

Surgical Treatment for Cervical Spine Fracture

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Outline

- *Introduction*
- *Anatomy*
- *C1 / C2 fracture*
 - Jefferson,
 - Hangman's,
 - odontoid
- *Subaxial fracture*
 - jumped facet,
 - tear drop
- *Special topic* (clearing C spine, steroid)

Rule #1

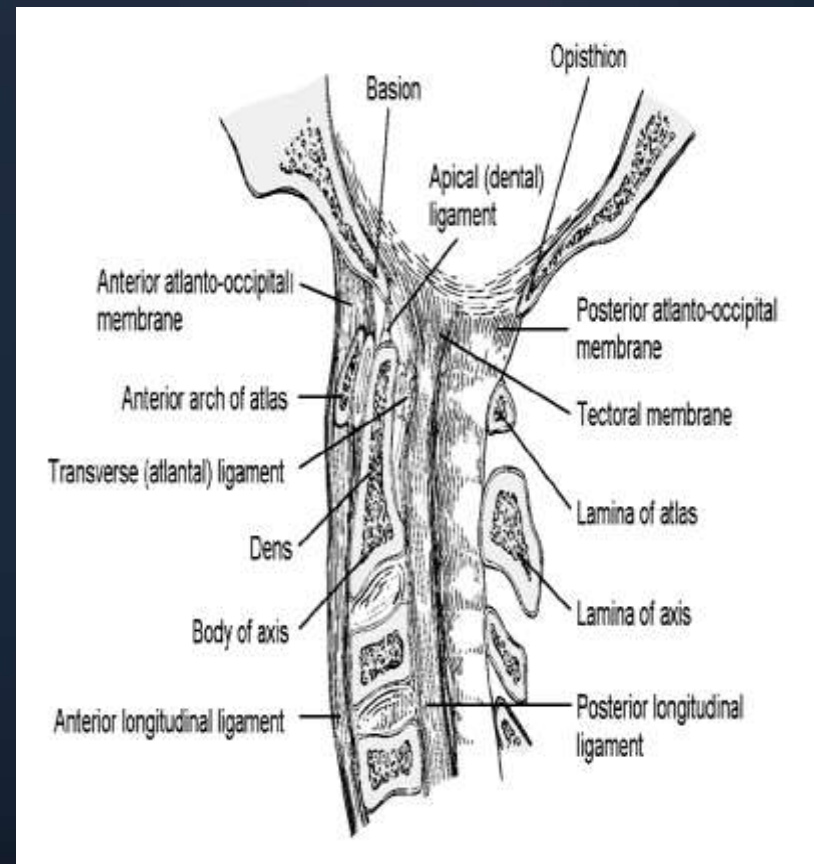
- Don't miss a injury
- Non-contiguous fX = 16%
- 2007 Lekovic et al.
 - 20 cases of missed or delay diagnosis C spine injury
 - Avg 2.9 million \$.
 - None due to test ordered that's miss read



Anatomy

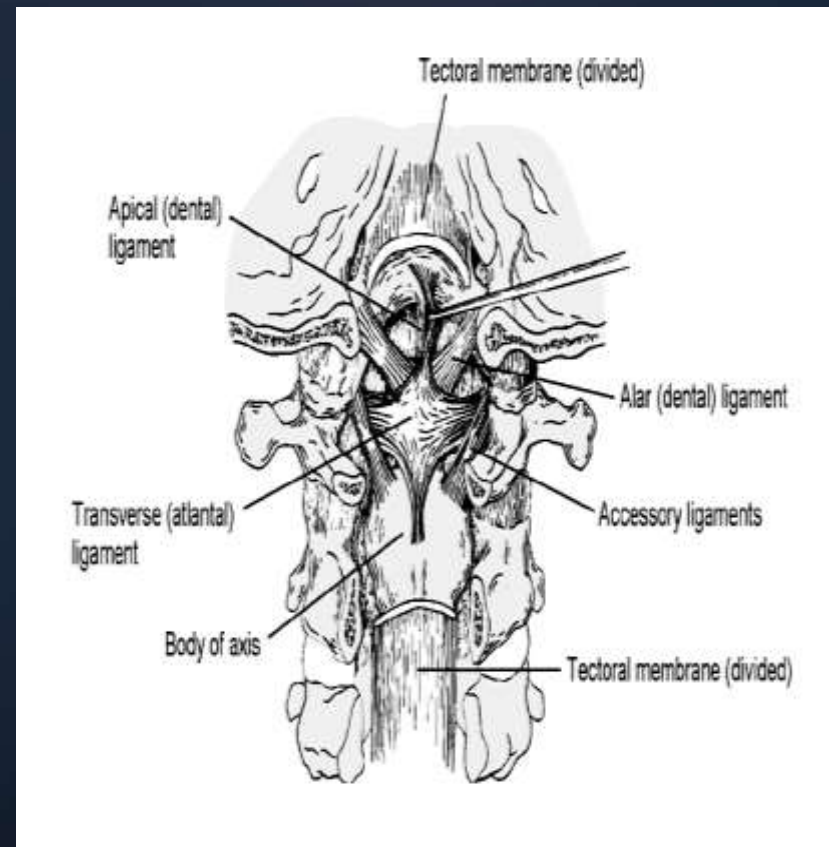
5 layers of ligament

- Anterior atlanto-occipital membrane
- Posterior atlanto-occipital membrane
- Occipitoatlantoaxial complex
 - Apical/alar ligaments
 - Cruciform ligaments
 - Tectoral membrane



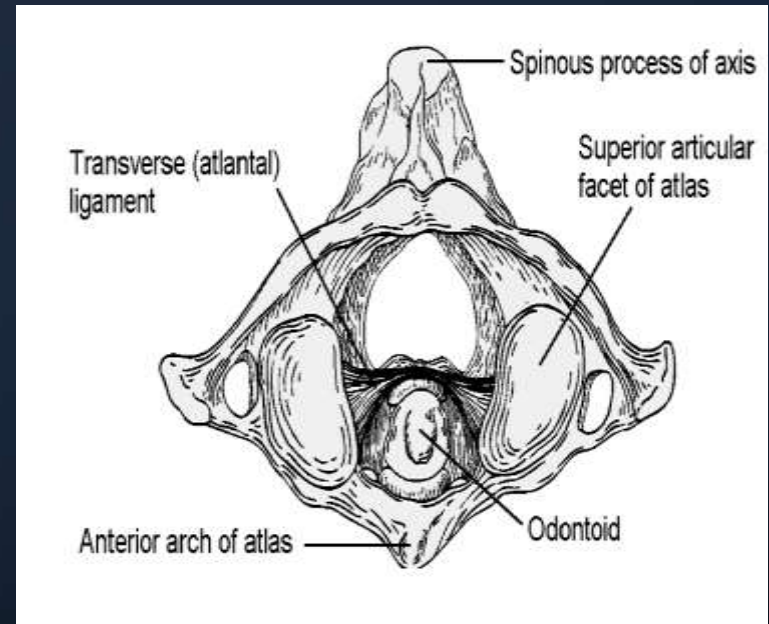
Anatomy

- Posterior occipitoatlantoaxial ligament complex
 - Tectorial membrane(PLL)
 - Cruciform ligament
 - Transverse ligament
 - Longitudinal fasciculi
 - Alar & Apical ligaments
- Alar ligaments
 - 2 portions
 - Primary to axial rotation/side bending



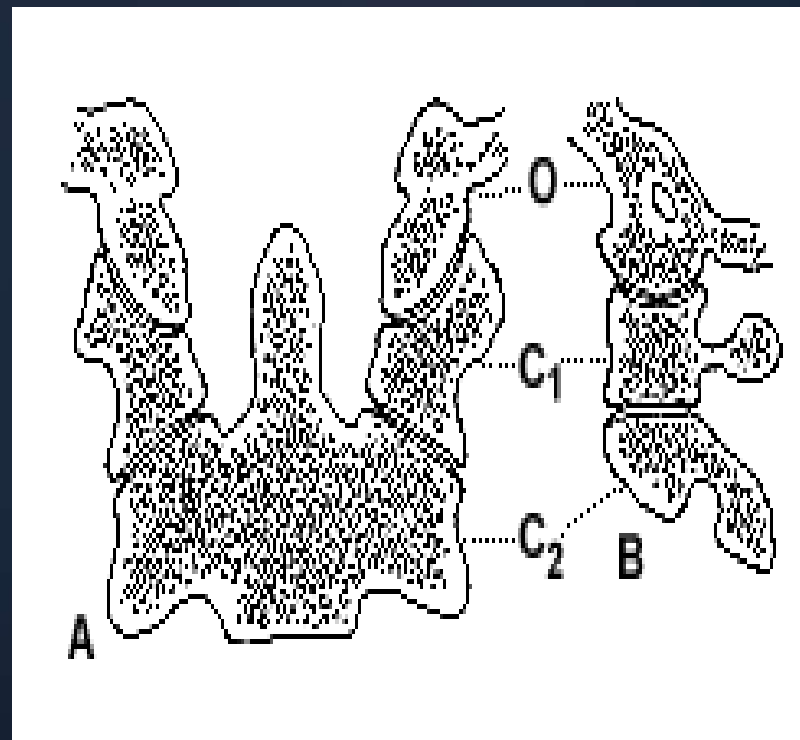
Anatomy

- *Steel's rule of thirds*
 - Internal diameter of the ring of C1 is 3 cm
 - $1/3 =$ odontoid
 - $1/3 =$ cord
 - $1/3 =$ space (compressible soft tissue)



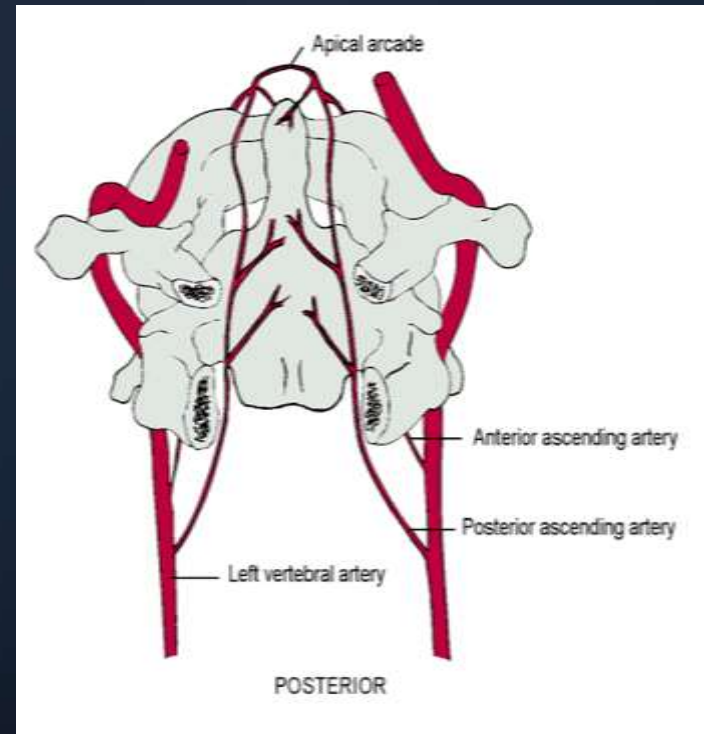
Anatomy

- C1-C2 = 50% of total axial rotation of cervical spine
- Occip – C1 = 50% of Cervical Flex/ext.
 - (20-30 deg. Of “nodding”)



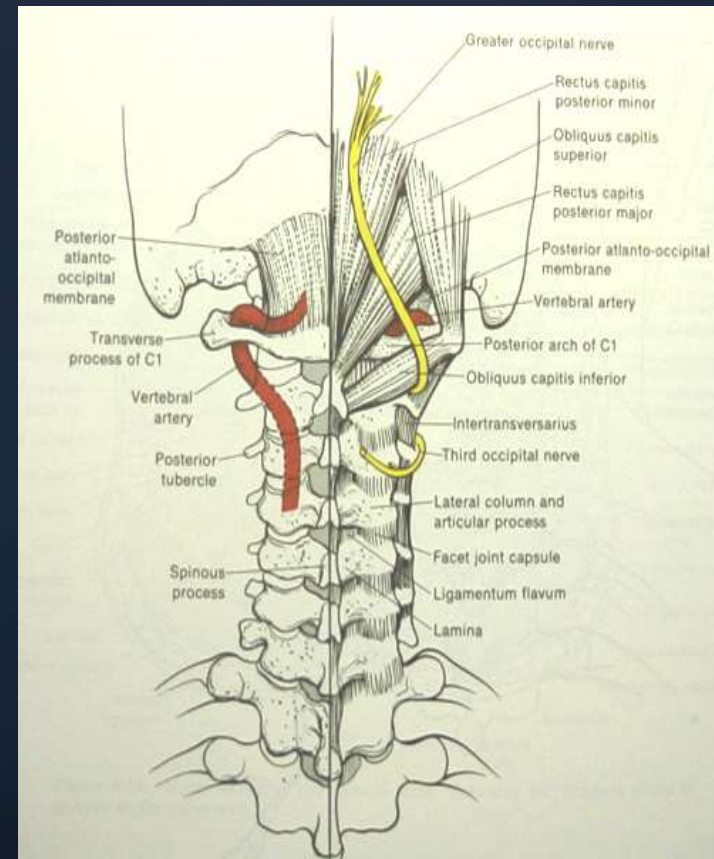
Anatomy

- Blood supply:
 - Vertebral A.
 - Carotid A.
 - Ascending A. penetrate C2 at base of dens.
- Dens is mostly surrounded by synovial cavity
- Soft tissue interposition



Anatomy

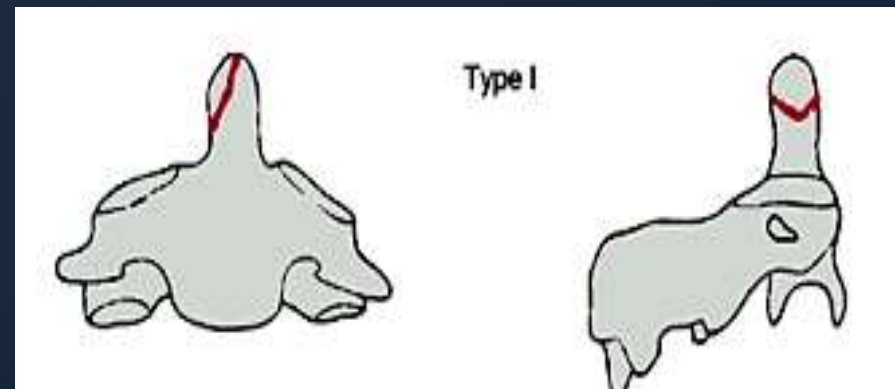
- Vertebral Artery
 - Safe zone (1.5 cm from midline)
- Greater occipital Nerve
 - Posterior rami of C2
 - Sensation to skin at the back of scalp



Odontoid Fractures Classification

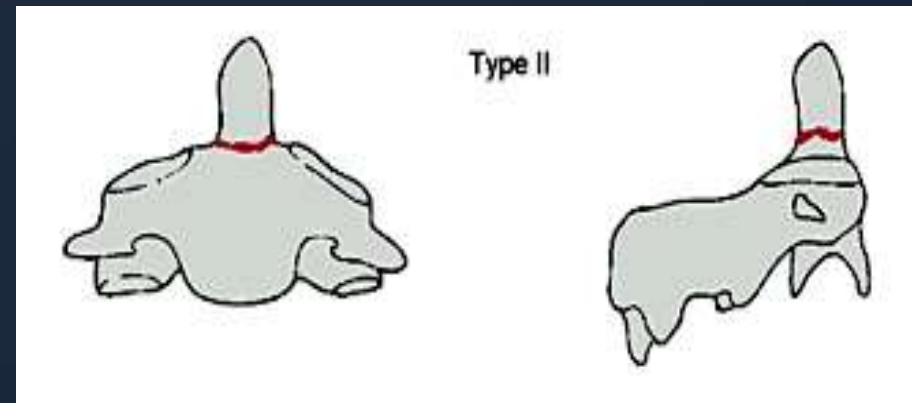
Anderson & D'Alonzo

- Type I (5%)
 - Fx. Cephalad to transverse ligament.
 - Avulsion of tip via apical and alar ligaments
 - Rule out craniocervical distraction.
 - Usually stable.
 - symptomatic treatment.



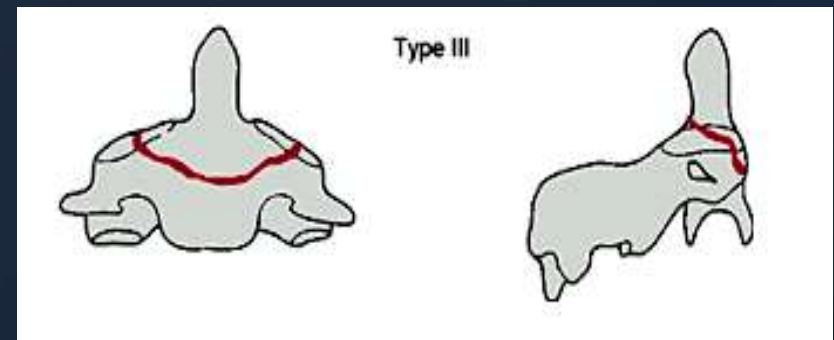
Odontoid Fractures Classification

- Type II (60%)
 - Fx. Through the base of odontoid
 - Nonunion Rate 32% (11–100%)
 - Displacement
 - > 4 to 5 mm
 - >10 deg of angulations
 - Delay diagnosis > 2wks
 - Intolerant of halo
 - >40 year old
 - Polytrauma
 - Head/cord injury



Odontoid Fractures Classification

- Type III (30%)
 - Fx. through the body of C2
 - Nonunion rate (0 – 15%)
 - Mech: suggest flexion
 - Reduction followed by halo vest



Treatment of Type II Odontoid Fractures

- *Stable = Halo vest*
 - Displacement < 4mm, 10 deg.
 - Age < 40 year old
 - Injury recognition < 2 weeks.
- *Unstable = primary surgical stabilization*
 - Displacement > 4mm, 10 deg.
 - Delay diagnosis > 2wks.
 - Intolerant of halo
 - Older, polytrauma, head/cord injury.
 - Irreducible C1-2 fx. dislocation.

Surgical Treatment of Type II odontoid Fractures

Direct anterior screw fixation

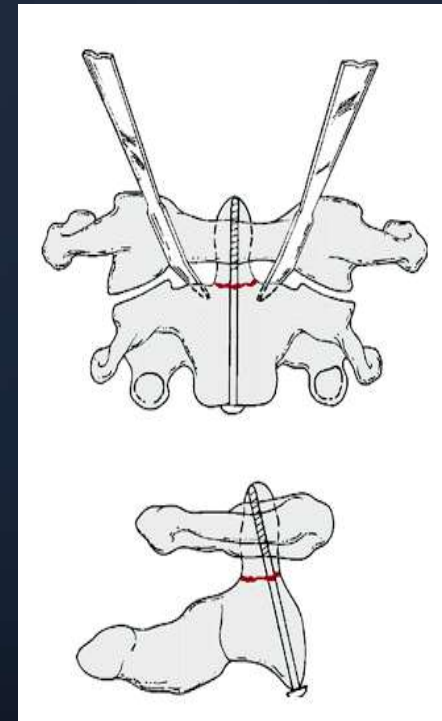
- Acute transverse fx.
(no comminution /
oblique coronal
pattern)
- Reducible with closed
reduction
- Chest wall/neck size
proportionate
- Bone density adequate

Posterior C1-2 fusion

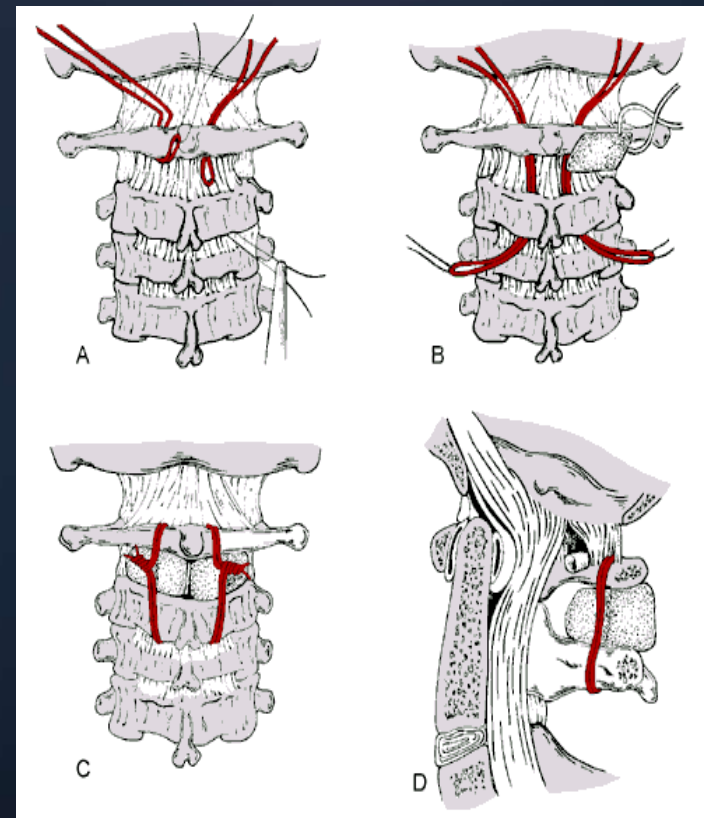
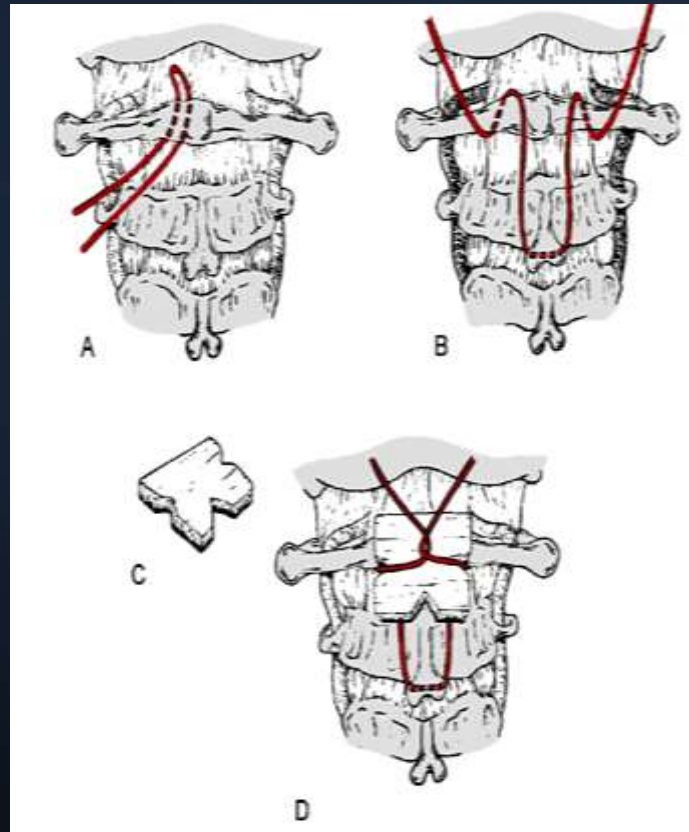
- Fx. Comminution /
oblique coronal pattern
- Irreducible odontoid
fx.
- Irreducible C1-2 fx
dislocation

Anterior Odontoid Screw

- *Advantages:*
 - Preservation C1-2 motion (50% rotation)
 - Early post op stability
- *Disadvantages:*
 - Significant learning curve
 - Complication

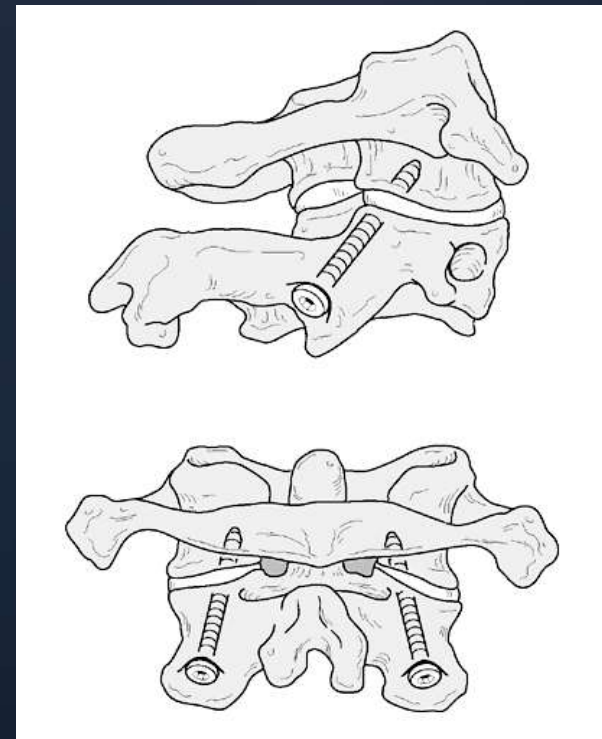


Posterior C1-2 Fusion



Transarticular C1-2 screws

- Unstable Jefferson Fracture
- Poor halo vest tolerance
- Polytrauma
- Elderly, debilitated



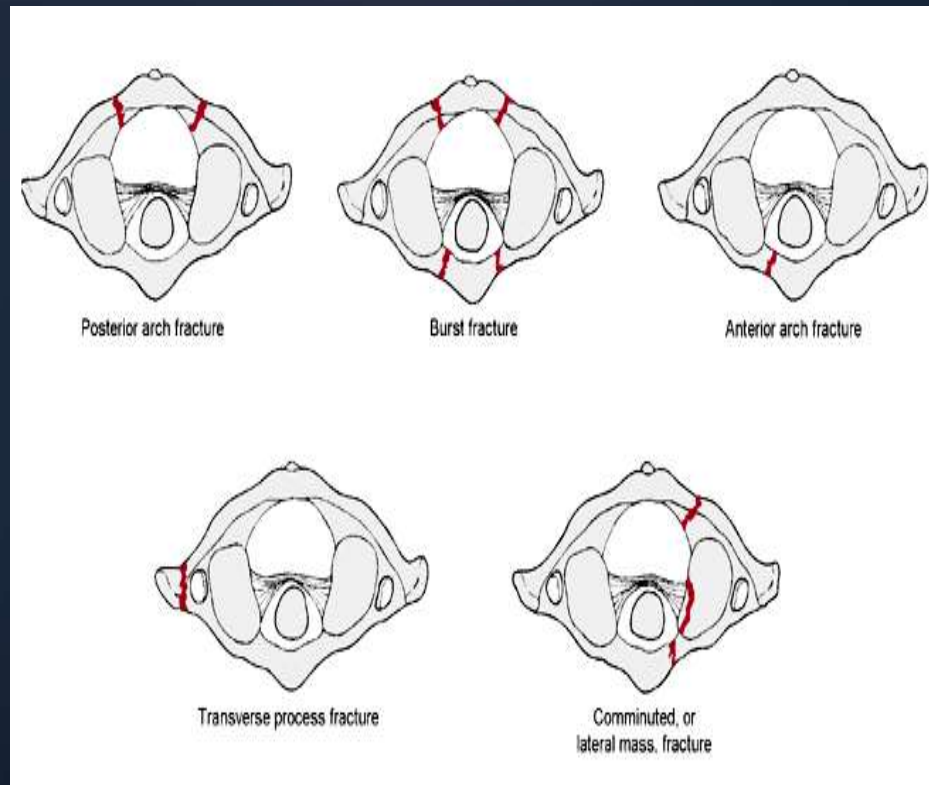
Atlas Fractures

- 10% of all cervical spine injuries.
- 48% has additional fractures in the C-spine
 - #1 Dens fractures.
 - #2 Traumatic spondylolisthesis C2
 - #3 Lower cervical fractures.
- Mechanism – axial loading (MVA, diving)

Atlas Fractures

Classification

1. Posterior arch .
2. Burst(Jefferson) .
3. Anterior Arch .
4. Transverse process.
5. Lateral Mass



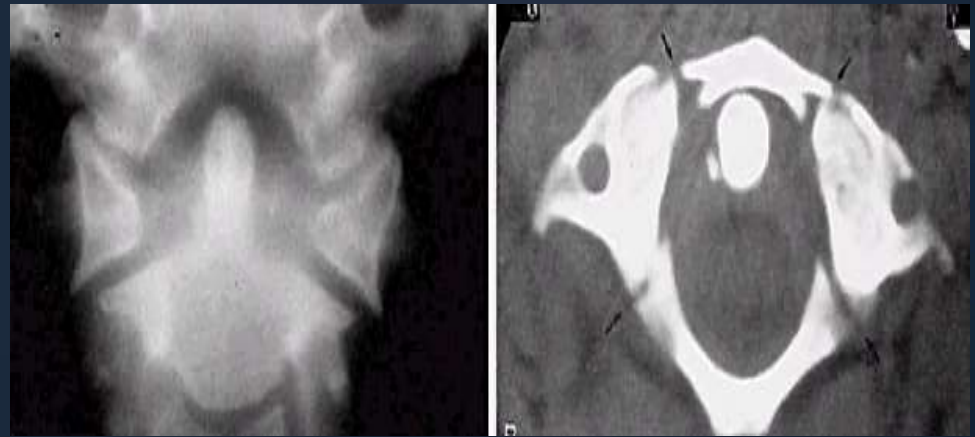
Posterior Arch Fracture

- Location – junction of lateral mass & post.arch.(thinnest bone)
- Incident – 28%
- Mech – hyperextension
- Association – odontoid and hangman's fx.



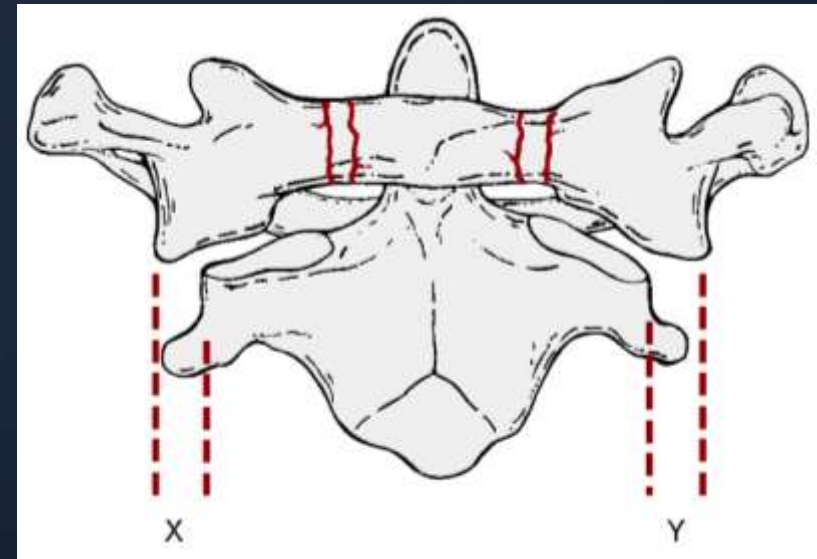
Burst Fracture (Jefferson's)

- Incident – Most common (33%)
- 3 or 4 part fx.
- Least neurologic injury.



Burst Fracture

- $(X + Y) > 6.9$ mm =
Disruption of
Transverse ligament.
- Accessory ligaments
spared
 - Apical/alar ligm.
 - Facet capsule
 - Ant/post long. Ligm.



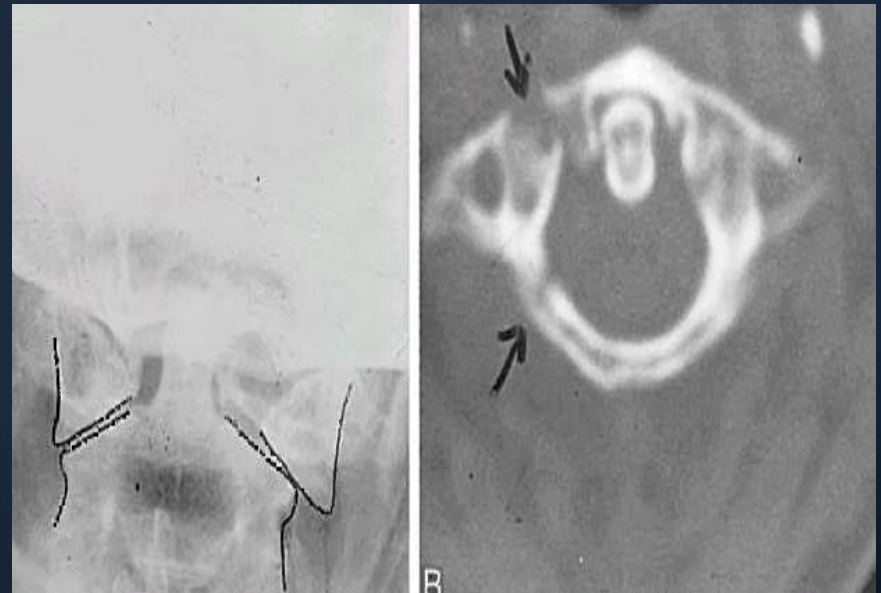
Anterior Arch Fracture

- Mech: In hyperextension injury, Longus colli avulse off the inferior portion of anterior tubercle of C1.
- Stable fracture.



Lateral Mass Fracture

- **Mech**: axial loading + lateral compression
- **2 part Fx**: ant & post to lateral mass on one side.
- **3 part fx**: 3rd fx line on contralateral post arch.
- **X-ray**: asymmetrical lateral mass displacement



Treatment-Posterior arch fx.

- Isolated posterior arch fx. :
 - collar
- Post arch fx. + type I “hangman’s fx”
 - collar
- Post arch fx. + type II dens fx. :
 - Reduction by traction then halo vest
 - Anterior dens screw + collar
 - C1-2 arthrodesis with Transarticular screw
 - Halo then delayed standard C1-2 fusion

Treatment – Jefferson & lateral Mass fractures

- *Nondisplaced:*
 - Collar or halo
- *Displacement < 7 mm:*
 - Halo
- *Displacement > 7 mm*
 1. Axial traction (6 weeks), reduction confirmed by open mouth view.
 2. Halo vest (6weeks)
 3. Flex/Ext view end of 3 month
- Immediate C1-2 fusion
 1. reduction via traction
 2. Transarticular screws

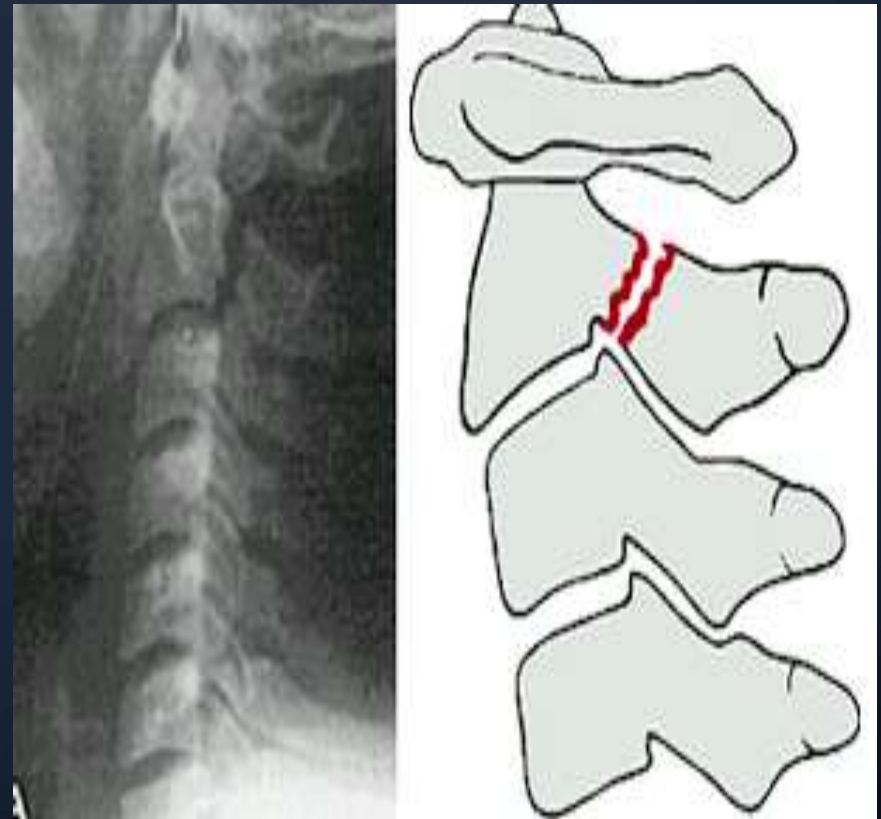
Treatment: Combined Injuries

Jefferson/lateral mass + others

- Stable Jefferson + stable dens
 - Halo vest
- Stable Jefferson + “unstable dens”
 - Anterior dens screw with halo vest?
 - Halo then delayed C12 fusion?
- Unstable Jefferson + “unstable dens”
 - Halo traction?
 - C1-2 fusion with Transarticular screws?

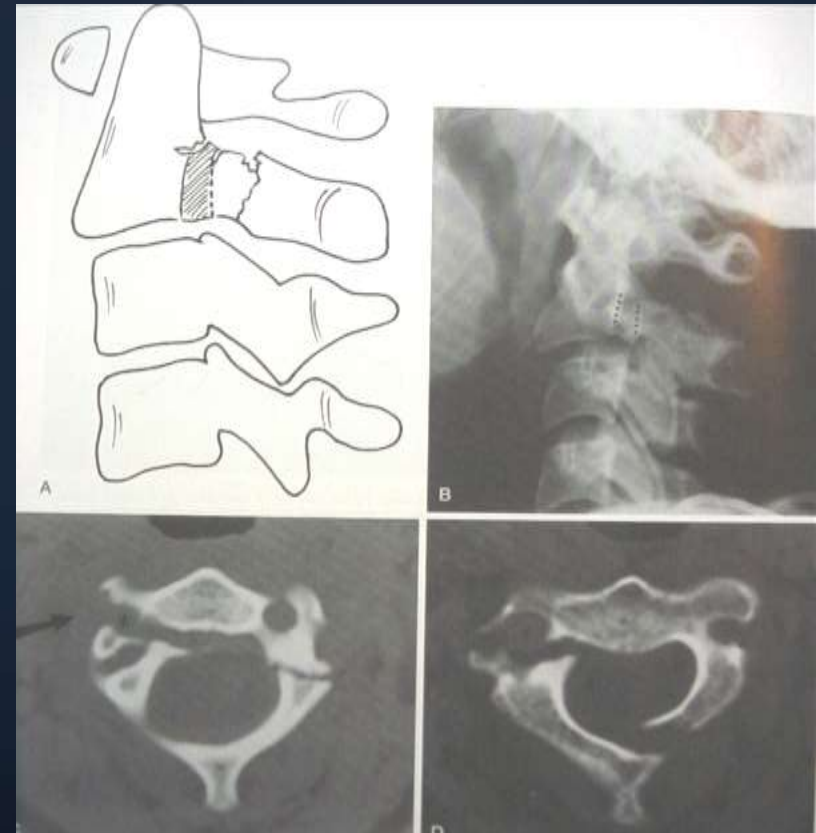
Traumatic Spondylolisthesis Type I

- X ray:
 - Almost no angulations
 - Translation < 3mm
 - Fx line near vertical
- Mech:
 - Hyperextension + axial load



Traumatic Spondylolisthesis Type IA

- X ray:
 - Almost No Angulations
 - Anterior translation < 3 mm, but posterior lines up.
 - Fx. Line not clear on lateral view.
- CT:
 - Fx one in body, extends to other side.
 - May traverse foramen for vertebral A. injury.
- Mech:
 - Hyperextension + lateral bending



Traumatic Spondylolisthesis Type II

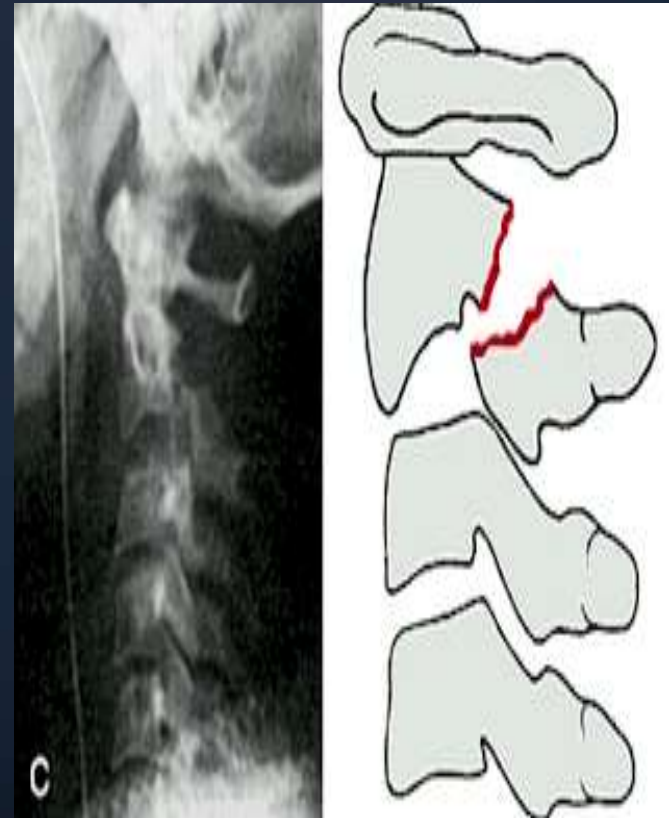
- X-ray:
 - Angulations > 10 deg.
 - Translation > 3 mm
 - Fx line near vertical
 - Fx at antsup. Of C3
- Mech:
 - Hyperextension then flexion injury
- Disruption:
 - PLL, anulus, disc
 - Ant long. Lig. stripped but intact



Traumatic Spondylolisthesis

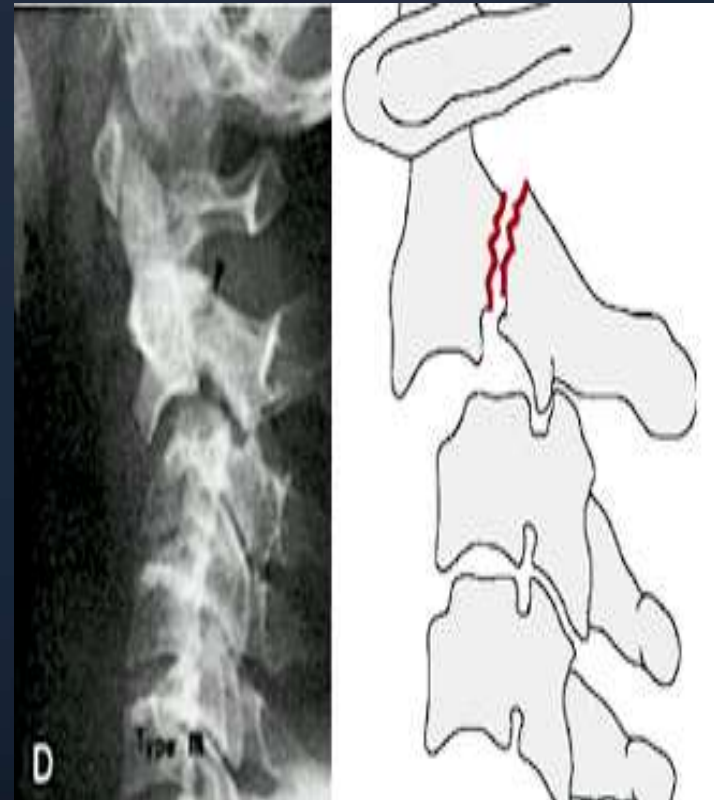
Type IIA

- X-ray:
 - Significant angulations but min. translation with widening of Post disc space, deformity worsen with distraction.
 - Fx. Line oblique
- Mech:
 - Flexion-distraction
- Disruption:
 - PLL, anulus, disc,
 - some rupture Ant long. Ligm.



Traumatic Spondylolisthesis Type III

- X-ray
 - Type I fx. + facet injuries.
- Mech:
 - Flex distraction then hyperextension



Treatment

Type I & IA

- Make sure obtain flexion/extension views to rule out type II injury. (especially for big shoulders)
- Obtain CT for type IA
- Collar for true type I and IA



Non-Surgical Treatment

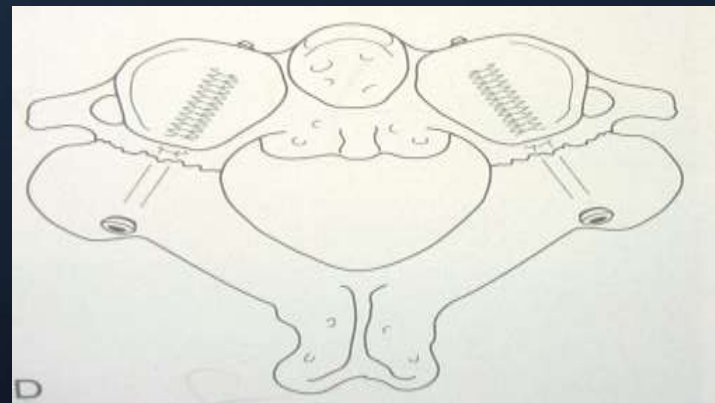
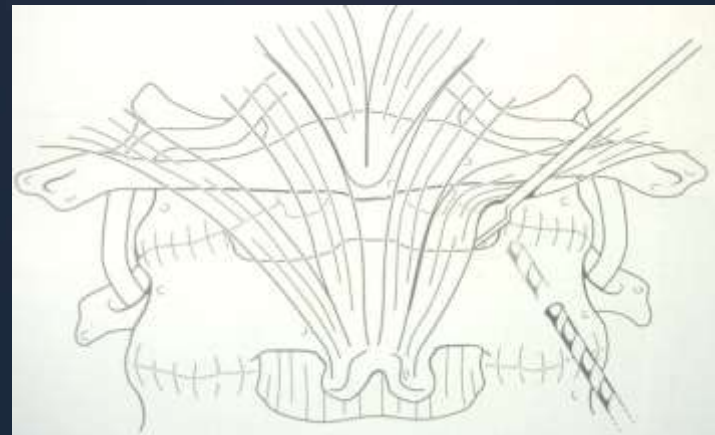
Type II

- $< 5\text{mm}$, $< 10\text{ deg}$
 - Halo vest
- $> 5\text{mm}$, $> 10\text{ deg}$
 - Reduction with distraction and slight extension
 - Traction (4-6 weeks)
 - Halo vest (4-6 weeks)
 - (Goal of reduction)
 - Reduce kyphosis to dec. hyperextension of lower levels
 - Reduce nonunion rate



Surgical Treatment type II

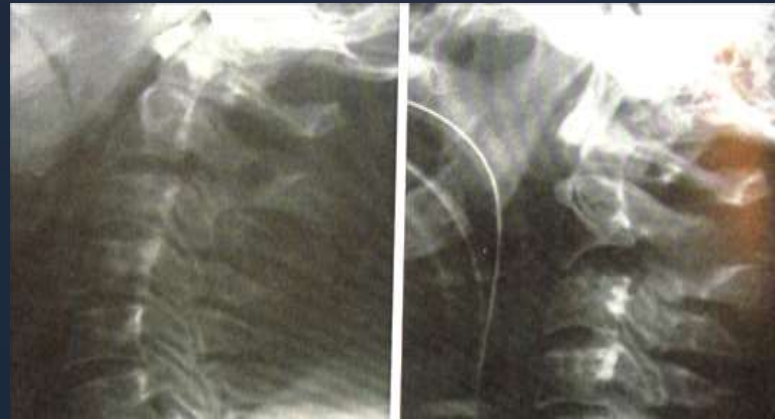
- Pedicle screw
- Anterior cervical fusion with plate?



Treatment

Type IIA

- Do not distract!
- Apply vest under image to apply extension and compression.



Treatment

Type III

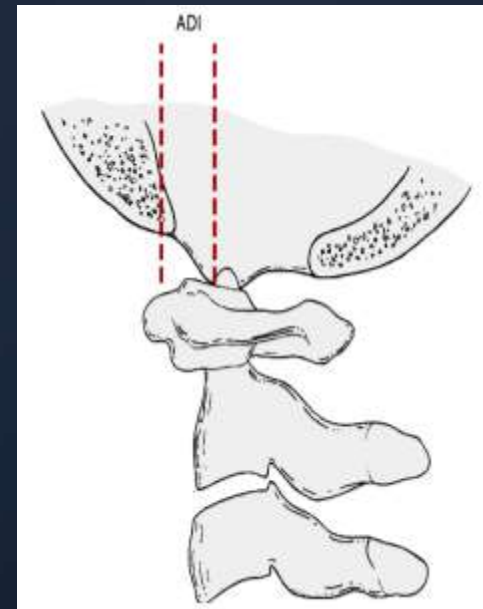
- (Usually can not close reduce.)
 1. Obtain MRI to r/o disc herniation
 2. Posterior open reduction of facets
 3. Fusion of C2-3 by wire/plates

Insufficiency of the Transverse Ligament

- *Incidence*
 - Fifth decade
- *Mechanism*
 - Forced flexion of the neck
- *Clinical Presentation*
 - Usually fatal
 - Survivor have neurologic symptoms from normal to transient quadriparesis.
 - Symptoms worse with flexion of neck.

Insufficiency of the Transverse Ligament

- Flex/ext views
- *If ADI > 3 mm*
 - Disruption of transverse ligament
- *If ADI > 5mm*
 - Disruption of transverse ligament + accessory ligaments.



Treatment

- Rupture of transverse Ligament:
 - (fail with non-surg. Tx)
 - C1-2 fusion
 - Gallie
 - Brooks
 - Magerl's transarticular screw
- Avulsion Fx:
 - Surgery vs. halo?

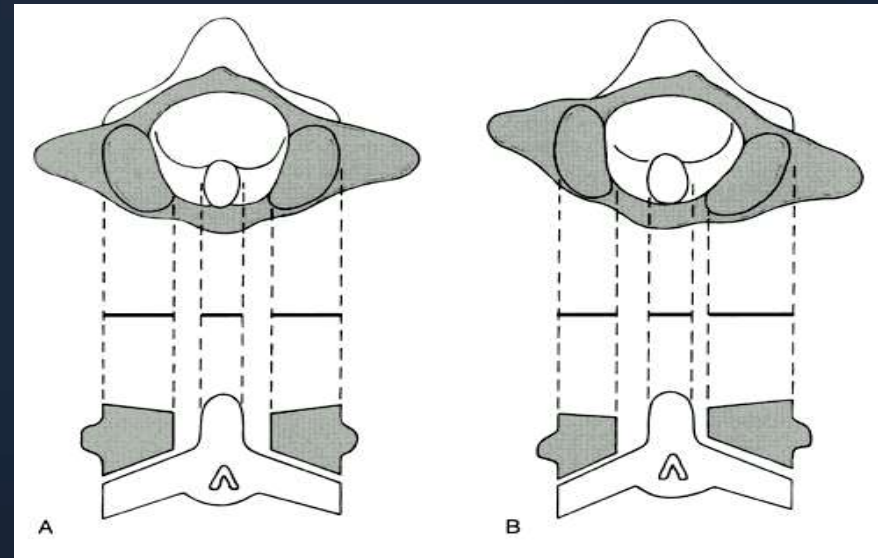


Atlantoaxial Rotatory Deformity

- *Incidence*
 - Rare in adults
- *Cause*
 - MVA
- *Mechanism*
 - Flexion and rotation
- *Max. rotation*
 - bilateral dislocation = 65 degree (intact transverse ligament)
 - Unilateral dislocation = 45 deg. (deficiency of transverse ligament)
- *Clinical Presentation*
(wide spectrum)
 - Neck pain
 - torticollis (cock-robin)
 - Neural deficit
 - Vertebral Artery Injury

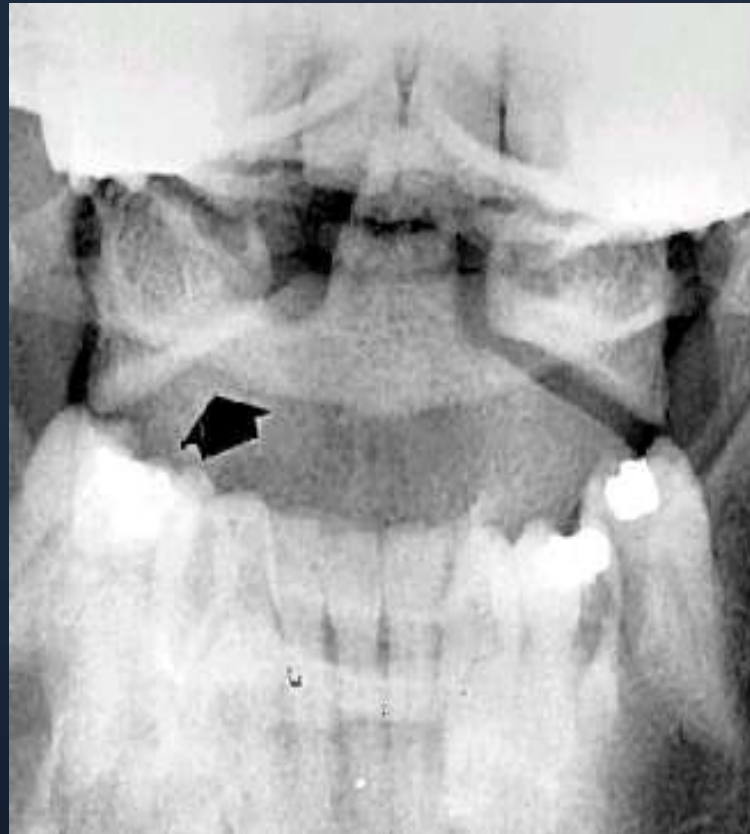
Atlantoaxial Rotatory Deformity

- Open-mouth radiograph
 - Increase width of C1 lateral mass
 - Widening of joint space



Atlantoaxial Rotatory Deformity

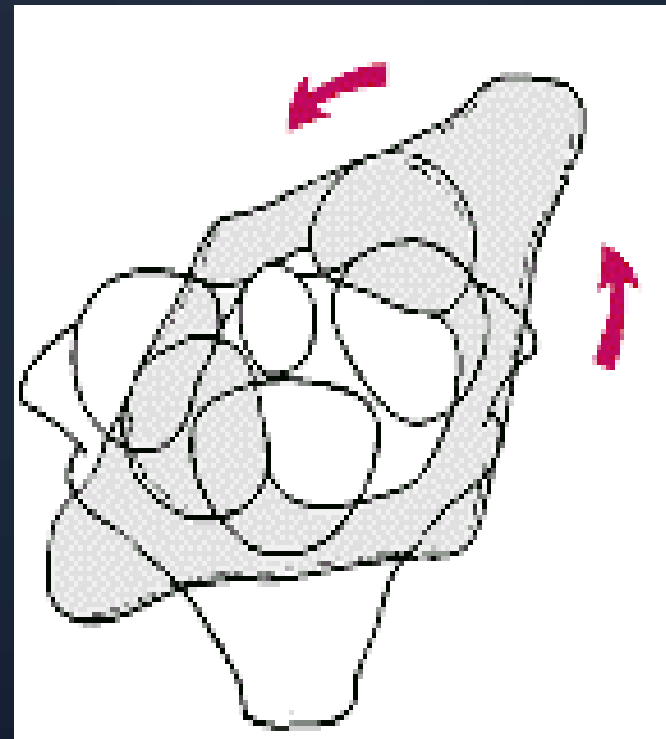
- Open-mouth radiograph
 - Wink sign
- Gold standard
 - Dynamic CT.



Atlantoaxial Rotatory Deformity

Type I

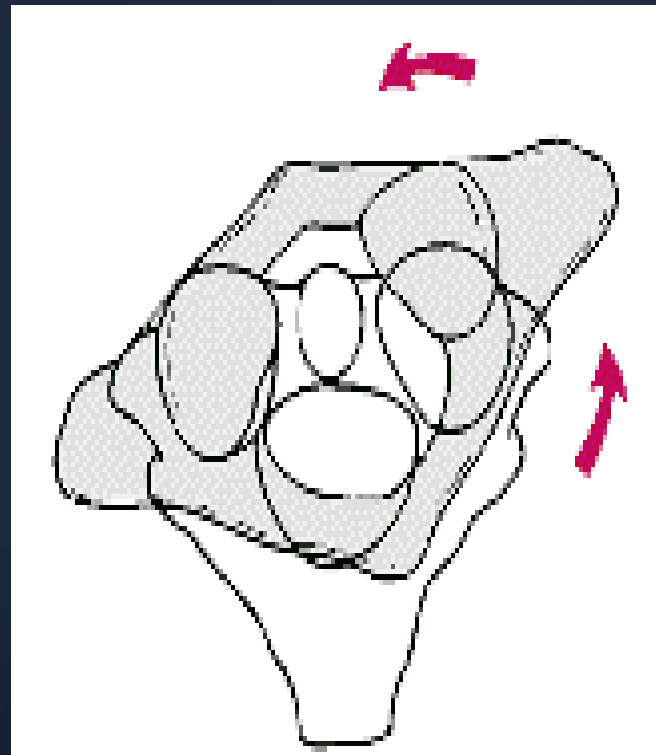
- Incidence
 - Most common (47%)
- Displacement
 - No anterior displacement
- Pivot
 - Odontoid
- Transverse ligament
 - Intact



Atlantoaxial Rotatory Deformity

Type II

- Incidence (30%)
 - Second most common
- Displacement
 - Anterior 3-5 mm
- Pivot
 - Intact lateral facet
- Transverse ligament
 - Deficient
- Accessory ligament
 - Intact

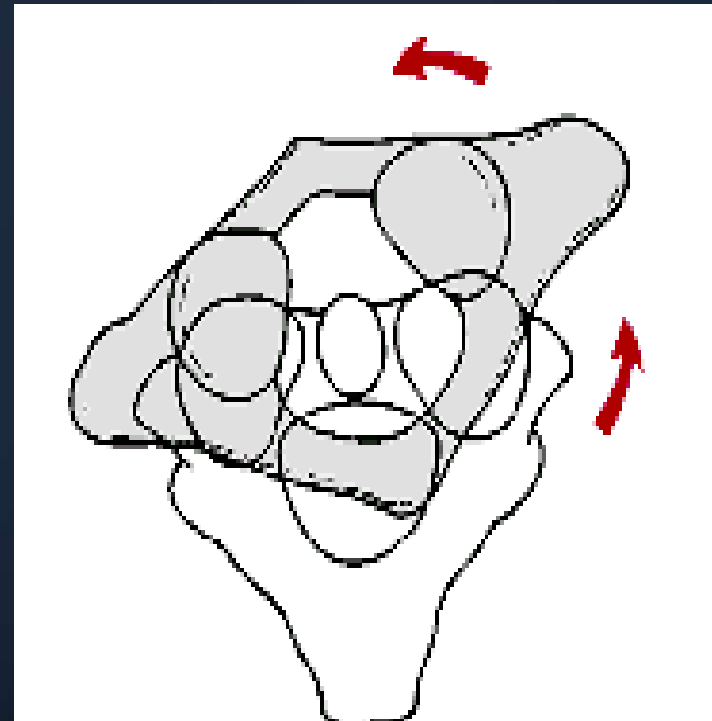


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Atlantoaxial Rotatory Deformity

Type III

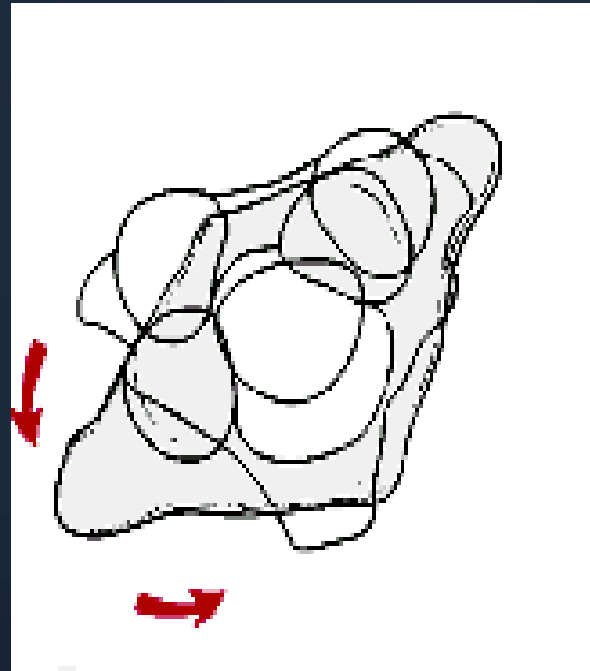
- Displacement
 - Anterior > 5mm
- Subluxation
 - Both lateral masses
- Transverse ligament
 - Disrupted
- Accessory Ligaments
 - Disrupted



Atlantoaxial Rotatory Deformity

Type IV

- Displacement
 - Posterior
- Cause
 - Deficient dens



Atlantoaxial Rotatory Deformities - Treatment

- *Look for etiology*
- *Traction*
 - Start with 6.8 Kg.
 - Increase 0.5 to 0.9 Kg every three days.
 - Maximum 9.1KG
- *Post reduction*
 - Immobilization for 2-3 months.
 - Flex/ext. x-ray to check stability

Surgical Treatment

Indications

- Spinal instability
- Neural involvement
- Fail to achieve reduction
- Fail to maintain reduction

Methods

- Gallie
- Brooks-Jenkins
- Transarticular screws

Thank you