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Anesthetic Management of Neck Trauma with Traumatized Airway: A Case Report and Review

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Abstract

Neck trauma with a traumatized airway can be challenging for airway management, as the neck is a vital structure. **Case Report:** We are reporting on a 33-year-old male worker who suffered an industrial accident. A steel cord severely hit his neck. He was brought to our ER immediately. Upon arrival, he was conscious with stable vital signs. A physical examination revealed that his Adam's apple was penetrated, and the adjacent soft tissue and structures were visible. A CT scan showed an anterior and left lateral neck penetrating injury with an open wound, exposure of the thyroid cartilage, a left thyroid cartilage fracture, and pneumoderma. He was urgently taken to the operating theater for airway stabilization and underwent six hours of exploration of the laryngopharyngeal cavity and closure of the laryngopharyngeal defect. He was then sent to the ICU. After two months in the hospital, he regularly follows up in the outpatient department. **Conclusion:** Effective decision-making for neck trauma with a compromised airway is crucial to ensure the patient's safety.

Keywords

Neck Trauma, Traumatized Airway, Neck Penetrating Injury, Airway Management, Surgical Airway

1. Introduction

Neck penetrating trauma accounts for 5% - 10% [1] of all injuries and is commonly caused by objects such as knives, bullets, metal rods, glass fragments, and bamboo sticks [2]-[4]. Data on neck injuries are typically derived from combat situations or industrial accidents. During the Vietnam War in the 1970s, 6% of soldiers killed in action sustained isolated airway injuries. Data from the Joint Theatre Trauma Registry of the United Kingdom Defence Medical Services from 2006 to 2008 indicate that 5% of penetrating vascular injuries in head, face, or

neck trauma cases involved airway injuries, with only 13 individuals experiencing laryngotracheal penetrating injuries [5]. In 2022, there were 4274 victims of workplace accidents in Macau, with an incidence rate of 11.7 per thousand workers [6]. Neck injuries accounted for only 1.1% [6]. Neck trauma with a traumatized airway is a rare situation, though less frequent (approximately 10%), carries a high mortality rate as penetrating neck injuries present a complex and critical challenge that necessitates a multidisciplinary approach. Clinicians may not always have sufficient time for thorough assessment and intervention when faced with a difficult airway [7]. Laryngeal and tracheobronchial injuries are particularly crucial to address in blunt trauma above or below the larynx, as these injuries can be difficult to diagnose and potentially life-threatening. For patients who are uncooperative, in urgent situations, or unable to undergo adequate preoxygenation, effective communication among operators is emphasized. Given the low incidence of airway trauma, anesthesiologists must recognize the risks associated with definitive airway management to ensure airway safety. A multidisciplinary approach, including anesthesiology, otolaryngology, and vascular surgery, is necessary to ensure airway safety, repair damaged tissues, and provide comprehensive perioperative care. Timely intervention and thorough evaluation are essential for improving patient survival rates. The anesthesiology team faces a significant challenge when confronted with complex clinical scenarios due to limited experience in managing such cases.

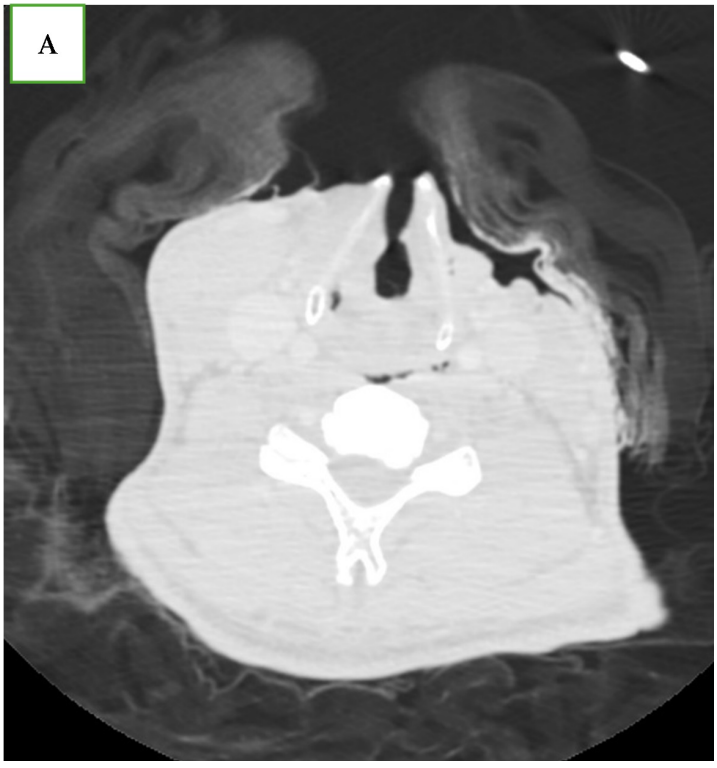
2. Case Report

A 33-year-old male worker with no significant medical history was sent by ambulance to the emergency room (ER) due to an industrial accident. A steel cord seriously hit his neck. He was immediately brought to the ER with an estimated blood loss of 1 liter at the scene (**Figure 1**). On arrival, he was conscious, could follow commands, and had full mobility in all four limbs. Physical examination revealed penetration of the laryngeal prominence, with adjacent soft tissue and structures visible. The patient's blood pressure was 139/86 mmHg, heart rate 83 bpm, and SpO_2 100% on room air. His face showed no apparent wounds or lesions, his mouth was open by 3 cm, and there were many blood clots inside. Bilateral lung auscultation revealed rough breathing sounds. Given the patient's relatively stable vital signs, a decision was made to proceed with computed tomography (CT) imaging for further diagnostic evaluation. This was deemed appropriate based on his hemodynamic stability, allowing for a comprehensive assessment of potential injuries without compromising his immediate physiological status.

Urgent CT showed an extensive irregular open wound on the anterior and left lateral neck, mainly in the left anterior triangle region. It is associated with local defects in the skin, subcutaneous soft tissues, and part of the left sternocleidomastoid muscle. The left lamina and laryngeal prominence of the thyroid cartilage are exposed. Linear radiolucency was noted on the thyroid cartilage left lamina near the laryngeal prominence. Subcutaneous emphysema is present in the neck,

predominantly on the left side, extending to the left carotid space and prevertebral/retropharyngeal spaces. There is no significant narrowing of the airway in the larynx and trachea. The left common carotid artery and left internal jugular vein are patent (Figure 2). No evidence of active contrast extravasation. The atlantoaxial space is within normal limits. The skull base and nasopharynx are unremarkable. There is no evidence of acute hemorrhage in the imaged intracranial region. Ground-glass and striped opacities are present in the left lung lower lobe (LLL). No infiltration or atelectasis in the right lung and the rest of the left lung. No pneumothorax, pleural, or pericardial effusion.

Figure 1. Physical examination showed that the patient's laryngeal prominence was penetrated, exposing the adjacent soft tissue and structures.



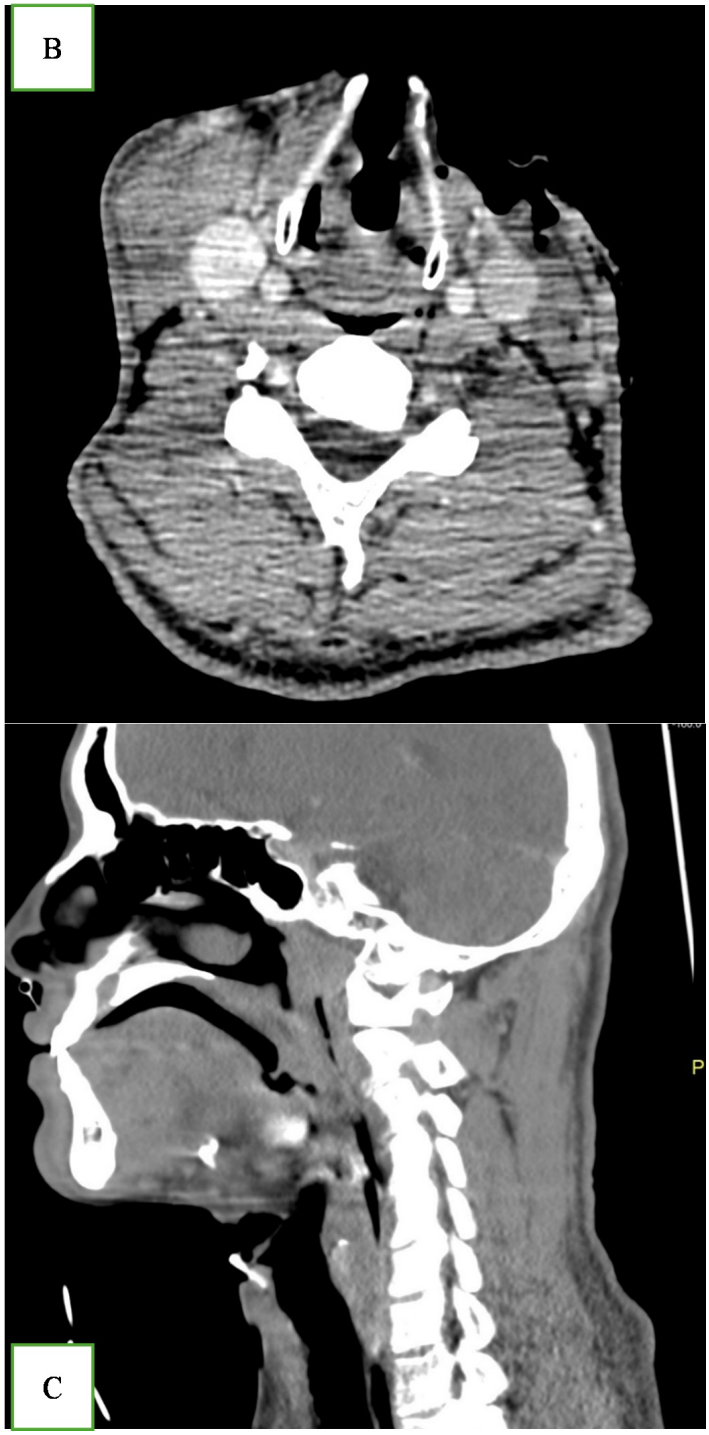


Figure 2. An urgent CT showed an extensive irregular open wound on the anterior and left lateral neck, primarily in the left anterior triangle region. It is associated with local defects of the skin, subcutaneous soft tissues, and part of the left sternocleidomastoid muscle. (A: Non-contrast CT scan of the injury; B: Contrast CT scan of the injury; C: Sagittal view).

Under the impression of:

1) Anterior and left lateral neck penetrating injury with an open wound, exposure of thyroid cartilage, left thyroid cartilage fracture, and pneumoderma.

2) Suspicion of LLL contusion.

He was sent to the operating theater immediately. While the patient was being prepared, he received fluid support, oxygen support, antibiotics, and a proton pump inhibitor injection. A three-way central catheter was inserted into the right femoral vein in the emergency department.

The patient's health history was noted, but the need for surgery due to open airway trauma was confirmed. The traumatic airway required stabilization, and the broken structure needed repair.

Anesthetic and Airway Management

Upon admission to the operating room, the patient's vital signs were stable. Standard anesthetic monitoring equipment, including invasive blood pressure monitoring, was prepared, and adequate oxygenation was ensured.

Extensive discussions with the ENT team focused on the anesthesia induction approach, considering the direct visualization of the exposed thyroid cartilage and glottis. A plan for general anesthesia with endotracheal intubation was established, prioritizing a stable and secure airway before proceeding with the surgery. Given the open-airway nature of the procedure, it was crucial to prevent tissue retraction or bleeding from compromising the success of tracheal intubation. Therefore, the thyroid cartilage was stabilized with assistance from the otolaryngologist.

Rapid Sequence Induction (RSI) was chosen as the induction technique, using fentanyl at 2 μg/kg, propofol at 2.5 mg/kg, and rocuronium bromide at 1.2 mg/kg. An ETT size 6 (ID: mm) was inserted (**Figure 3**). Additionally, the assisting anesthesiologist was prepared with a suction device to address any potential bleeding or blood clot obstruction of the airway [7] [8].

In light of the potential for pulmonary contusion, a protective lung ventilation strategy was implemented, setting the tidal volume initiate around 6 mL/kg and maintaining plateau pressure ≤ 30 cmH_2O. Fluid administration was conducted under invasive arterial monitoring to prevent fluid overload. Sevoflurane was used for inhalation, and the operation lasted for 6 hours.

Figure 3. Under the RSI plan, with suction ready and assistance from the ENT doctor, a cuffed 6.0 ETT was inserted through the open wound.

A 15 cm horizontal (Figure 4) wound was found in the anterior cervical region with exposed thyroid cartilage. The infrahyoid strap muscle and the bilateral anterior border of the SCM were lacerated, mainly on the left side. Further exploration revealed multiple oozing abrasions over the left external jugular vein, which was ligated. There was no obvious carotid sheath or nerve injury. A laryngopharyngeal cavity laceration was present at the level of the upper border of the thyroid cartilage, with approximately 4/5 of the circumference affected, worsening on the left side. The epiglottis was completely transected at the root level, and the hyoid bone was broken into fragments. Exploration of the laryngopharyngeal cavity and closure of the laryngopharyngeal defect were performed after a tracheostomy. Complete hemostasis was achieved, a nasogastric tube was inserted via the left nostril, and the surgical cavity was irrigated with normal saline and Flagyl solution. The wound was then closed in layers, and a compression dressing was applied. Total blood loss during the surgery was around 50 ml.

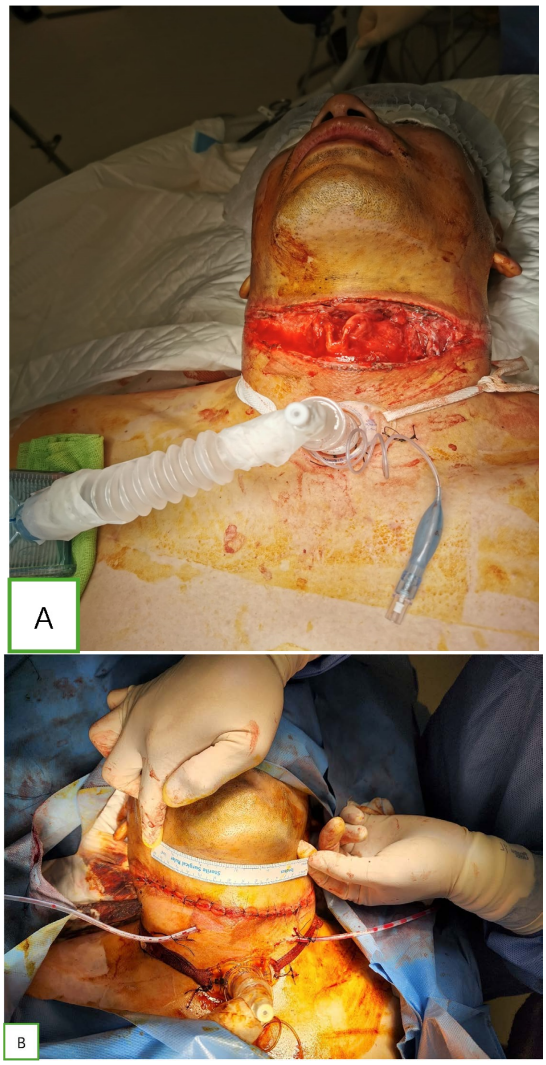


Figure 4. Post-tracheostomy; B: Post-exploration of the laryngopharyngeal cavity and closure of the laryngopharyngeal defect.

3. Evolution

The patient underwent a 12-day course of treatment in the Intensive Care Unit (ICU), which included intravenous antibiotics, pain management, and supportive therapies. During this period, the patient's overall condition and the surgical site in the neck gradually improved. To ensure no abscess formation in the neck and chest, the patient had two computed tomography (CT) scans, which showed no significant signs of abscesses. However, during the ICU stay, the patient received antifungal therapy for pneumonia caused by *Candida albicans*.

After 12 days of treatment, the patient tolerated a tracheal mask and supplemental oxygen (flow rate of 2.5 - 3 L/min), with stable blood gas analyses and reduced secretion at the neck wound site. On postoperative day 25, a flexible endoscopic examination revealed smooth mucosa in the pharynx and larynx without edema or hemorrhagic secretions, and normal bilateral vocal cord movement. The patient remained alert and oriented, without the need for oxygen support. The otolaryngologist replaced the tracheostomy tube with REF 888-306-08. The patient was discharged two months post-surgery and continued regular follow-ups in the ENT and rehabilitation outpatient departments. At a six-month follow-up, the patient's tracheostomy was closed already. He was able to eat and speck normally, exhibited good tongue mobility, and regained neck range of motion. Unfortunately, no photographs documenting the healing of the neck wound were retained. Aside from occasional neck pain complaints, the patient resumed normal community activities.

4. Discussion

Neck trauma is rare but can be fatal [9] [10]. Traumatic airway injury is even rarer, with an incidence rate of less than 1% in the general population [11]. Given the infrequency of penetrating neck trauma, it's crucial to ensure airway safety. Even when the airway is visible, careful attention is needed to prevent airway loss.

The anatomical region of the neck encompasses numerous critical structures (**Tabel 1**), rendering the management of cervical trauma highly challenging. The complexity of these structures can present significant difficulties in both diagnosis and treatment. For clinical management, the neck is divided into three zones [12]: Zones 1, 2, and 3. In cases of penetrating trauma, these zones significantly influence anatomical considerations, diagnostic approaches, and management strategies.

Table 1. The structures of the neck in Zone.

Zone I	Zone II	Zone III
Thoracic outlet vasculature	Common carotid arteries	Distal portion of the internal carotid arteries
Proximal carotid arteries	Internal and external branches of carotid arteries	Vertebral arteries
Vertebral artery	Vertebral arteries	Jugular veins
Apices of the lungs	Jugular veins	Pharynx
Trachea	Trachea	Spinal cord

Continued

Esophagus	Esophagus	Cranial nerves IX, X, XI, XII
Spinal cord	Larynx	Sympathetic chain
Thoracic duct	Pharynx	Salivary and parotid glands
Thyroid gland	Spinal cord	
Jugular veins	Vagus and recurrent laryngeal nerves	
Cranial nerve X (vagus nerve)		

A retrospective study of 19 cases of penetrating neck trauma admitted from January 2016 to December 2018 at a tertiary care hospital in India showed that the majority of patients had zone II injuries [9] [10]. In comparison to Zone I, which includes major vessels, lungs, and the trachea, and Zone III, where access is challenging due to its proximity to the skull base, hemorrhage control in Zone II is more manageable. The anatomical characteristics of Zone II facilitate easier access and intervention, making it more amenable to surgical exploration and hemostasis in cases of neck trauma or vascular injury [11]. Desjardins *et al*. [11] reported on the experience at Ryder Trauma Center in evaluating and managing zone II penetrating injuries. For patients with unstable vital signs, hemorrhage, or obvious injury, immediate exploration is recommended. For stable patients with platysma penetration, the following diagnostic steps are recommended: laryngoscopy/bronchoscopy, arteriogram, and esophagography. If results are positive, exploration is recommended, while observation could be considered when findings are negative. If findings are inconclusive, esophagoscopy could be considered.

According to the Advanced Trauma Life Support (ATLS) guidelines, airway assessment is the first and key step for trauma patients, followed by breathing, circulation, disability (e.g., neurologic evaluation and cervical spine stabilization), and exposure (e.g., hypothermia, smoke inhalation, intoxicants). Patients with traumatic airway injuries may exhibit nonspecific signs and symptoms that do not necessarily correlate well with the anatomical location of the injury. This discordance between clinical presentation and underlying pathology poses a significant diagnostic challenge. Moreover, the clinical status of these patients is often precarious and can deteriorate rapidly, necessitating vigilant monitoring and prompt intervention. For patients who are relatively cooperative and hemodynamically stable, and when time permits, it is prudent to proceed with advanced imaging studies to formulate a comprehensive management plan [9]. This approach allows for a more thorough evaluation of the patient's condition and aids in strategic decision-making. In the case presented, once the patient's vital signs were stabilized and baseline physiological parameters optimized, we elected to pursue diagnostic imaging studies. This course of action exemplifies the balance between immediate intervention and thorough assessment in trauma management. It underscores the importance of clinical judgment in determining the appropriate timing for advanced diagnostics. By ensuring the patient's stability before transport for

imaging, we mitigated the risks associated with movement while maximizing the potential for obtaining crucial diagnostic information. This decision-making process is dynamic and should be continually reassessed based on the patient's evolving clinical status. Safely obtaining detailed imaging can significantly inform subsequent management strategies, potentially improving patient outcomes in complex trauma cases. For uncooperative patients, time is critical. In such situations, pre-oxygenation can be challenging, and any delay in securing the airway may lead to rapidly worsening hypoxemia. Professional societies, including the American Society of Anesthesiologists (ASA), have developed specific advice for difficult airway management, as a traumatic airway can easily develop into a "cannot ventilate, cannot oxygenate" scenario. The ASA's 2021 guidelines emphasize oxygenation before and throughout airway management attempts. Tools for intubation, such as direct laryngoscopy, videolaryngoscopy, or a fiberoptic scope, are all reasonable options. The selection of the appropriate intubation technique depends on two critical factors: the operator's proficiency with the available equipment and the patient's current clinical status [13]. Rapid sequence induction (RSI) and manual linear axial stabilization of the head and neck for intubation can be successfully used, although the use of RSI in this context is still controversial [9] [11]. Leilani *et al*. [7] suggested prioritizing the avoidance of positive pressure ventilation above the site of airway injury, (e.g., BVM, SGA) as this may lead to subcutaneous emphysema, potentially obliterating airway landmarks and increasing the risk of catastrophic loss of the airway. Positive pressure ventilation can be safely initiated once the airway is secured below the site of injury. They also agreed that managing a partially transected trachea may seem easier since the trachea is visible. However, there is a significant risk of complete tracheal transection if a bronchoscope or endotracheal tube is inserted without proper tracheal stabilization, which can cause the distal trachea to retract into the thoracic cavity. Otolaryngology performed a distal tracheostomy, enabling proximal exploration and repair in the operating room, is recommended [14].

Furthermore, prolonged efforts to ensure airway safety can delay the definitive treatment of other life-threatening injuries. Airway management should be conducted concurrently with other resuscitative interventions performed by team members to minimize adverse outcomes. A surgical airway is always planned if the clinician cannot oxygenate or ventilate or after three failed attempts at endotracheal intubation, according to the guidance of the Western Trauma Association. In cases of extensive airway trauma or when the injury involves the subglottic region, establishing a surgical airway may be the optimal initial approach to airway management.

5. Conclusion

Airway management in patients with various trauma causes requires a variable management plan. Effective collaboration within the multidisciplinary surgical team significantly enhances the likelihood of successful airway management in

patients with cervical airway pathologies. This synergistic approach is crucial in navigating the complex challenges presented by such cases.

Ethical Considerations and Informed Consent

Informed consent was obtained from the patient for this case report. The process included explaining the report's purpose, content, potential benefits and risks, and assuring patient confidentiality. The patient was informed of their right to withdraw consent and agreed to the use of their medical information for educational and research purposes, in compliance with institutional ethical guidelines.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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