Spine Hi Yield Review

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Goals
1. Understand all of spine

Anatomy

Neural Anatomy

- 8 cervical roots
- Each cervical root exits the c-spine above the pedicle of the matching vertebrae
- The remainder of the spine roots all exit the canal under the corresponding pedicle

High-Yield Fact
- Herniated C4-C5 disc
  - C5 nerve
- Herniated L4-L5 disc
  - Posterolateral
    - L5 nerve root
  - Far lateral
    - L4 nerve root
  - Foraminal stenosis
    - L4 nerve root

YOU MUST KNOW THIS!!

<table>
<thead>
<tr>
<th>Level</th>
<th>Root</th>
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<tbody>
<tr>
<td>C3-4</td>
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<td>C4-5</td>
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<td>C5-6</td>
<td>C6</td>
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<td>C6-7</td>
<td>C7</td>
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<td>C7-T1</td>
<td>C8</td>
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<td>T1-T2</td>
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<td>L5-S1</td>
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### YOU MUST KNOW THIS !!

<table>
<thead>
<tr>
<th>MOTOR</th>
<th>SENSORY</th>
<th>REFLEX</th>
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<tbody>
<tr>
<td>C₅</td>
<td>Deltoid/Biceps</td>
<td>Shoulder</td>
</tr>
<tr>
<td>C₆</td>
<td>Wrist Ext/Biceps</td>
<td>Thumb/Index</td>
</tr>
<tr>
<td>C₇</td>
<td>Triceps/Wrist Flexors</td>
<td>Long</td>
</tr>
<tr>
<td>C₈</td>
<td>Intrinsics/Grasp</td>
<td>Ring/Little</td>
</tr>
<tr>
<td>L₄</td>
<td>Quad/Hip Add</td>
<td>Lat thigh/Medial Tibia</td>
</tr>
<tr>
<td>L₅</td>
<td>EHL Gluteus Medius</td>
<td>Anterolateral leg</td>
</tr>
<tr>
<td>S₁</td>
<td>Gastrocnemius</td>
<td>Lat malleolus/Lat foot</td>
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### Physical Examination

#### Test

- **Anatomy**
  - Carotid Sheath
    - Internal and Common Carotid Arteries
    - Internal Jugular Vein
    - Vagus Nerve
  - Recurrent Laryngeal Nerve
    - In Tracheoesophageal Interval
    - Possibly more variable on right side

- **Sympathetic Chain**
  - Posterior to carotid sheath
  - Anterior to longus capitus muscle
  - Anterior to transverse process
  - Disruption of inferior ganglion
    - Horner’s Syndrome

- **Anterior Approach C-Spine**
  - Recurrent laryngeal nerve
    - Left – Aortic Arch
    - Right – Subclavian artery
    - Supplies vocal muscles
  - Horner’s syndrome
    - [Inferior Ganglion of Sympathetic Chain]
      - Ptosis
      - Miosis
      - Facial Anhidrosis

- **Anterior Approach C-Spine**
  - Laryngeal Nerves in ACDF
    - Superior laryngeal nerve
      - traction in upper cervical surgery
      - high note phonation
      - no vocal cord paralysis
    - Recurrent laryngeal nerve
      - vocal cord paralysis on the side of injury
      - hoarseness
      - aspiration
      - can compensate partially for phonation
**Anterior Approach C-Spine**

C2-3 HNP

- **Think:**
  - Superior laryngeal nerve a risk with standard approach
  - A modified submandibular approach
  - Anterior retropharyngeal exposure
  - High phonation
  - Protect superior laryngeal nerve in Singers !!!!
**Applied Spinal Anatomy**

- Lateral mass screws
- Vertebral artery
- Exiting nerve root
- Facet joint

**Pure Anatomy**

- Artery of Adamkiewicz
  - Left side
  - Posterior intercostal artery
  - T8-T12 (T9-11)
  - Its relevance to iatrogenic spinal cord problems is still uncertain.
- Thoracic duct
  - Left side
  - Posterior to structures of carotid sheath
- Carotid tubercle
  - C6

**Relational Anatomy**

- Relational Anatomy
  - Posterior to longus colli
  - Anterior to lateral mass
- Trauma: Bilateral C5/6 facet dislocations
  - Vertebral artery injury
  - Diplopia, vertigo, tinnitus
- C1-C2 anatomy
  - 1.5 cm lateral from posterior midline dissection
  - 1.0 cm lateral for superior

**High Yield Facts**

- Structures at risk during graft harvest?
  - Anterior
    - Lateral femoral cutaneous n.
    - Anterior thigh numbness
  - Posterior
    - Superior cluneal nerve.
    - 8 cm lateral to PSIS
    - Buttock numbness
    - Superior gluteal artery

**High-Yield Vertebral Artery**

- Sympathetic chain
- Longus colli
- Vertebral artery
- Cervical nerve root
- Lateral mass
**Greater Occipital Nerve**

- Anatomy
  - C2 nerve root
  - Exits between C1 and C2

- Rheumatoid arthritis
  - Compression can cause base of the skull pain

- Trauma
  - At risk during C1-C2 transarticular screws placement

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**Retroperitoneal Lumbar Approach**

- Structures at risk
  - Ureter lies in peritoneal cavity
  - Genitofemoral nerve and Sympathetic chain at risk
  - iliolumbar vein at L5
  - Superior Hypogastric plexus

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**Retroperitoneal Lumbar Approach**

- Vascular anatomy of the anterior lumbar spine
  - IVC to the right of descending Aorta in lumbar spine
  - Bifurcation of Great Vessels are at L4/5 disc space
  - iliolumbar vein at level of L5
  - Segmental vessels at level of mid body

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**Sexual Dysfunction after Anterior Lumbar Surgery**

- Erectile dysfunction
  - Usually nonorganic.
  - Parasympathetics deep in the pelvis at S2-3 and S3-4
  - Erectile function not affected by sympathetic injury

- Retrograde ejaculation
  - Superior hypogastric sympathetic plexus injury
  - Anterior surface crossing at L4-5 and L5-S1 level

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**“Point and Shoot”**

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**Degenerative Spine**

**Herniated Disc**

- Management HNP
  - Conservative measures initially
    - Pain without significant motor deficit.
  - Painless Great Toe weakness
  - Surgery
    - Failed conservative > 3 mos
    - Progressive neurologic deficit

- Herniated C4-C5 disc
- C5 nerve
- Herniated L4-L5 disc
  - Posterolateral L5 nerve root
  - Far lateral L4 nerve root
  - Foraminal stenosis L4 nerve root
Spinal Stenosis

- Neurogenic claudication without spondylolisthesis
  - Decompressive laminectomy
- Neurogenic claudication with degenerative slip
  - Laminectomy with posterolateral fusion +/- instrumentation
- Iatrogenic instability
  1. Iatrogenic removal of the pars
  2. Unilateral total facetectomy (1 x 100% = 100%)
  3. Bilateral partial facetectomy >50% (2 x 50% = 100%)

Word Association

Cauda Equina

- Abdominal bloating
- Urinary retention
- Saddle anesthesia
- Bladder function = S2, S3, and S4 nerve roots.
- Decreased rectal tone and urinary retention
- Urgent surgical decompression

Sacral Root Anatomy

Anterior

Posterior

High Yield Facts

Conus Medullaris vs. Cauda Equina Syndrome

- Conus medullaris syndrome
  - Conus ends at level of L1 typically
  - Typically injury at T12-L1 or T11-T12
  - Isolated loss of bowel and bladder function
- Cauda equina syndrome
  - Injury at the lumbar levels
  - Large HNP, tumor, severe stenosis
  - Some degree of lower extremity

Degenerative Spinal Conditions

Mechanical axial LBP

- Make sure there are no red flag questions
- Conservative measures if <4 wks
- Imaging not indicated if <4 weeks of Sx
- Imaging -- start with plain films
- Think rheumatologic stuff
- esp if they give you ESR, titers, etc
- Discogram
- Concordant pain at one level best indicator for success with surgical fusion

Dural Tears

- Management of intraoperative tear.
  - Primary repair whenever possible.
  - Water tight closure.
  - Bed rest 48 hours
  - No drain necessary
- Management of post-operative tear.
  - Subarachnoid drain, Abx, bed rest
  - If persists greater than 3-4 days then surgical re-exploration
- Post-op nausea on PCA after Lumbar disc surgery
  - Don’t forget about dural tear as a possibility
Spinal Deformity

Harrington Instrumentation

- Flatback
- Lumbar distractive instrumentation
- Sagittal malalignment
- Loss of lumbar lordosis
- Positive sagittal balance

Isthmic Spondylolisthesis

- Pars (interarticularis) defect
- Scotty dog
- 5% of the general population
- Progression uncommon
- Familial predisposition
  - SPECT: Most sensitive test for isthmic spondy
  - Repetitive Hyperextension
  - Football player with low back pain
  - Gymnast with low back pain
  - Swimmer with low back pain
  - L5-ST isthmic spondylolisthesis—L5 nerve root
  - TLSO with thigh extension

Basic Science

High Yield Facts

- Spinal fusions
- NSAIDs decrease fusion rate
  - Ketorolac
  - Ibuprofen
  - Nicotine
  - Decreases
  - Smoking
  - Stop preoperatively and 6 months postoperatively

High-Yield: Axial Back Pain

Intradiscal Pressure

- Highest
  - Sitting leaning forward
  - Sitting
  - Standing
  - Supine
  - Test
- Lowest
High-Yield Facts

- Characteristics during disc degeneration?
  - Begins gradually during third decade of life
  - Glycosaminoglycan (GAG) levels in nucleus decline.
  - Water content decreases in the sixth decade and beyond.
  - Corresponding increase in noncollagen glycoprotein.

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GAG & H2O
Noncollagen glycoprotein
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Important Facts

- Trauma
  - Radiographs must include C7/T1 junction
  - Adhere to ABCs and primary survey
  - Spine precautions
  - If there are associated facial fractures
    - Consider cricothyroidotomy for airway

High-Yield Facts

- Neurogenic shock
  - Lower cervical upper thoracic spine injury
    - Usually does not occur in SCI below T6
  - Loss of sympathetics
    - Bradycardic with hypotension
    - Peripheral vascular dilatation, hypothermia

- Spinal shock
  - Complete loss of all neurologic function below the injury level
    - Including reflexes and rectal tone

Traumatic Spine

- Spinal cord injury
  - Spinal shock
    - Unable to determine if complete or incomplete spinal cord injury
  - Complete
    - Return of bulbocavernous
    - Lowest spinal reflex arch
  - Incomplete
    - Sacral sparing
Thoracolumbar burst fracture

- Mechanism: axial load
- Surgical indications:
  - Neurologic deficit
  - Kyphosis > 30 degrees
  - Anterior loss of height > 50%
  - Retropulsion > 50%
- Most burst fractures can be treated nonoperatively

Surgical Decision Making

- Anterior decompression, fusion, and instrumentation
- Neurologic deficit with retropulsion
- Late treatment for deformity / post-traumatic kyphosis
- Posterior procedure
  - LAMINA fracture → possible trapped nerve roots
  - Early treatment: 24-48 hours
  - Reduction through ligomento/annulotaxis with instrumented PSF
  - Laminectomy alone is not the answer!

MVA and lap belt

- Flexion distraction injury.
- Usual at thoracolumbar junction
- Don’t miss associated visceral injuries!!!
  - Ileus. Perforation of duodenum or cecum.
  - Positive DPL
- Neurologic intact
- Hyperextension bracing
- Look for evidence of posterior element injury
  - MRI ligaments disrupted
  - Anterior loss of height > 50%
  - Splaying of posterior elements

Acute Autonomic Dysreflexia

- HA, diaphoresis in SCI patient
- Sympathetic overdrive
- What should you look for in patients with autonomic dysreflexia?
  - Orthopaedic issues- femur fractures, etc
  - GU- urinary retention
  - GI- fecal impaction

Anteriorly placed SI screws place L5 nerve root at risk

Infections and Tumor

Factosarcomas
**Pathologic/Infectious Spinal Disorders**

**Spinal Infections**
- Osteomyelitis/Discitis
- Biopsy for tissue diagnosis
- Typically medical treatment
- Epidural abscess
- Typically surgical treatment
- Granulomatous infection
- Typically medical treatment
- But look for late deformity

**Chordoma**
- Midline
- Primitive notocord-midline structure
  - Sacral-coccygeal 50% (sacral mass)
  - Occipitocervical 30%
  - Remaining spine 20%
- Surgical
- Not sensitive to chemoTx or XRT
- Cure: en bloc resection
- Histology: Physaliphorous cell

**Factosarcomas**

**Tumor locations**
- Posterior elements
  - Osteoid osteoma
  - Osteoblastoma
  - Aneurysmal bone cyst
- Anterior body
  - Metastases
  - Giant cell tumor
  - Hemangiomas
  - Eosinophilic granuloma
  - Chondrosarcoma
  - Osteosarcoma

**Classic CT: Osteoid osteoma**
- Osteoblastic lesion
  - Osteoid osteoma < 2 cm
  - Osteoblastoma > 2 cm
- 2nd and 3rd decade of life
- Pain
  - Unrelated to activity
  - Persistent
  - Noted mostly at night
- Response to aspirin is not universal

**High-Yield Fact**
- Best predictors of postoperative neurologic prognosis:
  - Pretreatment neurologic status.
  - 60 - 90% who are ambulatory at the time of diagnosis will retain this ability after treatment
- Location
  - Less space is available for the cord in the thoracic spine.
  - Lesions located in vascular watershed regions may disrupt the vascular supply of the cord.

**Classic X-ray: Winking Owl Sign**
- Think:
  - Spine Tumor
  - Pedicle missing
  - Require 50% bony destruction to see lytic lesion on spine radiograph
  - Obtain MRI with Gadolinium
Inflammatory Arthritis

High-Yield Facts

**Ankylosing Spondylitis**

- **Features**
  - Limitation of chest expansion to 1 inch or less
  - Bamboo spine

- **Neck pain**
  - Assume fracture
  - Spine precautions
  - Admit
  - CT scan with recon
  - Halo immobilization (+/- Surgery)

- **Rheumatoid Neck**

  - Once neurologic symptoms → surgical intervention recommended
  - AAS - atlantoaxial subluxation
    - Most common deformity
    - PADI more important
    - 10 mm and 14 mm
    - Fuse C1-C2
  - AAI - atlantoaxial invagination
    - 4.5 mm above McGregor’s line
    - Cervicomedullary angle (CMA) <135 degrees
    - Surgical intervention: Fuse to occiput
  - SAS - subaxial subluxation
    - Fuse to the lowest level of sublux

Thank You!