Cervical Spine Imaging

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Overview

• Background
• Clinical Cases
• Diagnostic Tests and a Decision-Tree Algorithm
• Examples of Cervical Spine Evaluations
• Common C-spine fractures
• Summary
Cervical Spine Trauma

- 30,000 injuries to the spinal column every year in the US
- The majority of injuries are due to blunt trauma (motor vehicle accidents, falls, sports injuries, etc.)
- 2-3% of blunt trauma victims have cervical spine trauma
- 40-50% of spinal injuries produce a neurological deficit, often severe and sometimes fatal
- Costs of lifetime care and rehabilitation often exceed $1,000,000 per patient

Source: Bagley 2006
BIDMC Cases

www.legeros.com

• Patient ND – 39 year old female s/p MVA. Awake, alert, no neck pain.
• Patient TN – 32 year old male s/p MVA. Awake, alert, complains of neck pain.
• Patient WD – 84 year old man s/p fall down 10-12 stairs at home. Awake, alert, “cannot move my arms”.

What kind of neck injuries might these patients have?
Differential Diagnosis of Neck Pain s/p Trauma

- Cervical Spine Injuries
  - Cervical spine fracture
  - Spinal cord injury
  - Neck strain/Whiplash (ligaments, muscles, tendons)
- Epidural hematoma
- Vertebral Artery Dissection
- Atypical headache
- Acute on Chronic neck pain (OA, radiculopathy, spinal stenosis, etc.)

How would you evaluate for the presence of c-spine injuries?
Menu of Tests

Neck Trauma

- No imaging is necessary or mandated
- C-spine plain films
- C-spine CT
- C-spine MRI

What tests should be ordered and when?
Algorithm for C-spine imaging

**Neurological Status**

- Patient is A&O x 3
  - Neck Pain
    - No imaging necessary or mandated
  - + Neck Pain
- Patient has ΔMS, focal neurological deficit or extremity paresthesia

**Plain films**

- +/
- +/-

**CT** (significant plain film finding OR negative plain film finding but HIGH clinical suspicion)

**MRI** (ligamentous injury suspected)

Patient ND

39 year old female s/p MVA. Awake, alert, no neck pain.

Patient is A&O x 3
- Neck Pain
  No imaging necessary or mandated
+ Neck Pain
  Patient has ΔMS, focal neurological deficit or extremity paraesthesia

Plain films
+/-
CT (significant plain film finding OR negative plain film finding but HIGH clinical suspicion)
MRI (ligamentous injury suspected)

How about our second patient?
Patient TN

32 year old male s/p MVA. Awake, alert, complains of neck pain.

Patient is A&O x 3

- Neck Pain
  No imaging necessary or mandated (XXX study)

+ Neck Pain
  Plain films
    +/-
    CT (significant plain film finding OR negative plain film finding but HIGH clinical suspicion)
    MRI (ligamentous injury suspected)

Patient has ΔMS, focal neurological deficit or extremity paraesthesia

A 3 view c-spine plain film series is ordered
C-spine Anatomy: Atlas and Axis

How about the other cervical vertebrae?
C-spine Anatomy: 4th and 7th vertebrae

What holds the cervical vertebrae together?

Netter 1997

C4: superior view

C3-C5: anterior view
C-spine Anatomy: Cervical Spine Ligaments

**How is this anatomy imaged?**

*Netter 1997*

Atlantoaxial joint: superior view

Atlantooccipital junction: midline sagittal view
3 View Plain Film C-spine Series

How do you interpret these films?
Reading a Lateral C-spine Plain Film: 7 steps

- Quality Control
  - “See 7”. If can’t see C7, repeat the film with the shoulders lowered.
- Evaluate 5 parallel lines
  - Prevertebral Line
  - Anterior Vertebral Line
  - Posterior Vertebral Line
  - Spinolaminal Line
  - Posterior Spinous Line
- Inspect the Dens
  - Dens-C1 body space <2.5mm (<5mm)
- Check the atlanto-occipital alignment
- Check the bony landmarks
- Check disc spaces
- Check the soft tissue

What does TN’s lateral film look like?

TN’s Lateral C-spine Plain Film

What about the A/P film?

Non-displaced C1 fracture

www.trauma.org
normal

PACS, BIDMC, courtesy of Dr. Lai

TN
Reading an A/P C-spine Plain Film

What does TN’s A/P film look like?

- Quality Control
- Evaluate 3 parallel lines
  - Articular Pillar Line
  - Vertebral Body Line
  - Spinous Process Line
- Check the vertebral bodies
- Check disc spaces

TN’s A/P C-spine Plain Film

What about the open mouth film?

normal

TN

www.trauma.org

PACS, BIDMC, courtesy of Dr. Lai
Reading an Open Mouth C-spine Plain Film

- Quality Control
- Examine the alignment
  - Occipital condyles
  - Check the lateral dens space
  - Check the lateral tips of C1
- Check the bony landmarks

What does TN’s open mouth film look like?

TN’s Open Mouth C-spine Plain Film

What about our third patient?

normal

Lateral displacement of C1 masses aka “Jefferson Fracture”

PACS, BIDMC, courtesy of Dr. Lai
Patient WD

84 year old man s/p fall down 10-12 stairs at home. Awake, alert, "cannot move my arms".

- Neck Pain
  - No imaging necessary or mandated (XXX study)

+ Neck Pain
  - Patient has ΔMS, focal neurological deficit or extremity paraesthesia
  - Patient is A&O x 3

Plain films
  +/-
  - CT (significant plain film finding OR negative plain film finding but HIGH clinical suspicion)
  - MRI (ligamentous injury suspected)

CT and MRI c-spine studies are ordered
Patient WD: Sagittal CT

- Bone fragment
- Right of midline
- "Locked" facets
- Congenital block vertebrae
- Midline
- Osteophytes
- Anterolisthesis
- Left of midline
- "Perched" facets

PACS, BIDMC, courtesy of Drs. Sun and Zeikus
Patient WD: Axial CT

Is there ligamentous injury?

Normal facets

“Naked facet sign”
Patient WD: MRI

What about other common cervical spine fractures?

T2 weighted MRI

“Locked/Perched Facets w/ ligament damage”

STIR MRI

What about other common cervical spine fractures?

Hematomas

Ligament injury

PACS, BIDMC, courtesy of Drs. Sun and Zeikus
Hangman’s Fracture

Caused by a hyperextension injury

Fracture of posterior C2 elements

Displacement of C2 body

Source: Brant and Helms 2004
Clay Shoveler’s Fracture

Classically caused by shoveling sticky clay over shoulder

Fracture of C6 spinous process

Source: Brant and Helms 2004
Flexion-Teardrop Fracture

Caused by severe c-spine flexion

“Teardrop” fracture of an anterior vertebral body

Associated with spinal cord injury

Source: Brant and Helms 2004
Summary

• Significance of detecting cervical spine fractures
• Diagnostic Tests and a Decision-Tree Algorithm
• Clinical Examples of Cervical Spine Evaluations
• Common c-spine fractures: Jefferson, Locked/Perched Facets, Hangman’s, Clay Shoveler’s, Flexion-Teardrop
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References