

# Anterior Neck Injury

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**ANTERIOR NECK INJURY** - *one of greatest emergencies* - multitude of organ systems are compressed into compact conduit (single seemingly innocuous penetrating wound is capable of considerable harm - airway occlusion, exsanguinating hemorrhage, etc).

- anterior and lateral neck regions are most exposed to injury.

Structures at risk of injury:

**Musculoskeletal structures** – vertebrae, cervical muscles, tendons, ligaments, clavicles, first and second ribs, hyoid bone.

**Neural structures** – spinal cord, phrenic nerve, brachial plexus, recurrent laryngeal nerve, CN9-12, stellate ganglion.

**Vascular structures** – carotid (common, internal, external) and vertebral arteries; vertebral, brachiocephalic, and jugular (internal and external) veins.

**Visceral structures** – thoracic duct, esophagus and pharynx, larynx and trachea.

**Glandular structures** – thyroid, parathyroid, submandibular, parotid.

Two FASCIAL LAYERS invest neck:

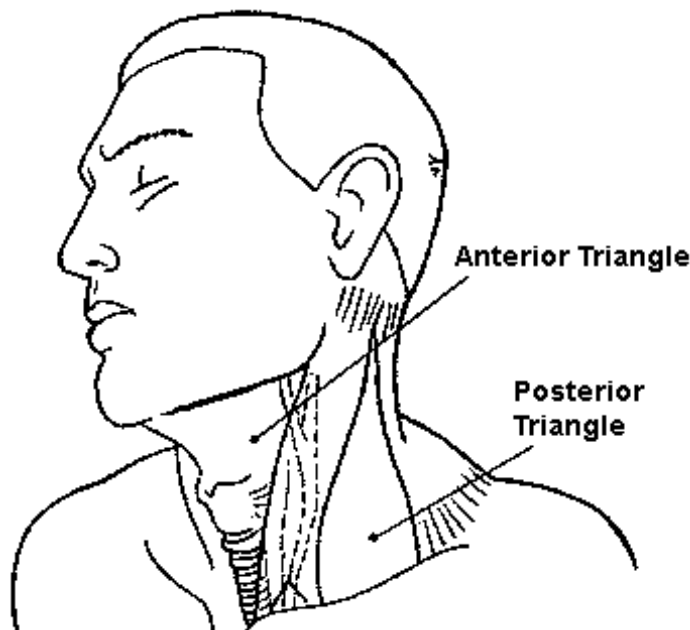
**SUPERFICIAL FASCIA** (enveloping platysma muscle)

**DEEP FASCIA** - envelops sternocleidomastoid and trapezius muscles; demarcates:

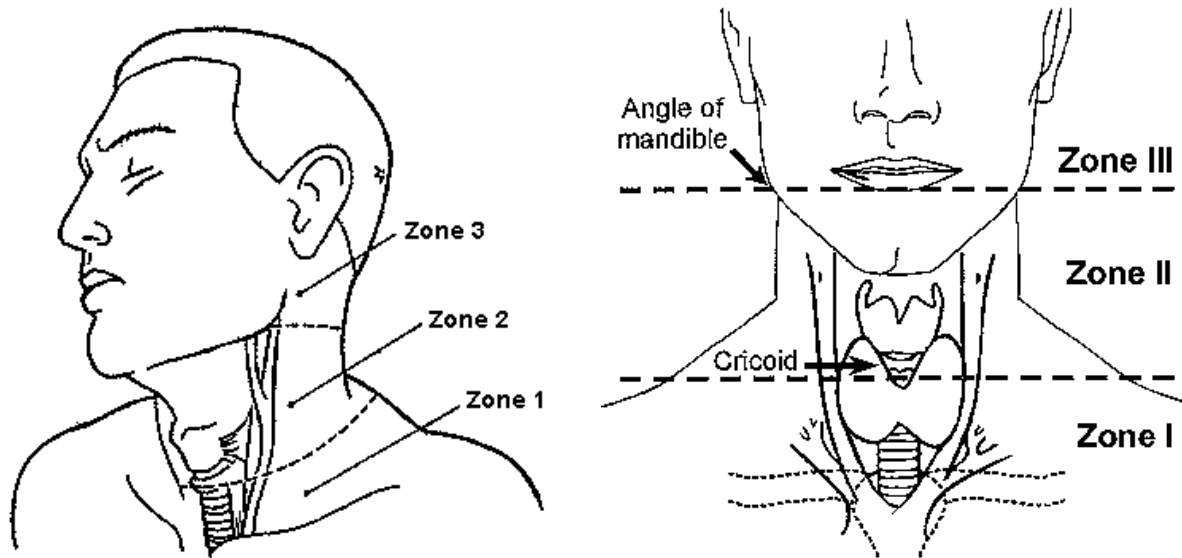
- 1) **pretracheal region** (trachea, larynx, thyroid gland, pericardium)
- 2) **prevertebral region** (prevertebral muscles, phrenic nerve, brachial plexus, axillary sheath)
- 3) **carotid sheath** (carotid artery, internal jugular vein, vagus nerve).

## ZONES OF NECK

- sternocleidomastoid separates neck into **ANTERIOR** and **POSTERIOR** triangles:



majority of important vascular and visceral organs lie within **ANTERIOR** triangle; few vital structures cross **POSTERIOR** triangle (only individual nerves to specific muscles), with exception of region just superior to clavicle, spinal cord and vertebral arteries.



**Zone III (superior neck)** - bounded by *angle of mandible* and *base of skull*.

- injuries can be very difficult to access surgically.
- structures at greatest risk: distal carotid artery, salivary glands, pharynx.

**Zone II (midportion of neck)** - region from *cricoid cartilage* to *angle of mandible*.

- largest portion – injuries are most common!
- injuries are likely to be most apparent on inspection (aggressive surgical exploration is rarely necessary) – leads to **best prognosis!**

**Zone I (neck base and thoracic outlet)** - demarcated by *thoracic inlet* inferiorly and *cricoid cartilage* superiorly.

- injuries are associated with **highest morbidity and mortality rates!** (because of major vascular and intrathoracic injury).
- structures at greatest risk: great vessels (subclavian vessels, brachiocephalic veins, common carotid arteries, aortic arch, jugular veins), trachea, esophagus, lung apices, cervical spine, spinal cord, cervical nerve roots.

Zone I wounds are often **associated with thoracic injury!** (pneumothorax, hemothorax) *pneumothorax may not develop until positive pressure ventilation is applied during anesthesia (may present as unexplained hypotension)*

## ETIOLOGY

**Penetrating trauma** (> 95% result from *guns* and *knives*).

**Blunt trauma** typically results from *motor vehicle crashes* (other causes - sports-related injuries, "clothesline" injuries\*, strangulation, blows from fists or feet, excessive manipulation).

\*rider of motorcycle, snowmobile, horse, or bicycle runs into unseen wire or cord suspended between two stationary objects

## CLINICAL FEATURES

- presence or absence of symptoms can be misleading, serving as poor predictor of underlying damage (e.g. only 10% blunt vascular damages manifest in first hour).
- sensitivity of physical examination to identify all significant neck damage remains controversial.
  - physical examination alone is sufficient to assess zone II for injury (others believe that diagnostic testing is mandatory in all cases).
  - *single examination is not sufficient* (onset of signs of injury may be delayed).
- *any violation of platysma* - potential for grave damage to neck contents.
- unnecessary wound probing / manipulation, performing any action that causes patient to gag, choke, or cough is discouraged – all these *may dislodge clot* and provoke life-threatening hemorrhage.
- **subcutaneous emphysema** means disruption of either upper airway or esophagus.
- **loss of characteristic lateral profile of anterior neck** (prominence of thyroid cartilage, etc) indicates edema or bleeding.
- consequences of vascular injuries: Auscultate neck to reveal carotid bruit!
  - 1) life-threatening external hemorrhage.
  - 2) soft tissue hematoma can distort / obstruct airway.
  - 3) disruption of cerebral perfusion (e.g. complete transection of carotid artery, air embolization after neck vein tear).

## DIAGNOSIS

1. **Cervical X-ray:** fractures, subcutaneous or retropharyngeal emphysema, retropharyngeal hematoma, tracheal narrowing or deviation, presence of foreign body.
  - risk of unstable cervical spine injury after *PENETRATING* neck wound is minimal; X-ray serves to detect soft tissue changes (e.g. in preventing catastrophic rupture of retropharyngeal hematoma during intubation).
1. **Chest X-ray** – indicated for at least **zone I** wounds: hemothorax, pneumothorax, widened mediastinum, mediastinal emphysema, apical pleural hematoma, foreign bodies.
2. Neck **CT** – mainly to evaluate laryngotracheal injuries in stable patients (CT readily identifies clinically subtle **blunt injuries of larynx**).
3. 4-vessel **angiography** – criterion standard for evaluation of vascular trauma; indications:
  - 1) penetrating wounds to zones I and III.
  - 2) blunt trauma when neurologic deficits are inconsistent with findings on head CT.
  - 3) therapeutic embolization.
4. **CTA** is alternative to angiography.
5. **MRI** – for evaluation of neurological impairments.
6. **Color flow Doppler studies** – for suspected (asymptomatic) blunt carotid injuries.
7. **Contrast studies of esophagus** with:
  - Gastrografin* - less likely to cause inflammatory response if extravasation through breach occurs.
  - ↓ negative
  - Barium* - induces less inflammation in lungs if aspirated, better detects small leaks, makes subsequent endoscopy more difficult.
8. **Endoscopy** (laryngoscopy, bronchoscopy, pharyngoscopy, esophagoscopy)
  - defer examination until airway is protected (by intubation) and patient is anesthetized.

## TREATMENT

### PREHOSPITAL

Cervical spine precautions!!!

(risk of unstable cervical spine injury after penetrating neck wound is minimal)

Loss of airway patency may occur precipitously, but **try to avoid intubation** in prehospital setting!

- endotracheal intubation by field paramedics may mask high tracheal injury.
- **supplemental oxygen** and **clearing airway** of all secretions and foreign bodies frequently prove sufficient, practical, and helpful for conscious patient.
  - *tracheal / laryngeal fracture or closed injury* – calm patient and ask to breath very slowly (the only way to decrease wall collapse during inspiration), 100% oxygen → cricothyrotomy.
  - *tracheal / laryngeal penetrating injury* – place patient semiprone with lowered head end, suction blood from airways, 100% oxygen → intubation via wound / cricothyrotomy.
- cover **sucking neck wounds** or **lacerations exuding bubbling air** with **impregnated occlusive gauze dressing**.

Bleeding is best controlled with direct pressure – with hand (not bandage pressure!) and thick dressing; when dressing is soaked, it is not replaced, but covered with dry one on top.

- place patient supine, legs elevated.
- jugular vein injury (risk of air embolization) → **mild Trendelenburg position** (in left lateral decubitus position).
  - if embolus settles into right ventricle (sudden hypotension, tachycardia, "machinery murmur", tachypnea) → right ventricle aspiration.
- *impaled objects* should not be extracted in field.
- do not blindly clamp blood vessels because other vital structures (e.g. nerves) travel alongside and may be irreparably damaged.
- **IV access** should be established in *upper extremity opposite side of injury* (in hospital add IV access site in *lower extremity*).
- if bleeding cannot be controlled / reached with direct pressure:
  - a) balloon tamponade with Foley catheter in wound.
  - b) temporary gauze packing (e.g. of pharynx wounds after intubation).

### HOSPITAL

Ensuring airway is highest priority! **Intubate early!**

- indications for emergency intubation: inadequate spontaneous respirations, blood / vomit obstructs airway, progressive cervical swelling from enlarging hemorrhage / emphysema threatens to occlude airway.
  - Procrastination converts simple intubation into difficult, bloody emergency tracheostomy!
- *endotracheal intubation with rapid sequence induction* is safe, effective, and preferable.
- be ready that intubation **may dislodge clots** → bleeding.
- **airway injury** (esp. **laryngeal injury**) is strong indication for **tracheostomy!** (intubation may detach larynx → complete loss of airway if larynx dislodges into chest).

- if airway is not jeopardized, nasogastric and endotracheal intubation may be deferred to allow endoscopic evaluation of larynx and hypopharynx (e.g. nasogastric / endotracheal tube can cause rebleeding from pharyngeal hematoma).

Shock should be vigorously resuscitated with crystalloid and blood; if hemodynamic stability cannot be achieved → prompt transfer to operating room.

Appoint assistant to maintain neck in neutral position → remove anterior aspect of collar → proceed with anterior neck evaluation:

### BLUNT INJURIES

- most can be managed nonoperatively.
- decision regarding admission is based on:
  - 1) presence of signs and symptoms
  - 2) patient's physiological status
  - 3) availability of outpatient care
 All but most trivial injuries should be admitted and observed for 24 hours.
- diagnostic workup is performed to establish need for surgery.
  - Blunt-injured patients can appear deceptively benign!
- **cervical & chest X-ray** are always necessary!
- signs of **vascular injury** (large hematoma, bruit) → **angiography** (regardless of neck zone), ± may be preceded by **color flow Doppler ultrasound**.
- signs of **laryngotracheal trauma** → **plain radiographs, CT, endoscopy**.
  - + always explore **esophagus (esophagogram → endoscopy)** - because of proximity of esophagus to trachea

### PENETRATING INJURIES

with platysma violated (*platysma* is treated like *peritoneum* - if violated, assess by qualified surgeon).

Admit all patients (with violated platysma) for exploration or at least 24 hours observation - to avoid missing occult injuries (esp. vascular and esophageal wounds – injuries with worst prognosis if treatment is delayed!!!).

- **cervical X-ray** is always necessary! (mainly, to detect soft tissue changes).
- **chest X-ray** is essential for **zone I** injuries.
- do not blindly probe wound in ED (in misguided attempt to determine extent of penetration)!!! – provides no useful information + may dislodge clot → bleeding, hemothorax!!!
  - N.B. can bleed internally – through neck wound connecting to pleural space! (if condition of patient with penetrating trauma deteriorates to cardiopulmonary arrest → emergent thoracotomy to gain better bleeding control)
- if **penetrating injury** is present in **zone I\* or III\*\*** → **angiography (aortography)\*\*\*** before any surgical exploration!!! (injuries to **zone II** are managed by exploration without prior invasive diagnostic studies)
  - \*possible injuries to thoracic outlet vessels
  - \*\*possible inaccessibility of internal carotid artery lesions
  - \*\*\*in all but most unstable patients

Strategies for penetrating injuries:

- A) **MANDATORY** exploration in operating room of all patients; major disadvantages - **exploration is negative in 46-50% cases + some injuries are missed** in spite of formal exploration.
- B) **SELECTIVE** exploration in operating room of following patients with **signs of significant injury**:
- vascular** – external hemorrhage, shock, expanding hematoma, diminished carotid pulse.
  - digestive tract** – dysphagia/odynophagia, subcutaneous air, blood in oropharynx.
  - airway** – hoarseness, stridor, dysphonia/voice change, hemoptysis, respiratory distress, air bubbling through wound.
  - neurologic** – lateralized neurologic deficit, altered state of consciousness, brachial plexus injury, Horner syndrome (stellate ganglion injury – near carotid).
- **transcervical gunshot injuries** (> 80% likelihood of injury to cervical structures) → surgical exploration is warranted in nearly all cases!
  - for other patients (clinically silent), no definitive recommendation exists:
    - bronchoscopy, esophagography, esophagoscopy, and angiography for all injuries.
    - angiography + other studies only for suspected aerodigestive system injuries.
    - no workup + angiography only for wounds in zones I and III.

Because of prospect of occult injuries with **zone I and III wounds**, relatively aggressive workup is warranted!

Whether one adopts policy of mandatory or selective exploration, once decision to operate has been made, approach is same:

- exploration is performed under general endotracheal anesthesia.
- patient is always prepared for **possible median sternotomy**.
- **INCISION** is planned to allow full exposure of tract of injury;
  - **proximal and distal major vessel control** must be considered in length and position of incision.
  - **unilateral** injury → **oblique incision along anterior border of sternocleidomastoid muscle**.
  - if **bilateral** exposure is required → **modified collar incision** (carried up along sternocleidomastoid muscle on both sides).
  - incising through fascial planes can release previously contained hematoma and cause life-threatening hemorrhage!
- injury tract is followed to its depth, systematically examining each structure in or near tract.
  - N.B. goal is to explore structures of neck to identify injuries, not to explore wound per se!
- wounds that approach carotid sheath or midline must be followed to end of wound tract to rule out injury; wounds that do not approach carotid sheath or midline do not need to be fully explored.
- **endoscopy** is performed intraoperatively if pharyngeal / esophageal injury is suspected but cannot be found.
- in most cases, **primary repair of nerve injuries** is impractical (in selected cases with clean nerve transection and no significant associated injuries, there may be role for primary repair of injured nerve).
- neck is exceptionally well perfused - clean lacerations may be sutured as late as 12-18 hours after injury.
- prophylactic **antibiotics** for all penetrating wounds (infection is major cause of death and disability!), **tetanus** prophylaxis.

## PROGNOSIS

MORTALITY for civilian penetrating wounds  $\approx$  2-6%.

- injury to major blood vessel  $\rightarrow$   $\approx$  65% fatality (incl. prehospital deaths).

Worst prognosis:

- 1) **blunt vascular** injuries.
- 2) **pharyngeal / esophageal** injuries with **delayed diagnosis**

## SPECIAL SITUATIONS

### CAROTID TRAUMA

- major arterial injuries occur in 18% penetrating neck wounds.

**BLUNT INJURY** (accounts for only 3% of all carotid injuries) – intramural hematoma, intimal tear ( $\rightarrow$  dissection), thrombosis, pseudoaneurysm formation  $\rightarrow$  delayed focal neurologic signs in patient with direct blow or compression of neck.

**PENETRATING INJURY:**

- no neurologic deficit** or **neurologic deficit short of coma**  $\rightarrow$  **primary vascular repair** (restored vascular continuity).
- comatose** patients, neither repair nor ligation appears to influence poor prognosis.
  - impact of prolonged ischemia and potential revascularization injury is not well defined.
  - carotid ligation is indicated in patient with no prograde flow, in presence of uncontrollable hemorrhage, or when technical reasons prohibit repair.

### LARYNGOTRACHEAL TRAUMA

- indicators of laryngeal injury:
  - 1) **voice quality alterations** (but normal voice does not rule out laryngeal injury).
  - 2) **loss of physiologic laryngeal crepitus** (rattling sensation when thyroid cartilage is grasped between thumb and finger and moved side to side).

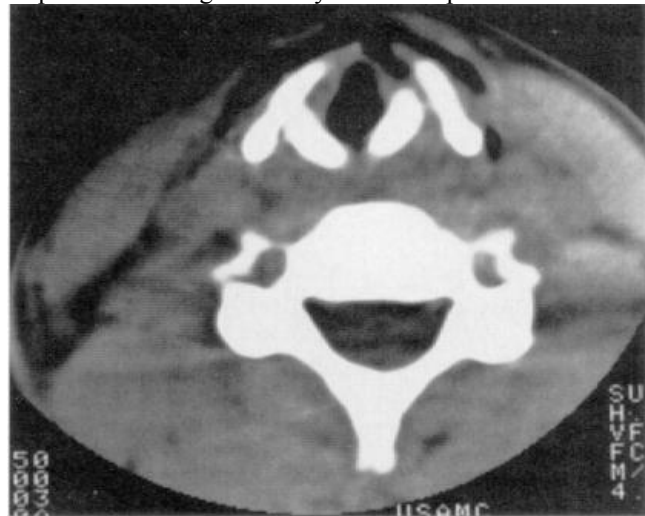
**PENETRATING WOUNDS** - subcutaneous emphysema (may compress airways extrinsically), crepitus, hemoptysis, air bubbling through wound.

- endotracheal intubation by field paramedics** may mask high tracheal injury!
- repair principles - debridement of devitalized cartilage, mucosal coverage of exposed cartilage, and closure of tracheal defects.
  - mucosal is repaired with fine absorbable suture.
  - if defect cannot be primarily closed, tracheal mobilization may bridge gap of several tracheal rings (loss of larger portions  $\rightarrow$  tracheostomy or complex reconstructive procedures).
  - tracheostomy is not always required following repair (but is useful if extensive edema or prolonged airway compression is anticipated).

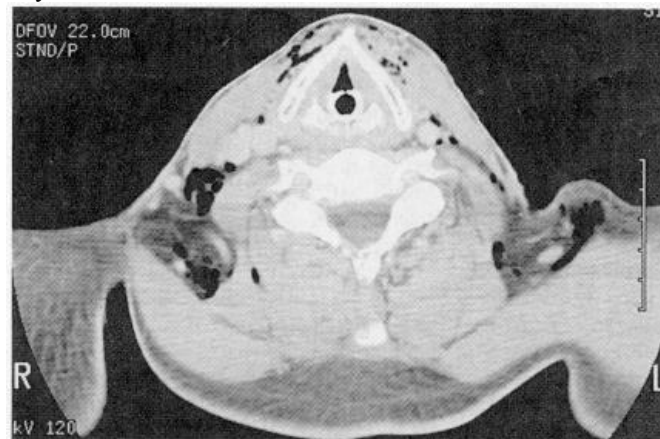
**BLUNT INJURIES** (easily overlooked in multiple trauma victim): fracture of thyroid cartilage (lost prominence of thyroid cartilage), recurrent laryngeal nerve injury, vocal cord disruption (voice pitch $\downarrow$ ), dislocation of airway cartilages, lacerations of mucosal surface of larynx / trachea.

- initially asymptomatic patient may suddenly develop severe respiratory distress.
- diagnosis - **plain radiographs** (supraglottic or subglottic narrowing of air column, prevertebral soft tissue swelling or air, hyoid bone fracture, high-riding hyoid bone\*), **CT**, **direct laryngoscopy**, **bronchoscopy**.
  - \*sometimes seen in complete tracheal transection
- patient should be placed on voice rest, and humidified air.
- if emergency airway is required:
  - a) **tracheostomy** - recommended emergency airway following blunt laryngotracheal injuries (incl. tracheal transections)!
  - b) **direct endotracheal intubation** (passing endotracheal tube over flexible endoscope) - may risk worsening tracheal injury!!!
- repair principles - reduction of cartilaginous fractures ( $\pm$  stenting), primary closure of mucosal lacerations.

CT of blunt neck trauma - subcutaneous emphysema, midline fracture and diastasis of thyroid cartilage, posterolateral displacement of right cricoarytenoid complex:



CT of blunt neck trauma - fracture of thyroid cartilage, significant airway swelling and air in soft tissues surrounding larynx:



### ESOPHAGEAL TRAUMA

- blunt injury is exceedingly uncommon! (clinical observation is sufficient in asymptomatic patients).
- odynophagia, hematemesis, spitting up blood, subcutaneous emphysema.
- esophagus injuries are *most difficult to diagnose* (sensitivity of esophagography 50-90%; sensitivity of endoscopy 29-83%).
- esophageal injuries are relatively silent until infection has developed!

- **high morbidity & mortality of missed esophageal injury** demands high index of suspicion (virtually all reported deaths are result of delayed / missed diagnosis).
- repaired **primarily** in two layers using absorbable and nonabsorbable suture; drain all such wounds!
  - massive tissue loss → **diversion**: cutaneous esophagostomy (for feeding) and cutaneous pharyngostomy (for salivary drainage) → secondary **reconstructive** procedure (after initial healing is complete).
- injuries diagnosed > 12-48 hours after injury → initial **diversion** and **drainage**.
- drain should be left in place after all esophageal repairs (infection or salivary fistula are not infrequent).

### PHARYNGEAL TRAUMA

- treated with debridement and primary closure whenever practical.
  - posterior aspect cannot be approached through neck - lacerations can be closed from within pharynx, and cervical area drained.
  - patient is kept "nothing by mouth" for 5-7 days.

### STRANGULATION

- **neck compression** by external mechanism:

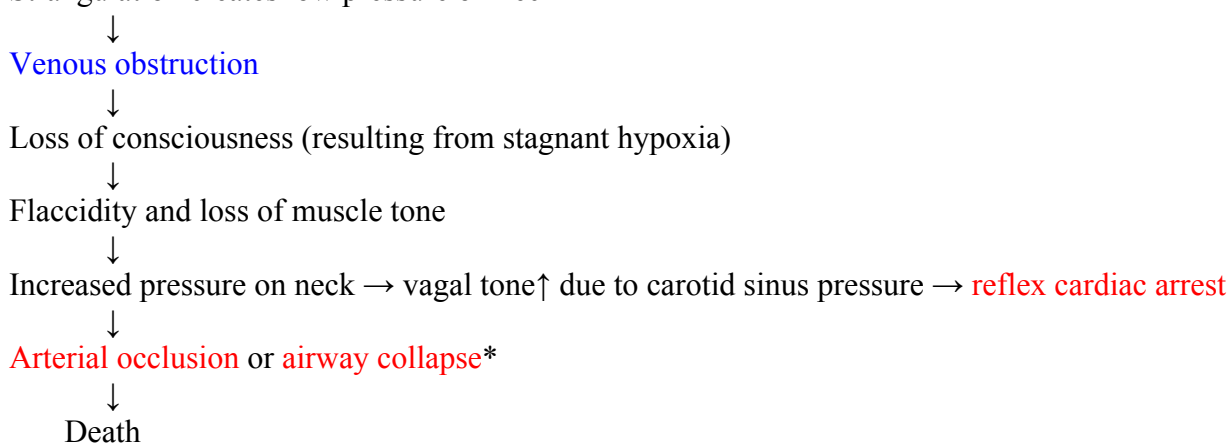
- hanging** (most common type) – ligature tightens because of weight of victim's body (body does not have to be suspended!); classified:
  - complete** (feet do not touch floor) vs. **incomplete** (all other positions)
  - typical** (point of suspension placed centrally over occiput - greatest likelihood of arterial occlusion) / **atypical** (point of suspension in any other position).
- ligature strangulation**
- manual strangulation**
- postural strangulation** – victim's neck lies over object with weight of body applying pressure to neck; most common in infants and toddlers.

Classified by setting in which it occurs:

- suicidal**
  - hanging is 3<sup>rd</sup> most common form of suicide, after firearms and poisons.
- accidental**
  - accidental strangulation deaths are rare (usually victim's clothing being caught in machinery; also described autoerotic hanging syndrome).
- homicidal**
- judicial**.

### PATHOPHYSIOLOGY

Strangulation creates low pressure on neck



\*asphyxiation is not main cause of death (hangings are reported in individuals with tracheostomy sites below level of constricting ligature)

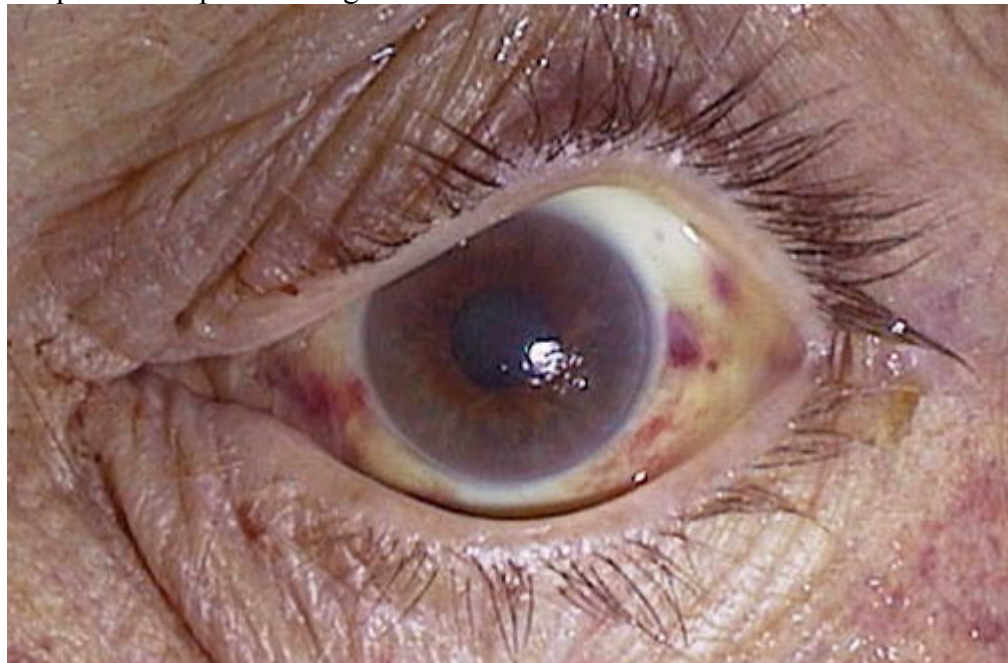
Pathophysiology of **judicial hanging\*** is similar to **DECAPITATION INJURY** - **forceful distraction of head from torso** → fracture of upper cervical spine, transection of upper spinal cord.

\*distance victim is dropped is at least equal to height of victim.

### CLINICAL FEATURES

#### Superficial Neck

- 1) **parchment-like compression groove** around neck (duplicates size and pattern of ligature).
- 2) **abrasions** from fingernails (if patient tried to get free before unconsciousness or if manual strangulation was cause of death)
- 3) **TARDIEU'S spots** – subconjunctival and skin **petechial hemorrhages** from increase in venous pressure cephalad to ligature.



#### Deep Neck

- only in judicial hangings and manual strangulations: **fractures of larynx, hyoid bone, thyroid cartilage** → palpable crepitus, tenderness, stridor, hoarseness, dysphagia.

#### Neurological Deficits

##### Respiratory

- cause delayed mortality:

- 1) **bronchopneumonia**
- 2) **aspiration pneumonitis**
- 3) **delayed airway obstruction**
- 4) **centroneurogenic ARDS** (congestion, edema, hemorrhage, surfactant activation, atelectasis) – via autonomically mediated constriction of pulmonary postcapillary sphincters.

##### Neuropsychiatric

- victim who survives attempted strangulation can display multitude of neuropsychiatric sequelae:

**EARLY PERIOD** - **restlessness** and **violence**.

**LATER PERIOD** - **psychosis**, **Korsakoff syndrome**, **amnesia**, **progressive dementia**.

- memory defects occur as result of selective vulnerability of hippocampus to anoxic damage.

**MANAGEMENT**

- all patients should be observed for at least 24 hours (for delayed airway obstruction).
- *cervical spine* does not need to be immobilized (unless mechanism is consistent with significant drop, i.e. fall at least equal to height of patient).
- immediate attention to airway - volume-cycled ventilator with PEEP and fluid restriction (for *centroneurogenic ARDS*).
- hyperventilation, **MANNITOL** and **FUROSEMIDE** (for *cerebral edema*).
- life-threatening *cardiac dysrhythmias* must be aggressively treated.
- steroids are not effective!!! (neither for cerebral edema nor *centroneurogenic ARDS*).
- potentially useful drugs:
  - 1) **PHENYTOIN** - preventing ischemic cerebral damage, arresting *centroneurogenic ARDS*.
  - 2) **NALOXONE** - reversing cerebrovascular ischemia in animal models by increasing cerebral perfusion to ischemic areas.
  - 3) calcium channel blockers.

**PROGNOSIS**

- dismal prognosis:
  - 1) patients who present in cardiac arrest
  - 2) complete lack of neurological function after successful resuscitation.

BIBLIOGRAPHY for ch. "Spinal Trauma" → follow this [LINK >>](#)