Radiological Evaluation of the Traumatic Cervical Spine Injury

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C-Spine Trauma: Imaging Algorithm

**RADIOGRAPHS**
- Neck Pain, Swelling
- Neurologic Signs/Sx
- Intoxication
- Altered Mental Status
- Loss of Consciousness

**CT**
- No Fracture on Radiograph despite Sx
- Suspicious Radiograph

**MRI**
- Evidence of Vertebral Canal Encroachment
- Evidence of Ligament Damage
- Neurological Sx

**CT Myelogram**
- MR Contraindicated

**LARGE MEDICAL CENTERS**

**NO IMAGING** *
- No Midline Neck Pain
- Not Intoxicated
- Normal Alertness
- No Focal Neuro Findings
- No Major Distracting Injuries

**CNS Pathology**
- Evidence of Vertebral Canal Encroachment
- Evidence of Ligament Damage
- Neurological Sx

**Vascular Pathology**
- MRA
- Conventional Angio
- CTA

*NEXUS CRITERIA FOR C-SPINE RADIOGRAPHY: 99% sensitive, 12.9% specific*
Standard C-Spine Radiographs
Standard Radiographs: Lateral Anatomy

Cervical Vertebra

Normal C-Spine Lateral

Body
Articular Proc.
Spinous Proc.

http://www.emory.edu/ANATOMY/AnatomyManual/back.html
Standard Radiographs: Odontoid Anatomy

C1: Atlas

http://www.emory.edu/ANATOMY/AnatomyManual/back.html

C2: Axis

Normal Odontoid View

BIDMC PACS

http://www.emory.edu/ANATOMY/AnatomyManual/back.html
Patient History and Physical

Patient:
- 48 year old male

HPI:
- Pt fell approximately 10 ft from ladder
- Landed on the right side of his head
- Right arm numbness (minutes)
- Persistent neck/skull base pain.

PMH/FmHx/SoHx: Unremarkable

Physical Exam:
- Vitals: WNL
- General: Uncomfortable
- HEENT: Tenderness on the posterior aspect of the head and neck
- Lungs: CTA
- Cardiac: RRR S1/S2
- Abdomen: Soft, NTND, BS+
- Extremities: No C/C/E
- Back: No Point tenderness
- Neuro: Alert and Oriented x3, No focal findings, Sensorium intact
Imaging Algorithm: C-Spine Trauma

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- MRA
  - Encroachment of Foramen Transversarium
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* NEXUS CRITERIA: 99% sensitive, 12.9% specific
Pt’s Lateral Scout Radiograph

No Gross Atlanto-Occipital Disslocation

Normal Atlanto-dens interval

CT Scout Lateral View
Pt’s Lateral Scout Radiograph

- No Obvious Dens Fracture
- Loss of Cervical Lordosis

CT Scout Lateral View

PACS Images Courtesy of Dr. Teich
1. Basion-dens interval <12mm
2. Anterior Atlanto-dens interval <2mm
3. Prevertebral soft tissue <6mm at C2
4. Osteoarthritic Changes C5-C6
   - Decreased disc vertical disc space
   - Subchondral osteosclerosis
   - Osteophyte formation
   - Subchondral cyst

1. Lateral Atlanto-dens interval <2mm difference side-to-side
2. Fracture to the Right Anterior Mass/Transverse Process of C2
3. Osteoarthritic changes C5-C6
Pt’s CT Axial Views: Multiple Fractures

Midline Sag.

A B C D

BIDMC PACS

PACS Images Courtesy of Dr. Teich
Radiographic Findings: Summary

1. Comminuted displaced fracture of the right lateral mass of C2 with encroachment upon the right foramen transversarium.

2. Minor lateral displacement of dens is non-specific and may be normal, but ligamentous damage cannot be ruled out.

3. Comminuted fracture through the right lamina and pedicle of C6 with extension inferiorly through the transverse process of C7 (Transient Sx). No encroachment of CNS or vascular structures suspected.
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These findings are concerning for vertebral artery injury given the encroachment of the displaced fracture fragment upon the foramen transversarium.
Imaging Algorithm: C-Spine Trauma

Traumatic injury

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Vascular Pathology

MRA
Conventional Angio
CTA

CNS Pathology

MRA
Conventional Angio
CTA
Choosing an Angiographic Modality

First Ask…

What is the most likely Pathology?

1. Traumatic Dissection
2. Pseudoaneurysm
3. Arteriovenous Fistula

Then Ask…

Which imaging modality best illustrates this pathology?
Comparison Pt #1: Traumatic Dissection

Aneurysmal Dilatation Of the Left Vertebral Artery

Increased Caliber lumen with an Intimal Flap within the Left Vertebral Artery

Shin et al.
Comparison Pt #2: Pseudoaneurysm

Conventional Angiography

Saccular dilatation Of the Left vertebral artery

Bullet lodged in Cervical region Near aneurysm

Amirjamshidi et al.
Comparison Pt #3: Arteriovenous Fistula

Conventional Angiography

Right vertebral artery
Showing communication
With vertebral venous plexus

Increased contrast within the Vertebral venous plexus

Amirjamshidi et al.
## Angiographic Modalities

<table>
<thead>
<tr>
<th>Imaging</th>
<th>Contrast</th>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td><strong>Conv. Angio</strong></td>
<td>Highest sensitivity for Lumen Pathology</td>
<td>Iodinated</td>
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<tr>
<td></td>
<td>Poor wall/extravascular visualization</td>
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<tr>
<td><strong>MRA</strong></td>
<td>Highest sensitivity for extravascular and vessel wall</td>
<td>Gadolinium</td>
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<td></td>
<td>Dissections, Aneurysms, patency/stenosis</td>
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</tr>
<tr>
<td><strong>CTA</strong></td>
<td>Inferior sensitivity</td>
<td>Iodinated</td>
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<td></td>
<td>Readily available</td>
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There is continued controversy over which is the “Best” Study. Institutional Capabilities combine with the stability of the Pt at the time of imaging typically determine which modality is used.
Pt’s Vertebral Artery Pathology: MRA

1. Normal Left Vertebral
2. Hypoplastic Right Vertebral
3. Signal Loss Throughout V3
4. Resumption of Low Caliber Right Vertebral in V4
5. Normal Signal Throughout Circle of Willis (not shown)

Findings are suggestive of traumatic occlusion of a congenitally hypoplastic right vertebral artery

Vertebral Artery MIP

- V1
- V2
- V3
- V4
- C2

BIDMC PACS

PACS Images Courtesy of Dr. Teich
Vertebral Artery Pathology: Multimodality

Axial CT
- Compressed R Foramen Transversarium

MR Time of Flight
- Normal L Vertebral
- Absent R Vertebral

MR T1 Fat Suppression
- Normal L Vertebral Flow Void
- Increased T1 Signal

Findings suggestive of occlusion of right vertebral artery at the level of C2 fracture. T1 Fat suppression images suggestive of possible hematoma formation at this level.

PACS Images Courtesy of Dr. Teich
Case Summary

48 year old male s/p fall with persistent neck discomfort due to multiple stable fractures of the cervical spine. Asymptomatic occlusion of the right vertebral artery is of no immediate concern in the absence of dissection or aneurysm, but due to the evolving nature of such lesions continued monitoring will be necessary.

**CT:**
1. Multiple fractures to superior and inferior cervical spine with damage to the right foramen transversarium of C2.
2. No spinal cord impingement or nerve root damage
3. Possible Atlanto-Axial ligment instability

**MRA:**
1. Congenital hypoplasia of the right vertebral artery
2. Occlusion of right vertebral artery throughout V3 with adequate Circle of Willis collateral circulation
3. Possible hematoma at the level of C2 with no signs of dissection or aneurysm of the right vertebral artery at that level.

Plan: Home in neck brace for 3-4 weeks, return for reassessment of vascular and vertebral anatomy.
Acknowledgements

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References

Articles


Web Sources