Upper Cervical Spine Injuries

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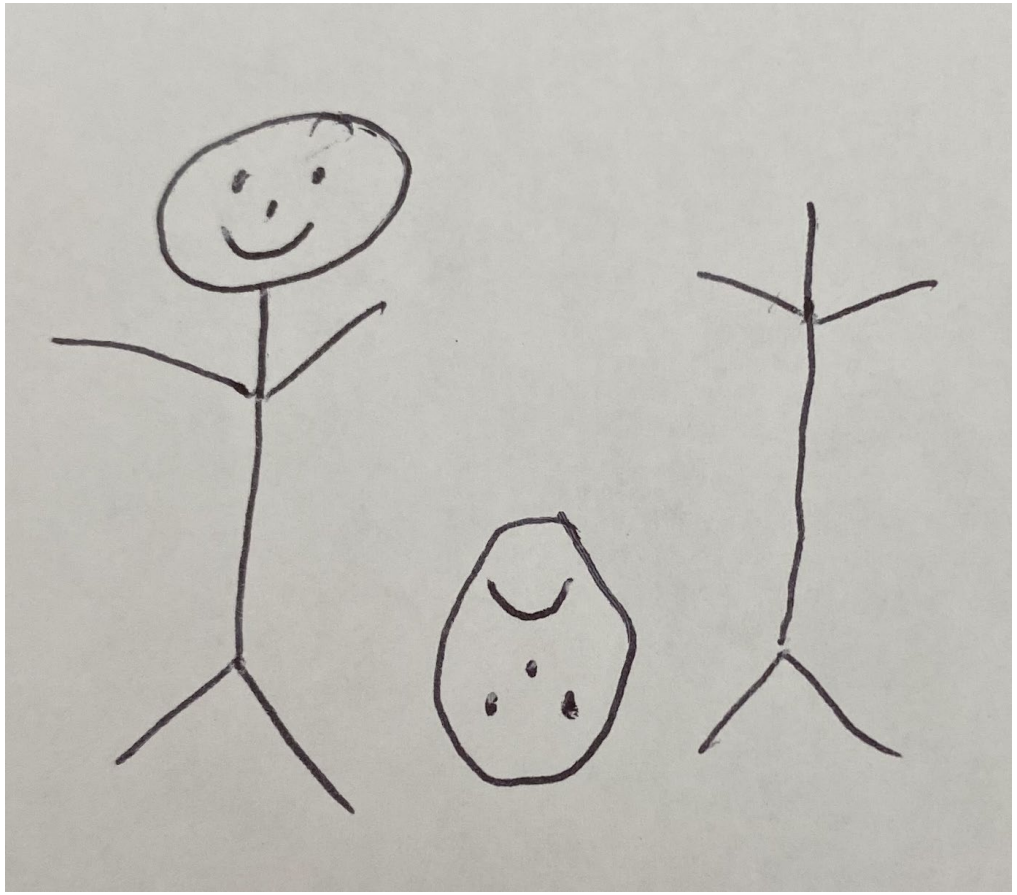
Objectives

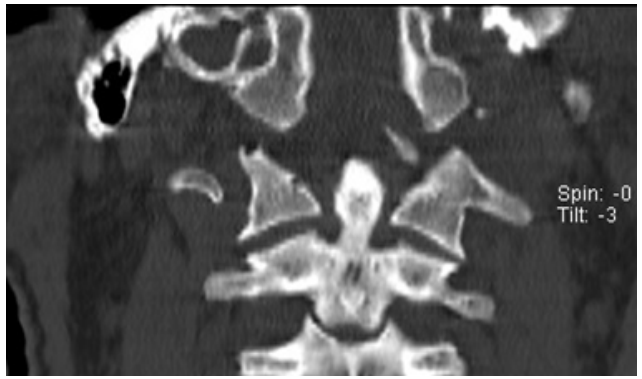
- Review Upper Cervical Spine injuries that can easily be overlooked!
  - Understand how to systematically review CT scans and MRI's to avoid missing an upper cervical spine injury!
- Review Common injuries
  - Occipital Condyle
  - Occipital Cervical Dissociation
  - C1 Ring
  - Odontoid
  - Rotatory 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



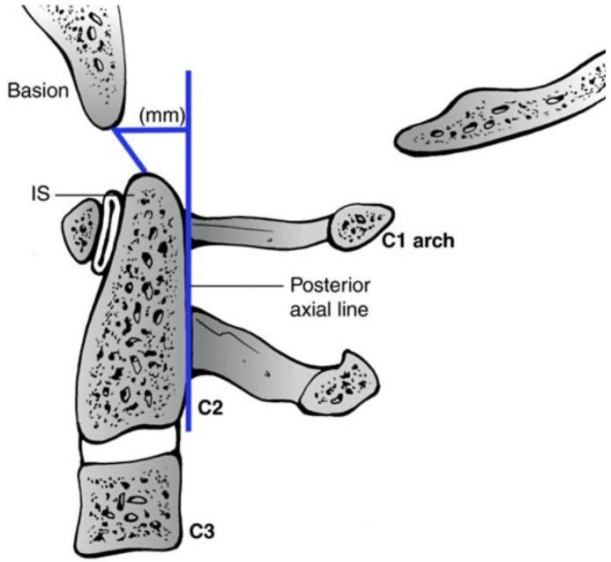
Do Not Miss an Upper Cervical Spine Injury?

- 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

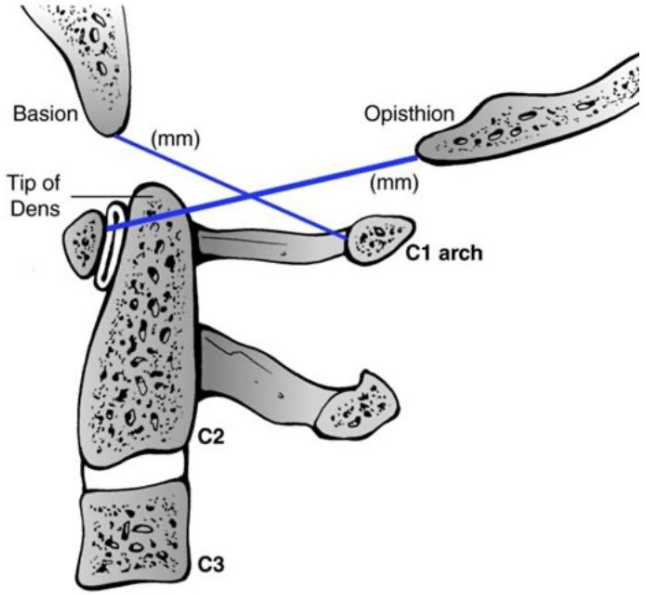
BDI: Basion Dens Interval
BAI: Basion Axial interval

Do Not Miss an Upper Cervical Spine Injury?

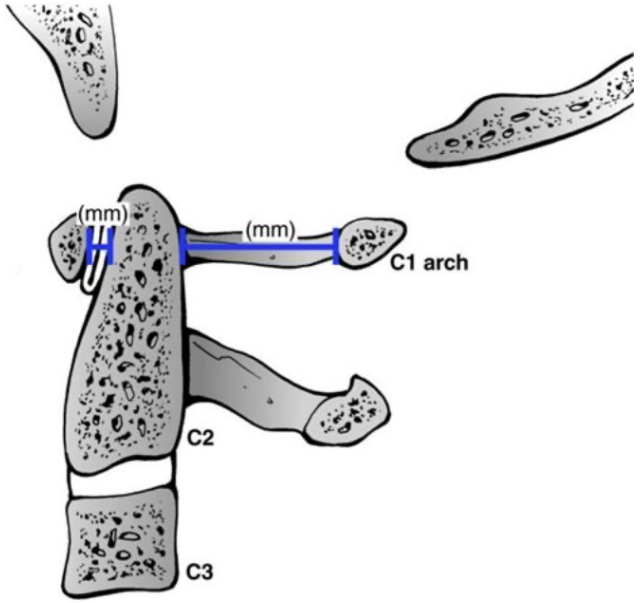
- MRI useful for evaluation of upper cervical ligaments



Harris measurement
"rule of 12"



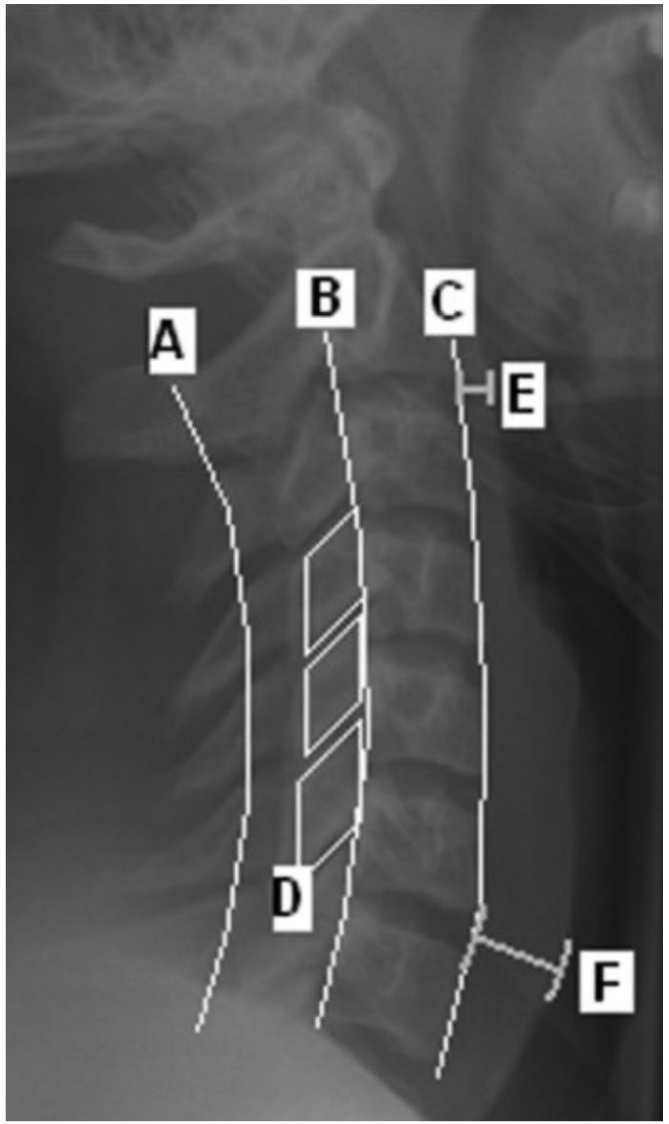
Powers Ratio
Basion to C1 arch / Opisthion to anterior C1 arch
ratio >1 suggestive of atlanto occipital dislocation



Atlanto Dens Interval (should be <3mm)
Posterior Atlanto Dens Interval (should be >13mm)

Plain Radiograph
(Most patients already have a CT)

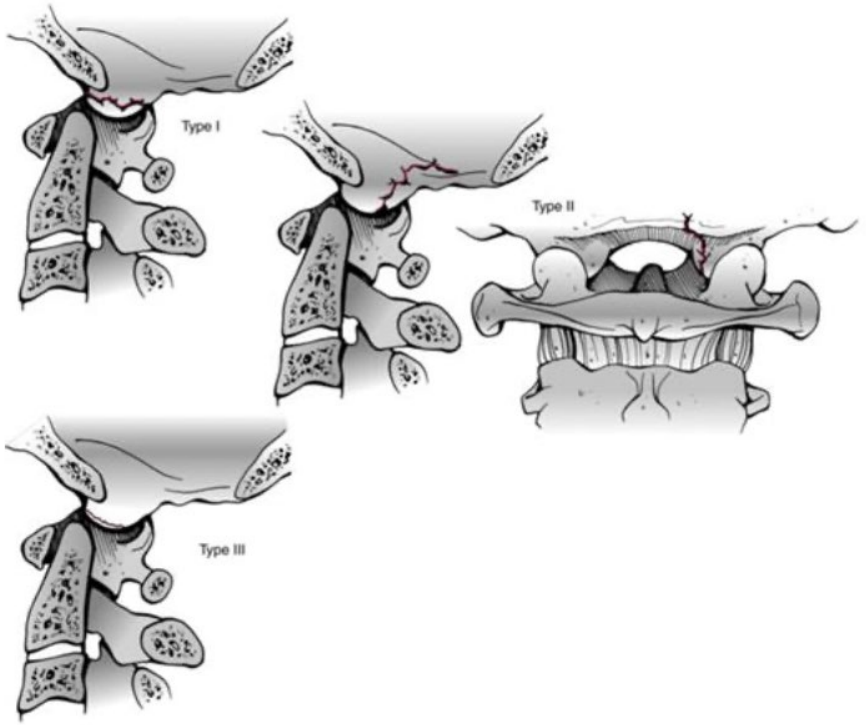
- Pre vertebral swelling
  - Soft Tissue shadow
    - <6mm at C2
- Atlanto – Occipital Joint Congruence
- Open Mouth AP
  - Distraction
  - C1-C2 symmetry
  - Rule of spence (>7mm offset combined over C2)



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



I	II	III
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

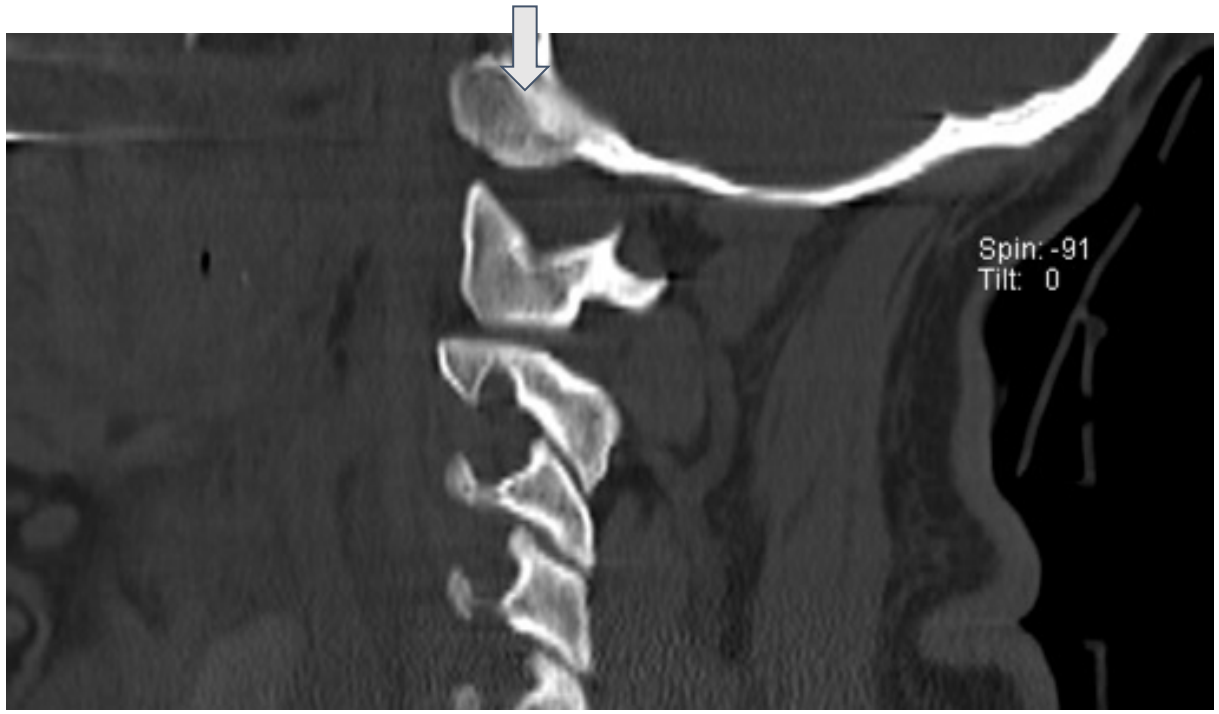
Occipital Condyle Fracture

- 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

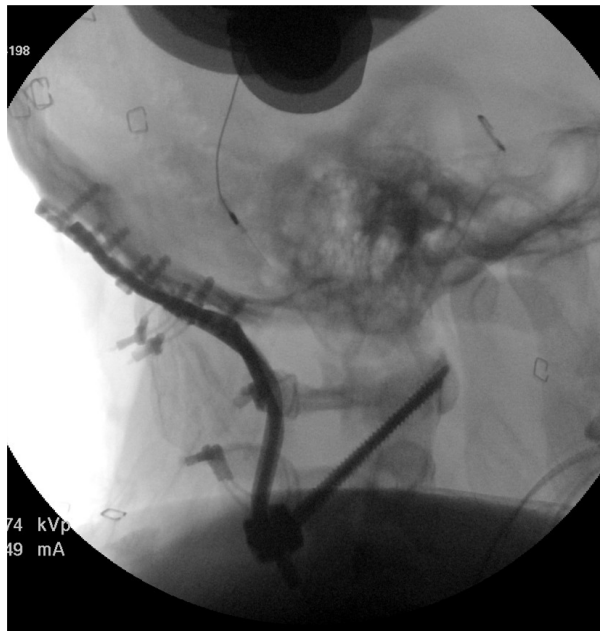
- Harborview Classification:
  - I. MRI evidence of craniocervical osseousligamentous injury, <2mm displacement with traction test
  - II. MRI evidence of craniocervical osseousligamentous injury, > 2mm displacement with traction test
  - III. Craniocervical malalignment of >2mm on static radiograph

Type 1 injury: ligamentous disruption without displacement

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”

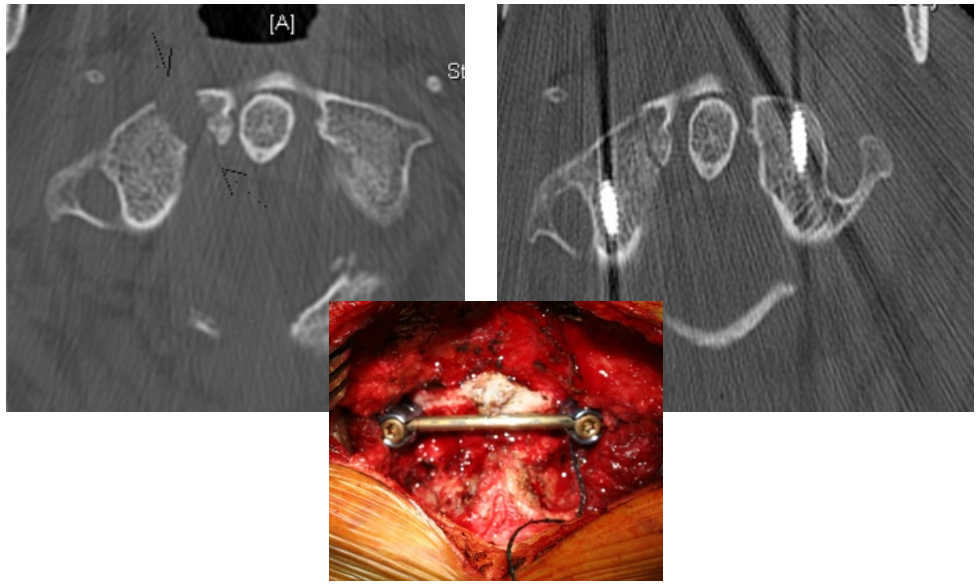
- Transverse Process fracture: Stable watch for forament involvement
- Posterior arch: Stable (hyperextension)
- Anterior arch: “blowout” unstable
- Comminuted or Unilateral split type: Unstable
- Burst fracture: lateral displacement of lateral mass (concern for transverse ligament disruption- determines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

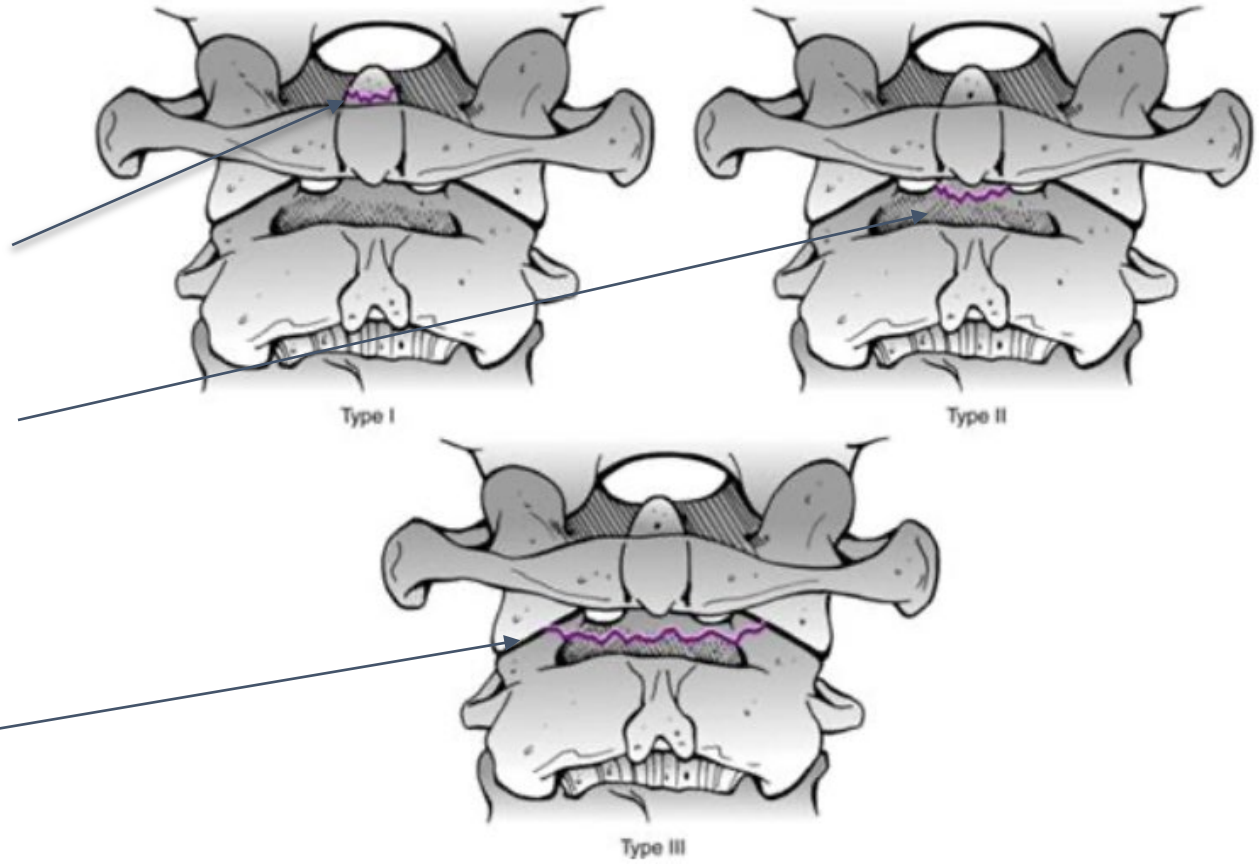
- Fractures of the Axis (C2) make up 27% of cervical injuries
  - Odontoid make up 41% of C2 fractures
    - Bimodal distribution
      - Young – high energy, multi-trauma
      - Elderly – Low energy, isolated injury
        - Most common C-spine fracture of elderly

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

France JC, Bono CM, Vaccaro AR. Initial radiographic evaluation of the spine after trauma: When, what, where and how to image the acutely traumatized spine. Jorthop trauma. 2005;19:640-9.

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

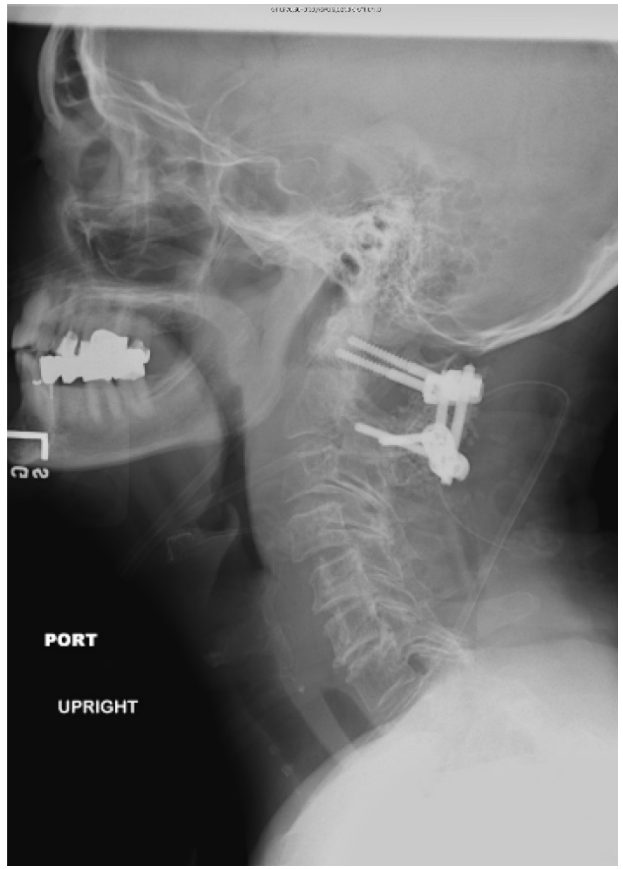
Treatment C2 Dens Fracture C1-C3 PSF

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

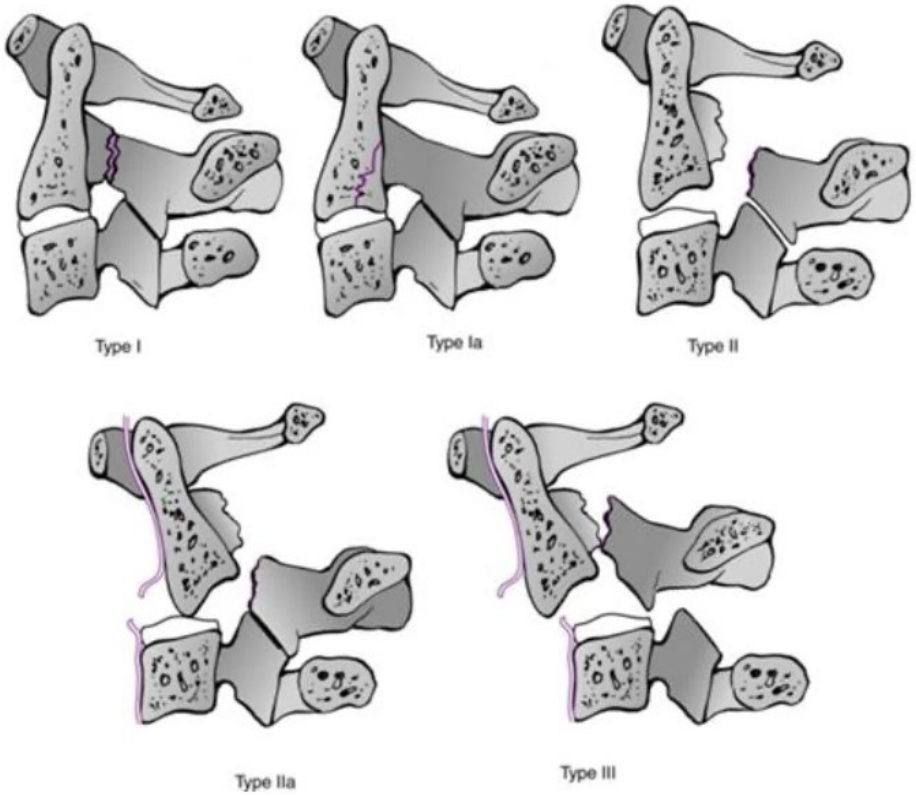
Fielding and Hawkins JBJS 1977

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!