The management and treatment of cervical spine injuries

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The cervical spine is a relatively fragile structure traversed by the spinal cord. Injuries to the cervical spine (c-spine) are therefore associated with potentially catastrophic neurological complications. This article illustrates the importance of routine c-spine immobilization in all trauma patients and highlights how early diagnosis of injuries can optimize outcome.

The cervical spine is a complex and fragile musculoskeletal structure. Important neurological, vascular, respiratory and gastrointestinal structures traverse the cervical region. Injuries to the cervical spine can produce a wide spectrum of clinical presentations. Early recognition of potential cervical spine trauma is vital for optimal functional outcome. Appropriate protective and diagnostic interventions need to be instituted in an efficient and timely manner to maximize treatment results and minimize adverse outcomes. Recent advances in resuscitation techniques, imaging modalities, and surgical technique, together with the establishment of regional trauma care systems, have enabled clinicians to maximize patients' chances of functional recovery from spinal cord injuries and to minimize risks of secondary injury.

This review covers the most common injuries to the cervical spine including whiplash injuries, discussing clinical evaluation, management and prognosis.

ANATOMICAL CONSIDERATIONS

Most cervical spine fractures occur predominantly at one of two levels, one third of injuries occurring at the level of C2, and one half of injuries occurring at the level of C6 or C7. Most fatal cervical spine injuries occur in upper cervical levels, either at the craniocervical junction, C1 or C2.

The normal anatomy of the cervical spine consists of seven cervical vertebrae separated by intervertebral discs and joined by a complex network of ligaments. This structure allows the individual bony elements to behave as a single unit.

The cervical spine can be divided into three distinct columns (*Figure 1*): anterior, middle, and posterior. The anterior column is composed of two thirds of the vertebral bodies, the annulus fibrosis, intervertebral discs, and the anterior longitudinal ligament. The middle column is composed of the posterior third of the vertebral bodies, the annulus, the intervertebral disc, and posterior longitudinal ligament. The posterior column contains all of the remaining posterior elements formed by the pedicles, transverse processes, articulating facets, laminae, and spinous processes.

The atlas C1 and the axis C2 differ markedly from other cervical vertebrae. The atlas has no vertebral body, it is composed of a thick anterior arch with two prominent lateral masses and a thin posterior arch. The axis includes the

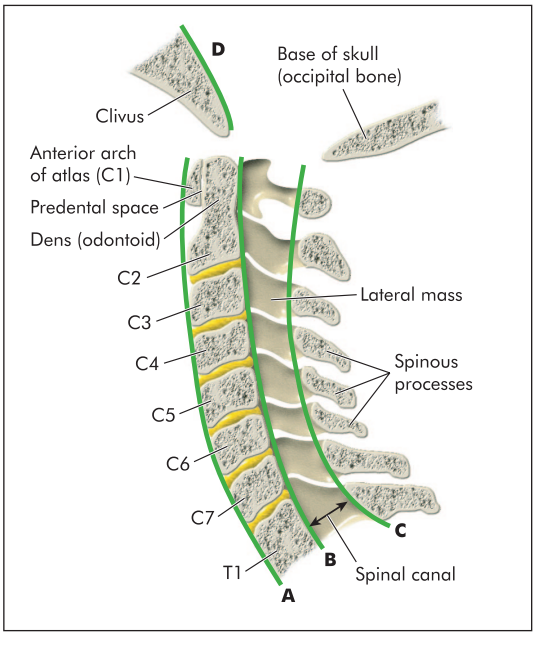

Figure 1. The divisions of the cervical spine. A: anterior; B: middle; C: posterior columns

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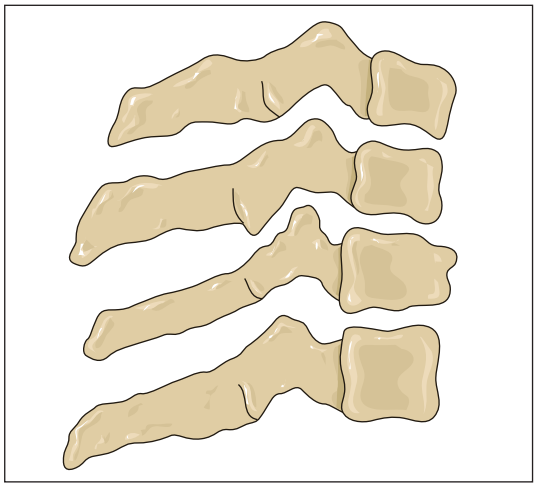

Figure 2. Simple wedge fracture.

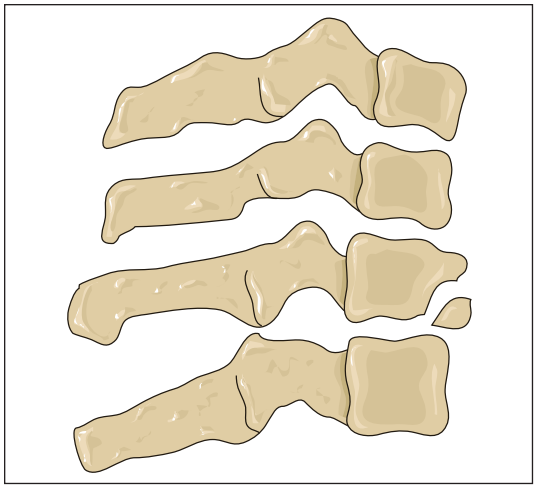

Figure 3. Flexion teardrop fracture.

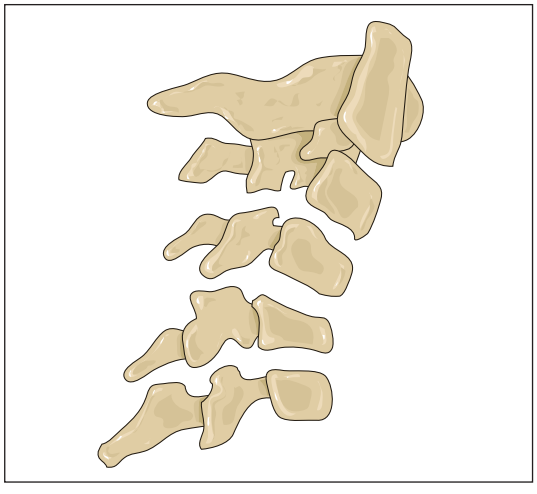

Figure 4. Anterior facet dislocation.

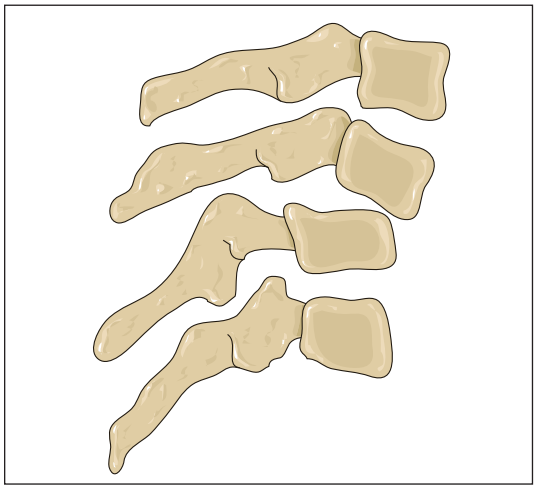

Figure 5. Bilateral facet dislocation.

odontoid process that represents fused remnants of the atlas body. The odontoid process is held in tight approximation to the posterior aspect of the anterior arch of C1 by the transverse ligament, which stabilizes the atlantoaxial joint.

PATHOPHYSIOLOGY

Cervical spine injuries are best classified by considering the mechanism of injury. This includes:

- Flexion
- Flexion-rotation
- Extension
- Extension-rotation
- Vertical compression
- Lateral flexion
- Imprecisely understood mechanisms that may result in odontoid fractures and atlanto-occipital dislocation.

Flexion injuries

Simple wedge fracture

With a pure flexion injury, a longitudinal pull is exerted on the strong nuchal ligament complex which usually remains intact (*Figure 2*). The prevertebral soft tissues appear swollen. The posterior column remains intact, making this a stable fracture that requires only the use of a cervical orthosis for treatment.

Flexion teardrop fracture

A flexion teardrop fracture occurs when flexion of the spine, along with vertical axial compression, causes a fracture of the anteroinferior aspect of the vertebral body (*Figure 3*). This injury involves disruption of all three columns, making this an extremely unstable fracture that frequently is associated with spinal cord injury. Initial management is application of traction with cervical tongs.

Anterior subluxation

Anterior subluxation in the cervical spine occurs when posterior ligamentous complexes (nuchal ligament, capsular ligaments, ligamenta flava, posterior longitudinal ligament) rupture

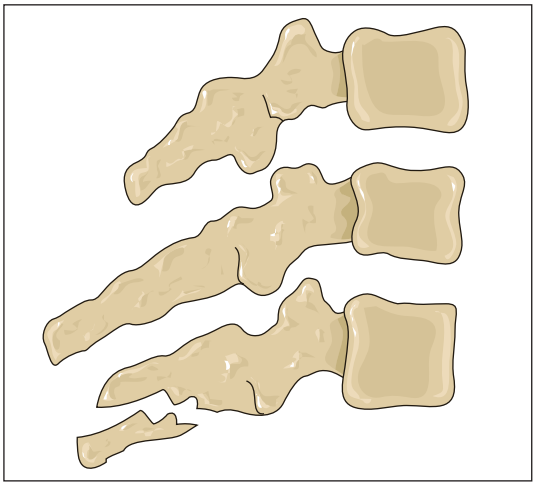

Figure 6. The 'Clay-Shoveler' fracture.

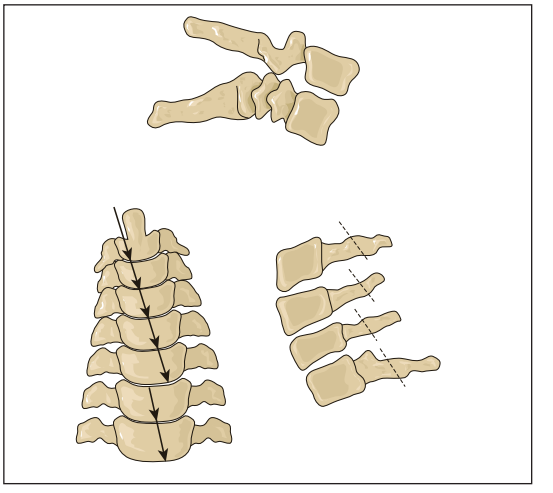

Figure 7. Unilateral facet dislocation.

(*Figure 4*). As the anterior columns remain intact, this fracture is considered mechanically stable by definition.

Bilateral facet dislocation

Bilateral facet dislocation is an extreme form of anterior subluxation that occurs when a significant degree of flexion and anterior subluxation causes ligamentous disruption to extend anteriorly, causing significant anterior displacement of the spine at the level of injury (*Figure 5*). This is an extremely unstable condition and is associated with a high prevalence of spinal cord injuries. Initial management is closed reduction and traction with cervical tongs.

'Clay shoveler' fracture

Abrupt flexion of the neck, combined with a heavy upper body and lower neck muscular contraction, results in an oblique fracture of the base of the spinous process, which is avulsed by the intact and powerful supraspinous ligament (*Figure 6*).

Injury is commonly observed in a lateral view, since the avulsed fragment is readily evident. Injury commonly occurs in lower cervical vertebrae; visualization of the C7–T1 junction in the lateral view is therefore imperative.

Since injury involves only the spinous process, this fracture is considered stable, and it is not associated with neurological impairment. Management involves only cervical immobilization for comfort.

Flexion rotation injuries

Unilateral facet dislocation

Unilateral facet dislocation occurs when flexion and rotation combine to force one inferior articular facet of an upper vertebra to pass superior and anterior to the superior articular facet of a lower vertebra, coming to rest in the intervertebral foramen (*Figure 7*). Although the posterior ligament is disrupted, vertebrae are locked in place, making this injury stable. The injury is seldom associated with neurological deficit.

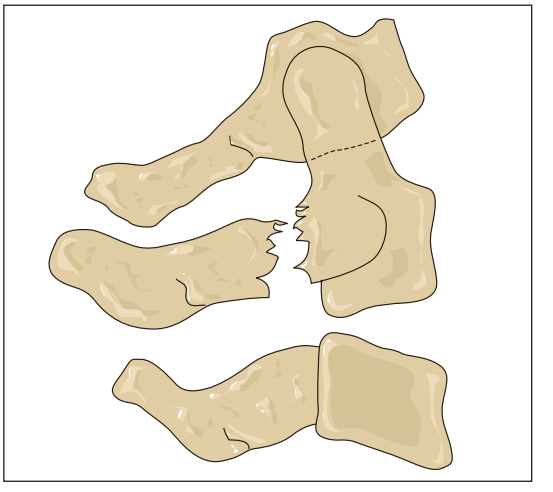

Figure 8. The Hangman fracture.

Rotary atlantoaxial dislocation

This injury is a specific type of unilateral facet dislocation. Radiographically, the odontoid view shows asymmetry of the lateral masses of C1 with respect to the dens along with unilateral magnification of a lateral mass of C1 (wink sign). This injury is considered unstable because of its location.

Extension injuries

Hangman fracture

The hangman fracture is a traumatic spondylolisthesis of C2 (*Figure 8*). In the past this type of fracture resulted from hanging, although nowadays road traffic accidents are a more common cause. Bilateral fractures through the pedicles of C2 result from hyperextension.

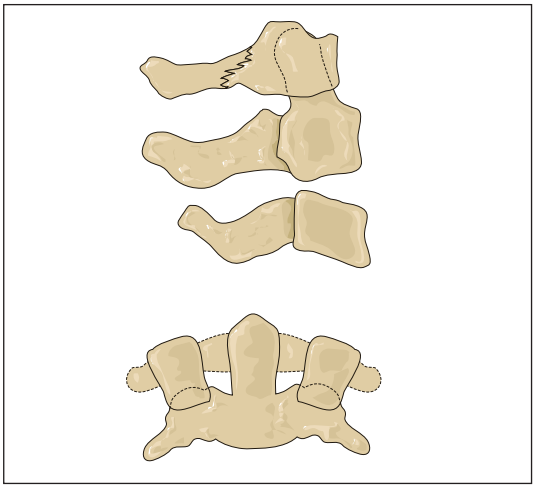

Figure 9. Posterior neural arch fracture.

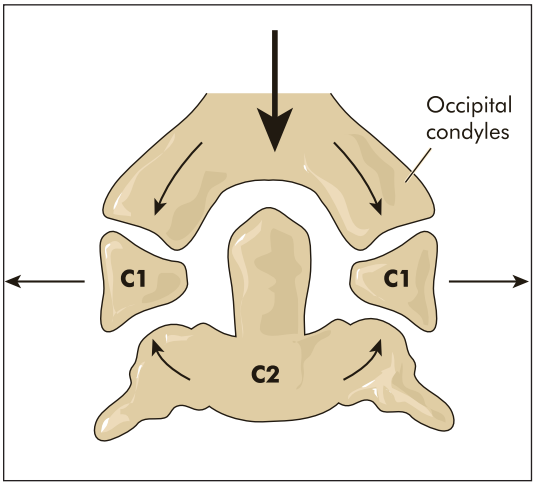

Figure 10. Pathophysiology of the Jefferson fracture.

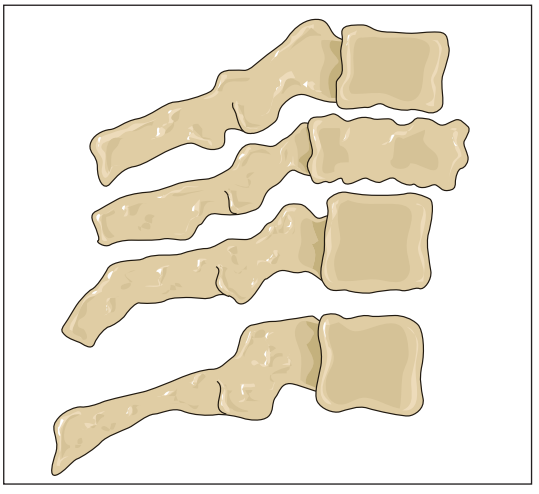

Figure 11. Burst fracture of the vertebral body.

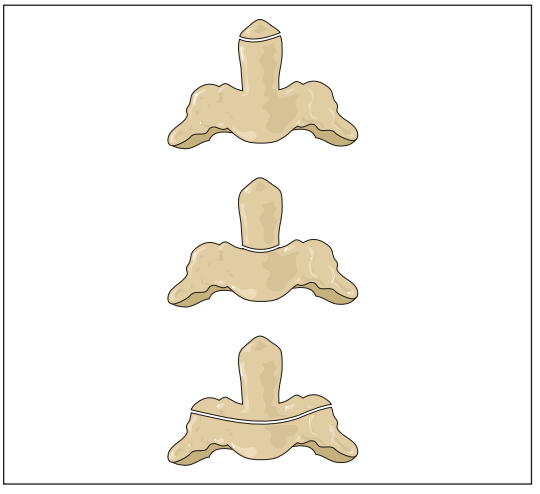

Figure 12. Odontoid process fracture.

Although considered an unstable fracture, it seldom is associated with spinal injury, since the anteroposterior diameter of the spinal canal is greatest at this level, and the fractured pedicles allow decompression. When associated with unilateral or bilateral facet dislocation at the level of C2, this particular type of hangman fracture is unstable and has a high rate of neurological complications that require immediate cervical traction to reduce the facet dislocation. All other types of hangman fracture can be managed initially with cervical immobilization.

Extension teardrop fracture

As with flexion teardrop fracture, extension teardrop fracture also manifests with a displaced anteroinferior bony fragment. This fracture occurs when the anterior longitudinal ligament pulls a fragment away from the inferior aspect of the vertebra because of sudden hyperextension.

The fracture is common after diving accidents and tends to occur at lower cervical levels. It may also be associated with the central cord syndrome as a result of buckling of the ligamenta flava into spinal canal during the hyperextension phase of the injury.

This injury is stable in flexion but highly unstable in extension. Initial management is avoidance of iatrogenic extension and cervical traction with tongs.

Posterior neural arch fracture

This is a fracture of the posterior arch of C1 (posterior neural arch fracture) (*Figure 9*). This fracture occurs when the head is hyperextended and the posterior neural arch of C1 is compressed between the occiput and the strong and prominent spinous process of C2, causing the weak posterior arch of C1 to fracture.

The transverse ligament and the anterior arch of C1 are not involved, making this fracture stable. Initial management involves the differentiation of this benign fracture from a Jefferson fracture. Once this is accomplished, the use of a cervical collar suffices.