Vertical (axial) compression injuries

Jefferson fracture

This is a burst fracture of the ring of C1 (*Figure 10*). This fracture is caused by a compressive downward force that is transmitted evenly through the occipital condyles to the superior articular surfaces of the lateral masses of C1. This process displaces the masses laterally and causes fractures of the anterior and posterior arches, along with possible disruption of the transverse ligament. Quadruple fracture of all four aspects of the C1 ring occurs.

When displacement of the lateral masses is more than 6.9 mm, complete disruption of the transverse ligament has occurred, and immediate cervical traction is warranted. If displacement is less than 6.9 mm, the transverse ligament is still competent and neurological injury is unlikely.

Burst fracture of the vertebral body

When downward compressive force is transmitted to lower levels in the cervical spine, the body of the cervical vertebra can shatter outward, causing a burst fracture (*Figure 11*). This fracture involves disruption of the anterior and middle columns, with a variable degree of posterior protrusion of the latter.

Burst fractures require assessment by axial computed tomography (CT) scan or magnetic resonance imaging (MRI) to document the amount of middle column retropulsion.

Burst fractures with a loss in height of more than 25%, retropulsion, or neurological deficit can be managed initially by the application of traction with cervical tongs. In the absence of these features, the fracture is considered stable.

MECHANISM OF INJURY, LOCATION AND CLINICAL RELEVANCE

Upper cervical spine (occiput to C2) injuries

Injuries at the upper cervical level are considered unstable because of their location. Nevertheless, since the diameter of the spinal canal is greatest at the level of C2, spinal cord injury from compression is the exception rather than the rule. Incompletely understood mechanisms or a combination of them usually produce injuries encountered at this level. Common injuries include:

Atlas (C1) fractures

Four types of atlas fractures result from impaction of the occipital condyles on the atlas, causing single or multiple fractures around the ring.

The first two types of atlas fracture are stable and include isolated fractures of the anterior and posterior arch of C1 respectively (posterior arch fracture is described under extension injury).

Initial management of types I, II, and III atlas fractures consists of the application of a cervical collar. The type IV or Jefferson fracture is managed with cervical traction.

Atlantoaxial subluxation

When flexion occurs without a lateral or rotatory component at the upper cervical level, it can cause an anterior dislocation at the atlantoaxial joint if the transverse ligament is disrupted. Since the transverse ligament is the main stabilizing force of the atlantoaxial joint, this injury is unstable. Neurological injury may occur from cord compression between the odontoid process and posterior arch of C1.

Atlanto-occipital dislocation

When severe flexion or extension exists at the upper cervical level, atlanto-occipital dislocation may occur. Atlanto-occipital dislocation involves complete disruption of all ligamentous relationships between the occiput and the atlas. Death usually occurs immediately from stretching of the brainstem, which causes respiratory arrest.

Cervical traction is absolutely contraindicated, since further stretching of the brainstem can occur.

Odontoid process fractures

The three types of odontoid process fractures are classified based on the anatomic level at which the fracture occurs (*Figure 12*).

With types II and III fractures, the fractured segment may be displaced anteriorly, laterally, or posteriorly. Since posterior displacement of seg-

TABLE 1.
Classification of odontoid process fractures

Type I	Odontoid fracture is an avulsion of the tip of the dens at the insertion site of the alar ligament.
Type II	Fractures occur at the base of the dens and are the most common odontoid fractures.
Type III	Odontoid fracture occurs when the fracture line extends into the body of the axis

TABLE 2.
The Gargan and Bannister classification

Grade A	No symptoms
Grade B	Nuisance symptoms but which do not interfere with occupation or leisure
Grade C	Intrusive symptoms requiring intermittent analgesia, orthotics or physical therapy
Grade D	Disabling symptoms requiring time off work and regular analgesia, orthotics, and repeated medical consultation

ment is more common, the prevalence of spinal cord injury is as high as 10% with these fractures.

Initial management of a type I dens fracture is use of a cervical collar. Management of types II and III fractures is by applying traction with cervical tongs.

Occipital condyle fracture

Occipital condyle fractures are caused by a combination of vertical compression and lateral bending. These fractures are associated with significant head trauma and usually are accompanied by cranial nerve deficits.

These mechanically stable injuries require only immobilization for management, and most heal uneventfully. These fractures are significant because of other associated injuries.

WHIPLASH INJURIES

The whiplash syndrome is a collection of symptoms produced by a soft tissue injury of the cervical spine, often following a rear-end automobile collision.

Biomechanics

The most common cause of whiplash injury is a rear-end impact in an automobile accident. The crash causes the trunk to accelerate in a forward direction and the unsupported head cannot follow this motion, resulting in hyperextension beyond the normal range of 60º.

Classification

Several classification systems exist, most commonly based on symptom severity. Both the Neck Disability Index and the Gargan and Bannister classification (*Table 2*) (Khan et al, 2002) utilize the impact a patient's symptoms have on their lifestyle.

Clinical evaluation

Hyperextention injury can result in a vast array of symptoms. Thirty percent of patients attending hospital after an automobile accident describe neck pain. There is often radiation to the occiput, shoulders, and upper limbs. Low back pain is a symptom often overlooked. Other symptoms include interscapular pain, arm and hand pain, vertigo, auditory problems, and visual problems.

Examination

The majority of patients experience discomfort within 2 days of the accident but delayed symptoms occur in 35%. Symptoms are usually disproportionate to the physical signs, the most common being a decreased range of movement in a tender neck but actual nerve deficit is infrequent, seen in 10 of 61 patients in one series (Norris and Watt, 1983).

Investigation

There is no diagnostic test for whiplash syndrome, and there is a poor correlation between symptoms and findings on plain radiographs, scintigraphy or MRI.

Conventional radiographs have low yield of bone injury – in the absence of high force or high speed impacts, clinicians should feel safe managing patients involved in rear end collisions without the use of radiographs.

The use of MRI is indicated only later to investigate patients with persistent neurological deficits or clinical signs of nerve root compression.

Treatment

The treatment of whiplash injury is generally disappointing, and many patients rapidly abandon conventional medicine and seek alternative practitioners. The most common acute treatment consists of a soft collar and physiotherapy, yet evidence (Khan et al, 2002) suggests that these are among the least useful modes of treatment.

In 1996, Lord et al identified the zygapophyseal joint as the common basis for chronic neck pain in whiplash injury and treatment is being targeted increasingly at relieving pain from the source.

CONCLUSIONS

The region between the occiput and axis is an inherently unstable region but fortunately has a large spinal canal diameter lessening the likelihood of neurological trauma. Strong ligamentous structures provide stability but have poor healing capacity when injured. Immobilization of the c-spine by the use of such devices as the halo-vest can be successful in the treatment of many injuries. This uses a series of pins inserted into the cranium which are then secured to a metal ring. This controls head movements. This ring or halo is then attached to a vest which fits securely over the upper part of the thorax. Thus head movements and therefore cervical spine movement can be controlled.

Surgery is warranted in patients with occipito-atlantal instability, transverse ligament disruptions, displaced type II odontoid fractures and rarely in hangman's fractures. Newer surgical techniques increase stability, allowing early mobilization and avoid the halo-vest.

Whiplash injuries are a common cause of

chronic disability. Most cases resolve in weeks or months but about 40% become chronic, and current treatment of patients is inadequate. The future must involve targeting treatments more effectively, either at the specific treatable organic lesion seen in about half of chronic cases, or at the predominantly psychologic response to pain seen in the other half.

Conflict of interest: none.

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KEY POINTS

- The cervical spine is a relatively vulnerable structure.
- Cervical spine injuries may be complicated by spinal cord injury.
- Routine c-spine immobilization of all trauma patients will help minimize further injury.
- Careful assessment and early diagnosis will help to optimize outcome.
- Whiplash injuries are a common cause of chronic disability.
- Combining psychological and physical therapy may be necessary to optimize outcome.