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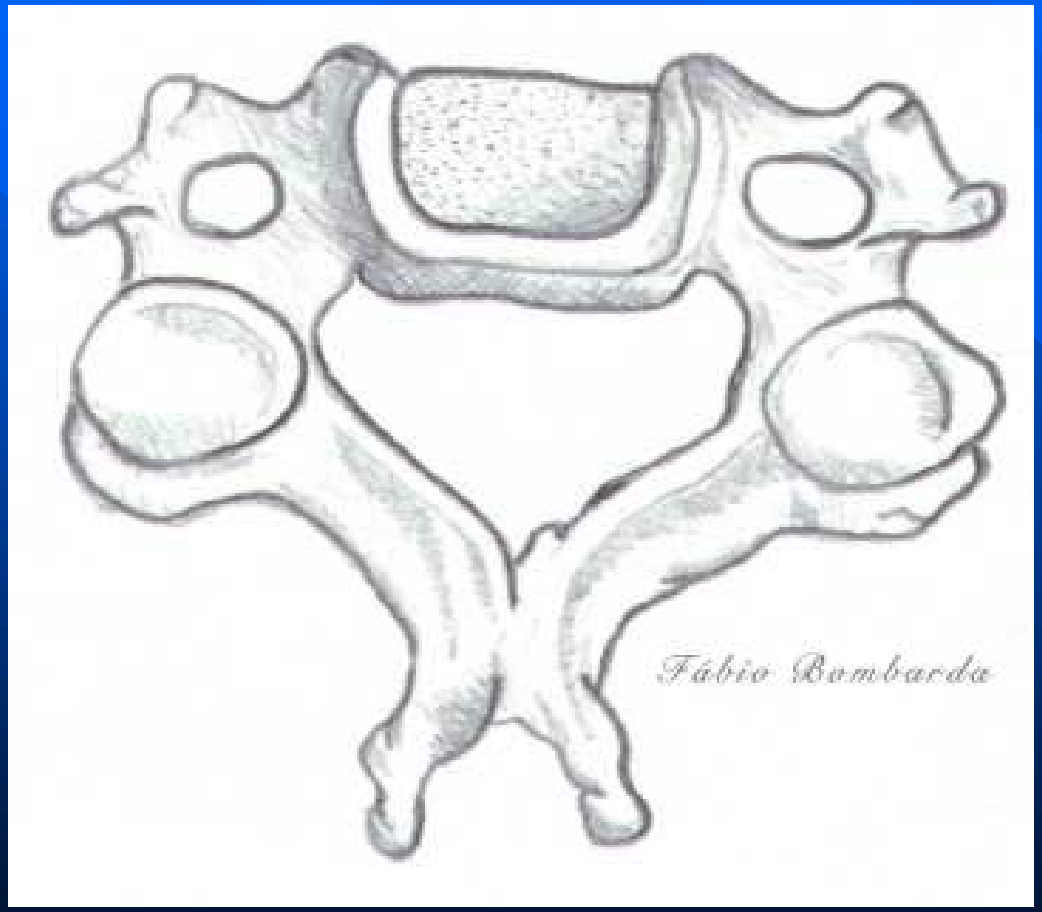
Cervical Spine Anatomy, Evaluation and Injuries

# Anatomy

# Bony Anatomy

- 7 cervical vertebrae
- Small vertebral bodies
  - Size increases C1 to C7
- Smaller and thinner intervertebral discs
  - No discs at C1/skull or C1/C2
- Bifurcated/bifid spinous processes
  - C2 – C5/6
- Transverse processes contain transverse foramen for passage of vertebral arteries

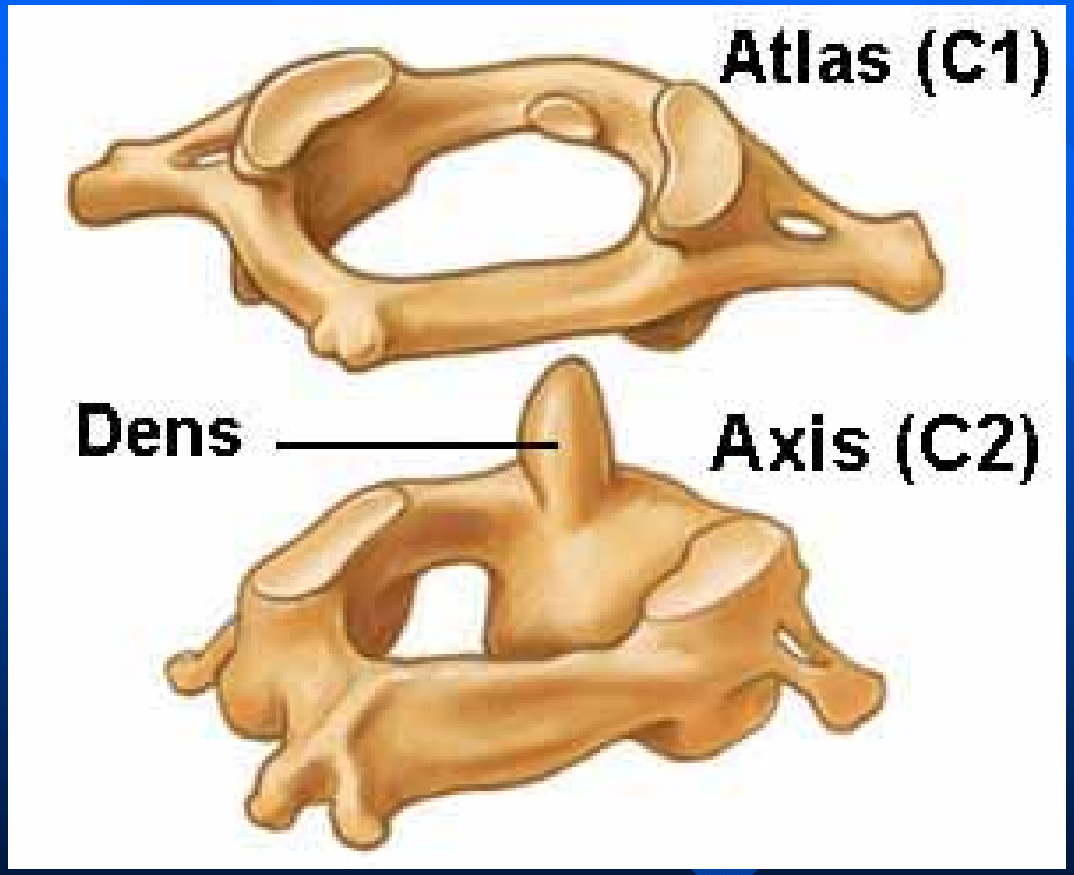
# Cervical Vertebral Segment



# Bony Anatomy

- C1 – atlas
  - Articulates with skull at atlanto-occipital joint
  - No vertebral body or spinous process
  - Transverse processes very long
  - Allows for “yes” movements
- C2 – axis
  - Small vertebral body with superior projection called the dens (odontoid process)
  - Dens articulates with atlas at atlanto-axial joint
  - Allows for “no” movements

# Atlas and Axis

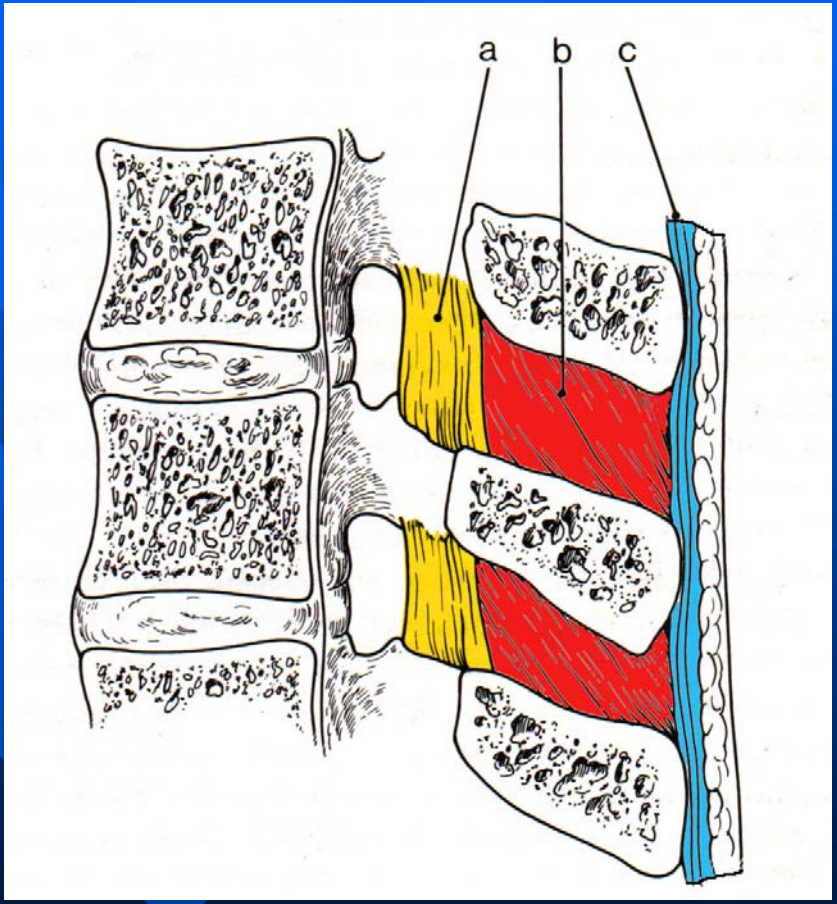


# Ligamentous Anatomy

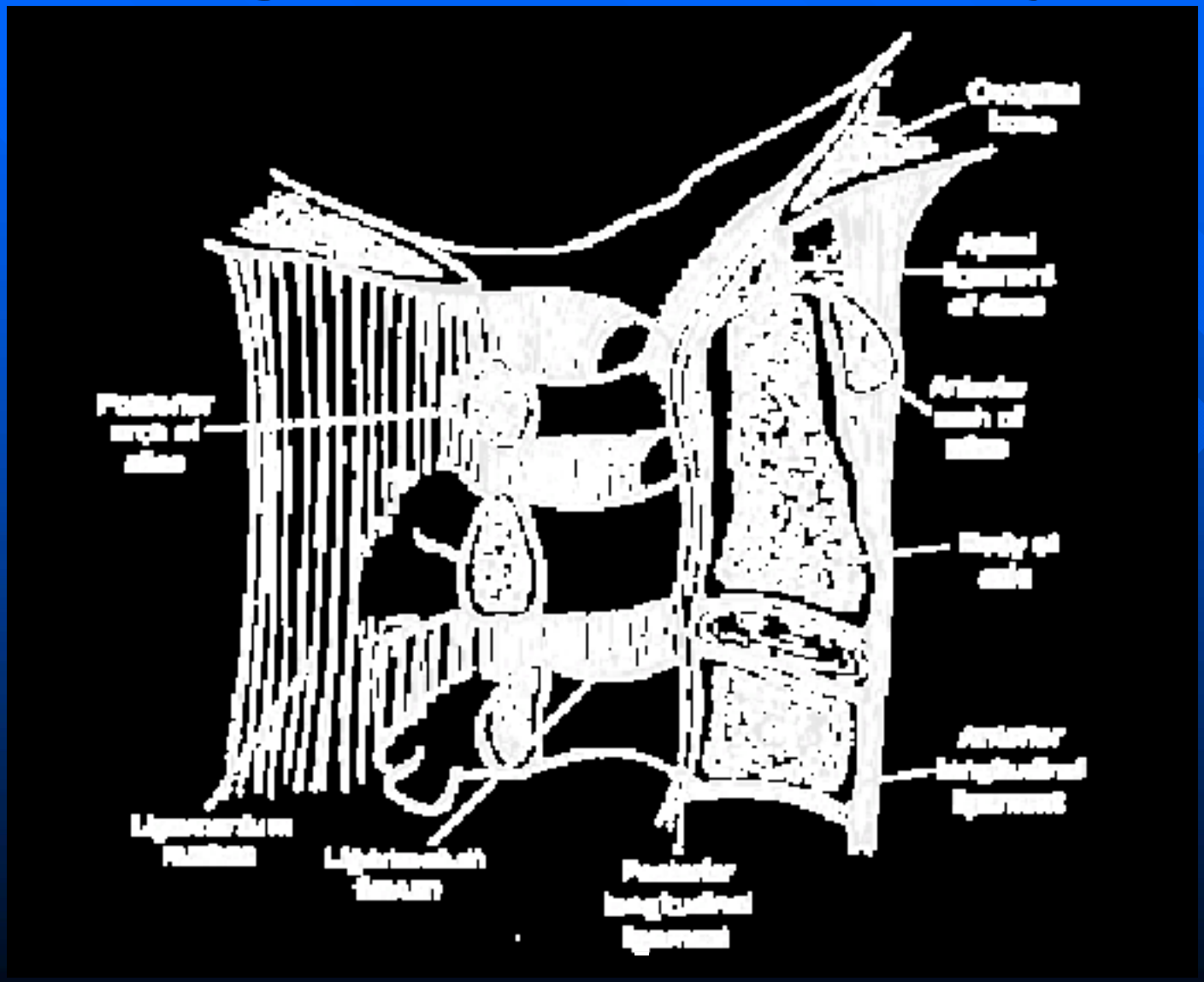
- **Anterior longitudinal ligament**
  - Reinforces anterior discs, limits extension
- **Posterior longitudinal ligament**
  - Reinforces posterior discs, limits flexion
- **Ligamentum nuchae = supraspinous ligament**
  - Thicker than in thoracic/lumbar regions
  - Limits flexion
- **Interspinous/intertransverse ligaments**
  - Limit flexion and rotation/limits lateral flexion
- **Ligamentum flavum**
  - Attach lamina of one vertebrae to another, reinforces articular facets
  - Limits flexion and rotation

# Ligamentous Anatomy

- a = ligamentum flavum
- b = interspinous ligaments
- c = supraspinous ligament



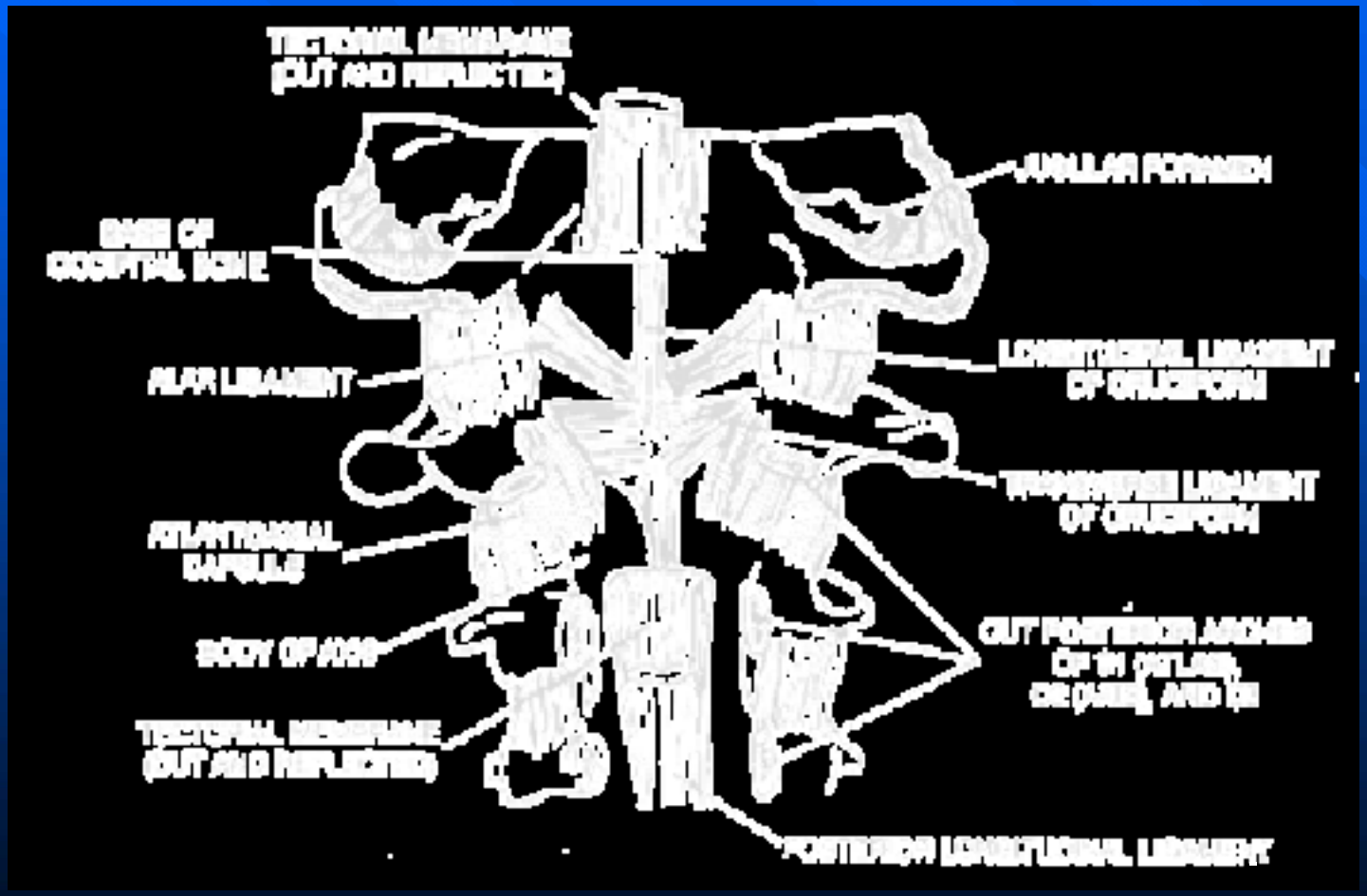
# Ligamentous Anatomy



# Ligamentous Anatomy

- Short ligaments at base of skull
  - Cruciform ligaments
    - » Transverse: anterior arch of atlas around dens
    - » Longitudinal: holds transverse portion between edge of foramen magnum and posterior body of axis
  - Alar ligaments
    - » “check” ligaments – dens to medial aspect of each side of foramen magnum
  - Apical ligaments
    - » Apex of dens to anterior foramen magnum

# Short Ligaments at Base of Skull



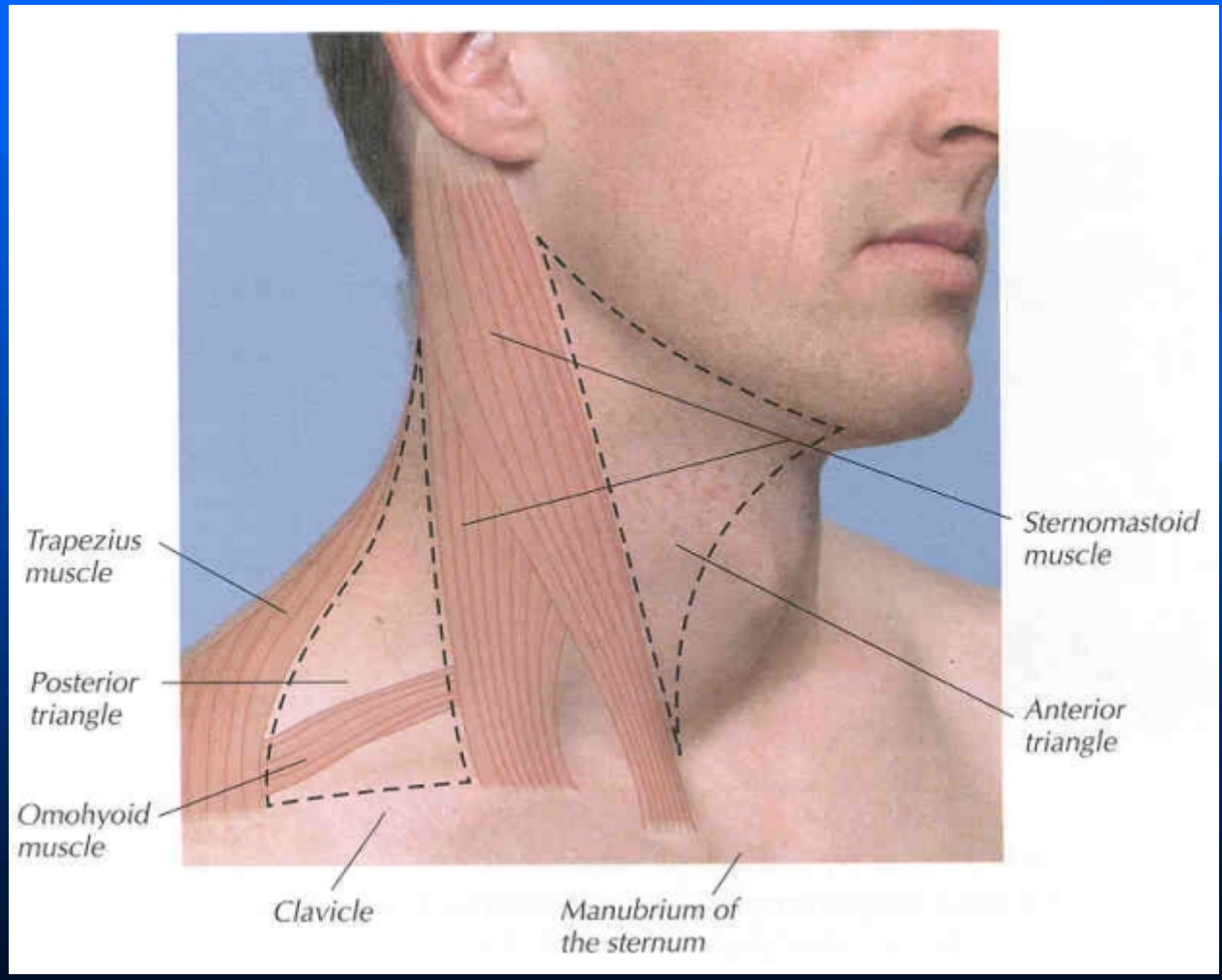
# Muscular Anatomy

- Anterior and posterior triangles
- Intrinsic muscles
  - Superficial layer
  - Deep layer
- Extrinsic muscles
- Suboccipital triangle

# Anterior and Posterior Triangles

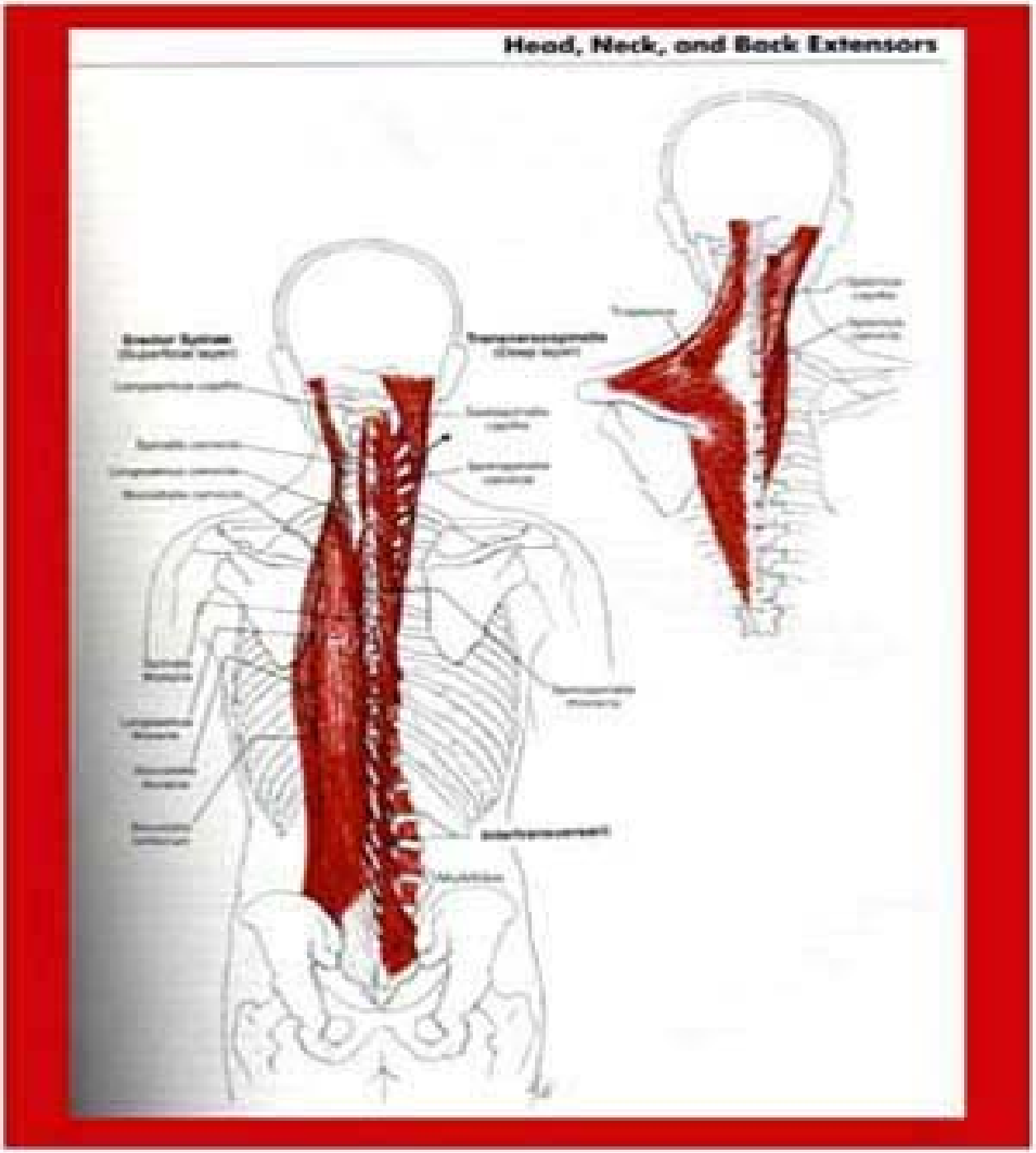
- Anterior triangle
  - Superior border – mandible
  - Medial border – cervical midline
  - Lateral border – anterior sternomastoid
- Posterior triangle
  - Inferior border – clavicle
  - Anterior border – posterior sternomastoid
  - Posterior border – upper trapezius

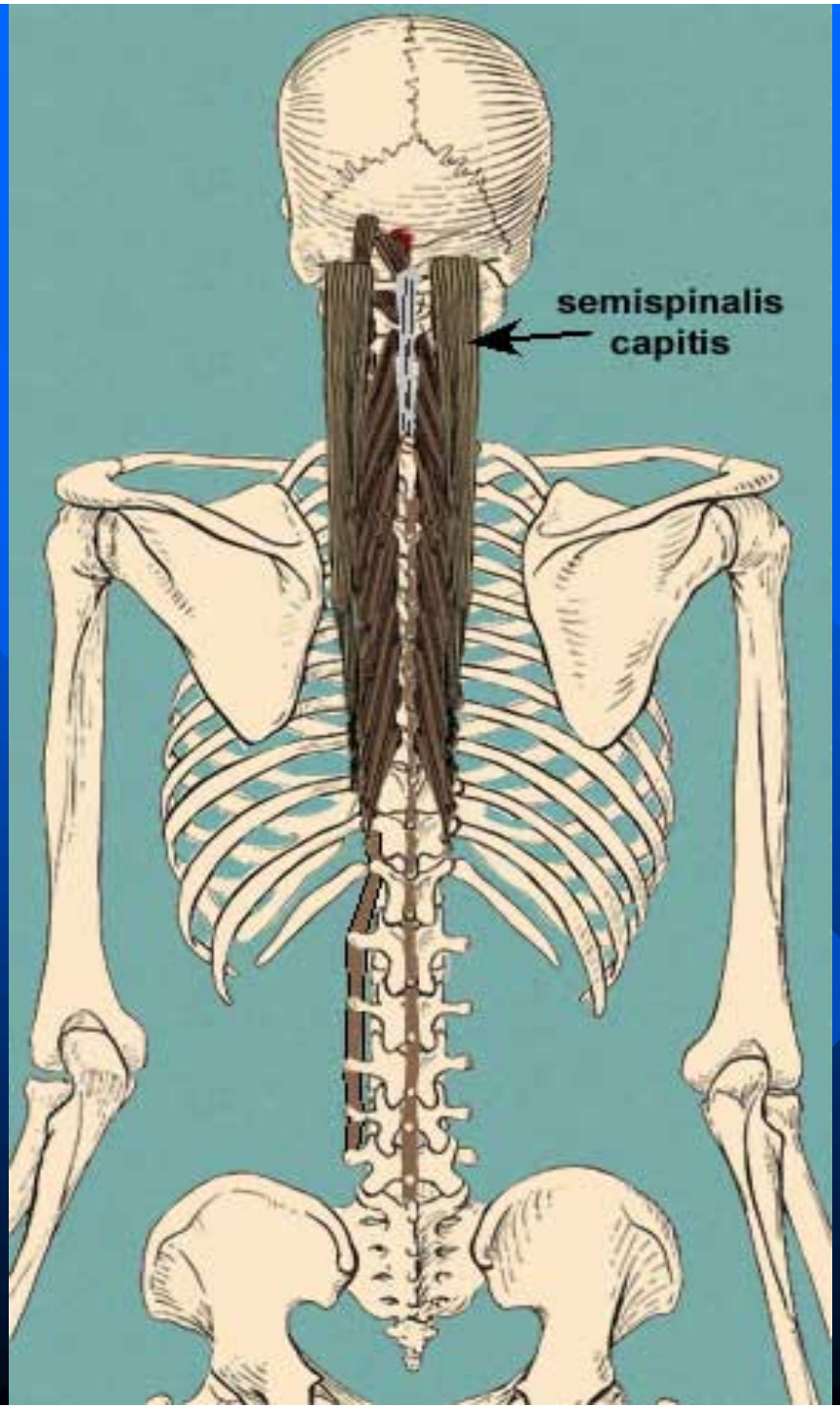
# Anterior and Posterior Triangles



# Intrinsic Muscles

- Superficial layer
  - Splenius capitis
  - Splenius cervicis
- Deep layer
  - Longissimus capitis
  - Spinalis capitis
  - Semispinalis capitis
  - Iliocostalis cervicis
  - Longissimus cervicis
  - Spinalis cervicis
  - Semispinalis cervicis
  - Multifidus
  - Rotatores

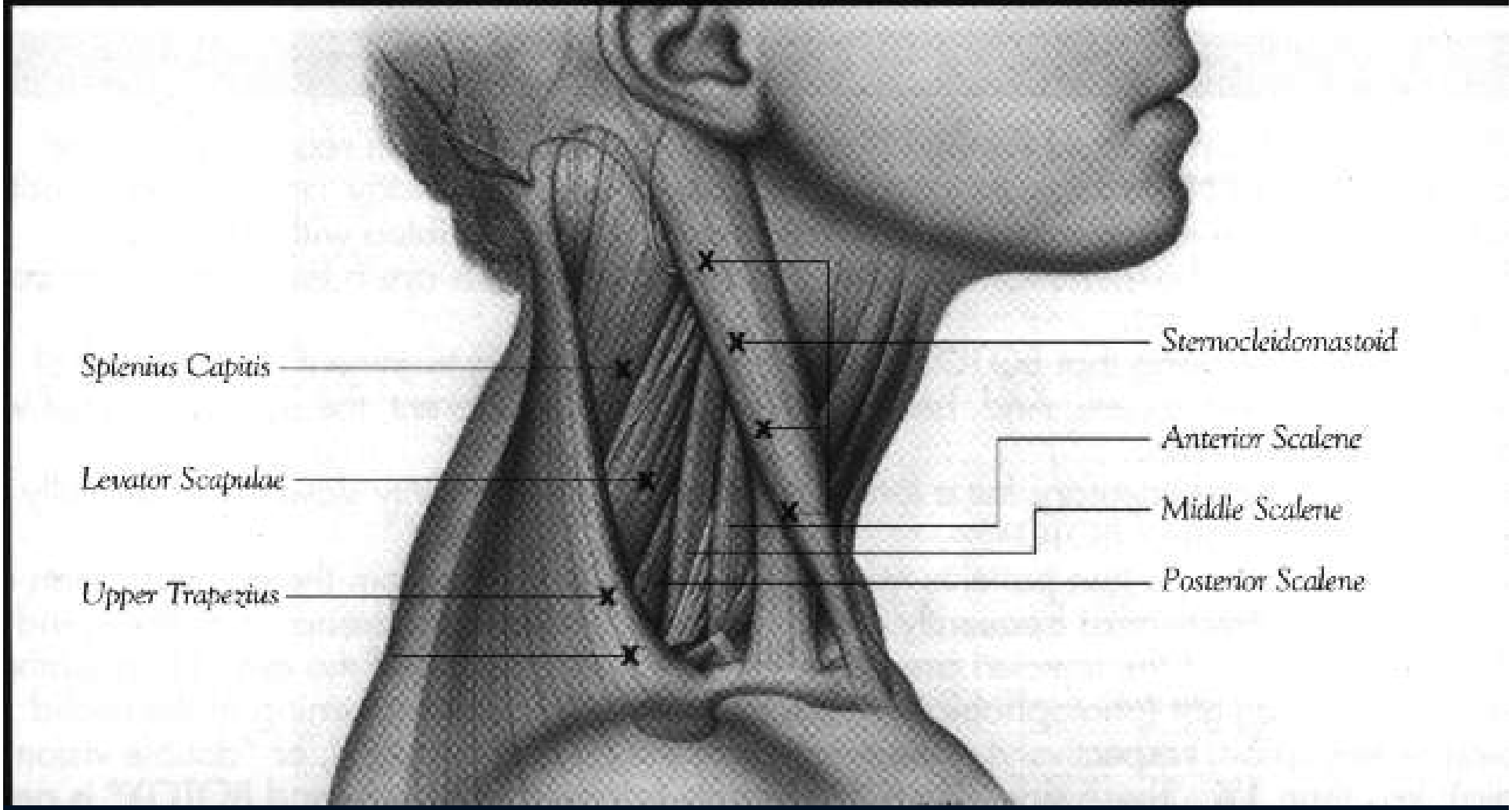

Head, Neck, and Back Extensors


semispinalis
capitis

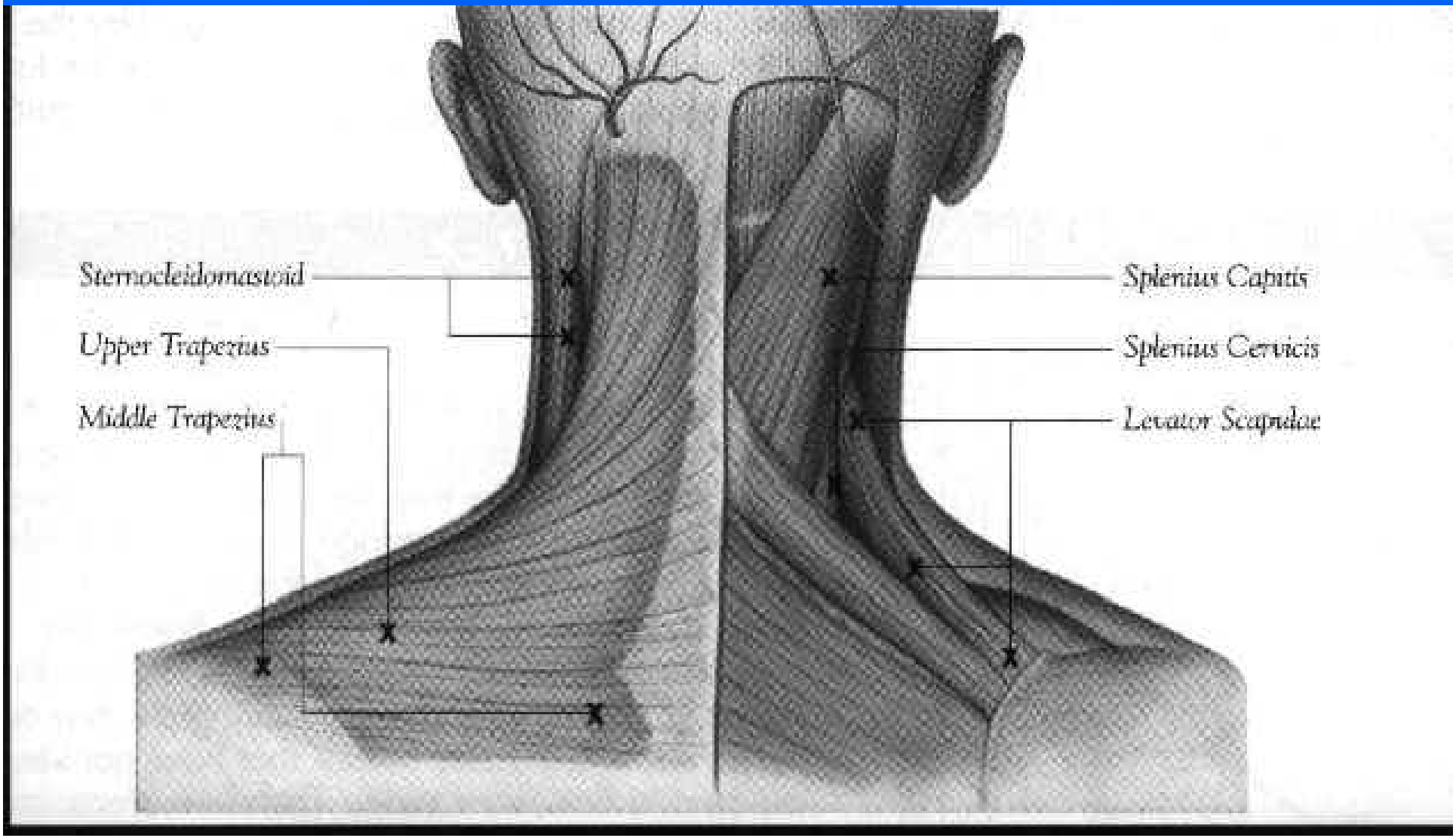
# Extrinsic Muscles

- Trapezius (upper third)
- Levator scapulae
- Sternomastoid
- Scalenes
  - Anterior
  - Middle
  - Posterior

# Lateral Neck Muscles



# Posterior Neck Muscles

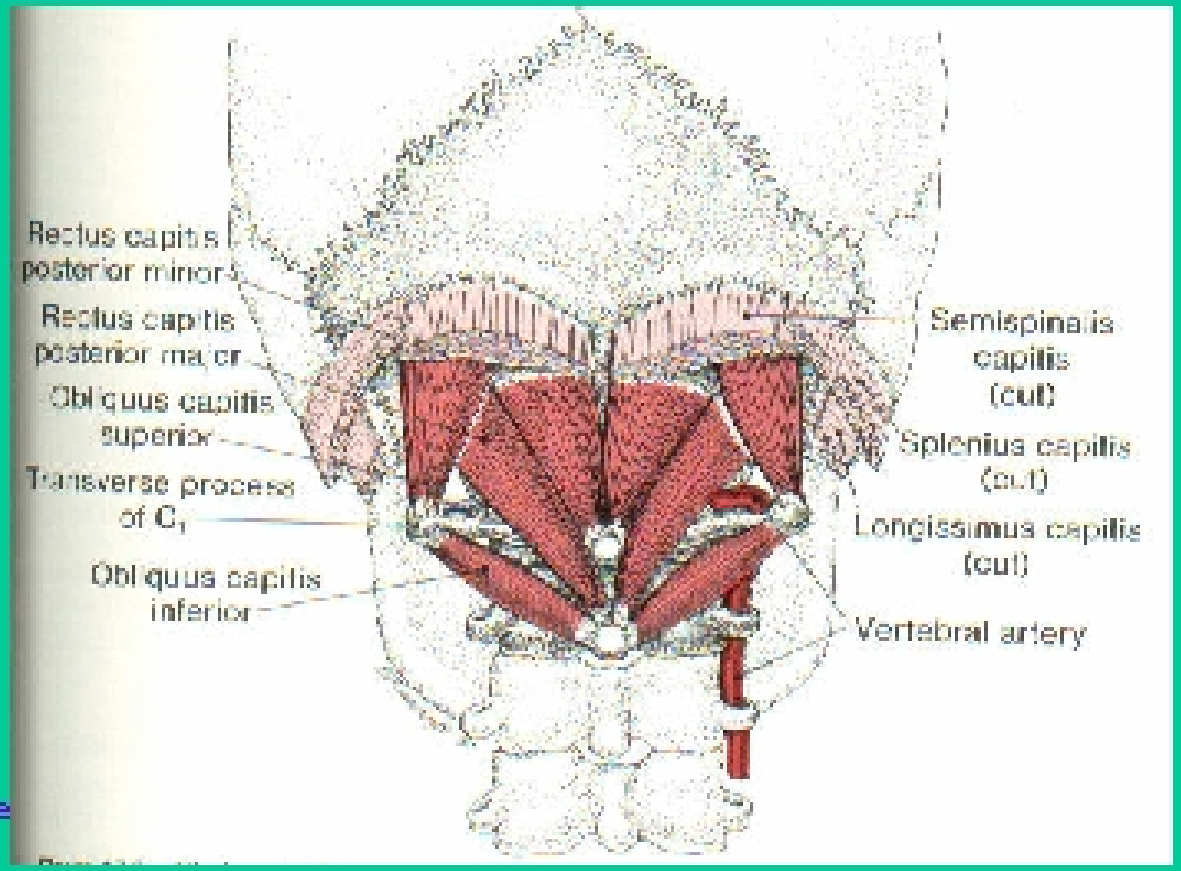


# Suboccipital Triangle

- Obliquus capitis inferior
  - Spinous process of axis to transverse process of atlas
- Obliquus capitis superior
  - Transverse process of atlas to occiput
- Rectus capitis posterior major
  - Spinous process of axis to occiput
- Rectus capitis posterior minor
  - Atlas to occiput (deep to RCP major)
- Contents
  - Vertebral artery, C1 nerve root, (greater occipital nerve)

# Suboccipital Triangle

## CERVICAL MUSCLES - SUBOCCIPITAL MUSCLES

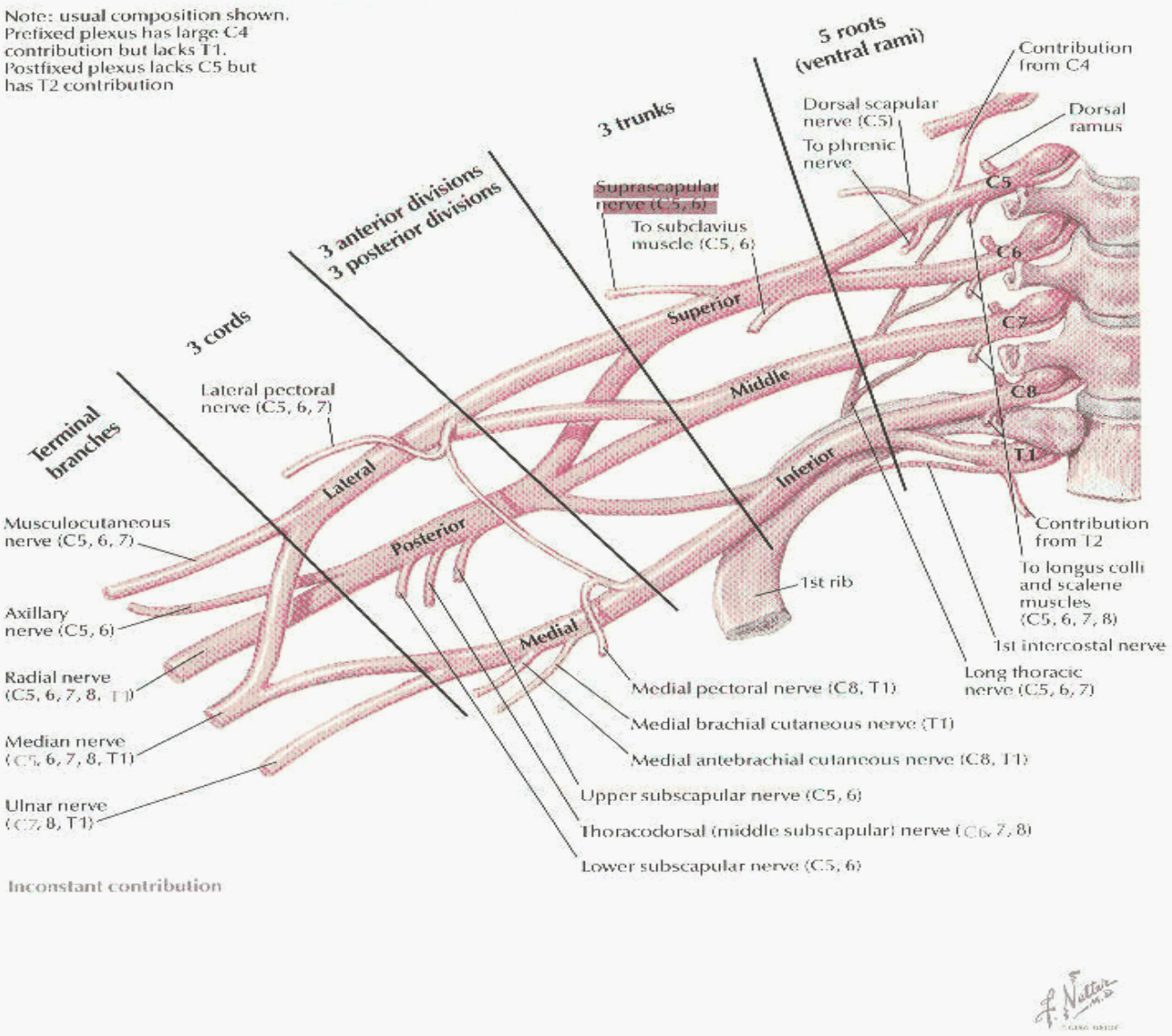


# Neurological Anatomy

- Eight cervical nerve roots comprise brachial plexus – C1 through C7 exit spinal column above related vertebrae and C8 exits spinal column below C7 vertebrae
- Provides sensory and motor function to cervical region, upper thoracic region and upper extremity

# Brachial Plexus

- R = roots = real
- T = trunks = trainers
- D = divisions = drink
- C = cords = cold
- B = branches = beer


Note: usual composition shown.
Prefixed plexus has large C4
contribution but lacks T1.
Postfixed plexus lacks C5 but
has T2 contribution
5 roots
(ventral rami)
3 trunks
3 anterior divisions
3 posterior divisions
3 cords
Terminal
branches
Contribution
from C4
Dorsal scapular
nerve (C5)
Dorsal
ramus
To phrenic
nerve
Suprascapular
nerve (C5, 6)
To subclavius
muscle (C5, 6)
Superior
Middle
Inferior
C5
C6
C7
C8
T1
Lateral pectoral
nerve (C5, 6, 7)
Lateral
Posterior
Medial
Musculocutaneous
nerve (C5, 6, 7)
Axillary
nerve (C5, 6)
Radial nerve
(C5, 6, 7, 8, T1)
Median nerve
(C5, 6, 7, 8, T1)
Ulnar nerve
(C7, 8, T1)
1st rib
Contribution
from T2
To longus colli
and scalene
muscles
(C5, 6, 7, 8)
1st intercostal nerve
Long thoracic
nerve (C5, 6, 7)
Medial pectoral nerve (C8, T1)
Medial brachial cutaneous nerve (T1)
Medial antebrachial cutaneous nerve (C8, T1)
Upper subscapular nerve (C5, 6)
Thoracodorsal (middle subscapular) nerve (C6, 7, 8)
Lower subscapular nerve (C5, 6)
Inconstant contribution

# Brachial Plexus - Roots

- C5
- C6
- C7
- C8
- T1

- Dorsal scapular nerve branches off C5 nerve root
- Long thoracic nerve branches off C5-C7 nerve roots

# Brachial Plexus - Trunks

- C5 and C6 nerve roots combine to form upper trunk
  - Suprascapular nerve and nerve to subclavius branch off of upper trunk
- C7 nerve root continues as middle trunk
- C8 and T1 nerve roots combine to form lower trunk

# Brachial Plexus - Divisions

- Each trunk then branches into anterior and posterior divisions

# Brachial Plexus - Cords

- All posterior divisions combine to form posterior cord
  - Subscapular (upper and lower) and thoracodorsal (middle subscapular) nerves branch off posterior cord
- Anterior divisions of upper and middle trunks combine to form lateral cord
  - Lateral pectoral nerve branches off lateral cord
- Anterior division of lower trunk forms medial cord
  - Medial pectoral, medial brachial cutaneous and medial antebrachial cutaneous nerves branch off medial cord

# Brachial Plexus - Branches

- Terminal branches of brachial plexus (5)
  - **Musculocutaneous** nerve from lateral cord
  - **Median** nerve from lateral and medial cord
  - **Ulnar** nerve from medial cord
  - **Axillary** and **radial** nerves from posterior cord

# Brachial Plexus

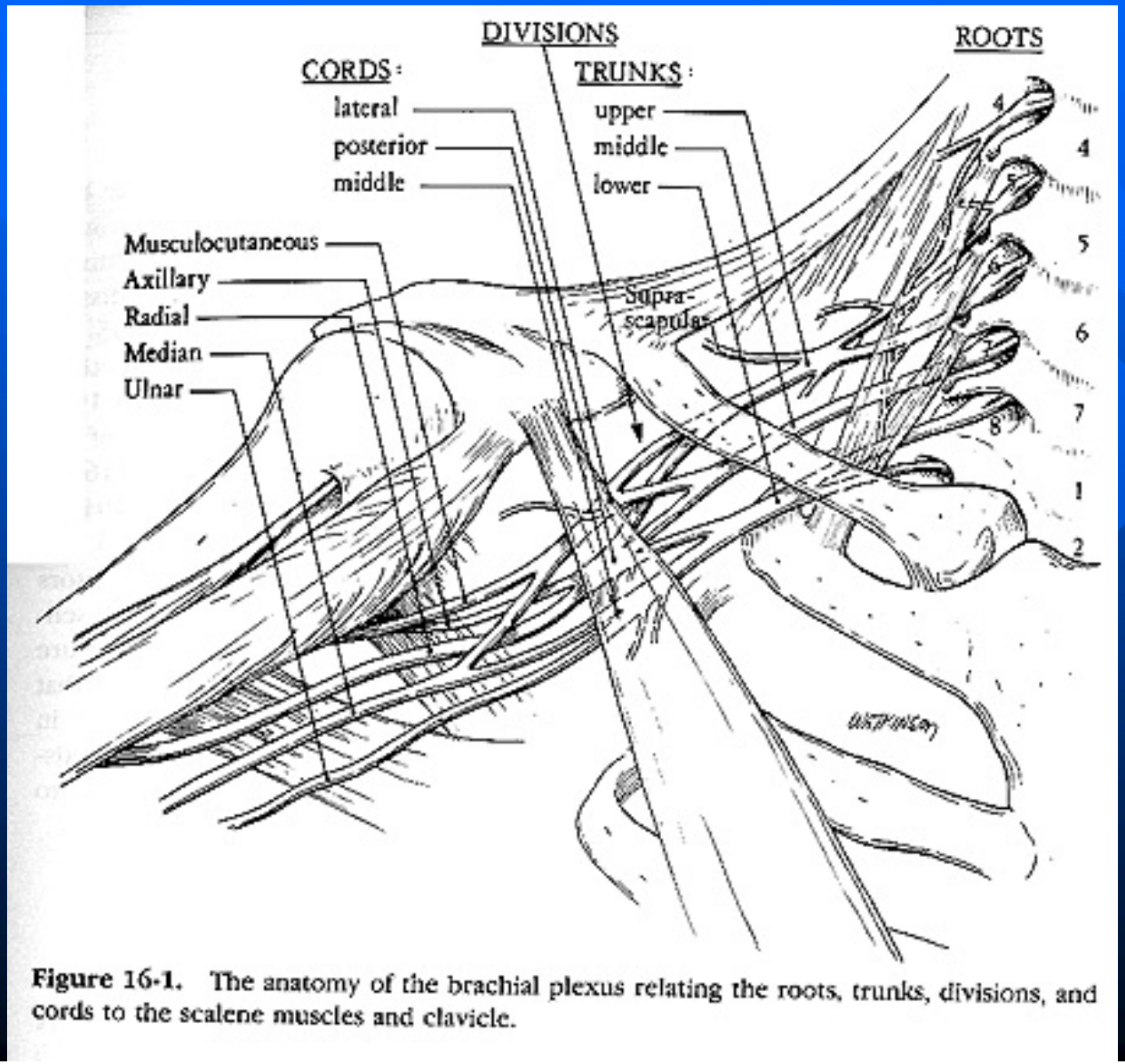
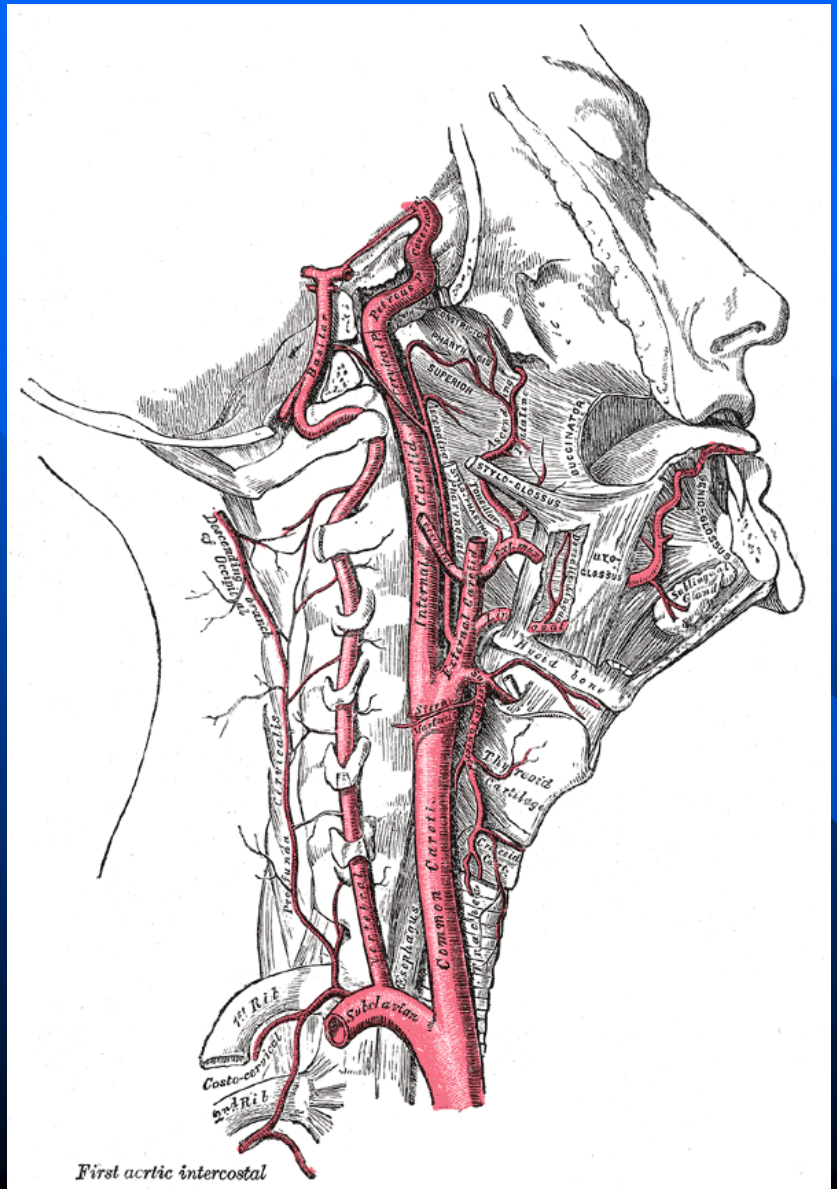



**Figure 16-1.** The anatomy of the brachial plexus relating the roots, trunks, divisions, and cords to the scalene muscles and clavicle.

# Vascular Anatomy

- Carotid arteries
  - Course through anterior/lateral cervical region
    - » Internal and external branches
  - Primary circulatory assessment site
- Vertebral arteries
  - Course through posterior cervical region via transverse foramina in transverse processes of cervical vertebrae

# Vascular Structures



# Evaluation of Cervical Spine Injuries

# History

# History

- Location of pain
- Onset of pain
- Mechanism of injury (etiology)
- Consistency of pain
- Prior history of cervical spine injury

# Location of Pain

- Localized pain
  - Typically indicative of muscular strain, ligamentous sprain, facet joint injury, fracture and/or subluxation or dislocation
- Radiating pain
  - Heightened risk of likely spinal cord, cervical nerve root and/or brachial plexus injury

# Onset of Pain/Mechanism of Injury

- Acute onset
  - Generally associated with one specific mechanism of injury/event
- Chronic or insiduous (unknown) onset
  - Generally related to overuse injuries (accumulative microtrauma) and/or postural abnormalities and deficiencies

# Consistency of Pain

- Pain from inflammation (strain, sprain, contusion) generally persists despite changes in cervical spine position
- Pain of mechanical nature (nerve root compression) varies depending upon cervical spine positioning and can be minimized or eliminated

# Prior History of Cervical Spine Injury

- Must evaluate for residual symptoms associated with previous injury
- Must appreciate structural changes (scar tissue, etc.) which may predispose individual to current injury and symptoms

# Inspection

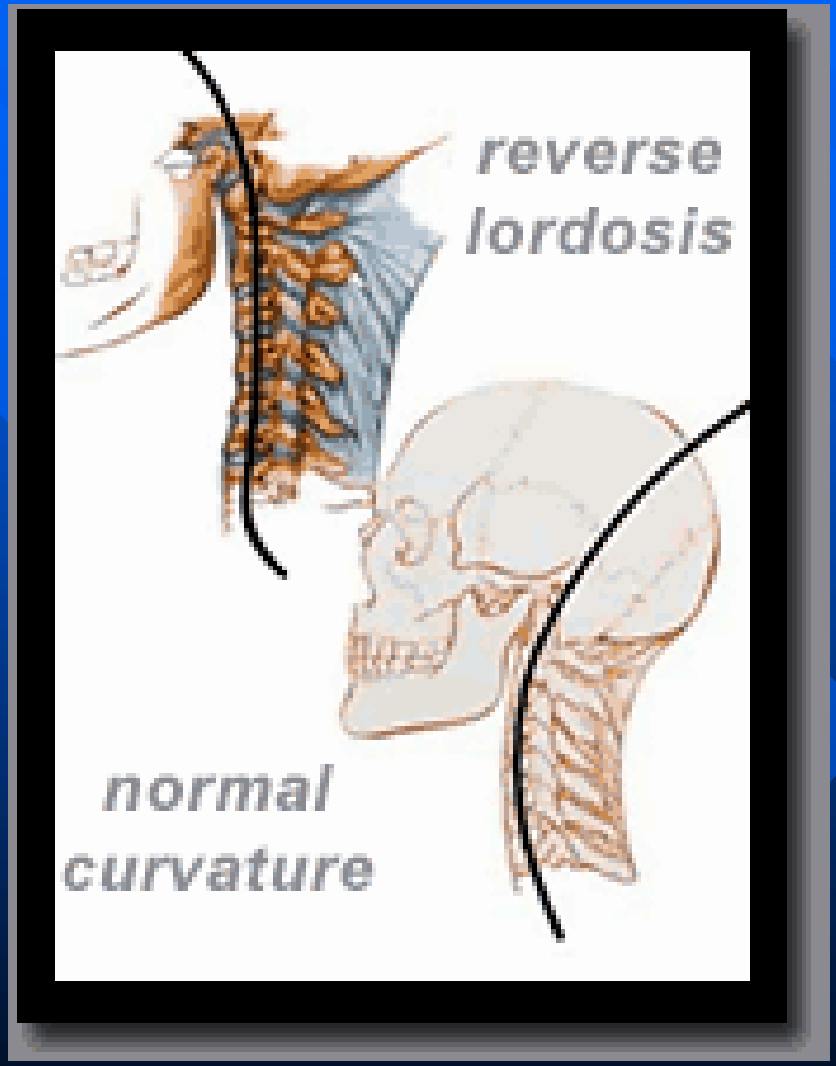
# Inspection

- Cervical spine curvature
- Position of head relative to shoulders
- Soft tissue symmetry
- Level of shoulders

# Cervical Spine Curvature

- Normal cervical spine has lordotic curve
- Increased lordotic curve (forward head) indicative of poor posture and muscular weakness or imbalance
- Lessened lordotic curve indicative of muscular spasm/guarding and/or nerve root impingement

# Lordotic Curve



# Position of Head Relative to Shoulders

- Head should be seated symmetrically on cervical spine
- Lateral flexion from unilateral spasm of muscles – strain and/or spasm (guarding)
- Rotation from unilateral spasm of sternomastoid muscle – strain and/or spasm (guarding) or torticollis

# Torticollis

# Soft Tissue Symmetry

- Observe for bilaterally comparable muscle mass, tone and contour
  - Dominant extremity may be hypertrophied vs. non-dominant extremity
  - Excessive tone indicative of possible strain/spasm
  - Atrophy indicative of neurological injury

# Level of Shoulders

- Inspect height of:
  - Acromioclavicular (AC) joints
  - Deltoids
  - Clavicles
- Dominant extremity often appears depressed relative to non-dominant extremity

# Palpation

# Anterior Palpation

- Hyoid bone
  - At level of C3 vertebrae, note movement with swallowing
- Thyroid cartilage
  - At level of C4/C5 vertebrae, also moves with swallowing, protects larynx
  - Aka – “Adam’s apple”
- Cricoid cartilage
  - At level of C6/C7 vertebrae, point where esophagus and trachea deviate, rings of cartilage

# Anterior Palpation

- Sternomastoid
  - Sternum (near SC joint) to mastoid process
- Scalenes
  - Posterior/lateral to sternomastoid muscles
  - Difficult to differentiate, palpate collectively
- Carotid artery
  - Primary pulse point
- Lymph nodes
  - Only discernable if enlarged due to illness

# Posterior and Lateral Palpation

- Occiput
  - Posterior aspect of skull, many ms. attachments
- Transverse processes
  - Can only palpate C1 transverse processes approx. one finger below mastoid processes
- Spinous processes
  - Flex cervical spine, C7 and T1 are prominent
  - Can palpate C5 and C6, maybe C3 and C4
- Trapezius
  - Upper fibers from occiput and cervical spinous processes to distal clavicle

# Special Tests

# Special Tests

- Range of motion testing
  - Active
  - Passive
  - Resisted
- Ligamentous/capsular tests
- Neurological tests
  - Brachial plexus evaluation
  - Reflex tests
  - Upper motor neuron lesions

# Active Range of Motion

- Best done in sitting or standing

- Flexion – touch chin to chest
- Extension – look straight above head
- Lateral flexion – approximately 45 degrees
- Rotation – nose over tip of shoulder

# Passive Range of Motion

- Best done laying supine

- Flexion – firm end feel
- Extension – hard end feel (occiput on cervical spinous processes)
- Lateral flexion – firm end feel (stabilize opposite shoulder)
- Rotation – firm end feel

# Resisted Range of Motion

- Easiest to perform all in seated position – stabilize proximally to avoid substitution

- Flexion – resistance to forehead
- Extension – resistance to occiput
- Lateral flexion – resistance to temporal and parietal regions
- Rotation – resistance to temporal region or side of face

# Ligamentous/Capsular Testing

- No specific named tests for cervical spine
- End feels associated with passive ranges of motion essentially become end points for joint capsule and ligamentous stress tests

# Neurological/Vascular Tests

- Brachial plexus evaluation
  - Dermatomes = sensory map
  - Myotomes = motor function
  - Reflex tests
  - Brachial plexus traction test
  - Cervical distraction/compression tests
  - Spurling test
- Upper motor neuron lesions
  - Babinski test
  - Oppenheim test
  - Loss of bowel and/or bladder control
- Vertebral artery test

# Brachial Plexus - Dermatomes

- All based upon anatomical position

- C5 – lateral arm
- C6 – lateral forearm, thumb, index finger
- C7 – posterior forearm, middle finger
- C8 – medial forearm, ring and little fingers
- T1 – medial arm

# Brachial Plexus - Myotomes

- Minor differences will exist from one resource to another

- C5 – shoulder abduction
- C6 – elbow flexion or wrist extension
- C7 – elbow extension or wrist flexion
- C8 – grip strength (shake hands)
- T1 – interossei (spread fingers)

# Brachial Plexus – Reflex Tests

- C5 – biceps brachii reflex (anterior arm near antecubital fossa)
- C6 – brachioradialis reflex (thumb side of forearm)
- C7 – triceps brachii reflex (at insertion on olecranon process)

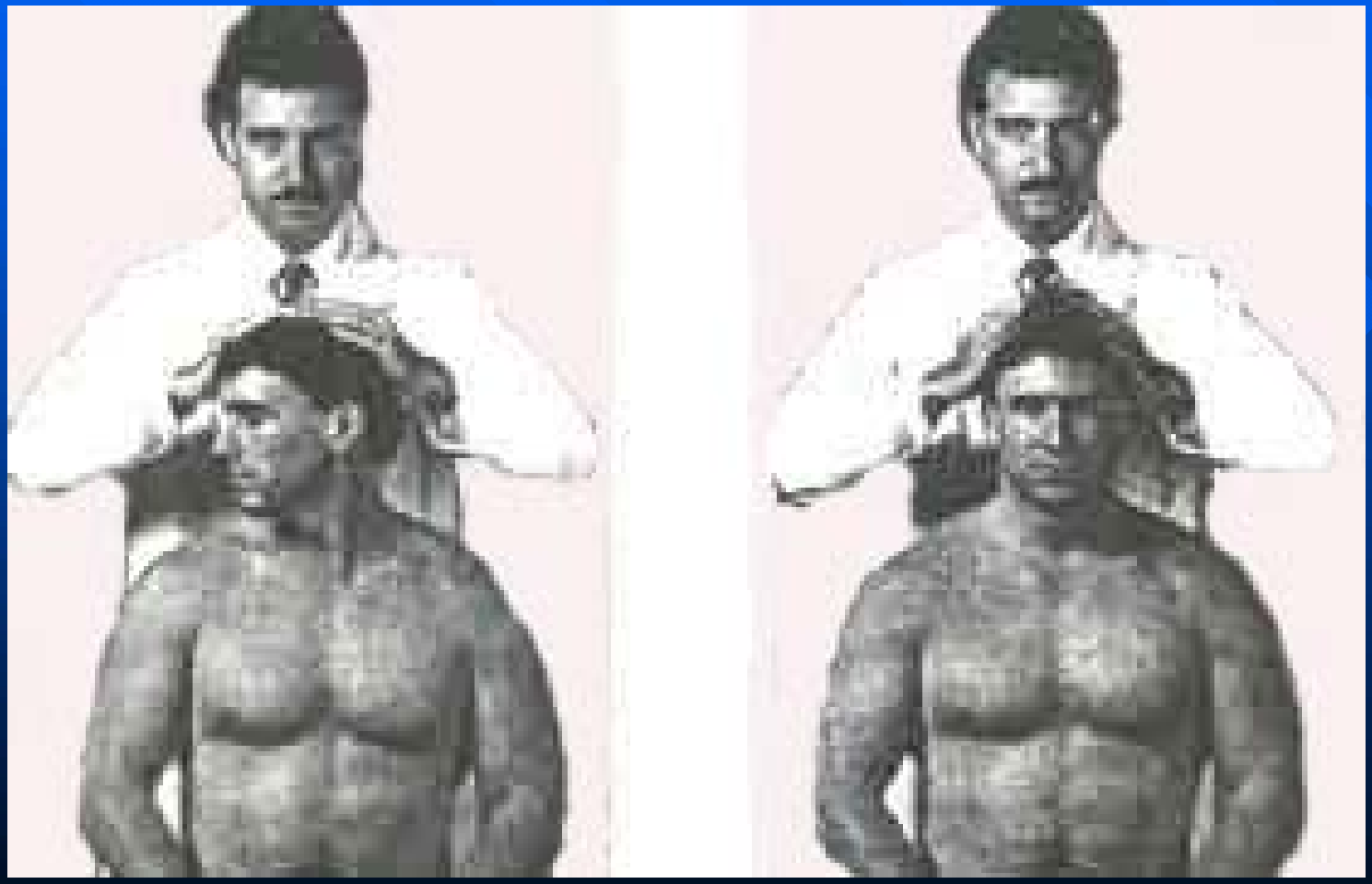
# Brachial Plexus Traction Test

- Mimics mechanism of injury
- Cervical spine laterally flexed and opposite shoulder is depressed
- Positive if radiating/”burning” pain in upper extremity
  - If traction injury, symptoms noted on side of depressed shoulder
  - If compression injury, symptoms noted in direction of lateral flexion

# Cervical Distraction/Compression Tests

- Distraction
  - Patient supine, clinician stabilizes head
  - Passive traction force applied to cervical spine
  - Positive test if neuro symptoms and/or pain reduced with traction force
- Compression
  - Patient sitting, clinician pushes down on top of patient's head
  - Positive test if pain and/or neuro symptoms reproduced in cervical spine and/or upper extremity

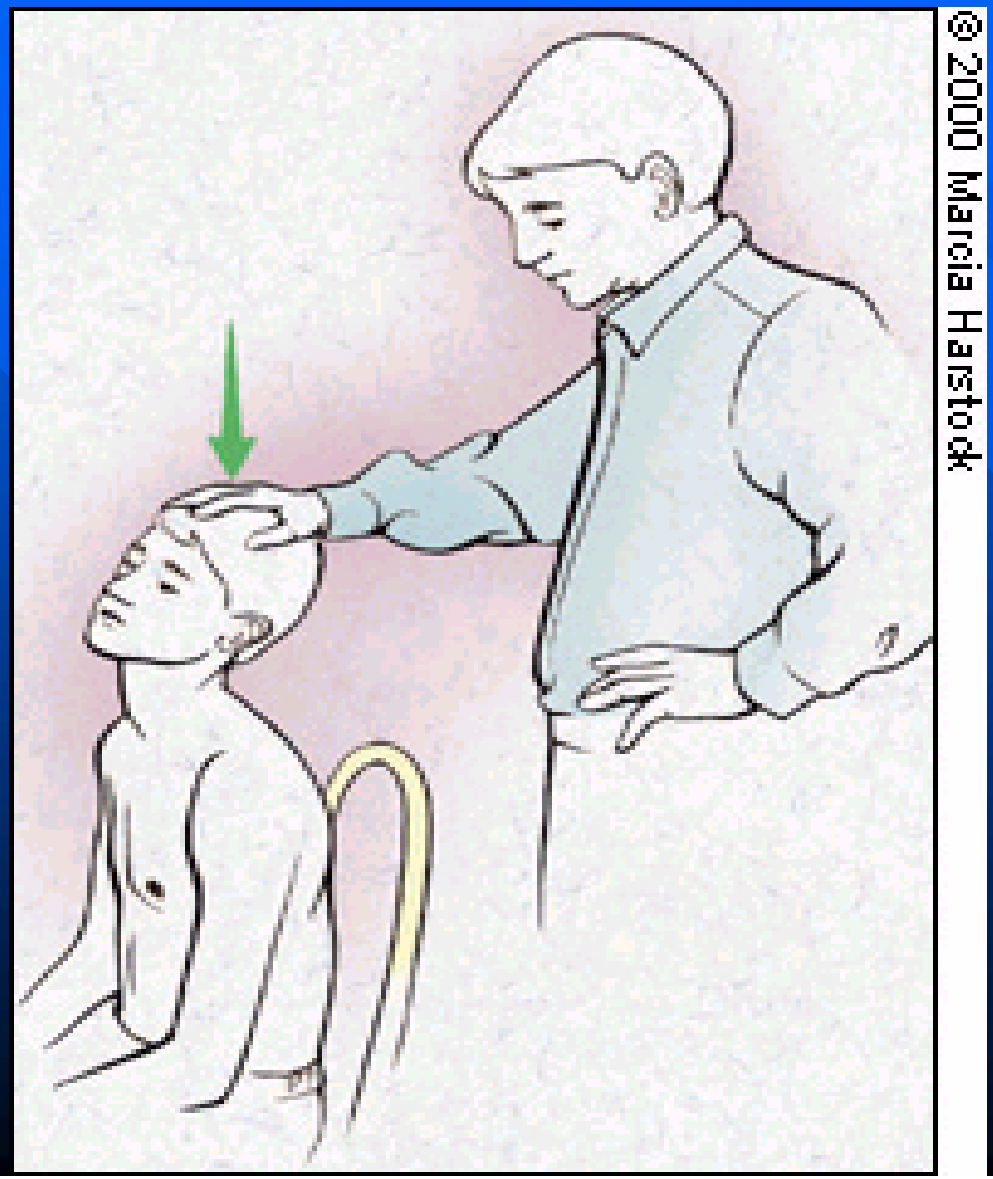
# Cervical Compression Test



# Spurling Test

- Same positioning as cervical compression test
- Instead of linear axial load through top of head, clinician extends and laterally rotates neck with compression to impinge on nerve root/s
- Positive if pain and/or neuro symptoms reproduced in cervical spine and/or upper extremity

# Spurling Test



# Upper Motor Neuron Lesions

- Symptoms of catastrophic head and/or spinal cord injury associated with trauma
- Babinski test
  - Blunt device stroked along plantar aspect of foot from calcaneus to 1st metatarsal head
  - Positive test if great toe extends and other toes splay
- Oppenheim test
  - Fingernail ran along medial tibial border/crest
  - Positive test if great toe extends and other toes splay

# Babinski Test

# Vertebral Artery Test

- Assesses patency of vertebral artery
- Patient placed supine on table
- Clinician supports head at occiput
- Patients neck passively extended, laterally flexed and then rotate toward laterally flexed side for ~30 seconds
- Positive test if dizziness, confusion, nystagmus, unilateral pupil changes and/or nausea present

# Cervical Spine Pathologies

# Cervical Spine Injuries

- Acute injuries typically trauma induced and involve excessive movement/s of the spine and injury to related structures
- Chronic conditions result from poor posture, muscle imbalances, decreased flexibility and/or repetitive movement related to activity

# Cervical Spine Injuries

- Brachial plexus injuries (stinger/burner)
  - Compression or distraction
- Cervical nerve root impingement
  - Degenerative disc changes
  - Acute disc injury
- Sprain/strain syndrome
  - Difficult to differentiate
- Vertebral artery impingement

# Brachial Plexus Injury

- Compression force – nerve roots pinched between adjacent vertebrae
  - Increased risk if spinal stenosis (narrowing of intervertebral foramen) exists
- Distraction force – tension or “stretch” force on nerve roots
  - Most common at C5/C6 levels but may involve any cervical nerve root
  - Erb’s point – 2-3 cm above clavicle anterior to C6 transverse process, most superficial passage of brachial plexus

# Erb’s Point

# Brachial Plexus Injury

- Signs and symptoms
  - Immediate and significant pain
  - “Burning” or radiating pain in upper extremity
  - Dropped shoulder on affected side
  - Myotome and dermatome deficiencies at affected nerve root levels
- Generally, symptoms minimize or resolve quickly
- If recurrent, takes less trauma to induce symptoms and longer for symptoms to diminish

# Cervical Nerve Root Impingement

- Disc related conditions
  - Degenerative disc changes
  - Disc herniations – most at C5/C6 or C6/C7 levels
  - Often presents with head in position of least compression on affected nerve root/s
  - Similar neuro symptoms to brachial plexus injuries at involved level/s
- Narrowing of intervertebral foramen
  - Exostosis (bone spur)
  - Facet degeneration

# Sprain/Strain Syndrome

- Since unable to directly palpate facet joints, difficult to differentiate pain/spasm associated with sprain of joint capsule from strain of musculature
- Inflammation from sprain/strain may irritate nerve roots in close anatomical orientation to affected area and produce neuro symptoms
- Severe sprains (dislocations) will present with postural change due to joint disassociation

# Vertebral Artery Impingment

- Due to anatomic location, may be compromised with same mechanism of injury as brachial plexus/cervical nerve root impingement injuries
- Signs and symptoms
  - Dizziness
  - Confusion
  - Nystagmus