Penetrating Neck Trauma

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Overview

The neck may be divided into bilateral anterior and posterior triangles by the sternocleidomastoid (SCM) muscles. Wounds to the posterior cervical triangles require operative management only for the control of bleeding and repair of wounds; there are no hidden structures that lead to late complications when not treated promptly.

Consequently, the challenges regarding care of penetrating neck wounds relate to injuries in the anterior triangles. These challenges include 1) emergent airway control, 2) immediate control of active bleeding, 3) urgent operative treatment of major injuries not causing acute airway compromise or life-threatening bleeding, 4) urgent diagnostic investigations for patients not requiring emergent or urgent operation, 5) deciding whether to explore or observe stable patients, 6) optimal exposure for patients requiring operation, and 7) care of specific injuries.

Emergent Airway Problems

Potentially life-threatening airway injuries may be caused by tracheal or cartilaginous rupture, soft-tissue compression of the airway from adjacent arterial injury, or active hemorrhage into the tracheobronchial tree due to a vascular-airway fistula. Air escape through the skin wound, dyspnea, stridor, hoarseness, or significant subcutaneous emphysema points toward airway disruption. The stable patient with hemoptysis wishes to sit up and lean forward in order to efficiently expectorate blood that enters the airway. Forcing the patient to lie down should be avoided until all preparations have been made for a rapid sequence intubation (RSI).

Ideally, the intubation is performed in the operating room by experienced anesthesia personnel. When excessive bleeding into the oral cavity is not present, an oral intubation should be successful; when bleeding obscures the passages, a fiberoptic nasotracheal intubation may be accomplished by experienced personnel. Although a coniotomy (cricothyroidotomy) is usually not needed in this circumstance, the resuscitation team should be mentally prepared to utilize this approach in patients suspected of having airway rupture.

Significant hemoptysis portends an arterial tracheal fistula; when the endotracheal tube is inserted, the balloon should be inflated at or below the site where the fistula is most likely located. Likewise, when a coniotomy is needed, the tracheostomy tube balloon should be positioned to occlude the fistula. After airway control, immediate neck exploration is performed.

External Bleeding

Major external bleeding or a pulsatile hematoma are indicative of an artery injury. Direct digital pressure with the gloved finger is the optimal way to provide temporary control of bleeding while the patient is taken to the operating room. Wraps and compression dressings are ineffective and potentially dangerous. The digital control of bleeding is maintained during RSI and the preoperative prep of the operative field.
Urgent Operation

Patients without life-threatening signs of airway injury or compromise and without uncontrolled external bleeding require urgent operation when hard signs indicate major injury. These signs include a large hematoma, pulsatile hematoma, continued oozing, cervical crepitus, hoarseness, dyspnea, and large wounds with severance of soft tissues that need reapproximation.

Urgent Diagnostic Investigation

Patients without the above needs for emergent or urgent operative intervention need to have diagnostic studies performed to exclude a subtle injury to important structures. These patients may have soft signs following a penetrating wound in the mid portion of the neck such as superficial bleeding from the skin or subcutaneous tissue, a history of bleeding prior to arrival, hoarseness, a bruit, dysphagia, blood-streaked sputum, or mild neck swelling.

The first component of this urgent investigation is a thorough physical examination of the neck that includes an intraoral examination to look for blood in the oral cavity and the hypopharynx. Chest auscultation and examination for trachea deviation help identify a pneumothorax from a thoracic outlet injury. Chest radiographs will confirm or rule out a pneumothorax or hemothorax, and tracheal or esophageal penetration may be identified by combined endoscopy of the trachea and esophagus. However, small injuries may be missed with these procedures. Barium swallow, which is potentially hazardous and fails to identify some injuries, is not recommended. CT angiogram, formal angiography, or color-flow duplex ultrasound will help identify arterial injury. All these procedures should be promptly available in the trauma center to provide care for patients with penetrating neck wounds.

Neck Exploration Versus Observation

The decision to explore a penetrating neck wound in a stable patient without the so-called hard signs depends upon the diagnostic findings and the zone in which the injury occurred (Figure 1). The anterior cervical triangles can be divided into three zones. Zone 1 is sometimes referred to as the thoracic outlet and extends from the clavicle to the cricoid cartilage. A decision to explore zone 1 injuries would be made on the basis of confirmed injury to the named vessels, trachea, or esophagus. Zone 2 of the anterior triangles extends from the cricoid to the angle of the mandible. Formerly, all patients who had penetration of the platysma muscle in zone 2 underwent mandatory exploration. Most surgeons would now explore zone 2 injuries only for patients who have evidence of organ injury, hematoma, continued bleeding, or high suspicion for tracheal or esophageal injury. Zone 3 of the anterior triangles extends from the mandible to the base of the skull. The decision to explore zone 3 injuries would be based upon angiographic evidence of arterial injury.

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FIGURE 1 Zones of the neck and optimal exposures. An incision along the anterior border of the sternocleidomastoid muscle provides access to zone 1 and zone 2 injuries. Extension of this incision inferiorly as a median sternotomy exposes anterior mediastinal injury. A lateral extension along the medial half of the
clavicle and then over the cephalic vein gives access to the subclavian vessels.

**Operative Exposure**

Most penetrating cervical wounds are best explored through an ipsilateral incision along the anterior border of the SCM muscle (see Figure 1). The incision is extended through the platysma into the deeper planes; the trachea and thyroid gland are retracted anteriorly, and the neurovascular bundle and esophagus are displaced posteriorly. This exposes the tracheoesophageal groove and allows the operator to identify when further dissection is needed anteriorly or posteriorly. Superficial crossing veins are divided and ligated along with the omohyoid muscle, thus facilitating deeper dissection.

When a zone 3 injury requires repair of the internal carotid artery at the base of the skull, the mandible can be detached posterior to the angle and subluxated anteriorly to facilitate a direct primary repair. When the injury involves zone 1 structures in the thoracic outlet, the incision can be extended as a median sternotomy, thereby giving excellent exposure of the trachea, innominate artery, left common carotid artery, subclavian artery, subclavian veins, innominate vein, and superior vena cava. When the injury involves the subclavian vessels as they pass laterally, the incision can be tied off over the medial half of the clavicle and then over the basilic vein, where it passes posterior to the mid-clavicle (see Figure 1). Resection of the medial head of the clavicle facilitates exposure, control, and repair of the subclavian arteries and subclavian veins. Rarely, a bilateral incision along the anterior border of the SCM muscles is required for bilateral injuries. We prefer not to combine bilateral incisions by joining them just superior to the manubrium.

**Repair of Specific Injuries**

**Venous Injuries**

Venous injuries are the most common cause of non–life-threatening hemorrhage from penetrating neck wounds. Small veins, including the external jugular vein, are best ligated. The internal jugular vein often can be repaired primarily using a running, nonabsorbable fine suture. When there are large through-and-through wounds to the internal jugular vein, the vein should be ligated, which is well tolerated by trauma patients.

**Arterial Injuries**

After proximal control is obtained, dissection should begin just above the clavicle and proceed distally. Digital pressure of the area of injury is maintained while distal control is obtained. Once exposure is obtained, most arterial injuries can be treated by a primary lateral repair using a running 5-0 nonabsorbable suture. When there is more extensive arterial injury from a gunshot wound, the segment is resected. When the gap is 1 cm long or less, an end-to-end anastomosis can be accomplished. Resection of longer segments requires a reversed saphenous vein graft interposition. Prosthetic grafts should be avoided, unless the patient has no saphenous vein. We prefer to instill a local heparin solution proximally and distally without using total body heparinization. A temporary arterial shunt should be used when the arterial repair cannot be performed promptly (within 30 minutes) because of higher treatment priorities elsewhere.

For zone 2 injuries, the branches of the external carotid artery can be safely ligated. When there is disruption at the carotid bifurcation, the intact external carotid artery can be anastomosed to the internal carotid artery distal to the area of irreparable damage. The distal stump of the external carotid artery is ligated.

Primary carotid arterial repair in patients with a neurologic neural deficit is controversial. This concern, in part, reflects the fear that a primary repair will convert an ischemic stroke into a hemorrhagic stroke. The
authors recommend repair in this setting, because patients who subsequently succumb have diffuse cerebral edema without hemorrhage at the time of the postmortem examination. Control of intracerebral pressure in these patients may lead to survival.

**Esophageal Injuries**

Exposure of the esophagus through the anterior SCM approach permits the esophagus to be freed up from the trachea anteriorly and the prevertebral fascia posteriorly, where it can be surrounded with a Penrose drain. The presence of a nasogastric (NG) tube facilitates identification and safe digital mobilization of the esophagus. Once mobilized, most unilateral stab wounds can be repaired in two layers, being certain to incorporate the full-thickness mucosal and muscular wall in the inverted inner layer with an absorbable suture. The second layer of the muscular esophagus can be performed with interrupted 4-0 permanent sutures. With bilateral injury, the esophagus can be rotated to facilitate bilateral simple repair. Alternatively, the injury on the ipsilateral side of the esophagus can be slightly extended to permit the contralateral wound to be closed from the intraluminal approach. The ipsilateral wound can then be closed as described above. It is essential to identify all injuries to prevent an esophageal cutaneous fistula from a missed injury.

Following closure, a paraesophageal drain should be left in place. If any drainage exudes, it should be monitored for amylase. The likelihood of an esophageal cutaneous fistula is low for patients who have early operative intervention. Once a fistula is confirmed, NG tube feedings are instituted, while the fistula closes within the ensuing three weeks. The NG tube is left in place to allow immediate feeding postoperatively.

**Pharyngeal Injuries**

Perforations of the pharynx and hypopharynx are often suspected when blood is seen on the deep oral examination, and it may be confirmed at operation by following the penetrating wound tract to the perforation. Primary closure with full-thickness inverted bites of tissue using absorbable suture provides both hemostasis and a secure closure.

**Tracheal and Cartilaginous Injuries**

Through the anterior SCM approach, the trachea is freed up posteriorly by blunt dissection in the tracheoesophageal groove. Perforations of the posterior wall can be repaired with running or interrupted 3-0 absorbable sutures with the knots tied on the outside. Identification of a posterior wound is essential to be certain there is no adjacent esophageal injury. Closure of perforations of the anterior wall often require that sutures be placed in the inner space above the superior tracheal ring and below the inferior tracheal ring at the site of injury; the knots are tied on the outside. Cartilaginous injuries, likewise, can be repaired with sutures heavy enough to go through the cartilage and to provide apposition. Some cartilaginous injuries are best left alone. Significant tracheal ring injuries often require a formal tracheostomy to ensure airway control and circumvent airway resistance from the glottis. High tracheostomy insertion at the second tracheal ring is preferred, even when the actual injury is located more distally.

**Thyroid Injuries**

Most wounds that cause tracheal injury will also cause injury to the thyroid. When the injured thyroid gland is not directly over the tracheal injury, it may be made hemostatic with simple sutures or electrocoagulation. When the thyroid injury occurs in the absence of tracheal injury, simple hemostasis by the above techniques is required. When the injury goes through the thyroid gland into the trachea, that
portion of the thyroid is best resected. Alternatively, the thyroid may be divided at the isthmus and rotated off the trachea to facilitate a primary tracheal repair.

**Miscellaneous Injuries**

Injuries to the recurrent laryngeal nerve from a penetrating neck wound are rare. If the injury is the result of a gunshot wound, the nerve is unlikely to be completely severed and is best left alone. If the surgeon identifies a stab wound with complete severance of the recurrent laryngeal nerve, a primary approximation is indicated using fine sutures. The results of such repairs are unknown.

Injuries to the thoracic duct may be recognized by the presence of lymph within the operative field. The duct should be freed up, isolated, and divided with each end appropriately ligated.

**Suggested Readings**


