Jefferson and Hangman fractures

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Isolated fractures of the Atlas

- A-Jefferson Fracture
- B-Comminuted lateral mass fracture
- C-Unilateral Ring Fracture
- D-Linear Lateral mass fracture
- E-Posterior ring Fracture
- F-Anterior Arch Fracture
- G-Controlateral Ring Fracture
Jefferson fracture

Four-part atlas fracture, with two in the posterior arch and two in the anterior arch.

2% of all cervical spine fractures.
High prevalence of concomitant fractures of C2.

The unstable Jefferson fracture is a C1 burst fracture with concomitant injury of the transverse atlantal ligament.
biomechanics

Caused by axial forces, with a variable component in flexion-extension

The axial forces cause an outward spread of the lateral masses of C1.
Treatment options

Stable fracture
  Conservative – Halo-vest

Unstable fracture
  Conservative
  Posterior fixation
  Alternative approaches
Treatment options – conservative

Primary option in stable Jefferson fracture

Possible option in unstable Jefferson fracture with type II TAL rupture

Not suitable for type I TAL rupture

Non-surgical treatment of displaced Jefferson fractures confers high rates of non-union and neurologic sequelae may arise due to cranial settling at C0–2

Spine 2009; 34 (23): 2505–2509
Treatment options – posterior fixation

Magerl’s technique

Goel-Harms technique

Occipito-cervical fixation

Provides a high grade of stability

Reduction of atlanto-axial joint ROM

Occipito-cervical fixation reserved for C0-C1-C2 instability
Treatment options – alternative approaches

Aims: immobilization of C1 lateral mass displacement

Allows maintenance of rotatory mobility in the C1–C2 joint and restoration of congruency in the atlanto-occipital and atlantoaxial joints

Is it effective in complete TAL rupture?

Spine 2004; 29 (7), pp 823–827
Subsequent to the axial loading injury of the C1 ring and the C1–2 joints, alar ligaments, portions of the facet capsules, and other secondary restraints to flexion remain intact, while the TAL may be ruptured.

With the TAL rupture, instability in flexion may be present, but it is limited by the remaining intact structures when the force couple at C0–2 is reconstructed using the C1–RO.

After C1–RO, the stability provided by the secondary ligaments seems sufficient to maintain C1–2 stability and translation of C1 on C2 within limits that do not endanger the spinal cord during physiological loading.
Useful for Type II TAL rupture alternatively to Halo-vest immobilization

Not useful in Type I TAL rupture due to the high grade of instability of C1-C2 junction

Not enough follow-up data
Treatment options - alternative approaches

Microendoscopic anterior approach

C3-C4 anterior standard approach

Use of a guide tube moving onto the anterior part of the vertebral body to arrive on the anterior arch of C1

Positioning of serial dilators

Introduction of a rigid microendoscope

Arthrodesis with bone graft

Useful for repairing the anterior component of the fracture

Eur Spine J - July 2011
Jefferson fracture: conclusions

The forces involved in biomechanics of Jefferson fracture may disrupt TAL, causing a high grade of C1-C2 instability.

Conservative treatment, in cases of TAL rupture, confers a high rate of non-union.

Posterior C1-C2 fixation confers a high grade of stability, and is the treatment of choice in cases of TAL rupture, especially type I.

Only in cases of Type IIA TAL rupture, C1 lateral mass screw fixation seems to be a safe option to reduce the fracture, because the secondary ligaments are apparently sufficient for maintaining C1-2 stability and translation of C1 on C2.
Hangman fracture or traumatic spondylolisthesis of the Axis

The second most common fracture of the second cervical vertebra.

Involves a bilateral arch fracture of the C2 pars interarticularis with variable displacement of C2 on C3.
**Classification of Levine-Edwards**

**type I:** non-displaced fractures with no angulation between C2 and C3 and a fracture dislocation of less than 3 mm

**type II:** significant angulation (>11°) and displacement (>3.5 mm)

**type IIA:** minimum displacement and significant angulation (>11°);

**type III:** severe angulation and displacement and concomitant unilateral or bilateral facet dislocation C2–3.
Concept of instability

Flexion-extension forces have been implicated in disruption of:

- anterior longitudinal ligament
- posterior longitudinal ligament
- C2–3 disc

a marked angulation of C2 on C3, an anterior translation and a displacement of the fracture on initial lateral radiographs are considered signs of instability

Disc injury may lead to instability of the cervical spine, and disc herniation may lead to spinal cord compression.

*International Orthopaedics (SICOT) (2010) 34:85–88*
Treatment options

Conservative
Direct pars screw
Posterior fixation
Anterior fixation
Combined approach
Treatment options – conservative

Most cases responded to conservative treatment comprised of mild skeletal traction and external immobilization in a halo device.

Some authors considered surgical intervention was only needed in Type III or chronic instability after conservative treatment.

Pseudo-arthrosis, anterior dislocation, or angulation of C2 over C3, and recurrent axial pain were observed in about 60% of Type II, Type IIa, and Type III cases which were primarily treated with conservative therapy.

This fact may explain why many surgeons choose primary operative treatment for unstable TSA.

Spine 2008; 33 (3):255 - 258
Treatment options - direct pars screws

The alignment of the vertebral artery through the body of C2 is variable in 4% of cases

ANGIO MRI STUDY

Has the advantage of preserving motion of the axis. Does not address instability at the disc and is not appropriate for all patients with Hangman fracture

Direct pars repair is insufficient for stabilizing a Hangman fracture with associated disruption of the C2–C3 disc.
Treatment options – anterior fixation

C2-C3 discectomy and anterior plating

Technical ease and a relatively short fusion, involves a C2–3 discectomy with interbody fusion and plating.

Suitable for Hangman’s fracture with intervertebral disc injury, which may compress the spinal cord or lead to spinal instability.
Treatment options – posterior fixation

C2 pars screws + C3 lateral mass screws

Addresses the detached posterior arch of C2 by pinning the fractured pars while simultaneously addressing instability at the disc by immobilising C2 to C3.

The location of the fracture within the pars interarticularis and the individual anatomy of C2 determine whether fractures are appropriate for treatment with pars screws.

Risk of injury to the vertebral artery and spinal cord.

Treatment options – combined approach

Anterior C2-C3 discectomy and fusion + C2 pedicle screws

Combined anterior C2–C3 reduction and fusion and posterior compressive C2 pedicle screw fixations can achieve better reduction and functional outcomes in patients with severe Type II and III Hangman fractures.

Spine 2010; 35 (6): 613-619
Biomechanics of Hangman fixation techniques

Disc disruption and pars interarticularis fractures significantly destabilized the spine in all loading models.

Direct pars repair is insufficient for stabilizing a Hangman fracture with associated disruption of the C2–C3 disc.

Anterior plating and posterior C2–C3 fusion both appear to provide adequate spinal immobilization, although the posterior construct appears to have some biomechanical benefits.

This limited biomechanical advantage of posterior fixation may not be clinically relevant in light of the relative surgical ease and high fusion success rate with anterior constructs.
Conservative treatment must be reserved to type I fractures because pseudarthrosis, anterior dislocation or angulation of C2 over C3, and recurrent axial pain were observed in about 60% of Type II, Type IIa, and Type III cases. Direct pars repair is insufficient for stabilizing a Hangman fracture with associated disruption of the C2–C3 disc. Posterior screw fixation appears to have some biomechanical benefits in terms of stability, but is not indicated in cases of traumatic disc herniation compromising the spinal cord.

In this event, an anterior C2–3 discectomy and fusion with optional plating is preferable.
Thank you for your attention