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Management of Neck Trauma: A Surgeon's Perspective

AJAI MALHOTRA, MD, FACS, FKCS

Professor of Surgery, University of Vermont
Trauma Medical Director, Level-I Trauma Center
University of Vermont Medical Center
Co-lead, ATLS XI FLEX Committee
E-mail: ajai.malhotra@uvmhealth.org

Background

The human neck is a relatively narrow cylinder densely packed with critical vascular, nervous, aero-digestive and bony structures making injuries to this area potentially devastating and management complex (Table I). Minor injuries, usually caused by blunt mechanisms (road traffic crashes; falls etc.), are relatively common affecting 10-21% of population annually.¹ On the other hand, major injuries to the neck are rarer, usually caused by penetrating mechanism (stabs; gunshots etc.) and are present in 5-10% of patients with major trauma.² Injury distribution for penetrating neck trauma among the major neck structures are presented in Table II.^{3,4} Since the structures in the neck are critical, major injuries to the neck are associated with 10% mortality.²

Table I: Anatomical considerations making injury to the neck potentially devastating.

Anatomical consideration	Impact
Critical large vessels	Bleeding – shock Ischemia to brain – stroke
Aero-digestive tract	Airway – immediately life threatening Digestive – infectious complications
Major nerves	Brachial plexus – upper extremity sensory/motor deficits
Cervical spine/spinal cord	Respirations – immediately life threatening Cord – long term paralysis

Initial management

Initial management of patients with neck injuries is no different from management of any patient with major trauma and follows basic ATLS principles. However, neck injuries impact all elements of xABCDE of the ATLS primary survey.

X: The neck has large vessels traversing it that can lead to very significant life-threatening external hemorrhage. Additionally, direct pressure to control external hemorrhage from the neck must be applied judiciously so as not to affect the air passages or cause significant upstream ischemia specially to the brain.

A: Neck injuries involving the trachea can be immediately life-threatening. Additionally, airway management

Table II: Injury distribution with penetrating neck trauma.^{3,4}

Structure	Incidence
Vascular	40%
Arterial	25% (Carotid: 80%; Vertebral: 43%)
Venous	15% (Jugulars)
Digestive tract (pharynx/esophagus)	5-15%
Respiratory tract (larynx/trachea)	4-12%
Nerves (cranial/brachial plexus/symp. chain)	3-8%
Spinal cord	1%

can be challenging with blood in the airway obscuring the view and/or need for surgical airway. For these reasons, all adjuncts to manage a difficult airway and specialists with skills to manage it are required for optimal outcomes.

B: The apices of the lung protrude into the lower part of the neck subjecting the lung to injury with the potential for pneumothorax. This is especially true for penetrating neck injuries in the lower part of the neck. Standard ATLS protocols with examination for breath sounds by auscultation and/or lung slide via eFAST is critical in diagnosing a pneumothorax early and taking appropriate action before it leads to tension and cardio-vascular collapse.

C: As mentioned with x, major vessels can cause large volume blood loss leading to hemorrhagic shock. Judicious pressure to control the hemorrhage, appropriate resuscitation with blood products and plan for operative/intervention-radiological control should rapidly be made.

D: Major nerves traverse the neck as does the spinal cord in the cervical vertebral column. Major injuries to the neck both blunt and penetrating can lead to neurologic deficits both from central nervous system injury to the spinal cord and/or peripheral nervous system injury especially the brachial plexus. Blunt injury to carotids and/or vertebral arteries (BCVI) can lead to delayed stroke.

E: As with all trauma patients, adequate exposure while maintaining normothermia is important for neck injuries as well. Small penetrating injurious could be obscured by hair, blood or a cervical collar. Maintaining a high index of suspicion and examining each part of the neck, including the back, will reduce the chances of missed injuries.

Definitive management

After initial management that follows the ATLS principles of primary and secondary survey, the approach for definitive management of patients with neck trauma depends largely on 1) stability of the patient from a hemodynamic and airway standpoint, and 2) the mechanism of injury – blunt or penetrating. Any patient with hemodynamic instability from a neck injury or having a tenuous airway due to injury, should immediately be taken to the operating room.

Tenuous airway

In a patient with a tenuous airway, careful examination of the extent of injury needs to be made in the operating

room. If the injury is simple and the appropriate skilled personnel to manage that type of injury are available, the injury should be repaired. In the absence of skilled personnel and/or complex airway injury, a definitive surgical airway usually via a tracheostomy should be done and the patient referred to higher level of care where specialist personnel are available.

Hemodynamic instability

In a patient with hemodynamic instability caused by bleeding from neck vessels, gentle pressure should be applied to control the bleeding without compromising the airway or completely occluding the internal carotid. With hemorrhage controlled by gentle pressure, preparations should be made gathering appropriate equipment, including vascular instruments, and specialist personnel. Permissive hypotension specially in young individuals without head injury is a useful technique to give time for adequate preparation. Once preparation is complete, the neck should be explored (see below for technique), and bleeding vessels identified. Smaller venous injuries can safely be ligated. Injuries to the internal jugular vein should preferably be repaired, but in patients in major shock, ligation is acceptable. Bilateral ligation of the internal jugular vein can lead to significant cerebral edema, and this should be considered. All branches of the external carotid artery can safely be ligated. Like the internal jugular vein, it is preferable to repair the main trunk of the external carotid artery, but if the patient is in deep shock, ligation is acceptable. If the internal carotid artery is injured, every attempt should be made to repair it. If due to patient condition or lack of personnel, immediate repair is not possible, a temporary shunt should be considered while specialists able to repair the vessel are summoned and/or patient transferred for higher level of care.

Patients with a patent airway or an airway that has been secured, and who are hemodynamically stable, definitive management depends upon mechanism of injury – penetrating or blunt.

Penetrating mechanism

Penetrating injuries superficial to the platysma are considered minor as no critical structures are superficial to this layer. Such injuries require simple repair of the laceration. Penetrating injuries traversing the platysma have the potential to involve critical structures and hence are considered major injuries. The traditional approach

to management of these major injuries was proposed by Monson et al in 1969.⁵ In this approach the neck is divided into three zones – zone I: lower part of neck (thoracic inlet); zone II: middle of neck; and zone III: upper part of neck (base of the skull). Injuries involving zone I or III can be difficult to manage due to difficult access and often require specialized equipment and personnel, while injuries involving zone II are relatively easily accessible and straightforward to manage. This defined the differential approach to management with injuries involving zones I and III initially managed with investigations (angiography with/without endoscopy) while injuries involving zone II could be managed either with surgical exploration or investigations (angiography with/without endoscopy).

The traditional approach was followed till the late 1990s. Three considerations led to a change in approach. First was the advancement in Computed Tomography with multi-detector scanners (MDCT). Multiple studies demonstrated that this modality was highly accurate in diagnosing, and more importantly, ruling out vascular and non-vascular soft tissue injuries.⁶⁻⁹ Second, the zones proposed by Monson et al were arbitrary with no anatomical structures dividing them. Hence any projectile that

entered in one zone often traversed to another with poor correlation between the zone of entry and zone of injury.¹⁰ Third, this approach led to high rates of non-therapeutic neck exploration and/or high resource utilization. These considerations have led to the current ‘no-zone’ approach.¹⁰⁻¹² The no-zone approach (Fig. I) is based on 1) stability of the patient; 2) presence/absence of hard signs of injury; and 3) liberal use of MDCT angiography (MDCT-A).

Table III: Hard signs associated with high incidence of major injury often requiring operative repair.⁹⁻¹¹

Neck hemorrhage with shock
Pulsatile hemorrhage/expanding hematoma
Audible bruit/palpable thrill
Tenuous airway
Air bubbling from wound
Extensive surgical emphysema
Stridor
Odynophagia
Major neurologic deficit

Fig I: No zone approach algorithm

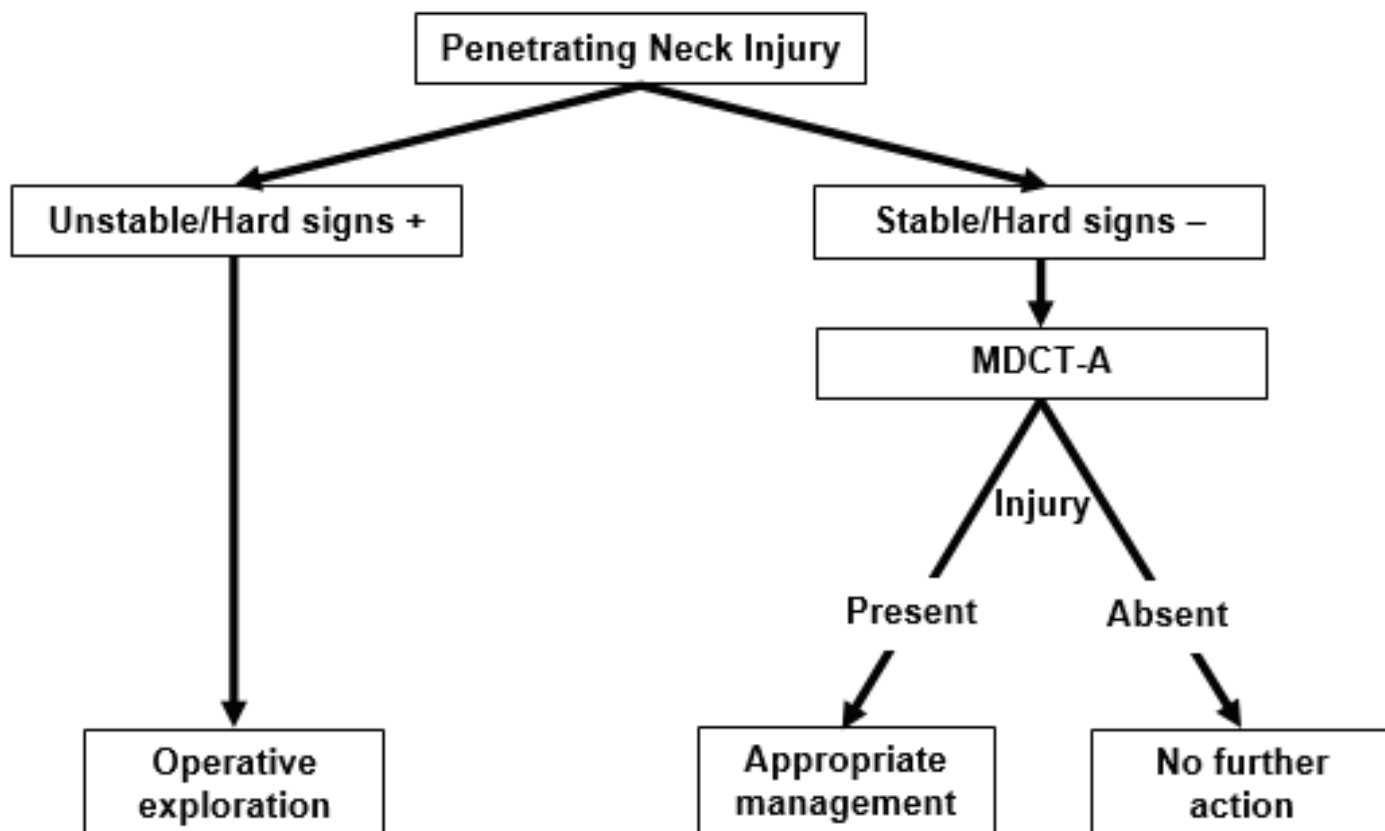


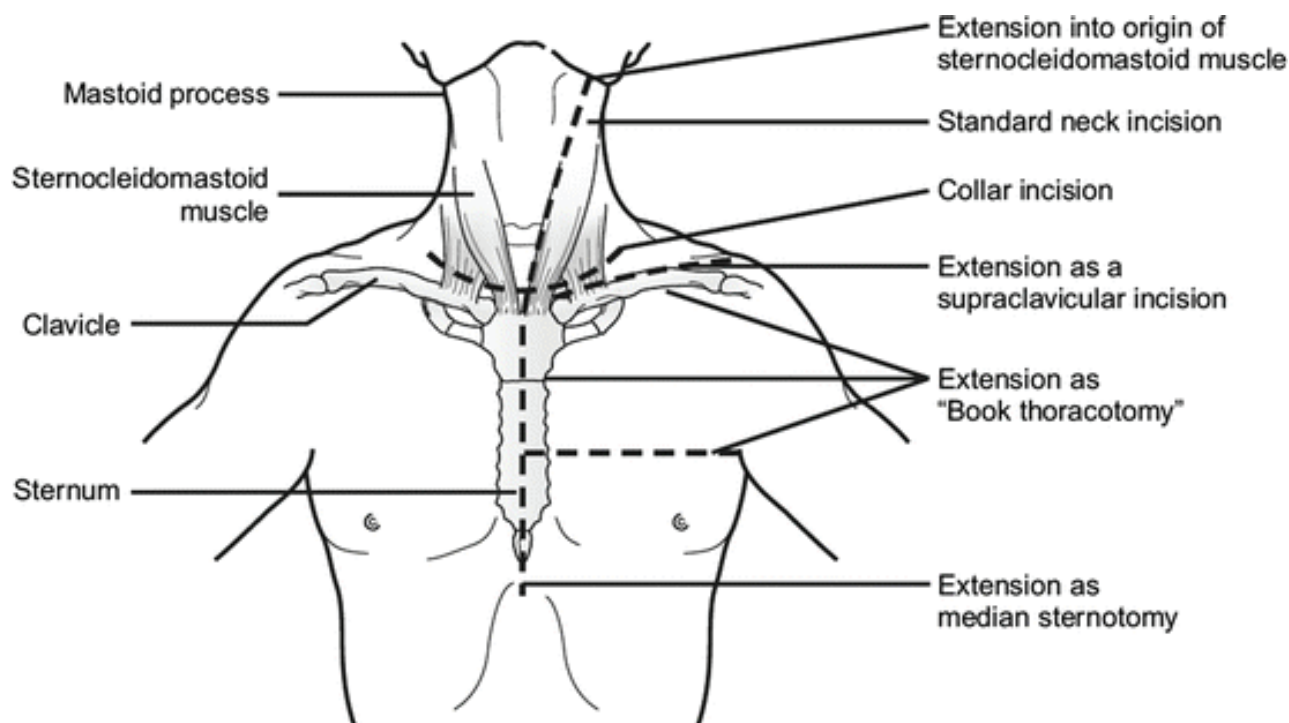
Table IV: Stroke rates associated with untreated BCVI by affected vessel and grade.¹⁷

BCVI Grade	Stroke rate	
	Carotid	Vertebral
I (<25% stenosis)	8%	6%
II (>25% stenosis)	14%	38%
III (Pseudoaneurysm)	26%	27%
IV (Occlusion)	50%	28%
V (Transection)	100%	100%

As stated above any patient with hemodynamic instability caused by bleeding from the neck and/or a tenuous airway should immediately be taken to the operating room and explored to control hemorrhage and/or secure the airway. In a patient with an adequate airway and who is hemodynamically stable, the next step is to evaluate for any ‘hard signs’ of injury (Table III).⁹⁻¹¹ If any one of these hard signs of injury are present, there is a high likelihood that there is a major injury that will require surgical repair. Hence if any of these signs are present, the patient should be taken to the operating room for exploration to identify and repair the injury. Adequate preparation ensuring availability of appropriate instruments, blood products and skilled personnel is key to optimal outcomes. The technique of neck exploration is

an incision along the anterior border of the sterno-cleido-mastoid muscle (Fig. II). Incision is deepened to expose the carotid sheath. For vascular injuries, proximal and distal control is strongly recommended prior to exposing the actual injury. To obtain this control the incision can be extended superiorly to base of skull and inferiorly into the chest. Standard vascular repair techniques are utilized (see above). In case conduit and/or patch is required, vein is preferred but PTFE is acceptable. For injuries to the trachea, a transverse incision at the base of the neck maybe preferred. Tracheal repair should be performed with interrupted non-absorbable mono-filament sutures. If the injury involves the larynx, specialist personnel would be required. If not available, a formal tracheostomy should be performed, and the patient transferred to a higher level of care where such personnel are available. Small pharyngeal injuries superior to the crico-pharyngeous do not need to be repaired and placement of a surgical drain is all that is required. For larger injuries, simple repair is preferred. For large destructive injuries complex coverage maybe needed and facial surgeons with specialized skills are often required. Injuries inferior to the crico-pharyngeous (ie to cervical esophagus) should be repaired if <12 hours old. If the injury is > 12 hours old, wide drainage with delayed repair is recommended. If the injury is large with significant tissue loss, specialist care will be needed.

Fig II: Neck incisions utilized in neck trauma



Blunt mechanism

Blunt injury to the neck is fairly common caused by road traffic crashes, falls etc. and usually result in minor injuries such as neck sprains etc. Major injuries via blunt mechanisms can be caused by high-speed crashes specially if the driver is not wearing a seatbelt and is thrown against the dashboard with the steering wheel crushing the front of the neck. Such injuries can be devastating and often lead to death at the scene from airway compromise. Other blunt injuries to the neck that can be severe are related to the cervical cord that can result in quadriplegia. In addition to the paralysis, patient may have neurogenic shock from loss of sympathetic tone leading to hypotension. Besides lack of movement the other clue maybe that despite the hypotension the patient feels warm to touch due to vasodilatation. It is important to differentiate hypotension from neurogenic shock and that caused by shock as in neurogenic shock the treatment is with vasopressors usually alpha agents eg Neosynephrine, while treatment of hemorrhagic/traumatic shock is with early use of blood products.

As with all major trauma, the initial management consists of following the ATLS principles of primary and secondary survey. For stable patients with an adequate airway, the two major considerations related to the neck are 1) cervical spine injury with/without spinal cord injury; and 2) blunt carotid/vertebral artery injury (BCVI). For both of these conditions it is extremely important to diagnose any injury present and provide appropriate therapy and equally important to rule out injury that may not be obvious to prevent paralysis due to a missed unstable cervical spine injury or stroke from missed BCVI.

Cervical spine injury

It is important to realize that a cervical spine injury that can lead to paralysis can be present even after the most trivial trauma eg fall from standing etc. Hence a high index of suspicion is required so as not to miss an injury. Cross-sectional imaging with CT scan is increasingly being utilized to diagnose or rule out injury. However, not all patients require such imaging. Stable patients who can participate in an examination – fully conscious, not under the influence of alcohol/drugs and without major distracting injury – can be cleared clinically. Two major criteria based on large studies are utilized for clinical clearance and/or determination that a patient needs imaging – NEXUS criteria and the Canadian C-spine rule. Both are widely utilized. The NEXUS criteria is simpler to use, but studies

show a slightly lower accuracy that the Canadian C-spine rule.¹³ Once it is determined that the patient needs imaging to rule out injury, MDCT is the optimal modality.¹⁴ While MRI is often suggested for ligamentous injury, a high quality MDCT with thin cuts that is interpreted by a specialist neuroradiologist has extremely high accuracy even for isolated ligamentous injury. If such a CT is negative for injury, it is safe to remove the cervical collar even if no clinical examination is possible.¹⁴

BCVI

BCVI can occur with major flexion/extension of the neck, extreme rotation or direct blow. The incidence of BCVI is 1-2% of all blunt trauma patients. Sometimes the injury can result in immediate stroke but more often in delayed stroke. The occurrence of delayed stroke can be reduced significantly by anti-platelet therapy usually 81mg Aspirin daily. For this reason, it is critical to detect these injuries to prevent devastating stroke. MDCT-A of the neck is extremely accurate in detecting BCVI. Some centers support using MDCT-A of neck for all major blunt trauma victims undergoing pan scan,¹⁵ while others recommend a more selective approach with defined criteria for MDCT-A of the neck.¹⁶ Stroke rates for untreated injuries depend on injury grade (Table IV) that can be significantly reduced with anti-platelet therapy.¹⁷ Higher grade injuries may require endo-vascular procedures to prevent evolution of the injury.¹⁸

Conclusions

The neck is tightly packed with critical vascular, aerodigestive, nervous and spinal structures. All patients with neck injuries are initially managed with basic ATLS principles of Primary and Secondary survey. Unstable patients should be taken to the operating room expeditiously while stable patients need a systematic approach to diagnose or rule out major injury. Liberal use of MDCT-A and the 'no-zone' approach are the recent developments in the management of these potentially devastating injuries. A systematic approach with adequate preparation – blood products, appropriate equipment and skilled personnel – are key to optimal outcomes.

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