BONE

BIOMECHANICS OF THE SPINE

Kenneth Alonso, MD, FACP

Superficial muscles of the neck

- The muscles of the neck are compartmentalized into seven fascial planes.
- These planes normally enable pain-free movement of one muscle group on the other.

- The platysma draws the corners of the mouth inferiorly and widens the mouth.
- It draws the skin of the neck superiorly when the teeth are clenched.

Superficial muscles of the neck

- The sternocleidomastoid tilts laterally, flexes the neck and rotates the neck so the face is turned superiorly toward the opposite side. (unilateral action).
- It is shortened in congenital torticollis
- The sternocleidomastoid extends the neck at the atlanto-axial joints while flexing inferior vertebrae so chin is thrust forward while the head is kept level. (bilateral action).
- With the cervical vertebrae fixed, the sternocleidomastoid may elevate the manubrium and medial ends of the clavicles, assisting in the pump-handle action of deep respiration.

Superficial muscles of the back

- The trapezius (superior fibers) elevate the pectoral girdle and maintain level of shoulders against resistance.
- With shoulders fixed, bilateral contraction extends the neck;
- Unilateral contraction produces flexion to the same side.
- Insert on the clavicle and scapula.
- Act on the scapula.

Superficial muscles of the back

- The trapezius (middle fibers) retract the scapula
- The trapezius (inferior fibers) depress the shoulders
- The superior and inferior fibers together rotate the scapula upward.
- Innervated by CN XI.

Superficial muscles of the back

- The latissimus dorsi inserts into the floor of the bicipital groove.
- Extends, adducts, and medially rotates the arm.
- Used in climbing.
- Innervated by the thoraco-dorsal nerve.

Superficial muscles of the back

- The levator scapulae, rhomboid minor and rhomboid major muscles lie inferior to the latissimus dorsi.
- All insert on the medial border of the scapula.
- They serve to rotate the scapula to turn the glenoid cavity inferiorly.
- Levator scapula innervated by C3-C4 and the dorsal scapular nerve.
- The rhomboids are innervated by the dorsal scapular nerve.

Intermediate muscles of the back

- Intermediate muscles of the back serve a respiratory function.
- Kinesiological monitor (proprioceptive).
- The serratus posterior superior elevates the 2^{nd}-5^{th} ribs.
- Innervated by T1-T4.
- The serratus posterior inferior depresses the 9^{th}-12^{th} ribs.
- Innervated by T9-T12.

Deep muscles of the back

- The deep muscles of the back are arranged in two layers:
- The more superficial layer contains the splenius muscle and the erector spinae (ileocostalis, longissimus, and spinalis muscles).
- The deeper layer contains the transverso-spinal muscles (semispinalis, multifidus, and rotators).

Deep muscles of the back

- The splenius capitis, acting alone, laterally flexes the neck and rotates the head to the side of activity.
- With the splenius cervicis, it extends the head and neck as a unit.
- The erector spinae, acting unilaterally, flex the vertebral column.
- Acting bilaterally, they extend the vertebral column and head.
- As the back is flexed, they control motion by gradually lengthening fiber length.

Deep muscles of the back

- The transverso-spinal muscles originate on the transverse processes and insert on the spinous processes.
- The transverso-spinal muscles extend the vertebral column.
- The semi-spinalis extends the head as well as cervical and thoracic regions of the vertebral column and rotates them contralaterally.

Deep muscles of the back

- The multifidus stabilizes vertebrae during local movements of the vertebral column.
- The rotatores stabilize the vertebrae and assist with local extension and rotatory movements of the column.
- Kinesiological monitor.

Minor muscles of the back

- Interspinales aid in extension and rotation of the vertebral column while the intertransversii aid in lateral flexion of the vertebral column.
- Acting bilaterally, the intertransversii stabilize the vertebral column.
- The levatores costarum assist with lateral flexion of the vertebral column.
- The intercostals function during forced respiratory maneuvers.

Sub-occipital triangle

- The rectus capitis posterior major, obliquus capitis superior and inferior run in the triangle.
- The rectus capitis minor does not serve as a boundary.
- Innervated by dorsal ramus of C1.
- The roof of the triangle is the semispinalis capitis.
- The floor is the posterior atlanto-occipital membrane.
- The posterior inferior cerebellar artery (from the vertebral artery in the cranial cavity) is contained within the triangle.

Anterior pre-vertebral muscles

- The longus colli flexes the neck with rotation (torsion) to opposite side if acting unilaterally.
- The longus capitis, rectus capitis anterior, and the anterior scalene muscles bend the head anteriorly or laterally (flexion) relative to the vertebral column at the atlanto-axial joints.

Lateral pre-vertebral muscles

- The rectus capitis lateralis bends the head anteriorly or laterally (flexion) relative to the vertebral column at the atlanto-axial joints, and helps stabilize the head.
- The splenius capitis laterally flexes and rotates the head and neck to the same side.
- Acting bilaterally, they extend the head and neck
- Rotation occurs about the atlanto-axial joints
- The middle and posterior scalene muscles flex the neck laterally as well as elevate the first and second ribs during forced inspiration.

Muscles producing movement of the atlanto-axial joint

- Flexion is produced by the longus capitis, rectus capitis anterior, suprahyoid and infrahyoid muscles as well as anterior fibers of the sternocleidomastoid muscle.
- Extension is produced by the rectus capitis posterior (major and minor), superior oblique of head, splenius capitis, longissimus capitis, and trapezius muscles.
- Lateral bending is produced by the sternocleidomastoid, superior oblique of head, rectus capitis lateralis, longissimus capitis, and splenius capitis muscles.

Muscles producing movement of the cervical spine

- Flexion is produced by the bilateral action of the longus coli, scalene, and sternocleidomastoid muscles.
- Extension is produced by the bilateral action of the semispinalis cervicis and iliocostalis cervicis (1); splenius cervicis and levator scapulae (2); splenius capitis (3); multifidus (4); longissimus capitis (5); semispinalis capitis (6); and trapezius muscles.

Muscles producing movement of the cervical spine

- Unilateral action of the iliocostalis cervicis, longissimus capitis and cervicis, splenius capitus and cervicis, as well as the intertransversii and scalenes produce lateral bending.
- Unilateral action of the rotatores, semispinalis capitis and cervicis, multifidus, and splenius cervicis muscles produce rotation.

Vertebral column

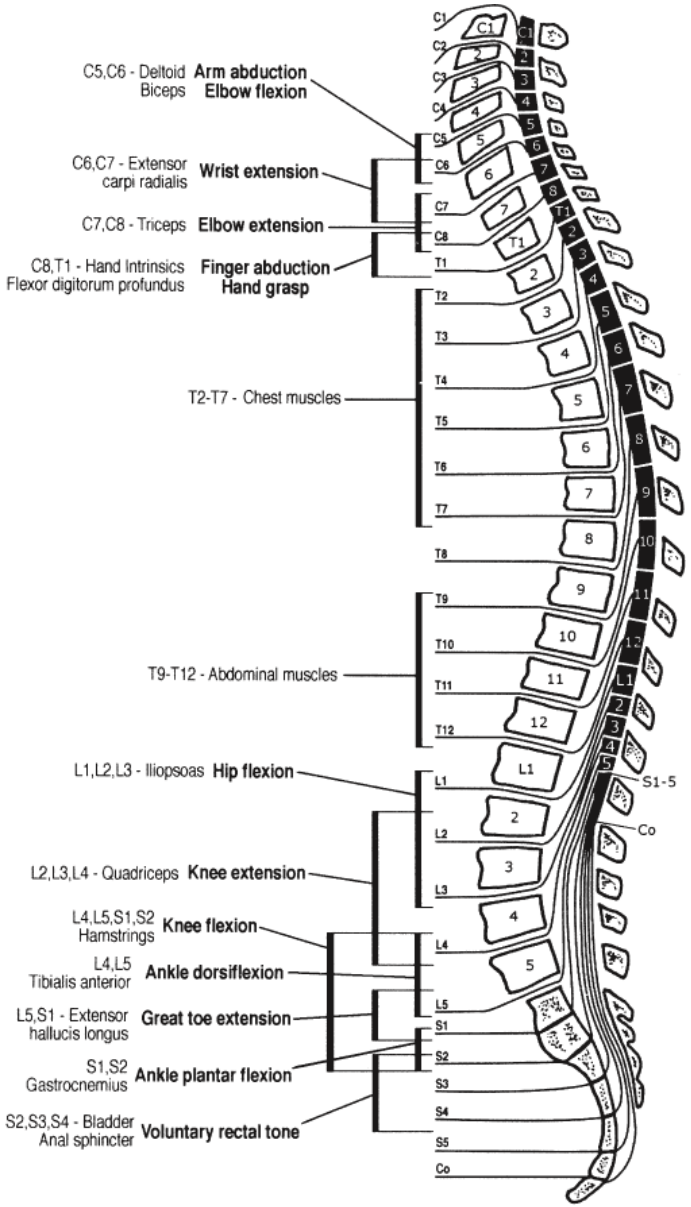


Fig. 256-6 Accessed 05/05/2010

Cervical spine

- The cervical spine consists of seven vertebrae.
- C1 is located immediately behind the angle of the mandible.
- The transverse process of the atlas is positioned between the angle of the mandible and the mastoid process.
- The hyoid bone is anterior to the level of C3; the thyroid cartilage is anterior to C4; and the cricoid cartilage is at the level of C6.

Cervical spine

- The upper cervical spine (occipito-atlanto-axial complex) is unique and is made up of the base of the skull, atlas (C1), axis (C2), and the transverse, accessory, and alar ligaments.
- The atlas (C1) supports the occipital condyles in its lateral masses.
- This articulation allows for flexion and extension but no rotation.
- The articular surfaces of the atlas (C1) and axis (C2) are convex to each other and allow flexion, extension, and especially rotation to occur.

Cervical spine

- The mid and lower cervical spine (C3 to C7) consists of vertebrae which are similar in size and shape.
- These vertebral bodies articulate with each other via their superior and inferior articular processes, enabling limited rotation and lateral flexion.
- The vertebral vessels pass through a foramen surrounded by the transverse processes of each vertebra.
- C6 has the carotid tubercle
- Only the vein passes through C7.

Cervical spine

- The costal element of C7 is part of the transverse process.
- May elongate, compressing the thoracic outlet.

Dermatomes

- C1 does not innervate any skin
- C2 innervates the back of the scalp
- C3 innervates the back of the neck
- C4 and C5 innervate the shoulder
- C6 innervates the thumb and index finger
- C7 innervates the middle finger
- C8 innervates the ring and little finger

Vertebral body

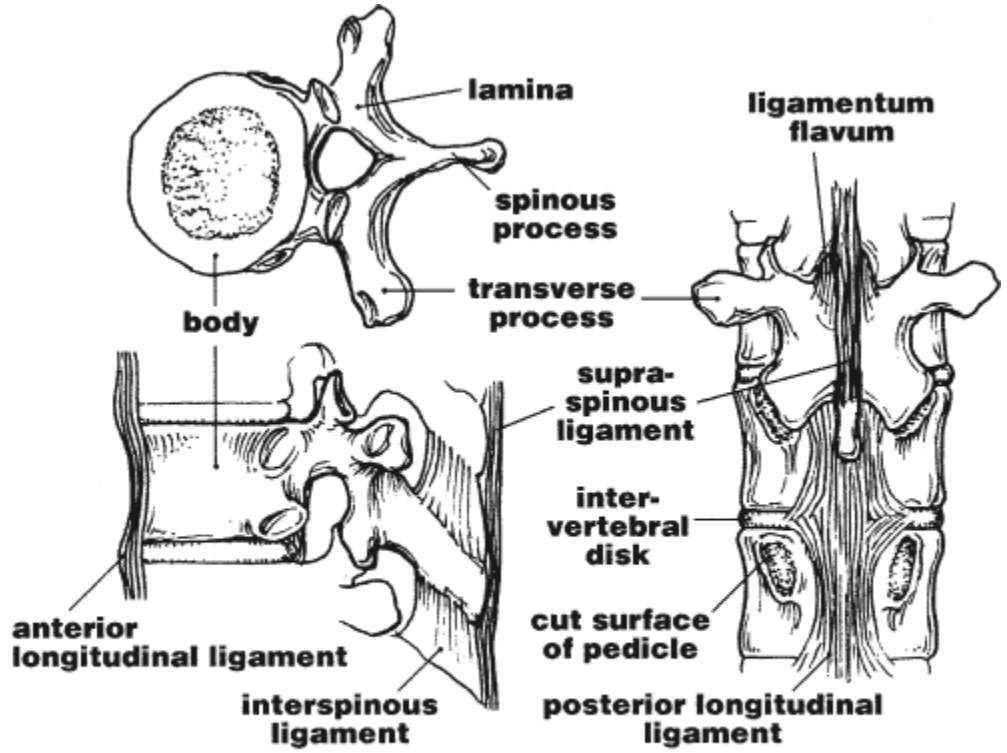


Fig. 256-1 Accessed 05/05/2010

The anterior longitudinal ligament checks hyperextension.

The posterior longitudinal ligament lies within the neural arch and limits posterior disc protrusion.

The ligamentum flavum lies within the neural arch and connects laminae.

Atlanto-occipital joint

- Plane sliding synovial joint.
- Anterior-posterior motion checked by anterior and posterior atlanto-occipital membrane.
- Occiput which sidebends left and rotates right is either posterior right or anterior left.
- Occiput which sidebends right and rotates left is either posterior left or anterior right.
- Sidebending and rotation are “always” in opposite directions.
- If the occiput rotates left on the axis, the occiput slides left and sidebends right.

Atlanto-axial joints

- There is no disc between C1 and C2.
- Paired lateral joints are sliding planes.
- Median joint is pivot.
- Anterior surface of dens articulates with atlas, while posterior surface of dens articulates with the transverse ligament of the axis.
- Transverse ligament is part of cruciate ligament.
- Alar ligaments attach dens to lateral sides of foramen magnum.

C3-C7 vertebral bodies

- Thickest of spinal disks (disk height : vertebral body ratio is 2:5).
- Wedge shaped (thicker anteriorly)
- Maintains Cervical lordosis.
- C2-C3 point of stress.
- Facets form palpable articular pillars.
- The superior face is backward and upward
- The inferior face is forward and downward.
- Rotation and side bending are coupled in same direction.

Unciform joints
(joints of Lushka)

- Maintain stability while allowing motion.
- Adaptation for upright posture.
- Synovial lined lateral edges of cervical vertebral bodies.
- Develop at age 8-10 yrs.
- Site of osteophyte formation.
- Act as “guide rails” for flexion and extension.
- Limit lateral translatory motion (side slip) that occurs with the coupled motions of rotation and sidebending.
- Rotation and sidebending could be excessive to the point of subluxation if not for the unciform joints.

Occipito-atlantal joint

- The superior facets of the atlas face backward, upward and medially
- Are concave.
- The occipital condyles match the facets of the atlas.
- Compression may affect CN IX-XII.
- Motion is limited by muscular and ligamentous attachments (principally the lateral occipito-atlantal ligaments).
- Flexion and extension are the primary motions.
- Complementary motions at the occiput are rotation and sidebending.

Occipito-atlantal dissociation

- In occipito-atlantal dissociation, the skull may be displaced anteriorly or posteriorly or distracted from the cervical spine.
- Occipito-atlantal dissociation frequently results in death.
- To exclude subluxation, the basion-axial interval (the distance between the tip of the clivus and a line extending from the posterior cortex of C2) should not exceed 12 mm.

Atlanto-axial joint

- Rotation only.
- Motion is limited by the dens and by the transverse ligament of the atlas.
- There are four facets.
- They are all convex in shape
- “Wobble” in flexion or extension (no true lateral flexion).
- With rotation to the right, the left facet of atlas slides uphill while the right facet of atlas slides downhill.

C3-C7 motion

- Move least in flexion or extension.
- Flexion (forward bending)
    - inferior facet must slide up 45 degree angle
    - rotation is primary motion
- Extension (backward bending)
    - normal lordotic curve
    - side bending is primary motion
- There is no “neutral position”

Herniated nucleus pulposus

- Nucleus pulposus is remnant of notochord.
- Avascular.
- Surrounded by annulus fibrosis.
- Herniation of disc occurs in a posterolateral direction.
- The nucleus pulposus pushes the annulus fibrosis and posterior longitudinal ligament.
- The posterior longitudinal ligament blocks direct posterior protrusion.

Herniated nucleus pulposus

- The most common site of herniation in the cervical spine is the disc between C5 and C6 (affecting spinal level C6).
- The most common site of herniation in the lumbar region is the disc between L4 and L5 (affecting spinal level L5).

Cervical spine fracture

- The Jefferson fracture is usually produced when the cervical spine is subjected to an axial load due to a direct blow to the top of the head.
- The occipital condyles are displaced downward and produce a burst fracture by driving the lateral masses of C1 apart.
- May see rupture of the transverse ligament.
- More than 3mm predental space is compatible with damage to the ligament.

Cervical spine fracture

- Fractures of the odontoid are usually due to major forces
- Hyperextension is associated with traumatic spondylolisthesis of the axis
- “Hangman’s fracture”

Jefferson fracture

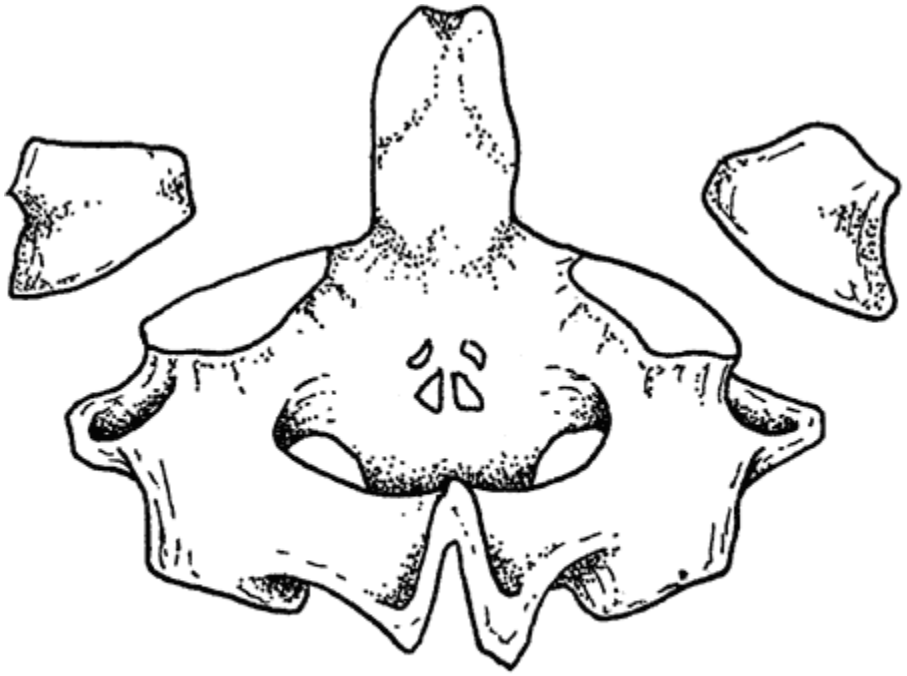


Fig. 272-8 Accessed 05/05/2010

Hangman's fracture

Fig. 272-10 Accessed 05/05/2010

Cervical spine instability

- Instability of the anterior column can occur when the anterior 20 percent of the vertebral body is damaged by compression
- Teardrop fracture.
- Loss of 25 percent or more of the vertebral body height also is a marker of failure.

Cervical spine instability

- Loss of integrity of the posterior wall of a vertebral body is a marker for instability in the middle column:
- Widening of pedicles
- Loss of more than 25 percent of posterior vertebral body height
- The presence of sagittal plane fracture lines through the posterior vertebral body cortex
- Instability is the result of damage to the facet complex.

Cervical spine subluxation and fracture

- A pure subluxation injury has no associated fractures.
- In hyperflexion sprain (anterior subluxation), the posterior ligamentous structures fail, because of the hyperflexion of the cervical spine.
- Intense flexion against contracted posterior erector spinal muscles causes avulsion of the spinous process (clay-shoveler’s fracture)
- Usually of C7.
- An isolated clay-shoveler's fracture is mechanically stable.

Teardrop fracture

- Caused by extreme flexion
- Complete disruption of all ligaments at the level of injury
- The “teardrop” is the anterior-inferior portion of the vertebral body which is separated and displaced from the rest of the vertebral body
- It is mechanically unstable
- Hyperkyphosis of the fracture impinges upon the spinal cord causing an anterior cord syndrome

Flexion-teardrop fracture

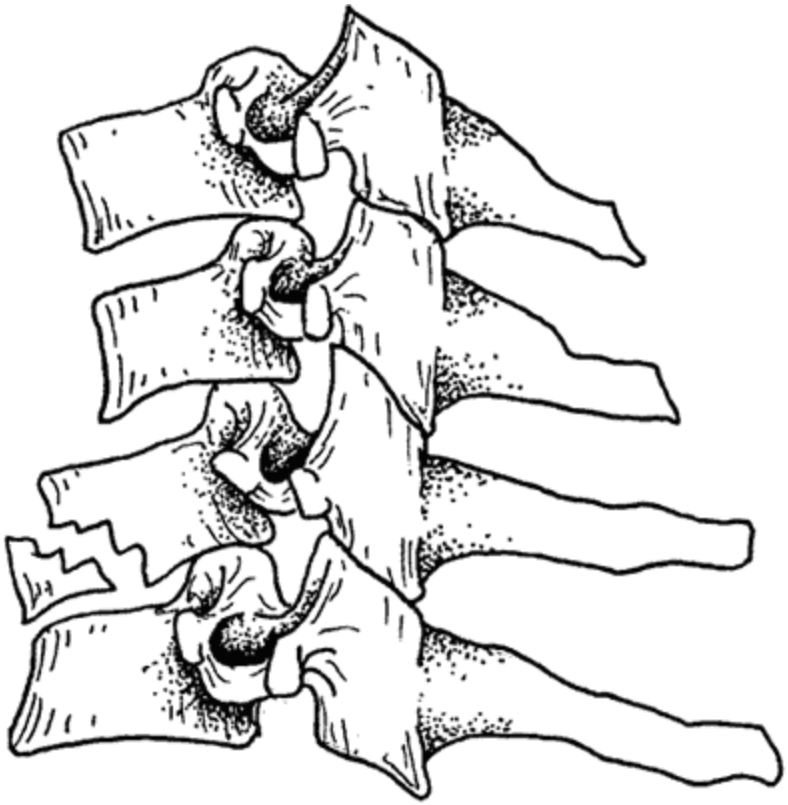


Fig. 272-13 Accessed 05/05/2010

Cervical spine facet dislocation

- Simultaneous forces of flexion and rotation can produce a unilateral facet dislocation.
- The articular mass and inferior facet on one side of the vertebra are anteriorly dislocated.
- Stable.

Cervical spine facet dislocation

- Bilateral interfacetal dislocation
- Disruption of all ligamentous structures due to hyperflexion
- The articular masses of the involved vertebra dislocate superiorly and anteriorly over into the intervertebral foramen inferior to the involved vertebra.
- Unstable.

Bilateral interfacetal dislocation

Fig. 272-14 Accessed 05/05/2010

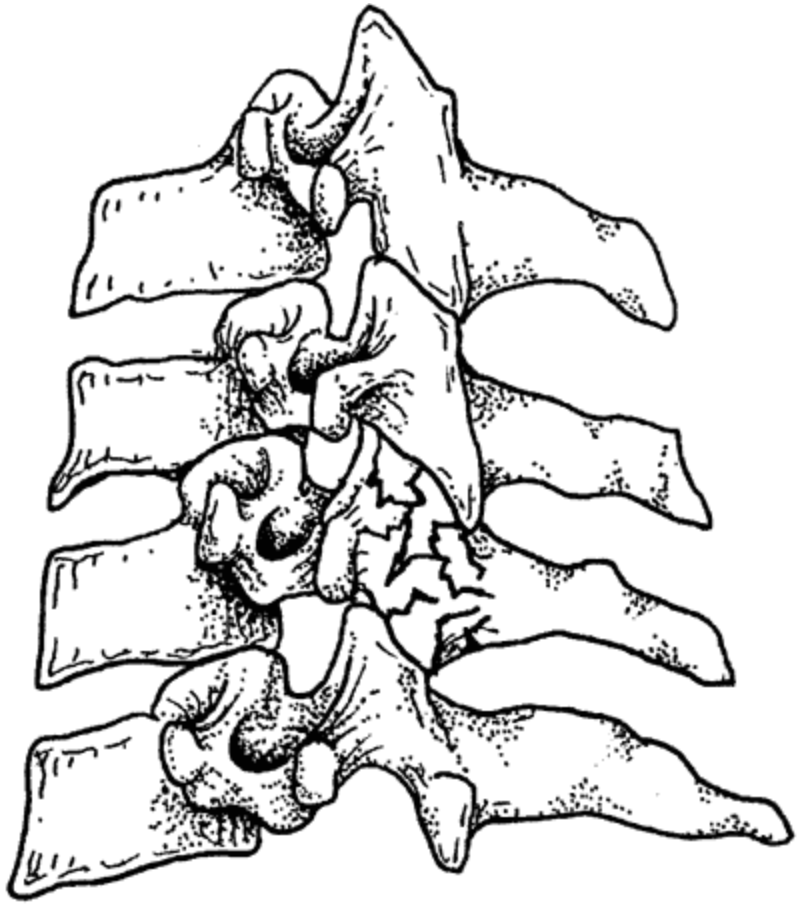
Cervical spine fracture

- Extension and rotation can cause impaction of a superior vertebra on the articular mass of its inferior neighbor.
- The resultant vertical or oblique fracture of the articular mass is called a pillar fracture.
- The adjacent lamina and pedicle remain intact.
- Stable.

Cervical spine fracture

- A direct axial load causes a burst fracture of the lower cervical spine.
- The axial force causes the vertebra to burst, with fragments displacing in all directions.
- The spinal cord may be injured if a fragment enters the spinal canal.
- Unstable.

Pillar fracture



Source: Tintinalli JE, Kelen GD, Stapczynski JS: *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*, 6th Edition: http://www.accessemergencymedicine.com

Fig. 272-17 Accessed 05/05/2010

Cervical spine fracture

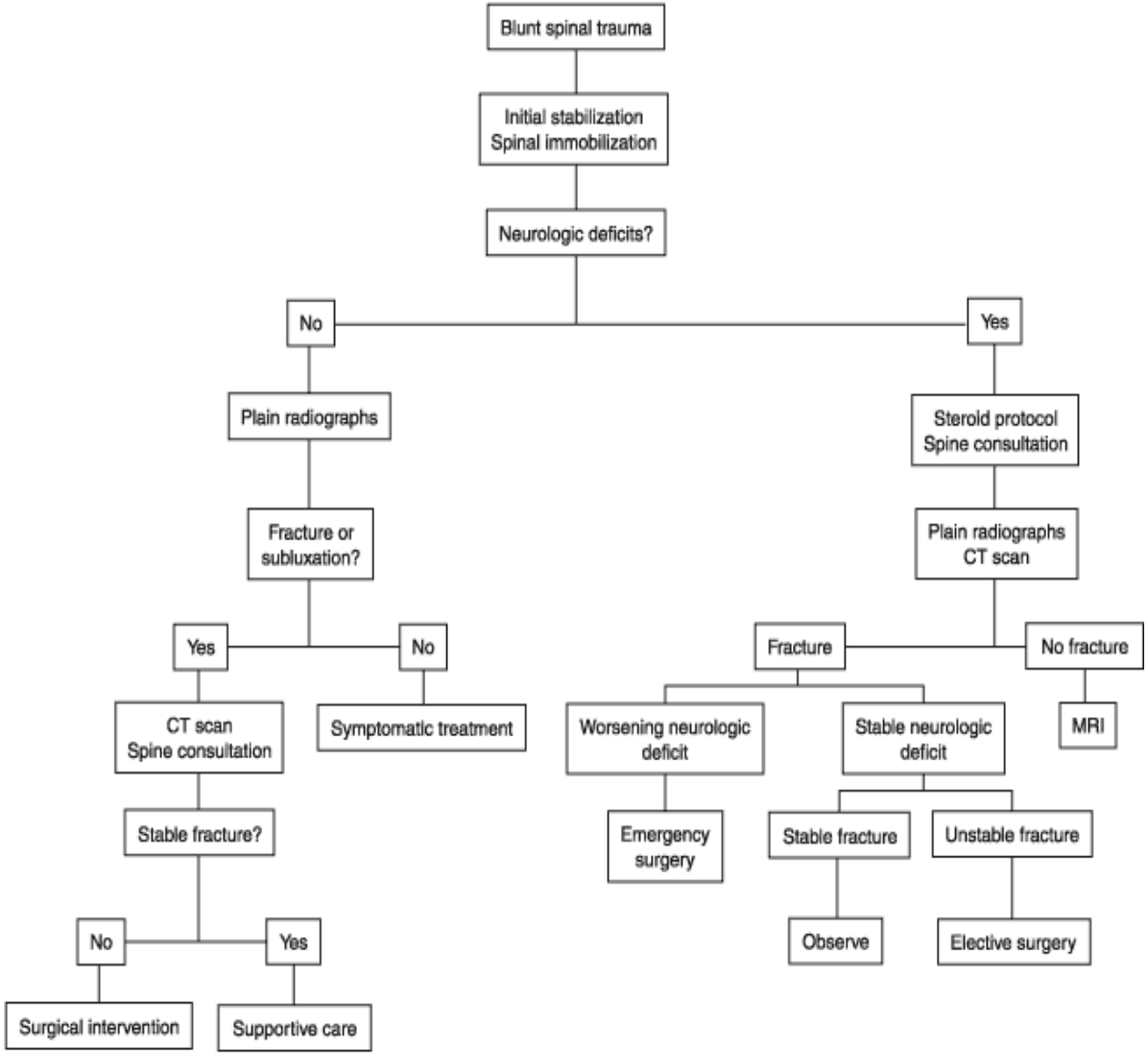
- A hyperextension injury involves a complete tear of the anterior longitudinal ligament and intervertebral disk, with disruption of the posterior ligamentous complex.
- Facial trauma with a central cord syndrome is the most common clinical presentation.
- A hyperextension mechanism may cause the anterior longitudinal ligament to avulse the inferior portion of the anterior vertebral body at its insertion.
- The height of the fragment usually exceeds its width.
- This fracture is more common in older patients with osteoporosis.
- The extension teardrop fracture is unstable in extension.

Cervical spine fracture

- Lateral flexion can cause a transverse fracture at the base of the uncinate process
- The lateral aspect of the superior vertebral body fractures the inferior uncinate process.
- During the initial injury, the degree of lateral neck flexion is limited, because the head strikes the shoulder.

Approach to a spine injury

- Patients with possible head or neck trauma who are not fully alert, Glasgow Coma Scale (GCS) <15, should have imaging of their cervical spines.
- The frequency of cervical spine injury in association with blunt head trauma is approximately 2 to 5 percent.
- It increases to almost 9 percent in patients with significant head injury, defined as a GCS score <10.
- A single lateral cervical spine film will identify 90 percent of injuries to bone and ligaments. The open-mouth odontoid view will identify many of the remaining abnormalities.



Source: Tintinalli JE, Kelen GD, Stapczynski JS: *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*, 6th Edition: http://www.accessemergencymedicine.com

Fig. 256-7 Accessed 05/05/2010

Thoracic and lumbar spine

- Disc between T4 and T5 is at the plane separating the superior and inferior mediastinum.
- T8 is at the level of the foramen for the inferior vena cava and the right phrenic nerve.
- T10 is at the level of the esophageal hiatus.
- T12 is at the level of the aortic (and thoracic duct) hiatus as well as the origin of the celiac axis.

Thoracic and lumbar spine

- L1 is at the origin of the superior mesenteric artery.
- L3 is at the origin of the inferior mesenteric artery.
- Disc between L3 and L4 is at the level of the umbilicus.
- L4 is at the level of the union of the common iliac veins to form the inferior vena cava.

Dermatomes

- T4 is at the nipple
- T7 is at the xiphoid process
- T10 is at the umbilicus
- L1 is at the suprapubis
- L4 innervates the first toe and medial side of the foot
- L5 innervates the 2^{nd}-4^{th} toes
- S1 innervates the fifth toe and the lateral side of the foot

Thoracic and lumbar spine

- The thoracic and lumbar spine is relatively more protected and stable than the cervical spine.
- Vertebrae T1 through T10 are fixed, owing to their articulation with the thoracic cage.
- Large forces are required to fracture thoracic vertebrae, and neurologic abnormalities are common.
- The mobility of the thoraco-lumbar junction predisposes it to injury.
- The thoraco-lumbar junction is second only to the cervical spine in frequency of injury.

Thoracic and lumbar spine

- The anterior column contains the vertebral column and the intervertebral disks.
- Its functions are:
- Support
- Weight bearing
- Shock absorbance
- Protection of the spinal cord.
- The anterior column bends
- The disks accommodate
- Moves away from the concave side.

Thoracic and lumbar spine

- The posterior column includes the transverse processes and the spinous processes.
- Its functions are to direct joint motion (facets and ligaments) and protect the spinal cord.
- In the upright position it contributes little to weight bearing.
- The posterior column moves away from the concave side during sidebending.

Thoracic and lumbar muscle function

- Flexion is produced by the bilateral action of the rectus abdominus and psoas major muscles.
- Extension is produced by the bilateral action of erector spinae, multifidus, and semispinalis thoracis muscles.
- Lateral bending is produced by the unilateral action of the iliocostalis thoracis and lumborum, longissimus thoracis, multifidus, external and internal oblique, quadratus lumborum, rhomboids, and the serratus anterior muscles.

Thoracic and lumbar muscle function

- Rotation is produced by the unilateral action of the rotatores, multifidus, iliocostalis, longissimus, splenius thoracis and external oblique (synchronously with the opposite internal oblique) muscles.

Kyphosis and lordosis

- Kyphosis refers to exaggerated thoracic curvature.
- Can be due to:
- Poor posture
- Structural abnormality (Scheurmann's disease)
- Congenital anomalies in the vertebral bodies.
- Symptomatic patients have signs of nerve compression.
- May require orthoses or casting.
- Congenital kyphosis requires surgical correction as it may lead rapidly to paraplegia.
- Lordosis refers to exaggerated lumbar curvature.

Scoliosis

- Idiopathic scoliosis is painless curvature of the spine
- Usually convex to the right
- May have thoracic as well as lumbar deformities.
- CHAD7 gene mutation associated with disorder.
- Presents in childhood or adolescence.
- Elevated shoulder and/or short-leg syndrome as presenting signs.

Scoliosis

- Curvatures are best treated at an early age when there is little deformity (10-15°)
- The Schroth method is an exercise program individualized to patient curvature to restore function in three dimensions
- Bracing (to reduce curvature angle by 50%
- Braces must be worn >20 hours daily.

Scoliosis

- High degrees of scoliosis (>40^0)are treated surgically.
- Rod placement (extendible) and bone fusion (utilizing recombinant human bone morphogenetic protein at prosthesis sites) successful.
- However, 2-3° curvature loss yearly post-surgery.
- Loss may be delayed by continuation of Schroth exercise regimen.
- Pulmonary function impairment the major problem with idiopathic scoliosis.

Scoliosis

- Congential scoliosis is a curvature of the spine that is due to a defect in the formation of vertebrae or disks.
- May present with bladder problems, loss of motor function in lower limbs.
- Requires spinal fusion if severe.

Scoliosis

- Neuromuscular scoliosis is a curvature of the spine due to weakening of muscles due to progressive neuromuscular disorders:
- Muscular dystrophy, cerebral palsy, superior mesenteric artery syndrome, spina bifida
- The curvature is progressive due to progression of weakness.

Lumbar spondylosis and spondylisthesis

- Spondylosis is a defect allowing the posterior projection from the vertebral body that surrounds the spinal canal and bears the articular, transverse, and spinal processes, to be separated from its body.
- The defect resembles a Scot Terrier on oblique view.
- When the vertebral arch defect is bilateral, the body of the vertebra may slide anteriorly. (Spondylisthesis.)
- This may cause nerve compression.
- This may interfere with parturition.

Lumbosacral joint

- L5 rotates in the opposite direction to the sacrum. L5 sidebends on the oblique axis of the sacrum.
- Sacral torsions rotate on an axis.
- Sacral torsion is diagnosed when the deep sulcus and the posterior-inferior ischiolumbar are on opposite sides.
- With a forward torsion, the restriction is in flexion (left on left; right on right).
- With a backward torsion, the restriciton is in extension.

Conus medullaris

- The spinal cord ends at L1 (or L2), the conus medullaris.
- The individual nerve roots extending from the conus medullaris constitute the cauda equina.
- These nerve roots are less susceptible to damage and neurologic injury, because trauma to the lower lumbar and sacral segments occurs less often and is less severe.
- The dural-arachnoid sac extends inferiorly to S2.
- Filum terminale attaches spinal cord to coccyx.

Freyette principle I

- Spine is in neutral.
- Group motion involves more than one vertebra.
- Sidebending occurs to the side of concavity.
- Rotation occurs opposite that of the sidebending (to the convexity).
- Maximal rotation at the apex.
- Prominent muscle mass at the convexity.
- Rotation is a normal movement of spine.
- When due to dysfunction, usually because of contracted musculature.

Freyette principle II

- Single segment motion restriction.
- Involves flexion and extension.
- Rotation and sidebending to the same side (toward the concavity).
- Posterior component on the side of concavity.
- These are lesions that occur suddenly.
- Usually involves a motion to another plane while in an extreme position in one plane.

Freyette principle III

- Initiate motion in any plane.
- This will modify the movement in other planes of motion.
- Freyette did not write about the cervical or the lumbar spine.

Back pain

- Inter-observer agreement is low for assessment of bone tenderness (κ 0.40) or soft tissue tenderness (κ 0.24).
- Absence of sciatica makes clinically important disc herniation unlikely (straight leg raising inter-observer agreement, a κ of 0.70; weak ankle dorsiflexion, a κ of 1.0).
- Ankle reflexes diminish with age
- 30% over age 60 lack one or both ankle reflexes.
- The single leg sit to stand is the most reliable test to detect quadriceps weakness (κ of 0.85; positive likelihood, LR+, 26)

Back pain

- 20% of patients aged 14-25 years have degenerative disks on plain x-rays of the spine but are asymptomatic
- 75% of patients >50 years of age have bulging or herniated disks on MRI but are asymptomatic (90% have degenerated disks)
- 20% of patients >50 years of age have spinal stenosis but are asymptomatic
- Anatomic abnormalities are not necessarily causative of back pain nor generally influence initial treatment decisions.
- Generally resolve with conservative measures.

Low back pain

- L4-L5 and L5-S1 disk compressions comprise 98% of symptomatic presentations
- Moderate to severe pain radiating from the back down the buttock and leg, usually to the foot or ankle. (Sciatica). Positive likelihood ratio, LR+, 7.9.
- Straight leg test is positive if it reproduces sciatica when leg is elevated between 30-60°.
- A pulling sensation in the hamstrings or pain in the back when the leg is raised are negative findings.
- Most common site of weakness is foot (plantar flexion or dorsiflexion).

Low back pain

- Proximal weakness suggests femoral neuropathy or lumbar plexus compression.
- Associated numbness, paresthesias, motor weakness can occur in the absence of pain
- Pain worsened by Valsalva maneuver
- No bowel or bladder symptoms with unilateral disk herniations
- CT or MRI of equal utility.
- Image those who do not respond to therapy.

Low back pain

- NSAIDs important for pain control.
- Opioids may be required.
- Osteopathic manipulation may shorten disability by 1-2 days.
- Bed rest does not hasten recovery.
- Median time to recovery is 12 weeks.
- 50% recur.
- If surgery required, median time to recovery is 4 weeks.

Spinal stenosis

- Claudication symptoms with back pain.
- Usually bilateral and relieved by sitting or bending forward.
- Worsened by extension.
- Central stenosis associated with bilateral, non-dermatomal pain involving the buttocks and posterior thighs.

Spinal stenosis

- Lateral stenosis associated with pain in a dermatomal distribution.
- Lumbar spinal stenosis does not progress to paralysis.
- Cervical and thoracic stenoses may cause myelopathy and lead to paralysis.

Cauda equina syndrome

- Bilateral sciatica
- Sensory loss in a saddle distribution
- Urinary retention diagnostic (positive likelihood ratio, LR+, 18; LR-, 0.1).
- Decreased anal sphincter tone seen in 80%
- Bilateral midline herniations
- This is a medical emergency requiring decompression.

Vertebral metastases

- Constant back pain not relieved by rest and worsened at night is suggestive of malignancy.
- Once cord compression begins, it can proceed rapidly.
- This is a medical emergency.
- Previous history of cancer has a positive likelihood ratio, LR+, of 14.7 for a diagnosis of vertebral metastasis.
- More than 50% loss of trabecular bone before lytic lesion apparent on plain radiographs.
- Bone scan may not detect lytic lesions.
- MRI best test to evaluate cord compression.

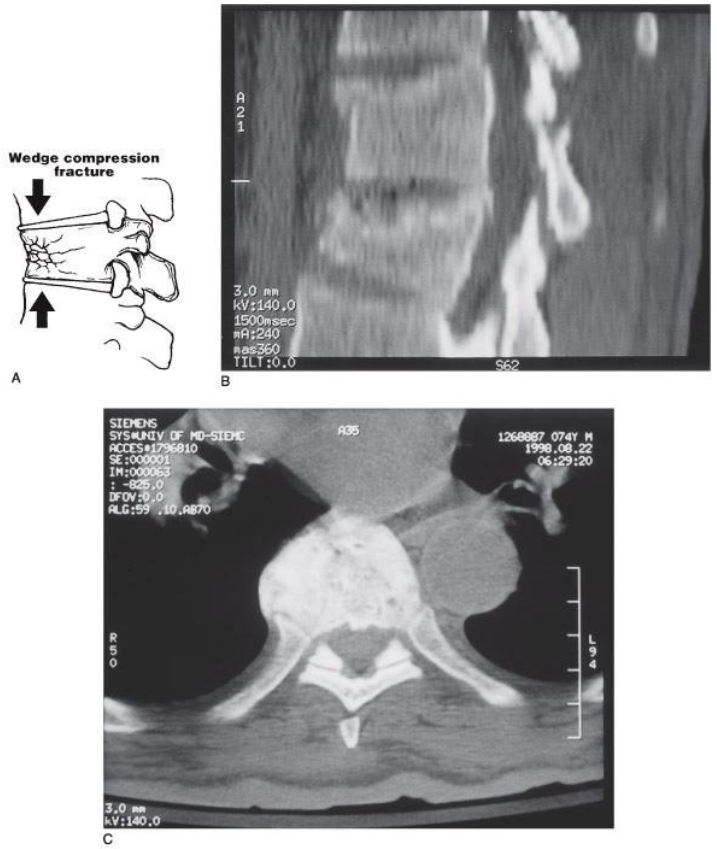
Compression fractures

- Compression fractures present as acute, severe pain that radiates around the flank to the abdomen.
- May be precipitated by trivial activity.
- Worsened by movement.
- Usually mid-thoracic to lumbar region.
- Osteoporosis most common cause.
- A compression fracture above T4 is usually due to malignancy.
- MRI best test to distinguish malignant lesion from osteoporotic compression fracture.
- Pain usually resolves in several weeks with conservative therapy.

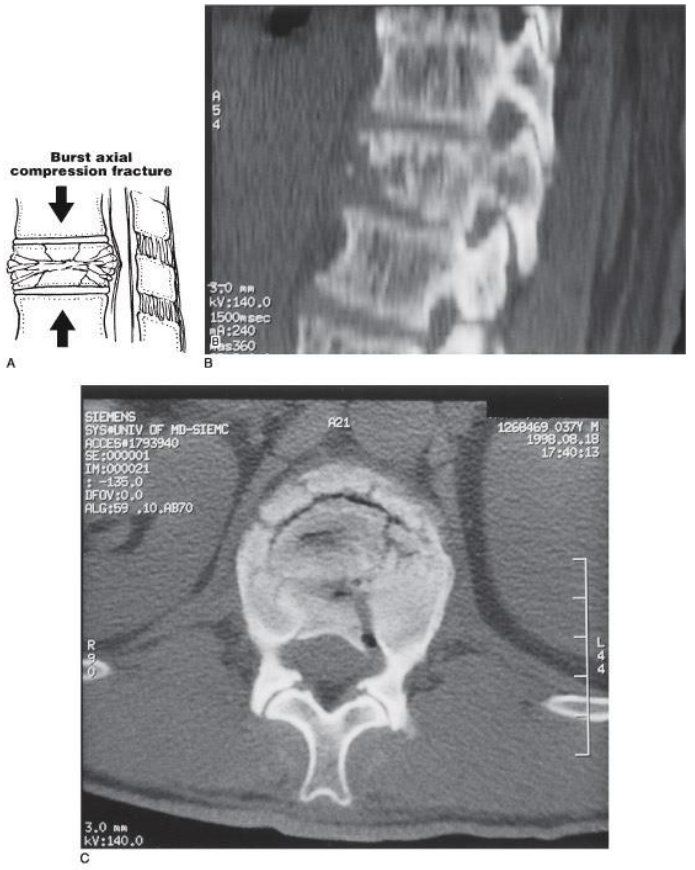
Wedge and burst fractures

- A wedge fracture of a vertebra is caused by compression between two other vertebrae.
- The superior end plate fractures while the inferior surface of the vertebra remains intact.
- The posterior ligaments may be disrupted, leading to an increase in the distance between spinous processes.
- Posterior element disruption makes the injury unstable.
- The simple wedge fracture is differentiated from a burst fracture by the absence of a vertical fracture of the vertebral body.

Wedge and burst fractures



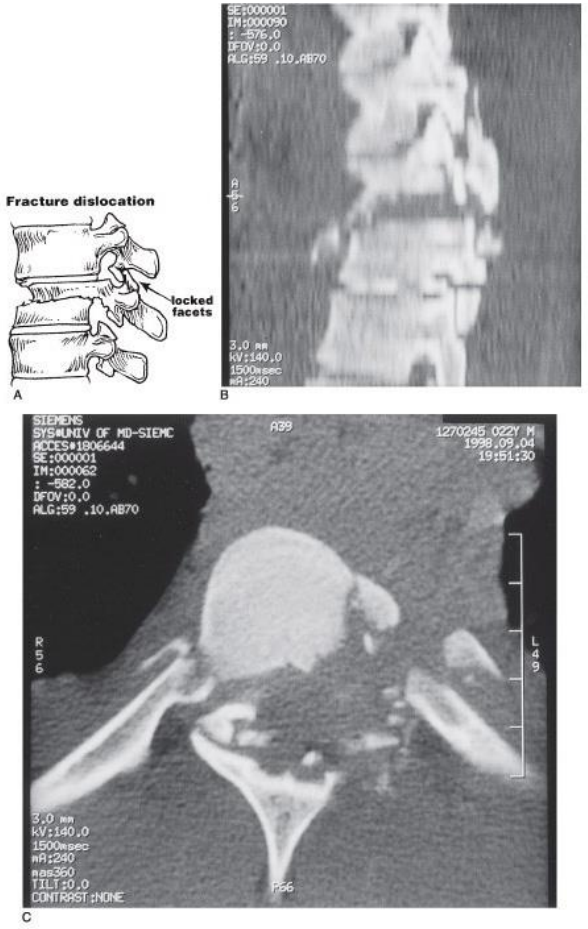
Source: Tintinalli JE, Kelen GD, Stapczynski JS: *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*, 6th Edition: http://www.accessemergencymedicine.com



Source: Tintinalli JE, Kelen GD, Stapczynski JS: *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*, 6th Edition: http://www.accessemergencymedicine.com

Fig. 256-2 and Fig. 256-3 Accessed 05/05/2010

Fracture dislocation



Source: Tintinalli JE, Kelen GD, Stapczynski JS: *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*, 6th Edition: http://www.accessemergencymedicine.com

Fig. 256-5 Accessed 05/05/2010

Flexion-distraction fracture

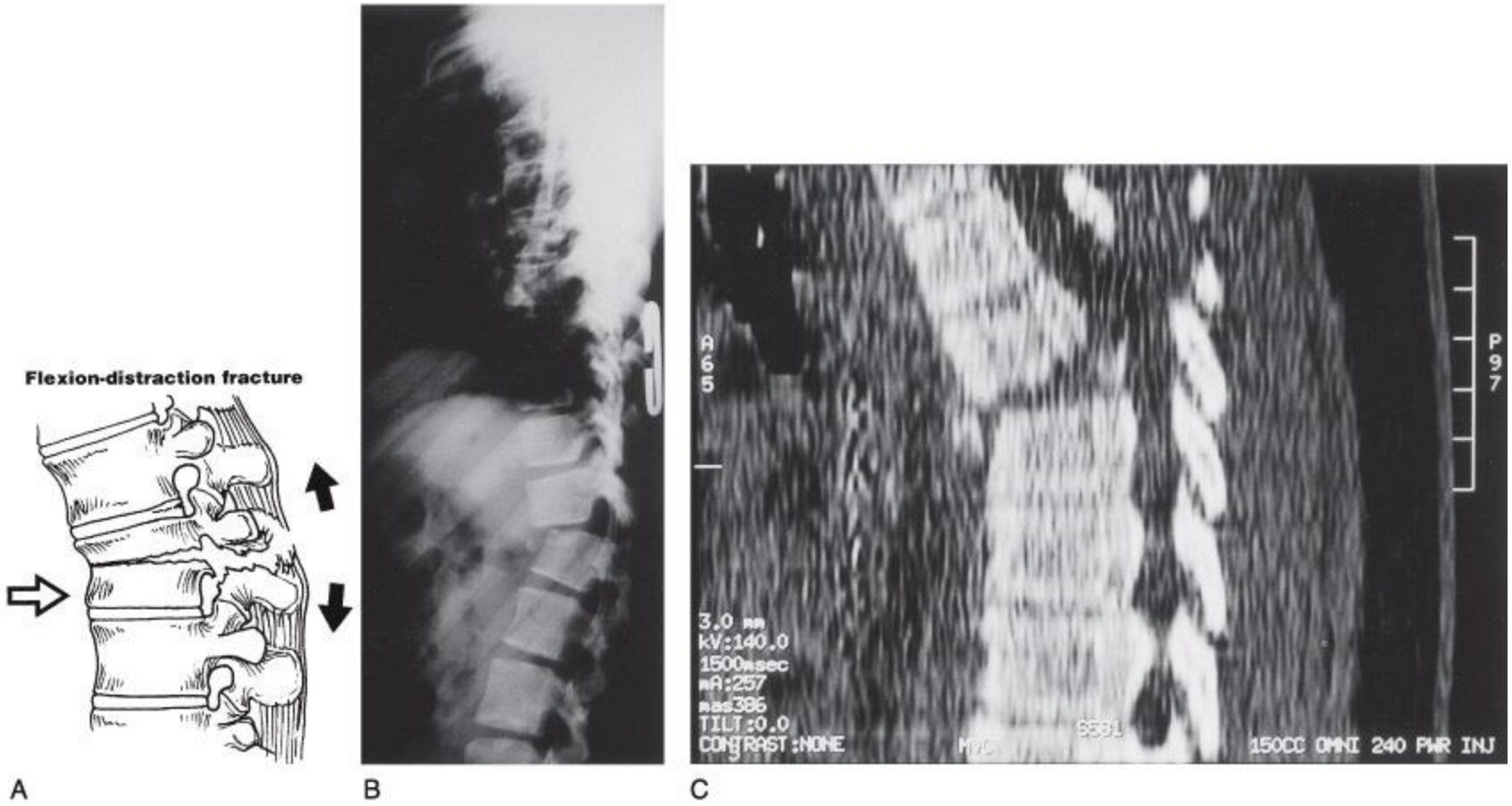


Fig. 256-4 Accessed 05/05/2010

Epidural abscess

- Rapidly progressing neurological deficits in a patient with fever and back pain
- History of diabetes
- Parenteral drug use
- May see after instrumentation of bladder
- Infection occurs by contiguous spread in one-third of cases
- Hematogenous spread in half the cases
- May be associated with osteomyelitis involving adjacent vertebrae with collapse of the disk

Epidural abscess

- More common in posterior epidural space
- More common in thoraco-lumbar region
- Generally extend over several vertebrae
- Staphylococcus aureus the usual organism.
- Streptococcus B and G are seen as well in diabetic patients.
- Gram negative enteric organisms may be found after instrumentation of the bladder
- MRI imaging
- Requires decompression and drainage