Case Report

# Delayed subcutaneous emphysema, mediastinal emphysema and pneumothorax after tracheal intubation in a child: a case report

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**Background:** Subcutaneous emphysema and mediastinal emphysema and/or pneumothorax after mechanical ventilation through endotracheal intubation is not uncommon. However, cases of delayed mediastinal emphysema and subcutaneous emphysema after extubation and their further development into pneumothorax have rarely been reported, especially in children. Given this, we provide such a case for the reference of clinicians.

**Case Description:** We report a case of a 2-year-old girl with no abnormalities at the preoperative examination, who developed subcutaneous emphysema and mediastinal emphysema 4 hours after recovery from general anesthesia due to ophthalmic arterial infusion chemotherapy for retinoblastoma, and bilateral pneumothorax 12 hours later. The patient recovered and was discharged following aggressive treatment of subcutaneous exhaust and thoracic closed drainage. Due to fiberoptic bronchoscopy was refused by the guardian to determine the cause, we hypothesized tracheal intubation injury occurs, air enter the trachea or bronchial mucosa, extend up to the neck, head and face along the blood vessels, larynx and deep cervical fascia spaces, causing subcutaneous emphysema, and then gradually spread to the mediastinum, resulting in mediastinal emphysema and pneumothorax. However, the etiology and preventive measures warrant further study.

**Conclusions:** Strengthen the etiological study of subcutaneous and/or mediastinal emphysema and pneumothorax due to endotracheal intubation, perioperative observation and postoperative follow-up are important measures for the effective prevention, early diagnosis, and timely treatment of subcutaneous and/or mediastinal emphysema and pneumothorax, and are also conducive to ensuring the safety of patients.

**Keywords:** Tracheal intubation; subcutaneous emphysema; mediastinal emphysema; pneumothorax; case report

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## Introduction

Pneumothorax or subcutaneous emphysema or mediastinal emphysema after tracheal intubation is common, especially in elderly patients with an underlying tracheal disease or lung disease. However, the phenomenon of delayed after tracheal intubation is relatively rare in children. Occurrence of pneumothorax/pneumomediastinum of severe tracheal intubation–associated events was 0.2% in North American (1). In this article, we describe the development and recovery process of such a case. We present the following article in accordance with the CARE reporting checklist (available at https://tp.amegroups.com/article/view/10.21037/tp-22-453/rc).

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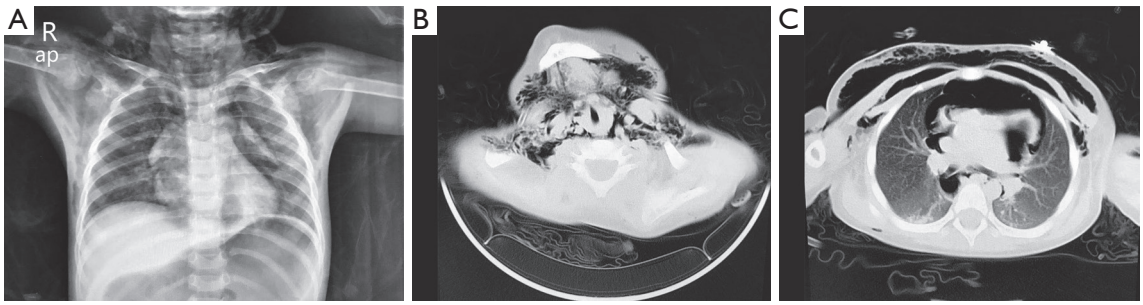


**Figure 1** X-ray and CT scan showing subcutaneous emphysema and mediastinal emphysema respectively. CT, computed tomography; R, right; ap, anterior posterior.

## Case presentation

A 2-year-old girl (weight: 12.0 kg, height: 90.0 cm) was admitted for a 3rd interventional operation to treat retinoblastoma of the right eye, which was first diagnosed 2 months earlier. The preoperative examination revealed no obvious abnormalities. On the 2nd day after admission, supers-elective arterial chemotherapy was performed under general anesthesia.

Anesthesia was induced in theatre and the child was fully monitored. A gaseous induction with oxygen and sevoflurane was used, venous access was established, and atracurium (2.0 mg), midazolam (1.2 mg), ketamine (15 mg), etomidate (5 mg), and propofol (30 mg) were administered. Gentle mask ventilation was performed for 5 min, there was bilateral expansion and the peripheral capillary oxygen saturation ($SpO_2$) was 100%.

The laryngoscopy view was grade 1, and endotracheal intubation (size: 4.5 and depth: 14.0 cm) was successfully completed for the 1st time. The catheter was fixed and the intermittent positive pressure ventilation (IPPV) mode was then applied with a tidal volume (VT) of 10 mL/kg, a respiratory rate (RR) of 20 breaths per minute, an inhalation/respiration ratio of 1:2, and an air/oxygen ratio of 1.1:0.6.

Sevoflurane was used to maintain anesthesia during the operation. The operation was finished 50 minutes later, and spontaneous respiration was restored after 3 minutes, the tracheal tube was removed, and the child was transported to the recovery room. The child was fully awake and returned to the ward about 40 minutes later with a blood pressure of 110/70 mmHg, a heart rate (HR) of 80 beats per minute, an RR of 18 breaths per minute, and a $SpO_2$ of 99%.

Some 4 hour later, the child developed irritability and cyanosis after crying. Apophysis and crepitus under the local skin of the head and neck were checked. An emergency chest X-ray revealed subcutaneous gas in the bilateral neck and chest wall, and the possibility of pneumomediastinum (see *Figure 1A*). Oxygen was given through a nasal cannula immediately, and a 14-gauge needle was used for the subcutaneous exhaust. A further computed tomography (CT) scan showed slight inflammation in the upper lobe of the right lung and the lower lobes of both lungs, subcutaneous emphysema in the neck and bilateral chest walls, and mediastinal emphysema (see *Figure 1B,1C*). Changes in the child's condition were closely observed.

A CT performed on the 2nd day post-surgery showed that the bilateral pneumothorax and right pneumothorax were more obvious than the left pneumothorax, subcutaneous air in the neck and chest wall, pneumomediastinum, and patchy shadows scattered in both lungs (see *Figure 2*). The patient underwent emergency closed drainage of thoracic cavity, and a chest tube was placed on the right side without any complication. The patient also continued to receive oxygen for symptomatic treatment.

On the 3rd postoperative day, a CT showed a small amount of pneumothorax and partial atelectasis on both sides, and subcutaneous pneumatosis in the neck, mediastinum, and chest wall (see *Figure 3A,3B*). The drainage tube was removed on the 3rd day after thoracic closed drainage following no gas extraction for 24 h.

A CT examination on postoperative day 4 showed a small amount of subcutaneous gas accumulation in the neck, mediastinum, and chest wall (see *Figure 4A,4B*). The patient left the hospital (Xinhua Hospital Affiliated to Shanghai Jiaotong University School of Medicine, China), on postoperative day 7, and refuse conduction of fiberoptic bronchoscopy to determine the etiology, and no abnormality was observed in the follow-up after discharge.

All procedures performed in this study were in

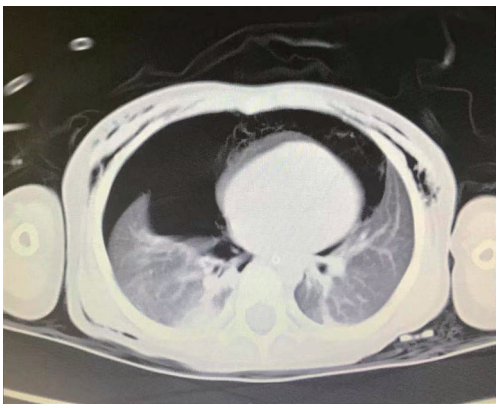

**Figure 2** CT showing bilateral pneumothorax, subcutaneous emphysema, and mediastinal emphysema. CT, computed tomography.

accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki (as revised in 2013). Written informed consent was obtained from the patient's parents for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

## Discussion

When performed by an experienced provider, endotracheal intubation is considered a safe and reliable method for securing an airway in the operating room, intensive care unit, and the emergency department (2). The physiology of the airway differs in pediatric and adult patients (3).

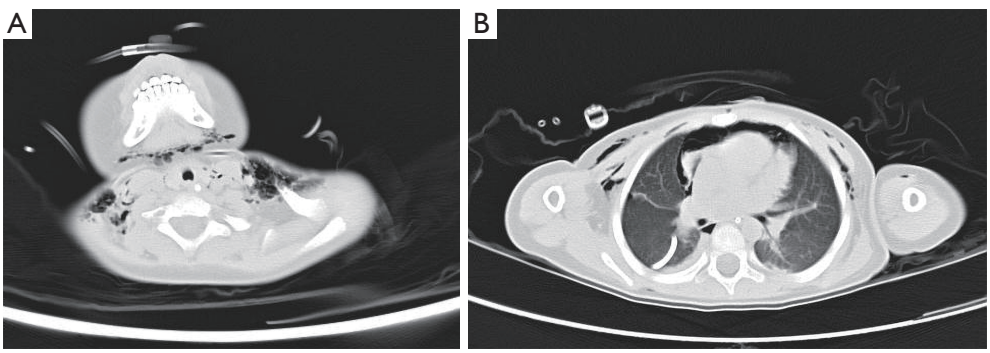


**Figure 3** CT showing a small amount of pneumothorax, subcutaneous emphysema, mediastinal emphysema, and the right chest drainage tubes. CT, computed tomography.

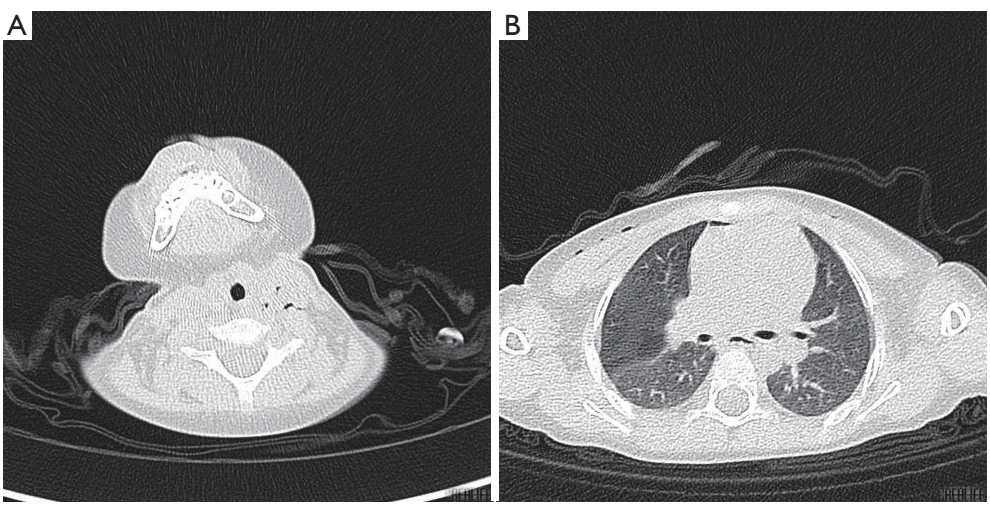


**Figure 4** CT showing a small amount of subcutaneous gas in the neck, mediastinum, and chest wall. CT, computed tomography.

Complications and adverse physiological effects [e.g., atelectasis, post-extubation stridor, failed extubation, pneumothorax, accidental extubation, nasal or perioral tissue damage, and ventilator-associated pneumonia (VAP)] of intubation with mechanical ventilation are still unavoidable problems facing anesthesia and clinical physicians (4).

Previous reports have analyzed the common causes of pneumothorax and/or subcutaneous and mediastinal emphysema after mechanical ventilation through endotracheal intubation. They include: the rupture of alveoli or bullae caused by underlying diseases secondary to mechanical ventilation (e.g., pulmonary infection and emphysema), and tracheal intubation or extubation leading to trachea and bronchus injury or rupture (5). Cervical fascia injury may be one of the causes of subcutaneous emphysema with or without pneumomediastinum and pneumothorax (6).

Chest and head and neck surgery are rare in hypopharyngeal injuries. However, cases of delayed mediastinal emphysema and subcutaneous emphysema after extubation and the further development into pneumothorax have rarely been reported, especially in children without obvious pulmonary diseases at the preoperative examination.

In this case, the child experienced multiple subcutaneous emphysema and mediastinum emphysema 4 h after anesthesia recovery and the bilateral pneumothorax 12 h later. If a tracheal intubation injury occurs, air can enter the trachea or bronchial mucosa after minimal damage, extend up to the neck, head and face along the blood vessels, larynx and deep cervical fascia spaces, causing subcutaneous emphysema, and then gradually spread to the mediastinum, resulting in mediastinal emphysema. Discomfort in children leads to irritability and crying, and increased pressure leads to parietal pleura rupture and pneumothorax. The parents in this case refused to allow the child to undergo a diagnostic bronchoscopy due to its high risk, so the cause of delayed subcutaneous emphysema, mediastinal emphysema, and pneumothorax remains uncertain.

It is very important to detect and diagnose subcutaneous emphysema and/or mediastinal emphysema and pneumothorax in patients under general anesthesia. A diagnosis can be established when the airway pressure (Paw) and postapneic end-tidal carbon dioxide pressure ($PETCO_2$) increase, hyperventilation does not improve, $SpO_2$ continuously declines, and at the same time, apophysis and crepitus can be touched under the skin of the neck, face and/or chest. Subcutaneous emphysema of the face and trunk following tracheal intubation should immediately trigger a diagnosis (7). Once subcutaneous emphysema is found, it is necessary to confirm whether pneumothorax and pneumopericardium is present by auscultation and chest X-ray in the operating room. Subcutaneous emphysema can usually be reabsorbed in the absence of drainage, but puncture deflating should be performed in a timely manner to treat severe or life-threatening subcutaneous emphysema of the eyes, face, or airway (8). For tension pneumothorax, the rapid removal of pleural air is the main life-saving measure. The consultation system should be actively improved and further treatment implemented according to the suggestions of specialists.

Endotracheal intubation injury cannot be completely avoided; however, some measures can reduce its incidence, including a pre-anesthetic evaluation, the selection of appropriate anesthetic equipment, especially catheters, and a skilled intubation technique. Preoperative CT or fiberoptic bronchoscopy should be actively performed in patients with a poor airway structure to clarify the airway anatomy, variation, and pathological changes. Non-invasive airway ultrasound provides a new choice for clinical assessments of airway size and can be used to predict the appropriate diameter of endotracheal and tracheostomy tubes (9,10). For patients with airway difficulties, a Macintosh or Miller laryngoscope can be used as an alternative to replace traditional intubation methods, such as video laryngoscopy or fiberoptic bronchoscopy. Noppens *et al.* confirmed that the success rate of the 1st intubation was higher using video laryngoscope than traditional laryngoscope (11), which can be used to easily observe the openings of the glottis.

The use of a bougie should be avoided as much as possible during intubation, as it may penetrate deep into the distal airway, causing trauma and air leakage (12). If used, the bougie material should be chosen carefully, and close attention should be paid to the insertion depth. The pressure of the endotracheal tube cuff must be appropriate, as under-inflation will cause leakage and overinflation will cause tracheal mucosa tears or even tracheal rupture. During the intubation, excessive backward of head should be avoided. When the intubation passes through the glottis, the movement should be gentle and accurate, and the intubation should be inserted into the cavity area as far as possible to avoid scratching the laryngotracheal mucosa.

In conclusion, subcutaneous and/or mediastinal emphysema and pneumothorax due to endotracheal intubation are not uncommon. Thus, to strengthen the etiology of complications, perioperative observation and postoperative follow-up are important measures for the effective prevention, early diagnosis, and timely treatment

 

of subcutaneous and/or mediastinal emphysema and pneumothorax, and are also conducive to ensuring the safety of patients.

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## Footnote

*Reporting Checklist:* The authors have completed the CARE reporting checklist. Available at https://tp.amegroups.com/article/view/10.21037/tp-22-453/rc

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at https://tp.amegroups.com/article/view/10.21037/tp-22-453/coif). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki (as revised in 2013). Written informed consent was obtained from the patient's parents for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.



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