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Timing and order of surgeries for thoracic trauma with multiple injuries: A case report

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ABSTRACT

The timing and order of multiple surgeries for patients with multiple thoracic injuries have not been standardized. A 75-year-old man, who was injured because of a closing elevator door, underwent intubation, bilateral chest drain insertion, and massive blood transfusion due to shock and respiratory distress. Computed tomography showed hemopneumothorax with extravasation, tracheobronchial injury, aortic injury, thoracic vertebral anterior dislocation, and multiple rib fractures. He was hospitalized and underwent embolization on the day of admission. Next, veno-venous extracorporeal membrane oxygenation (VV-ECMO) was conducted to address severe respiratory failure. The most crucial aspect of the management was treating the tracheobronchial injury because weaning the patient off the VV-ECMO depended on the success of the repair. Thus, the tracheobronchial repair was performed 7–10 days after injury. A right intrathoracic hematoma removal was performed on the third day and a thoracic endovascular aortic repair on the fifth day. The tracheobronchial repair was performed on the ninth day followed by the posterior thoracic fusion on the 18th day. The patient was successfully weaned off the VV-ECMO and mechanical ventilation on the 24th and 46th days, respectively. Early surgery is not always ideal when managing thoracic trauma cases involving multiple sites. Rather, the treatment should be individualized, and the essential surgical procedures should be timed appropriately.

Introduction

Thoracic trauma causes life-threatening respiratory distress, such as pneumothorax, hemothorax, and tracheobronchial disruption. Veno-venous extracorporeal membrane oxygenation (VV-ECMO) has been reported to be effective and safe for thoracic trauma patients. However, it only provides temporary relief from respiratory distress, and surgical treatment is necessary [1]. The timing and order of multiple surgeries for thoracic trauma patients have not been standardized. We encountered a patient with respiratory distress, requiring VV-ECMO due to severe thoracic trauma. The patient underwent tracheobronchial repair, thoracic endovascular aortic repair (TEVAR), and posterior thoracic fusion. The timing and order of the surgeries for tracheobronchial, aortic, and spinal cord injuries remain controversial. This report describes a case of severe thoracic trauma involving multiple sites, and discusses the timing and order of the necessary surgeries. Written informed consent for the publication of this report and accompanying images was

Abbreviations: TEVAR, thoracic endovascular aortic repair; VV-ECMO, veno-venous extracorporeal membrane oxygenation.

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obtained from the patient.

Case presentation

A 75-year-old man had experienced blunt thoracic trauma caused by a closing elevator door at a wholesale market. He developed respiratory failure and shock, presenting with significant subcutaneous emphysema upon arriving at the hospital. He underwent intubation, bilateral chest drain insertion, and massive blood transfusion. Computed tomography imaging showed bilateral hemopneumothorax, extravasation of blood from the right internal thoracic artery and carpal artery, tracheobronchial injury, aortic injury (grade 2, distal to the left subclavian artery bifurcation), fifth thoracic vertebra anterior dislocation, sternum fracture, and multiple rib fractures (Fig. 1). Embolization for the right internal and uppermost thoracic arteries, as well as stent grafting for arterial dissection from the brachiocephalic artery to the right subclavian artery, were performed. During the embolization, the tidal volume was not maintained due to the tracheobronchial injury and massive right hemothorax. Therefore, VV-ECMO was initiated immediately after the procedure. Upon initiating VV-ECMO, the patient's respiration and circulation stabilized, and the mediastinal and subcutaneous emphysema improved. On the third day, he underwent right intrathoracic hematoma removal through the right lateral chest opening for right lung expansion. On the fifth day, TEVAR was performed to address the traumatic aortic dissection, that was noted from the distal aortic arch to the level of the diaphragm. Isolated lung ventilation was initiated with a double-lumen tube on the sixth day. Then, tracheobronchial repair and lipofilling were performed on the ninth day (Fig. 2a, b). The laceration was observed 4 cm above the tracheal bifurcation, extending to the right main bronchus (Fig. 2c). The intra-airway pressure and tidal volume increased gradually postoperatively without pneumothorax development. A posterior thoracic fusion was performed to manage the anterior dislocation of the fifth thoracic vertebra on the 18th day. His respiratory condition improved over time, and by the 24th day, he was weaned off of VV-ECMO. The portable chest x-ray findings from the second (Fig. 3a) and 25th days (Fig. 3b) showed dramatic improvement. He was successfully weaned off the ventilator on the 46th day. On the 53rd day, the patient became ambulatory with a walker and was transferred to another hospital for rehabilitation.

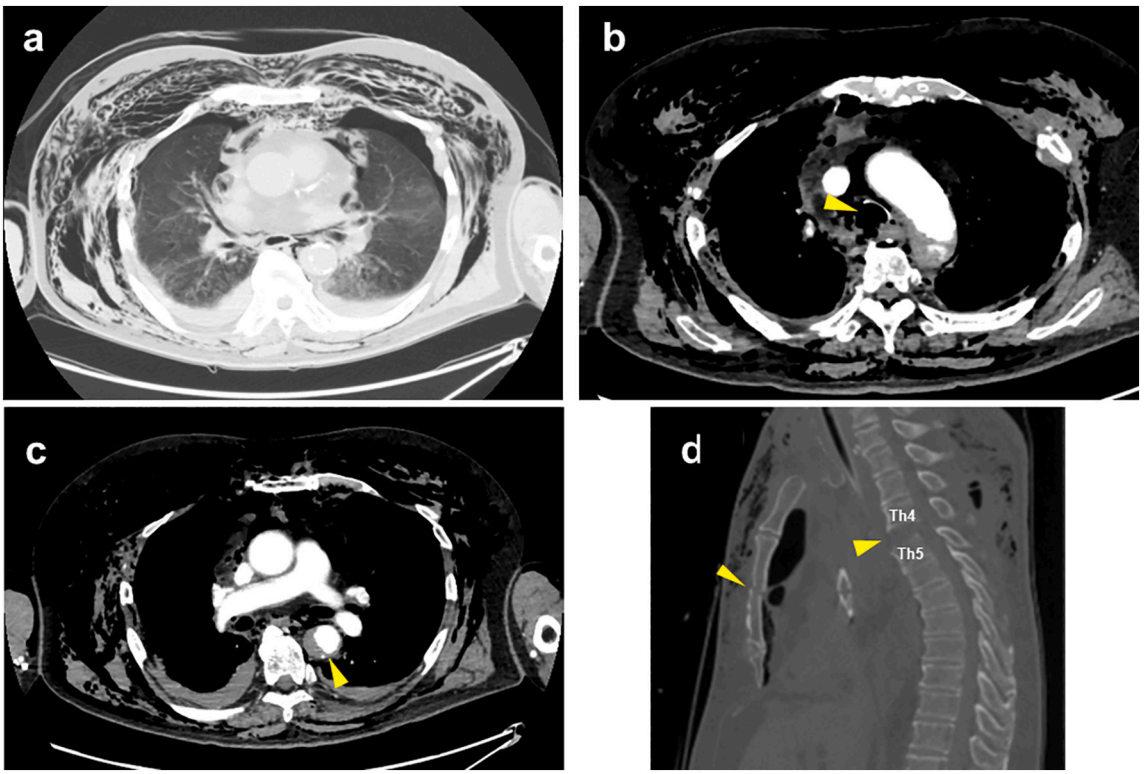

Fig. 1. Computed tomography images upon arrival.
(a) Extensive subcutaneous emphysema over the anterior to the posterior chest, mediastinal emphysema, and hemopneumothorax were noted. (b) Tracheobronchial injury: Discontinuity of the posterior wall of the trachea at the tracheal bifurcation (arrow). (c) Aortic injury: In the early phase, aortic dissection and contrast medium pooling (arrow). (d) Fifth thoracic vertebra anterior dislocation (arrow) and sternum fracture (arrow). Th, thoracic vertebra.

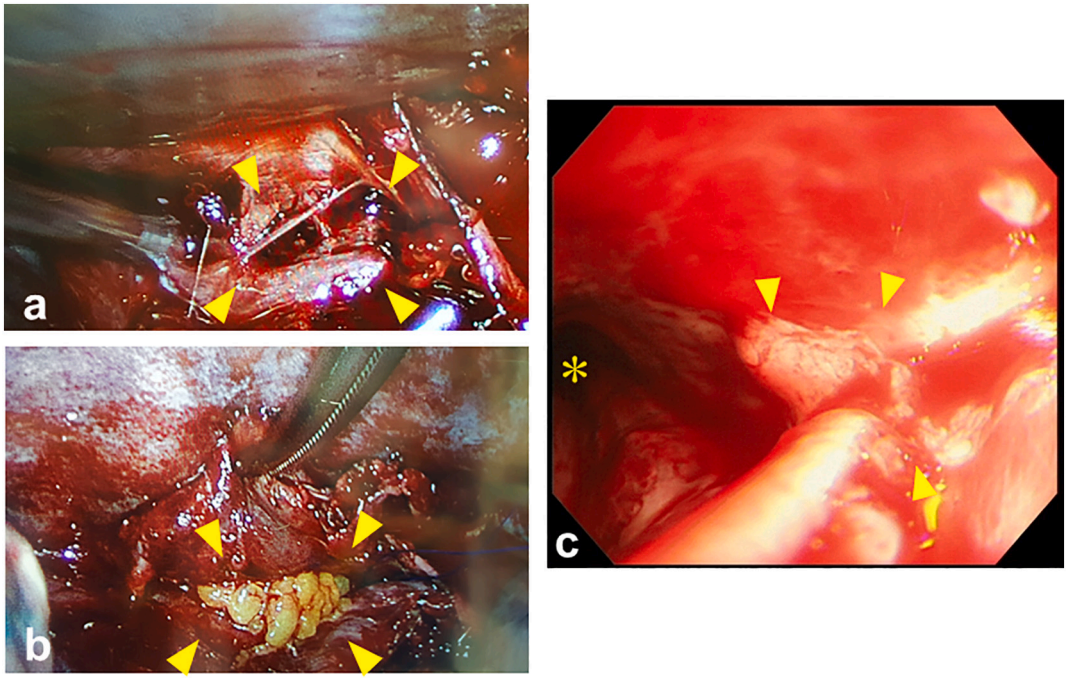

Fig. 2. Intraoperative and bronchoscopic findings of the tracheobronchial injury.
(a) A laceration in the membranous area (arrow). (b) The injury was covered with thymic tissue and sutured (arrow). (c) The laceration (arrow) extends from 4 cm above the tracheal bifurcation to the left main bronchus (asterisk).

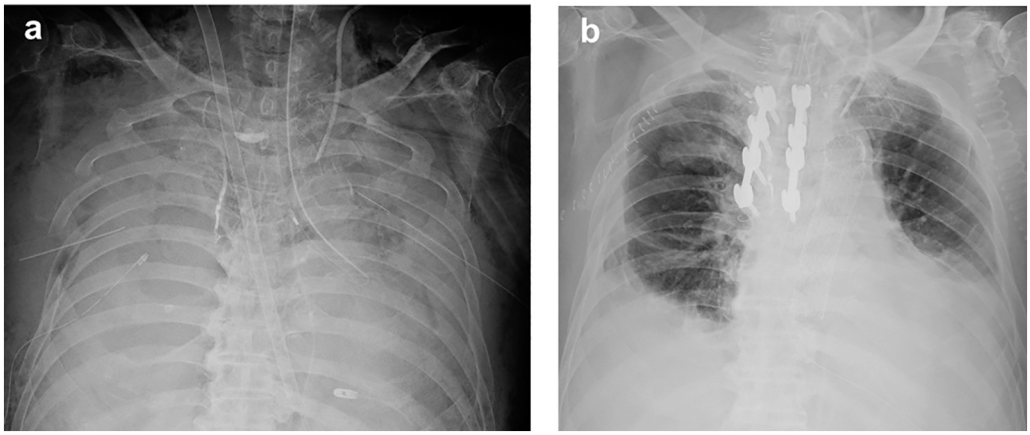

Fig. 3. Portable chest x-ray findings on days 2 and 25 post-trauma.
(a) Venovenous extracorporeal membrane oxygenation (VV-ECMO), left unilateral lung intubation, bilateral thoracic drains, a blood access catheter, and a gastric tube were inserted. Permeability was low owing to hemothorax in bilateral lungs. (b) Chest radiography was performed the day after VV-ECMO removal. Both lungs were well inflated, and the permeability improved.

Discussion

Severe injuries and deaths due to elevators have been reported. Approximately 30% of these injuries were caused by doors, as seen in this patient [2,3]. Soft tissue injuries are commonly caused by elevators. However, severe thoracic injuries rarely occur because the elevator doors close from the side, and a safety mechanism is activated in case of an emergency [2,3].

The proportion of traumatic tracheobronchial injuries is unknown because approximately 75% of the patients die before reaching the hospital. Based on autopsy findings, it is a rare type of trauma, that accounts for 0.8–2% of traumatic deaths. Due to fatal injuries, the in-hospital mortality rate of traumatic tracheobronchial injury reportedly exceeded 30% [4].

In this case, VV-ECMO was conducted to manage respiratory failure due to severe thoracic trauma. Treating the tracheobronchial

injury was the most critical aspect of management because weaning off of VV-ECMO depended on the success of the repair. Decompression of the injured area via an intubation tube reportedly alleviated the symptoms of patients with mild tracheobronchial injuries [5]. However, surgical treatment is indicated for patients with worsening subcutaneous emphysema and respiratory failure or massive intratracheal bleeding. Several concerns regarding early tracheobronchial repair surgery have been raised. According to a previous report [6], undergoing tracheobronchial repair surgery within 24 h of injury was related to a high mortality rate. Other studies have reported that surgeries within seven days of injury had low rates of successful surgical repairs [6,7]. In this patient, tracheobronchial edema was evident due to massive transfusion. Therefore, surgery was performed 7–10 days after the injury, when the edema had improved. On the third day, the right intrathoracic hematoma was removed to expand the patient's right lung. Isolated lung ventilation was initiated using a double-lumen tube and two ventilators on the sixth day. As a result, the right lung was re-expanded and ventilated, while the left lung, which had been compressed by the right lung, re-expanded simultaneously. Thus, the tracheobronchial repair was successfully performed.

The guidelines of the Society for Vascular Surgery recommend surgery for traumatic aortic injuries of grade 2 (internal flap, thrombus, or intramural hematoma >1 cm) or more [8]. The mortality rate of patients, undergoing TEVAR, was reportedly lower than that of patients, undergoing emergency surgery and conservative treatment. Therefore, TEVAR is the preferred treatment for traumatic aortic injuries. Performing aortic injury repair within 24 h is also recommended in cases, wherein the trauma is limited to the aorta [9]. However, the survival rate was reportedly higher in patients, whose general condition had stabilized. In this case, TEVAR was performed on the fifth day because the patient's general condition had stabilized before the tracheobronchial repair was performed. Moreover, he was scheduled to undergo multiple chest surgeries.

The timing of surgical intervention for spinal cord injury remains controversial. However, early treatment improves the neurological prognosis [10]. In this case, surgery was not feasible, regardless of the spinal cord injury, because of the patient's unstable condition. A posterior fusion was performed to address the thoracic spine instability after TEVAR. Then, the tracheobronchial repair was performed. VV-ECMO was performed to prevent the patient's respiration from worsening intraoperatively.

In conclusion, we reported a case of severe blunt thoracic trauma, treated via VV-ECMO, TEVAR, tracheobronchial repair, and posterior thoracic vertebral fusion. The timing and order of surgeries for severe thoracic trauma, involving multiple injury sites, have not been standardized. Therefore, the management plan should be individualized, and essential surgical procedures should be performed at the most appropriate time.

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Declaration of competing interest

Not applicable.

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