Cervical Spine Stenosis

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BIDMC Radiology Core Clerkship
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Our Patient

- MC is a 50 yo Asian female s/p MVA 9.28.05
  - Low speed rear end collision while stopped
    - No LOC or head trauma
  - Declined Ambulance
  - The next day presented to PCP c/o
    - HA, myalgias
    - L neck/shoulder pain
    - L thumb and 4/5 digit toe pain
    - Mild numbness of distal L 3/4/5 digit hand
- PMH
  - Cervical spine sprain 2001
    - C-spine at that time revealed degenerative changes in lower cervical spine, band-like calcific density C5/6, and loss of normal lordosis
    - Treated with NSAIDs, Flexeril, and PT
- Social Hx:
  - Non-contributory
Our Patient cont’d

- Physical Exam
  - Neck:
    - Mild L tenderness
    - ROM limited to 45° b/l
  - Back:
    - No spinous process tenderness
    - + tenderness to palpation along the edge of the scapula and upper trapezius
  - Left Ext:
    - Mild numbness on dorsal aspect of 3/4/5 digits
    - Tenderness @ thenar eminence, lateral elbow, 4/5 toes
    - ? Faint weakness of upper/lower ext.

- Assessment
  - Acute Whiplash Injury s/p MVA
  - w/ C8 involvement

- Plan
  - Start motrin 400 mg TID, flexeril 10 mg QD, soft cervical collar when upright, PT, acupuncture
  - Return if sx worsen or sx do not resolve
Follow-up 11.1.05

- **CC:**
  - Persistent neck “tightness”
  - Paresthesias of L upper extremity worse in the morning and with certain positions and movements
  - Pain in left knee assoc. w/ “tightness” in posterior thigh and calf

- **PE**
  - Flexion, extension, and bilateral rotation causes neck discomfort.

- **A/P**
  - Cervical Radiculitis w/ C8 involvement
  - Given duration and interval change in sx:
    - MRI
Clinical DDx

- **A**
  - Intramedullary
    - Neoplasms – *Ependymoma, Astrocytoma*
    - Hydrosyringomyelia
    - Trauma
    - AVM
    - Demyelinating Disease - MS
    - Transverse Myelitis
    - Radiation myelitis
  - **B**
    - Intradural-Extramedullary
      - *Meningioma*
      - *AVM*
      - *Neurofibroma*
      - Nerve Sheath Tumor
      - Metastasis
      - Arachnoiditis
      - Arachnoid cyst
    - Extradural
      - Disk – *Cervical Spondylosis, Disk herniation*
      - Osseous processes – Cervical Spondylosis, *Joint/ligament hypertrophy*, DISH, RA, Paget’s Disease, Fluorosis
      - Neoplasm – Myeloma, Lymphoma, Epidural lipomatosis
      - Trauma – *Acute Whiplash Injury, Burst Fractures*
      - Infection – Vertebral Osteomyelitis/Discitis (TB)

Woodruff, *Fundamentals of Neuroimaging*
Cervical Spine Anatomy

Let’s quickly review the anatomy of the region before reviewing our patient’s imaging
Cervical Spine Anatomy cont’d

Cervical Spine Anatomy cont’d

http://daphne.palomar.edu/ccarpenter/Models/spinal%20cord%20XS.htm; www.uicomp.uic.edu/mri/cerv.spinal.html
Cervical Spine Anatomy cont’d

C-Spine in Evaluating Spinal Stenosis

- Preferred Initial Modality
  - Findings
    - Lateral
      - Outlines of vertebral bodies (osteophytes, fractures), Uncovertebral hypertrophy
    - Oblique
      - Hypertrophic facet joints, Narrowing of the neuroforamina
    - AP
      - Alignment, Soft Tissues
  - Degrees of Confidence
    - Useful in cases of trauma or severe stenosis
    - Displays soft tissue abnormalities
CT Imaging for Evaluating Spinal Stenosis

- Traditionally Used
  - Findings
    - Diminished diameter and cross-sectional area of the spinal canal
    - IV contrast maybe administered to enhance the epidural veins and thereby better define the epidural margins
    - Myelogram also add greater definition to the thecal sac
    - Ossification of neuroformina
  - Degrees of Confidence
    - Osseous and calcified lesions well defined
    - False -/+ (-) Lateral lesions may become averaged with surrounding neuroforaminal bone
MRI for Evaluating Spinal Stenosis

- Preferred Modality
  - Findings
    - Osteophytic and calcific lesions appear dark (T1/T2-SE)
    - Vertebral endplates show increased signal intensity post contrast in the setting of inflammation or chronic degenerative changes (T1)
    - Cord enhancement with edema or myelomalacia
    - Spinal infection
    - Primary/Secondary tumor
  - Degrees of Confidence
    - Sagittal spinal canal measurements are particularly useful
  - False +/-
    - (-) Stenosis overestimation and false dorsal stenosis seen as a consequence of gradient-echo and CSF pulsation respectively

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Gillian Lieberman, MD
October 2005
There is a thickened linear signal along the posterior margin of the cervical vertebral bodies extending from the C3/C4 disc level to the superior endplate of T1(yellow). The appearance is consistent with ossification of the posterior longitudinal ligament. The AP diameter at the C3/C4 disc level is only 5.47mm. The normal AP diameter in the cervical spine is 13-20mm. Neurologic symptoms present with an AP diameter < 8mm.
Our Patient MC 11.03.05

**T2-SE** At C3/C4, there is marked narrowing of the AP diameter of the spinal canal due to the ossified ligament with flattening of the cord (yellow).

**T2-SE** At C4/C5, there is similar narrowing of the spinal canal with deformity of the spinal cord (yellow). The neural foramina are moderately narrowed, right greater than left (red).
Our Patient MC 11.03.2005

**T2-SE** At C5/C6, there is also severe spinal stenosis with moderate cord deformity (yellow). The neural foramina are moderately narrowed, left greater than right.

**T2-SE** At C6/C7, there is contact of the ventral surface to the cord with the ossified posterior longitudinal ligament without significant cord deformity (yellow). The neural foramina are patent at this level.
Radiographic Differential Dx

- Cervical Spine Stenosis
  - Ossification of Posterior Ligament
  - Diffuse Idiopathic Skeletal Hyperostosis (DISH)
  - Cervical Spondylosis
  - Foraminal encroachment / herniated disc
  - Seronegative spondyloarthropathies
  - RA
  - Epidural Lipomatosis
  - Congenital Spinal Stenosis
- Radiculopathy
Diagnosis: Ossification of Posterior Longitudinal Ligament

- **Epidemiology**
  - Highest incidence in Japanese populations
  - ~1.7% of Japanese patients with cervical spine disorders (increasing awareness of OPLL in other populations)
  - 2:1 male:female ratio
  - Associated with and similar to DISH

- **Clinical Presentation**
  - Diagnosis typically established in 5th-7th decades
  - Cord Signs:
    - Dominant sensorimotor disturbances in lower ext. 16%
    - Dominant sensorimotor disturbances in upper ext. 56%
  - Cervico-brachialgia – pain in the neck, shoulder, and arm 28%
  - Symptoms typically appear when PLL is 30% of the sagittal canal length
  - Predisposed to myelopathy precipitated by trauma

- **Pathophysiology**
  - Hyperplasia of cartilage cells with eventual endochondral ossification of the posterior longitudinal ligament
  - Most Common in C3-5
  - Anterior vertebral osteophytes

- **Radiologic Findings**
  - Low signal intensity between the vertebral body and dural sac on T1 and T2 spin echo (SE) MRI images; calcific densities on CT
  - Spinal Canal AP diameter of <12 mm associated w/ onset of neurologic symptoms (nml 13-20mm)
  - Cord edema/myelomalacia as a result of compression, microtrauma, and ischemia

*Singh et al*
Molecular Biology of OPLL

- OPLL mapped to Npp gene using the ttw mouse model
  - Npp
    - Encodes nucleoside pyrophosphatase
      - Regulates soft-tissue calcification and bone mineralization by producing inorganic pyrophosphate – an inhibitor of calcification
      - Non-sense mutation (gly568 to ter) leads to production of a truncated protein thought to be responsible for the accelerated bone formation

Additional OPLL Imaging

C-spine Radiopacity posterior to vertebral bodies consistent with OPLL (black)

Axial CT Increased density posterior to vertebral body consistent with OPLL (red)

Singh et al
Cervical Spine Stenosis

Now let’s review the common causes of cervical spine stenosis and their radiological features.
Cervical Spine Stenosis

- Epidemiology
  - Cervical spondylosis myelopathy (CSM) is the most common cause in adults > 55
  - 95% of adults >65 have spondylositic changes and 20% develop myelopathy
  - Frequent in high contact sports athletes

- Clinical Presentation
  - Predisposed to myelopathy as result of minor trauma
  - Initial sx:
    - Loss of hand dexterity/mild proximal lower extremity weakness
    - +/- neck, arm pain
  - Progression:
    - Progresses in up to 1/3 of patients (initial onset, period of stability, and deterioration to myelopathy)
    - + Babinski, Hoffman sign, clonus, ataxia, hyperreflexia
    - Spastic quadriparesis +/- Pain
  - +/- Radiculopathy

- Pathophysiology
  - CSM: Cord compression due to mechanical compression and degenerative instability
  - Aging -> intervertebral discs degeneration…
    - 1. Collapse and spur formation -> compression (C5-7)
    - 2. Joint instability with antero/retrolisthesis -> compression (C3-5) (often accompanied by ligamentum flavum hypertrophy)
  - Other Common Etiologies
    - Disk herniation, AVM, neoplasms, RA, DISH, TB spondylitis, Paget’s Disease, Metastatic Disease

Adams et al
**Companion Patient 1: CSM**

*Severe cervical spondylosis can manifest as a combination: osteophyte formation with spinal cord compression (blue), vertebral subluxation (yellow), and attempted auto-fusion (red).*

*Small volume CT reconstruction*

Large central osteophyte (black arrow) at the C3/C4 vertebral level, which narrows the anterior-posterior diameter of the cervical spine.

*Oblique 3-D CT reconstruction*

Right foraminal stenosis resulting from unilateral facet hypertrophy (black arrow).
Companion Pt. 2: Disk herniation

**T2 Sagittal**
Demonstrates multiple disk herniations from C3 to C7 (open arrows) that were most prominent at the junction of C4 and C5 (solid arrow).

*Ansari et al NEJM*
Sagittal T1/T2 MRI demonstrates marked spinal stenosis of the C1/C2 vertebral level cervical canal resulting from formation of the panus (red) surrounding the dens in a patient with rheumatoid arthritis. T2 MRI scans better define the effect of the panus (red) on the anterior cerebrospinal fluid space. Note the anterior displacement of the upper cervical cord and the lower brainstem.
Companion Pt. 4: Ependymoma

*Sagittal Post-gadolinium T1* There is an enhancing intramedullary cervical tumor with a caudal cyst.
Postgadolinium sagittal T1
Numerous enhancing veins posterior to the conus (arrows) to the cervical region.
Companion Pt. 6: Cervical Meningioma

**Sagittal and Coronal T2 weighted MRI** Soft tissue mass with increased signal in the upper cervical canal and compressing the cord.

http://myweb.lsbu.ac.uk/dirt/museum/margaret/342-3661m-2321340.jpg
Sagittal 3-D CT reconstruction Note the cavity within the central portion of the thoracic vertebral body (black arrow). The posterior margin of the vertebral endplate has begun to displace into the spinal canal (blue arrow), resulting in spinal canal stenosis.
Sagittal 3-D CT reconstruction
The central portions of the vertebral bodies have been replaced by the nonossified tumor (yellow). There is also spinal canal stenosis (blue).
Summary

- Cervical Spine Stenosis
  - Adults > 50
    - 40% have clinical sx (eg neck crepitus/pain restricted ROM)
    - Remaining asymptomatic individuals have radiographic evidence of cervical spine stenosis
  - Most common cause CSM

- Imaging
  - MRI is preferred modality due to its superior soft tissue depictions (spinal cord and surrounding soft tissues)
  - CT and CT myelography also helpful particularly with osseous abnormalities

- Patient Presentation and surveyed common causes of Cervical Spine Stenosis
References

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