Blunt and Penetrating Airway Trauma

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KEYWORDS

• Airway management • Penetrating airway injury • Blunt airway injury

KEY POINTS

- Penetrating and blunt airway injury are associated with serious morbidity and mortality but fortunately are also relatively rare. Their infrequency has resulted in a relative paucity of data (usually in the form of retrospective observational cases or case series). These infrequent injuries vary in their location and associated injuries, precluding a prescriptive singular approach.
- Airway injury requires shifting our usual approach (bag-valve-mask ventilation [BVM], endotracheal intubation [ETI] with videolaryngoscopy [VL] or direct laryngoscopy [DL], and SGA insertion or cricothyrotomy should hypoxia occur) to avoiding many of these.
- Positive pressure ventilation *above* the airway injury (eg, BVM, SGA) should be avoided if at all possible because this can result in subcutaneous emphysema obliterating airway landmarks with catastrophic airway loss. Positive pressure ventilation may be instituted once the airway is secured below the area of airway injury. Spontaneous ventilation should be maintained.
- Depending on the location of injuries, endotracheal intubation with VL or DL may result in formation of a false passage due to forces applied and the inability to visualize structures below the glottis. Blind supraglottic airway [SGA] placement and cricothyrotomy can convert tenuous airway continuity to complete airway disruption. Low open tracheostomy under local anesthesia only while keeping the patient in their position of comfort (generally sitting) may be the best approach. Therefore, airway management in patients with penetrating and blunt airway injury is best managed using a coordinated team approach including otolaryngology.
- Comfort with awake airway management is required. "Judicious sedation" is a retrospective descriptor. If the airway requires management (some do not), topicalization of the airway and clinician skillset should be the primary means of patient comfort, not sedation.

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CLINICAL PEARLS: GENERAL PRINCIPLES

1. Direct airway trauma, be that penetrating or blunt, is a high-stakes high-stress patient management challenge for any airway manager and their team. Blunt versus penetrating airway trauma has varied patterns of injury requiring prepracticed skills and coordination of care between specialties including prehospital and emergency medicine, anesthesiology, otolaryngology, and intensive care.
2. Variables including patient cooperation, coexisting trauma, cardiorespiratory stability, care location (remote vs tertiary care center), and anticipated course of airway trauma (eg, oxygenating well and comfortable vs increasing subcutaneous emphysema) will all play a role in determining airway if and when airway management is required.
3. Direct airway trauma is relatively infrequent, but its presence should be accompanied by in-person or virtual otolaryngology support.

CLINICAL PEARLS: BLUNT LARYNGEAL INJURY

1. The laryngeal complex (tracheal and cricoid cartilage) is protected by the jaw, but direct laryngeal blunt trauma (eg, hanging or assault) can occur. The laryngeal complex can be fractured, subluxed, or dislocated. The finding of one laryngeal fracture should lead to a search for other laryngeal injuries.
2. Blunt laryngeal trauma is associated with a myriad of symptoms and signs, including very little objective findings. The patient's muscle tone may be keeping their airway patent. Unless initiated below the area of injury, positive pressure ventilation can result in severe subcutaneous emphysema, loss of structure identification, and airway loss. Usual airway maneuvers, whether awake or postinduction, including endotracheal intubation, supraglottic device insertion, and cricothyrotomy can result in further airway injury, complete airway transection, and airway loss.
3. Airway managers should not be reassured by the diameter of an airway seen on CT scan; CT scan is a "snapshot" that does not show inspiratory and expiratory changes. Attempting to traverse an injured swollen laryngeal complex, even with a small ETT and flexible pediatric bronchoscope, can completely obstruct a swollen injured airway and lead to false passage creation.
4. Unless a patient is hypoxic and uncooperative, conservative oxygenation maneuvers such as high-flow humidified oxygen via face mask or nasal prongs should be used. Low tracheostomy under local anesthesia keeping the patient in their position of comfort can be lifesaving.

CLINICAL PEARLS: BLUNT TRACHEAL INJURY

1. The extrathoracic trachea below the larynx is less connected to surrounding structures compared to the larynx itself. Tracheal injury can oftentimes be managed conservatively. Owing to its tenuous blood supply, tracheal injury can result in long-term scarring and stenosis. Repeated attempts at endotracheal intubation can also result in tracheal injury.
2. Intrathoracic airway trauma is infrequent but can occur in the setting of blunt high-force thoracic trauma (eg, a patient holding their breath while an airbag goes off or an industrial incident such as cement truck impaction). If repair is required, oxygenation using venous-venous extracorporeal membrane oxygenation to minimize the need for anticoagulation while maintaining oxygenation not through the surgical field may be of benefit.

CLINICAL PEARLS: PENETRATING AIRWAY INJURY

1. Penetrating airway trauma is more common than blunt trauma. Although zones of the neck are useful in describing the initial point of injury, trajectory characteristics (eg, mass of trajectory, kinetic energy, direction and relative densities of encountered tissues) are unpredictable; zone of the neck on entry does not predict injury pattern.
2. Like blunt laryngeal injury, patients should be maintained in their position of comfort.
3. Any mucosal disruption along the aerodigestive tract can result in bubbling from a penetrating wound and/or subcutaneous emphysema; presence of these signs does not mean undeniable laryngeal or tracheal injury. Depending on the forces involved, penetrating injury can result in some subcutaneous emphysema around the entry and exit points.
4. Nasopharyngoscopy and CT scan may assist in determining the location and extent of airway injury above, in, or below the larynx. If airway management is required, these findings will help inform how to proceed.
5. Should airway management be required, options are awake or postinduction intubation. With either approach, the combination of videolaryngoscopy with flexible bronchoscopy allows for visualization above and below the vocal cords before and during the passage of the ETT.

BLUNT AIRWAY TRAUMA

Cause

Blunt neck injuries can lead to more morbidity and mortality than penetrating injuries.[1] Fortunately, of all patients presenting with head and neck trauma, laryngeal injuries are relatively rare: approximately 0.2% in a tertiary care trauma center.[2] If laryngeal injuries are present, 50% of patients will have concomitant trauma elsewhere including facial fractures, cervical spine fractures, and intracranial injuries.[2] Owing to its size and anterior location, thyroid fractures are the most common type of laryngeal injury and can be associated with additional subtle fractures (**Fig. 1**).[1]

The larynx consists of the tracheal and cricoid cartilages connected to one another via the cricothyroid joints laterally and the cricothyroid membrane anteriorly (**Fig. 2**).

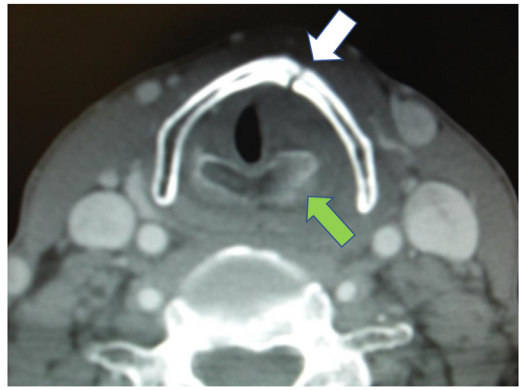

Fig. 1. Blunt injury due to an elbow to the neck showing a fracture to the thyroid cartilage (*white arrow*), and a less obvious fracture of the cricoid cartilage (*green arrow*).

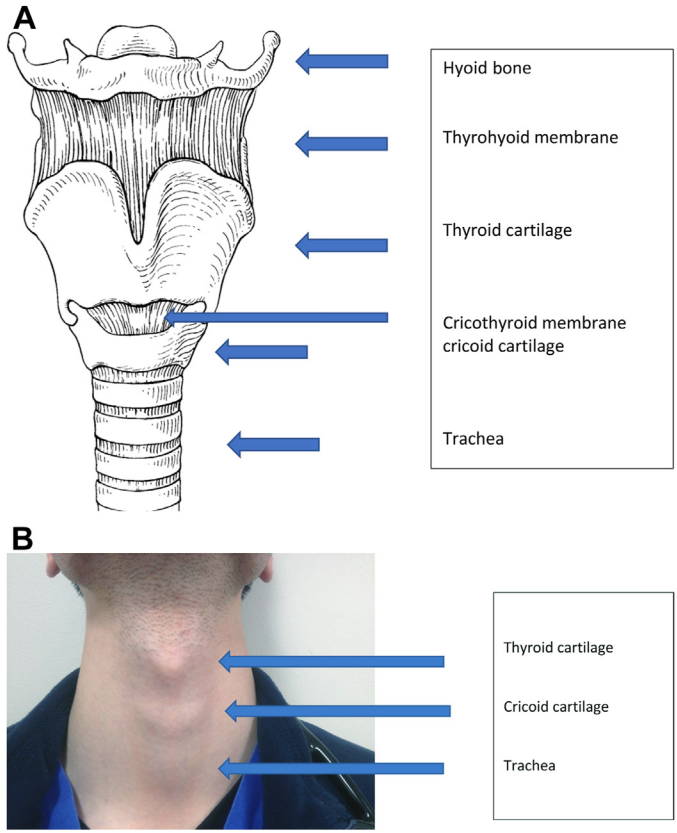

Fig. 2. (*A*) Normal airway anatomy. (*B*) Normal airway on physical examination. Males have a much more prominent thyroid cartilage compared with females. This photograph shows excellent cartilaginous landmarks for teaching purposes, not usually identified so easily in clinical practice. Neck extension results in the jaw no longer protecting the larynx from blunt or penetrating trauma.

Superior to the tracheal cartilage is the hyoid bone, and inferior to the cricoid cartilage is the trachea. Laryngeal trauma occurs when force is directed on the anterior neck resulting in laryngeal compression against the rigid posterior cervical spine. The lumen of the larynx may fill with hematoma, edema, or fracture fragments culminating in airway obstruction.[1]

Motor vehicle crash (MVC) is the most frequent cause of blunt neck injury, followed by assault[3] (**Fig. 3**). If vehicle occupants are unrestrained, MVC can lead to cervical spine extension leaving the larynx, usually relatively protected by the jaw, vulnerable to dashboard or steering wheel blunt trauma. Handlebars of a motorcycle can behave in a similar manner.[3,4] "Clothesline" injury occurs when a patient is caught by a fencing or wire at the neck level usually during a high-speed activity such as snowmobiling. These injuries can cause complete or incomplete airway transection. In a review of 655 patients with a hanging injury, only 5% were found to have laryngeal injuries. These hanging injuries were associated with 33% mortality, generally associated with global brain injury.[5] Sports injuries can also lead to laryngeal trauma from direct high-force projectiles to the throat (eg, rugby,[6] hockey[7]).

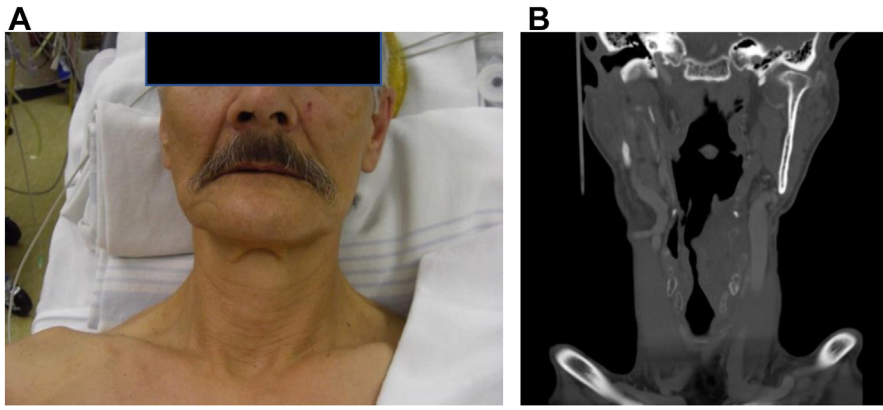

Fig. 3. (*A*) Laryngeal injury from an elbow to the larynx during an altercation. The patient had tenderness on palpation, odynophagia when swallowing secretions, and voice change. Loss of thyroid cartilage prominence may be present, but not obvious. (*B*) Computed tomographic scan revealed immense swelling of the larynx due to multiple fractures of both thyroid and cricoid.

Signs and Symptoms

Mechanism of injury may be helpful in increasing suspicion for a potential airway injury. The patient should be maintained in their position of comfort (eg, sitting up). In a large case series of patients who attempted suicide by hanging, more than 60% ingested alcohol before the attempt,[8] potentially influencing accuracy of obtained history or examination findings. If in place, the cervical spine collar requires removal to appropriately assess the patient. Symptoms of airway trauma include anterior neck pain, dysphonia, odynophagia, and dysphagia. Signs of airway trauma include neck and laryngeal tenderness, crepitus, ecchymosis, loss of laryngeal prominence in males, cartilaginous asymmetry, and subcutaneous emphysema. Gentle examination may reveal pain out of keeping with visual findings.

Supraglottic injuries may present with subcutaneous emphysema and dysphagia, whereas subglottic injuries are more subtle and may present with a persistent air leak after endotracheal intubation or chest tube insertion.[5] Injuries to the distal trachea and carina may present with subcutaneous or mediastinal emphysema.[6] Cricotracheal separation may show some external contusions and abrasions. Subcutaneous emphysema is almost always observed and indicates that surgical exploration is required due to breach in continuity of the airway.

Investigations

Should no external signs be present, and a high index of suspicion remains, nasopharyngoscopy can be invaluable in providing a bird's-eye view of the laryngeal inlet (the glottis) and surrounding structures (**Fig. 4**).[4] Unlike computed tomographic (CT) scan, nasopharyngoscopy has the advantage of keeping the patient sitting in their position of comfort. This position also prevents the patient's tongue from obstructing the view of the airway.[9] Endoscopic examination allows for a dynamic assessment of the airway throughout the patient's respiratory cycle versus a simple snapshot on CT scan. For this reason, nasopharyngoscopy should be performed before CT scan if possible.

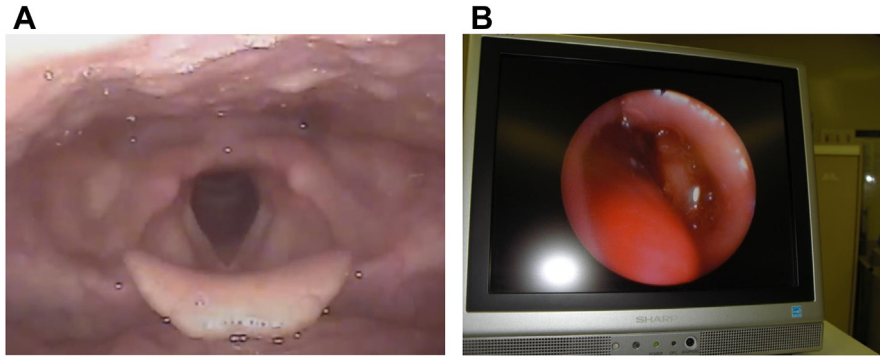

Fig. 4. (*A*) View of a normal larynx on nasopharyngoscopy. (*B*) View of the larynx after tracheostomy was placed in a patient with tracheal and cricoid fractures (also seen in Fig. 3A and B). Swollen hemorrhagic vocal cords are seen with almost complete obstruction of the glottic inlet. Attempting to place an ETT through such friable tissue with fractured cartilages would be perilous.

Important findings on nasopharyngoscopy include the presence of hematoma, edema, mucosal disruption, exposed cartilage, and impaired vocal fold mobility. Diagnostic imaging, such as CT should only be obtained if the patient is clinically stable and able to lay flat. CT helps evaluate the laryngeal framework, soft tissues vascular injuries, and the cervical spine.[10,11]

Airway Management

Important points

- Patients with airway trauma are at risk for airway obstruction due to ongoing swelling; this may occur over minutes or hours, depending on injuries.
- Avoid positive pressure ventilation above the level of injury; this can result in obliteration of identifiable landmarks and further airway obstruction.
- Traversing through a damaged larynx with an endotracheal tube (ETT) is high risk. Creation of a false passage, further airway damage, and complete airway obstruction can all occur. If a patient is oxygenating in their position of comfort, no airway management is required. Consult otolaryngology for possible awake open tracheostomy under local anesthesia with the patient in the sitting position.
- Should the patient decompensate, tracheostomy below the level of injury is required. Help in the form of a general or trauma surgeon should be called upon if otolaryngology is not immediately available.
- Because these injuries are infrequent and highly variable, the clinician must decide if tracheostomy below the level of injury is within their skillset or if the patient would be better served by using the skills the clinician possesses. The combination of gentle laryngoscopy (preferably videolaryngoscopy) with flexible bronchoscopy provides the ability to visualize above and below glottis simultaneously, and is recommended by the authors.
- Induction and paralysis of the patient can result in complete airway obstruction. Awake techniques are strongly indicated, however, should a patient become uncooperative and hypoxic from worsening airway obstruction; this may be required to optimize attempts at securing an airway.
- In the setting of laryngeal trauma, cricothyrotomy and rescue oxygenation with a supraglottic device are contraindicated.[9,11,12]

Specific Circumstances

- Surgical airway should be considered in cases of near transection of the trachea.[13]
- If there is known injury to the carina or main bronchi, there is a major risk that positive pressure ventilation (PPV) may lead to air leaks, creating respiratory insufficiency. Isolation of the affected bronchus is required along with thoracic surgery consultation.[14]
- Hyoid bone fractures usual require only conservative management and rarely require surgery.[15]

PENETRATING NECK AND AIRWAY TRAUMA

Cause

The neck contains a high concentration of vital structures important to survival all within a congested, narrowed space. Consequently, penetrating neck injuries (PNI) can be immediately life threatening (eg, expanding hematoma), or missed altogether on initial evaluation (eg, esophageal injury). Thankfully, PNI is relatively uncommon in civilian settings[16] such as Canada[17] and European countries.[18] In the US trauma centers PNI can account for up to 5% to 10% of trauma cases,[17] an incidence commonly reported in military settings.[19,20] Mortality in civilian studies is 3% to 6%[21,22] in contrast to military studies with mortality rates of 11% to 28%.[19,20] This difference is likely due to the higher incidence of firearm and shrapnel injuries in the patients with military versus civilian trauma. Weapons producing higher kinetic energy inflict more damage[19] in a wider area compared with low-velocity PNI such as stab wounds.[16]

Approach to Penetrating Neck Injury

A well-prepared multidisciplinary trauma team is essential to improve the outcome.[18,23] Patients with PNI should be managed according to general trauma principles regardless of the mechanism[18] including a primary survey that looks to manage immediately life-threatening injuries.[10] Unlike blunt trauma, the cervical trachea is the part of the airway most commonly injured in PNI accounting for two-thirds of injuries and the larynx accounting for the other one-third.[24] Death is caused primarily by exsanguination secondary to major vascular injury or airway compromise[20,25] rather than due to the airway injury per se. Mortality due to major vascular injury may reach as high as 50%.[26] For this reason catastrophic hemorrhage must be prioritized and immediately addressed while preparing to secure the airway, and initiating hemodynamic resuscitation—the so-called cABCD approach to trauma.[27] Massive exsanguinating hemorrhage from a PNI may kill more quickly than suboptimal airway management and should be prioritized accordingly.[22]

PNI are classified according to the anatomic level of the injury[28] (**Fig. 5**).

However, when approaching the patient with PNI it is important to remember that the zone of the external wound correlates poorly with the level of the internal injury.[29,30] The internal structures injured are more a function of entry location and vector of travel.[27] Furthermore, PNI second to energized fragments such as from explosive devices or gunshot wounds can produce relatively innocuous entry wounds that belie the seriousness of the underlying injury[20] (**Fig. 6**).

The surgical management of PNI has undergone a shift in recent decades. The rigidity of the zone approach has been replaced with a more selective approach to surgical exploration especially of Zone 2 injuries.[26] Patients who show evidence of vascular or aerodigestive injuries may undergo immediate surgical exploration.[16]

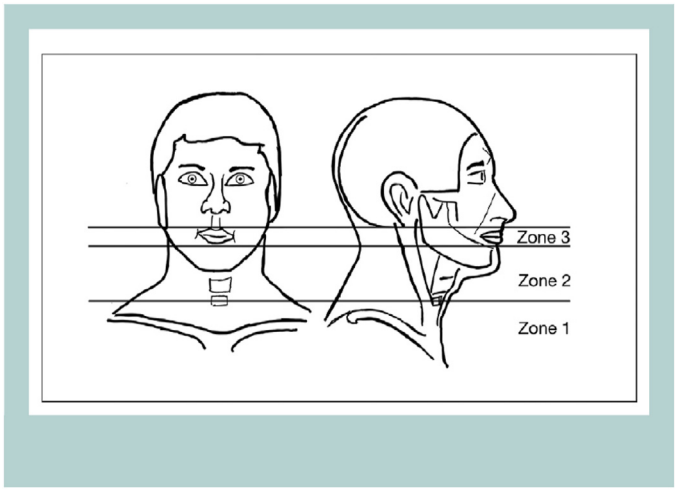

Fig. 5. Classic zones of the neck with respect to penetrating neck injury. Although these zones may be helpful to describe the entry point of an injury, multiple factors including kinetic injury, angulation, and encountering variable tissue densities will result in a trajectory that is not always predictable or guaranteed to stay in a single zone. (*Courtesy of* Shilston and colleagues, BJA Education 2021;21(9):329–35.)

The Western Trauma Association (WTA) algorithm for the approach to PNI emphasizes the importance of "hard signs" or vascular instability as the initial decision point in the management of patients with PNI.[31] "Hard signs" are defined as airway compromise, massive subcutaneous emphysema/bubbling through the wound, expanding/pulsatile hematoma, active bleedings, shock, neurologic deficit, and hematemesis.[31] Patients with any of these signs should be brought to the operating room expeditiously with delay only for airway management urgently required. Attempts to tamponade major active bleeding should occur while en route.

Fig. 6. Gunshot wound to Zone 1 of the neck at the sternal notch due to a gunshot. Minimal subcutaneous emphysema was palpable around the entry site. The patient complained of shortness of breath and numbness of her left hand but could lay flat. CT scan revealed no airway or lung injury. The bullet trajectory included grazing the brachial plexus and embedding into the medial border of the scapula.

There is *no* role for probing neck wounds in the trauma bay.[32] Moreover, clinically significant cervical spine injuries second to PNI are rare; therefore, there is also no role for cervical collars in the patients who are neurologically intact.[32] If a cervical collar is present, it should be removed to facilitate patient examination and management.

Airway Management

In keeping with the WTA approach to PNI, patients can be divided into 2 groups: unstable (the signs as listed earlier) and stable.[33] Clinical signs of upper airway injury due to PNI are often self-evident[34] with the vast majority presenting with respiratory distress. Injuries to the distal trachea and carina can present more insidiously sometimes with subcutaneous or mediastinal emphysema as the only sign present in an otherwise normal airway.[34] A persistent pneumothorax or a large air leak following chest tube placement should alert the clinician to this possibility and prompt further investigation and management.[35]

If an airway injury cannot be ruled out—either directly or secondary to distortion caused by hematoma and swelling deep within the wound—then the safest approach is to assume there is one and proceed accordingly.[33] Early airway intervention is advocated to avoid further distortion; decompensation may be rapid.[33] Inspiratory stridor suggests impending airway loss.[36] The specific approach to airway management will depend on the patient's clinical status, local resources, and clinical expertise.[2] PNI is one name for a constellation of pathologic conditions therefore airway managers may wish to base their approach and decision making on their own skill and available equipment versus a specific didactic treatment algorithm.[37]

Fortunately there are some general principles that can be applied. First, the airway should be considered difficult—both physiologically and anatomically—requiring both resuscitation and task focus simultaneously. These cannot be done well by a single person.[38] Calling for assistance and having an equipment checklist is a start. Equipment includes: (1) having at least 2 suction devices; (2) multiple-sized ETTs, including small-diameter ones, 5.0, 5.5, and 6.0 that are normal adult length (30 cm); pediatric ETTs are shorter and therefore may not be useful; (3) rescue airway devices including equipment for cricothyrotomy, tracheotomy, and supraglottic devices for rescue oxygenation and as a conduit for flexible scope-guided intubation; and (4) a well-briefed team as the airway plan.[30]

Optimizing human factors is paramount in the management of the anticipated difficult airway[39]; this includes acknowledging that this is an extremely stressful situation while engaging in strategies to mitigate the stress response and improve performance such as acknowledging the situation, team discussion, tactical breathing, and visualization.[38]

Patients presenting with PNI can be divided into 1 of 2 groups with respect to urgency of airway management—time critical versus non–time critical.[37] These patients will be further subdivided into cooperative and uncooperative. The authors focus on the patients for whom airway management is time critical.

Positive pressure ventilation before successful endotracheal intubation should ideally be avoided[33] or, if forced to do so, done with low inspiratory pressure to mitigate forcing air into injured tissue planes further distorting and disrupting the anatomy.[30] Positive pressure ventilation through supraglottic devices, usually a cornerstone for rescue oxygenation, should similarly be avoided.

Ideally airway management should be done in the operating room (OR) for reasons such as availability of airway and surgical expertise as well as an extended array of equipment. For example, the potential of converting a partial airway transection into a complete airway transection can be catastrophic (**Fig. 7**). The trachealis muscle, which constitutes the posterior wall of the trachea, will contract if complete airway

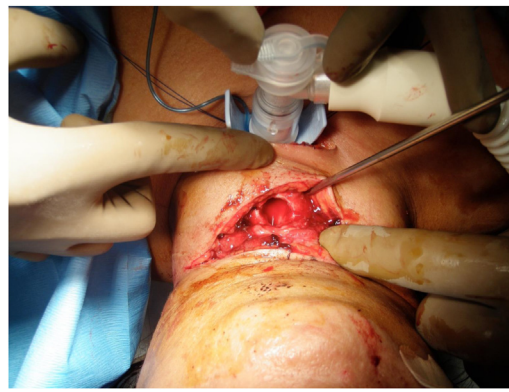

Fig. 7. Partial transection of the trachea due to assault. In a very real way, airway management becomes easier because the trachea can be visualized. The danger is forcing a bronchoscope or ETT into the trachea without stabilizing the trachea itself (eg, with tracheal hooks on opposite sides of the trachea). Without such stabilization, there can be complete airway transection and the loss of the distil trachea as it contracts into the thoracic cavity. In this case, airway management was performed by otolaryngology in the operating room as a distil tracheostomy to allow for proximal exploration and repair.

transection occurs, resulting in a distil trachea being pulled into the thoracic cavity. The loss of the airway may precipitate the need for immediate sternotomy. If a patient is unstable, uncooperative, or uncooperative because they are unstable, airway management will need to occur where the patient is, be that emergency department or CT scanner.

If possible, a device that allows to both access the trachea and inspect for more distil injury should be used[33]; flexible bronchoscopy meets this criteria. Fiberoptic bronchoscopes (FOBs) have now been replaced by camera chip technologies, and are now termed flexible bronchoscopes. Reusable flexible bronchoscopes are expensive ($15,000CAD and up) and require cleaning and maintenance. Disposable bronchoscopes cost approximately $300CAD not including the required screen (approximately $5000CAD), which usually has a proprietary connection port. Both pediatric and adult-sized disposable flexible bronchoscopes are available. Pediatric bronchoscopy may be useful if the airway is narrowed. Although at first glance disposable bronchoscopy may seem to be more environmentally costly, the impact of repeated processing of reusable bronchoscopes is similar to one-patient bronchoscopes.[40] One advantage of disposable bronchoscopy is the lack of worry required when handling the bronchoscope in a chaotic trauma room.

A flexible bronchoscope should not be relied on to suction large amounts of blood or clotted blood out of an airway, and the pediatric-sized bronchoscope generally has no suction ability. Although oxygen can be insufflated through the bronchoscope, we do not recommend this even at low flows (1–2 L/min) because it can lead to insufflating tissues similar to positive pressure ventilation. Because airway management in trauma generally consists of secretions and blood, the authors suggest placing a videolaryngoscope in the mouth such that a suction (eg, yaunker, DuCanto catheter [SSCOR Incorporated, California, USA]) can be used to decontaminate the airway under direct visualization. It is important that the ETT fit snuggly on the FOB and be well lubricated to decrease the chances of causing injury as the tube is being cautiously railroaded over the FOB into the airway.[28] The cuff of the ETT should be placed distal to the level of the injury before being inflated.[28]

For the cooperative non–time critical patient, diagnostic imaging can be performed, a plan formulated, and the patient maintained with spontaneous ventilation.[37] If airway injury is suspected—laryngotracheal or tracheobronchial—and endotracheal intubation is required, it should ideally be performed in the OR via awake FOB.[37] For the cooperative but time critical patient, awake flexible bronchoscopic intubation remains an option for both laryngotracheal and tracheobronchial injuries.[33,37] Dense airway topicalization is the cornerstone of smooth successful awake intubation, no matter what intubation instrument is used. Ideally topicalization should be performed without sedation to decrease the risk of oversedation, loss of upper airway tone, and apnea. Sedation should not be used to attempt to compensate for inadequate topicalization; the result is a coughing uncomfortable intermittently apneic and/or uncooperative patient, a situation that one has created. Careful titration of ketamine is an obvious choice because it tends to produce a more cooperative patient whilst maintaining upper airway reflexes.[33] There is the risk that the flexible bronchoscope may cause temporary complete airway obstruction in patients with already narrowed airways (see **Fig. 3**), which can be mitigated by minimizing the time of both bronchoscope and ETT in the airway and being cognizant of any patient indications of obstruction during this time. A calm anticipatory voice is equivalent to 2 mg of midazolam.

Primary surgical airway may be the best option depending on the level of the injury in the anatomically disrupted airway.[28,30] Of note, the surgical airway may be more difficult as a result of anatomic distortion second to hematoma and/or massive subcutaneous emphysema[41] especially if it is performed after a failed airway attempt if tissue emphysema or a false passage was created.[37]

If PNI may have inflicted damage to the airway above and below the vocal cords, the ideal approach is to use a VL tin conjunction with a flexible bronchoscope.[33] Each device overcomes the shortfalls of the other. The VL allows for direct visualization above the vocal cords and suctioning of gross fluids and blood. VL also allows for a better inspection of the upper airway because the use of the VL creates more space to see the upper airway anatomy and allows for targeted suctioning. The FOB should be placed into the upper airway under VL guidance. Rapid sequence intubation (RSI) drugs could also be used; however, this creates more time pressure to secure the airway because the patient is now apneic, and PPV is to be avoided. The choice of which VL blade to use is not simple (hyperangulated or approximately 60°-angled VL vs Macintosh or 30°-angled VL). Both can be equally obscured by blood and airway secretions; however, the MAC blade can be used as a direct laryngoscope should this occur, whereas the hyperangulated VL blades do not perform this double duty as well. Hyperangulated VL may have an advantage in that it requires less force for laryngeal visualization.[42] This less force may lead to more patient comfort.

Most importantly, the combination of VL + flexible bronchoscopy allows the airway managers (because 2 people are required) to visualize the ETT above and below the vocal cords. When flexible bronchoscopy is used alone, it is essentially a placeholder as the ETT is passed blindly, and sometimes with some twisting and force, over it. Adding VL to this allows for visualization of the ETT through the cords and bronchoscopy allows the airway manger the luxury of placing it exactly at the level they wish (video of this technique included with this submission).

RSI is the mainstay of emergency airway management, and it is considered by some to be the preferred option of intubating the airway in PNI especially in the time critical situation.[21] However, it is not without risk. RSI is a blind technique, which carries a higher risk of creating a false lumen outside the trachea, which will cause further airway distortion should it be unrecognized and PPV instituted. It can worsen an undiagnosed airway injury or laceration[29] precipitating complete obstruction of the

already tenuous airway.[43] If RSI is performed, cricoid pressure should be avoided because it may further injure the airway.[37] In addition, the loss of muscle tone and apnea caused by the medications used in RSI can precipitate complete and irreversible airway collapse.[4,22] It is not recommended in cases of near-airway transection because the tone of the supportive muscles may be all that is holding the airway together.[37] RSI can be considered a viable option especially in PNI where the airway needs to be controlled urgently and the anatomy is thought to be intact.[44] However, the clinician should anticipate complications and be immediately prepared to mitigate them including performing a surgical airway should a "Can't Ventilate, Can't Oxygenate" situation occur.[45]

CLINICS CARE POINTS

If you only have 2 minutes before the patient arrives:

- Significant blunt airway injury may have very little external findings on examination. These rare injuries generally have a history of direct anterior neck trauma such as assault or sporting injury. The forces involved may not be particularly large. Pain out of keeping with physical examination, swallowing inability or pain, voice change, and subcutaneous emphysema should make the clinician consider airway fracture and/or soft tissue injury.
- Cricothyrotomy is contraindicated in thyroid and/or cricoid cartilage fractures. Awake low tracheostomy can be lifesaving.
- In both blunt and penetrating airway trauma, if at all possible, the patient should be kept awake, alert, and in their position of comfort (usually sitting). "Judicious sedation" is a retrospective descriptor; avoid sedation.
- Awake tracheal intubation in the setting of thyroid and/or cricoid cartilage fractures has a high rate of failure and further airway injury.
- These infrequent injuries require a multidisciplinary approach including otolaryngology support.

DISCLOSURE

The authors have nothing to disclose.

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REFERENCES

1. Shi J, Uyeda JW, Duran-Mendicuti A, et al. Multidetector CT of Laryngeal Injuries: Principles of Injury Recognition. RadioGraphics 2019;39(3):879–92. Available from: http://pubs.rsna.org/doi/10.1148/rg.2019180076 [cited 2022 Oct 6].
2. DePorre AR, Schechtman SA, Hogikyan ND, et al. Airway Management and Clinical Outcomes in External Laryngeal Trauma: A Case Series. Anesth Analgesia 2019;129(2):e52–4. Available from: http://journals.lww.com/00000539-201908000-00024 [cited 2022 Oct 6].
3. Berger J, Tonglet M, Ransy P, et al. Direct and indirect injuries of the pharynx and larynx. B-ENT 2016;Suppl 26(2):59–68.

4. Verdonck P. Penetrating and blunt trauma to the neck: clinical presentation, assessment and emergency management. B-ENT 2016;Suppl 26(2):69–85.
5. Martin MJ, Weng J, Demetriades D, et al. Patterns of injury and functional outcome after hanging: analysis of the National Trauma Data Bank. Am J Surg 2005;190(6):838–43. Available from: https://linkinghub.elsevier.com/retrieve/pii/S000296100500680X [cited 2022 Oct 7].
6. Famokunwa B, Kemp S, Selby J, et al. Life-threatening laryngeal injury in Elite Rugby Union: Prevention and management laryngeal trauma in rugby. Clin Case Rep 2021;9(1):494–8. Available from: https://onlinelibrary.wiley.com/doi/10.1002/ccr3.3565 [cited 2022 Oct 7].
7. Feng AL, Parikh A, Gadkaree SK, et al. Laryngeal fractures in professional and semiprofessional ice hockey players. Laryngoscope Invest Otolaryngol 2020;5(6):1110–6. Available from: https://onlinelibrary.wiley.com/doi/10.1002/lio2.474 [cited 2022 Oct 7].
8. JJP Buitendag, Ras A, Kong VY, et al. Hanging-related injury in Pietermaritzburg. South Africa S Afr Med J 2020;110(5):400. Available from: http://www.samj.org.za/index.php/samj/article/view/12917 [cited 2022 Oct 7].
9. Comer BT, Gal TJ. Recognition and Management of the Spectrum of Acute Laryngeal Trauma. J Emerg Med 2012;43(5):e289–93. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0736467910003975 [cited 2022 Oct 6].
10. Lowe E, Patil S. Management of subacute airway emergency after blunt neck trauma. BMJ 2017;j141. Available from. https://www.bmj.com/lookup/doi/10.1136/bmj.j141 [cited 2022 Oct 6].
11. Mendis D, Anderson JA. Blunt laryngeal trauma secondary to sporting injuries. J Laryngol Otol 2017;131(8):728–35. Available from: https://www.cambridge.org/core/product/identifier/S0022215117001220/type/journal_article [cited 2022 Oct 6].
12. Leach R, Idrissi SH, Meulemans J, et al. Complex intubation, cricothyrotomy and tracheotomy. B-ENT 2016;Suppl 26(2):103–18.
13. Grewal HS, Dangayach NS, Ahmad U, et al. Treatment of Tracheobronchial Injuries. Chest 2019;155(3):595–604. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0012369218311127 [cited 2022 Oct 7].
14. Zhao Z, Zhang T, Yin X, et al. Update on the diagnosis and treatment of tracheal and bronchial injury. J Thorac Dis 2017;9(1):E50–6. Available from: http://jtd.amegroups.com/article/view/11555/9978 [cited 2022 Oct 7].
15. Ramchand T, Choudhry OJ, Shukla PA, et al. Management of Hyoid Bone Fractures: A Systematic Review. Otolaryngol Head Neck Surg 2012;147(2):204–8. Available from: http://journals.sagepub.com/doi/10.1177/0194599812451409 [cited 2022 Oct 7].
16. Tisherman SA, Bokhari F, Collier B, et al. Clinical Practice Guideline: Penetrating Zone II Neck Trauma. J Trauma Inj Infect Crit Care 2008;64(5):1392–405. Available from: https://journals.lww.com/00005373-200805000-00042 [cited 2022 Oct 7].
17. Tallon JM, Ahmed JM, Sealy B. Airway management in penetrating neck trauma at a Canadian tertiary trauma centre. CJEM 2007;9(02):101–4 . Available from: https://www.cambridge.org/core/product/identifier/S148180350001486X/type/journal_article [cited 2022 Oct 7].
18. Van Waes OJ, Cheriex KCAL, Navsaria PH, et al. Management of penetrating neck injuries. Br J Surg 2011;99(Supplement_1):149–54. Available from: https://academic.oup.com/bjs/article/99/Supplement_1/149-154/6140926 [cited 2022 Oct 7];.

19. de Régloix SB, Baumont L, Daniel Y, et al. Comparison of Penetrating Neck Injury Management in Combat Versus Civilian Trauma: A Review of 55 Cases. Mil Med 2016;181(8):935–40. Available from: https://academic.oup.com/milmed/article/181/8/935-940/4158374 [cited 2022 Oct 7].
20. Breeze J, Bowley DM, Combes JG, et al. Outcomes following penetrating neck injury during the Iraq and Afghanistan conflicts: A comparison of treatment at US and United Kingdom medical treatment facilities. J Trauma Acute Care Surg 2020;88(5):696–703. Available from: https://journals.lww.com/10.1097/TA.0000000000002625 [cited 2022 Oct 7].
21. Brywczynski JJ, Barrett TW, Lyon JA, et al. Management of penetrating neck injury in the emergency department: a structured literature review. Emerg Med J 2008;25(11):711–5. Available from: https://emj.bmj.com/lookup/doi/10.1136/emj.2008.058792 [cited 2022 Oct 7].
22. Burgess CA, Dale OT, Almeyda R, et al. An evidence based review of the assessment and management of penetrating neck trauma: Management of penetrating neck trauma. Clin Otolaryngol 2012;37(1):44–52. Available from: https://onlinelib20rary.wiley.com/doi/10.1111/j.1749-4486.2011.02422.x [cited 2022 Oct 7].
23. Cobzeanu MD, Palade D, Manea C. Epidemiological Features and Management of Complex Neck Trauma from an ENT Surgeon's Perspective. Chirurgia (Bucur) 2013;108(3):360–4.
24. Putz L., Muschart X., Borgers G. Tracheal Damage. B-ENT, 12 (Suppl. 26/2), 2016, 87-102
25. Simmons JD, Ahmed N, Donnellan KA, et al. Management of Traumatic Vascular Injuries to the Neck: A 7-Year Experience at a Level I Trauma Center. Am Surgeon 2012;78(3):335–8. Available from: http://journals.sagepub.com/doi/10.1177/000313481207800343 [cited 2022 Oct 6].
26. Bell RB, Osborn T, Dierks EJ, et al. Management of Penetrating Neck Injuries: A New Paradigm for Civilian Trauma. J Oral Maxillofacial Surg 2007;65(4):691–705. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0278239106013528 [cited 2022 Oct 7].
27. Simpson C, Tucker H, Hudson A. Pre-hospital management of penetrating neck injuries: a scoping review of current evidence and guidance. Scand J Trauma Resusc Emerg Med 2021;29(1):137. Available from: https://sjtrem.biomedcentral.com/articles/10.1186/s13049-021-00949-4 [cited 2022 Oct 7].
28. Shilston J, Evans DL, Simons A, et al. Initial management of blunt and penetrating neck trauma. BJA Education 2021;21(9):329–35. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2058534921000524 [cited 2022 Oct 7].
29. Madsen AS, Bruce JL, Oosthuizen GV, et al. Correlation between the level of the external wound and the internal injury in penetrating neck injury does not favour an initial zonal management approach. BJS Open 2020;4(4):704–13. Available from: https://academic.oup.com/bjsopen/article/4/4/704-713/6135879 [cited 2022 Oct 7].
30. Nowicki J, Stew B, Ooi E. Penetrating neck injuries: a guide to evaluation and management. Annals 2018;100(1):6–11. Available from: https://publishing.rcseng.ac.uk/doi/10.1308/rcsann.2017.0191 [cited 2022 Oct 7].
31. Sperry JL, Moore EE, Coimbra R, et al. Western Trauma Association Critical Decisions in Trauma: Penetrating neck trauma. J Trauma Acute Care Surg 2013;75(6):936–40. Available from: https://journals.lww.com/01586154-201312000-00002 [cited 2022 Oct 7].

32. Ball CG. Penetrating nontorso trauma: the head and the neck. CJS 2015;58(4): 284–5. Available from: http://www.canjsurg.ca/lookup/doi/10.1503/cjs.012814 [cited 2022 Oct 7].
33. Kovacs G, Sowers N. Airway management in trauma. Emerg Med Clin North America 2018;36(1):61–84. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0733862717300755 [cited 2022 Oct 6].
34. Putz L, Muschart X, Borgers G, et al. Tracheal damage. B-ENT 2016;Suppl 26(2): 87–102.
35. Kulkarni M, Prabhu M, Maddineni S. A novel method of airway management in a case of penetrating neck injury. Indian J Anaesth 2016;60(7):509. Available from: https://journals.lww.com/10.4103/0019-5049.186019 [cited 2022 Oct 7].
36. Jain U, McCunn M, Smith CE, et al. Management of the Traumatized Airway. Anesthesiology 2016;124(1):199–206. Available from: https://pubs.asahq.org/anesthesiology/article/124/1/199/14297/Management-of-the-Traumatized-Airway [cited 2022 Oct 7].
37. Mercer SJ, Jones CP, Bridge M, et al. Systematic review of the anaesthetic management of non-iatrogenic acute adult airway trauma. Br J Anaesth 2016 Sep; 117:i49–59. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0007091217337686 [cited 2020 Dec 26].
38. Lauria MJ, Gallo IA, Rush S, et al. Psychological Skills to Improve Emergency Care Providers' Performance Under Stress. Ann Emerg Med 2017;70(6): 884–90. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0196064417303141 [cited 2022 Oct 7].
39. Owston H, Jones C, Groom P, et al. The anaesthetic management of the airway after blunt and penetrating neck injury. Trauma 2020;22(1):3–6. Available from: http://journals.sagepub.com/doi/10.1177/1460408619886216 [cited 2022 Oct 7].
40. Andersen CØ, Travis H, Dehlholm-Lambertsen E, et al. The Cost of Flexible Bronchoscopes: A Systematic Review and Meta-analysis. PharmacoEconomics Open 2022;22. Available from: https://link.springer.com/10.1007/s41669-022-00356-0 [cited 2022 Oct 7].
41. Weale R, Madsen A, Kong V, et al. The management of penetrating neck injury. Trauma 2019;21(2):85–93. Available from: http://journals.sagepub.com/doi/10.1177/1460408618767703 [cited 2022 Oct 7].
42. Russell T, Khan S, Elman J, et al. Measurement of forces applied during Macintosh direct laryngoscopy compared with GlideScope ® videolaryngoscopy*: Applied forces during videolaryngoscopy. Anaesthesia 2012;67(6):626–31. Available from: https://onlinelibrary.wiley.com/doi/10.1111/j.1365-2044.2012.07087.x [cited 2022 Oct 7].
43. Kim JP, Cho SJ, Son HY, et al. Analysis of Clinical Feature and Management of Laryngeal Fracture: Recent 22 Case Review. Yonsei Med J 2012;53(5):992. Available from: https://eymj.org/DOIx.php?id=10.3349/ymj.2012.53.5.992 [cited 2022 Oct 7].
44. Youssef N, Raymer KE. Airway management of an open penetrating neck injury. CJEM 2015;17(1):89–93. Available from: https://www.cambridge.org/core/product/identifier/S1481803514000050/type/journal_article [cited 2022 Oct 7].
45. for the Canadian Airway Focus Group, Law JA, Broemling N, Cooper RM, et al. The difficult airway with recommendations for management – Part 2 – The anticipated difficult airway. Can J Anesth/j Can Anesth 2013;60(11):1119–38. Available from: http://link.springer.com/10.1007/s12630-013-0020-x [cited 2021 Apr 24].