Upper Cervical Spine Injuries

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Objectives

• Review Upper Cervical Spine injuries that can easily be overlooked!
  • Understand how to systematically review CT scans and MRI’s to avoid missing an upper cervical spine injury!

• Review Common injuries
  • Occipital Condyle
  • Occipital Cervical Dissociation
  • C1 Ring
  • Odontoid
  • Rotatory Subluxation Atlanto axial Injuries
  • Hangmans fracture

• Discuss anatomy and methods of surgical stabilization
Do Not Miss an Upper Cervical Spine Injury!
Do Not Miss an Upper Cervical Spine Injury!

• Complex bony and vascular anatomy
• Relationship of atlas and axis with cranial base
• Intrinsic stability that relies on ligaments and joint capsules
  • Can be missed on radiographic images
Do Not Miss an Upper Cervical Spine Injury?

• Severe ligamentous injury can be missed with patient in the supine position while they are getting images done.
  • Bony alignment can be maintained

• CT allows direct visualization of the AO and AA joints

• Harris Lines most clinically relevant
  • BDI ≤12
  • BAI ≤12
Do Not Miss an Upper Cervical Spine Injury?

• MRI useful for evaluation of upper cervical ligaments

Harris measurement
“rule of 12”

Powers Ratio
Basion to C1 arch / Opisthion to anterior C1 arch ratio >1 suggestive of atlanto occipital dislocation

Atlanto Dens Interval (should be <3mm)
Posterior Atlanto Dens Interval (should be >13mm)
Plain Radiograph
(Most patients already have a CT)

• Pre vertebral swelling
  • Soft Tissue shadow
    • <6mm at C2

• Atlanto – Occipital Joint Congruence

• Open Mouth AP
  • Distraction
  • C1-C2 symmetry
  • Rule of spence (>7mm offset combined over C2)
Common Injuries of the Upper Cervical Spine
Occipital Condyle Fracture

• Image Evaluation
  • Thin slice CT scan

• Anderson and Montesano
  • I. Comminuted
  • II. Basilar Skull Fracture
  • III. Avulsed

Axial load

Communicate with foramen magnum

Tension from alar ligament
Occipital Condyle Fracture

• Usually occur with other cervical spine injuries
• Commonly go undiagnosed
• Suspicion for injury with:
  • Retropharyngeal soft tissue swelling
  • Lower cranial nerve paresis (CN IX-XII)
    • CN XII most common
  • Occipital pain
Occipital Condyle Fracture

• Treatment
  • Dictated by ligamentous injury and craniocervical stability
  • May be necessary to evaluate with dynamic fluoroscopy
  • Instability considered with bilateral occipitoatlantoaxial joint complex injury
  • Type I - Type III injuries can treat non operative with external brace or with surgery.
    • Stability have to be evaluated
      • Instability considered when:
        • > 2mm widening or translation of Occipitoatlantal joint
        • Can evaluate with fluoroscopy
  • Surgery: Indicated for instability
    • Occiput to C2 PSF
Occipital Cervical Dissociation

• Rarely seen in patients that survive

• Associated injuries:
  • Submental lacerations
  • Mandible fractures
  • Posterior pharyngeal wall lacerations

• Thought to be twice as common in children

• 50% missed injury rate
  • 1/3 neurologic worsening
    • Davis et al, 1993

Occipital Condyle is displaced anteriorly on C1
Symptoms/Findings

- Lower Cranial Nerve deficits (V,IV,VII,XII)
- Horner’s syndrome
- Cerebellar ataxia
- Often associated with Wallenberg syndrome:
  - Involve occlusion of PICA
  - Nystagmus
  - CN X nerve palsy (dysphagia)
  - cerebellar ataxia
  - Ipsilateral Horner’s syndrome
  - Ipsilateral pain/temperature deficit over upper half of face
  - Contralateral pain/temperature deficit over body
  - Hiccups
Classification

• Harborview Classification:
  • I. MRI evidence of craniocervical osseousligamentous injury, <2mm displacement with traction test
  • II. MRI evidence of craniocervical osseousligamentous injury, > 2mm displacement with traction test
  • III. Craniocervical malalignment of >2mm on static radiograph

Bellabarba et al. Spine 2006
Occipital Cervical Dissociation

• Treatment
• Type I: Rigid Collar
• Type II and III: Occipital Cervical fusion to at least C2
C1 Ring

• Transition between cranium and C-Spine
  • Occiput –C1: 50% of cervical flexion and extension

• Anatomy
  • No body
  • 2 arches
    • Anterior
    • Posterior
      • Vertebral artery groove
  • Transverse atlantal ligament (TAL)
    • Constrains the posterior Dens to the anterior atlas arch

• Look for other injuries in cervical spine
  • 43% associated with C2 fracture
C1 Ring

• Classification
  • Morphologic
  • Levine and Edwards
    • Transverse process
    • Posterior arch
    • Lateral mass
    • Anterior arch
    • Burst
      • “Jefferson type”

• Transverse Process fracture: Stable
  watch for forament involvement
• Posterior arch: Stable
  (hyperextension)
• Anterior arch: “blowout” unstable
• Comminuted or Unilateral split type: Unstable
• Burst fracture: lateral displacement of lateral mass (concern for transverse ligament disruption-determines stability)
C 1 Ring

• Image
  • Open mouth odontoid view
  • Congruence of C1 on C2
    • Lateral displacement of C1
    • 7mm rule of Spence
      • Concern for transverse ligament
  • Evaluate with CT
  • >6.9mm
    • Spence et al. JBJS 1970
C1 Ring Treatment

• Most isolated minimally displaced C1 injuries can be treated in cervical collar 3 months

• Displaced can be reduced and placed in halo for 3 months

• If associated with C2 can treat with C1-C2 fusion
  • If associated with atlantoaxial dissociation, consider Occiput to C2 fusion

• Unstable: consider surgical stabilization

• Halo falling out of favor for collar

C1 lateral mass displacement treated with C1 stabilization with C1 lateral mass screws and rod construct
C2

• Fractures of the Axis (C2) make up 27% of cervical injuries
  • Odontoid make up 41% of C2 fractures
    • Bimodal distribution
      • Young – high energy, multi-trauma
      • Elderly – Low energy, isolated injury
        • Most common C-spine fracture of elderly
C2

• Anatomy
  • Dens extends cranially from the axis to form a synovial articulation with posterior aspect of anterior atlas
    • Embryological C1 body
    • Base has watershed zone (poorly vascularized)
  • Flat C1-C2 joints: rotation
  • Vertebral artery foramen
    • Inferomedial to superolateral
Odontoid

• Anderson and D’Alonzo Classification:
  • Type I: located above the waist; consistent with an avulsion of alar ligament
  • Type II: located in the waist; covered by transverse ligament
  • IIa: (Hadley) segmentally comminuted at base of odontoid extending into the body
  • Type III: extend into the vertebral body
Odontoid

• Treatment
  • Type 1
    • C collar
    • Beware of unrecognized craniocervical dissociation

• Type 3
  • C collar (10-15% nonunion)
  • SOMI brace
  • Halo vest
Odontoid

- Type 2
  - C Collar
  - SOMI/Minerva
  - Halo vest
  - Odontoid screw
  - C1-2 PSF
- Halo treatment is avoided in elderly patients
- Halo option for younger patient to avoid surgery
- Hard collars reserved for nondisplaced fractures or displaced fractures in elderly patients that will not tolerate surgery
  - may get painless fibrous nonunion
Risk Factors for nonunion in type II odontoid fractures

- Secondary to watershed blood supply
- Higher ratio of cortical to cancellous bone
- Displacement >6mm (associated with > 50% nonunion rate)
- Age > 50 years old
- Fracture comminution
- Angulation >10 degrees
- Treatment delay >4 days
- Smoker

Koivikko et al. JBJS Br 2004
Anterior Odontoid screw

- **Indications:**
  - Displaced type II and shallow type III
  - Polytrauma
  - Unable to tolerate halo-vest
  - Early displacement despite Halo
  - Reduces in extension

- **Contraindications:**
  - Non-reducible
  - Reduces in flexion
  - Barrel Chest
  - Associated TAL injury
  - Subacute injury (>6 months)
  - Reverse obliquity
  - Elderly
  - Severely displaced or comminuted fractures

Anterior Odontoid screw

• Advantages:
  • Direct fracture osteosynthesis
  • Maintenance of C1-C2 motion
  • Minimal EBL
  • Decreased wound issues vs. posterior approach
  • More useful for young patients

• Disadvantages:
  • Require favorable patient anatomy
  • Must not have:
    • Barrel chest
    • Congenital cervical fusion
    • Thoracic kyphosis
    • Cervical kyphosis
    • Reverse obliquity/comminution
    • Irreducible fracture
  • Require intact transverse ligament
  • Higher incidence of dysphagia in elderly
  • Higher failure rate in osteoporotic bone
Treatment C2 Dens Fracture C1-C3 PSF

C1 lateral Mass screw

C2 Pars screw
Treatment of Dens fracture with C1 lateral mass, C2 trans-laminar (no room for pedicle screw because of large transverse foramen)

Study anatomy on CT prior to surgery!
Rotatory Subluxation
Atlantoaxial Injuries

• Anatomy
  • AA articulation stability provided by ligamentous restraint
  • AA joint provide primarily rotatory motion

• Most common in pediatric population

• Evaluate with patient history and use of rotatory CT
Rotatory Subluxation

• Three patterns:
  • Category A: rotationally displaced in the axial plane
  • Category B: translationally unstable in a sagittal plane because of injury to transverse atlantal ligament
  • Category C: multiplanar vertical atlantoaxial dissociation

Field and Hawkins
• Type I. Rotation without translation
• Type II. Unilateral lateral mass subluxation 3-5 MM
• Type III. Unilateral subluxation >5 mm
• Type IV. Posterior displacement of C1-2
Rotatory Subluxation

- Treatment
  - Halo
  - Lateral facetectomy, reduction, fusion
  - Transoral facetectomy, reduction, fusion

Fielding and Hawkins JBJS 1977
Traumatic Spondylolisthesis of the Axis
Hangman’s Fracture

• Fracture through the pars interarticularis

• Second most common axis fracture (odontoid #1)

• Result of hyperextension and axial load

• Neurologic injury is rare unless injury causes narrowing of spinal canal
Hangman’s Fracture

- Classification:
  - I. Minimally displaced
    - < 3mm translation
  - IA. Atypical
    - Oblique thru pars on one side
    - Anterior to pars thru body on other side
  - II. > 3mm translation
  - IIA. Kyphosis > translation
    - C2-C3 disk involved
    - PLL involved
  - III. Associated with dislocation of C2-C3 facet
Hangman’s Fracture

• Treatment
  • Type I and Ia: treat in cervical collar for 12 weeks
  • Type II: Halo for 12 weeks
  • Type IIa: ACDF C2/3 or posterior fixation
    • C2/3 acdf spares C1/2 motion segment
    • Posterior fixation
    • C1-C3
    • Directly treat pars fracture with reduction and Lag technique
  • Type III: posterior reduction and PSF
Conclusion

- Do not miss an upper cervical spine injury
  - Critically evaluate imaging and patient
- Be aware of patient's anatomy when choosing treatment option
  - Which type of technique to use
- Many upper cervical spine injuries can be managed nonoperatively
  - Do not miss the unstable ones!