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

www.discoverchiropractichawaii.com
BIDMC Cases

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

Patient has ΔMS, focal neurological deficit or extremity paresthesia
+ Neck Pain
  Plain films
    +/-
    CT (significant plain film finding OR negative plain film finding but HIGH clinical suspicion)
    +/-
    MRI (ligamentous injury suspected)

Back to our patients...

Patient ND

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

- 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

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)

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?
C-spine Anatomy: Cervical Spine Ligaments

How is this anatomy imaged?

Netter 1997

Atlantoaxial joint: superior view

Atlantooccipital junction: midline sagittal view

Netter 1997
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

normal

PACS, BIDMC, courtesy of Dr. Lai

www.trauma.org

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?
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?

What about our third patient?

Lateral displacement of C1 masses aka “Jefferson Fracture”
Patient WD

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

- **Patient is A&O x 3**
  - Neck Pain
  - No imaging necessary or mandated (XXX study)

- **Patient has ΔMS, focal neurological deficit or extremity paraesthesia**
  - + Neck Pain
  - CT (significant plain film finding OR negative plain film finding but HIGH clinical suspicion)
  - MRI (ligamentous injury suspected)

- **Plain films**
  - +/-

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

- Right of midline
- Midline
- Left of midline

- Bone fragment
- "Locked" facets
- Congenital block vertebrae
- Osteophytes
- Anterolisthesis
- "Perched" facets

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

Is there ligamentous injury?

Normal facets

“Naked facet sign”

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

T2 weighted MRI

“Locked/Perched Facets w/ ligament damage”

STIR MRI

What about other common cervical spine fractures?
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