



# Diagnosis and Management of an Isolated Tracheal Gunshot Wound

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## Abstract

Penetrating trauma to the intrathoracic tracheobronchial tree continues to present a unique and challenging emergency. We present a case of an isolated gunshot wound to the distal trachea, and discuss the challenges in diagnosis and management of such injuries.

## Case Presentation

A 43-year-old male was found by bystanders with decreased level of consciousness and a gunshot wound to the left chest immediately lateral to the right sternoclavicular joint. He was brought to the local Level II trauma center. Primary trauma survey was remarkable only for dyspnea. Secondary survey demonstrated a gunshot wound to the right clavicle area, intact peripheral pulses, and no findings consistent with a gunshot exit wound. Initial chest X-ray showed a small right hemopneumothorax. A right chest tube was placed with evacuation of 180 mL of blood and a very small air leak. Shortly after chest tube insertion, he developed hemoptysis, became more dyspneic and agitated as a result, and required intubation. Subsequent chest X-ray showed what appeared to be development of pneumomediastinum and a new left pneumothorax and a left-sided chest tube was placed. He underwent a CT scan of the head, neck, chest, abdomen, and pelvis. This revealed a bullet trajectory from near the right clavicular head, traversing the mediastinum, and ending in the T4 vertebral body with the bullet lodged in the spinal canal. There was no vascular injury including the great vessels, but the bullet tract appeared have resulted in an injury to the distal trachea associated with a large amount of subcutaneous and mediastinal air. (Figures 1A and 1B). At this point, the patient was transferred to our Level I trauma center at an academic, quaternary referral institution.

Upon arrival at our facility, the patient was intubated and hemodynamically stable. He had a minimal air leak from the right chest tube, and no air leak from the left (Figure 2). There was a large amount of subcutaneous air tracking along the right chest. Flexible bronchoscopy and esophagoscopy were performed in the trauma bay following primary and secondary surveys to assist with operative planning. Esophagoscopy revealed normal mucosa throughout. Bronchoscopy revealed the suspected injuries – a small tracheotomy in the anterior cartilaginous wall of the trachea about 2 cm above the carina just right of midline about 15% circumference, as well as an additional tracheotomy in the posterior membranous wall of the trachea directly across from the first hole, just right of midline, about 10% circumference (Figure 3). The patient was then brought emergently to the operating room.

General anesthesia was induced, and the previously placed endotracheal tube was advanced into the left mainstem bronchus under bronchoscopic guidance. The patient was then placed in left lateral decubitus. A posterolateral thoracotomy was created and the chest was entered in the 4<sup>th</sup> intercostal space taking the 4<sup>th</sup> intercostal muscle as a flap. With the lung retracted, a bullet hole in the mediastinal pleura was identified immediately superior to the arch of the azygos vein. Using this pleurotomy, we extended the dissection onto the airway proximally and distally. The azygos vein was divided using an endo-GIA stapler for better exposure of the injury. The bronchoscopically identified holes were appreciated in the anticipated location immediately proximal to the carina. Posterolateral to the airway injury, the defect in the vertebral body of T4 could be appreciated with palpation. The esophagus was also exposed and examined externally revealing an intact esophageal wall, consistent with prior esophagoscopy. With the injury fully exposed, the two holes amounted to about 25% circumference injury with minimal surrounding devitalized tissue with at least 2 cm of intact, viable airway between. Appropriate debridement was performed. We then repaired the injuries separately and primarily using 4-0 PDS suture. Two figure-of-eight sutures were placed in

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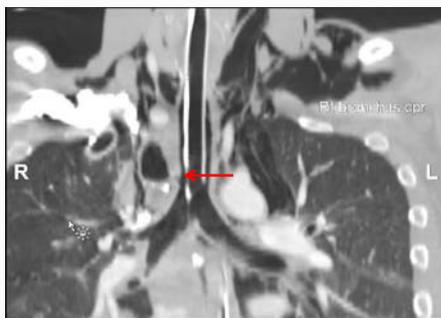
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**Figures 1A:** CT scan Coronal & Sagittal images demonstrating gunshot trajectory.



**Figure 1B:** The arrow marks the site of the anterolateral tracheal injury. A small piece of shrapnel is appreciated adjacent to this.



**Figure 2:** Chest X-ray at our facility.



**Figure 3:** Endobronchial view of the injury. The arrows mark the entrance anterolaterally and the exit posteriorly.

the anterior cartilaginous tracheotomy. A series of simple interrupted sutures were placed in the posterior membranous tracheotomy and secured without tension. The previously harvested intercostal muscle flap was then secured to both anterior and posterior repairs using 3-0 vicryl. Two apical chest tubes and a soft basilar blake drain were placed and secured to the skin. The chest was irrigated with antibiotic solution and closed in layers. The endotracheal tube was then positioned well above the repair under bronchoscopic guidance. A leak test was performed with Valsalva maneuvers while the repair was submerged and was negative for any airway leak. At the completion of the procedure, bronchoscopy demonstrated both repairs to be intact. The patient was then transferred to the Intensive Care Unit.

Postoperatively, the patient was extubated on postoperative day 0. He did not have any evidence of recurrent laryngeal nerve injury and pulmonary toilet was satisfactory. His drains were all removed sequentially by postoperative day 4. His hospital course was routine and uncomplicated. Because of the need for a spinal rehabilitation unit and complex social issues, the patient was ultimately discharged on postoperative day 24.

## Discussion

Penetrating trauma to the intrathoracic tracheobronchial tree continues to present a unique and challenging emergency. Cervical tracheal injuries are more common, accounting for 75% - 90% of penetrating tracheal trauma [1-4]. This may be due in part to more distal injuries being frequently associated with fatal injuries to the heart and great vessels. Such patients likely do not survive to evaluation in a trauma center. The rate of associated major injuries in penetrating intrathoracic tracheobronchial trauma is 50% - 80% [3],

with a majority being esophageal and vascular injuries, followed by spinal cord and pulmonary injuries. We present a case of a tracheal gunshot wound associated with only spinal cord injury.

The first challenge with intrathoracic tracheobronchial injury is diagnosis. This requires a high index of suspicion, and bronchoscopy is mandatory. The most common signs of airway injury are emphysema, pneumothorax, pneumomediastinum, and hemoptysis. Imaging studies such as chest radiography and CT scans may show indirect signs of airway injury, but are less sensitive for detecting injury directly to the airway [5,6]. Bronchoscopy remains the definitive diagnostic study for suspected airway injury. Flexible bronchoscopy can be performed quickly and easily, and offers the advantage of directed, non-traumatic intubation in a patient population that often requires cervical spine immobilization. While rigid bronchoscopy can offer the ability to realign a completely disrupted airway, it requires extreme neck extension, and can exacerbate injury. In the stable patient, flexible esophagoscopy should also be performed due to the frequent incidence of associated esophageal injury [3]. In our patient, the airway injury was suspected only after a CT scan demonstrated a large amount of subcutaneous air. Upon arrival at our institution, prompt bronchoscopy quickly identified the suspected injury, and esophagoscopy ruled out associated esophageal injury.

The second challenge is airway management. It is important to have a pre-operative discussion with the anesthesia team regarding the complexities of managing the injured airway, and to have multiple airway adjuncts available. Cross-table ventilation should be prepared. In the non-intubated patient with suspected airway injury, immediate intubation is appropriate, and ideally with guidance of flexible bronchoscopy. This allows for intubation without neck extension, can be performed without sedation and paralysis, and can direct the endotracheal tube carefully past the injury. Double-

lumen tubes are avoided due to their larger size and rigidity which can extend the existing injury. Preferably, a long single lumen tube is advanced with the cuff beyond the site of injury, and into a mainstem bronchus if necessary. In our patient, with the injuries on the right side of the trachea immediately proximal to the carina, left-mainstem intubation was appropriate and achieved with the guidance of flexible bronchoscopy. Left-sided injuries that require isolation of the left lung present a challenge to the above strategy in that it can be difficult to maintain appropriate ventilation via a single lumen tube placed in the right mainstem bronchus and resulting occlusion of the right upper lobe of the lung. In the event of complete airway disruption or inability to maintain an adequate airway for the purposes of repair, use of extracorporeal membrane oxygenation (ECMO) can be considered [8,9]. The cardiac surgery perfusion team should be made readily available. If the patient is hemodynamically stable, venovenous ECMO can be adequate. Otherwise, veno-arterial ECMO or full cardiopulmonary bypass should be considered. The latter is most appropriate in the setting of a combined airway and great vessel vascular injury. Cannulation strategies should account for concomitant vascular repairs and likely limited access to neck vessels.

Following airway stabilization, other life-threatening injuries are stabilized and managed appropriately. The third challenge is the repair of the tracheobronchial injury itself. In cases of critically injured, unstable patients, repair can be delayed [7]. This can be particularly helpful if the injury is cranial to the cuff of the endotracheal tube to minimize the effects of positive pressure and ongoing mediastinal contamination. Otherwise, prompt and definitive repair should follow the diagnosis of the injury. Intrathoracic tracheal and right bronchial injuries are best approached through a right thoracotomy in the fourth intercostal space. An injury to the proximal left bronchial tree is also best approached via right thoracotomy as long as it is within 2 cm of the carina. A sternotomy adds little utility to a cervical collar incision as the airway dives behind the great vessels

and heart. A left thoracotomy is useful only for distal left mainstem injuries once the airway is accessible from its location beneath the aortic arch. A vascularized pedicle flap is desirable when possible, which can include pericardium, pericardial fat, pleura, intercostal muscle, or omentum.

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