# Traumatic Lesions of the Spine and Spinal Cord

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# ANATOMY

- Twenty-four *vertebrae* are incorporated into the spinal column between the base of the skull and the sacrum.
- About 80 percent of the vertical strength of the spinal column is assumed by the vertebral bodies and the intervertebral disks, with the remainder being provided by the facets.
- Protection of the neural elements is a most important role of the spinal column.

# VASCULAR SUPPLY TO THE SPINAL CORD

- Anterior spinal artery
- Posterior spinal arteries
- Radicular branches of the vertebral and intercostal arteries
  - artery of Adamkiewicz

# ANATOMY

Peculiarities in its anatomy make some segments of the spinal column more vulnerable to certain injuries than others.

The neck, being more mobile and joining two large body masses, is subject to a majority of closed spinal injuries.

Because of its length, the thoracic spine is vulnerable to a high percentage of missile injuries

The thoracolumbar junction, again, is subject to a large number of closed injuries.

# ANATOMY

Holdsworth thought of the spine as made up of two columns:

- one of vertebral bodies with its intervertebral disks and longitudinal ligaments and
- one of posterior elements

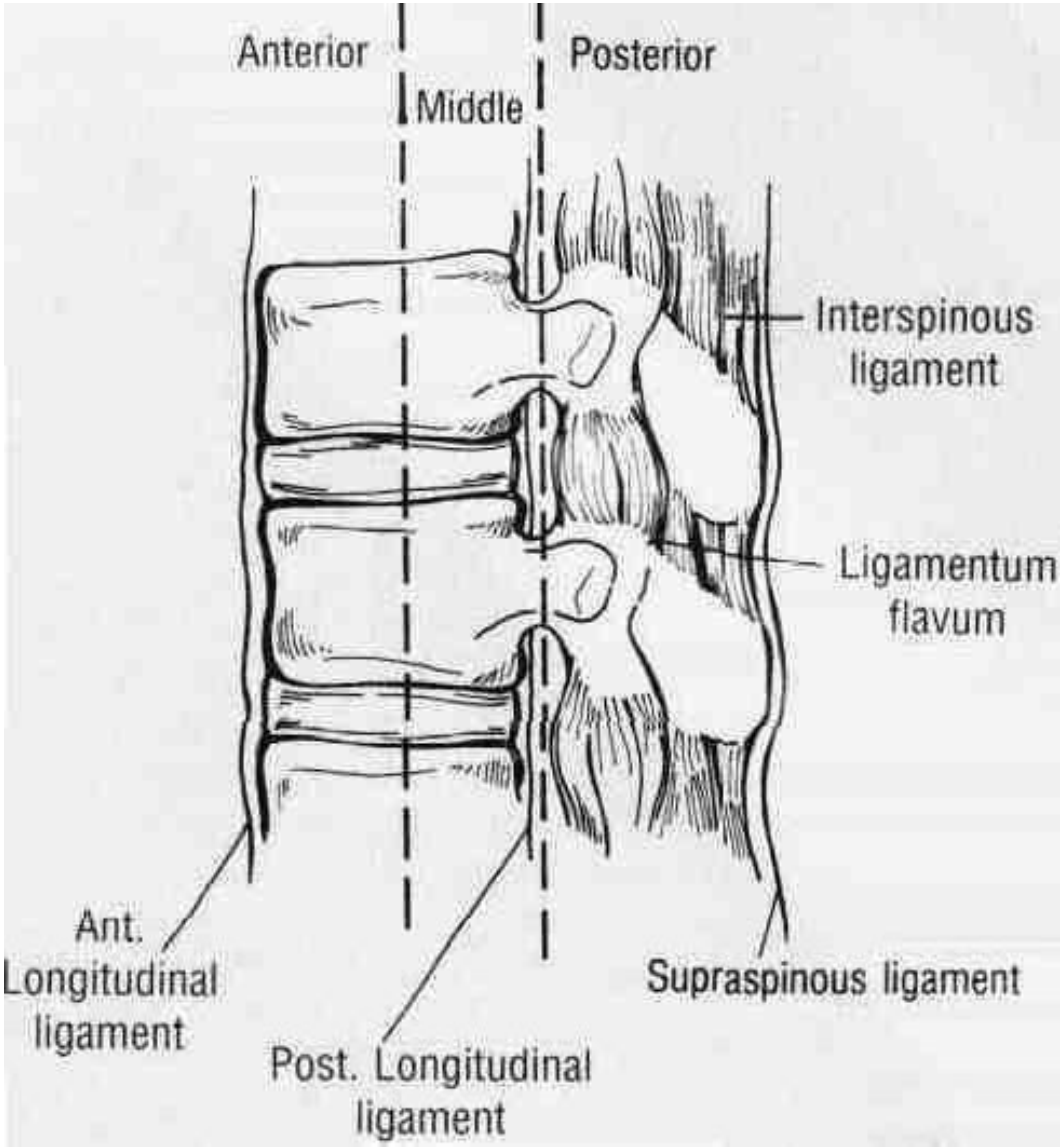
  The "posterior ligamentous complex" is composed of laminae and pedicles with their attached spinous and transverse processes and the pars articularis, and their intervening supra- and interspinous ligaments, ligamentum flavum, and joint capsules.

# ANATOMY

Denis identified three columns of the spine.

He divided the vertebral body column of Holdsworth into two segments, *anterior* and *middle.*

- The anterior column is composed of the anterior halves of the vertebral bodies, with their intervening disks, and the anterior longitudinal ligament.
- The middle column is composed of the posterior halves of the vertebral bodies and their intervertebral disks, as well as the posterior longitudinal ligament.
- Denis's posterior column was basically the same as Holdsworth's.




Illustrative sketch of three-element system of vertebral column, originally proposed by Denis. Vertebrae and disks are divided into anterior and middle columns. Posterior column made up of posterior elements and ligaments.

# INCIDENCE

The incidence of traumatic para- and tetraplegia ranges from 10 to 50 new patients per year per million population.

The lower cervical region (C4-7) and the thoracolumbar junction (T11-L1) are the most frequent sites of traumatic cord damage.

# FACTORS

Most of the patients experiencing such damage are under 30 years of age, and more men are involved than women.

- In industrialized countries, car, motorcycle, bicycle, and pedestrian accidents account for between 30 and 50 percent of the total number of such paralyzing injuries.
- Industrial accidents account for another 20 to 40 percent.
- Sports injuries of the cervical spine have become increasingly common.

# PATHOLOGY

The primary traumatic lesion, resulting directly and at the moment of injury from a mechanical impact on the spine, includes laceration of the dura and meninges, extradural, intradural, and subarachnoid hemorrhage, and damage to the cord and spinal roots.

# PATHOLOGY

The secondary changes following spinal injury comprise local or diffuse edema, circulatory disorders, and cord infarction with hemorrhagic necrosis.

The formation of a hematoma in the cord - known as *hematomyelia* - is rarely seen.

# CLASSIFICATION OF SPINAL INJURIES

Holdsworth classified injuries as:

- *flexion,*
- *flexion-rotation,*
- *extension,*
- *vertical compression,*
- *direct shearing.*

# CLASSIFICATION OF SPINAL INJURIES

Kelly and Whitesides classified fractures into ***stable*** and ***unstable*** *injuries.*

Stable injuries included compression of the vertebral bodies, either anterior or lateral, and "stable burst“ injuries.

Unstable injuries included the flexion-dislocation, flexion-rotation, fracture-dislocation ("slice" injuries), and "unstable burst" fractures.

# Stable injuries

Currently, the most common classification of these injuries is based on the three-column concept by Denis. About 50 percent of these injuries are *burst fractures* resulting from axial compression with damage to the anterior and middle column. The spinal canal is narrowed, due to the displacement of the broken-off posterior part of the vertebral body. In about 50 percent of patients with a burst fracture, there is neurological involvement that may be incomplete or complete.

# Unstable injuries

In the second most common type of injury, *the fracture dislocation,* all three columns of the spine are disrupted, due to translation forces in combination with axial compression or distraction and/or torsion. Radiologically, there is usually an anterior dislocation and angulation of the upper vertebra with detachment of an anterosuperior wedge fragment from the body of the lower vertebra. This results in a marked deformation of the spinal canal. About half of the patients have complete cord or cauda lesions, and in another 25 percent of these cases partial cord or root involvement exists.

# CLASSIFICATION OF SPINAL INJURIES

Lesions of the cord or cauda may be complete or incomplete (partial).

The complete paralysis of both lower limbs that may result from injuries to the spine is termed *paraplegia,* while incomplete lesions are designated as *paraparesis.* When all four limbs are involved, *tetraplegia* and *tetraparesis* are the internationally accepted terms.

# Incomplete Lesions of the Cervical Cord

There are various types of incomplete cervical cord lesions. They are not due to different mechanisms but represent a progression in the magnitude of the applied forces with increasing severity of injury. A root syndrome is the least serious clinical pattern. With greater force a central cord syndrome results, followed by the anterior cord syndrome, and finally a complete syndrome. Oblique forces can produce Brown-Sequard syndromes. Variations in clinical syndromes are caused by the magnitude and direction of the applied force of injury.

# Complete Cord Lesions

In the acute stage of complete cord lesions there exists a total flaccid paralysis with full loss of tendon reflexes and sensibility below the level of the injury. The cremasteric, sphincter ani, and bulbocavernosus reflexes may persist for some time after the injury, then disappear.

# NEUROLOGICAL DEFICITS

Neurological deficits resulting from injury to the spine depend upon the level of the injury as well as the portion of the spinal cord injured.

# Spinal Shock

The term *spinal shock* was introduced by Marshall Hall in 1841 to indicate the state of transient inexcitability or hypoexcitability of the isolated spinal cord below the level of a transection of the cord.

# Spinal Shock

The intensity and duration of the shock depend on the level of the organism on the vertebrate scale; the higher the degree of cerebral development, the greater the shock.

In spinal shock, the motor paralysis below the level of the lesion is at first of a flaccid type, even if the paralysis is of the upper motor-neuron type. All cutaneous and tendon reflexes below the level of the shock are greatly depressed or abolished, although bulbocavernosus and anal reflexes may persist.

When the shock subsides, the reflexes return. In humans, the duration of the areflexia varies, with reflex activity sometimes appearing within a period of three or four days in children or after three to six weeks in adults.

## *C1 to C4*

With cord lesions at the Cl to C4 level, the diaphragm is paralyzed as a result of interruption of the segmental innervation of the phrenic nerve.

Because all respiratory muscles below the transection are also paralyzed, lesions at this level will lead to death within a short time unless artificial respiration is applied immediately.

## *Below C4*

In the acute stage of injuries below the C4 level, diaphragm function is usually impaired but may recover.

The arms of the patient are paralyzed and the shoulders are drawn up by the action of the levator scapulae and trapezius muscles.

The neck and a small area of the anterior aspect of the upper arm have normal sensation; the rest of the body has a complete loss of sensibility.

## *Below C5*

Patients with lesions below C5 may also need artificial respiration.

In such injuries, the shoulders are elevated, the arms abducted, and the forearms flexed owing to uninhibited action of the deltoid, biceps, and brachialis muscles.

## *Below C6*

With injuries below C6, there is usually sufficient respiratory function for spontaneous breathing; tracheostomy and artificial ventilation are only rarely indicated.

The hands show radial deviation, owing to the action of the extensor carpi radialis muscles, but are paralyzed.

## *Below C7*

The hand and finger extensors and flexors are functional in the case of injuries below the C7 vertebra, but the interossei and some opposing muscles are greatly reduced in power. This usually results in a claw hand.

Most of these patients are able to write, to feed themselves, to type, and, after adequate training, to sit in a wheelchair with good balance, and can even take up wheelchair-bound athletic activities.

## *Thoracic Level*

The lower a transverse lesion is localized, the greater the number of intercostal muscles that function normally.

## *Epiconus and Conus*

Patients with epiconal and conal injuries may have a paralysis of the legs of the upper or of the lower motorneuron type.

Initially, they usually have urinary retention. Ultimately, plantar extensor responses and spasticity may develop.

# *Anterior Cord Syndrome*

The anterior cord syndrome is characterized by immediate complete paralysis with hypesthesia and hypalgesia below the level of the injury, but with preservation of the touch, motion, position, and vibration senses.

# *Central Cord Syndrome*

The central cord syndrome is characterized by disproportionally greater motor impairment of the upper than of the lower extremities.

There may be bladder dysfunction and varying degrees of sensory loss.

In milder variants of the syndrome, paresis of the arms or hands is combined with some weakness of the legs; in severe variants, the arms or hands are paralyzed and the legs are paretic.

In patients with the latter type there may be sensory loss involving all modalities, and urine retention is always present. This form of the syndrome is predominantly seen in hyperextension injuries but may also occur in hyperflexion injuries.

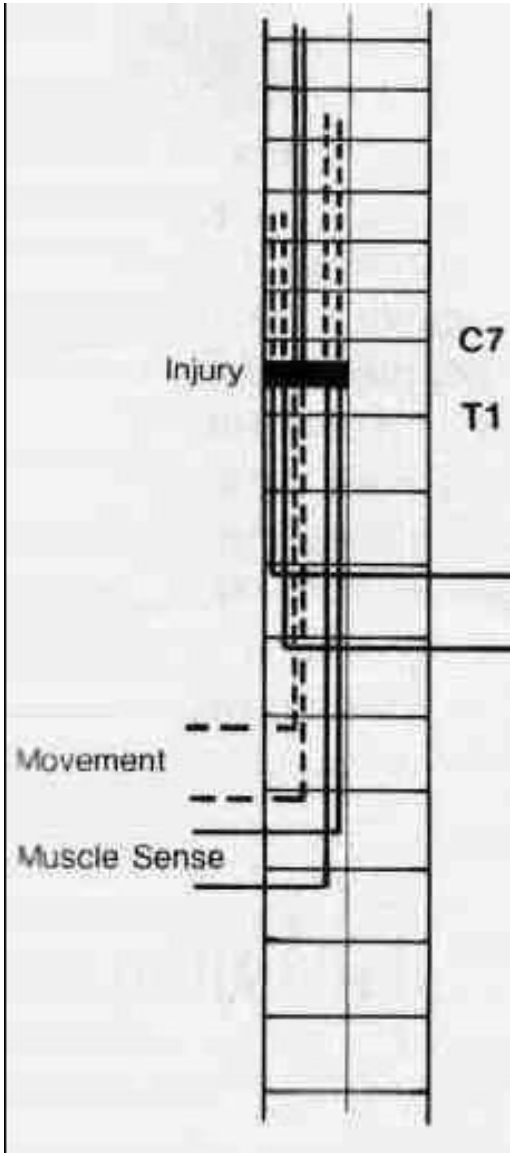
# Why ?

Rich vascularization of the central cord region that allows the extension of edema and hemorrhage along the central canal in a longitudinal direction.

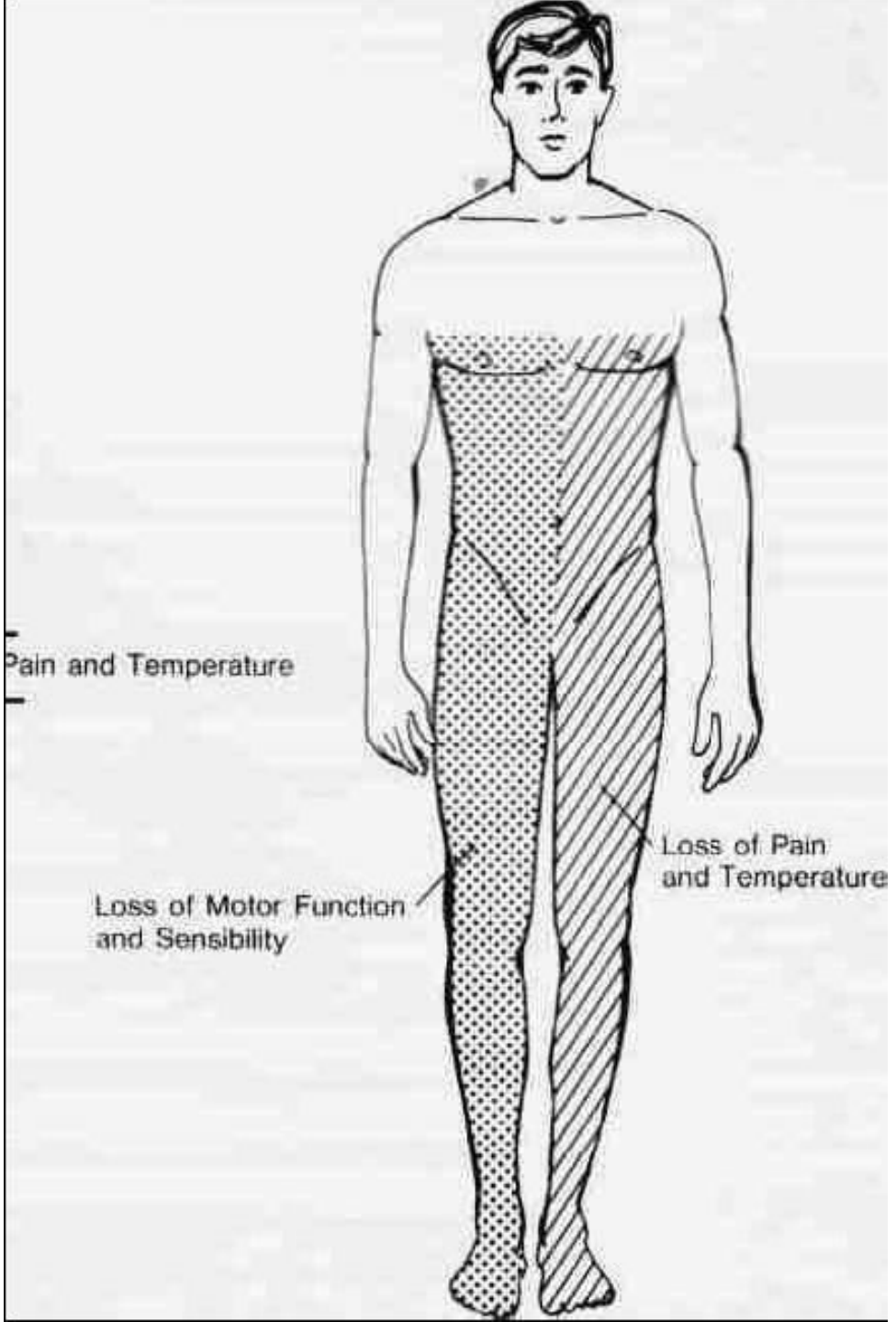
# Brown-Sequard Syndrome

The Brown-Sequard syndrome indicates a lesion of one lateral half of the spinal cord. It is characterized by an ipsilateral paresis and loss of proprioceptive sensation, with sensory ataxia below the level of the lesion, and contralateral loss of pain and temperature sensation.

A slowly progressive Brown-Sequard syndrome suggests spinal cord compression on one side, such as by a prolapsed intervertebral disc.




Schematic illustration of hemilateral injury to the spinal cord, producing the Brown-Sequard syndrome.



# CLASSIFICATION OF FRACTURES OF THE THORACOLUMBAR SPINE

**Compressive Flexion**

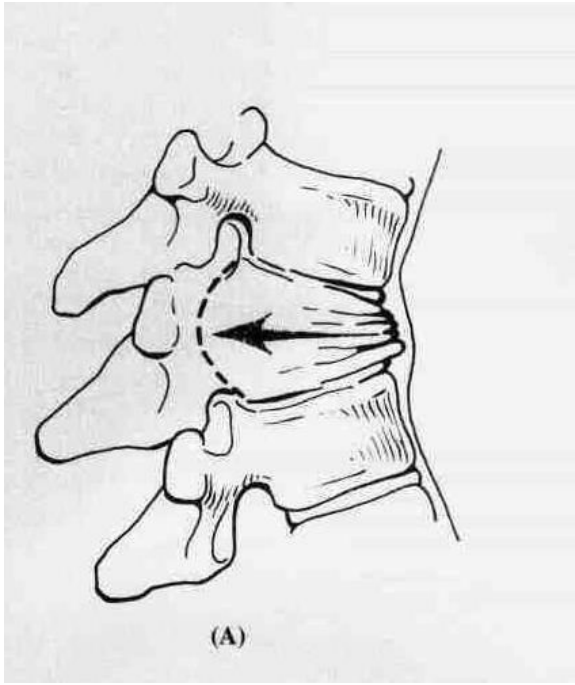
Compression through anterior elements.

***Patterns*** *of failure*

**1. Wedge** fracture anteriorly.

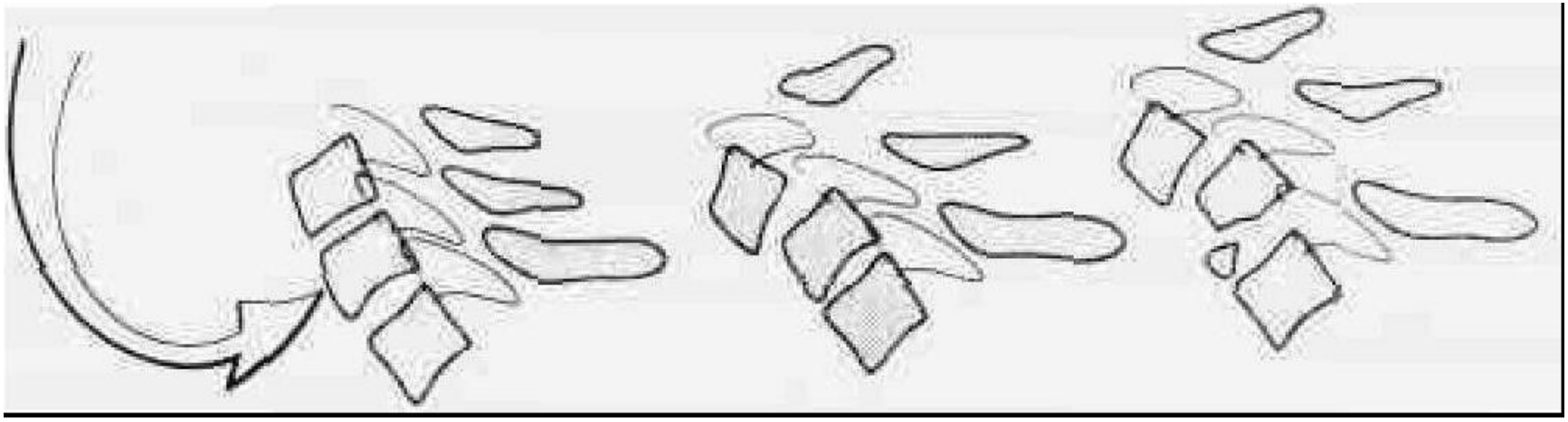
2. Anterior wedge fracture plus tension disruption of posterior elements,

3. Anterior wedge fracture plus middle element failure. Neural canal compromised by bony elements. Neurological deficits may progress.




Compression flexion injury of spinal column in an illustrative sketch, in a lateral view, showing collapse of the vertebra

# The compressive hyperflexion mechanism



The compressive hyperflexion mechanism. **Left:** before injury, showing C5-C6-C7; **middle:** first stage of injury. The compressive hyperflexion force causes the spine to move through an arc, displacing C6 backwards with respect to C7 and rupturing the corresponding intervertebral joint capsules and the C6-7 disc. A disc extrusion may result; **right:** last stage. There is marked widening of the C6-7 intervertebral joint space; C6 has been displaced backward with disruption of the posterior part of the intervertebral disc; the anteroinferior margin of C6 has broken off, although it remains in a normal relationship with C7. The C5-6 disc is usually intact but may be torn. The articular processes remain intact.

# CLASSIFICATION OF FRACTURES OF THE THORACOLUMBAR SPINE

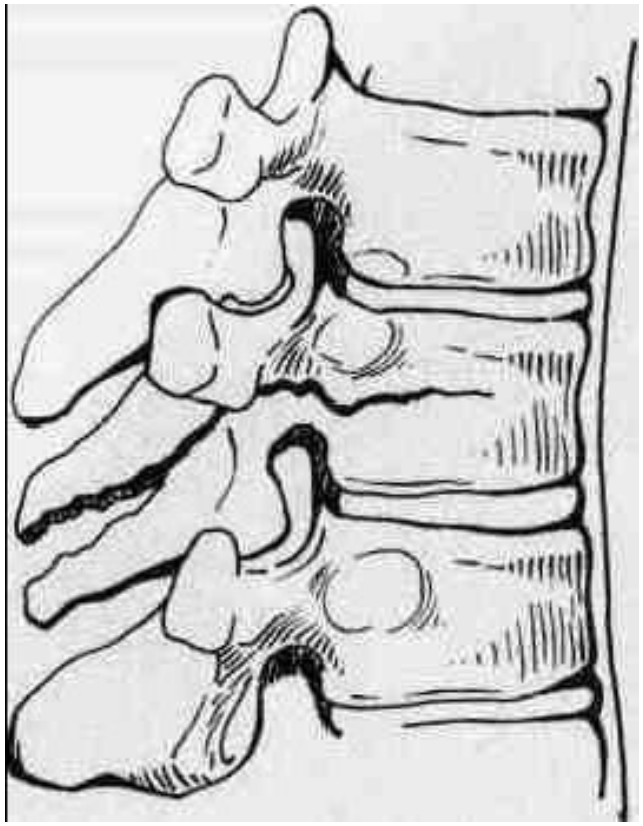
## Distractive Flexion

Failure of all three elements.

*Examples*

1. Chance fracture
2. Pure distraction

Neurological injuries proportional to amount of translation.



Illustrative sketch of a distractive flexion injury showing a "Seat belt" of "Chance" fracture.

# CLASSIFICATION OF FRACTURES OF THE THORACOLUMBAR SPINE

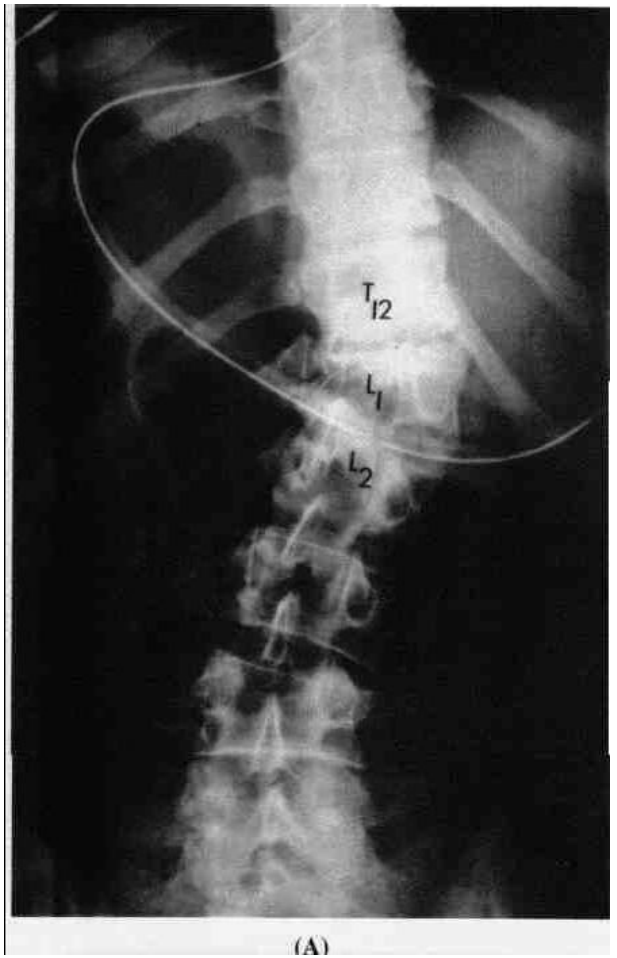
## Lateral Flexion

Compressive force caused by lateral bending in compression.

*Patterns of failure*

1. Anterior and middle elements, unilaterally (usually stable)
2. All three elements fail.

Neurological deficits likely to progress.




Lateral flexion injury of vertebral column at the L1-L2 junction, showing acute scoliosis in the frontal x-ray

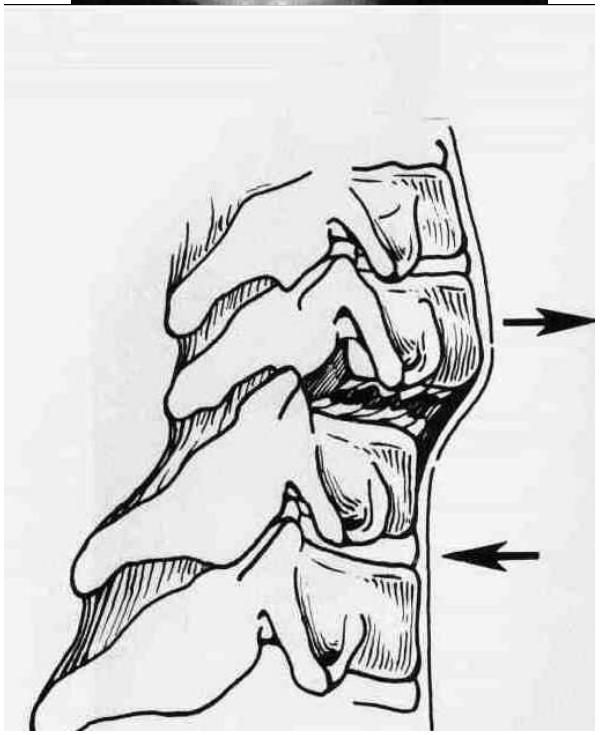
# CLASSIFICATION OF FRACTURES OF THE THORACOLUMBAR SPINE

## Translation

Results from displacement of vertebral body, anteriorly, posteriorly, or laterally.

All connecting processes and ligaments likely disrupted if displacement exceeds 25%.

Neurological deficits are usual.

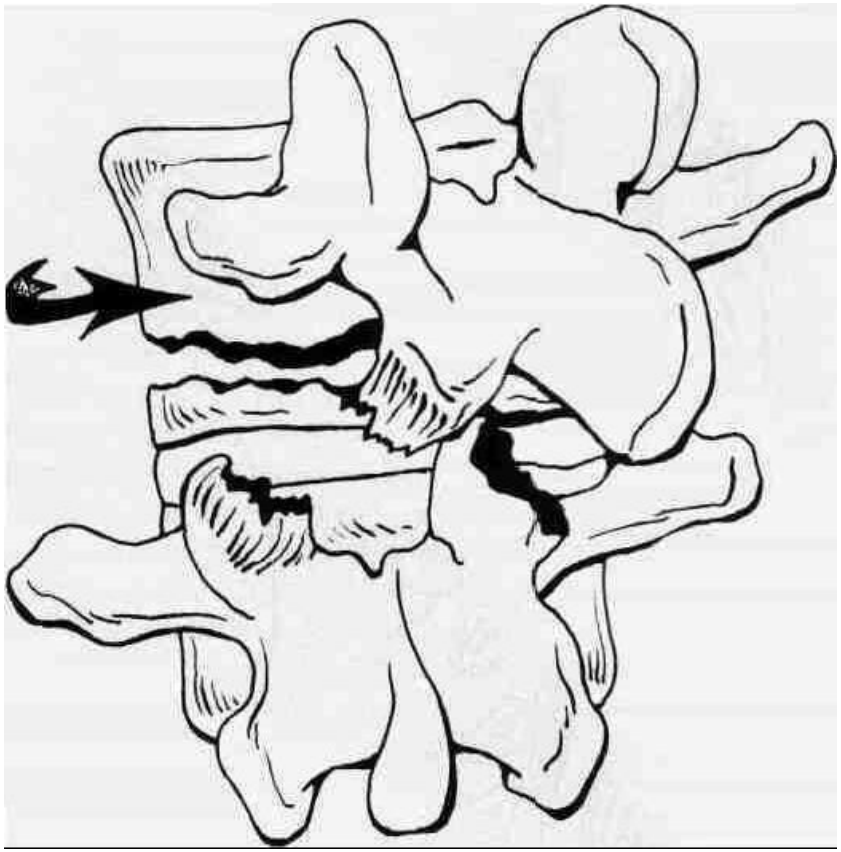


An illustrative sketch of a translational injury to the vertebral column showing displacement

# CLASSIFICATION OF FRACTURES OF THE THORACOLUMBAR SPINE

**Torsional Flexion**
Torsion with compression of anterior elements and tension and torsion of posterior elements.

**Involvement** of middle elements inconstant. Neurological deficits may progress.



An illustrative sketch of a torsional injury to the vertebral column.

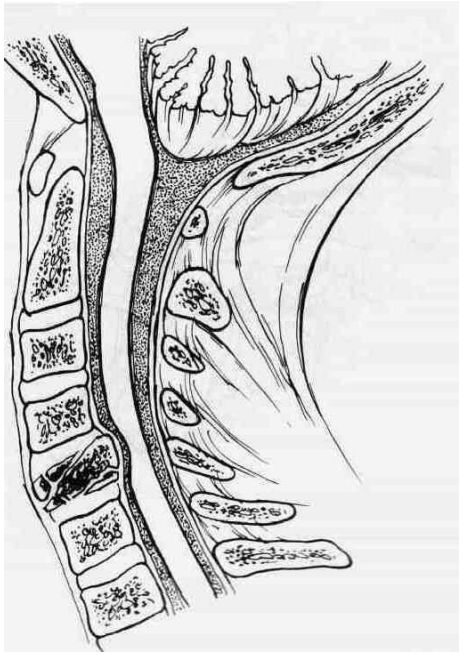
# CLASSIFICATION OF FRACTURES OF THE THORACOLUMBAR SPINE

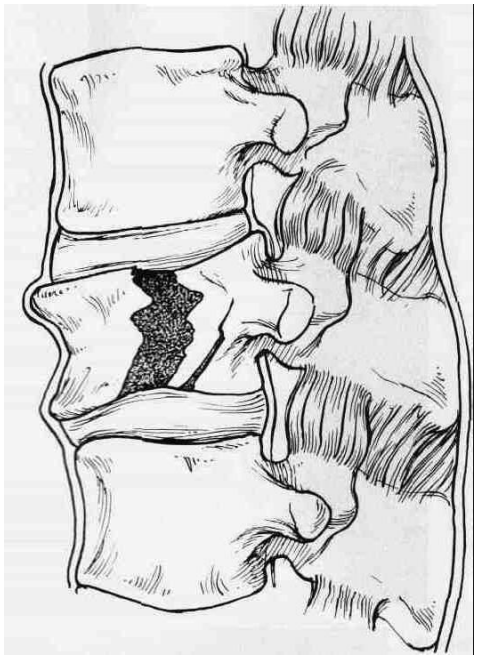
**Vertical Compression**

**Shortened** vertebral body.

Patterns of protrusion into canal.

1. Wall **may bulge** into canal.
2. Wall **may enfold** with apex at superior or inferior segment of vertebral body.





Examples of vertical compression injuries of the fifth cervical vertebra

# CLASSIFICATION OF FRACTURES OF THE THORACOLUMBAR SPINE

## Distractive Extension

Tension disruption of anterior elements and compression failure of posterior elements.

Rare except in cervical area. Displacements may reduce spontaneously.

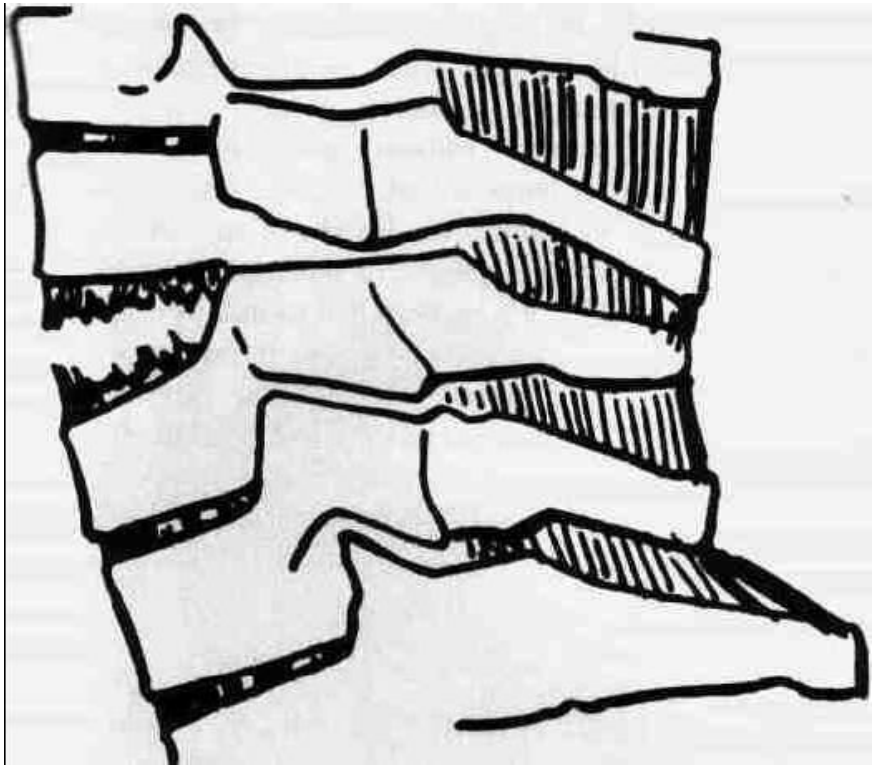
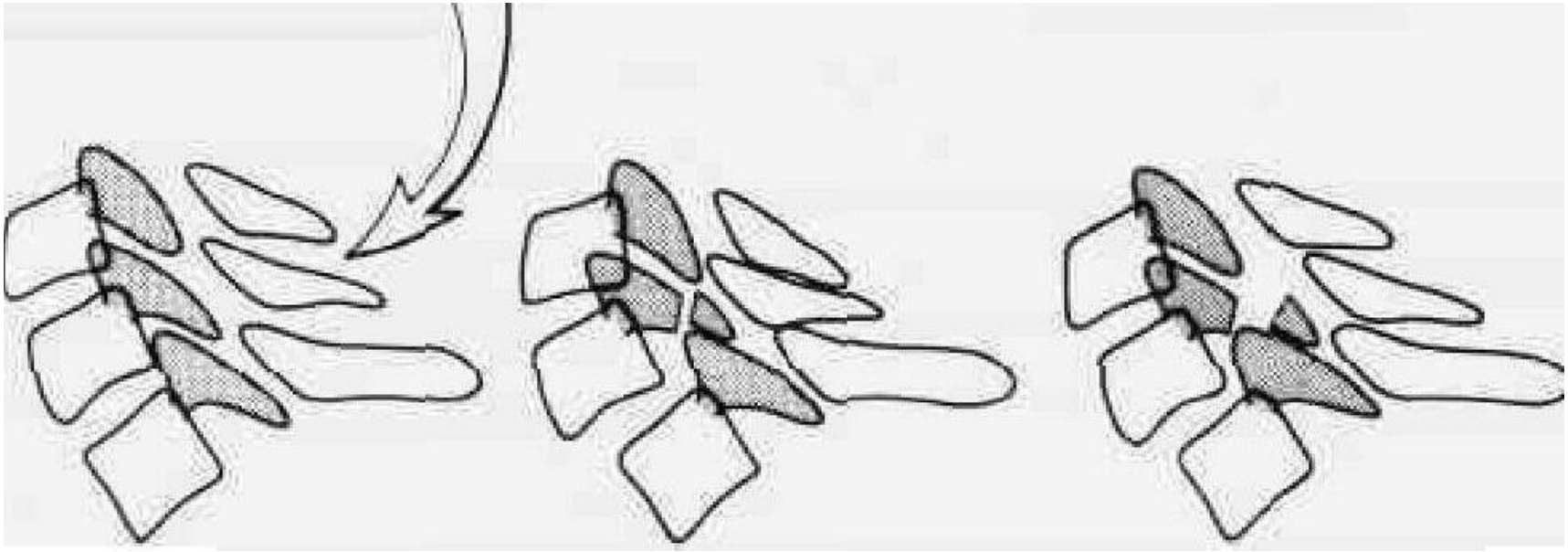


**Figure 19-10** An illustrative sketch of a distractive extension of the vertebral column, most commonly occurring in the cervical area and rarely demonstrating significant damage by x-ray.

# The mechanism in compressive hyperextension injuries



The mechanism in compressive hyperextension injuries. The trauma forces the head backwards and downwards, resulting in a hyperextension fracture dislocation with fracturing of the articular processes and marked forward slipping of the corresponding vertebra. In many cases, the anterior longitudinal ligament is ruptured. The sagittal diameter of the spinal canal is not reduced. Consequently most of these patients have no neurological deficit.

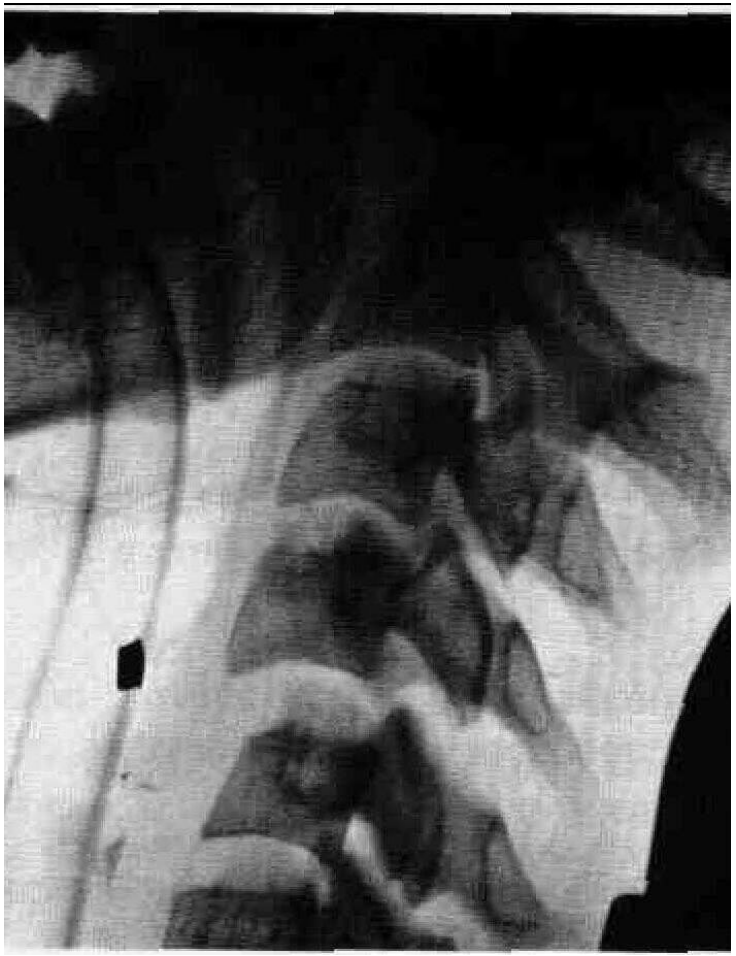
# CLASSIFICATION OF FRACTURES OF THE THORACOLUMBAR SPINE

Hyperextension sprain - even dislocation - in a 40 - year-old male patient with ankylosing spondylitis. Marked dehiscence at the C5-6 level.

# CLASSIFICATION OF FRACTURES OF THE THORACOLUMBAR SPINE

***Facet Interlocking***

Facet interlocking occurs if the articular facets lose contact, override, and, while springing back after injury, become interlocked.



Unilateral interlocking C4-5 in a 21-year-old male.
Note the abrupt shift in the column of intervertebral joints on one side.
This picture was taken during skull traction and displays the rupture of the anterior and posterior longitudinal ligaments at the C4-5 disc space and the capsules of the intervertebral joints.

# EVALUATION

Identification of soft tissue injury in the spinal canal is generally best accomplished by MRI, but computerized tomography is usually the first examination after plain radiographs in patients with potential injury to the spinal column. Fresh blood may not be readily apparent on MR images, and better bone detail is obtained with CT.

# X-ray

- A. Order lateral spine X-ray study first; all seven cervical vertebrae and C7-T1 junction should be seen
- B. Order anterior/posterior cervical X-ray and an open-mouth odontoid X-ray, if possible

# X-ray

look at:

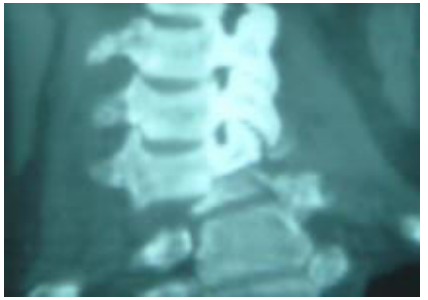
1. Shape, size, and alignment of vertebral bodies
2. Pre-vertebral swelling
3. Position and integrity of the vertebras
4. Orientation and clarity of facet joints
5. All spinous processes
6. Alignment of the spino-laminal lines

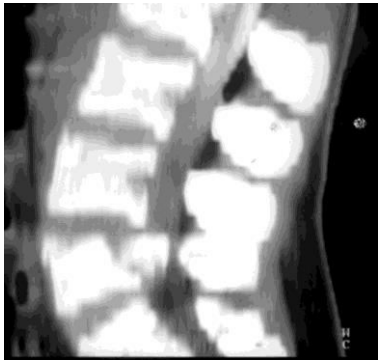
# Myelography

Contrast enhancement of the spinal canal prior to CT scanning may be useful in assessing the effect of the spinal injury on the thecal sac.

# Computed Tomography

Computed tomography is useful in differentiating compression fractures from burst fractures. Computed tomograms are quite helpful in diagnosing Jefferson's fractures, pedicle fractures, laminar fractures, and fractures of the spinous process. Atlantoaxial rotary dislocations are also well visualized on CT scans.

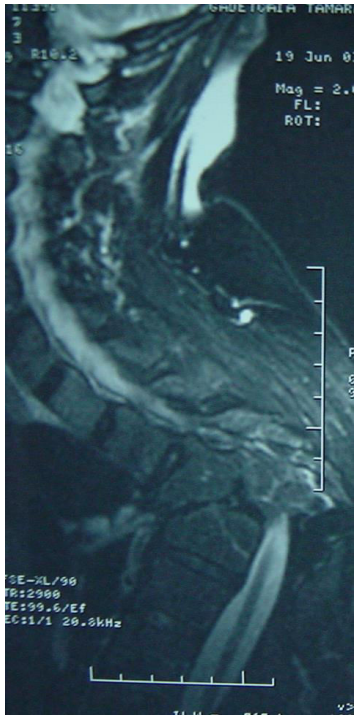


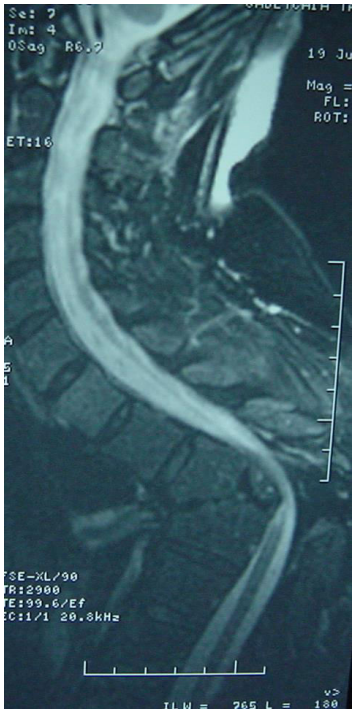


# Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) provides important data concerning the nature and extent of injury to the spinal cord and reveals the spinal epidural and subarachnoid spaces.

An excellent way of assessing spinal cord damage and ligamentous injury.





# FIRST AID AND TRANSPORT

The principal aim of first aid is the preservation of life and the reduction of risk to the patient.

Careful first aid followed by immediate transport to a well-equipped hospital unit should be the aim of all concerned.

# FIRST AID AND TRANSPORT

Whether patients who probably have a spinal injury but are unconscious should be transported in the supine or in the semiprone lateral position is still a matter for discussion.

Vomiting by a patient in the supine position may cause airway obstruction, in which case the semiprone lateral position may be advisable.

# FIRST AID AND TRANSPORT

- Respiratory function is the first concern.
- The next consideration is assurance of adequate circulation.
- Structural stability is the next consideration.

  A spine board is applied at the place of injury, or in the absence of a spine board, stability of the injured part may be assured during the course of transport by sandbags or cervical traction on a firm stretcher.

# FIRST AID AND TRANSPORT

- Hemorrhage must be stopped.
- Shock recognized, and
- The thorax, extremities, and abdomen examined for associated injuries.

# FIRST AID AND TRANSPORT

- A nasogastric tube should be passed to aspirate the stomach contents in all patients with severe cervical or upper thoracic cord injuries.

# FIRST AID AND TRANSPORT

- loss of ability to evacuate the urinary bladder is likely, and catheterization may be necessary.

# FIRST AID AND TRANSPORT

Neurological deficits resulting from injury to the spinal cord can be significantly reduced by the intravenous administration of Methylpredniolone IV, bolus dose of 30 mg per kg of body weight over 15 minutes, followed by maintenance dose of 5.4 mg per kg per hour for 23 hours if treatment can begin within 3 hours of injury, and for 48 hours if treatment is begun between 3 and 8 hours of injury.

# TREATMENT

Pneumatic alternating-pressure mattresses fail to prevent pressure sores in paraplegic patients.

To prevent the sores from developing, these patients must be turned every 2 to 3 hours.

This turning has the additional purpose of sustaining respiratory, renal, and intestinal function.

# TREATMENT

If the patient is incorrectly positioned in bed, contractures are likely to develop.

# TREATMENT

Lifesaving procedures have the highest priority, and measures to prevent pressure sores, urinary infection, and pulmonary collapse or infection should be undertaken immediately after the accident, since they are more critical than orthopedic measures for the spine injury.

# TREATMENT

In nonspecialized hospitals, inflatable balloon catheters such as the Foley catheter are recommended for treating this.

With the use of the intermittent catheterization three or four times per day by well-trained nurses or by doctors under aseptic conditions as strict as those in surgery, it is possible to maintain a sterile urine in the paralyzed patient for a period of weeks or months.

# TREATMENT

Acidifying drugs will bring about the desired acidification of urine and may help in preventing the formation of stones.

# TREATMENT

Physiotherapists and the nursing staff should take care of respiratory exercises and coughing assistance, particularly in tetraplegic patients.

Any retention of bronchopulmonary secretions should be alleviated with the aid of secretion stimulants.

Bronchoscopic aspiration or controlled ventilation may be necessary to relieve atelectasis.

# TREATMENT

The incidence of deep venous thrombosis and pulmonary embolism in paralyzed patients can be reduced by the immediate use of prophylactic anticoagulants, and particularly by the use of small doses of heparin.

The incidence of thrombosis and embolism can also be decreased by regular turning and intensive physiotherapy (passive movement) of the patients.

# Treatment of Cervical Spine Injuries

The deformation of the cervical spinal canal following a spinal injury can be corrected by

- postural reduction,
- manual reduction,
- manual reduction under anesthesia,
- skull traction, or
- open surgical reduction.

# Postural Reduction

Postural reduction is the method of choice in hyperflexion sprains, hyperextension sprains, and anterior atlantoaxial dislocations.

The kyphotic angulation in hyperflexion sprains can be corrected by retroflexion of the neck over a roll placed in the nape of the neck.

The lordotic angulation in hyperextension sprains can be reduced by careful flexion of the neck under fluoroscopic control.

Anterior atlantoaxial dislocations can also be reduced by retroflexion of the neck.

# Manual Reduction

Manual reduction under anesthesia with traction in the long axis of the spine under fluoroscopic control but without manipulation is, according to many European authors, the method of choice in cases of recent interlocking.

# Traction

Traction along the axis of the cervical spine has been used for centuries to reduce dislocations and to realign the spinal canal in fracture dislocations.

# Nonsurgical Stabilization

The conservative management of cervical spine injuries with bed rest, corselette for periods of weeks or months is universally used.

# Surgical Stabilization

The main argument for the surgical approach is the occasional recurrence of dislocation or of kyphotic angulation after distractive and compressive hyperflexion injuries and conservative management.

Another is the long period of bed rest required with conservative management, an approach that may be too expensive for the patient and may hamper rehabilitation.

# Surgical Stabilization

These procedures permit many patients to be ambulated within a few days after the operation.

They are the most effective methods of achieving reduction, stability, decompression, and early mobilization in cases of thoracolumbar and lumbospinal injuries.

# Approach

The surgical procedure may be performed through a posterior or anterior approach to the spine, depending upon the level and the type of vertebral injury and the preference and experience of the surgeon.

# Stabilization for Traumatic Cervical Lesions: How ?

Anterior or combined approach ?

anterior posterior combined

# Approach

In the posterior approach, wiring of the spinous processes or arches, or plating of the arches is usually done, followed by bone grafting.

# Approach

The anterior approach has several advantages over the posterior approach.

During the operation, the patient can remain in the supine position, which is an advantage when there are maxillofacial injuries or injuries of the chest or limbs.

Blood loss is minimized, and it is easier to keep the spine immobile during the positioning on the operation table and during the operative procedure itself.

The postoperative immobilization of the patient is also somewhat shortened.

However, there are more disappointing long-term results due to an imperfect operative technique with the anterior approach than with the posterior approach with wiring and grafting.

# Treatment of Thoracic Spine Injuries

Most injuries between TI and T10 are quite stable, due to splinting by the rib cage and the sternum. Consequently most of them do not need internal fixation and can be treated with external support. Ambulation is allowed within a few weeks.

In more severe, complex fracture dislocations, open reduction may be required, and internal fixation and spinal fusion or long-term bed-rest immobilization is necessary to achieve stability.

Many patients with paraplegia due to an injury of the thoracic spine are anoxic and hypercarbic as a result of multiple associated injuries and require intensive care.

# Treatment of Thoracolumbar Spine Injuries

Currently, most surgeons believe that neurological recovery can best be achieved by the restoration of alignment of the spine through open reduction and internal fixation, facilitating rapid restoration of the spinal alignment and reducing nursing problems.

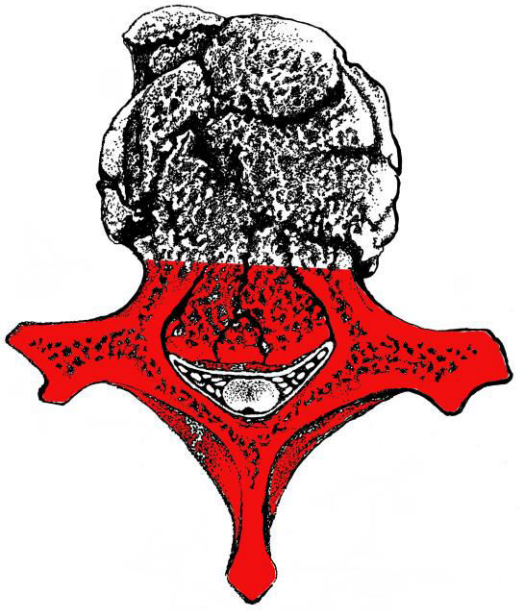
Wire loops, metallic plates, springs, compression and distraction rods, and anterior or posterior bone grafts may be used as an internal splint.

# SURGICAL TREATMENT OF TRAUMATIC SPINAL INJURIES

The objectives of treatment for traumatic injury to the spine are

- **Decompression**
- **Realignment**
- **Stabilization**
- **Preventing second injuries**
- **Early mobilisation**

# TREATMENT OF OPEN WOUNDS OF THE SPINE



- **PENETRATING WOUNDS**

  Exploration of the injury is usually accomplished by *laminectomy.*

  In the event that the missile has destroyed the vertebral body, it may be necessary to debride the body and implant a graft or prosthesis.

# TREATMENT OF CLOSED WOUNDS OF THE SPINE

## INJURIES AT THE CRANIOVERTEBRAL JUNCTION

- **CERVICAL TRACTION**

Gardner-Wells tongs are most commonly used to apply *skeletal traction.*

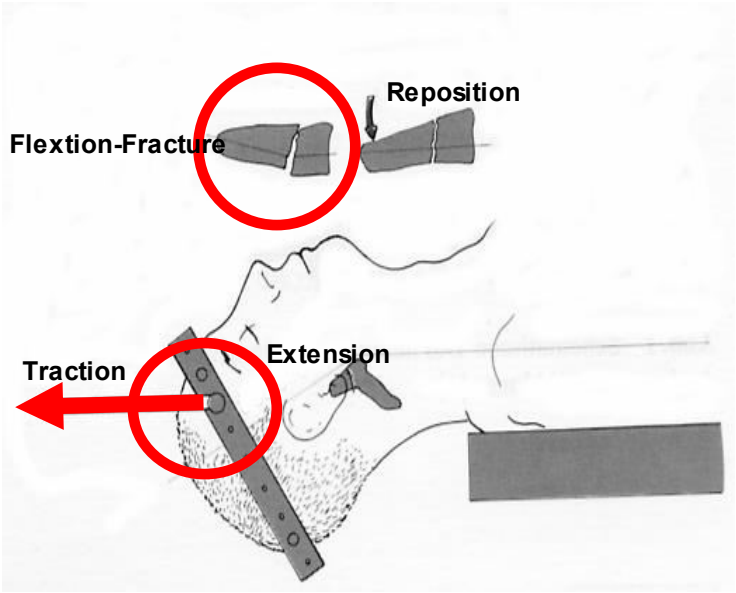
# CERVICAL TRACTION

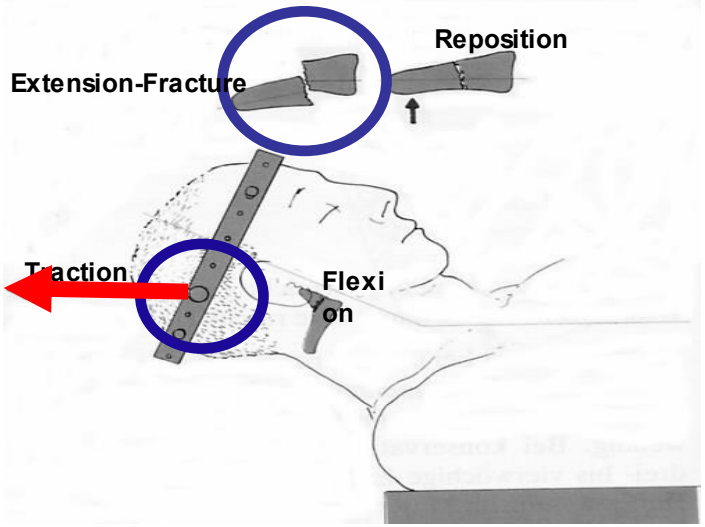
Photograph of a patient, showing the Gardner-Wells tongs for distraction and/or stabilization of an injury to the cervical vertebrae.

# CERVICAL TRACTION

- A more anterior placement will provide traction with the neck in extension, which is often desirable when treating dislocations of the odontoid.

- A more posterior placement will provide traction with the neck in flexion which may be desirable when trying to "unlock" facets. Otherwise, traction is usually applied in a straight line.

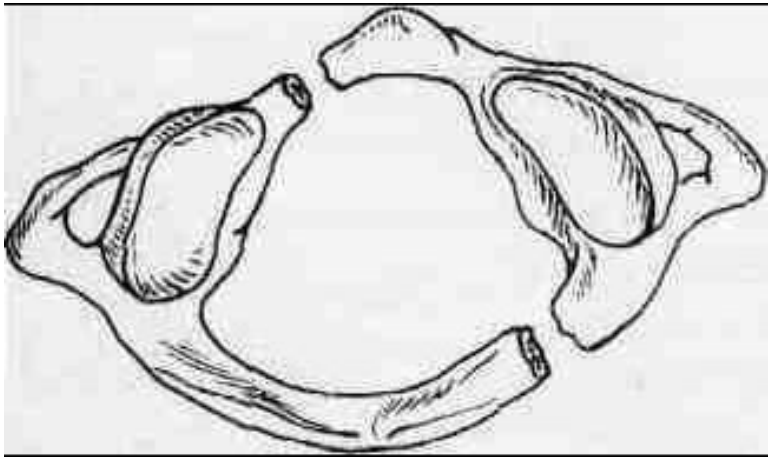


# TREATMENT OF SPECIFIC INJURIES

## JEFFERSON FRACTURE

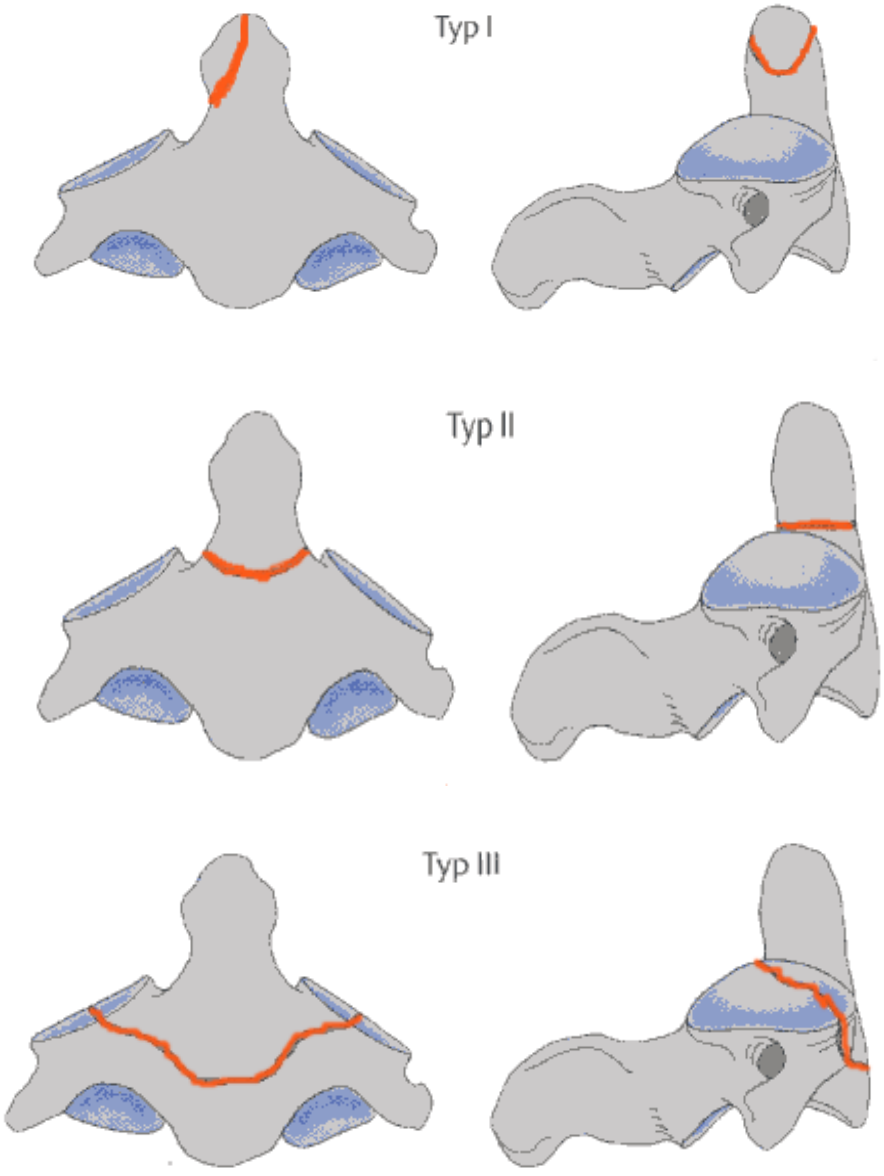
A *Jefferson fracture* is a fracture through the ring of the atlas



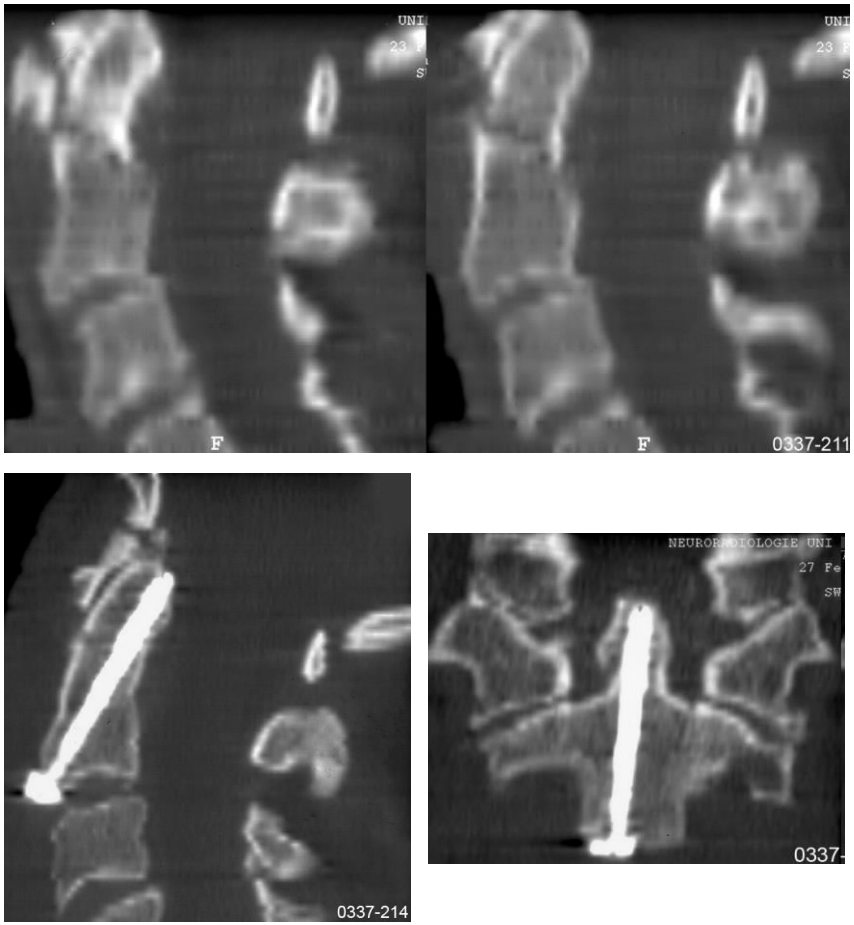
Schematic illustration of a Jefferson fracture. Note that there are fractures in both the anterior and posterior segments of the ring. Injury to the ligamentous elements in such a fracture is variable.

# FRACTURE OF THE ODONTOID PROCESS

Schematic illustrations of the three types of fractures of the odontoid.
Type I (upper) involves the apex of the odontoid. This is rare but may be associated with significant ligamentous injury.
Type II (middle), across the neck, is often associated with ischemic necrosis of the odontoid process.
Type III extends into the body of the axis



# FRACTURE OF THE ODONTOID PROCESS



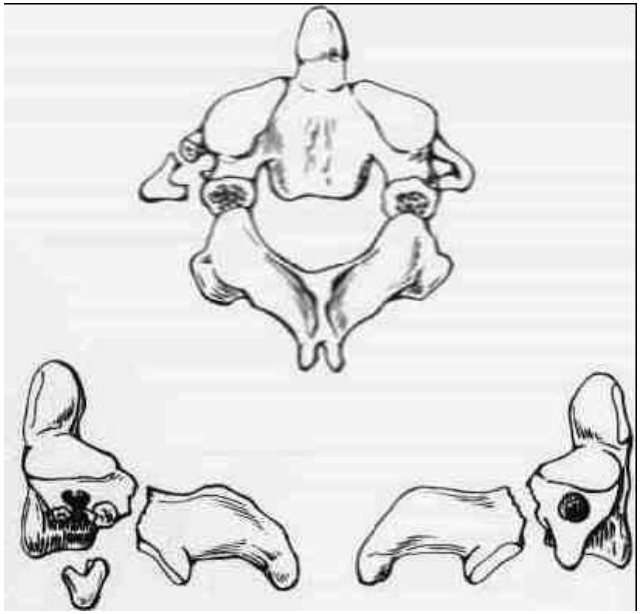

A schematic illustration of fixation of the odontoid process with one or two screws. This form of fixation is reportedly quite effective early but frequently met with failure when delayed.

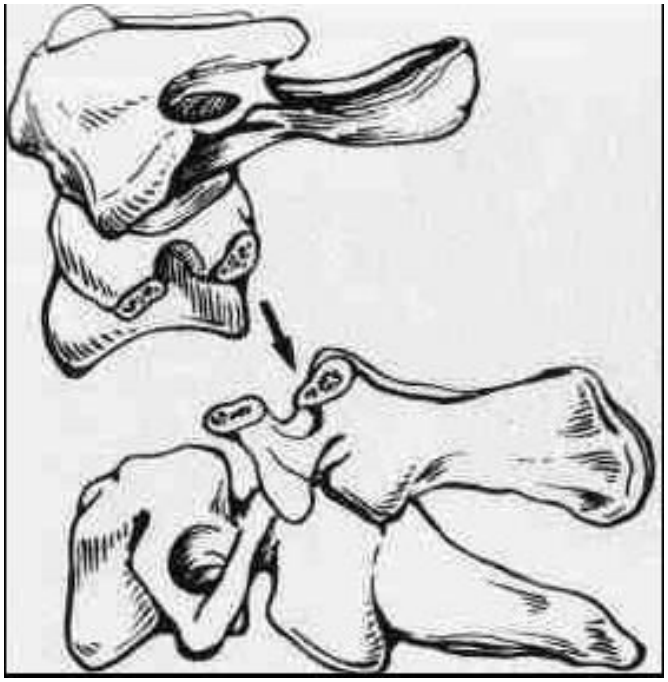
# HANGMAN'S FRACTURE

Whiplash-injury

A hangman's fracture is a fracture through the pedicles of the second cervical vertebra that may be accompanied by anterior translocation of the body of C2 on C3.

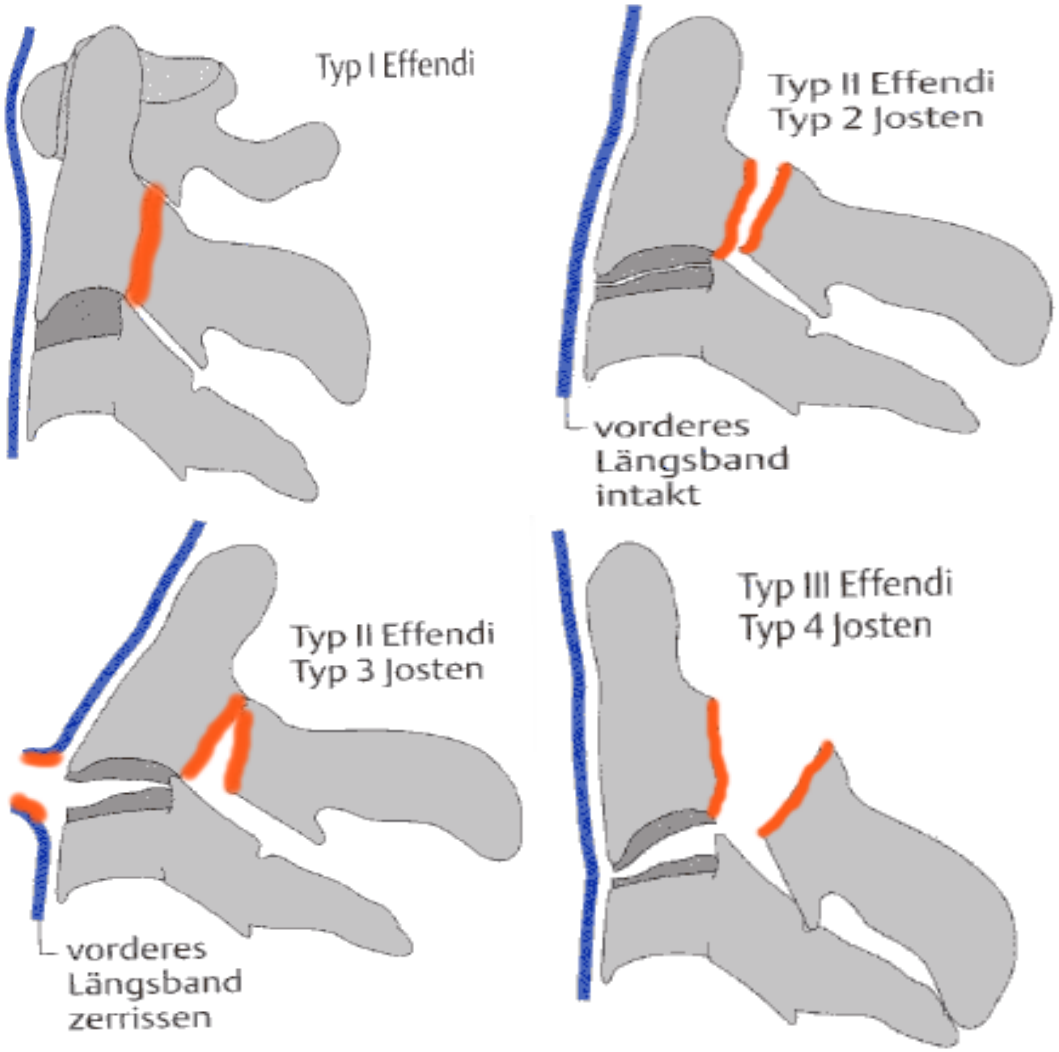
# HANGMAN'S FRACTURE



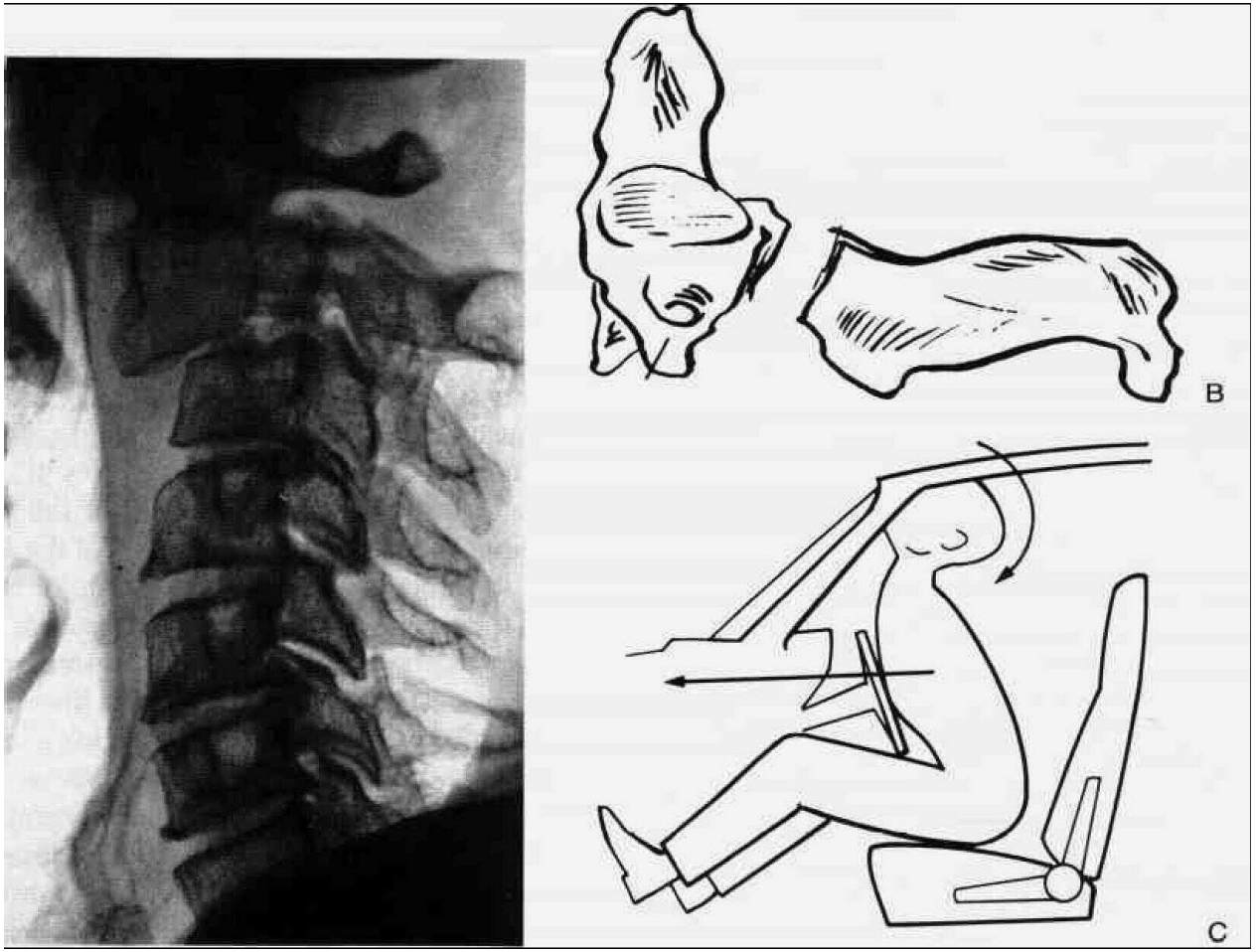


Schematic illustration of fractures through the pedicles of the axis (Hangman's fracture) *(A),* showing potential dislocation *(B).*

# HANGMAN'S FRACTURE

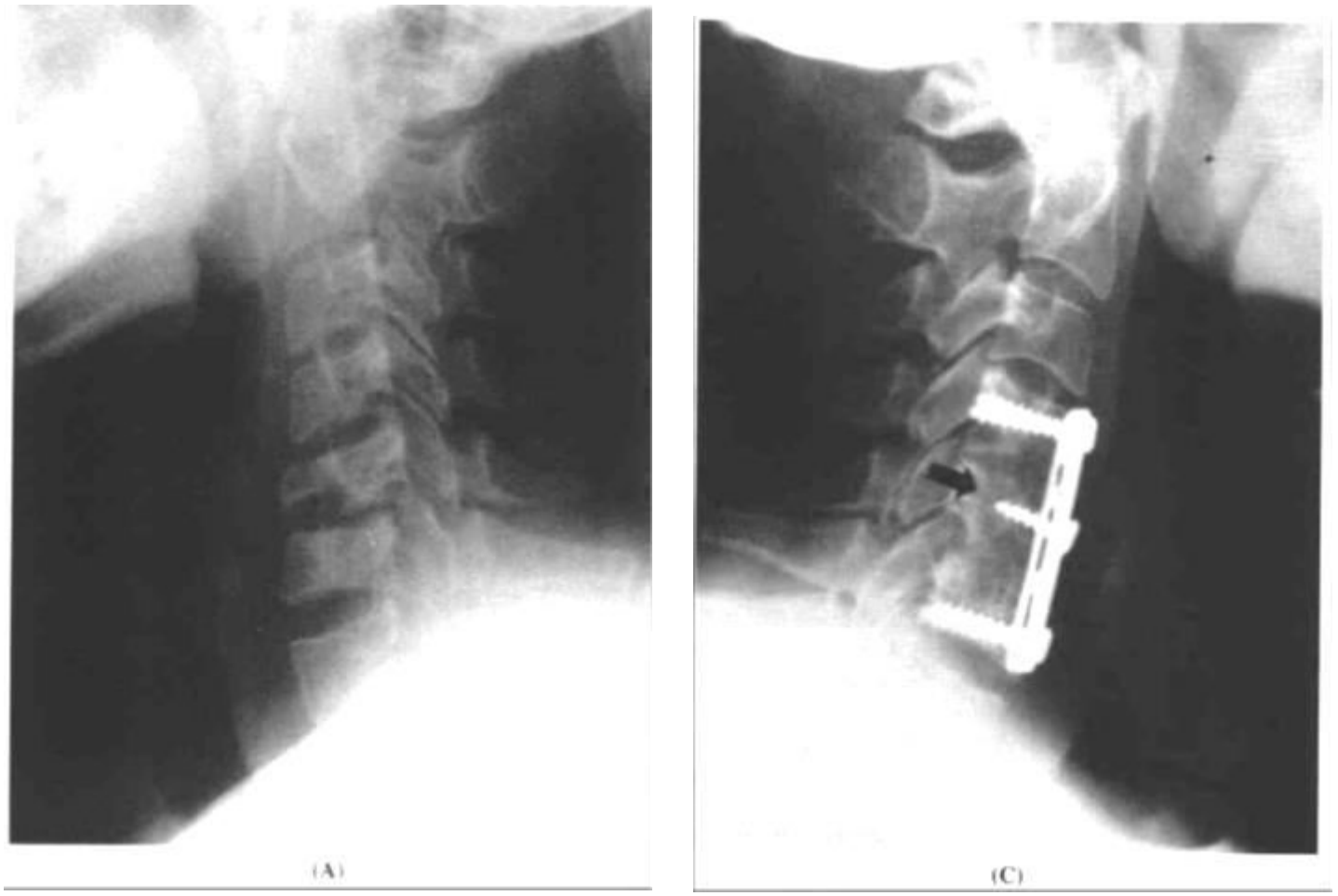


# HANGMAN'S FRACTURE

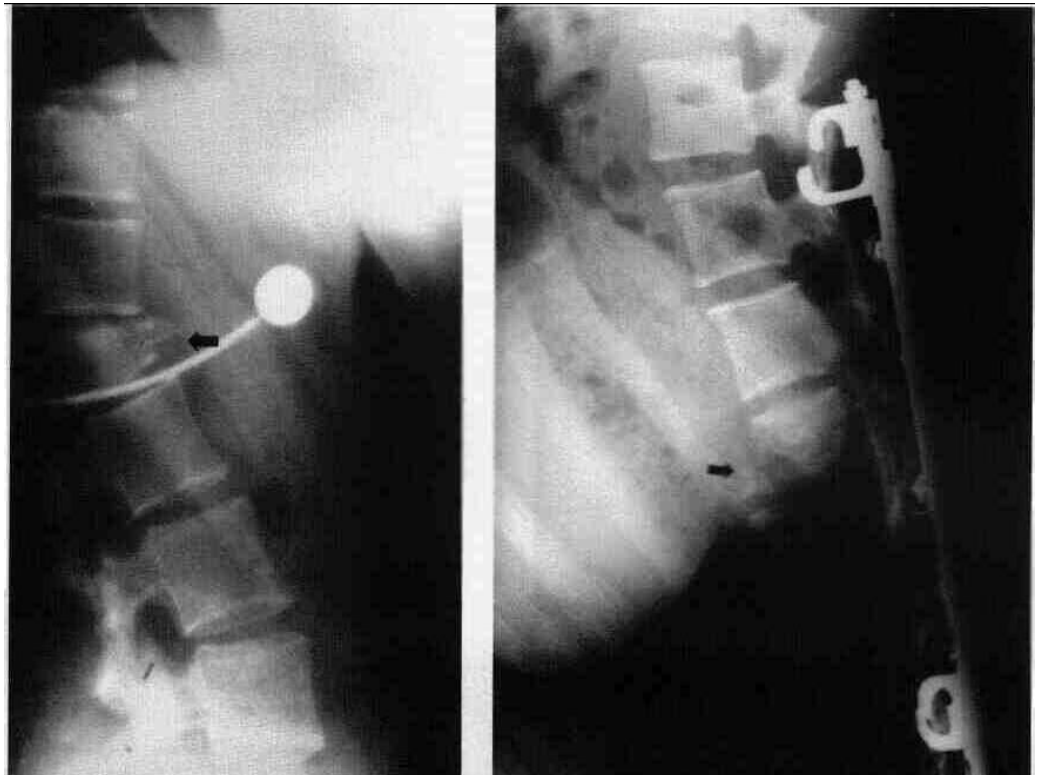



(A) Hangman's fracture with marked anterolisthesis at C2-3 in a 55-year-old man involved in a car accident; (B) the site of the fracture; (C) mechanism of injury.

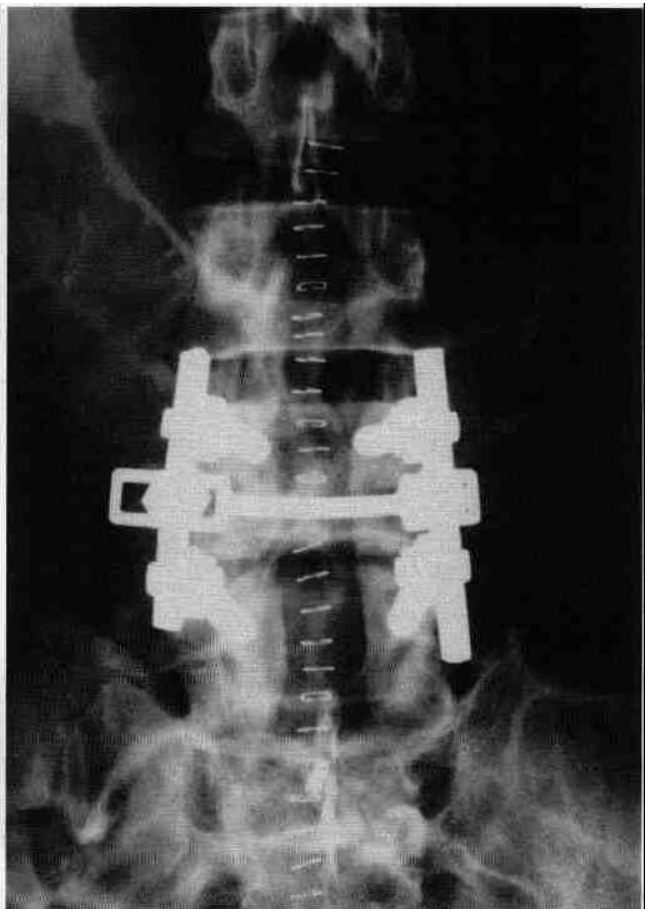
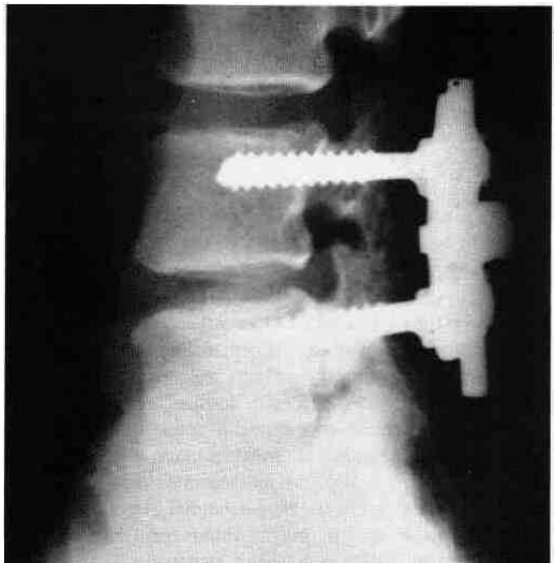
Compression flexion injury with ligaments torn between the spinous processes of C4 and C5 *(A)* fixed with Halifax clamps and fusion *(B).*




Flexion compression fracture of C5 seen in the lateral radiograph fixed by corpectomy and fusion maintained with a Caspar plate.



Compression fracture of LI seen in the lateral radiographs before *(A)* and after *(B)* reduction with Harrington rods. The postoperative frontal view is also shown *(C).*

An iatrogenic fracture of the inferior facet of L4 seen in the lateral projection *(A)* is immediately immobilized with pedicle screws and connecting rods, using the Texas Scottish Rites Hospital system, shown in *B* and *C.* The patient's pain was relieved.

# Frankel's Classification

Frankel's system of classification enables one to compare more easily the neurologic state of a spinal cord - injured patient on admission and on discharge. In this classification, there are five categories:

# Frankel's Classification

A. Complete. There is a complete loss of motor and sensory function below the level of the lesion.

B. Sensory only. Motor paralysis is complete below the level of the lesion, but some sensation is present.

C. Motor useless. Some motor power is present below the level of the lesion but is of no practical use to the patient.

D. Motor useful. There is useful motor power below the level of the lesion. The patient can move his or her lower limbs and many patients can walk with or without support.

E. Recovery. The patient is free of neurologic symptoms such as weakness, sensory loss, or sphincter disturbances; however, reflexes may be abnormal.

# PROGNOSIS

Mortality following a spinal cord lesion depends on the level and severity of the lesion, the presence of severe associated injuries, and the age and premorbid medical condition of the patient.

# Causes of death

The main causes of **early** death are

- pulmonary embolism,
- other pulmonary complications,
- cardiorespiratory failure due to bulbar involvement,
- head injuries or multiple lesions elsewhere in the body.

In thoracic and thoracolumbar spinal fractures, death is usually due to massive trauma with complete disruption of the spine and spinal cord, and major abdominal and thoracic injuries.

# Causes of death

The most common causes of death in patients with a survival of from three months to five years are **respiratory complications** and pulmonary embolism.

In those surviving more than five years **urogenital complications and hypertension** are the major causes of death.

Less common causes of delayed mortality are **cerebrovascular accidents, bladder carcinoma, and suicide.**

# Recovery of Function in Survivors

An initially complete cord lesion may be fully reversible if it is owing to spinal shock.

Moreover, a combination of spinal shock and partial destruction of the cord will progress to partial recovery.

In cases of complete cord destruction, however, the lesion is irreversible.

1. transverse lesion syndrome: involvement of corticospinal and spinothalamic tracts and posterior columns, with anterior horn cells segmentally involved. Most frequent syndrome, possibly an "end-stage" of the disease process
2. motor system syndrome: primarily corticospinal tract and anterior horn involvement with minimal or no sensory deficit. This creates a mixture of lower motor neuron findings in the upper extremities and upper motor neuron findings (myelopathy) in the lower extremities which can mimic ALS (*see below*). Reflexes may be hyperactive below the area of maximal stenosis (including the upper extremities, occasionally beginning several levels below the stenosis)
3. central cord syndrome: motor and sensory deficit affecting the UEs more than the LEs. This syndrome is characterized by dysfunction of the watershed areas located centrally within the cord, which may be responsible for prominence of hand symptoms[242] (results in "numb-clumsy hands"[243]). Lhermitte's sign may be more common in this group
4. Brown-Séquard syndrome: often with asymmetric narrowing of the canal with the side of greater narrowing producing ipsilateral corticospinal tract (upper motor neuron weakness) and posterior column dysfunction with contralateral loss of pain and temperature sensation
5. brachialgia and cord syndrome: radicular UE pain with lower motor neuron weakness, and some associated long tract involvement (motor and/or sensory)