Case Conference

Field Airway Management of a Construction Worker with an Impaling Rebar Injury to the Neck and Brain
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Abstract

This article discusses a case of airway management by air ambulance emergency medical services (EMS) providers in a 22-year-old man impaled through the neck into the brain with a 0.5-inch rebar. Penetrating neck injuries (PNIs) with impalement are extraordinarily rare. It is important for EMS providers and emergency medicine physicians to have an understanding of the initial management of an impaled patient with PNI, including having an organized approach to establishing a definitive airway and recognizing the airway complications that PNI may cause. This article discusses out-of-hospital management of impaled patients. Key words: impalement; penetrating neck injury; airway management; rapid-sequence intubation

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Case Report

An air ambulance was dispatched to rendezvous with a rural volunteer emergency medical services (EMS) unit at the scene of a construction accident. A healthy 22-year-old man standing on a 12-foot construction ladder had lost his footing and fell, impaling himself through the left anterior neck with a 0.5-inch rebar that was sticking approximately 6 feet out of the ground. He did not lose consciousness. The injured man screamed for help, and his coworkers immediately called 9-1-1. The patient was fixed in the standing position with his knees slightly bent, as the rebar impaled him in an upward trajectory through his left anterior neck. He was awake, alert, and talking. A side grinder was used to cut the rebar 1.5 feet from the entrance wound; the estimated time between finding and freeing the patient was approximately 5 minutes. After being freed, the patient was laid on his back with the rebar extending over his chest. The patient was initially talking; however, his mental status quickly declined and he attempted to pull out the rebar, at which point he was restrained by his coworkers.

Volunteer firefighters and emergency medical technician (EMT)-Basic providers arrived approximately 15 minutes after receiving the emergency call and found the patient unresponsive with seizure-like activity in progress. Blood was noted in the upper airway, with minimal blood loss from the entrance wound. The patient was placed on his side for airway protection, and once the seizure-like activity ceased, he was strapped to a long spine board with the rebar secured by a rolled-up blanket and 4×4 gauze. The patient would no longer follow commands as he was attempting to free himself. He was taken to the back of a ground ambulance and vital signs were verbally reported as stable, with oxygen saturation of 100% on room air. His airway was suctioned and he was placed on oxygen via face mask, which was later transitioned to a nasal cannula. Intravenous (IV) access was established after advanced EMTs arrived. The patient continued to be combative and minimally responsive, requiring several first responders to restrain him.

The air ambulance arrived on scene 52 minutes after the initial 9-1-1 call, and found the patient strapped to a backboard, combative, and being restrained by four first responders. The rebar was visible overlying the left anterior aspect of the chest with blankets surrounding the entrance site. Upon removal of the
overlying material, the rebar was noted to be protruding superiorly through the left anterior aspect of the neck, lateral to the trachea and inferior to the angle of the left side of the mandible, with no exit wound noted (Figs. 1 and 2). The rebar was firmly in place with minimal movement and there was scant bleeding with notable tracheal displacement to the right. There was trace blood in the oral cavity and the patient had snoring respirations but no evidence of stridor. Given the location of the injury with the declining respiratory and mental status, an imminent loss of airway was anticipated and plans for a definitive airway were activated. The patient’s neck was assessed for possible emergent cricothyrotomy, but the positioning of the rebar resulted in flexion of the neck and difficulty palpating anterior neck landmarks. Given that the airway was intact without obvious visible trauma, preparations were made for oral tracheal intubation.

![Figure 1](image1.jpg)

**Figure 1.** Entrance wound located at the left anterior aspect of the patient’s neck just lateral to the trachea and inferior to the mandible.

![Figure 2](image2.jpg)

**Figure 2.** The 0.5-inch rebar impaled through the left anterior aspect of the patient’s neck with a superior medial trajectory. There is notable flexion of the neck and poor access to the anterior aspect of the trachea.
Air ambulance providers were positioned on the floor in the back of an ambulance, and the patient was preoxygenated with 15 L of oxygen via face mask. After appropriate nitrogen washout, the patient was sedated with etomidate 20 mg IV and ventilated with a bag–mask a few times before he was paralyzed with succinylcholine 100 mg IV. There was initial difficulty visualizing the oropharynx secondary to flexion of the neck, and attempts at sweeping the tongue out of the way resulted in the laryngoscope handle’s striking the rebar overlying the patient’s chest. The laryngoscope was rotated clockwise and a Macintosh 4 blade was used to visualize a laterally displaced larynx (Fig. 3). No blood was noted in the larynx and the rebar was not visible, allowing the gum elastic bougie to be advanced through the trachea followed by placement of a 7.0 endotracheal (ET) tube. The ET tube position was confirmed with bilateral breath sounds and positive end-tidal carbon dioxide exchange. The patient’s oxygen saturation (SpO₂) maintained at 100% with a bag–mask. The patient then received rocuronium 50 mg IV and fentanyl 50 mg IV while a brief secondary survey was completed, showing no other injuries. Because of the position of the rebar, a cervical collar could not be placed. Vital signs at the time of transfer to an air ambulance were blood pressure 195/109 mmHg, pulse rate 114 beats/min, respiratory rate 17 breaths/min, and SpO₂ 100% via bag–mask ventilation. En route to the hospital, the patient became bradycardic with continued hypertension despite adequate sedation. His heart rate was in the upper 40s to lower 50s (beats/min) and this change was concerning for increased intracranial pressure, as the rebar had likely entered the cranial cavity. As a result, mannitol 100 g IV was infused and the patient was delivered to the trauma center in critically ill condition.

Computed tomography (CT) of the head and neck revealed rebar extending through the jugular foramen next to the carotid artery and internal jugular vein. A significant portion of the rebar protruded into the brain (Fig. 4). There was evidence of cerebral edema with midline shift, intraventricular hemorrhage, and subdural hematoma. A multidisciplinary team of neurosurgeons, otolaryngologists, and interventional radiologists was assembled and the patient was taken to the operating room. A tracheostomy was performed and the rebar was successfully removed (and noted to be within 1 mm of transecting major vessels within the patient’s neck). There was no significant damage to any major neurovascular structures of the neck. The patient recovered well from the surgery, spending three weeks in the hospital and one week in rehabilitation. At the last follow-up he was at home with his
family and nearly back to baseline with minimal neurologic deficits.

**DISCUSSION**

Penetrating neck injuries (PNIs) make up approximately 1% of all traumas, and PNIs in which the patient becomes impaled are extraordinarily rare. Very few cases described in the literature have successful outcomes, and none of these cases include airway management and intubation at the scene by EMS personnel. Prehospital care is a crucial component to the successful outcomes of trauma patients, and standard trauma protocols should be followed at all times for any patient with an impalement injury. The initial priority of EMS should be ensuring rapid freeing of the patient from suspension by qualified personnel. The penetrating object should be left in place with the overall size and bulk of the object trimmed if possible.

Appropriate equipment for freeing patients is often not available at the scene, especially in the rural setting, as in this case. Hydraulic cutters are capable of cutting thick metal objects, but the pressure force generated often results in bending and twisting of the object as it is being cut. This can result in additional damage to underlying tissues and structures. Saws are capable of cutting metal; however, the metal can become significantly heated, which may also result in further damage. Fortunately, the heat generated by the side grinder used in this case did not result in significant damage.

The neck contains many vital structures in a confined space, and injury to any of these structures can have disastrous outcomes. Fatalities from PNI generally result from direct injury to the major vessels of the neck. Following removal of the patient from the impalement suspension, cervical spine protection and controlled airway management are of the utmost importance. Because of the nature and rarity of PNIs, there is no consensus on optimal airway management in these types of patients. Penetrating neck injuries are among the most difficult airways cases to manage. Studies describing airway management in PNIs have been performed in emergency departments or operating rooms where alternative airway technology and physician specialists are available. Penetrating injuries requiring prehospital intubation are associated with a twofold increase in mortality rates as compared with a patient whose airway placement can wait until arrival at the hospital. However, studies have shown that the need for on-scene definitive airway establishment is an independent predictor of mortality, given that these patients suffer from the most severe injuries. Waiting until arrival at the hospital for definitive airway placement in a patient with a PNI may not always be an option. Bleeding and swelling within the tight fascial compartments of the neck can rapidly cause airway compromise in a patient who is initially felt to have a patent airway and no signs of acute respiratory distress. The absence of symptoms or swelling does not exclude the possibility of serious underlying injury, and failure to secure the airway drastically increases morbidity and mortality. Criteria for urgent intubation in PNI include acute respiratory distress, aspiration risk, airway compromise from blood or secretions, extensive subcutaneous emphysema, tracheal shift, or severe alteration in mental status. The patient in this case had multiple concerning signals for airway compromise, including tracheal shift, neck swelling, snoring respirations, and poor mental status. Waiting until hospital arrival was not an option for this patient.

The area of neck injury or the mechanism of injury does not correlate with the difficulty of
intubation. Careful evaluation of the airway and a planned approach, with knowledge and availability of an alternative procedure, are essential. Patients are often uncooperative and combative, as in this case, which can result in further damage and more rapid loss of the airway. It is recommended that the trachea and cricothyroid membrane be located before attempting any intubation in a patient with a PNI. The patient in this case had a flexed neck with poorly palpable landmarks. Had oral tracheal intubation not been an option or failed, repositioning the patient for improved access to the trachea and cricothyroid membrane would have been crucial. Blind intubations have the potential to create a blind passage and cause further airway injury and obstruction and, thus, should never be attempted in a patient with a PNI. Direct visualization is the preferred method. A comprehensive emergency medicine literature review on airway management in PNI concluded that rapid-sequence intubation (RSI) is the preferred method. Muscle relaxation has the potential to convert a partially obstructed airway to a complete obstruction; however, the passage of the ET tube is significantly facilitated and the “benefit of a secured airway likely outweighs the risk induced by paralysis.” It is always important to ensure the patency of the airway and the ability to ventilate the patient with bag-mask prior to complete paralysis.

Some form of cervical spine management should be carefully observed at every step in the care of these patients. As in this case, impalations often prevent placement of cervical collars. A comprehensive literature review concluded that in trauma patients with PNI, cervical and spinal immobilization may not be necessary, unless focal neurologic deficits are present. The risk of obscuring life-threatening complications such as expanding hematomas or airway compromise may outweigh the benefits of having a rigid cervical collar in place. Finally, it is important not to become distracted by the dramatic presentation of the impalement, and providers much ensure that an adequate secondary survey is performed, especially in injuries that occur from a fall from height.

CONCLUSION

Although PNIs with impalement are rare, it is important for EMS and emergency medicine physicians to understand the initial steps in managing these cases, including recognizing the difficulties that may be encountered when establishing a definitive airway. Any patient with signs or symptoms of impending airway compromise should have a definitive airway placed prior to transport. Although PNIs are some of the most difficult airways to manage, studies have shown that RSI with direct laryngoscopy remains the preferred method of securing the airway. Planning and setup for an alternative airway method should be completed prior to attempting RSI. Although standard trauma protocols should be followed at all times, it is important to recognize that cervical collar placement in PNIs or neck impalements may not be possible and may obscure life-threatening complications.

References