration was hampered because of the tube obstruction. This could have led to an

Figure 2. CT-thorax: no compression of the tube (left arrow) by surrounding tissue. Subcutaneous emphysema (right arrow) and pneumomediastinum are visible.

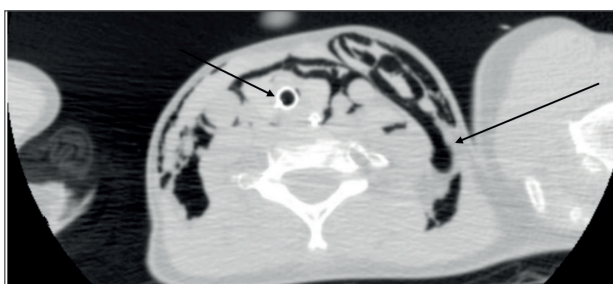
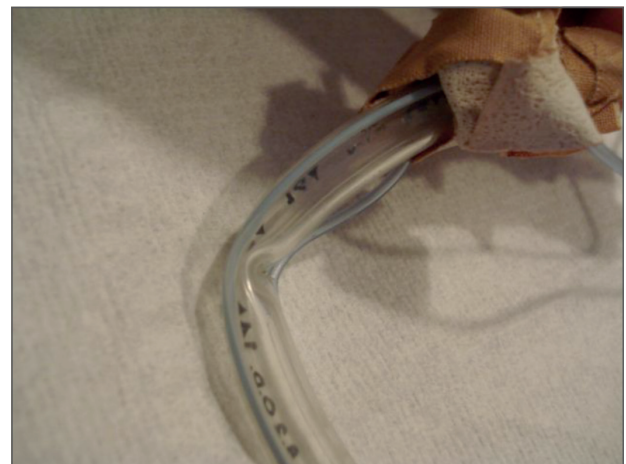


Figure 3. Endotracheal tube after removal.



increase in the intrapulmonary alveolar pressure, resulting in pneumomediastinum and subcutaneous emphysema.

This case demonstrates the importance of proper fixation of the endotracheal tube and the avoidance of tube rotation, especially while positioning the patient from a supine to a prone position and vice versa. Tube kinking is rare and difficult to recognize. Kinking of the endotracheal tube in a prone position has been mentioned before in the literature in a case report of a 52-year-old female who underwent craniotomy for tumour resection in a prone position [5]. Meta-analyses of clinical trials concerning patient outcomes and complications of prone positioning of critically ill patients have shown that complications occur at the same rate as in supine positioning [6,7]. Adherence to protocols for positioning the patient proved helpful in limiting complications related to an endotracheal tube [1]. Nowadays, protocols for prone positioning are available in almost every ICU department. Awareness of the possibility of endotracheal tube kinking will facilitate early recognition. Furthermore, this case illustrates that we need to take all clinical symptoms seriously, however trivial they may seem. Whenever any kind of airway obstruction is suspected in an intubated patient, prompt intervention is necessary to locate and relieve the obstruction. In the case described, the underlying problem was not assessed properly until complications occurred on the second post-operative day. It is obvious that when an endotracheal tube is suspected of being

partially obstructed, it has to be replaced at an early stage, thus preventing further complications.

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