Evaluation and Management of Penetrating Neck Injuries: No More Zones

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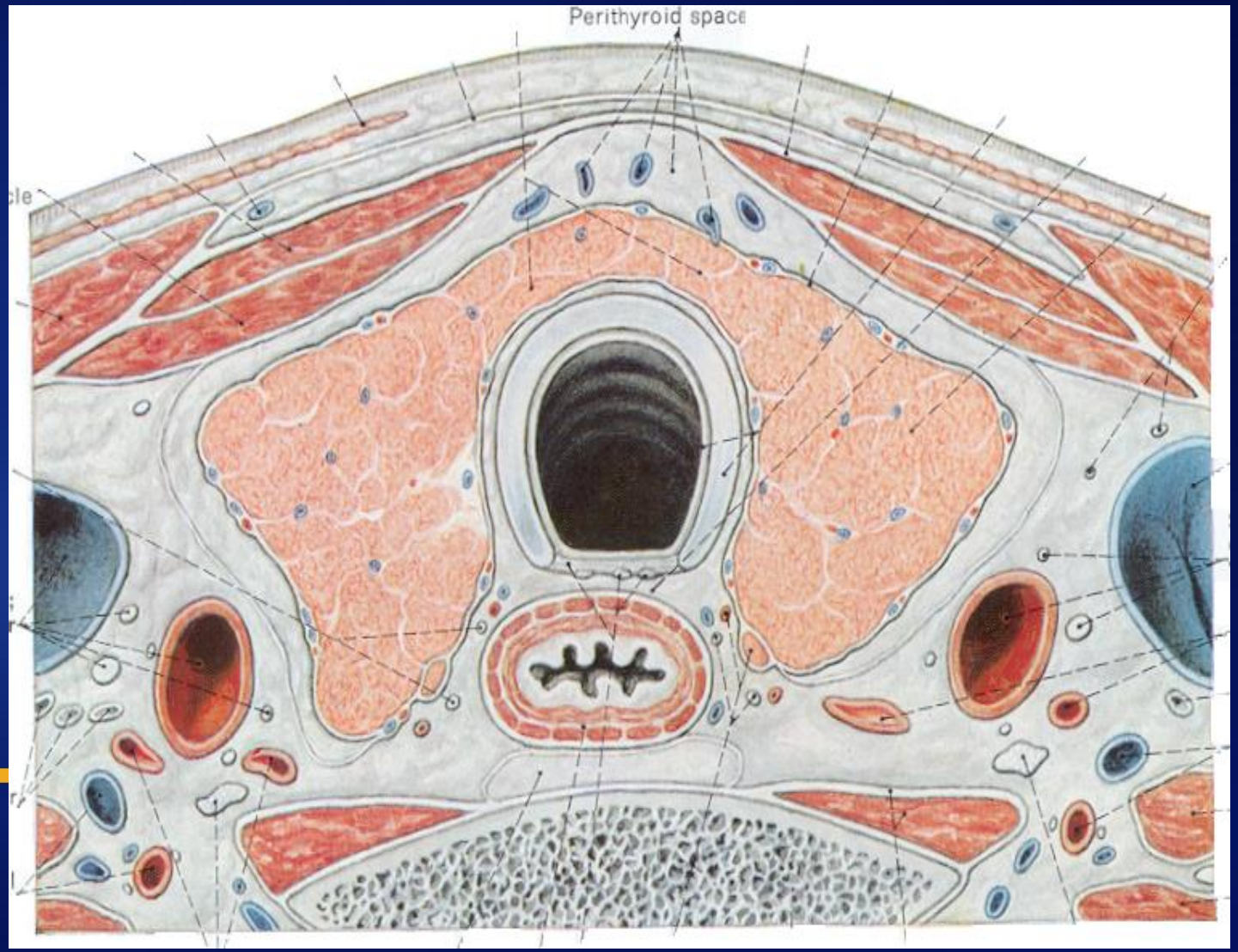
History

- 1552, Paré reported first carotid artery injury, ligated CCA, patient survived w/ extensive neuro deficit.
- 1802, Fleming performed same procedure in a suicidal sailor w/successful outcome.
- Controversy mandatory surgical intervention continued for 2 centuries, but now most are managed selectively.

Anatomy

- VASCULAR
- RESPIRATORY
- DIGESTIVE
- NEUROLOGIC
- ENDOCRINE
- SKELETAL



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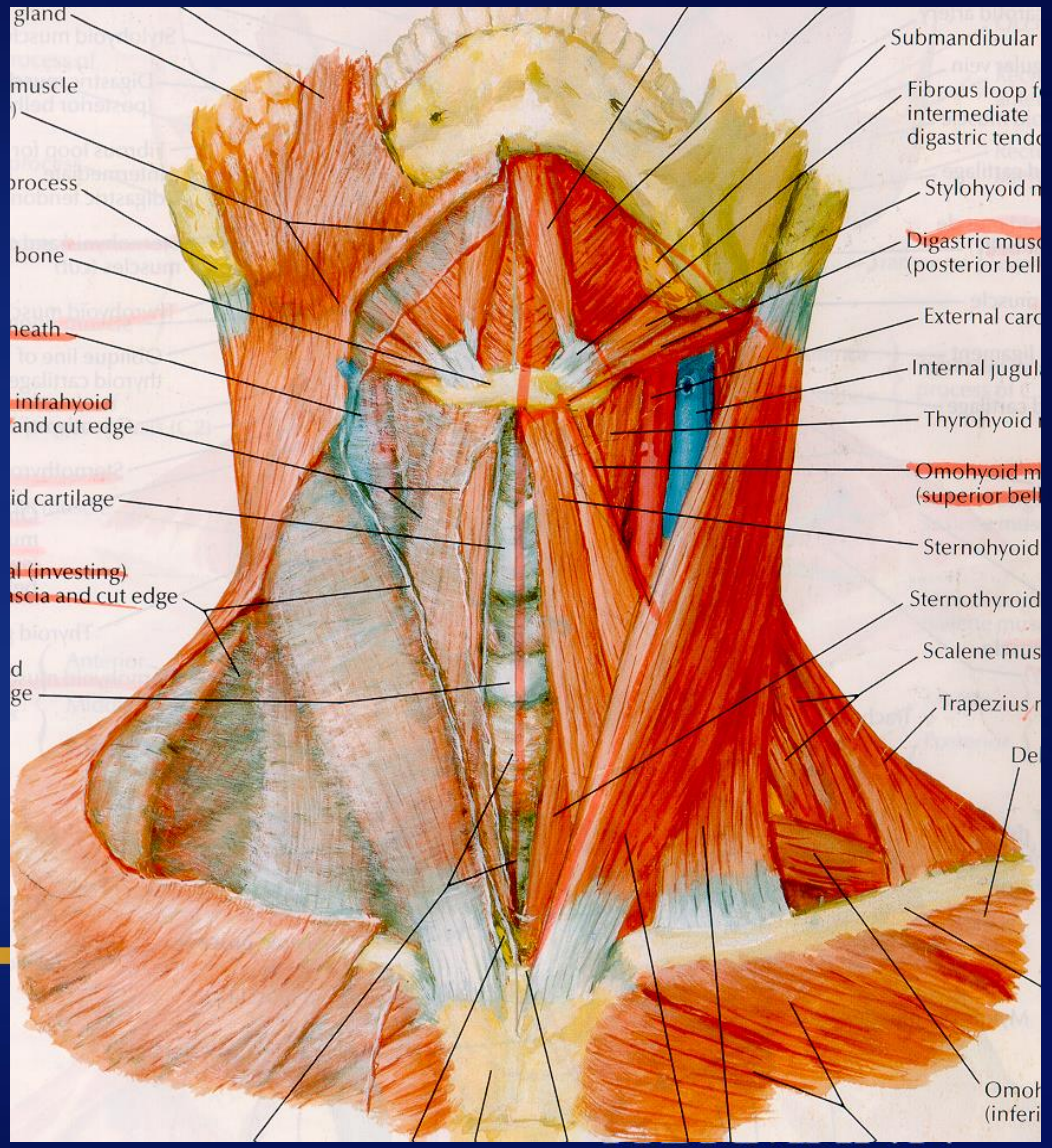
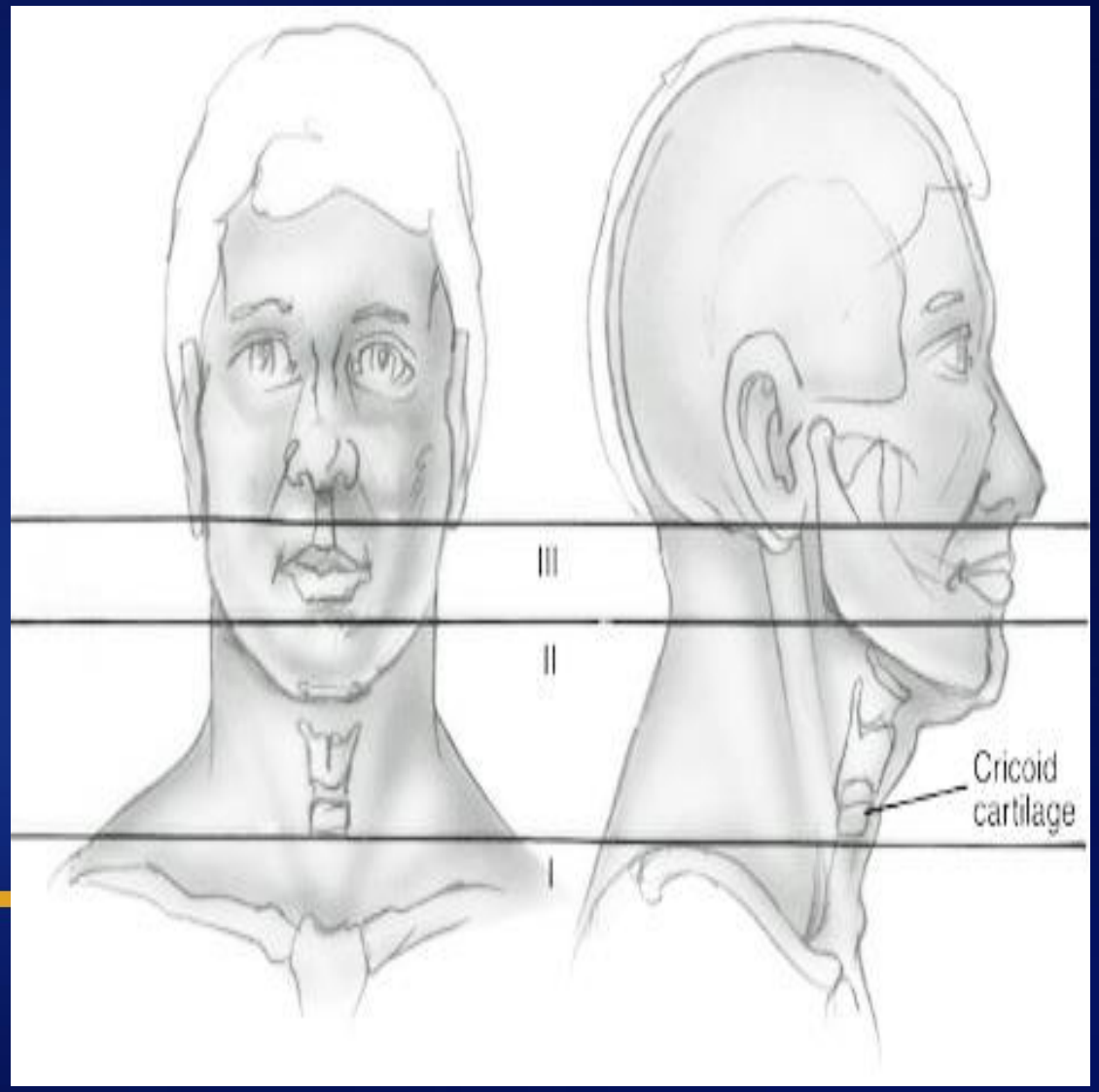


Those Zones…

- Zone I : carotid, subclavian, lung, trachea, esophagus
- Zone II : carotid, jugular, larynx, hypopharynx
- Zone III : distal carotid, jugular, hypopharynx



Management of penetrating neck injury in the emergency department: a structured literature review

J J Brywczynski,[1] T W Barrett,[1] J A Lyon,[2] B A Cotton[3]

Table 1 Result of studies investigating the use of cervical spine immobilisation in penetrating neck injury (PNI)

Author	Study type	Patient population	Intervention	Results
Arishita *et al*[7]	Retrospective study	Vietnam casualties	Data from these casualties reviewed to determine benefit of cervical spine immobilisation on the battlefield	Patients with PNI to the cord were always fatal. Only 1.4% of casualties who were candidates for immobilisation might have benefited
Barkana *et al*[8]	Retrospective study	44 military casualties in Israel with PNI over 4.5 years	Data from these soldiers and autopsy reports reviewed; none had cervical spine immobilisation	8/36 patients (22%) had life-threatening complications diagnosed in the exposed neck (haematomas, emphysema); none required surgical stabilisation of spine injuries
Medzon *et al*[9]	Retrospective study	81 patients with gun shot wounds to the head or neck reviewed over a 10-year period	Data reviewed to determine frequency of stable and unstable cervical spine fractures	19/81 patients had cervical spine fractures (11%); of the 65 awake and alert patients without neuro deficit, 3 (5%) had a fracture, none of which was unstable
Klein *et al*[6]	Retrospective cohort study	2450 patients with gun shot wounds to the trunk, head or neck who survived >24 h reviewed over a 10-year period	Physical examination, radiographs, final diagnoses reviewed	244 (10%) had spine injuries; 66% of the spine injuries were "significant" and 13% were "unsuspected"
Rhee *et al*, 2006	Retrospective study	57 532 trauma patients evaluated at two level 1 trauma centres over 87 and 144 months, respectively	Determine the incidence of cervical spine fracture and cervical cord injury based on mechanism following blunt and penetrating assault	All patients, both blunt and penetrating, who had cord injury had neuro deficit on presentation. No penetrating patients with cord injury regained significant neuro function
Connell *et al*[11]	Retrospective analysis of prospectively collected data	12 patients coded as penetrating trauma and spinal cord injury over 8 years without blunt mechanism	Identified the incidence of unstable or potentially unstable spinal column injures in PNI patients	Of the 12 patients with PNI and cord injury, all had clinical neuro deficit on initial assessment or were in traumatic arrest

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In conclusion, many prehospital providers will continue to place patients with PNI in cervical collars. However, based on available retrospective data, the incidence of unstable cervical spine injuries is very low and the risks of obscuring an expanding neck haematoma or other hard signs of injury with a cervical collar in the prehospital setting might outweigh the benefits of spinal immobilisation in patients sustaining penetrating neck trauma.[6–11]

Initial Management…

- Stable, no obvious vascular/aero-digestive injury >>dx evaluation
- UNSTABLE or obvious injury >> O.R.
- NO platysma violation >> local wound mgt

Initial Management…

- AIRWAY! AIRWAY! AIRWAY!
- ETT complicated by hemx/trach deviation
- Get GCS, neuro exam EARLY & document before ETT & paralysis

Which way do we go?

- Stable?
- Hard Signs?
- Location?

Which way do we go?

- Immediate Exploration: bleeding, expanding hematoma, stridor, extensive SQ emphysema, “blow-hole”
- Mandatory Evaluation: hoarseness, dysphonia, dysphagia, hematemesis, hemoptysis, change in voice

The Physical Exam

- 28 pts with NO “hard” or “soft” signs, found careful PE & observation safe — Frykberg et al, JACS 1994
- 145 pts, PE & observation in 91 pts had one false negative, no false positives — Frykberg et al, J Vasc Surg 2000
- Asymptomatic pt with Zone II injuries can be safely observed, 0-1% missed injury — Biffl et al, AJS 1997; Weigelt et al, JACS 1997

The Physical Exam

- PE: 94-100% sens for vascular injury
- Screening angiogram cost $3 mil/CNS event prevented

  Jarvick et el, Am J Neuroradiology 1995
- 353 pts, 20% pts > immediate exploration, of 78% pts w/ NOM, <1% missed Demetriades et al, BJS 1993

The Physical Exam

- Zone I injury: 5 level-1 centers, no false negatives nL PE & CXR

  Eddy et al, JOT 2000

- Zone III injury- 72 patients; 73% no hard signs, no false negatives among observed, 1 out 4 angiograms (+), none required intervention, 10% exploration (all negative).

  Ferguson E et al, Vascular 2005

The Physical Exam

- Durban, South Africa, 59 GSWs to the neck
- 13 patients (+) soft signs on physical exam had vascular injury
- 10 patients with no physical exam findings had vascular injury
- Angiography is necessary

  Mohammed GS et al, Eur J Vasc Endovasc Surg 2004

Non-op management

- Zone I/III : HD stable > Diagnostic W/U
- Zone II : no “hard” signs > Diagnostic W/U

Non-op management

- Zone I & II : Angiography, pharyngo- esophagoscopy (?esophagography), & tracheobronchoscopy

- Zone III: Angiography, pharyngoscopy

Esophageal work-up

- Esophagoscopy or –gram: 60% sensitivity
- Combined modalities- 90% sensitivity
- PE + esophagoscopy + -gram = 100%

  Demetriades et al, WJS 1997

- Flex.Endoscopy 100% sens, 93-97% spec

  Srinivasan et al, Am J Gastro 2000

  Flowers, et al, J Trauma 1996

Trajectory determination defines anatomic injury

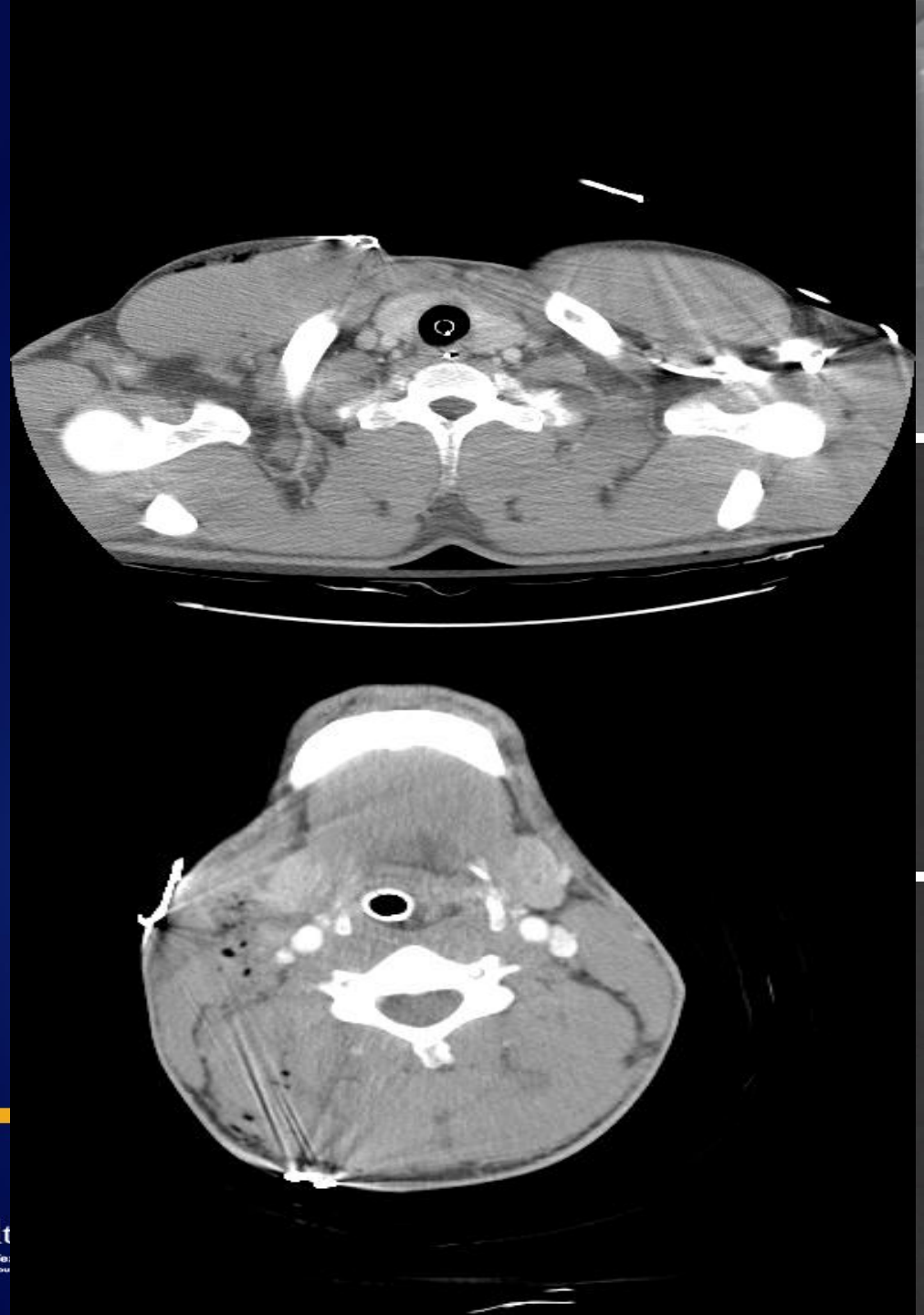
CT angiogram

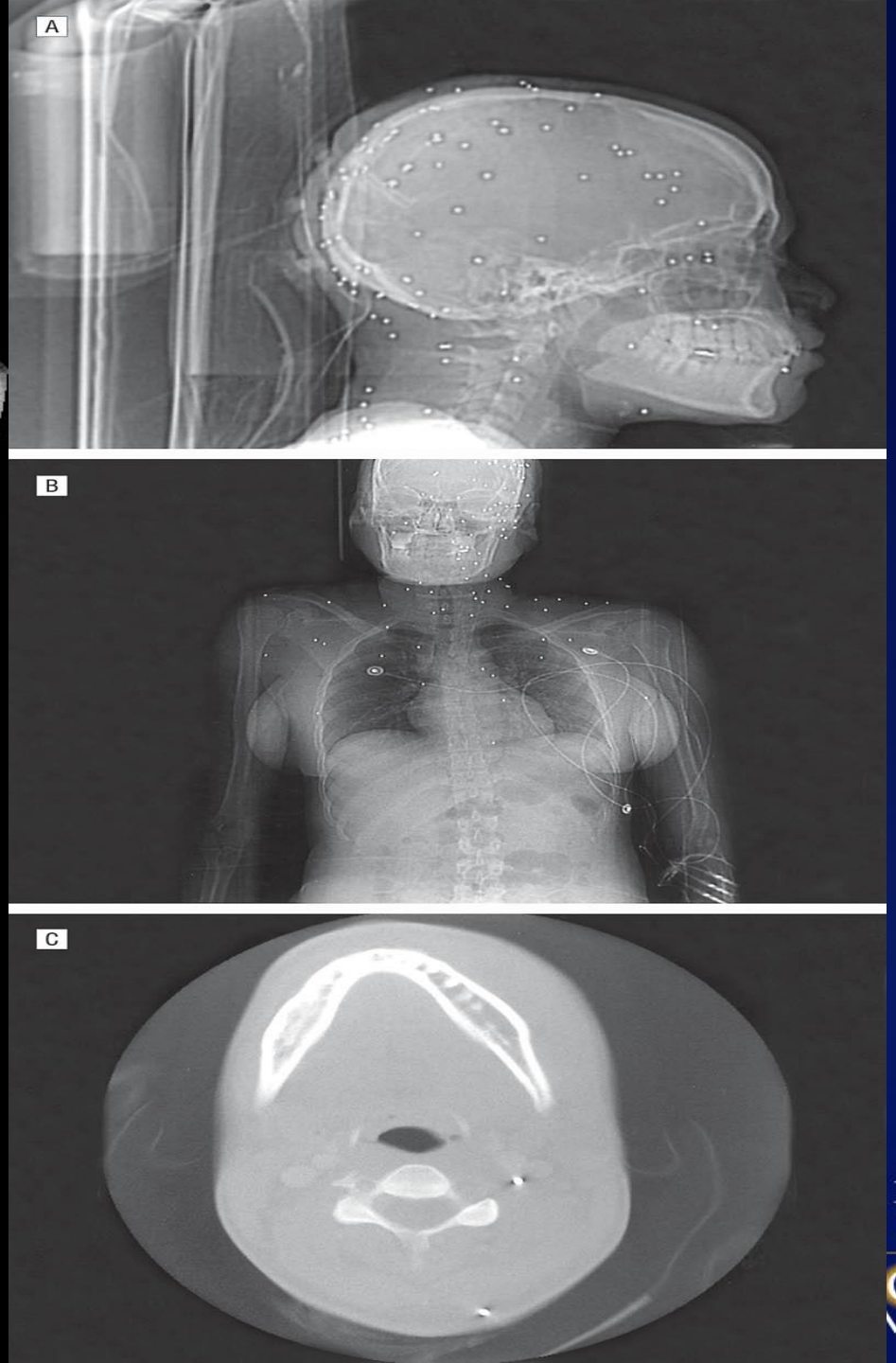
- CTA = 100% PPV, 98% NPV

  Munera F et al, Radiology 2000 & 2002

- MD-CTA- 57 pts, blunt-pen, 3 were inconclusive, neg=neg

  Stuhlfaut JW et al, AJR 2005





CT angiogram

- CT offer little over physical exam (stab)
  Gonzales et al, J Trauma 2003

- CT allows elimination invasive studies, demonstrates trajectory, & safe obs. without mandatory exploration (GSW)

  Gracias et al, Arch Surg 2001

  Mazolewski et al, J Trauma 2001

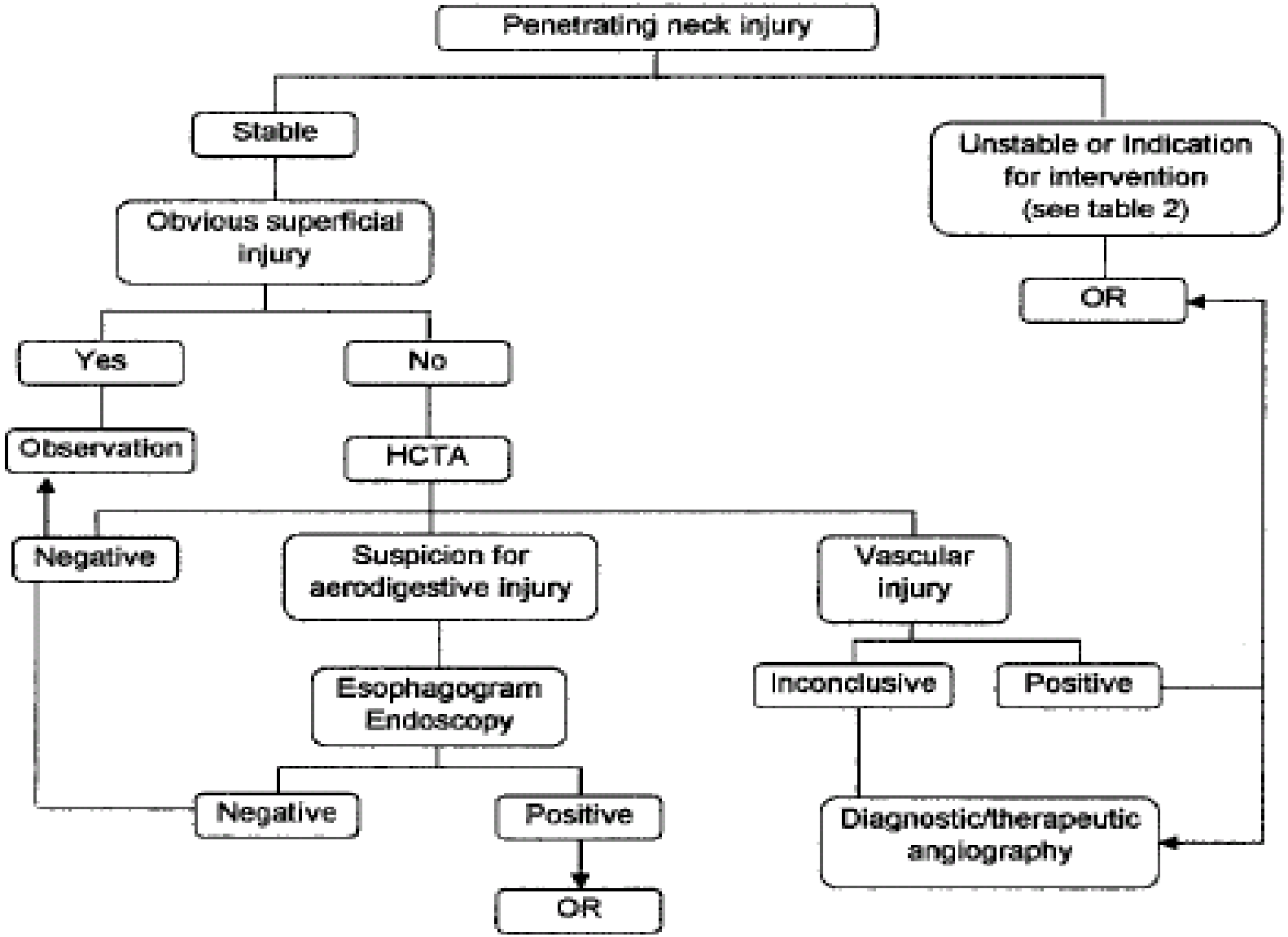
Before and after CTA

- 130 cases: 34 with CTA, 96 without (n-CTA)
- Fewer neck explorations (3% vs 33%, p< 0.001)
- Negative neck explorations significantly higher in no-CTA group, 22 % vs 0% in CTA (P < 0.01)
  Woo K et al, Am Surg 2005

Before and after CTA

- Angiogram & esophagram use significantly lower in CTA vs no-CTA ($p = 0.02$ and $p = 0.04$)
- In CTA group, 12% had angiography & 12% contrast esophagram
- In the no-CTA group, 29% had angio & 26% contrast esophagram

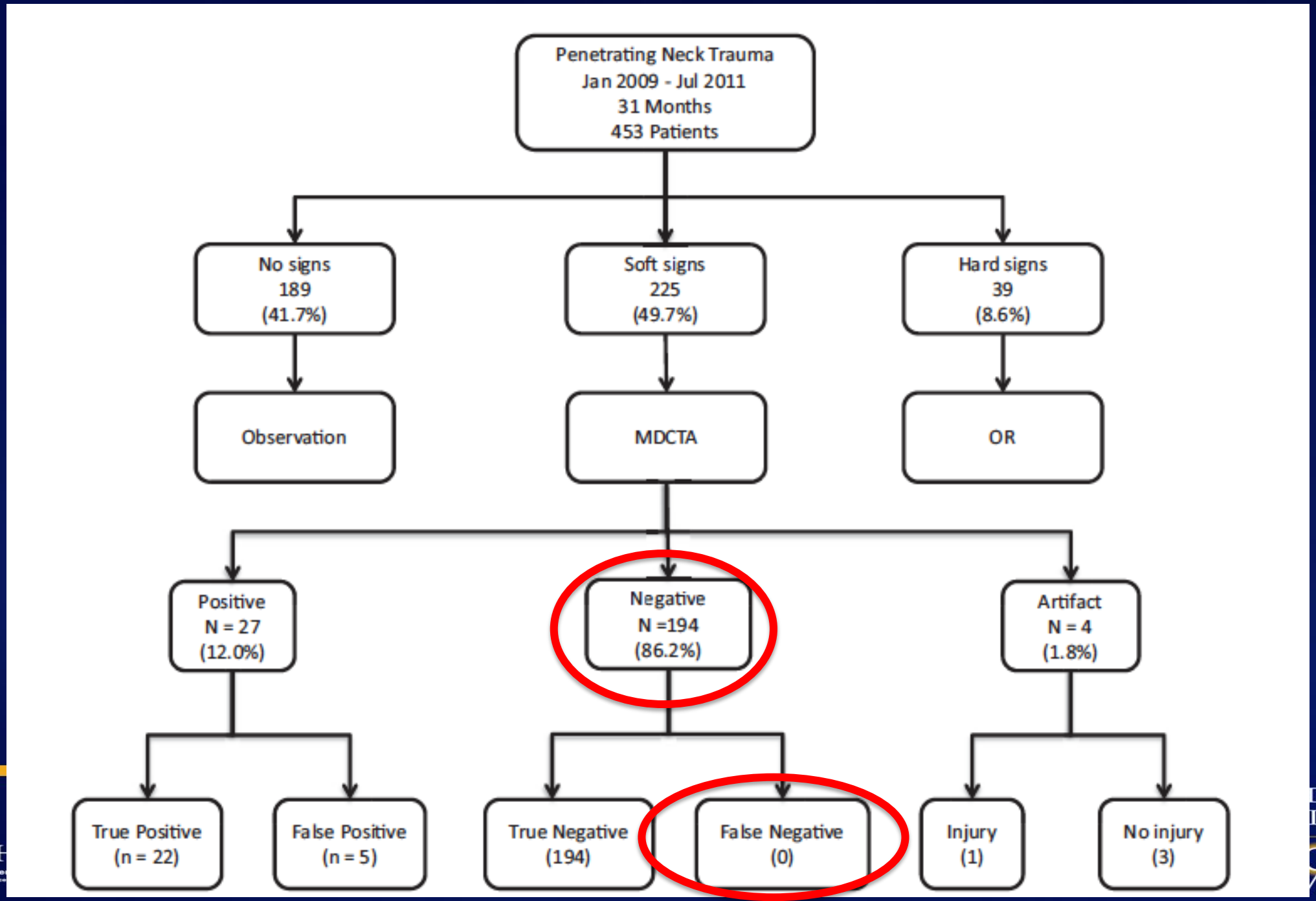
Woo K et al, Am Surg


Penetrating neck injury
Stable
Unstable or Indication for intervention (see table 2)
Obvious superficial injury
OR
Yes
No
Observation
HCTA
Negative
Suspicion for aerodigestive injury
Vascular injury
Esophagogram Endoscopy
Inconclusive
Positive
Negative
Positive
Diagnostic/therapeutic angiography
OR

AAST 2011 Plenary Paper

Evaluation of multidetector computed tomography for penetrating neck injury: A prospective multicenter study

Kenji Inaba, MD, Bernardino C. Branco, MD, Jay Menaker, MD, Thomas M. Scalea, MD, Sean Crane, MD, Joseph J. DuBose, MD, Lily Tung, BSc, Sravanthi Reddy, MD, *and* **Demetrios Demetriades, MD, PhD,** *Los Angeles, California*


Penetrating Neck Trauma
Jan 2009 - Jul 2011
31 Months
453 Patients
No signs
189
(41.7%)
Soft signs
225
(49.7%)
Hard signs
39
(8.6%)
Observation
MDCTA
OR
Positive
N = 27
(12.0%)
Negative
N =194
(86.2%)
Artifact
N = 4
(1.8%)
True Positive
(n = 22)
False Positive
(n = 5)
True Negative
(194)
False Negative
(0)
Injury
(1)
No injury
(3)

Injury, Int. J. Care Injured 46 (2015) 1720–1725

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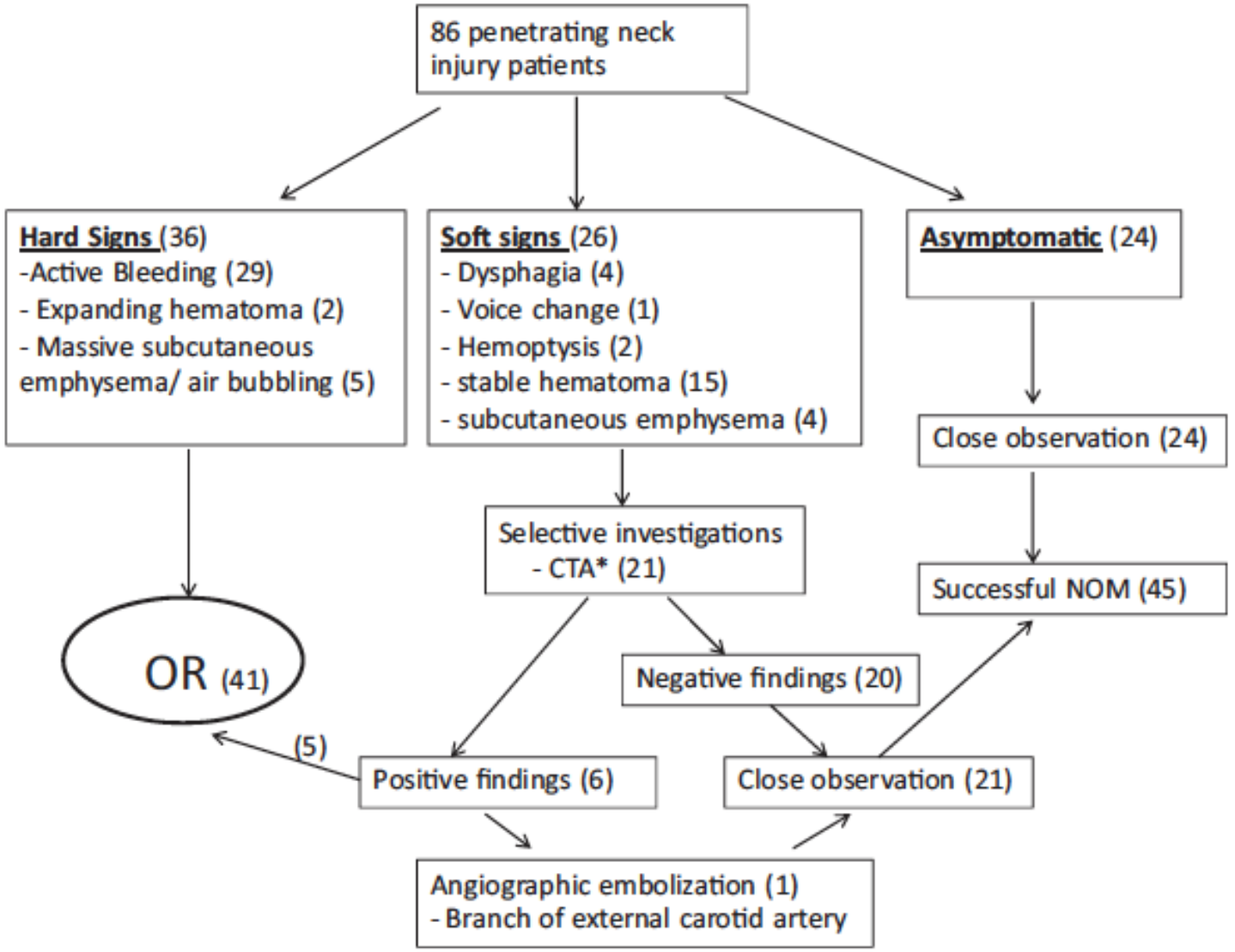
Injury

journal homepage: www.elsevier.com/locate/injury

Selective management of penetrating neck injuries using "no zone" approach

Supparerk Prichayudh*, Jirat Choadrachata-anun, Suvit Sriussadaporn, Rattaplee Pak-art, Sukanya Sriussadaporn, Kritaya Kritayakirana, Pasurachate Samorn

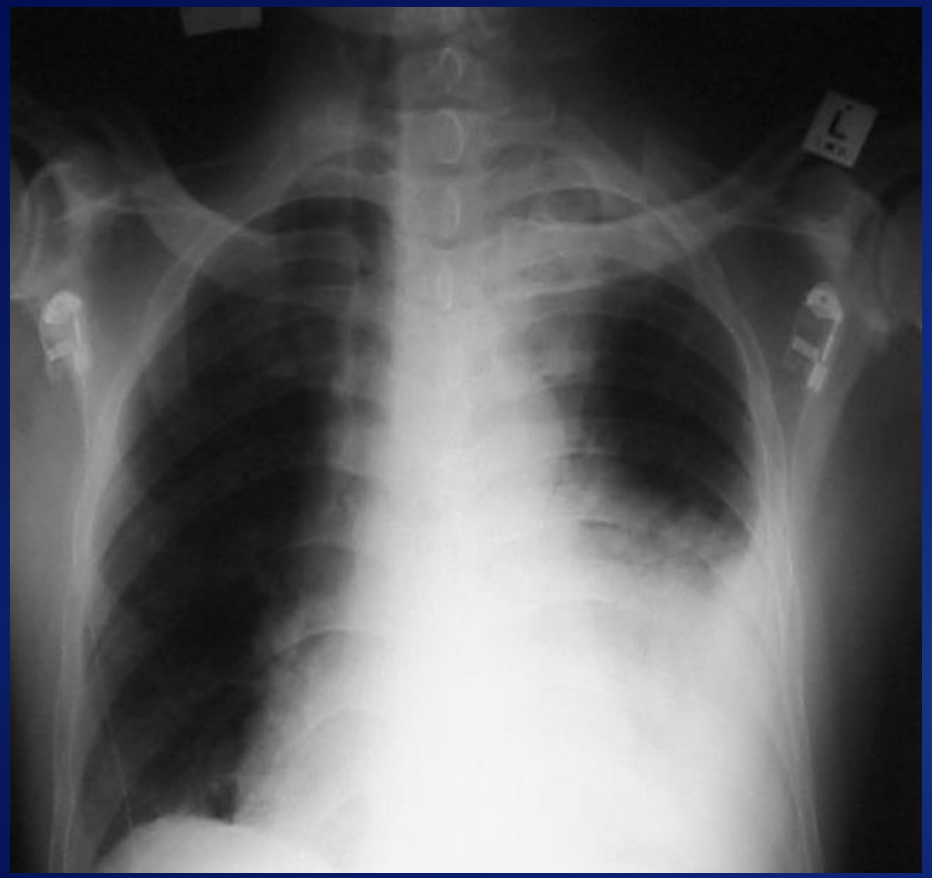

86 penetrating neck injury patients
Hard Signs (36)
-Active Bleeding (29)
- Expanding hematoma (2)
- Massive subcutaneous emphysema/ air bubbling (5)
Soft signs (26)
- Dysphagia (4)
- Voice change (1)
- Hemoptysis (2)
- stable hematoma (15)
- subcutaneous emphysema (4)
Asymptomatic (24)
Close observation (24)
Successful NOM (45)
Selective investigations
- CTA* (21)
OR (41)
(5)
Negative findings (20)
Positive findings (6)
Close observation (21)
Angiographic embolization (1)
- Branch of external carotid artery

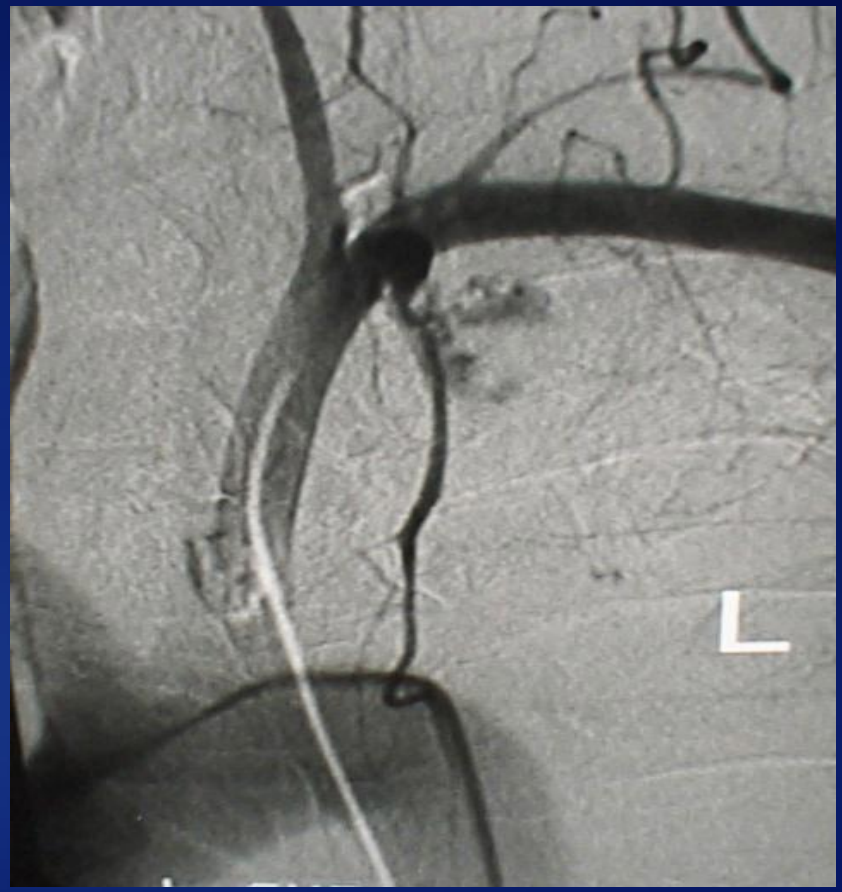
LET'S CUT !!!

Preoperative Approach

- AIRWAY
- Apply PRESSURE until vascular control
- DON'T probe/explore
- LEAVE object in place until vascular control

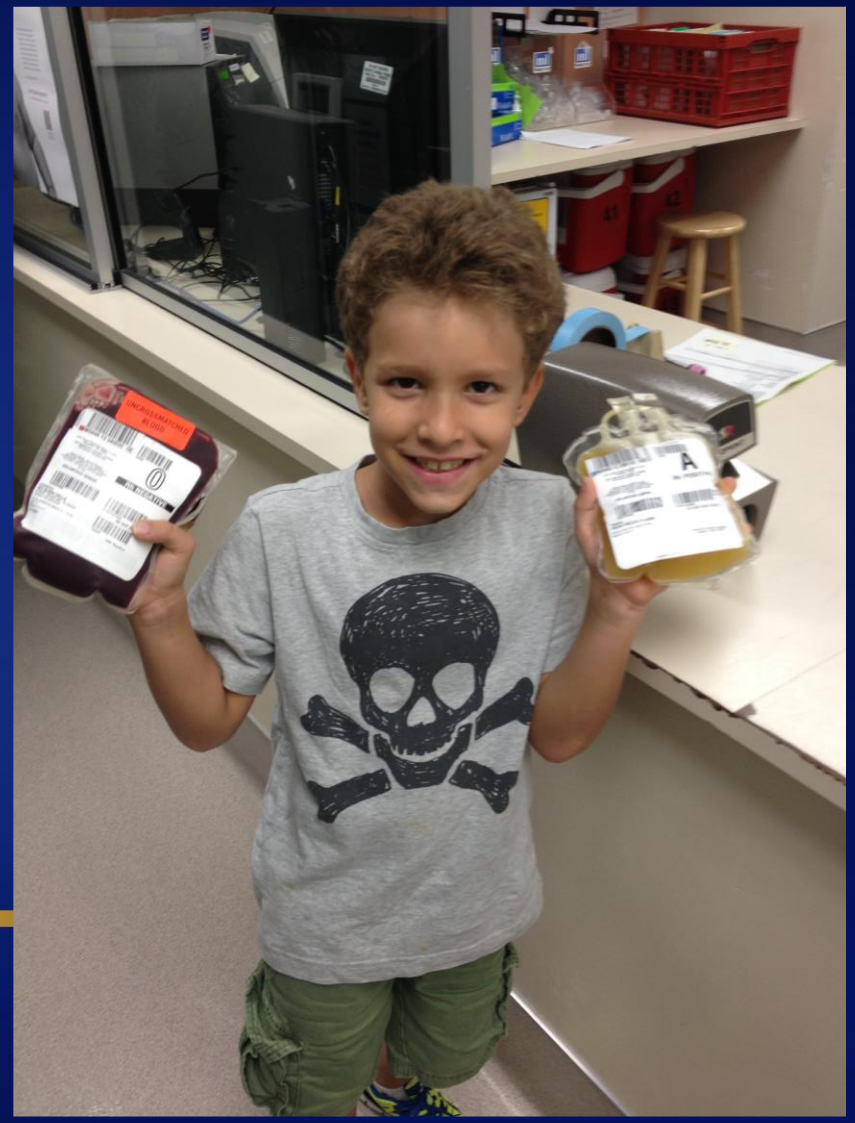
Preoperative Prep/Evaluation





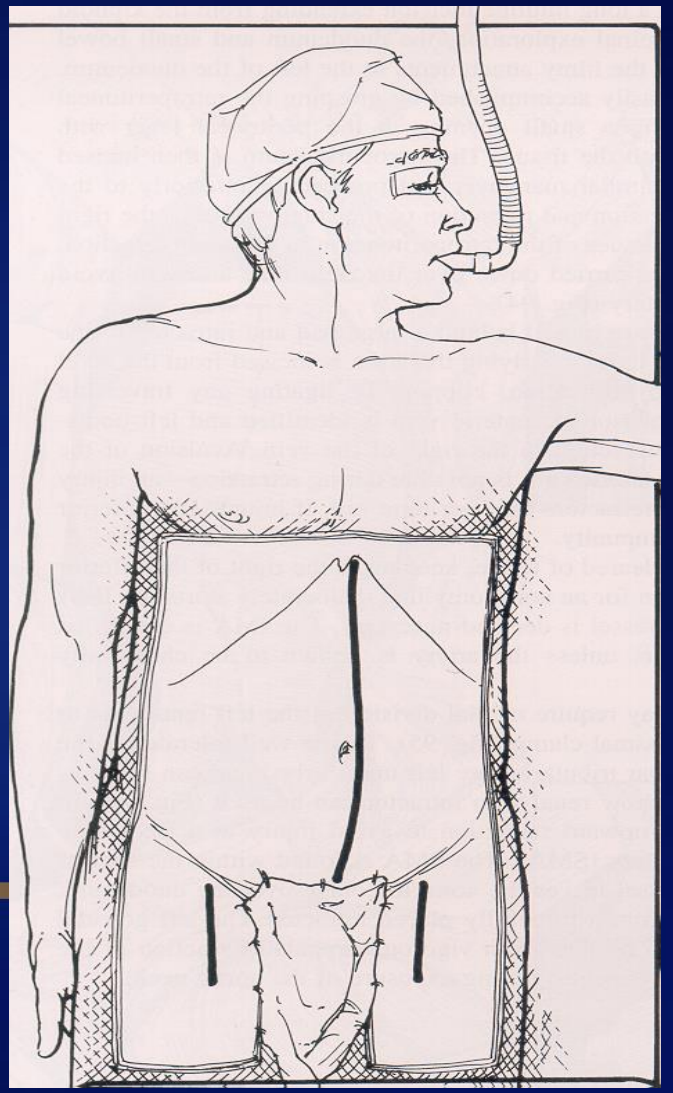
Preoperative Evaluation/Prep

- Call Blood Bank ASAP
- Give IR a “heads up” Zone I/III

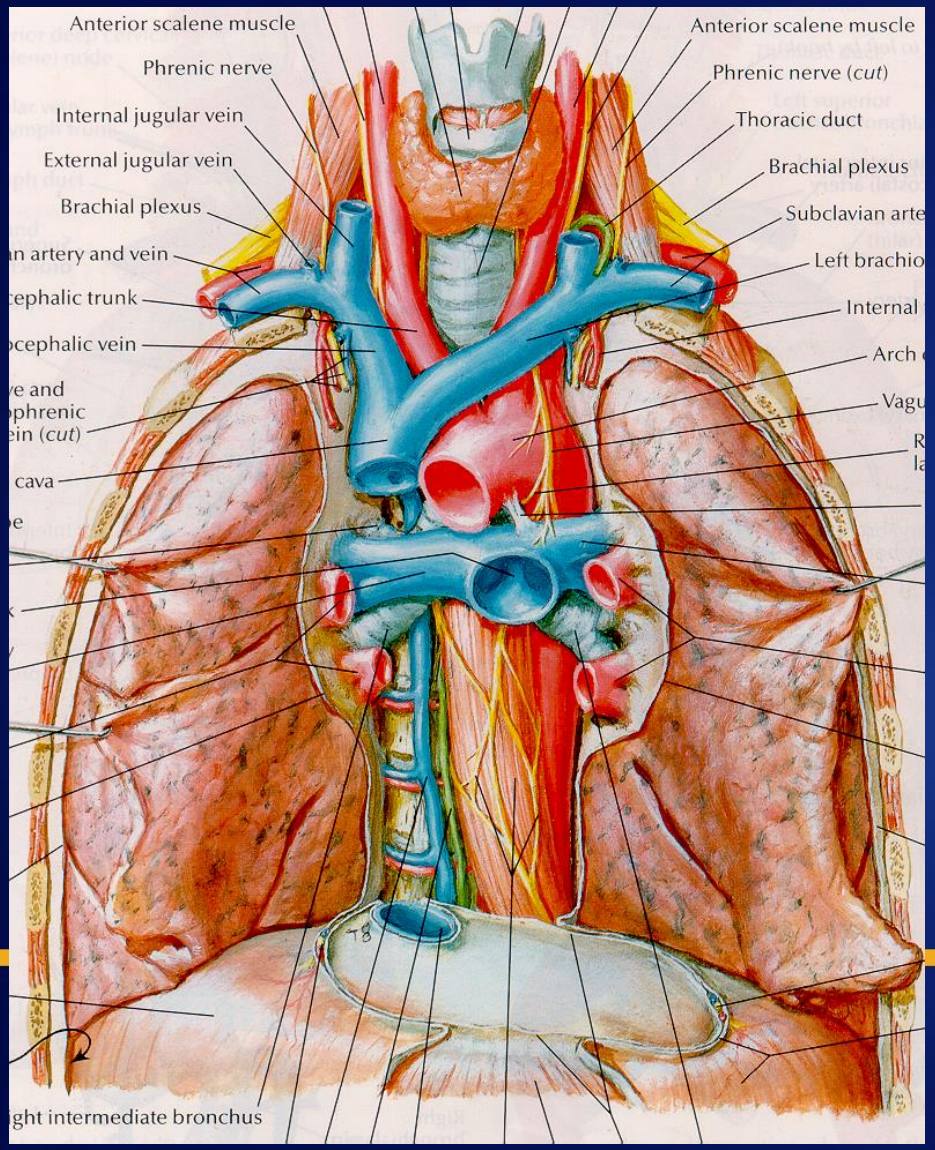


OR Positioning and Prep

- Supine, arm(s) tucked, neck to the opposite side & extended
- Prep from ears to mid-abdomen & at least one groin
- Keep up the communication with blood bank, IR, & anesthesia



Zone I


Anterior scalene muscle
Phrenic nerve
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External jugular vein
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Anterior scalene muscle
Phrenic nerve (cut)
Thoracic duct
Brachial plexus
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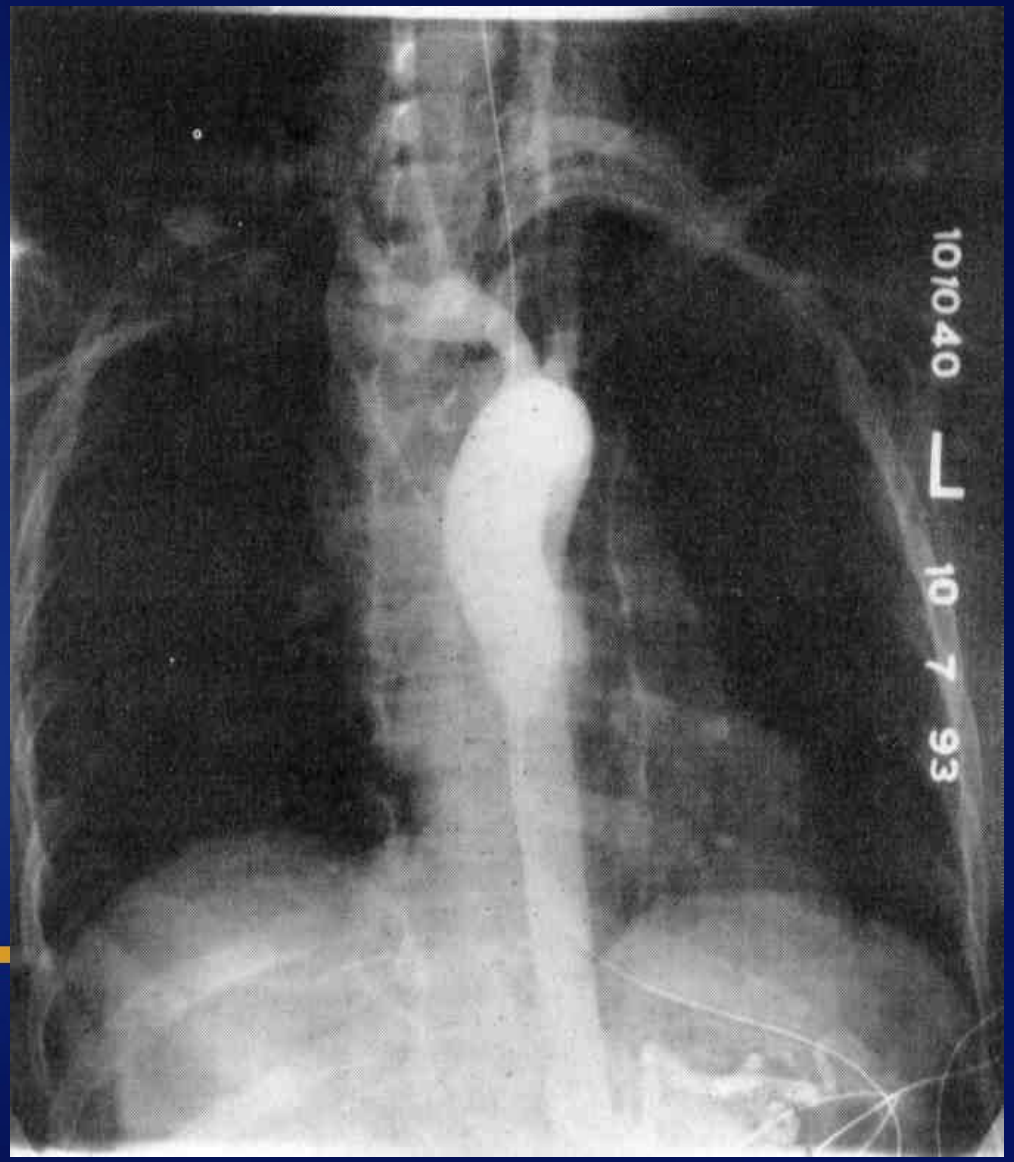
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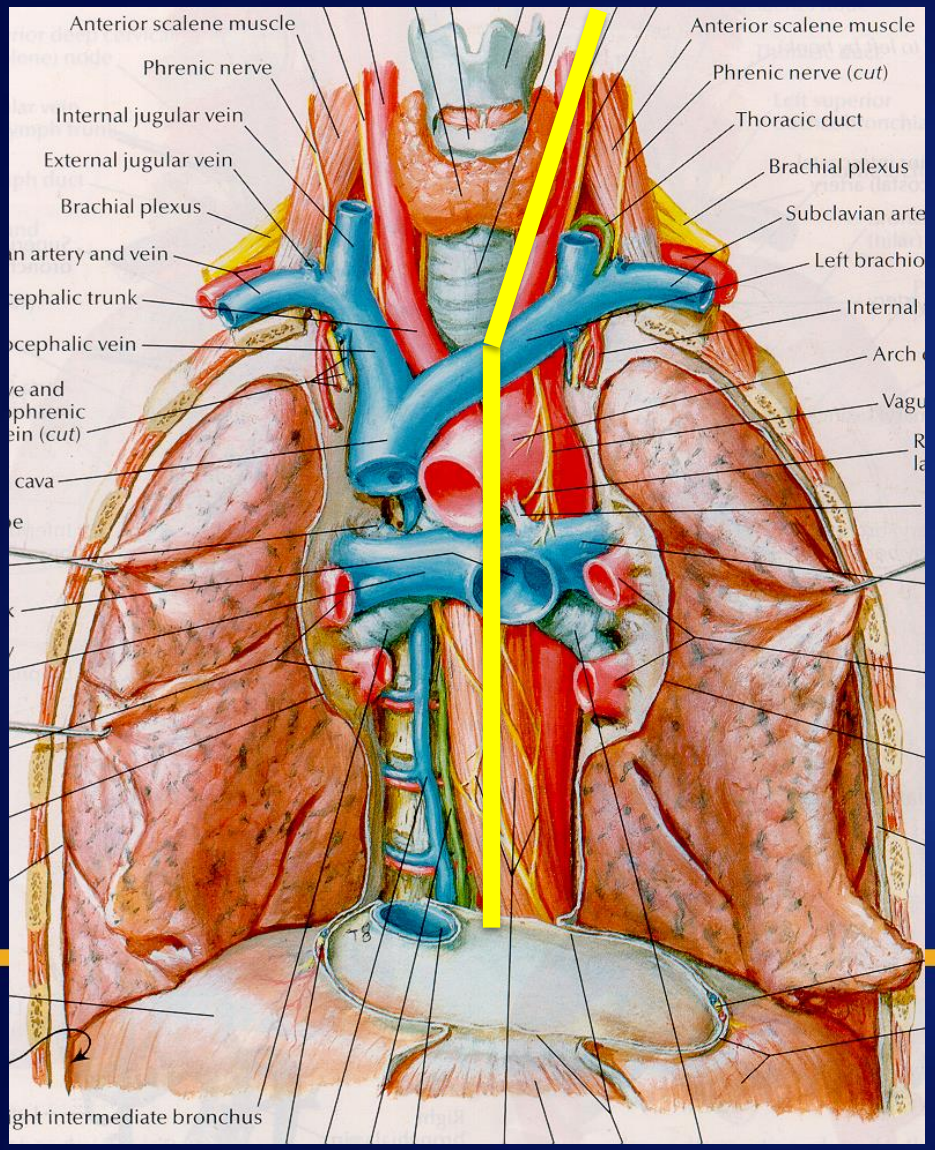
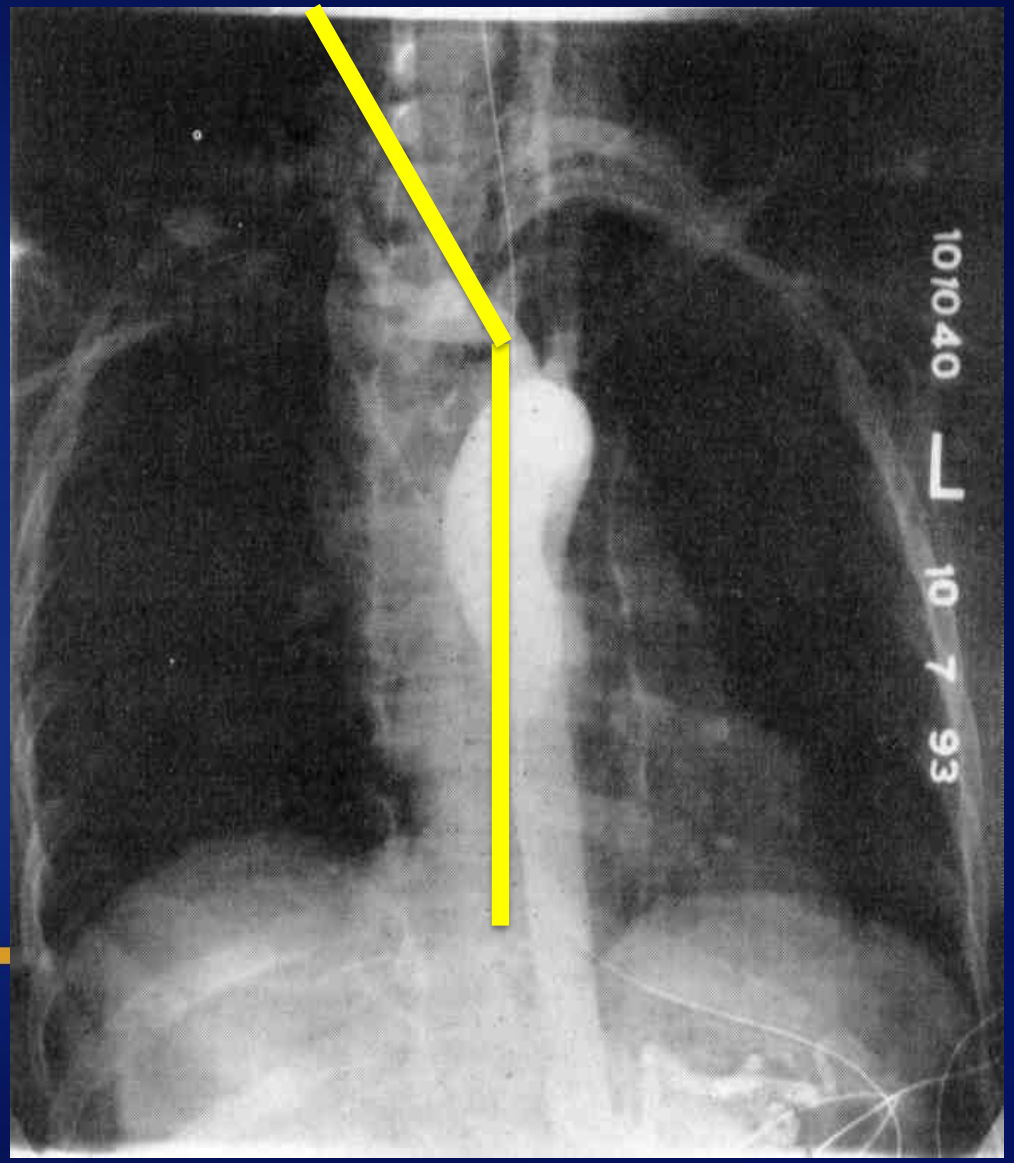
Zone I Approach





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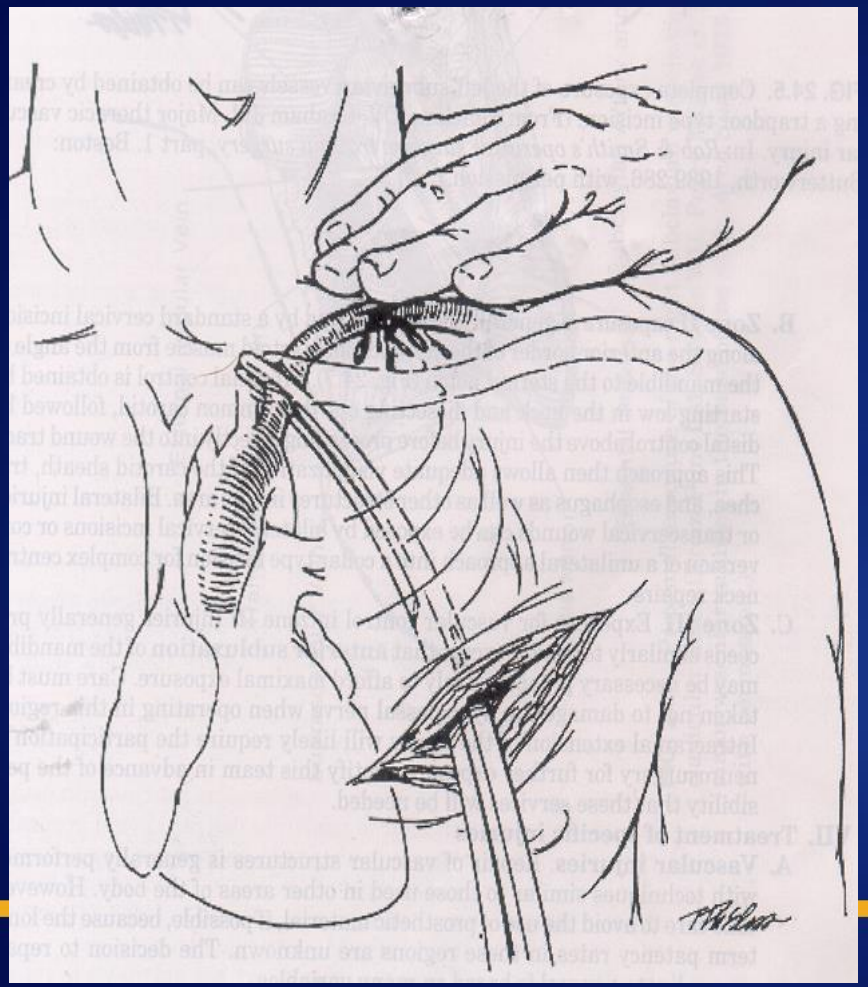

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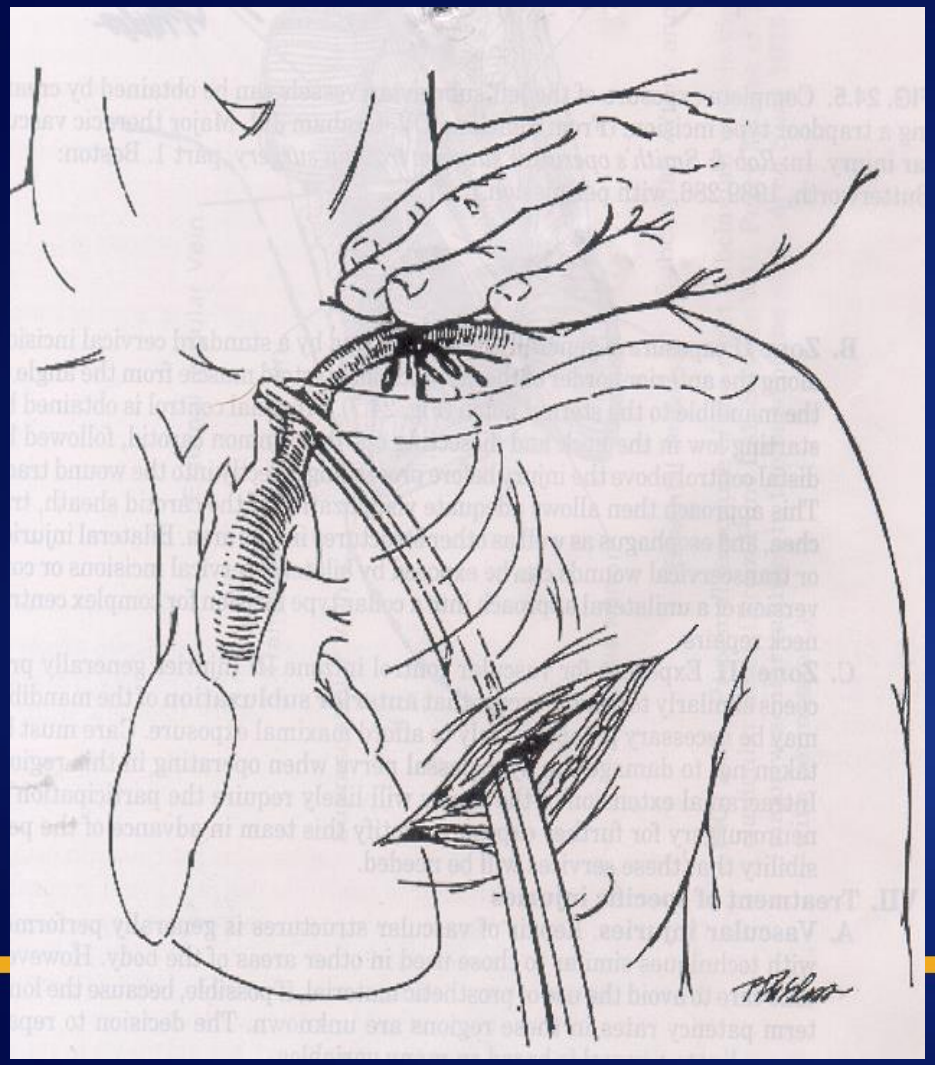
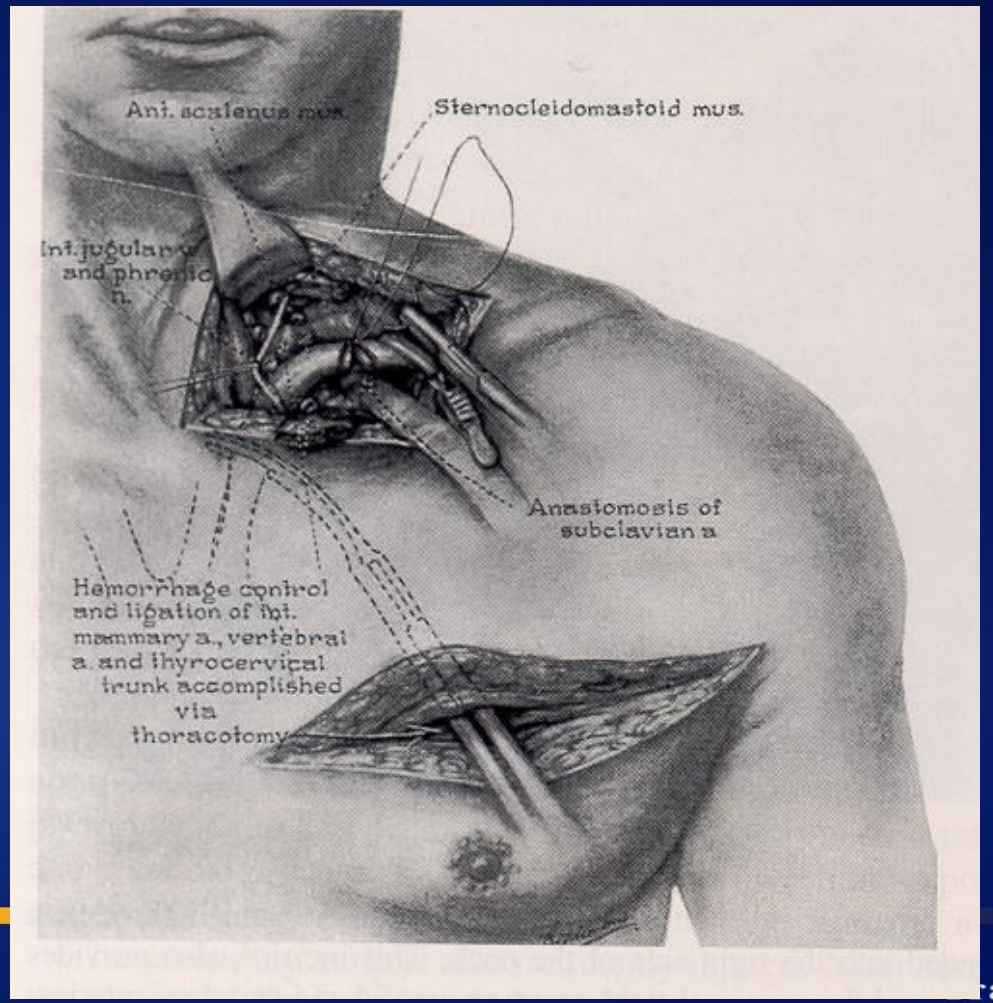
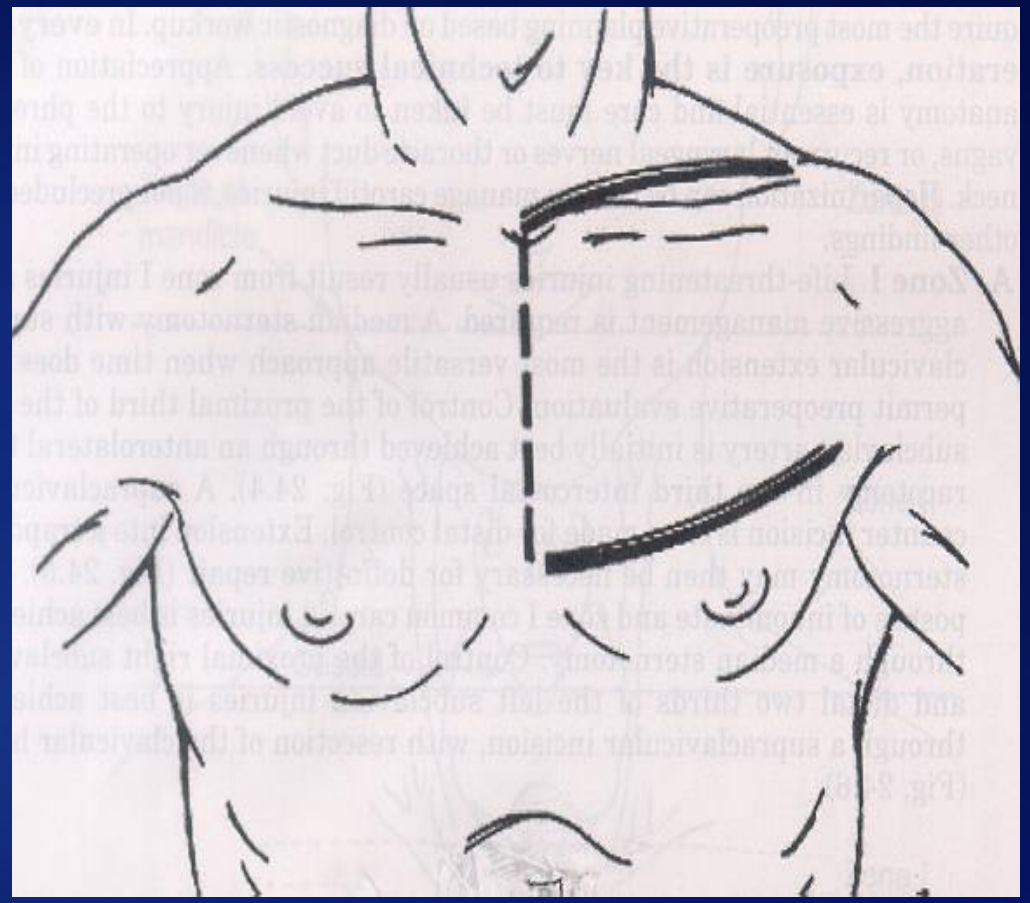


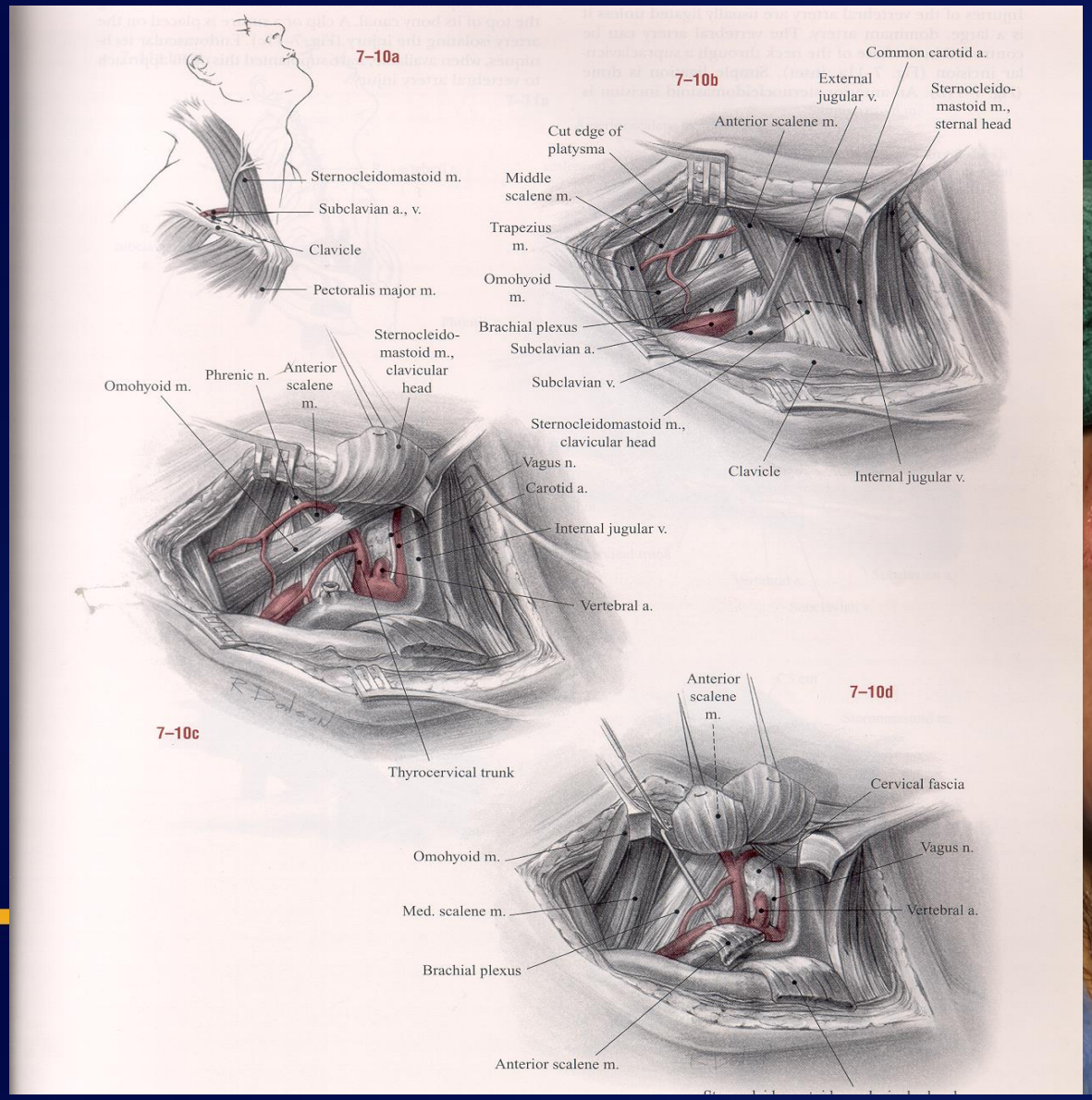


Zone I Approaches

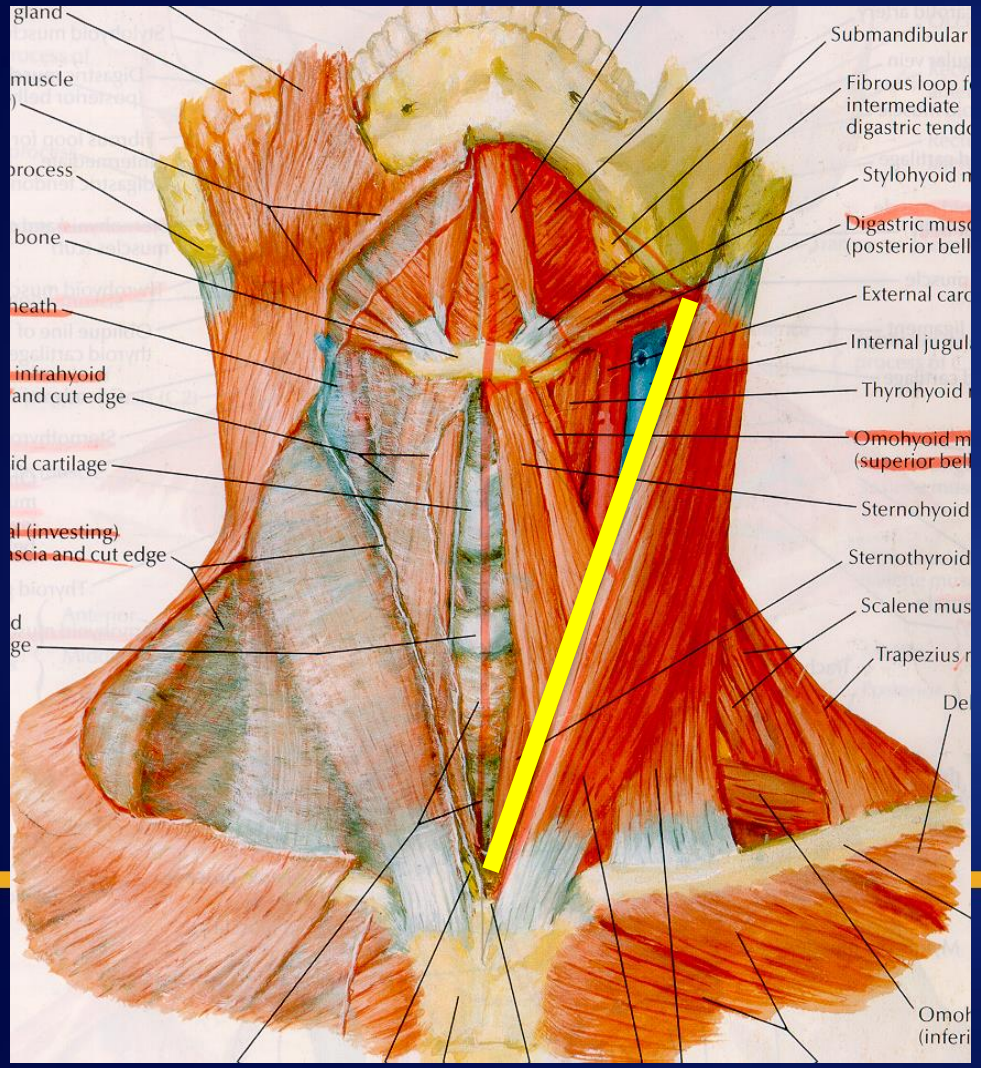
- “Trap door” rarely needed
- Best exposure through median sternotomy
- Right subclavian injuries- through supraclavicular or infraclavicular incision



Zone I Approaches-R subclavian



Zone I-II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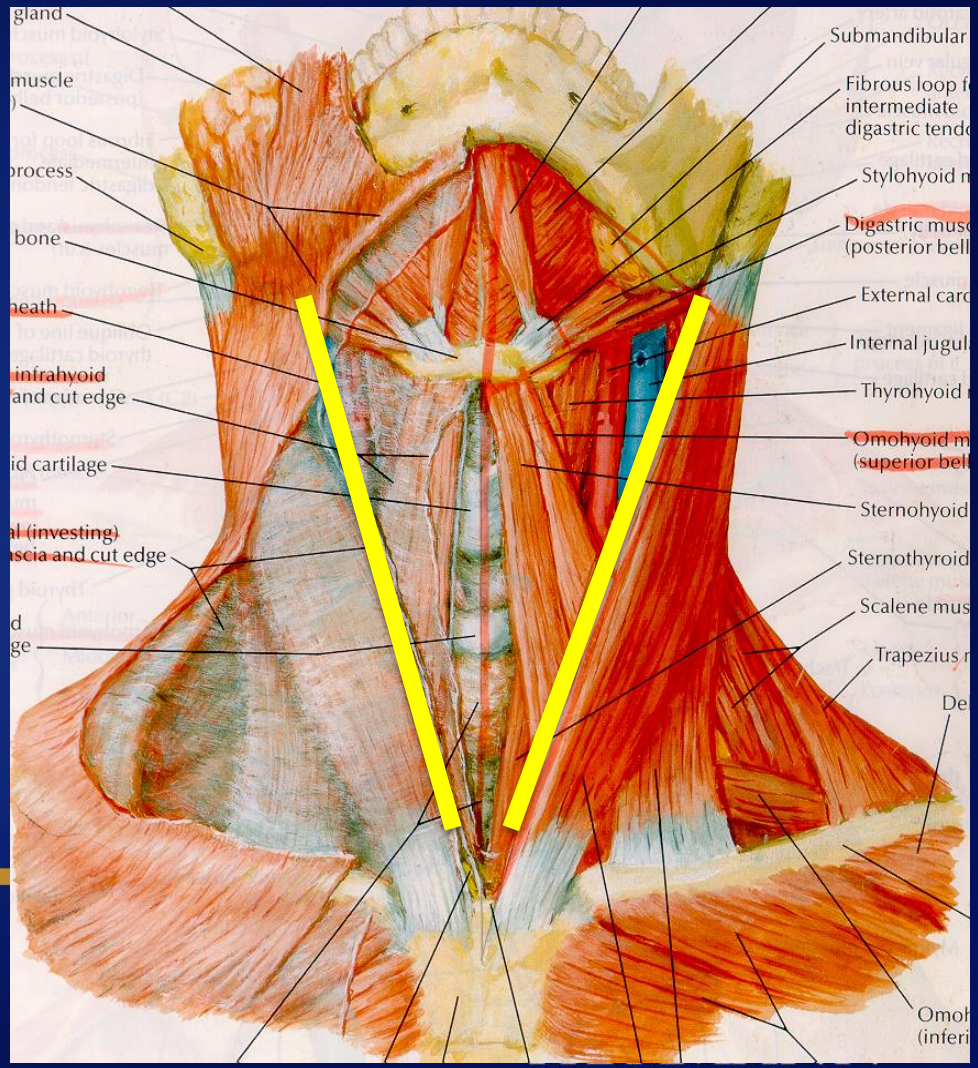
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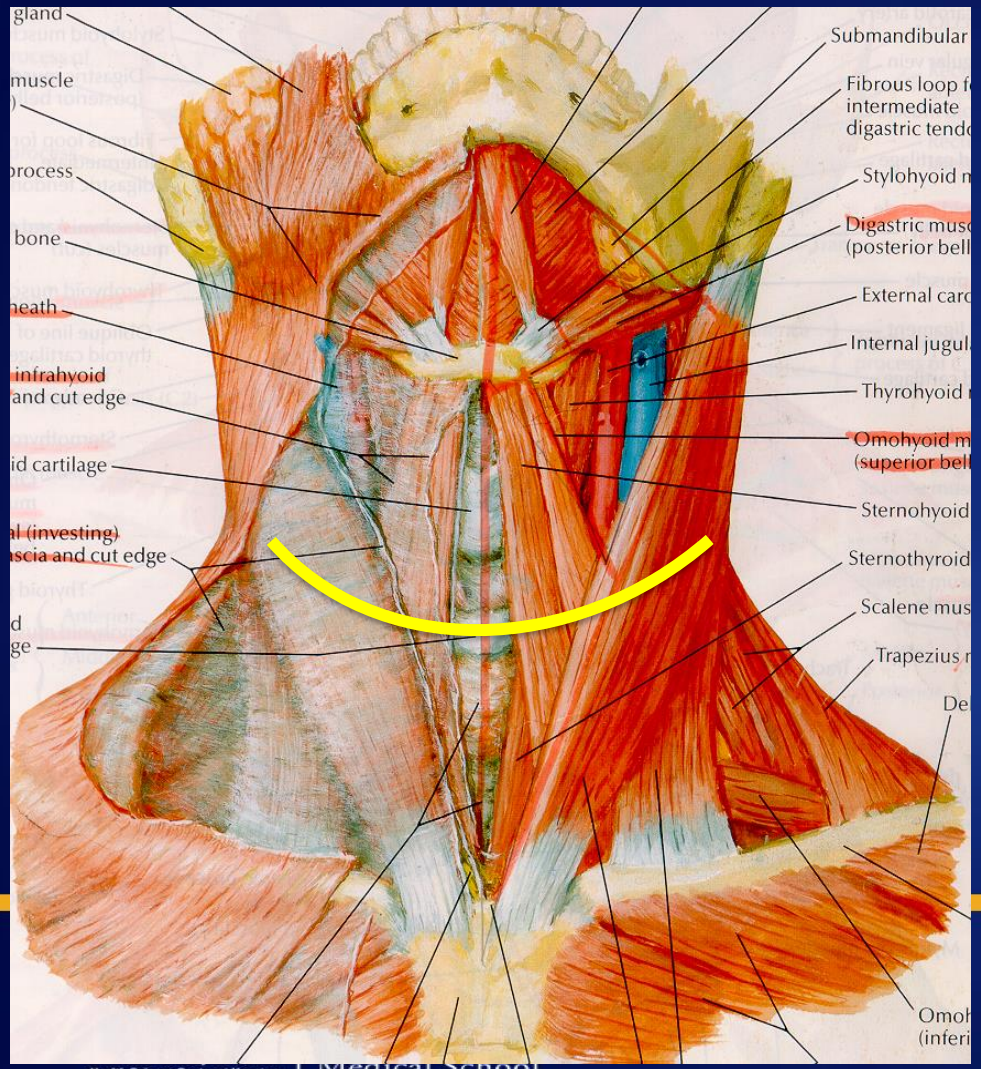
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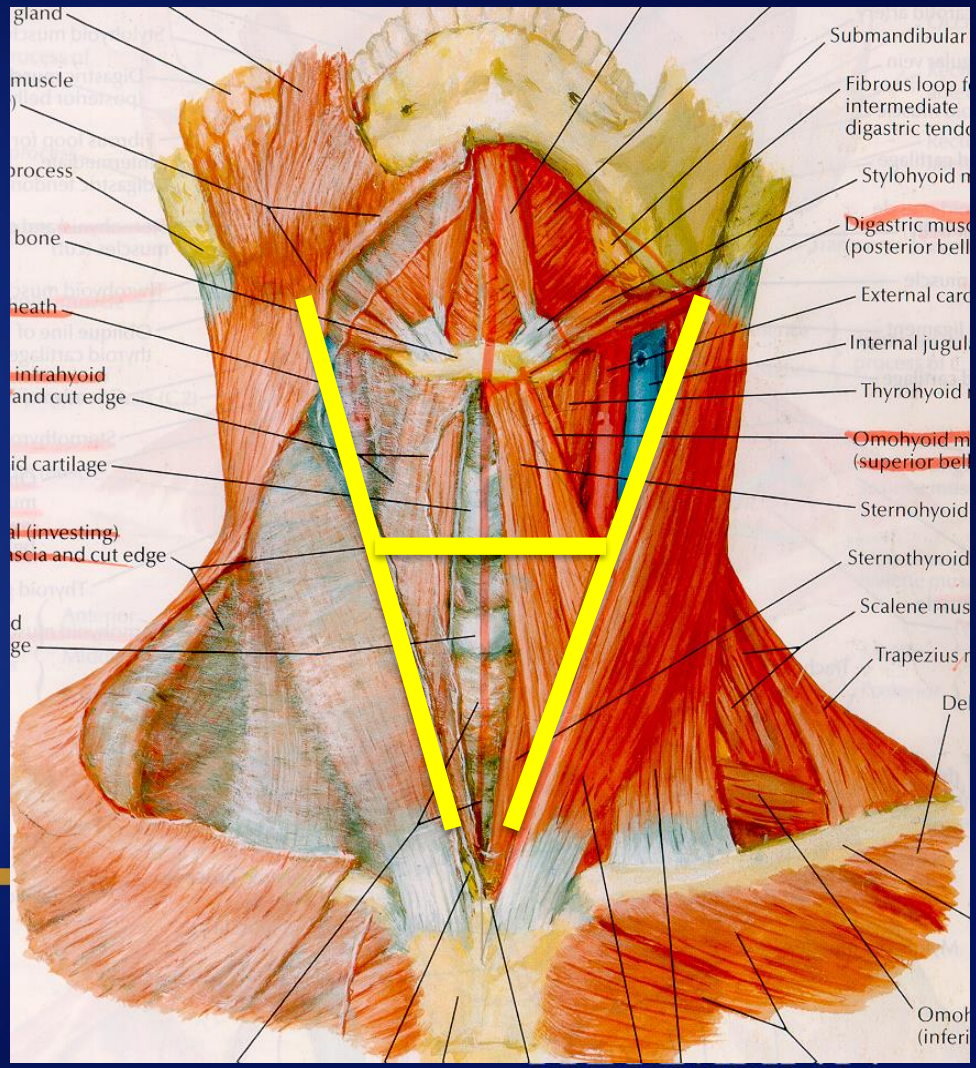
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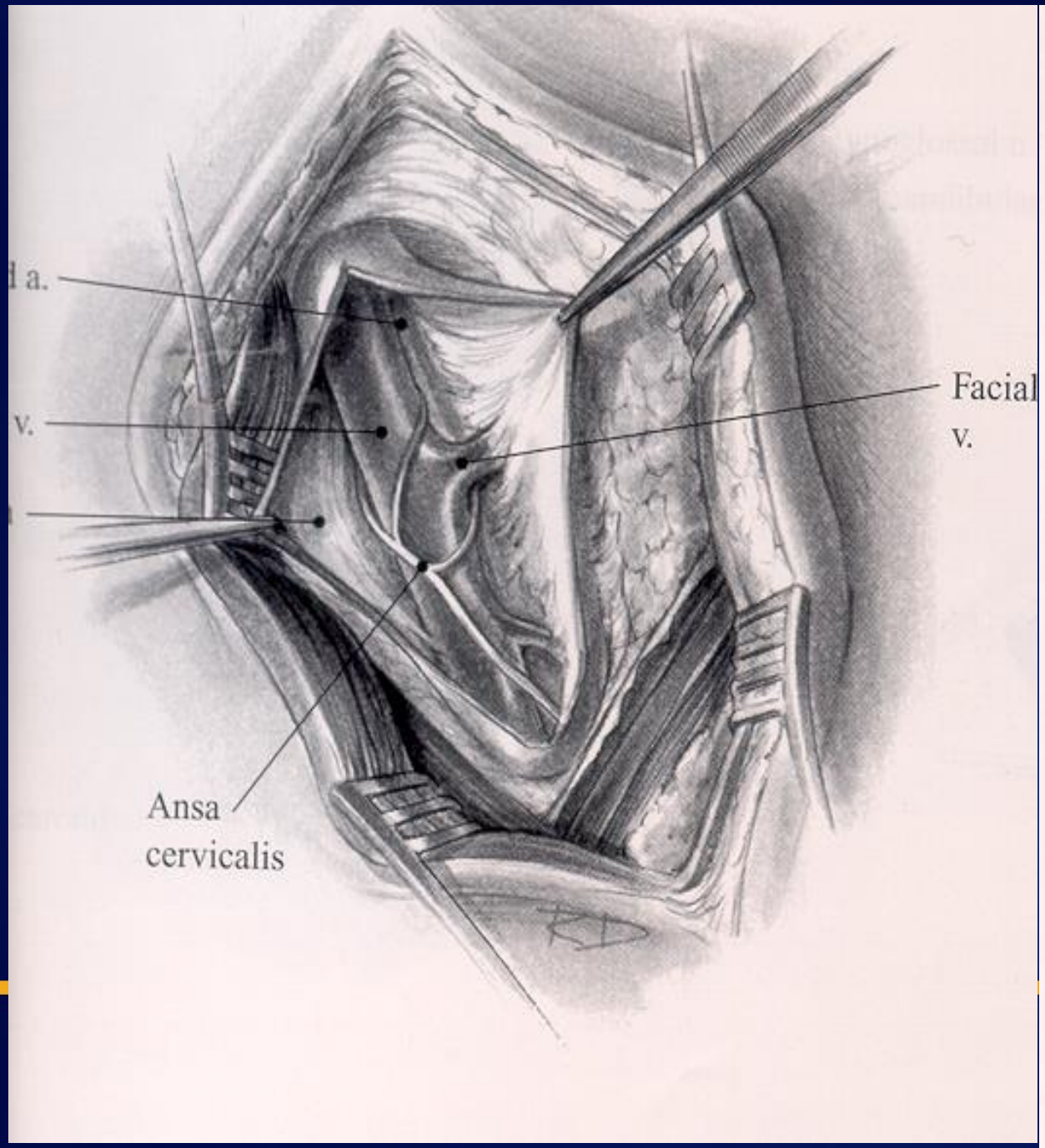
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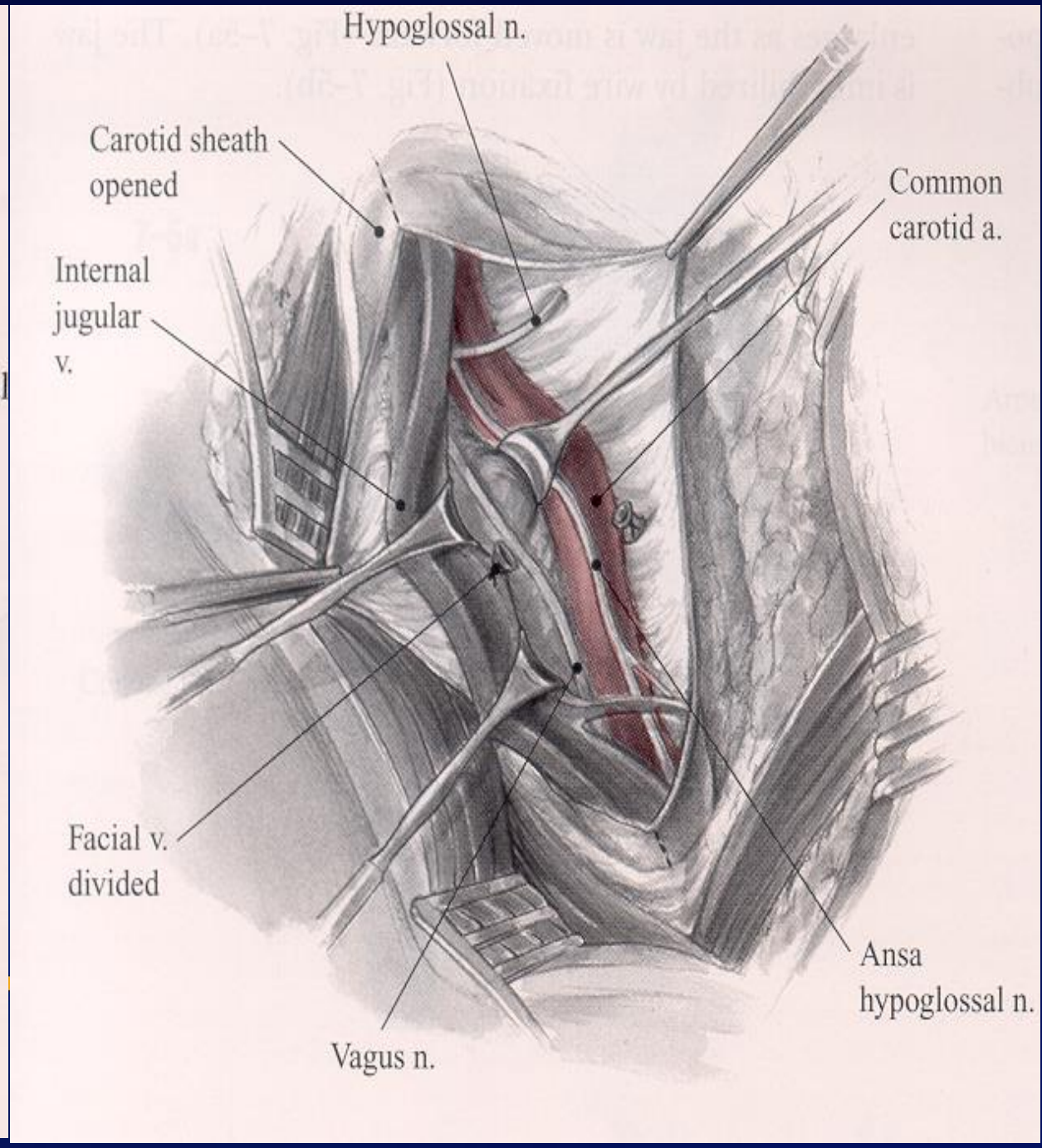
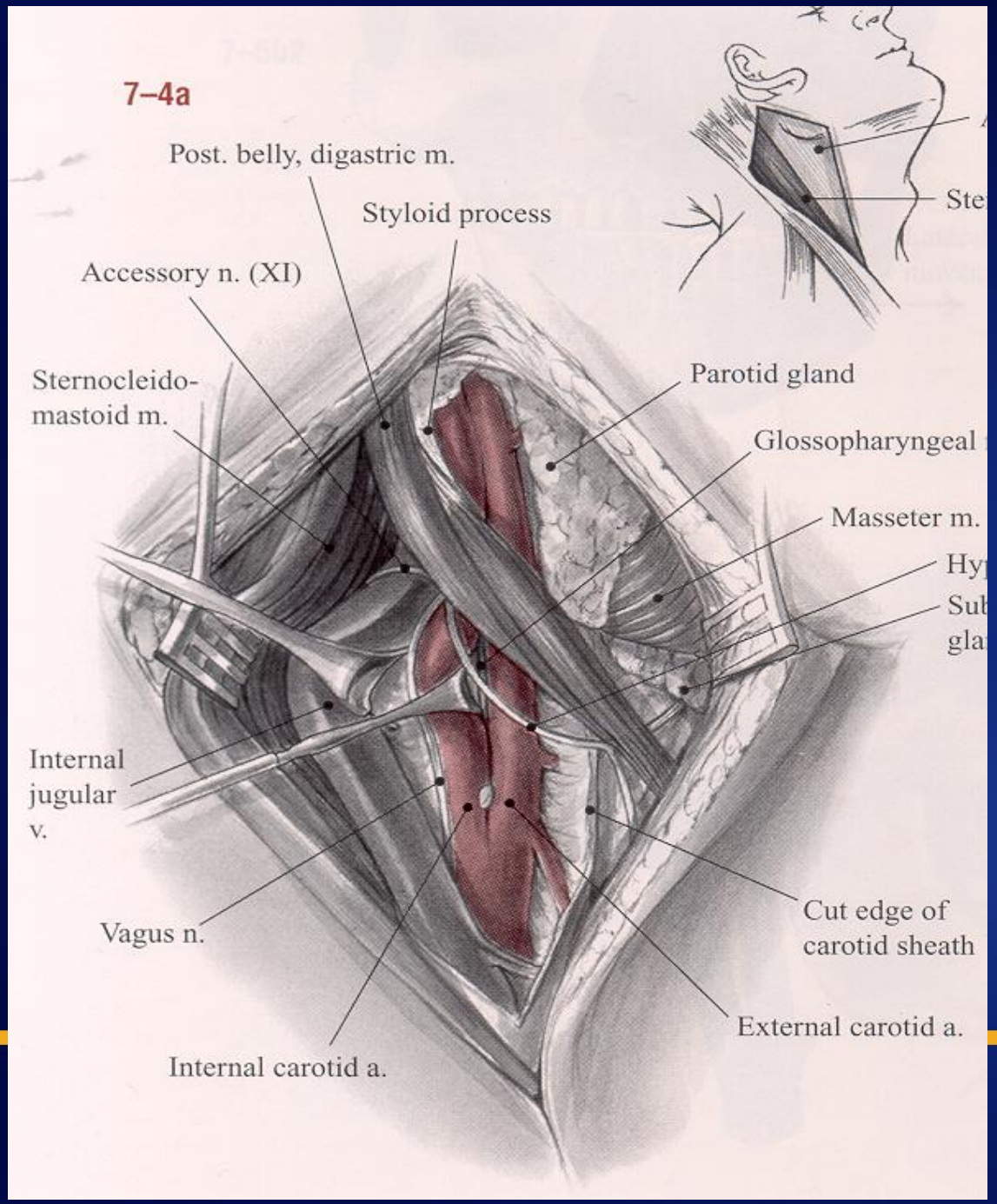
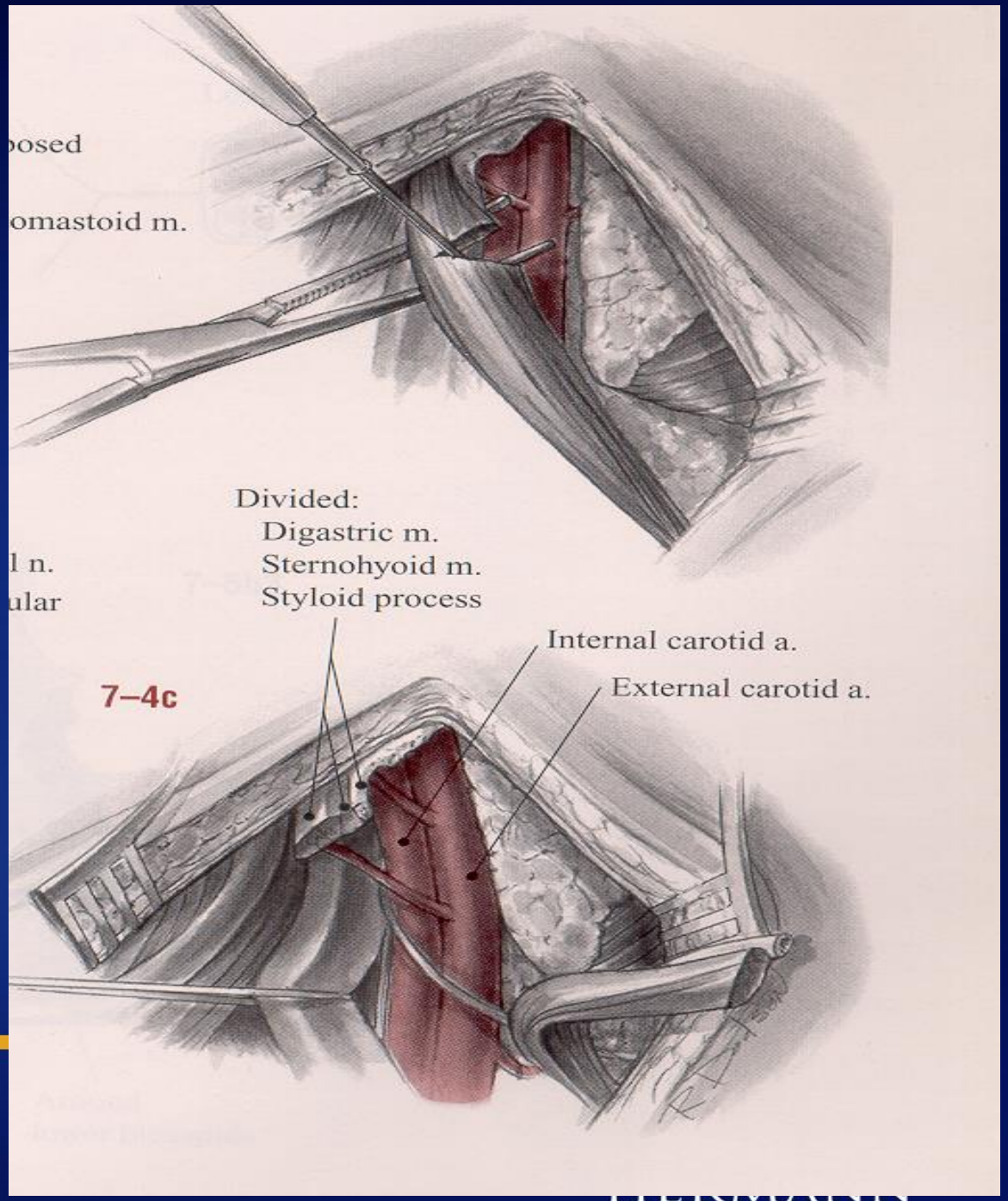
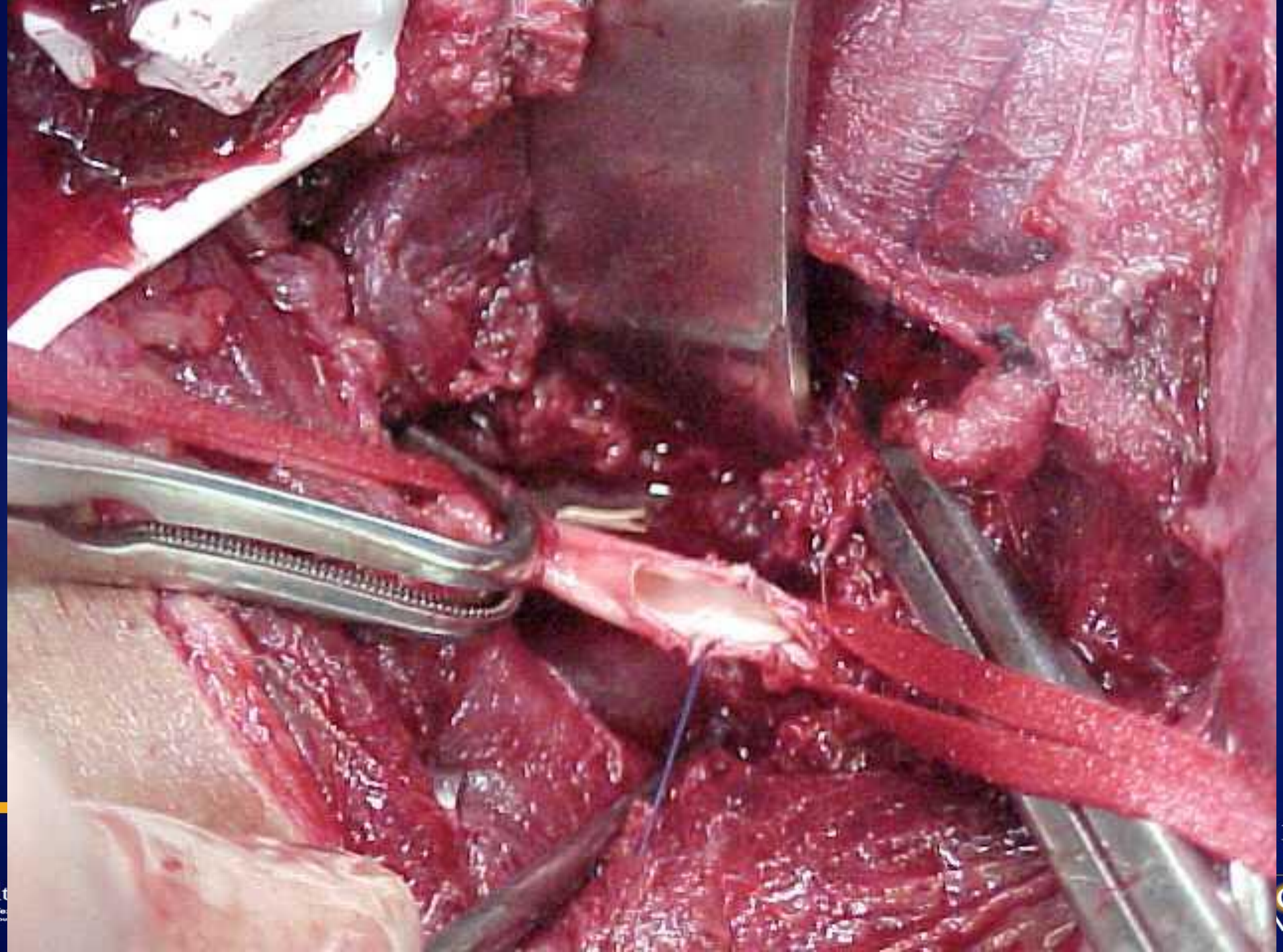

Hypoglossal n.
Carotid sheath
opened
Common
carotid a.
Internal
jugular
v.
Facial v.
divided
Ansa
hypoglossal n.
Vagus n.


7–4a
Post. belly, digastric m.
Styloid process
Accessory n. (XI)
Sternocleido-
mastoid m.
Parotid gland
Glossopharyngeal
Masseter m.
Internal
jugular
v.
Vagus n.
Cut edge of
carotid sheath
External carotid a.
Internal carotid a.


Divided:
Digastric m.
Sternohyoid m.
Styloid process
Internal carotid a.
External carotid a.
7–4c



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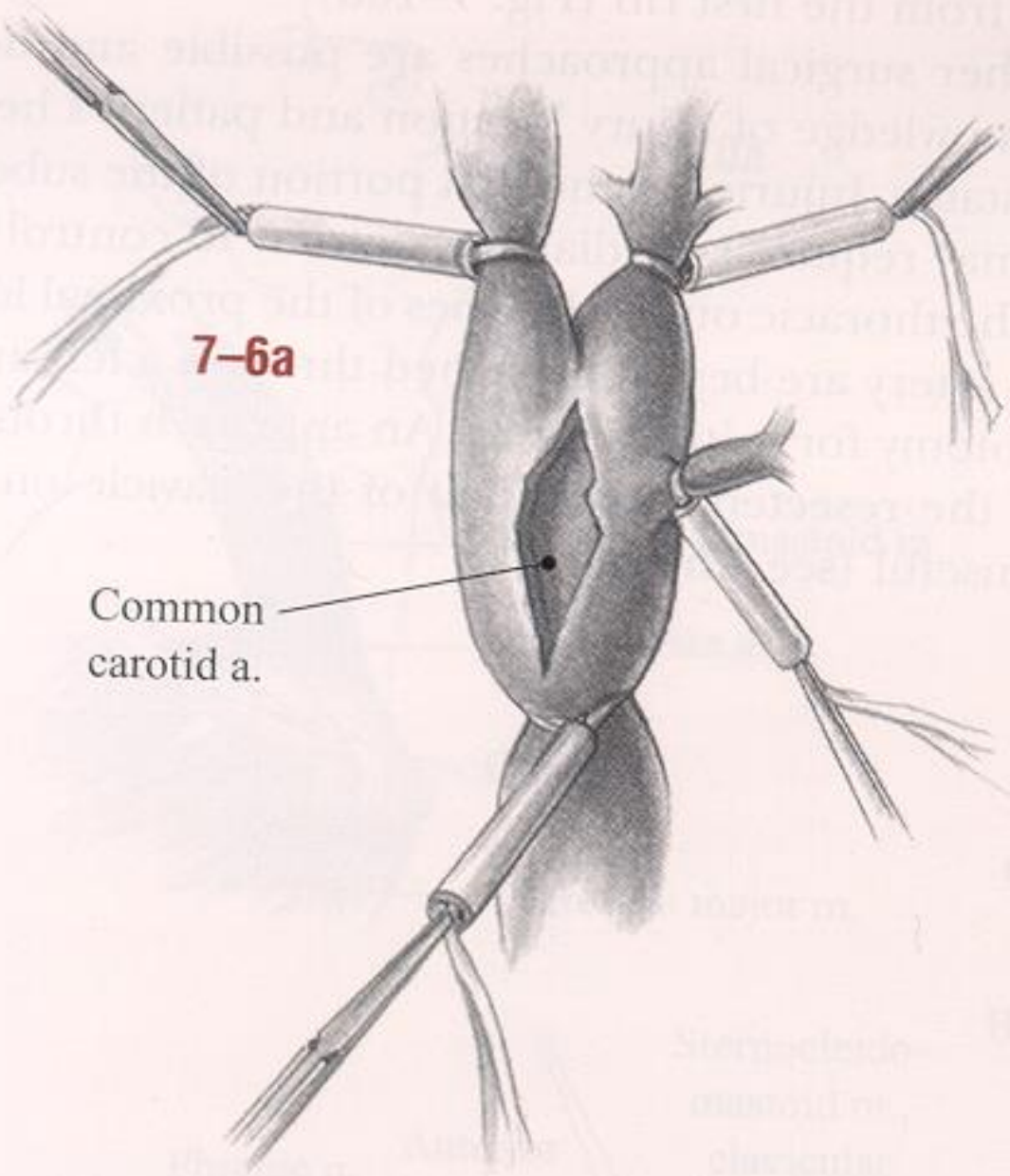
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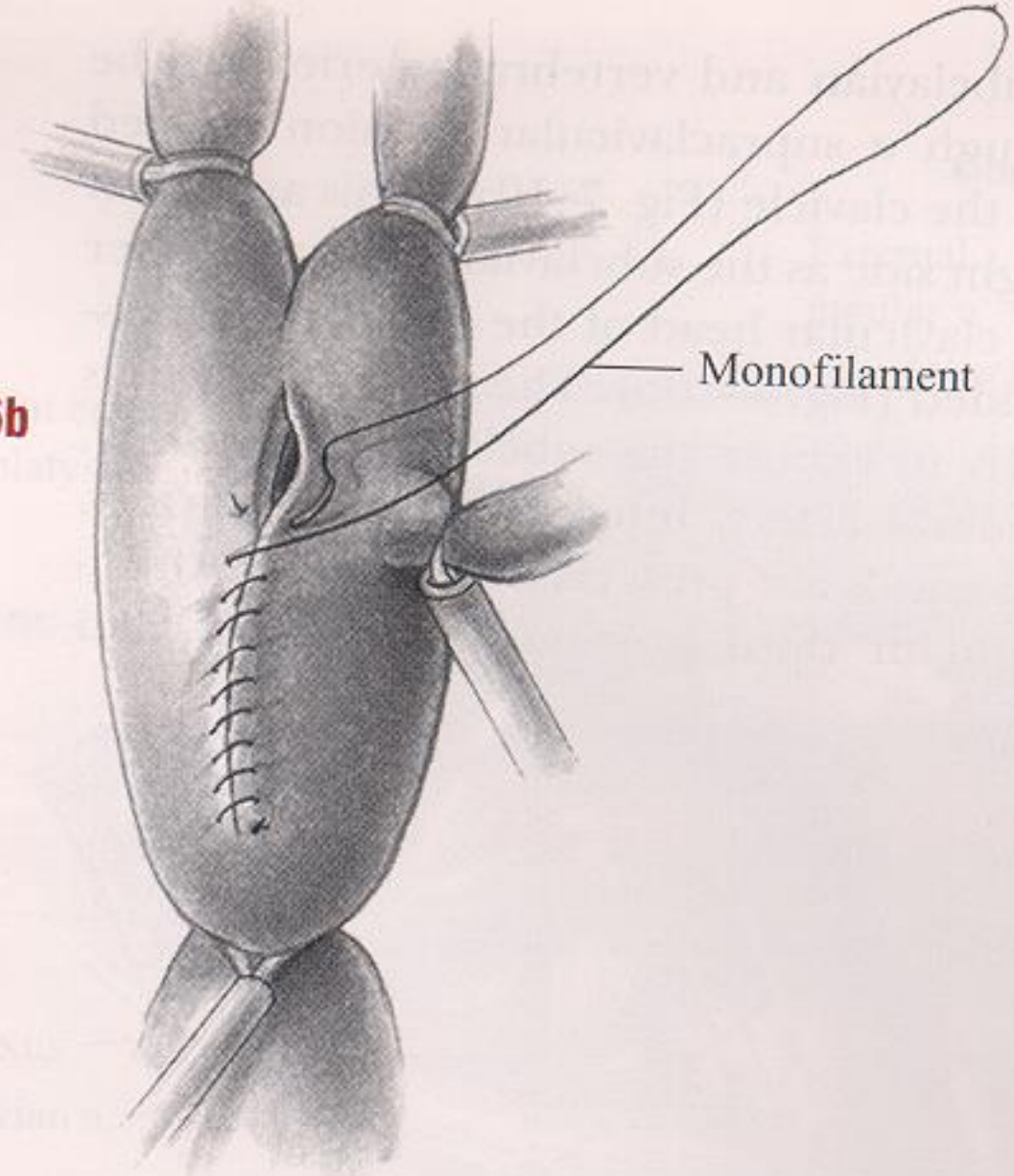
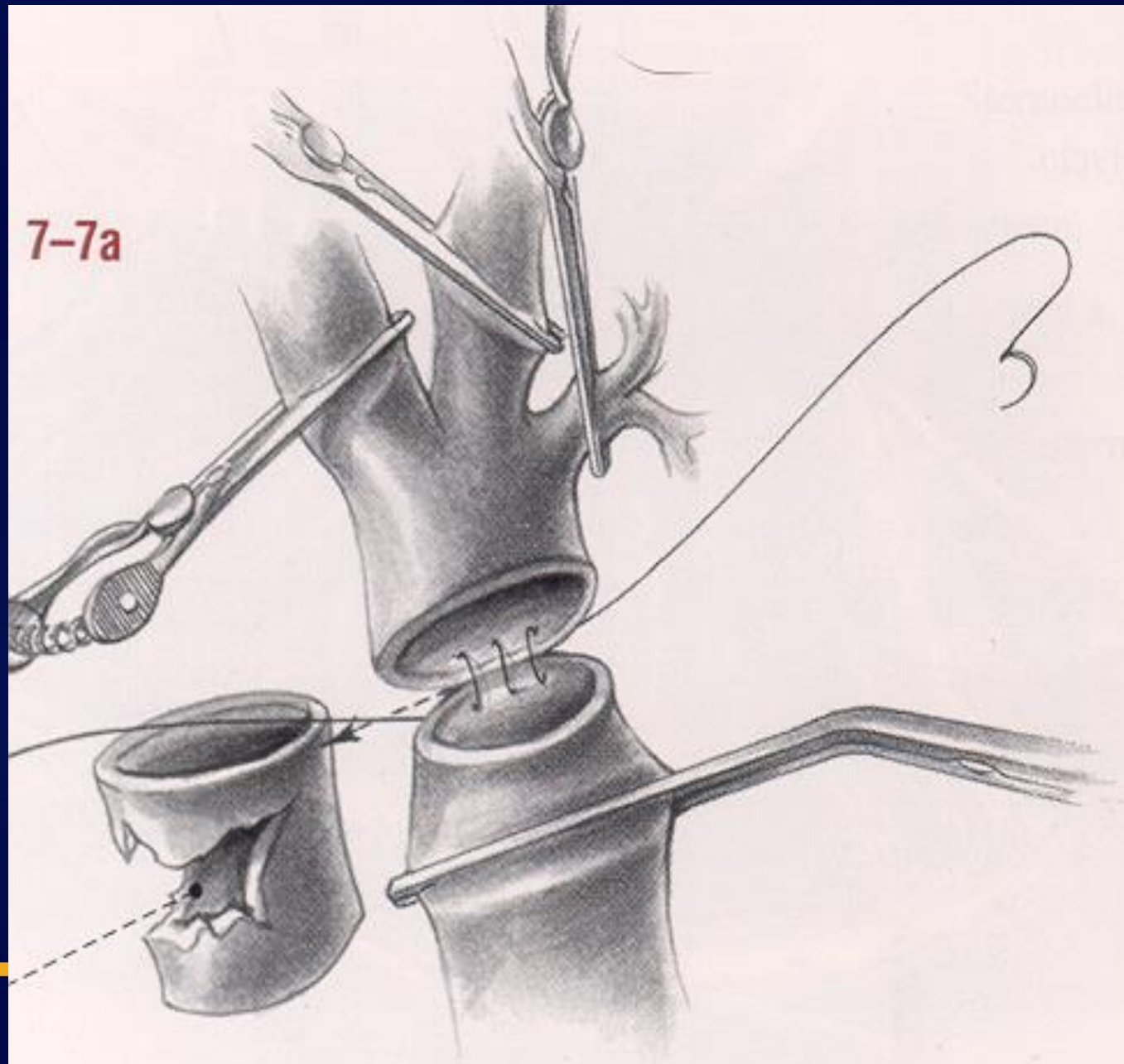
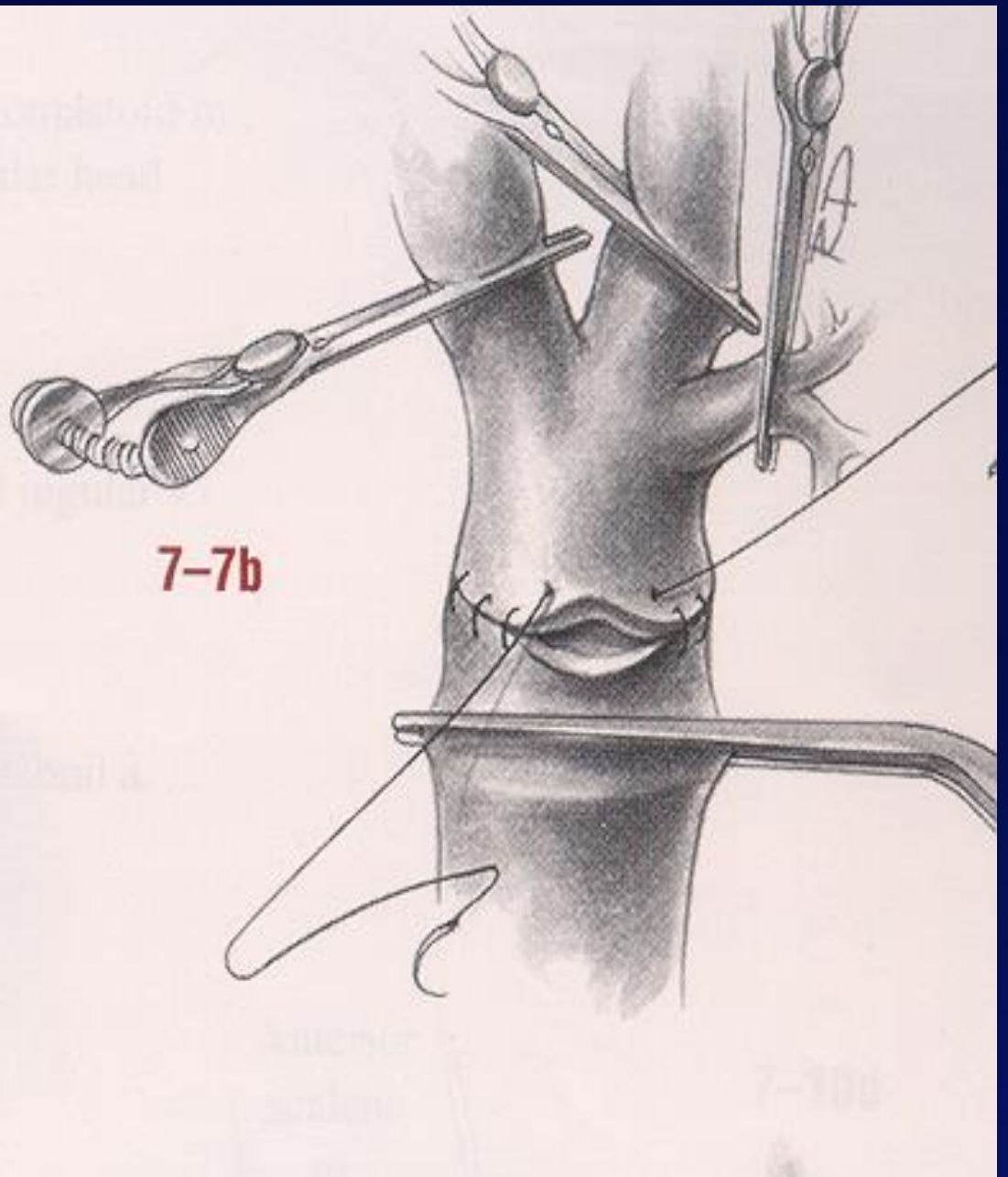
Common
carotid a.

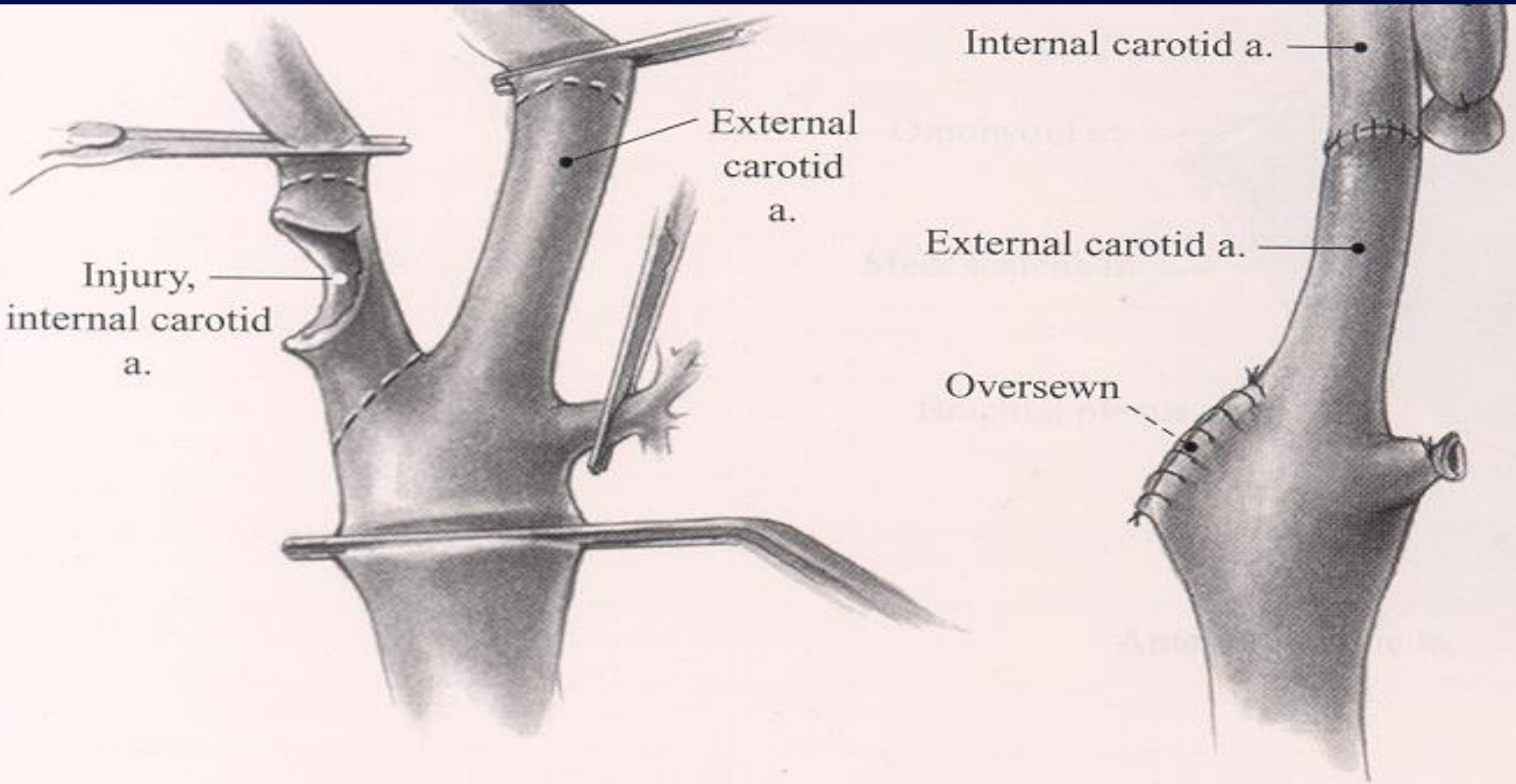

7–6b
Monofilament



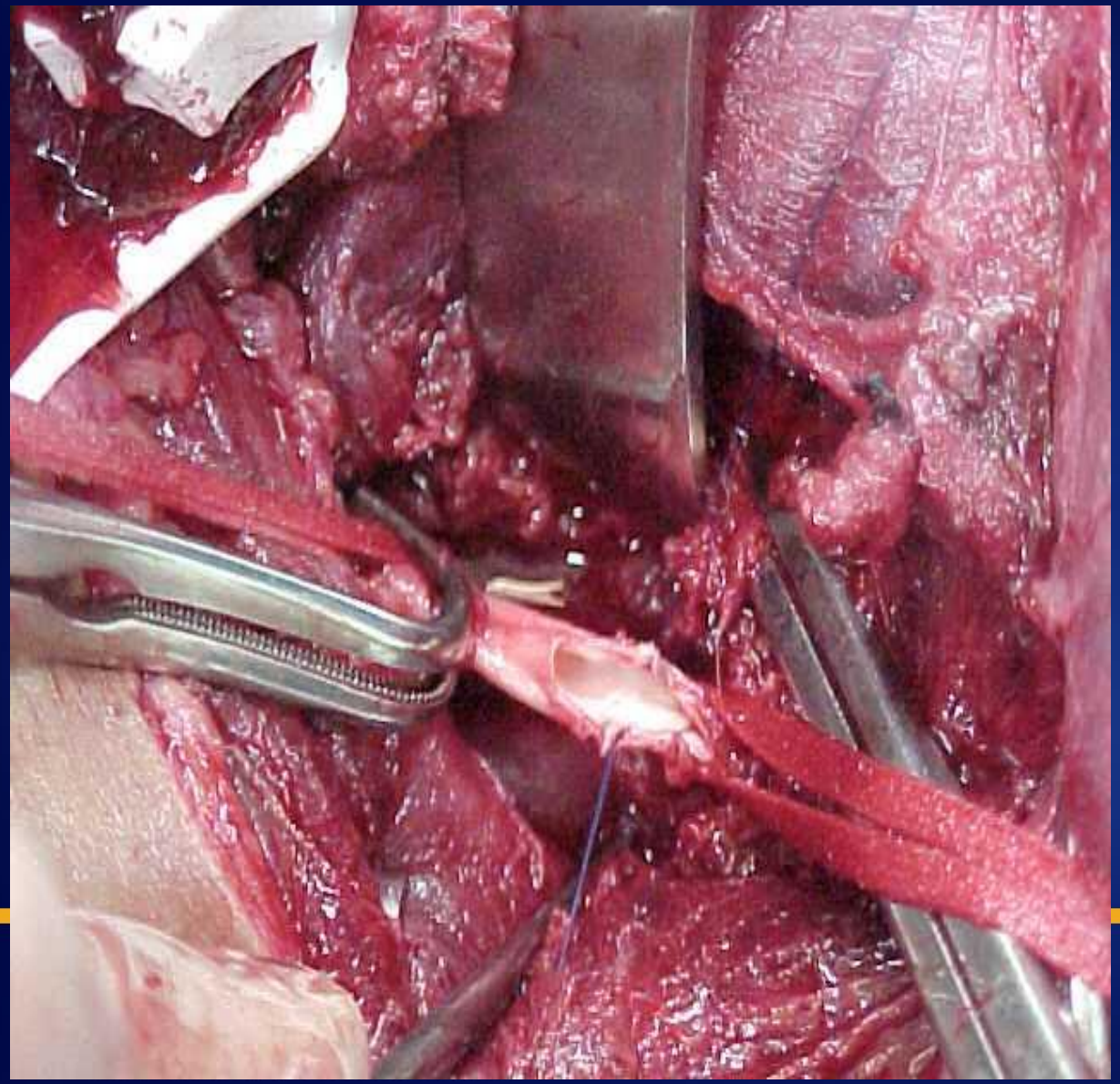
7–7a

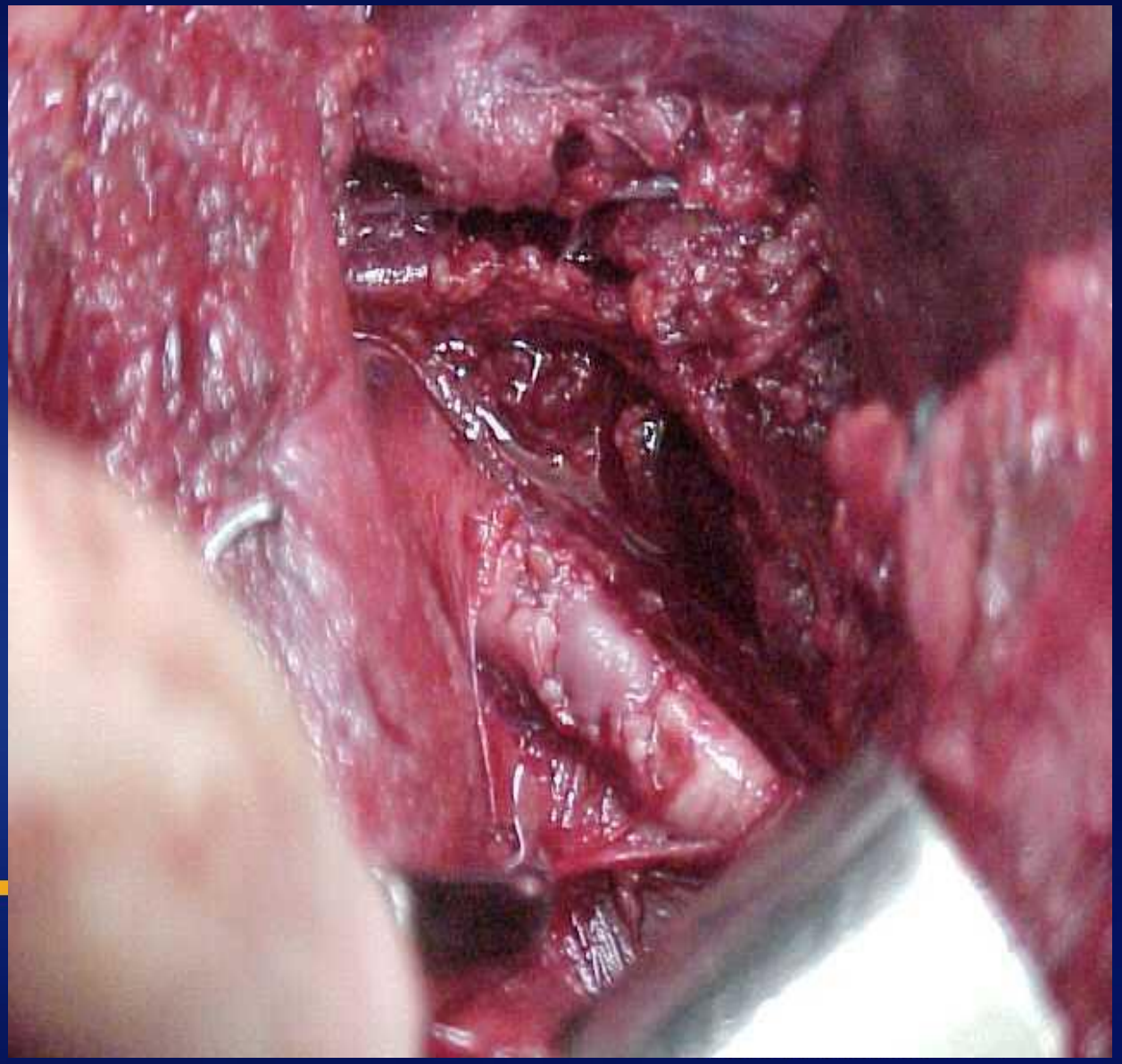


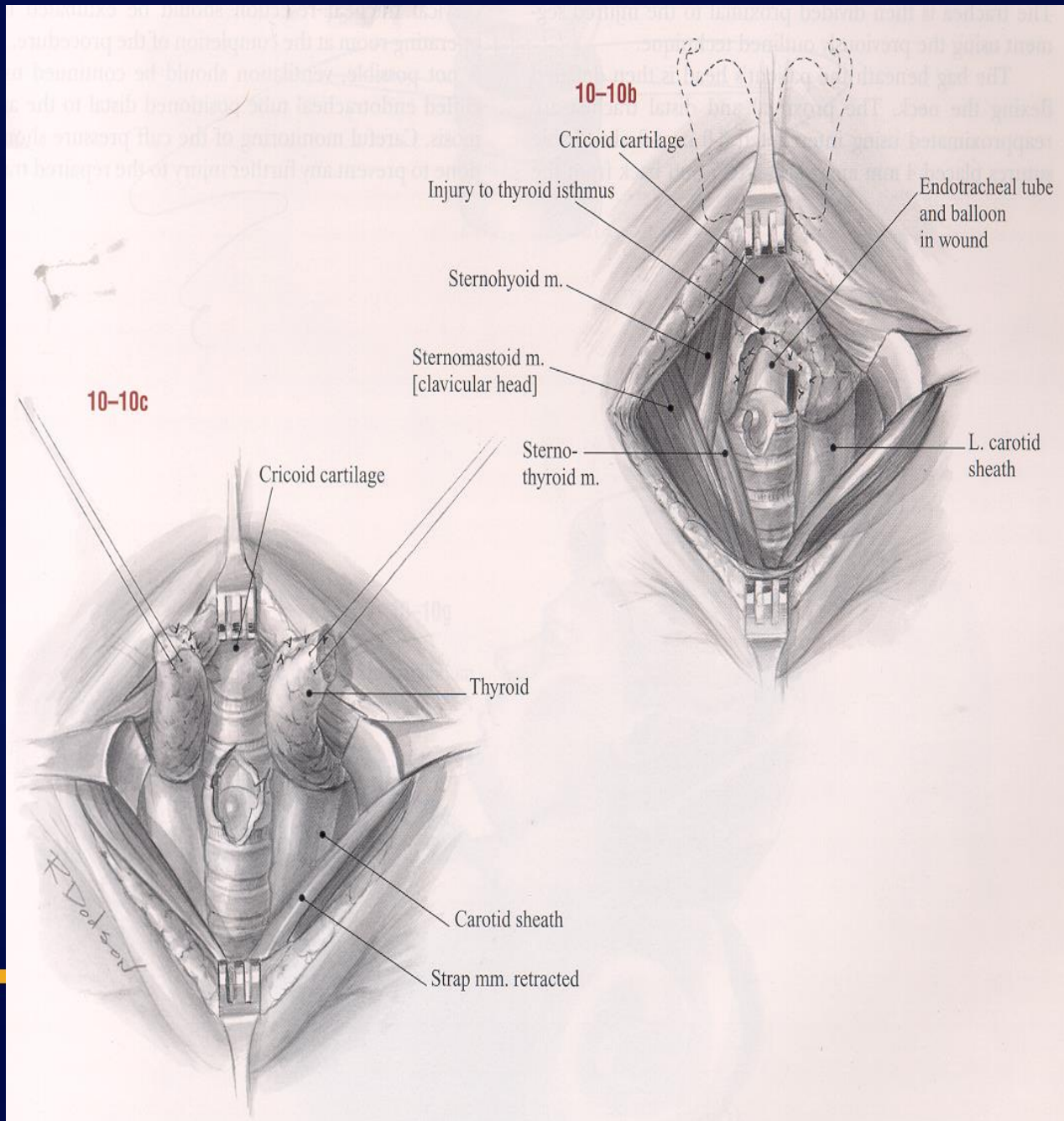
7–7b

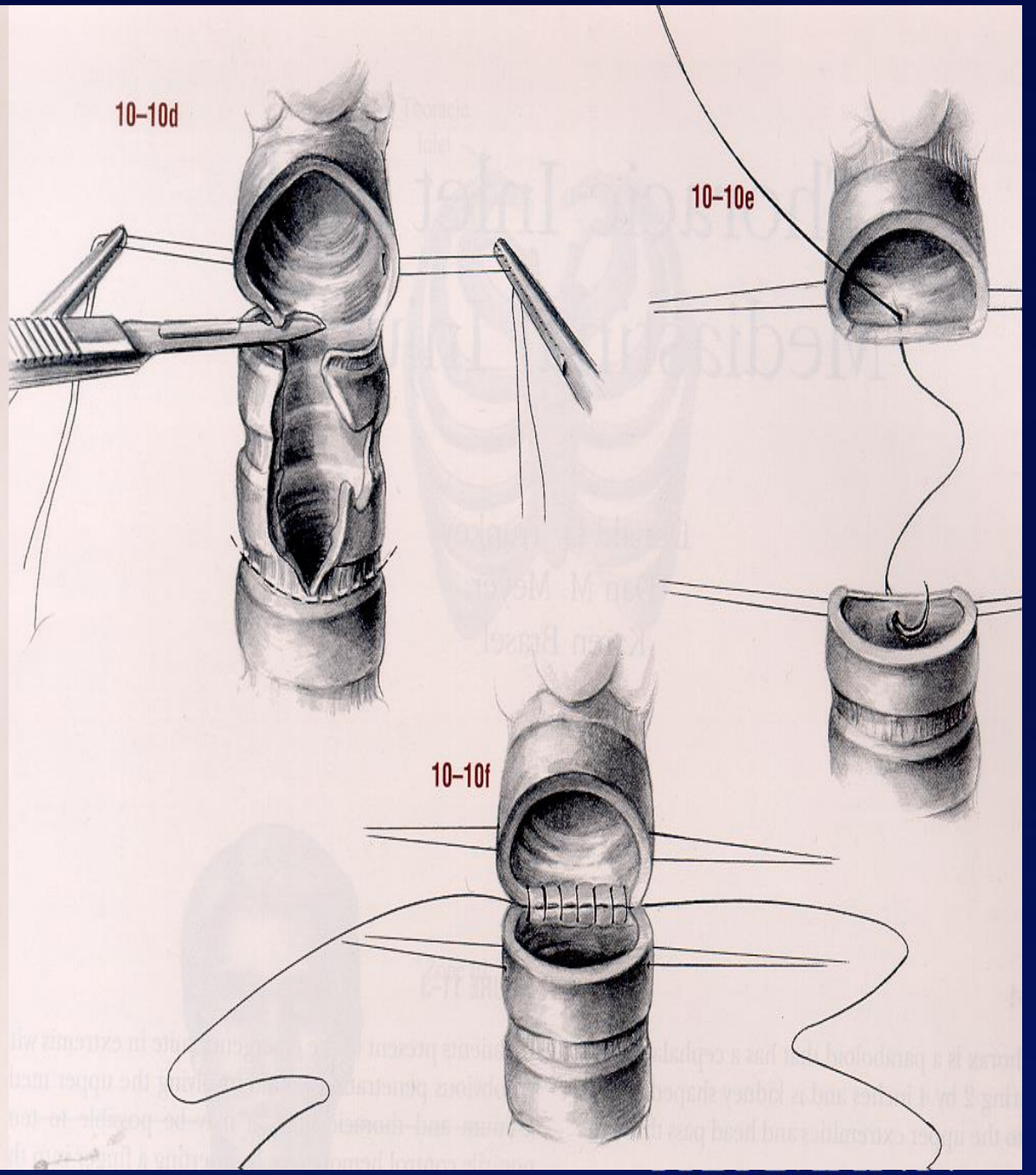

External carotid a.
Injury, internal carotid a.
Internal carotid a.
External carotid a.
Oversewn

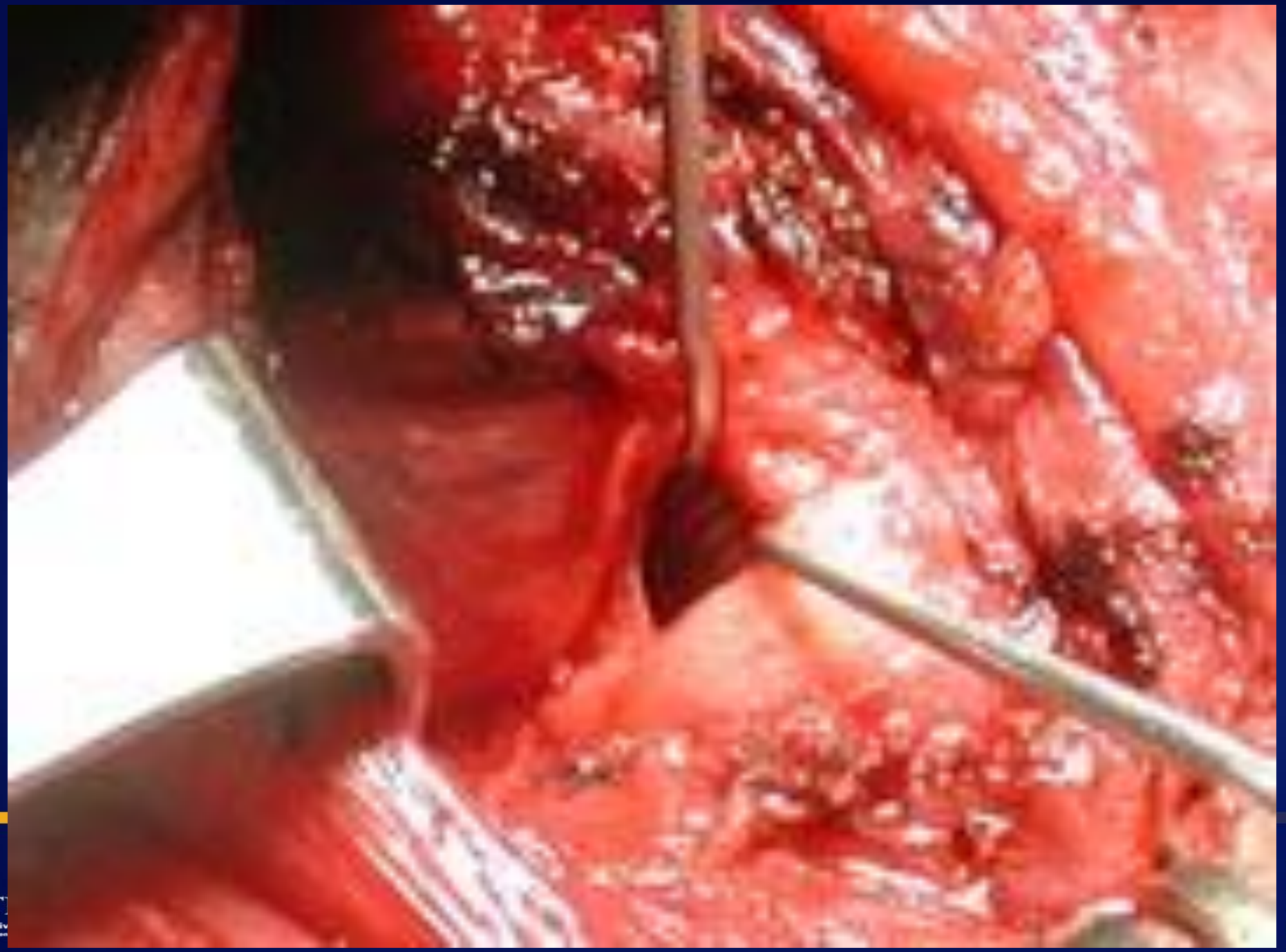
CCA Repair with GSV

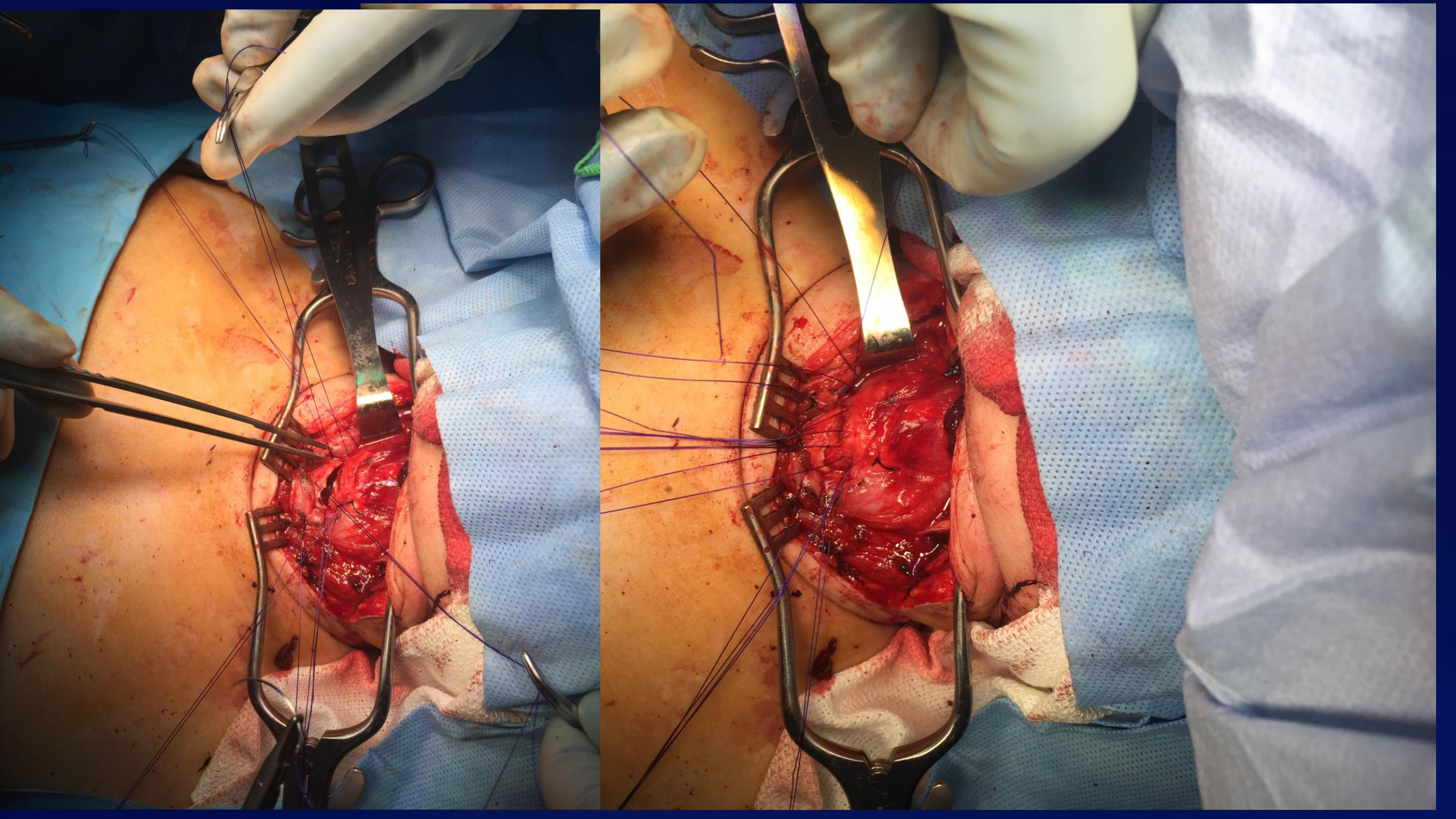


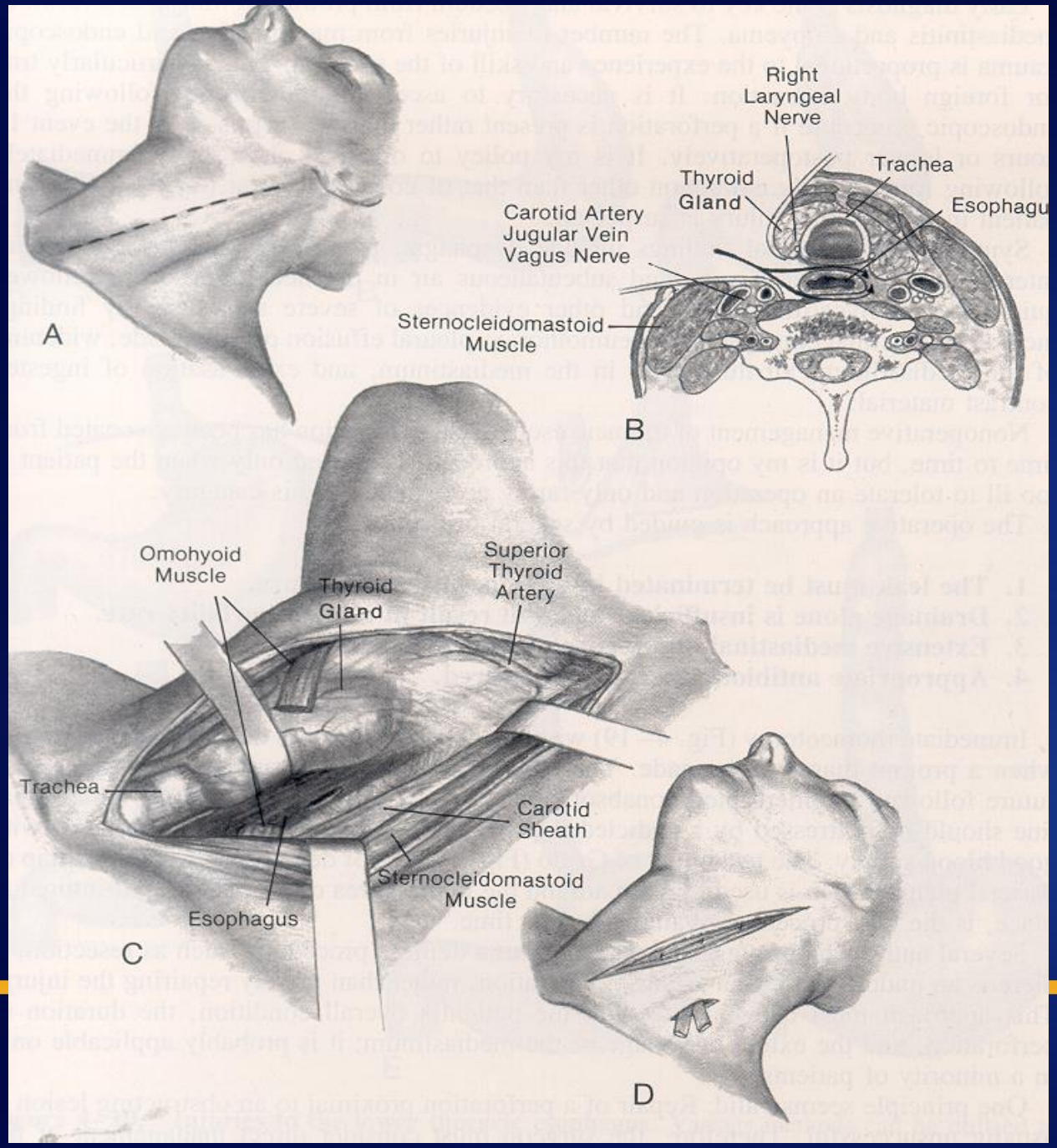


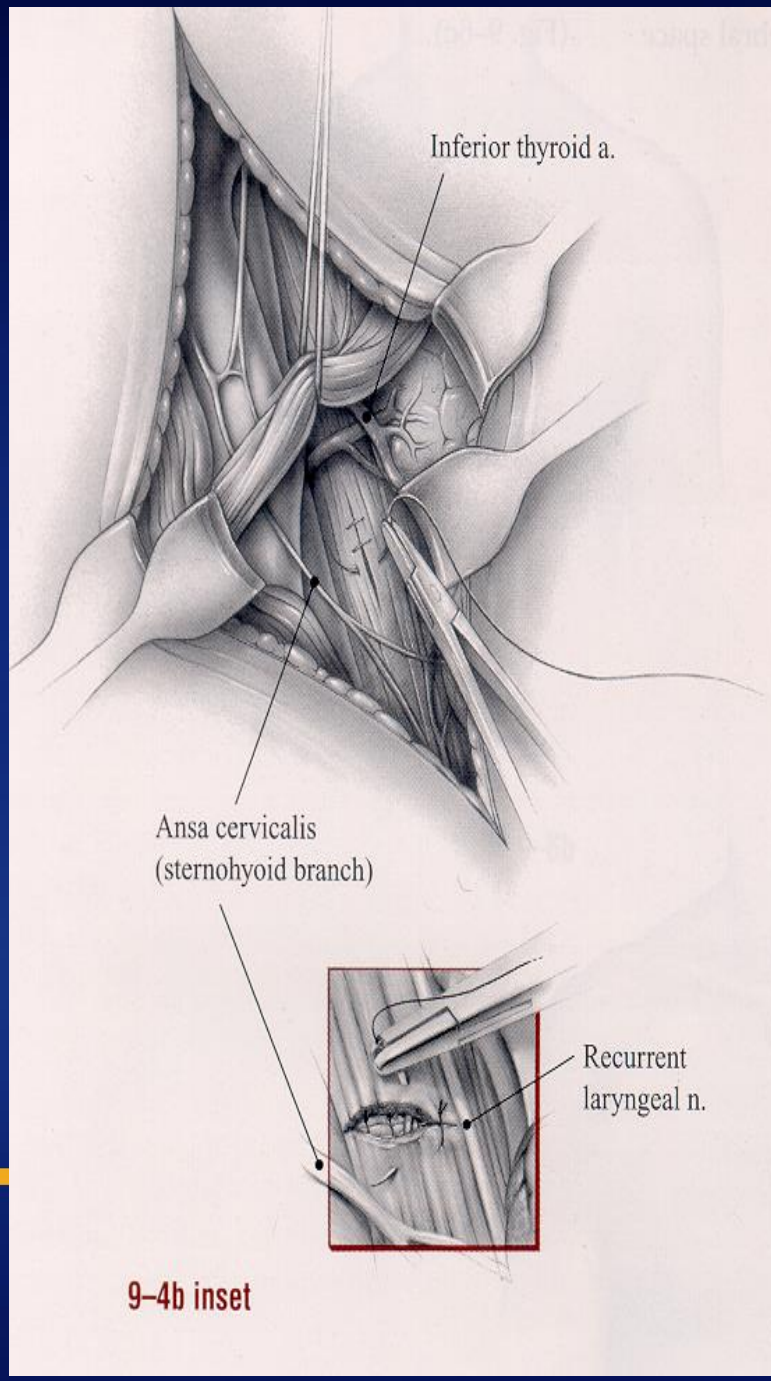

10–10b
Cricoid cartilage
Injury to thyroid isthmus
Endotracheal tube and balloon in wound
Sternohyoid m.
Sternomastoid m. [clavicular head]
Sterno-thyroid m.
L. carotid sheath
10–10c
Cricoid cartilage
Thyroid
Carotid sheath
Strap mm. retracted


10–10d
10–10e
10–10f



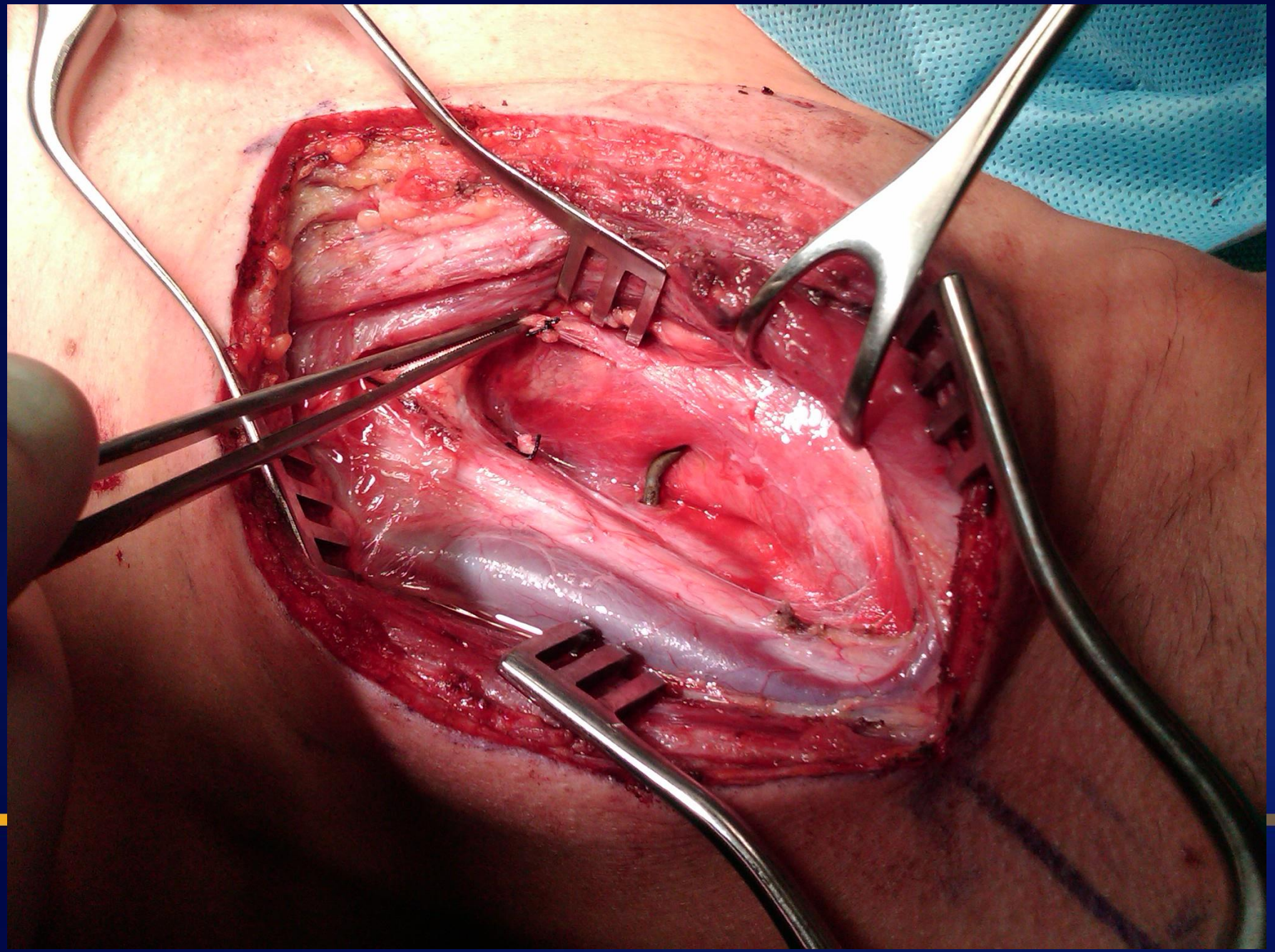


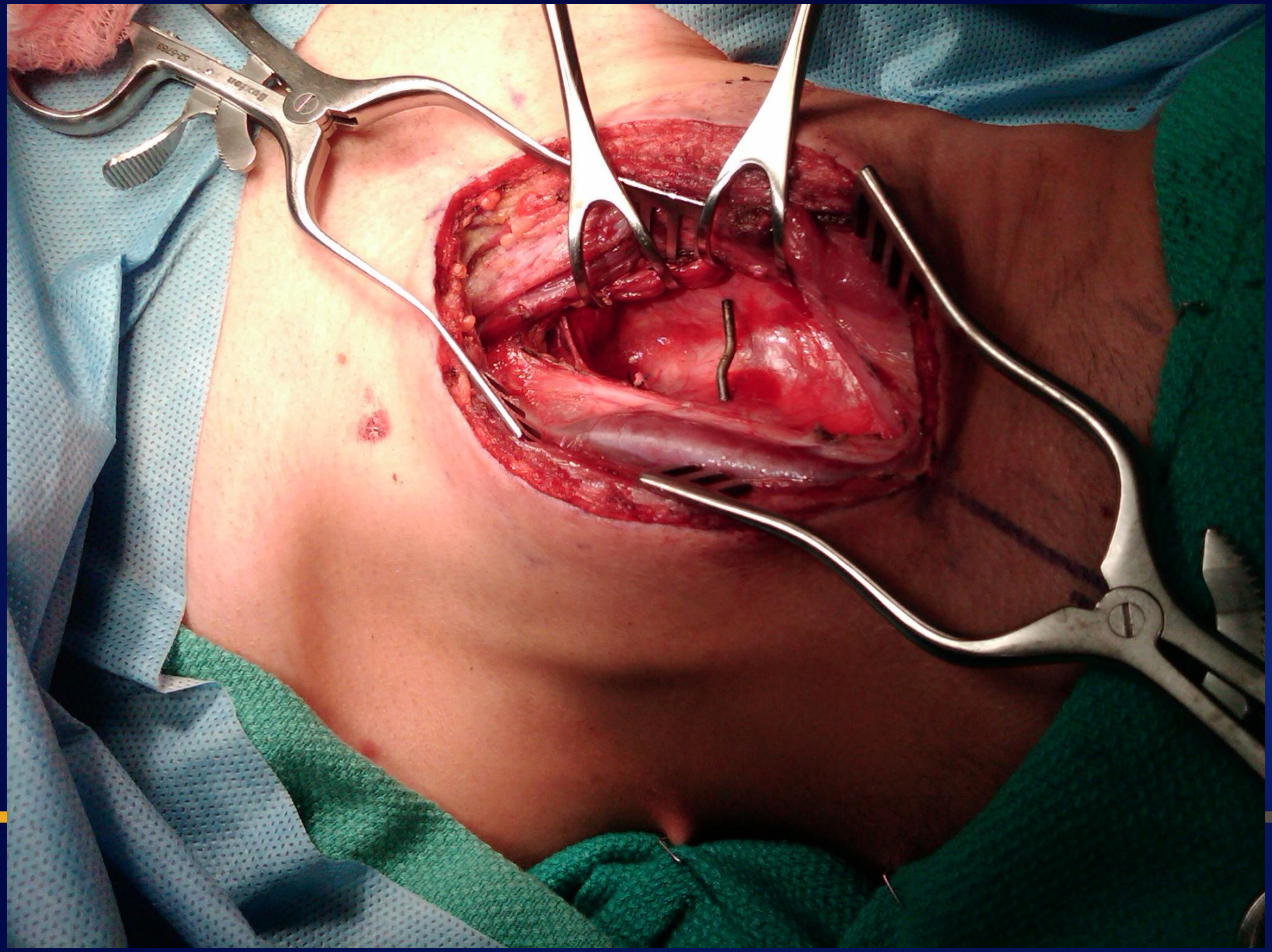




9–4b inset

9–4c





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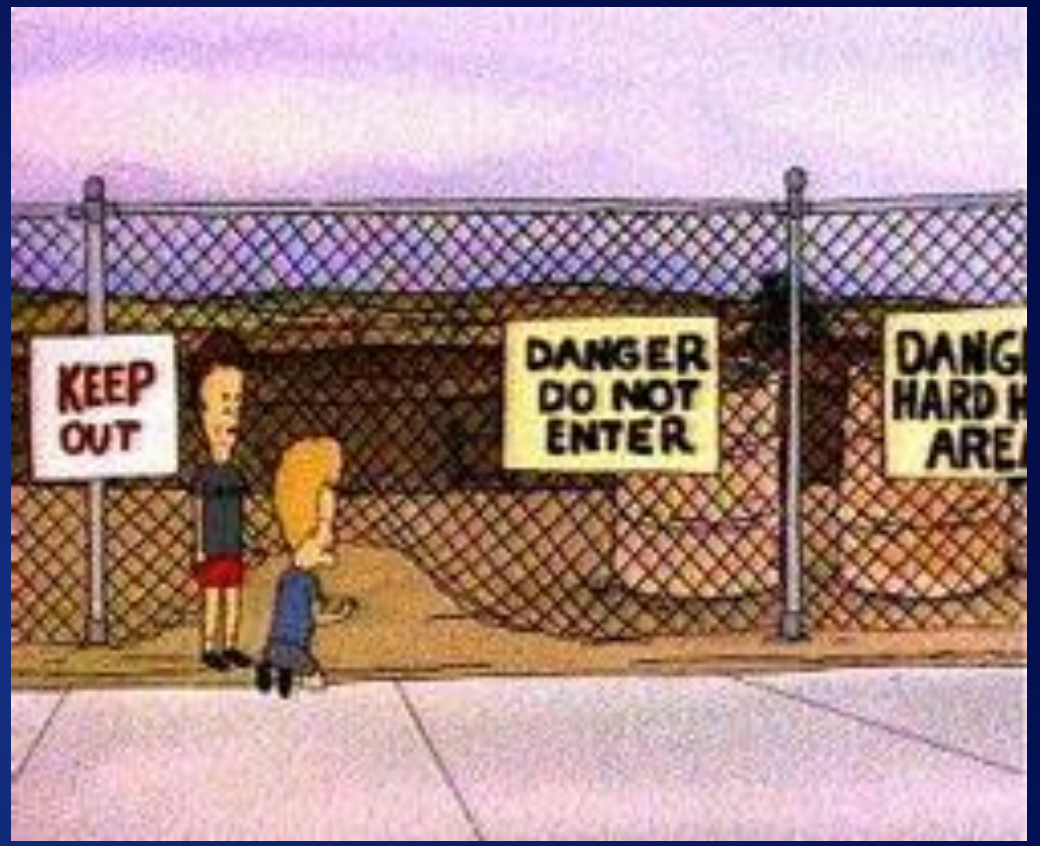
Zone III Approach

- Incision similar to Zone II
- Cut the digastric? Subluxation of mandible?
- Get IR involved EARLY
- Watch out for the hypoglossal nerve



Zone III Approach

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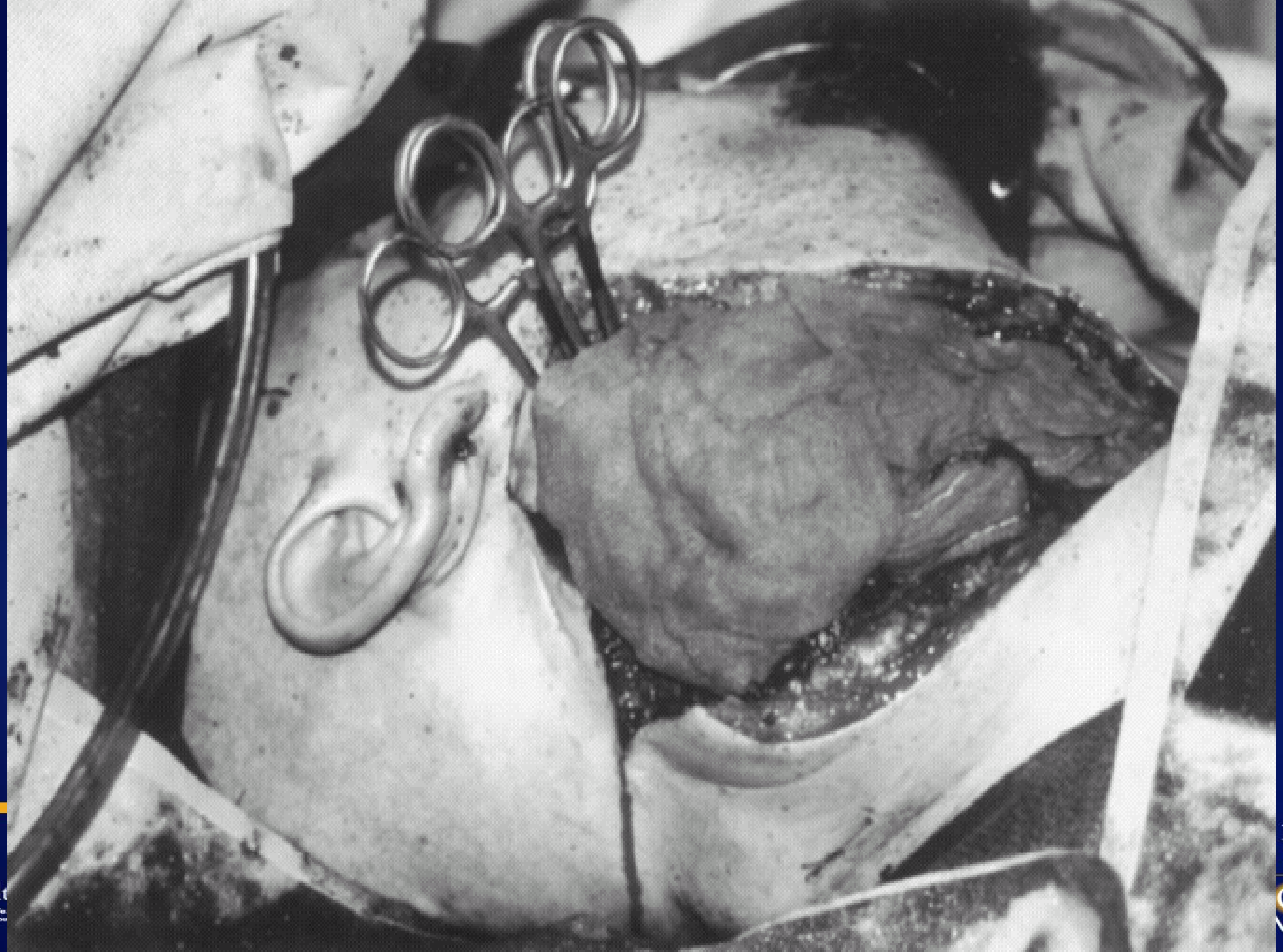

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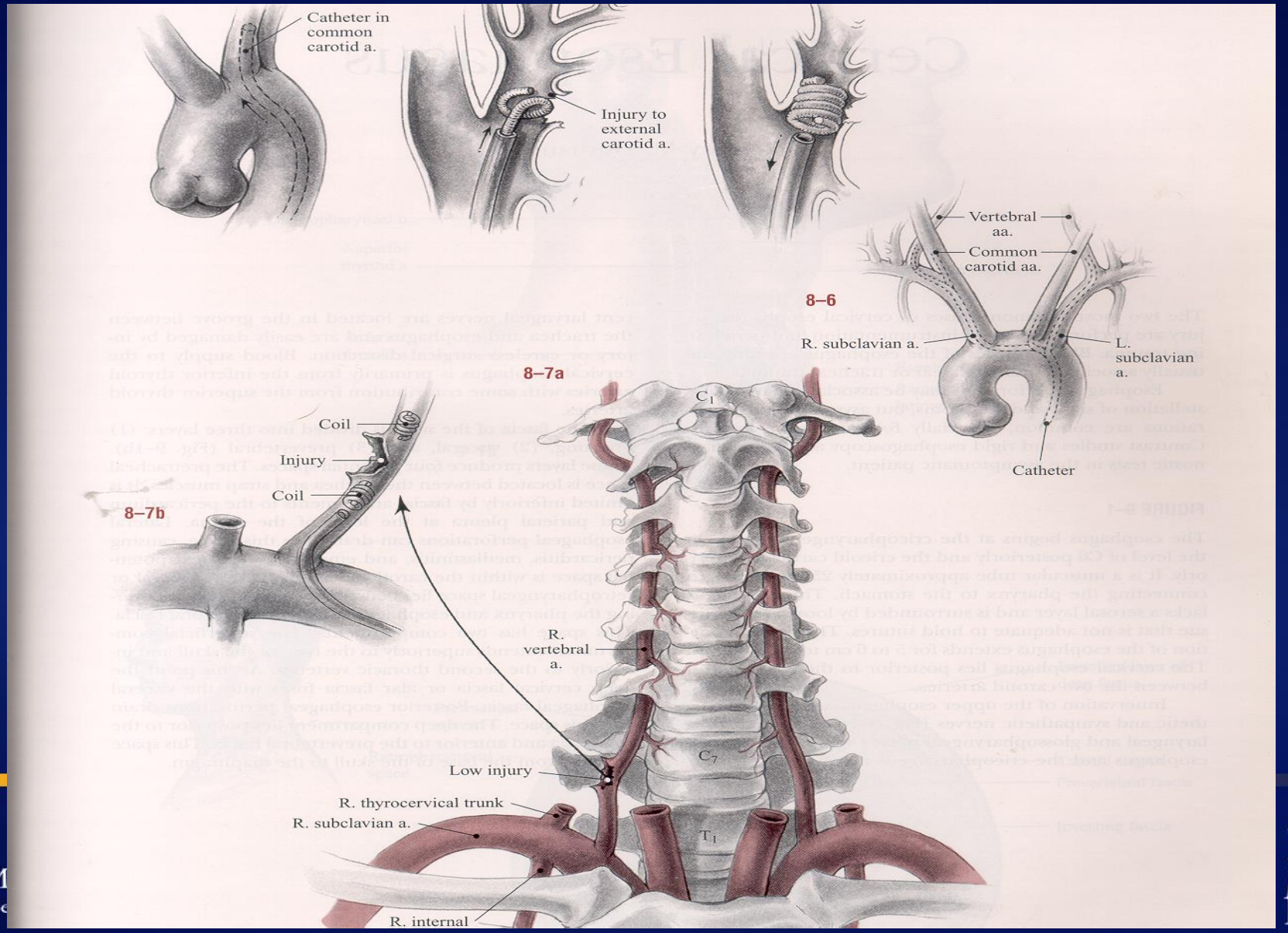
Vertebral Control



AAST 2015 PLENARY PAPER

Airway management following repair of cervical tracheal injuries: A retrospective, multicenter study

John A. Harvin, MD, Ethan A. Taub, DO, Bryan A. Cotton, MD, MPH, Jason Brocker, MD, Deborah M. Stein, MD, MPH, Evren Dilektasli, MD, Kenji Inaba, MD, Michael A. Vella, MD, Oscar Guillamondegui, MD, Lisa M. Kodadek, MD, Elliott R. Haut, MD, PhD, Cory R. Evans, MD, Jordan A. Weinberg, MD, Michael D. Goodman, MD, Bryce R.H. Robinson, MD, MS, *and* **John B. Holcomb, MD,** *Houston, Texas*

Cervical Tracheal Injuries

- Multicenter study: immediate or early extubation following cervical tracheal injury repair was common and safe.
- However, among those with more severe tracheal or extratracheal injuries, immediate tracheostomy versus prolonged intubation presents a risk-benefit decision.
- While immediate tracheostomy placement is associated with increased risk of SSI, prolonged intubation is associated with a higher risk of pneumonia and mortality and fewer ICU-free and ventilator-free days.
-

Damage Control in the Neck

- Esophageal injuries: small lacs may be repaired w/primary closure, covered with intercostal muscle flap, and widely drained both internally and externally.
- Destructive injuries should be excluded with a stapling device and widely drained.
- To handle oral secretions, a sumping nasal tube should be sutured to the nose with the tip just proximal to the cephalad staple line.

Damage Control in the Neck

- A gastric tube should be placed as well to allow for interval decompression and feeding.
- Cervical esophagostomy is an option to divert flow from injury.
- Cervical or pharyngeal esophagus is different than thoracic or mediastinal esophagus, and they can easily be repaired simply and if a spit fistula later forms, it will most often close spontaneously if properly drained.

Review

Damage Control in the Neck

- Similar to esophageal injuries, small tracheal injuries should undergo primary repair.
- If this is not feasible or if the injury is destructive, ETT should be advanced beyond injury to allow for continued ventilation.
- Alternatively, if this is not possible, an endotracheal tube can be placed through the wound to either be occlusive or to allow for ventilation.

Initial Management

- Remember your ABCs/ATLS principles
- Intubate EARLY, Intubate OFTEN
- Direct pressure until vascular control

Initial Management

- CXR ***<u>if HD stable</u>***
- (+) “Hard” signs > O.R.
- HD unstable > O.R.

Diagnostic Work-up

- Zone I, stable > angiogram, scope+/- esophagram, bronch
- Zone II, stable > O.R > Zone I work-up
- Zone III, stable > angiogram, pharyngoscopy, DL+/-esoph
- CTA to avoid many of these

Management

- Prep/drape ears to mid-abdomen + GROINS
- Repair ALL carotids, even with neurological deficits
- For high ICA injuries, sublux jaw, utilize Fogarty catheters for distal control
- Primary repair if ?, if >2cm length,use GSV
- “Shunt” if necessary

Management

- Innominate/ prox R subclavian > sternotomy
- Proximal L subclavian > left thoracotomy
- Injuries to subclavian DISTAL to vertebral take-off > ligate if difficult to repair
- Vertebral artery injury > IR if stable

Management

- *Jugular* > if easy repair, otherwise ligate
- *Esophageal* > 2 layer repair, mucosal-interrupted, absorbable, muscular- nonabsorbable

*no drains needed

*SCM tissue flap if too large, too friable, too many perforations

Management

- *Esophageal*(>24 hours) > drain + debride
- *Tracheal* > single layer vicryl, buttress, trach if SEVERE
- *Laryngeal* > stabilize fx, mucosal repair
- *Thoracic Duct* > ligate it !

NEVER TRUST A MAN WHO CALLS YOU "DOC." HE RARELY PAYS HIS BILLS. -William Osler

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