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Case Report

Robot-assisted thoracoscopic repair of tracheal gunshot wound

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ABSTRACT

A 23-year-old man suffered two gunshot wounds and upon arrival to the emergency room was found on imaging to have a large pneumothorax with considerable subcutaneous emphysema. Intubation and placement of bilateral chest tubes did not improve the patient's oxygenation; bronchoscopy revealed a 1 cm tracheal defect in the membranous wall 4 cm proximal to the carina. The patient underwent robot-assisted primary repair of the tracheal injury with a #3-0 PDS Stratafix barbed suture buttressed with an intercostal muscle flap. The patient was discharged in good condition on post-operative day 17, with follow-up bronchoscopy showing complete healing of the trachea.

Introduction

Tracheobronchial injury (TBI) is a relatively rare complication of trauma; its incidence may be around 0.4 % in patients with trauma [1,2]. If TBI is suspected, urgent bronchoscopy is necessary to confirm the diagnosis. While conservative management can be considered for select patients, the mainstay of treatment is primary repair of the injury [3,4]. Repair is most often performed via an open approach; the role of robotic surgery in trauma patients remains uncertain, and there is only one other reported case in the literature of robotic surgery used for traumatic injuries [5]. Here we describe the robot-assisted repair of a tracheal injury in a young man who suffered a gunshot wound.

Case report

A 23-year-old male was brought to the emergency room after suffering gunshot wounds to the left chest and scapula. Upon arrival the patient was unresponsive, and his oxygen saturation was reduced. Radiographs and computerized tomography of the chest showed a large left pneumothorax with mediastinal shift, pneumomediastinum, and significant supraclavicular subcutaneous emphysema (Fig. 1A, B). The patient was intubated, and bilateral chest tubes were placed without improvement in his oxygenation. Bronchoscopy was performed, revealing a 1 cm defect in the membranous tracheal wall 4 cm proximal to the carina (Fig. 2), after which the endotracheal tube was advanced past the defect.

The patient underwent operative repair of the tracheal defect. The decision was made to proceed with robot-assisted repair since this approach would provide the best visualization of the injury and allow for an easier dissection of the posterior mediastinum. The patient was positioned in the left lateral decubitus position and the single-lumen endotracheal tube was advanced into the left mainstem bronchus for right lung isolation; robotic trocars were placed under direct visualization (Fig. 3). Dissection was started

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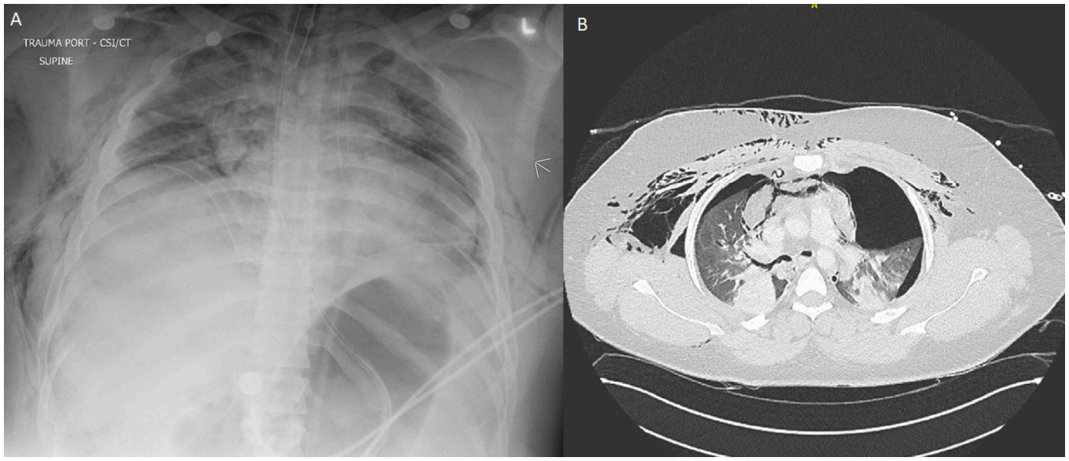

Fig. 1. Chest radiograph (A) and CT scan (B) showing massive left pneumothorax with left pneumothorax with mediastinal shift, pneumomediastinum, and significant supraclavicular subcutaneous emphysema.

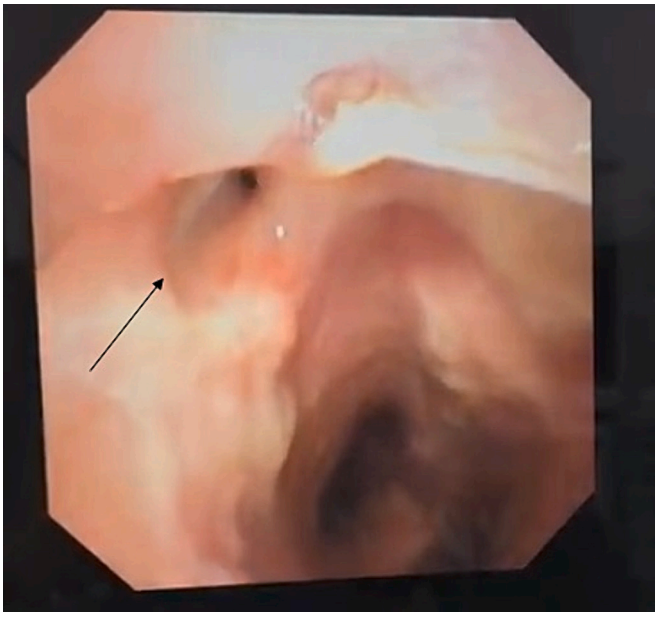

Fig. 2. Bronchoscopy revealing the 1 cm tracheal defect (arrow) in the membranous wall 4 cm proximal to the carina (bottom right of image).

superiorly in the posterior mediastinum. The azygos vein was divided to allow for better exposure, after which the posterior mediastinal pleura was opened, and the trachea was separated from the esophagus. The tracheal defect was encountered, through which the endotracheal tube was visualized (Fig. 4A). The endotracheal tube was then retracted proximal to the defect. The defect was primarily repaired without tension using a #3–0 PDS Stratafix barbed suture with good approximation (Fig. 4B). Next, an intercostal muscle flap was harvested and used to buttress the repaired injury (Fig. 4C). A water submersion test demonstrated no air leak from the repaired defect. Following the procedure, a tracheal stent was placed to protect the tracheal repair and to allow for high-pressure ventilation to treat the patient's acute respiratory distress from his initial traumatic insult.

The patient's post-operative course was complicated by fevers and a protracted ICU stay due to inability to wean off mechanical ventilation. On post-operative day 13, the patient was successfully extubated, and was discharged home in good condition on post-operative day 17. Chest radiographs on the date of discharge showed marked improvement, with near-complete return to the patient's baseline. The tracheal stent was removed 3 weeks later with bronchoscopy showing complete healing of the trachea.

Discussion

Tracheobronchial injury (TBI) is a rare but serious complication of both blunt and penetrating trauma. These injuries are associated

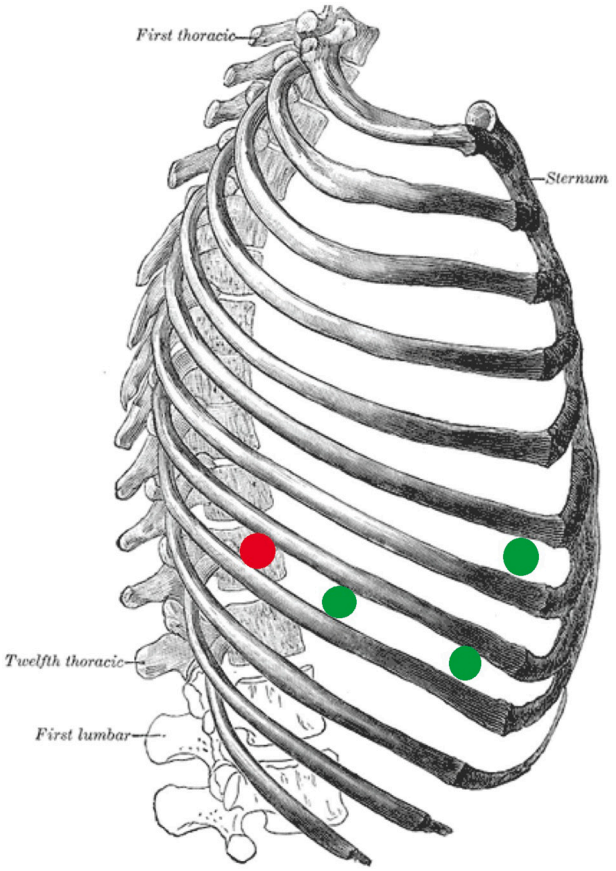

Fig. 3. Diagram showing the location of the four robotic trocars. An Optiview trocar was placed in the 8th intercostal space at the posterior axillary line (red). Two of the remaining trocars were placed along the 8th intercostal space, with the last trocar inserted anteriorly in the 6th intercostal space (green). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

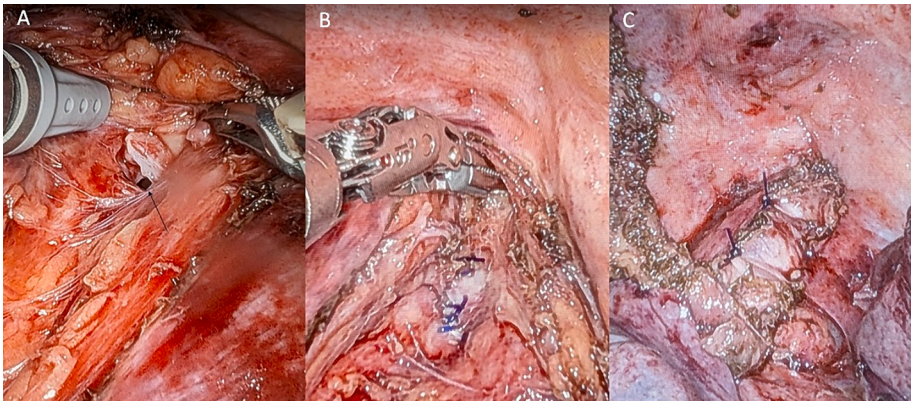

Fig. 4. Visualization of the tracheal defect prior to repair with an arrow showing the defect (A), after primary closure with a #3-0 PDS Stratafix barbed suture (B) and after buttressing with an intercostal muscle flap (C).

with a high rate of mortality and portend a worse prognosis for patients suffering from trauma; the presence of TBI is associated with a 10 % increase in mortality rate [1]. Therefore, early recognition and treatment of these injuries is vital to reducing mortality in trauma patients. Traditionally, repair of TBI is done via an open approach. Cervical tracheal injuries are accessed through a collar incision, while intrathoracic tracheal and bronchial injuries are most often repaired via a right posterolateral thoracotomy, with occasional need for median sternotomy in those with high thoracic tracheal injuries [3].

Minimally-invasive techniques are seldom used in trauma patients requiring surgery, and there is very little literature on the

application of robotic surgery in these patients. So far, most research involving the use of robots in trauma surgery investigates its use in telesurgery and orthopedic trauma [6]. However, robotic surgery has been used in patients requiring emergency general surgery with promising results [7]. Though it has not seen much use in traumatic injuries, robot-assisted surgery has been used in the thorax since at least 2001 for a growing number of indications and is associated with faster recovery times when compared to open approaches for similar procedures [8]. The use of a robot can assist surgeons performing repair of traumatic injuries by helping access difficult-to-reach areas such as the superior mediastinum, where a posterolateral thoracotomy or midline sternotomy provide poor visualization and limited workspace. This report suggests that robotic surgery can be a safe and effective modality for the treatment of certain traumatic injuries within the thorax.

CRediT authorship contribution statement

Antoine Nehme: Writing – original draft, Writing – review & editing. **Salman Zaheer:** Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Alexander Leung:** Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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