

CAUDA EQUINA & ACUTE SPINAL INJURIES



Lecture objectives:

The ability to demonstrate knowledge of the following:

1. Basic anatomy of the spine
2. Initial assessment and treatment of spinal injuries at the field
3. Principle of spinal stability
4. Understanding of neurologic syndromes caused by spinal trauma
5. Management of Cauda equina syndrome

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References: Dr's slides & 436 team, Toronto notes'2020'

INTRODUCTION

We can determine the mechanism of injury from these pictures



High velocity injury that is sufficient to cause fracture and traumatic spine injury



High power injury if this patient had cervical spinal injury and we must suspect thoracolumbar junction injury (non contagious level injury), and probably has knee and tibia injuries.



Advanced age curved back probably osteoporotic related injury as well as there is a huge mass in the neck it could be a tumor on top of osteoporosis .



Fixed cervical flexion and fixed thoracic kyphosis (patient can't raise his head) example of ankylosing spondylitis which is a weak bone due to lack of mobility as well as diffuse spine without buffer mechanism and the shock absorbent mechanism of the disc.



Dark spots on the skin it could be a tumor, this could lead to spinal metastasis

SPINE PATHOLOGY RED FLAGS CONDITIONS

1. **Cauda Equina** متلازمة ذنب الفرس or any severe neurologic injury sensory or motor (perianal numbness (**saddle paresthesia**), decreased rectal tone + bladder tone, loss of movement in the extremities) Cauda equina syndrome = saddle paresthesia + urinary retention¹ احتباس البول + stool incontinence سلس البراز.
2. **Tumor** weakening the vertebrae according to the level, if it is cervical or thoracic it will end up with (causing cord compression or vertebral “pathological” fracture), if it’s lumbar it could lead to radiculopathy.
3. Infection weakening bone (causing disc/vertebral destruction or cord compression **infection will lead to pus and the pus will compress the bone**).

Remember that tumors and infections present the same way! So ddx of tumor is infection and ddx of infection is tumor. In infection and tumors the patient will present initially with rest pain or night pain when the tumor starts to eat the vertebral body (biological pain) Then as the destruction continues the vertebral body will start losing its strength which will lead to pathological fracture that causes pain all the time (constant pain) then they will have pain with activity then sudden loss of ability to stand or walk with neurological deficit. Some patients may first present with pathological fracture (from low impact) & we have to look for the cause: tumor, infection, etc.. Both infection and tumor weaken the bone and cause lytic lesion which increases the risk of pathological fracture and soft tissue expansion.

4. **Traumatic Spine Fracture** cause instability and neurological injury (vertebral angulation, pain, or neuro compromise). Remember that spine fracture can occur **without trauma (like pathological fractures in severe osteoporosis هشاشة العظام or history of tumor or infection)**!

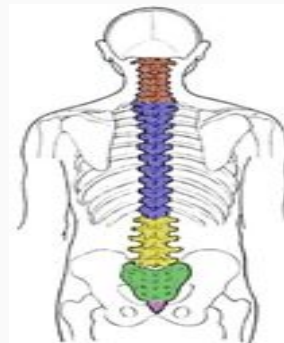
High energy: trauma. Low energy: pathological.

ANATOMY OF THE SPINE

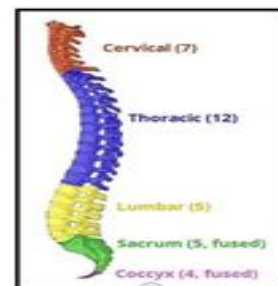
- The spinal cord appears straight from the coronal view and curved from the sagittal view.
- There are normal spinal curvatures: cervical lordosis, thoracic kyphosis, lumbar lordosis and sacral kyphosis.
- The spinal column is made up of 33 vertebrae: 24 are discrete (7 cervical vertebrae, 12 thoracic vertebrae, 5 lumbar vertebrae) and 9 are fused (5 sacrum and 4 coccyx).
- The basic vertebra is composed of a body and of an arch surrounding the vertebral canal.
- Vertebral column has 2 Functions: (1) weight bearing, (2) movement.
- Stabilizing ligaments of the spine:
 - 1- posterior/anterior longitudinal ligament.
 - 2- apical ligament.
 - 3- flaccid capsule.
 - 4- transverse ligament. In (C1-C2)

You should know:

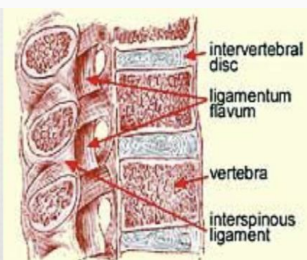
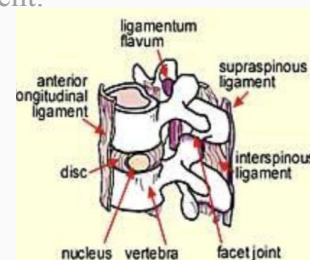
- How to read the x-ray
- Stabilizing ligaments
- Normal anatomy



Coronal

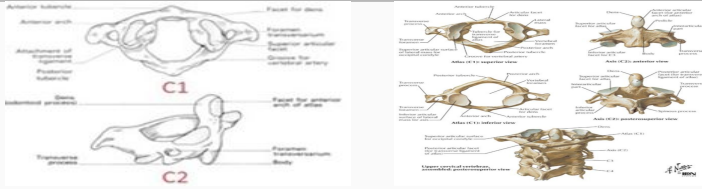


Sagittal



CERVICAL VERTEBRAE

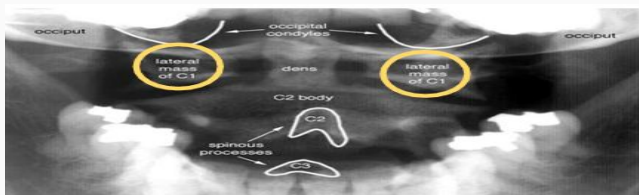
Atypical C1 (Atlas) & C2 (Axis)



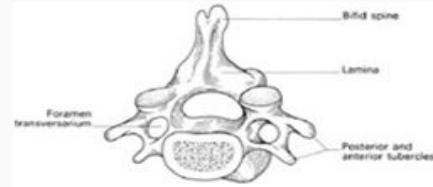
- The atlas (C1) is only an arch, it has no body, the occipital condyle is a hemisphere attaches to C1 in the lateral masses.
- C1 on x-ray will only appear as anterior and posterior arches
- The axis (C2) has the odontoid process (dens), that projects upward into the Atlas. Between the 2 lateral masses of C1 there is a transverse ligament which fixes the atlas to dense of C2
- If C1 is broken the transverse ligament, the integrity of it's arch become disrupted
- Approximately 50% of flexion and extension (nodding) of the neck happens between the occiput and C1.
- 50% of right and left **rotation** of the neck happens between C1 and C2.

So if a pt lost C1 and C2 joints due to fracture or fusion that means he lost 50% of all neck ROM.

- To visualize C1 and C2 on an x-ray we take an open mouth view to see the dens, lateral masses and occipital condyle, (b/c they are obscured by the jaw)
- Lateral masses of C1 (circled above) should be aligned and equal distance from the dens. If تباعدت then there may be fracture of anterior and



Typical C3 -C7



C3-C7 are more classic vertebrae, having a body, pedicles, laminae, spinous processes, and facet joints.

Note that: All cervical vertebrae (C1 to C7) have a foramen transversarium.

The vertebral artery travels through foramen transversarium. (no vertebral artery after c6 b/c it runs outside of foreman)

- Look for the C spine for any swellings

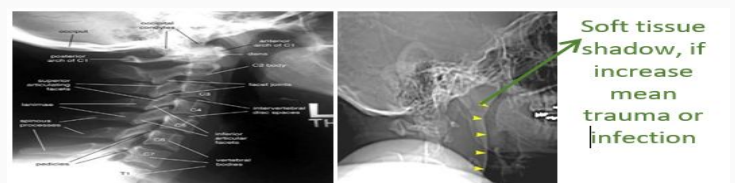
Always look at the bone and soft tissue

When examining a radiograph, we need to first make sure that the anterior body line, posterior body line and spino-laminar line are متوازي

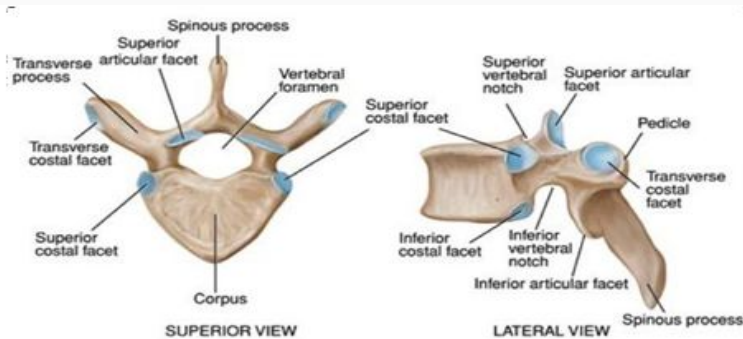
- This means it is a straight spine and there is no subluxation.

Also examine the facets, and disc spaces.

If there was any disruption in the 3 lines or displacement of soft tissue shadow in front of the vertebral bodies then there is a fracture or dislocation



THORACIC VERTEBRAE



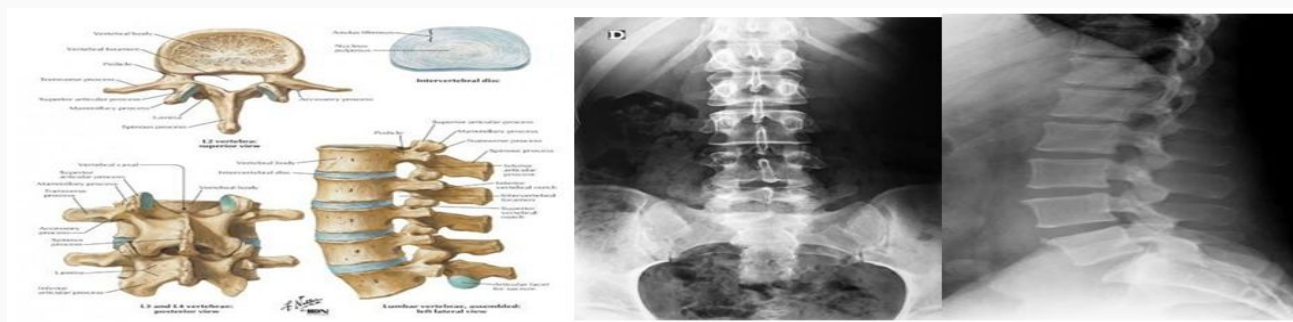
- The thoracic vertebrae have 6 facets 2 superior & 2 inferior for attachment with vertebra above and below, and 2 costal for rib attachments which stabilize and splint and make it get more rigid. That's why most of the time it's treated conservatively unless it's a huge energy and significant disruption. Most of the injuries are at the junctional level of cervical or lumbar because thoracic is splint
- The superior and inferior facet orientation are aligned along the coronal plane (facing us).
- **Function: thoracic spine is the one responsible for rotation** range of motion.
- On x-ray we will see square shaped vertebral bodies and look for pedicles, on sagittal there is kyphosis, and on coronal it is straight.
- What's different about Thoracic V? 1- facet orientation coronal plane. 2-articulation of the ribs

LUMBAR VERTEBRAE

Thoracolumbar Spine:

General Principles

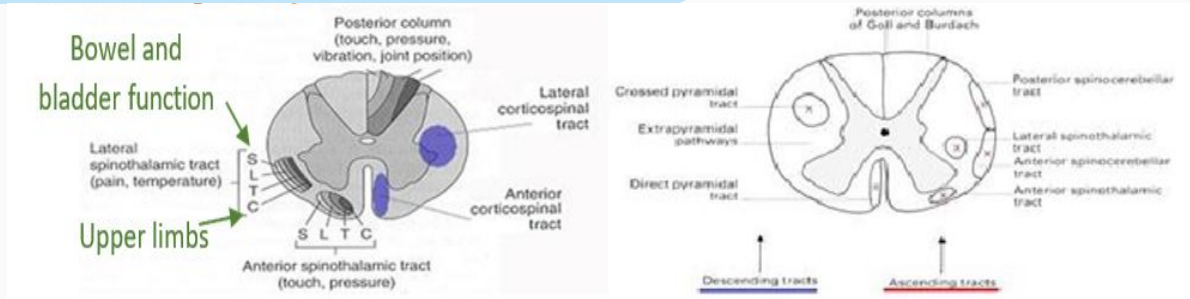
- spinal cord terminates at conus medullaris (L1/2)
- individual nerve roots exit below pedicle of vertebrae (i.e. L4 nerve root exits below L4 pedicle)



- Lumbar vertebrae are bigger because they are weight bearing.
- On x-ray they have box shaped body, then assess the pedicle, process, facets, pars reticularis², disc space. Separation or widening of spinous process distance that means possible injury, and any defect in pars reticularis will leads to spondylolisthesis انزلاق الفقار.
- Ligaments: anterior and posterior longitudinal ligaments which they are strong stabilizer, annulus around disc and ligamentum flavum which is weak stabilizer, intertransverse, facet capsules, interspinous and supraspinous ligaments which is stronger than interspinous.
- Pinups
- **Function: lumbar spine is the one responsible for flexion and extension** (facet aligned along sagittal plane)

- **In case of painful flexion, which part is having the load?** The disc.
- **In case of painful extension, which part is having the load?** Pars interarticularis.
- **In case of painful flexion and extension which part is having the load?** Spine motion segment.

INTRINSIC PATHWAY



- There are 2 pathways in the spinal cord: ascending and descending tracts.
- Representation of nerve roots within tracts goes from cervical, thoracic, lumbar, sacral (CTLS) where **cervical is more central! And sacral is most peripheral.**
- So if the central part of the spinal cord is affected how will it present?
 - Cervical representation will be affected (i.e **upper limb**) so there will be disproportionate upper limb weakness compared to lower limb.
- In thoracic representation **trunk sensation and superficial/ abdominal reflexes** will be affected. In lumbar **lower limb** function will be affected. In sacral **bladder and bowel function** will be affected.
- If there is a posterior column issue what will the general clinical presentation be?
 - a. Gait will be affected. Why? Because proprioception and joint position will be lost. On examination it can be tested by Romberg test: ask patient to close his eyes and he will start swaying because we eliminated visual field feedback **يترنح**.
 - b. Also fine hand movements will be affected like writing (handwriting will change), typing, they will drop items, can't close buttons, etc.. losing dexterity.
- Generally speaking if a patient has complete or almost complete spinal cord injury the **last** thing to be affected is the **sacral** representation which is responsible for bowel and bladder control.

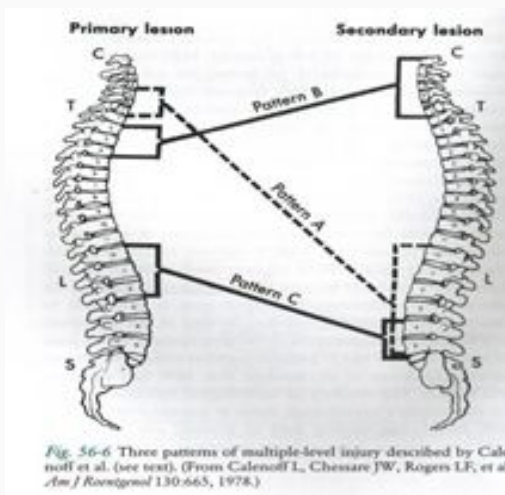
Descending (<u>motor</u>)	Ascending (sensory)	
Corticospinal tract	Posterior column (Romberg test)	Spinothalamic tract
Carries motor fibers.	Carries proprioception, vibration, 2-point discrimination.	Carries pain, temperature, general "crude touch".
Decussate at brainstem	Decussate at brainstem	Decussate at spinal level ³
Lesion: ipsilateral upper motor neuron syndrome (weakness, spastic tone, increased reflexes, clonus, and a Babinski response)	Lesion: ipsilateral loss of fine touch, vibration and proprioception sense below the site of the lesion	Lesion: contralateral loss of pain and temperature sense below the site of the lesion.

BLOOD SUPPLY

- The arterial blood supply to the spinal cord is derived from two branches of **vertebral artery**, the **anterior and two posterior spinal arteries**.
- So, if anterior spinal artery is injured that's it, the anterior 2/3 of the spinal cord is infarcted.
- However posterior spinal infarctions are less common, due to the **dual** posterior spinal artery.

EPIDEMIOLOGY

- 56000 cases per year.
- 11000 new spinal cord injuries.
- **15-20% multiple non-contiguous levels**. If the patient is comatose or have a distraction injury you cannot exclude cervical injury or others so you have to screen and examine full spine.
- 10% involving the cervical spine.
- **90% involving thoracolumbar spine**.
- 25% have neurologic deficit.
- Age: mostly between **15-24 years**.
- Gender: mostly **males** (4:1). **Male are more into adrenaline rush and irresponsible driving**



Dens fracture with significant displacement

- There are 3 possible patterns of multiple non-contiguous level injury: pattern A, B, and C.
- If a patient presents with a primary lesion in the upper or lower cervical spine, he will also have a secondary lesion in the lumbar area (see pattern A), and the same goes for the other patterns.
- This is a real patient (picture A) presented with T3 fracture with mild subluxation and retropulsion of this fracture because it is collapsed the T3, he had brain injury and can't move the lower limb so you can't examine him. This is the image we received, is it enough? **NO** we need cervical spine image because if we follow pattern B he may also have another non-contiguous injury, so we asked for another image (picture B) and see that he does have another injury in cervical spine (C1).

MECHANISM OF INJURY

Trauma can be divided into high velocity (like skiing or falling from horse) or low velocity injury.

- **High energy** trauma such as an **MVA** (motor vehicle accident) or fall from a height or a horse
 - MVA: 40-55%
 - Falls: 20-30%
 - Sports: 6-12%
 - Others: 12-21%
- **Low energy** trauma in a high-risk patient (i.e. a patient with known spinal canal compromise such as **ankylosing spondylitis**⁴ التهاب الفقرات التصلبي (no shock absorbent mechanism of the disc so a hit in the head will lead to extension and opening of the fracture) **Osteoporosis** هشاشة العظام or metastatic vertebral lesions or spinal infection (pathological fracture!)
- **Penetrating** trauma from gunshot or knives.



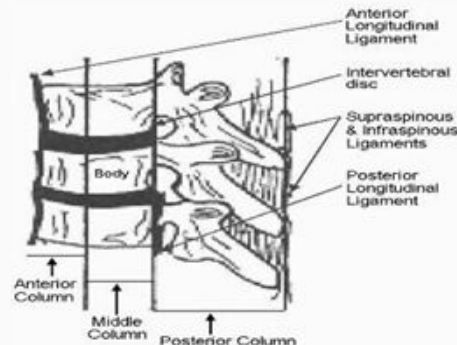
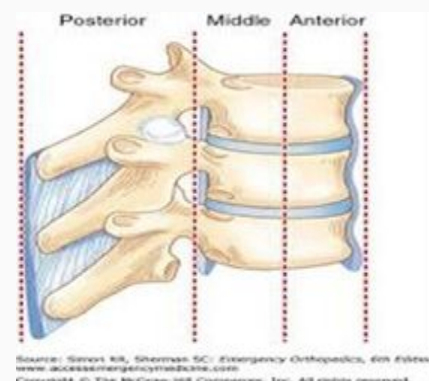
This is a pathological fracture in a patient with cervical **ankylosing spondylitis**, you can see loss of vertebral space and **fusion** of the vertebral bodies.

SPINE STABILITY

- There is cervical spine instability if:
 - Compression fracture with 25% loss of height.
 - Angular displacement > 11 degrees.
 - Translation > 3.5 mm (الفقره تحركت)
 - Disc space separation > 1.7mm
- Thoracic and lumbar spine stability depends on Denis three column theory a **Instability exists with disruption of any two of three columns** (≥ 2 columns affected = instability)

THREE COLUMNS

- Denis three column model divides the **thoracolumbar** spine into three columns: put a line through the vertebral body and you have the anterior and middle columns then everything behind the vertebral body makes up the posterior column.
- 1) **Anterior column**: includes the anterior longitudinal ligament (ALL) up to the first half of the vertebral body).
- 2) **Middle column**: includes the second half (posterior half) of the vertebral body, up to, and including the posterior longitudinal ligament (PLL).
- 3) **Posterior column**: includes the **pedicles**, spinal cord/theal sac, lamina, transverse processes, facet joints, spinous process, and the posterior ligaments (supraspinous, interspinous, and ligamentum flavum).
- If the injury involved **one third or less of the spine** (= one column or less) - it is considered a “stable injury” and it is **managed conservatively**. If the injury involved **two third or more of the spine** - it is considered an “unstable injury” and it is **managed by surgery**.



ASSESSMENT

- In cases of trauma, **ABCDE's⁵ or ATLS** must be assessed first and treated appropriately.
- Patients should be examined with a **spinal collar** until spinal pathology is excluded.
- Careful log rolling keeping the head, neck and pelvis in line should be done to examine the spine properly.

1. A: Airway with **Immobilization of cervical spine**

To immobilize the fracture spine we do log rolling!

- Trauma patients are usually first assessed at the scene by paramedics and then transported to the hospital. The assessment at the scene is very important. So every trauma patient that presents in the emergency needs to be **immobilized with cervical collar and spinal board** and spinal injury is assumed in every patient to prevent further neurological deficit that can happen if the patient was not immobilized.
- At the scene, one member of rescuer team stabilizes head and neck in neutral position without applying traction. Another rescuer should apply a cervical collar. Then rescuer 1 stabilizes the head and neck and the others perform log rolling to place the patient in the spine board. Even with the collar in place, Rescuer 1 must maintain the head and neck in a neutral position until the log-rolling maneuver is complete.
- Once the patient is transported safely to the hospital, we can use **cervical traction**.
- Spinal board is **only** used for **transport** not for immobilization! Prolonged use at the hospital may lead to pressure ulcer.
- Log rolling is done by 3 or 4 (preferably) people: one for the head, one for the torso or trunk, and one for the lower limb with head and neck aligned to the spine, pt in ICU with fracture the management of fracture is by log rolling.

Types of Immobilization

Collar طوق	Spine board لوح شوكي	Log rolling
<div data-bbox="90 1325 483 1507"> </div> <p data-bbox="69 1560 500 1671">Left: Hard collar (used in trauma) Right: Soft collar (only for neck pain NOT for trauma)</p>	<div data-bbox="659 1325 982 1507"> </div> <p data-bbox="610 1549 927 1583">Only used for transport.</p>	<div data-bbox="1157 1325 1533 1566"> </div> <p data-bbox="1114 1591 1484 1625">Prevent ulcers in the back</p>

2. History and AMPLE history

- Mechanism of injury: compression, flexion, extension, distraction.
- Seat belt (People who are wearing a lap belt only → can lead to chance injury)
- Other injuries.
- Other casualties

3. Physical examination we follow the dermatome, myotome, reflexes.

- Inspection (ecchymosis, swellings, open wound...), palpation (tenderness)
- Neurologic examination:
 - Muscle Test.
 - Sensory exam: light touch, sharp dull discrimination, vibration sense, proprioception and two-point discrimination.
 - Reflexes.

SIGNS OF SPINAL TRAUMA

- Apnea (diaphragm may be affected), lower cranial nerve injury VIII-XII (high C-spine) which is mainly occipito-cervical.
- Deformity of the spine or neck.
- Tenderness on palpation along spinal processes.
- Paralysis or muscle weakness (which spinal level).
- Loss of sensation (which dermatomes).
- Loss of rectal tone.
- Positive Babinski sign or plantar response (brainstem injury)

AMERICAN SPINAL INJURY ASSOCIATION (ASIA) SCORE:

L1 and L2 dermatomes
No need to know anything but dermatomes and the scale: A>B>C>D >E

You are not going to be asked about how to calculate the score or how the chart is done only know it's for standardization + Or like pt with ASIA B score, you should know what does mean

ASIA Score Brief Trauma Neurologic Survey: evaluates sensation (dermatomes) and muscle action (myotomes) of the nerve roots.

- You **have to know** the nerve roots for lumbar = dermatomes + reflexes.
- After thorough neuro-assessment an ASIA score is given:
- E = "Excellent" Normal examination
- A = "Absent" = absent motor / sensory / reflexes Complete injury
- B = Incomplete (only sensation)
- C = Incomplete (only sensation and muscle power < 3)
- D = Incomplete (muscle power ≥ 3)

If you label a patient as incomplete or complete you have to classify him into one of the clinical syndromes: central cord, brown-sequard, anterior cord, conus medullaris, or cauda equina.

Level of Cord Injury determines level of function (conus medullaris + cauda equina happen only in conus and below, does NOT occur in cervical or thoracic area / while central, brown, and anterior syndromes happen in thoracic spine area).

ASIA IMPAIRMENT SCALE

- A = Complete:** No motor or sensory function is preserved in the sacral segments S4-S5.
- B = Incomplete:** Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5.
- C = Incomplete:** Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3.
- D = Incomplete:** Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more.
- E = Normal:** motor and sensory function are normal

CLINICAL SYNDROMES

- Central Cord
- Brown-Sequard
- Anterior Cord
- Conus Medullaris
- Cauda Equina

Myotomes,

- L2 hip flextime,
- L3 knee extension,
- L4 ankle dorsiflexion,
- L5 longus extensor,
- S1 plantar flexion,
- in reflexes for knee will be L4

Dots areas are important and sensitive in exam u have to know general dermatomes but may ask u about dots area

Patient Name _____ Date/Time of Exam _____
 Examiner Name _____

STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY **ISC 68S**

MOTOR (M) **SENSORY** (S)

The form includes a grid for recording motor and sensory levels, a diagram of the human body with key sensory points marked, and a section for recording the ASIA Impairment Scale score and clinical syndrome.

PROGNOSIS FOR RECOVERY OF SPINAL CORD INJURY

- **Poor** prognosis for recovery if:
 - Patient arrives in shock.
 - Patient cannot breathe.
 - Patient has a complete injury.

SEVERITY OF NEUROLOGICAL DEFICIT (SPINAL CORD SYNDROME)

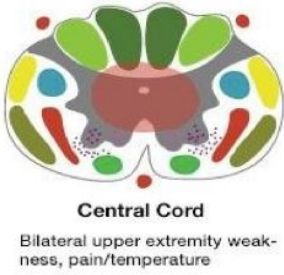
(DR.NABIL)

COMPLETE

- Flaccid paralysis الشلل الرخو below level of injury: **initially** the patient will have flaccid paralysis and might develop rigidity later⁶.
- May involve **diaphragm** (respiratory function may be affected) if injury above C5⁷. (C3-C5)injury----> may need mechanical ventilators
- Sympathetic tone loss if fracture above T6⁸: **Neurogenic shock** is a circulatory status due to loss of sympathetic tone and unopposed vagal tone (hypotension + bradycardia).

INCOMPLETE


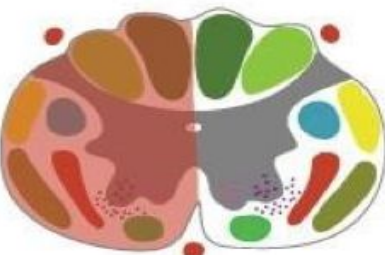
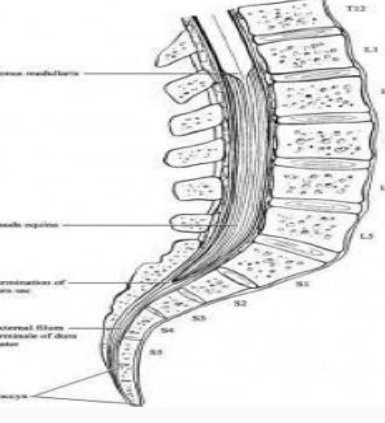

If the patient has **any sensation** or **sacral sparing**.

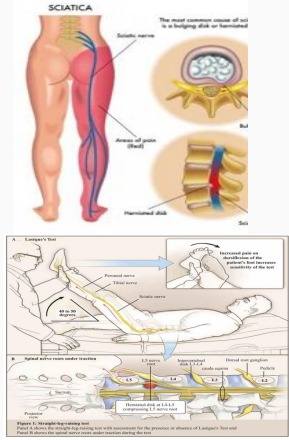
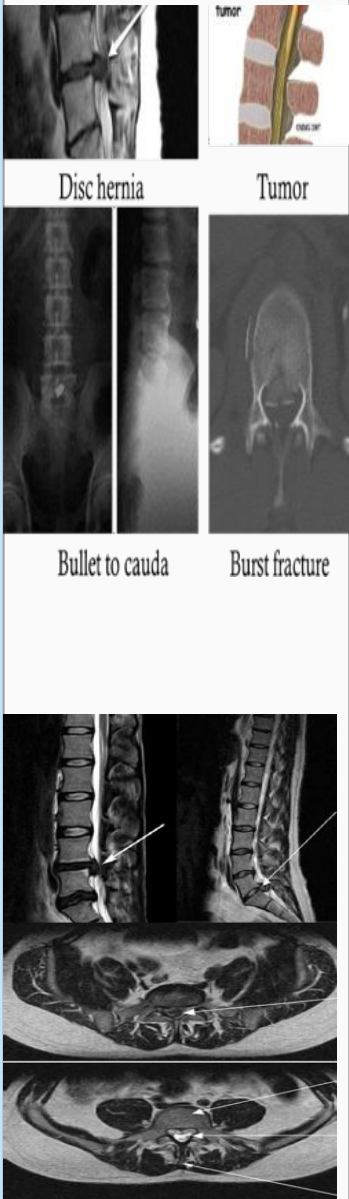
Syndrome	Picture	Features
Central cord syndrome متلازمة الحبل المركزية CERVICAL (DR.NABIL)		<ul style="list-style-type: none"> • Characterized by disproportionately (UL>LL) The distal affect more than proximal, hand more than shoulder. • Mechanism: hyperextension (spondylosis nutcracker effect on spinal cord.) • Occur with or without fractures. • Recovery: 50% regaining function! مهم الرقم • Prognosis is fair. • Disc and osteophyte affect cord progression leading to ---->loss of proprioception,hand function loss • Cervical spondylotic الفقار الرقبية neuropathy if developed ---> chronic

⁶ Complete cord transection causes **spastic** paralysis (UMN injury), but in acute settings they present with LMN injury (due to spinal shock) which will manifests as flaccid paralysis.

⁷ Patient fractured his C1 and C2 spines and arrived to the hospital and the ICU team failed to extubating him, what's the diagnosis? Diaphragmatic Palsy.

⁸ Patient fractured his T1 and T2 spines and arrived to the hospital with full conscious but the ICU team can't increase his blood pressure, what Is the treatment? Vasopressor because he is having Neurogenic Shock

Syndrome	Picture	Features
<p>Anterior cord syndrome</p>	 <p style="text-align: center;">Anterior Cord</p> <p>Bilateral motor, pain/temperature</p> <p style="text-align: center; color: red;">Sleep normal wake up paraplegic</p>	<ul style="list-style-type: none"> ● Characterized by loss of corticospinal(motor)and spinothalamic(pain, temperature)tract with preserved posterior column (proprioception, vibratory sense). ● Mechanism: ischemia (reversible) or infarction (complete loss of function) to spinal cord = anterior spinal artery (supplies anterior 2/3 of spinal cord) gets occluded due to injury, infection, abscess, tumor. ● Common injury ● Recovery: 10% , if ischemia recovery will be really good, if infarction there will be no recovery ● Prognosis is good if progressive recovery within 24hrs, absent SS(sacral sparing) after 24hrs pretends a poor outcome. ● Rapid loss of function = vascular related injury
<p>Brown-Sequard syndrome متلازمة الشلل النصفى (COSMOSIS) (HIGH YIELD) (NOTES) (OSMOSIS)</p>	 <p style="text-align: center;">Brown-Sequard</p> <p>Unilateral weakness, contralateral pain/temperature</p>	<ul style="list-style-type: none"> ● Characterized by hemicord injury with ipsilateral paralysis, loss of proprioception and light touch (dorsal “posterior”column), and contralateral temperature and sharp pain loss (spinothalamic tract) ● Caused by disc, tumor, fracture, or hemicord transection due to penetrating trauma. ● Anything other than transection Prognosis is good, with over 90% regaining of bowel and bladder function and ambulatory capacity
<p>Conus Medullaris Syndrome</p> <p>(IMPORTANT) (DR. NABIL)</p> <p>Cauda Equina and UMN disease (Rigidity, Hyperreflexia)</p>		<ul style="list-style-type: none"> ● Conus medullaris: It is the terminal part of the spinal cord around T12/L1. It is the area between spinal cord and the cauda equina. ● Seen in T12-L1 injuries. ● Loss of voluntary bowel and bladder control with preserved lumbar root function. ● Uncommon as pure lesion (mixed conus-cauda). ● Will have features of cauda equina and UMN signs (fasciculations).
<p>Posterior cord syndrome متلازمة الحبل الخلفى</p>	 <p style="text-align: center;">Posterior Cord</p> <p>Bilateral proprioception</p>	<ul style="list-style-type: none"> ● Extremely rare, vascular compromise appears to be the most common etiology. With occlusion to the posterior spinal artery, a Posterior Cord Syndrome will ensue. (Remember we have 2 posterior spinal arteries. That’s why it is very rare) ● Patient will have loss of proprioception which will affect gait and fine hand movements (as discussed above).

Syndrome	Picture	Features
<p>Nerve root deficit (LMN deficits)</p>		<p>Example:</p> <ul style="list-style-type: none"> ● LMN and radiculopathy اعتلال الجذور ● Sciatica عرق النسا (most common) due to disc herniation الانزلاق الغضروفي. SLR test ● Patient with L3 fracture will present with ipsilateral weakness in knee extension and absent knee jerk, loss of sensation in L3 dermatome with no other deficits. ● This is the simplest kind of neurological deficit and usually have the best outcome in term of prognosis
<p>Cauda-Equina syndrome متلازمة ذنب الفرس (OSMOSIS) (HIGH YIELD) NOTES OSMOSIS)</p>		<ul style="list-style-type: none"> ● Urinary retention, bowel incontinence (can start incomplete and the patient will say he can't control his gait initially) and saddle anesthesia. ● Patient comes complaining of back pain+sciatica, if you find CES triad it turns into emergency right away!!! ● Causes (usually due to large central disc herniation rather than fracture): <ul style="list-style-type: none"> ○ Central disc prolapse. ○ Burst fractures of lumbar spine. ○ Penetrating injuries such as stab wounds or bullets. ○ Epidural hematoma from spinal anesthesia, or post- surgery (rare). ○ Tumors compressing the lower spinal nerve roots. ○ Severe spinal stenosis. ● Management: It is a surgical emergency, requires full neurologic examination including rectal examination for anal tone. ● No anal sphincter working, but there is severe constipation because nerves not working (ileus) ● Investigations: X-rays initially, but MRI is mandatory as X- rays are usually unremarkable. If MRI is contraindicated (like patient has bullet) do CT scan! (ex: Patient has Arrhythmia and having pacemaker? CT not MRI). ● Treatment: Emergency decompression-usually discectomy استئصال القرص - and wide laminectomy within 24 hours. If fracture = stabilization ● After 24 > Will lead to permanent bowel and bladder injury ● SAQ: Mention symptoms: Back pain, sciatica, numbness in lower limb, stiffness of spine, severe leg pain, urinary retention, stool Incontinence. ● SIGNS: TENDERNESS, weakness, drop foot, palpable bladder, sacral paresthesia ● Most common presentation is back pain and sciatica radiculopathy, numbness ● WHAT MAKES IT RED FLAG? SUDDEN PARESTHESIA, CAN'T CONTROL BOWEL

- Keep in mind:
 - Patient who have disc which lead to cauda equina is different from the patient with thoracic spine injury and paraplegia w/ features of cauda equina b/c if he has complete spinal injury at the thoracic level he will have:
 - - Complete loss of sensation from the chest down (including perianal area).
 - - Neurogenic bladder (urinary retention).
 - - Loss of anal tone = completely open (but they are constipated b/c of bowel paralysis + no ambulation > stool harden need digital disimpaction)
 - These are all features of cauda equina BUT this is not cauda equina syndrome but complete spinal injury.

CAUDA EQUINA VS CONUS MEDULLARIS (EXTRA)

	Conus Medullaris	Cauda Equina
Pain	Less common & less severe, LBA	Pain is prominent, severe & radicular in type;
Location	Bilateral and symmetric; in perineum or thighs	Unilateral or asymmetric; in perineum, thighs, legs, or back;
Sensory deficit	Saddle distribution; Bilateral, usually symmetric; Dissociation of sensation	Saddle distribution; Unilateral and asymmetric; No dissociation of sensation
Motor loss	Symmetric; Not marked; Fasciculations may be present	Asymmetric; More marked; atrophy may occur; usually no fasciculations
Reflex loss	Only Ankle reflex absent	Knee and Ankle reflexes may be absent
Bladder and rectal symptoms	Early and marked	Late and less marked
Trophic changes	Common	Less common
Sexual functions	Erection and ejaculation impaired	Less marked impairment
Onset	Sudden and bilateral	Gradual and unilateral

Spinal shock

صدمة نخاعية

(This is neurological and transient) [\(DR.NABIL\)](#)

- Transient (مؤقت) loss of spinal reflexes.
- Physiologic shutdown of all spinal cord (sensory, motor, reflexes) function b/c of injury.
- Lasts **24-72** hours.

How do I know if spinal shock is over (b/c you can't declare him as complete or incomplete due to the physiological shutdown)?

Return of **bulbocavernosus reflex**
(examination through rectal contraction)

It will be below the level of injury

Neurogenic shock

صدمة عصبية

(Vascular "circulatory" phenomena) **Above**

T6

- Reduced tissue perfusion due to loss of sympathetic outflow and unopposed vagal tone.
- Peripheral vasodilatation (**hypotension and bradycardia**).
- Rx: **fluid resuscitation** initially and **vasopressors** (is a **MUST**)

IMAGING

★ X-rays: **fell from tree normal examination x-ray**

- Cervical: 3 views (AP, lateral and open mouth⁹).
- Thoraco-lumbar: 2 views (AP & lateral).
- Flexion-Extension views¹⁰

★ CT: (CT NEUROGRAM)

Best for **bony** anatomy. “In case of burst fracture”

★ MRI:

Best to evaluate **soft tissue**.

MANAGEMENT OF SPINAL INJURY

★ Depends on:

- (1) Level of injury. (C3 Vs. L5? totally different consequences).
- (2) Degree and morphology of injury: **STABILITY**.
- (3) Presence of neurologic deficit.
- (4) Other factors (Pathological fracture vs. High energy trauma)

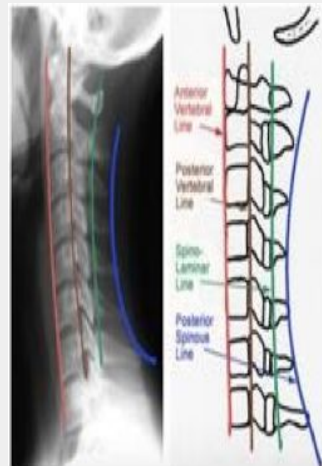
★ Some general rules:

- **Stable** injuries are usually treated **conservatively**.
- **Unstable** injuries usually require **surgery**.
- **Neurologic compression** requires **decompression**.

SPECIFIC INJURIES

1- Cervical spine fractures:

- Descriptive: depends on mechanism of injury:
 - Flexion/extension. (horse riding)
 - Compression/distraction.
 - Shear.
- Presence of subluxation/dislocation.
- SCI spinal cord injury:
 - **High fracture** (upper in cervical) results in **quadriplegia** شلل رباعي
 - **High fractures** requires ventilators.
 - **Low fracture** (lower in thoracic) results in **paraplegia**. شلل نصفي
- If a pt presented with cervical fracture/dislocation:
 - Symptoms: can't move, can't feel, **neck pain**
 - Signs (go with the symptoms): paralysis, loss of sensation, ecchymosis, neck swelling, etc...



Normal cervical x-ray
Anterior and Posterior line should be congruent



C5/6 fracture dislocation
(Spine is **Unstable**)
Could be quadriplegic, paraplegic, or have initial presentation of spinal shock

9. An open mouth view is a special view → AP view of C1 and C2 vertebrae

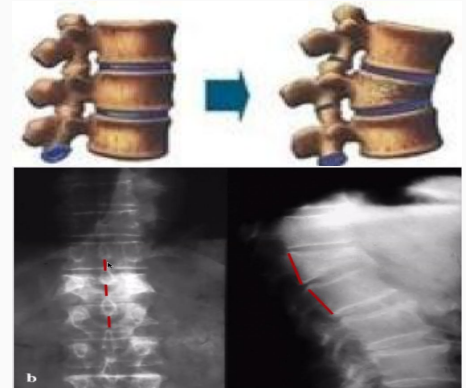
10. Do not do it in trauma patient as it may cause iatrogenic spinal cord injury. You might do it later.

2- Thoracolumbar fractures:

- Spinal cord terminates at L1/2 disc in adult (L2/3 in a child).
- 50% of injuries occur at Thoracolumbar junction (T12/L1).
- Common fractures: wedge(flexion, compression), **burst (compression)**, chance fracture(flexion, distraction).

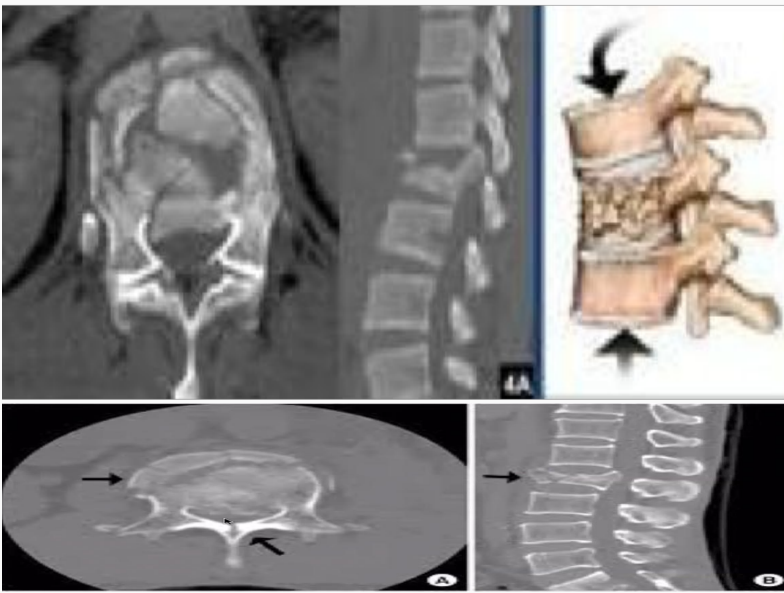
★ Wedge¹¹ fracture (flexion/compression الكسور الانضغاطية):



- This is by far the most common vertebral fracture and is due to severe spinal flexion.
- Anterior part is **مخفوس** compressed and posterior is intact and distance b/w spinous process are normal.
- The posterior part of the vertebral body, pedicles, laminae and spinous processes are intact.
- Only the anterior column is affected so the spine is stable.



★ Burst fracture المتفجرة (compression):

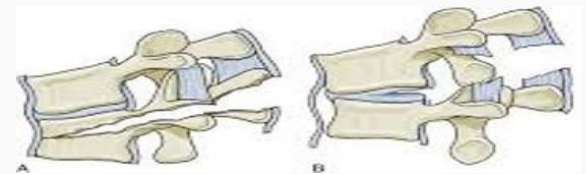
- Severe axial compression may ‘explode’ the vertebral body.
- Posterior wall is involved and there is loss of height anterior and posterior compared to adjacent vertebrae + there might be widening of spinal processes, the spine is compromised (unstable)
- **The whole vertebral body is affected = anterior column and middle column.**



Burst Fractures - characteristics	
1. Retropulsion of posterosuperior vertebral body fragment. - Wedge compression may bulge posterior cortex but not posteriorly displace	
2. Sagittal fracture of vertebral body (90%)	
3. Sagittal posterior element fracture (85%)	
4. Widening of interpedicular distance (80%)	

★ Chance fracture كسر حزام الأمان (flexion/distraction):

- Hyperflexion injury can result in 2 issues:
 - bony chance: affecting vertebral body + pedicle + spinous process fracture and opened
 - ligamentous chance: supraspinous, interspinous, intertransverse, facet capsule and disc without bony fracture.
- This is a three columns injury = unstable injury.
- **40% associated w/ abdominal injury = bowel perforation, mesenteric rupture or bowel rupture.**
- Mechanism? Wearing only lap belt.
- Children must either be in a car seat or have a seat booster to prevent these types of injuries!



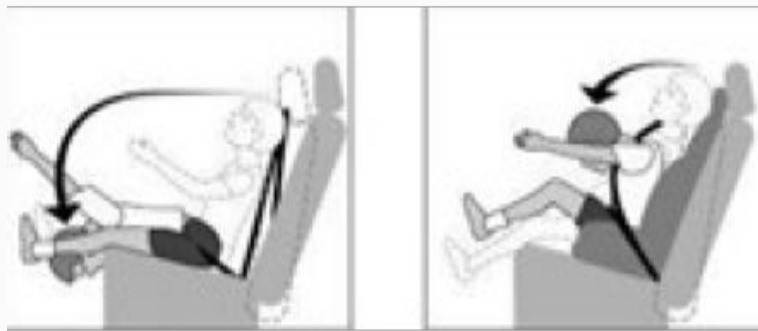


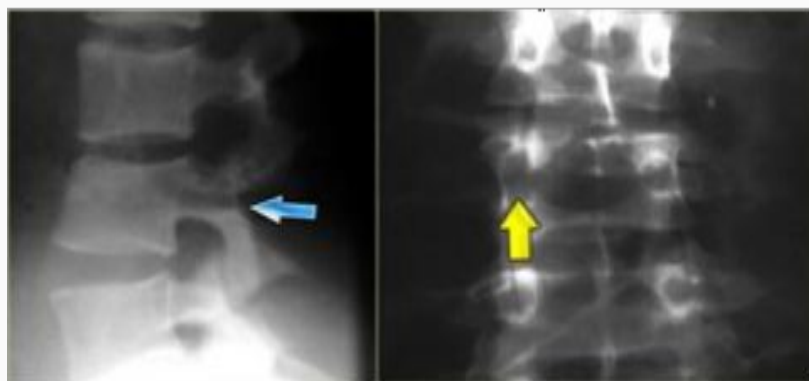
Figure 1. Lap Belt Ecchymosis



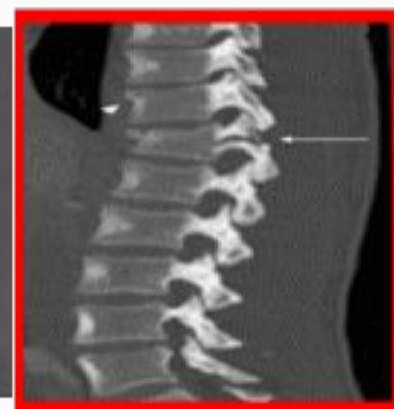
Image courtesy of Dr. Antonio Muriz



- X-rays may show horizontal fractures in the pedicles or transverse processes, and in the AP view the apparent height of the vertebral body may be increased.
- If it was in the ligaments the x-ray will be normal, but in clinical examination you will feel the gap, and there will be severe tenderness upon palpation.



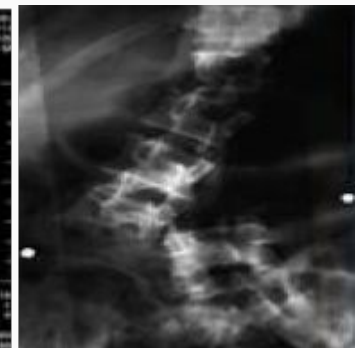
One pedicle is longer than other



EXAM Q: ABDOMINAL SWELLING, RIGIDITY, ECCHYMOSIS, HIGHEST ASSOCIATION IS WHAT INJURY?
INTRA-ABDOMINAL INJURY CAUSING CHANCE

★ Fracture dislocation:

- **Unstable** = all three columns are disrupted
- These are the most dangerous injuries and are often associated with neurological damage to the lowermost part of the cord or the cauda equina.
- There will be coronal and sagittal loss of alignment on X-ray



★ Pathological fractures:

- Usually due to infection or tumor.
- Low-energy fractures.
- **Osteoporotic** is common. **What is the most common cause of pathological fracture? Osteoporosis**
- X-rays **winking owl sign** (pathognomonic for infection or tumor) **The (absent) pedicle sign.**
- You need to treat the fracture and the underlying cause.



From Dr Khalid Bakarman:

Myotomes,

-*Upper limb*

- C4: Deltoid.
- C5: Elbow flexion and Biceps reflex.
- C6: Wrist extension and Brachioradialis.
- C6 and C7: Wrist flexion.
- C7: Finger abduction and Triceps.
- C8: Finger adduction.

Lower limb

- L2: Hip flexors.
- L3: Knee extension.
- L4: Ankle dorsiflexion and Knee jerk.
- L5: Big toe.
- S1: Plantar flexion and Achilles tendon.

Spine

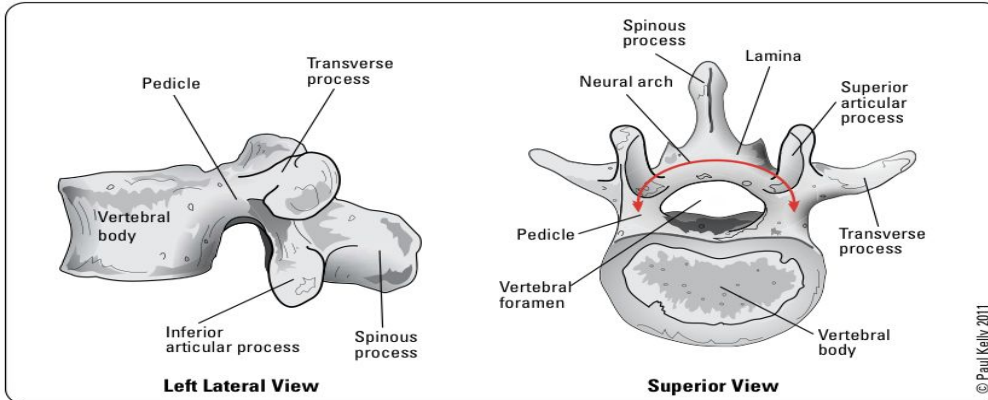


Figure 27. Schematic diagram of vertebral anatomy
Adapted from: Moore KL, Agur AMR. Essential Clinical Anatomy, 3rd ed. Philadelphia: Lippincott Williams and Wilkins, 2007. p274

Fractures of the Spine

- see [Neurosurgery, NS34](#)

Cervical Spine

General Principles

- C1 (atlas): no vertebral body, no spinous process
- C2 (axis): odontoid = dens
- 7 cervical vertebrae; 8 cervical nerve roots
- nerve root exits above vertebra (i.e. C4 nerve root exits above C4 vertebra), C8 nerve root exits below C7 vertebra
- radiculopathy = impingement of nerve root
- myelopathy = impingement of spinal cord

Special Testing

- compression test: pressure on head worsens radicular pain
- distraction test: traction on head relieves radicular symptoms
- Valsalva test: Valsalva maneuver increases intrathecal pressure and causes radicular pain

Figure 24. ORIF left scaphoid

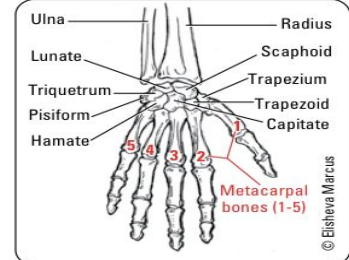


Figure 25. Carpal bones

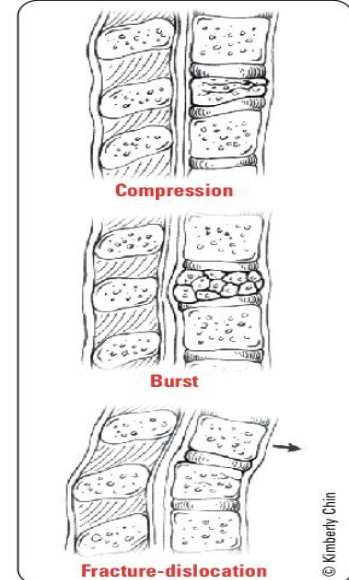


Figure 26. Compression, burst, and dislocation fractures of the spine

Table 14. Cervical Radiculopathy/Neuropathy

Root	C5	C6	C7	C8
Motor	Deltoid Biceps Wrist extension	Biceps Brachioradialis	Triceps Wrist flexion Finger extension	Interossei Digital flexors
Sensory	Axillary nerve (patch over lateral deltoid)	Thumb	Index and middle finger	Ring and little finger
Reflex	Biceps	Biceps Brachioradialis	Triceps	Finger jerk

X-Rays for C-Spine

- AP spine: alignment
- AP odontoid: atlantoaxial articulation
- lateral
 - vertebral alignment: posterior vertebral bodies should be aligned (translation >3.5 mm is abnormal)
 - angulation: between adjacent vertebral bodies (>11° is abnormal)
 - disc or facet joint widening
 - anterior soft tissue space (at C3 should be ≤3 mm; at C4 should be ≤8-10 mm)
- oblique: evaluate pedicles and intervertebral foramen
- ± swimmer's view: lateral view with arm abducted 180° to evaluate C7-T1 junction if lateral view is inadequate
- ± lateral flexion/extension view: evaluate subluxation of cervical vertebrae

Differential Diagnosis of C-Spine Pain

- neck muscle strain, cervical spondylosis, cervical stenosis, RA (spondylitis), traumatic injury, whiplash, myofascial pain syndrome, acute discogenic nerve root entrapment, infection, fracture, neoplasm, pain from soft tissue structure

Spinal Cord Injury

- see [Orthopedic Surgery, OR23](#) and [Emergency Medicine, ER9](#)

NEUROGENIC AND SPINAL SHOCK

1. neurogenic shock: hypotension that follows SCI (sBP usually ≤ 80 mmHg) caused by
 - interruption of sympathetics (unopposed parasympathetics) below the level of injury
 - loss of muscle tone due to skeletal muscle paralysis below level of injury \rightarrow venous pooling (relative hypovolemia)
 - blood loss from associated wounds (true hypovolemia)
2. spinal shock: transient loss of all neurologic function below the level of the SCI, causing flaccid paralysis and areflexia for variable periods

Whiplash-Associated Disorders

- definition: traumatic injury to the soft tissue structures in the region of the cervical spine due to hyperflexion, hyperextension, or rotational injury to the neck

Initial Management of Spinal Cord Injury

- major causes of death in SCI are aspiration and shock
- the following patients should be treated as having a SCI until proven otherwise:
 - all victims of significant trauma
 - minor trauma patients with decreased LOC or complaints of neck or back pain, weakness, abdominal breathing, numbness/tingling, or priapism

Stabilization and Initial Evaluation in the Hospital

1. ABCs, immobilization (backboard/head strap), oxygenation, Foley catheter to urometer, temperature regulation
2. hypotension: maintain sBP >90 mmHg with pressors (dopamine), hydration, and atropine
 - DVT prophylaxis
3. monitor CBC/electrolytes
4. focused history (see Trauma Assessment, NS30)
5. spine palpation: point tenderness or deformity
6. motor level assessment (including rectal exam for voluntary anal sphincter contraction)
7. sensory level assessment: pinprick, light touch, and proprioception
8. evaluation of reflexes
9. signs of autonomic dysfunction: altered level of perspiration, bowel or bladder incontinence, priapism
10. radiographic evaluation
 - 3 views C-spine x-rays (AP, lateral, and odontoid) to adequately visualize C1 to C7-T1 junction
 - flexion-extension views to disclose occult instability
 - CT scan (bony injuries) typically most trauma centres use CT as the modality of choice for looking at fractures, very sensitive with the high resolution scanners
 - MRI mandatory if neurological deficits (soft tissue injuries)

Resolution of spinal shock is indicated by the return of reflexes (most commonly the bulbocavernosus reflex)



Pharmacological Therapy for Acute Spinal Cord Injury: Congress of Neurological Surgeons (CNS) and American Association of Neurological Surgeons (AANS) Guidelines
Neurosurgery 2013;72(Suppl 2):93-105

Level I Recommendations

- No Class I or Class II medical evidence supports the use of methylprednisone in the treatment of acute SCI. Several Class II and Class III studies have been published stating inconsistent effects of methylprednisone likely related to random chance or selection bias.
- Administration of GM-1 ganglioside (Sygen) for the treatment of acute SCI is not recommended.



Early vs. Delayed Decompression for Traumatic Cervical Spinal Cord Injury: Results of the Surgical Timing in Acute Spinal Cord Injury Study (STASCIS)
PLoS ONE 2012;7:e32037. doi:10.1371/journal.pone.0032037

Introduction: This study sought to determine the relative effectiveness of early (<24 h after injury) versus late (≥ 24 h after injury) decompressive surgery following a traumatic cervical SCI.

Methods/Population: A prospective cohort study completed in 2002-2009 involving 6 North American institutions. Participants were 16-80 yr with a cervical SCI. Outcomes evaluated were changes in American Spinal Injury Association Impairment Scale (AIS) grade at 6 mo follow-up, complications, and mortality.

Results: Of 313 participants enrolled, 182 underwent early surgery and 131 underwent late surgery. 222 participants were available for follow-up at 6 mo. The odds of at least 2 grade AIS improvement were greater for those who had early surgery compared to those with late surgery (OR = 2.83, 95% CI 1.10, 7.28). Mortality was observed for each group during the first 30 d post injury. No statistically significant differences were observed for complications ($p=0.21$).

Conclusion: Early decompression surgery following a SCI is safe and associated with higher AIS improvement at 6 mo following injury.

Medical Management Specific to Spinal Cord Injury

- option: methylprednisolone (given within 8 h of injury) this is controversial and you need to confer with Neurosurgery service
- \pm decompression in acute, non-penetrating SCI

Spinal Cord Syndromes

Complete Spinal Cord Lesion

- bilateral loss of motor/sensory and autonomic function at ≥ 4 segments below lesion/injury, with UMN signs
- about 3% of patients with complete injuries will develop some recovery within 24 h, beyond 24 h, no distal function will recover

Incomplete Spinal Cord Lesion

- any residual function at ≥ 4 segments below lesion
- signs include sensory/motor function in lower limbs and "sacral sparing" (perianal sensation, voluntary rectal sphincter contraction)

Table 17. Comparison Between Incomplete Spinal Cord Lesion Syndromes

Syndrome	Etiology	Motor	Sensory
Brown-Séquard	Hemisection of cord	Ipsilateral LMN weakness at the lesion Ipsilateral UMN weakness below the lesion	Ipsilateral loss of vibration and proprioception Contralateral loss of pain and temperature Preserved light touch
Anterior Cord	Anterior spinal artery compression or occlusion	Bilateral LMN weakness at the lesion Bilateral UMN weakness below the lesion Urinary retention	Preserved vibration and proprioception Bilateral loss of pain and temperature Preserved light touch
Central Cord (most common)	Syringomyelia, tumours, spinal hyperextension injury	Bilateral motor weakness: Upper limb weakness (LMN lesion) $>$ Lower limb weakness (UMN lesion) Urinary retention	Variable bilateral suspended sensory loss Loss of pain and temperature $>$ loss of vibration and proprioception
Posterior Cord	Posterior spinal artery infarction, trauma	Preserved	Bilateral loss of vibration, proprioception, light touch at and below the lesion Preserved pain and temperature

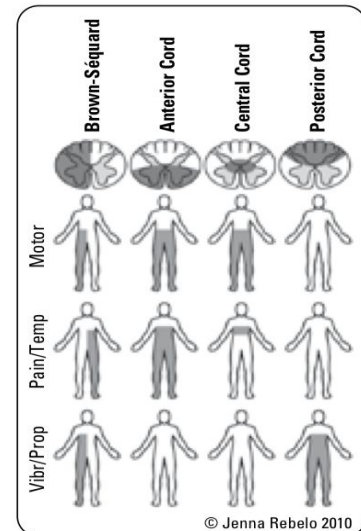


Figure 25. Spinal cord lesion syndromes



Guideline for Timing of Decompressive Surgery in Management of Acute Spinal Cord Injury and Central Cord Syndrome: Results of a Systematic Review
Global Spine Journal 2017; 7(3S): 195S-202S

Summary of recommendations:

- Low quality of evidence: Early surgery (<24 hours after injury) should be considered as a treatment option in adult patients with traumatic central cord syndrome.
- Low quality of evidence: Early surgery should be offered as an option for adult acute SCI patients, regardless of level of lesion.

Peripheral Nerves

Cauda Equina Syndrome

Etiology

- compression or irritation of lumbosacral nerve roots below conus medullaris (below L2 level)
- decreased space in the vertebral canal below L2
- common causes: herniated disc ± spinal stenosis, vertebral fracture, and tumour

Clinical Features

- usually acute (develops in less than 24 h); rarely subacute or chronic
- motor (LMN signs)
 - weakness in multiple root distribution
 - reduced deep tendon reflexes (knee or ankle)
- autonomic
 - urinary retention (or overflow incontinence) and/or fecal incontinence due to loss of anal sphincter tone
- sensory
 - low back pain radiating to legs (sciatica) aggravated by Valsalva maneuver and by sitting; relieved by lying down
 - bilateral sensory loss or pain: depends on the level affected
 - saddle area (S2-S5) anesthesia
 - sexual dysfunction (late finding)



Causes of Cauda Equina Syndrome

- Lumbar disc herniation
- Spinal stenosis
- Spinal tumour
- Epidural abscess
- Hematoma
- Trauma

Investigations

- urgent MRI to confirm compression of S2-S3-S4 nerve root by a large disc herniation
- post-void residual very helpful to determine if true retention is present; volumes controversial but anything over 250 cc in a healthy individual is cause for concerns

Treatment

- surgical decompression (<48 h) to preserve bowel, bladder, and sexual function, and/or to prevent progression to paraplegia
- consult radiation oncology for urgent symptomatic management if palliative oncology patient

Prognosis

- markedly improves with surgical decompression
- recovery correlates with function at initial presentation: if patient is ambulatory, likely to continue to be ambulatory; if unable to walk, unlikely to walk after surgery

Fractures of the Spine

FRACTURES AND FRACTURE-DISLOCATIONS OF THE THORACIC AND LUMBAR SPINE

- assess ligamentous instability using flexion/extension x-ray views ± MRI
- thoracolumbar spine unstable if 4/6 segments disrupted (3 columns divided into left and right)
 - anterior column: anterior half of vertebral body, disc, and anterior longitudinal ligament
 - middle column: posterior half of vertebral body, disc, and posterior longitudinal ligament
 - posterior column: posterior arch, facet joints, pedicle, lamina and supraspinous, interspinous, and ligamentum ligaments

Types of Injury

Table 20. Denis Classification of Spinal Trauma

Fracture Type	Description
Compression Fracture (58%)	Produced by flexion Posterior ligament complex (supraspinous and interspinous ligaments, ligamentum flavum, and intervertebral joint capsules) remain intact Fractures are stable but lead to kyphotic deformity
Burst Fracture (17%)	Stable: anterior and middle columns parted with bone retracted nearby Hallmark is pedicle widening on AP x-ray Spinal cord (seen on x-ray and CT); posterior column is uninjured Unstable: same as the stable but with posterior column disruption (usually ligamentous)
Flexion Distraction Injury (6%)	Hyperflexion and distraction of posterior elements Middle and posterior columns fail in distraction Classic: Chance, horizontal fracture through posterior arch, pedicles, posterior vertebral body Can be purely ligamentous, i.e. through PLL and disc
Fracture-Dislocation (6%)	Anterior and cranial dislocation of superior vertebral body → 3 column failure Three types: (1) flexion-rotation, (2) flexion-distraction, (3) shear/hyperextension (rare)

Management of Thoracolumbar Injury

- severity and management based on thoracolumbar injury classification and severity (TLICS) classification

FRACTURES OF THE CERVICAL SPINE

Types of Injury

Table 21. Fracture Patterns of the Cervical Spine

Fracture Type	Description
C1 Vertebral Fracture (Jefferson fracture)	Vertical compression forces the occipital condyles of the skull down on the C1 vertebra (atlas), pushing the lateral masses of the atlas outward and disrupting the ring of the atlas Also can cause an occipital condylar fracture
Odontoid Fracture	Causes C1 and odontoid of C2 to move independently of C2 body This occurs because Normally C1 vertebra and odontoid of C2 are a single functional unit Alar and transverse ligaments on posterior aspect of odontoid usually remain intact after injury Patients often report a feeling of instability and present holding their head with their hands Type II fracture the most common
C2 Vertebral Fracture (hangman fracture)	Bilateral fracture through the pars interarticularis of C2 with subluxation of C2 on C3 (spondylolisthesis of axis) Usually neurologically intact
Clay-Shoveler Fracture	Avulsion of spinous process, usually C6 or C7

Imaging

- AP spine x-ray (open-mouth and lateral view), CT

Treatment

- immobilization in cervical collar or halo vest until healing occurs (usually 2-3 mo)
- Type II and III odontoid fractures
- consider surgical fixation for comminution, displacement, or inability to maintain alignment with external immobilization
- confirm stability after recovery with flexion-extension x-rays

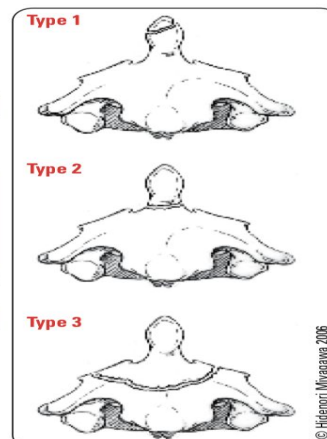


Figure 28. Odontoid fracture classification

TEST YOURSELF !

1-2-an x-ray of winking owl, where's the defect?

- A. Pedicle
- B. Facet joint
- C. Pars interarticularis

Ans : A

2-A 60-year-old woman comes to the emergency department because of urinary incontinence and bilateral medial thigh paresthesia for the past 3 hours. Her past medical history is noncontributory. She says symptoms suddenly started with mild back pain that is gradually worsening. She is now unable to feel toilet paper on her perineum when wiping after urination. Which is the most appropriate next step in management?

- A. immediate surgical consultation
- B. Lumbar puncture
- C. observation and NSAID

Ans: A

3-A 50-year-old man comes to the emergency department because of urinary incontinence for the past 5 hours. His past medical history is noncontributory. He says the onset was sudden and accompanied by worsening back pain. He now cannot feel anything as he wipes after voiding his bowel or bladder. He also feels "pins and needles," along both medial thighs. Which of the following is the most likely diagnosis?

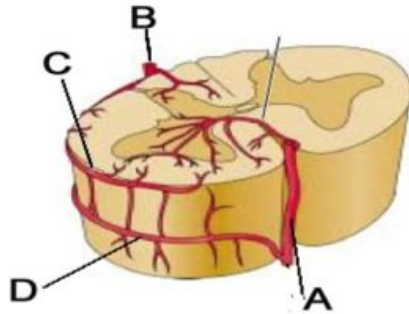
- A. cauda equina
- B. conus medullaris
- C. lumbar disc herniation

Ans: A

TEST YOURSELF !

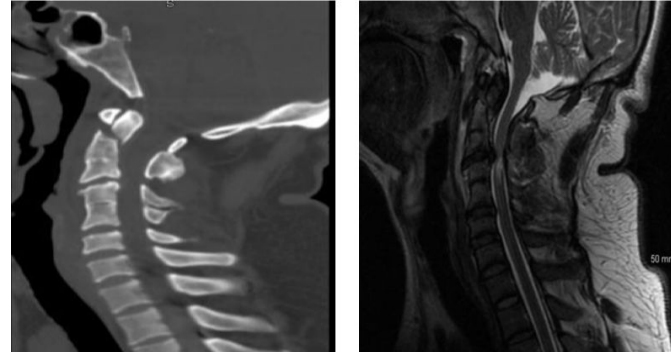
Answers in the last page

Q1- -Which artery labeled in Figure A provides the predominant blood supply to the spinal cord?



1. A
2. B
3. C
4. D
5. None of the above

Q2- -A 23-year-old man falls down a flight of stairs while intoxicated and is brought to the emergency room the following morning. On physical exam he has no motor function in his upper and lower extremities. Sensory exam shows diminished but present sensation in the perianal area and in the lower extremities. Reflex exam shows his bulbocavernosus reflex is intact. The initial CT and MRI are seen in Figures A and B. According to the American Spinal Injury Association (ASIA), how would this injury be classified?



1. ASIA A
2. ASIA B
3. ASIA C
4. ASIA D
5. ASIA E

Q3-

-A 52-year-old male is involved in an altercation where his neck was twisted and extended with force. Upon presentation he complains of neck pain, and loss of ability to stand or ambulate. On physical exam, he has Grade 3 motor strength in the majority of his muscles groups in his upper and lower extremities. His sensory is intact in all four extremities, and his bulbocavernosus reflex is intact. Sagittal and coronal computed tomography are shown in Figure A and B respectively. The patient's neurologic condition is best classified as?



1. ASIA E
2. ASIA D
3. ASIA C
4. ASIA B
5. ASIA A

Q4-

-A 30-year-old male is involved in a motor vehicle accident and sustains a fracture-dislocation of the cervical spine. On physical exam he has absent distal motor function, absent sensation, absent rectal tone, and an intact bulbocavernosus reflex. Which term best describes this spinal cord injury pattern?

1. Central cord syndrome
2. Incomplete spinal cord injury
3. Complete spinal cord injury
4. Neurogenic shock
5. Spinal shock

Q5-

-An 16-year-old male is involved in a diving accident six months ago that leads to a spinal cord injury. On physical exam he has 5 out of 5 deltoid and biceps strength. He has good brachioradialis muscle tone and 5 out of 5 bilateral wrist extension. He has 0 out of 5 wrist flexion and triceps strength. He has no anal sphincter tone, absent perianal sensation, and an intact bulbocavernosus reflex. He has no motor tone in his lower extremities. How would you define this patients neurologic deficit.

1. Incomplete C5 spinal cord injury (ASIA A)
2. Complete C5 spinal cord injury (ASIA E)
3. Complete C6 spinal cord injury (ASIA A)
4. Complete C7 spinal cord injury (ASIA A)
5. Incomplete C7 spinal cord injury (ASIA B)

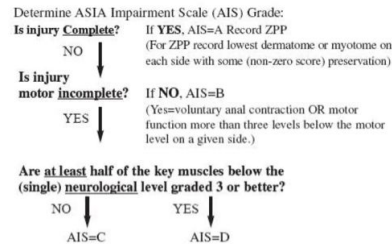
ANSWERS

ANS1

The anterior spinal artery (A) is the predominant blood supply to the spinal cord and supplies the anterior 2/3rds of the spinal cord. There is only one anterior spinal artery in comparison to the paired dorsal spinal arteries. The paired dorsal spinal arteries (B) supply the dorsal 1/3rd of the spinal cord, mainly to the dorsal columns.

ANS2

This patient has some sensory function but no motor function below the injury level. His bulbocavernosus reflex is intact so we know he is no longer in spinal shock. Therefore, he would be classified as an ASIA B.



ANS3

This patient has a spinal cord injury as a result of a rupture to his transverse ligament. This is evidenced by the increased atlanto dens interval on his computed tomography. Motor and sensory function are preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more. His bulbocavernosus reflex is intact, so we know he is no longer in spinal shock. Therefore, he would be classified as an ASIA D.

ANS4

This patient has a complete spinal cord injury which is defined as no voluntary anal contraction (sacral sparing) AND 0/5 distal motor AND 0/2 distal sensory scores (no perianal sensation) AND an intact bulbocavernosus reflex. The key to answering this question is understanding the meaning of an intact bulbocavernosus reflex. If the bulbocavernosus reflex is intact then the patient is no longer in spinal shock and we can determine a final classification of their spinal cord injury pattern. If the bulbocavernosus reflex is absent, then it is possible the patient is in a state of spinal shock, and therefore we can not classify his final spinal cord injury pattern.

ANS5

According to the ASIA Classification of Spinal Cord Injuries, this patient's neurologic deficit would be best described as a Complete C6 spinal cord injury (ASIA A).

There are three general steps to define a spinal cord injury using the ASIA classification system.

Step 1: Identify the neurologic level, which is described as the lowest segment where motor and sensory function is normal on both sides. Because this patient has normal function at C6 (brachioradialis and wrist extension), and no function at C7 (triceps and wrist flexion), his last normal functional level is C6. Therefore his neurologic level is C6.

Step 2: Determine if injury is complete or incomplete. Complete injuries are defined as no voluntary anal contraction (sacral sparing) AND 0/5 distal motor AND 0/2 distal sensory scores (no perianal sensation) AND intact bulbocavernosus reflex (patient not in spinal shock). Therefore, this patient has a complete injury.

Step 3: Assign ASIA impairment score. Because this patient has a complete injury, his ASIA impairment score is ASIA A.