Spinal injury

(1)
* وظيفة ال spinal cord وصلة ما بين ال brain وال periphery.

→ spinothalamic tract + touch [posterior column] + vibration.

- [motor, sensory, proprioception]

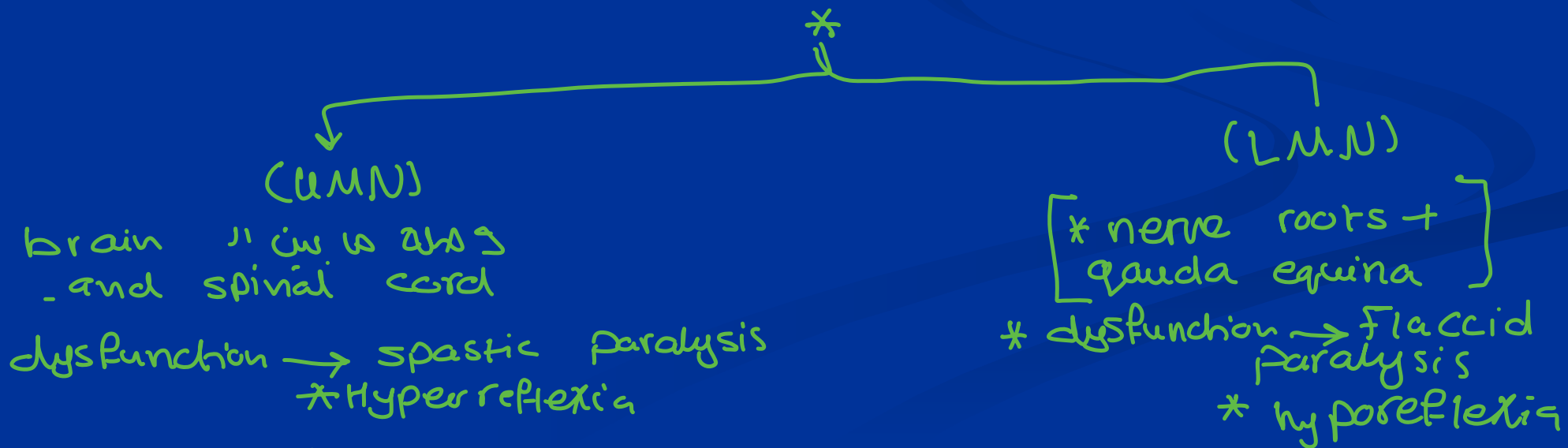
(tract) voluntary ←

في ال posterior column ← مشكلة ← sensory ataxia.

(2) reflexes [داخل ال brain] → separate from the brain (internal function) مالها دخل في ال tract.

*burning sensation type of neuropathic pain

Spinal Cord Injury (SCI) is damage to the spinal cord that results in a loss of function such as mobility or feeling due to traumatic or non-traumatic causes.



* hypertonia
* spastic gate

* loss of tone

* anterior horn cells ⟶ lower motor neuron.

- Signs and Symptoms …

* spinal shock (clinical)
loss of all intrinsic function
temporary (unknown cause)

– Weakness, numbness, tingling sensations or loss of feeling
– Painful movements of arms and legs
– Pain or tenderness along spine
↳ type of neuropathic pain
– Burning sensations along the spine or in an extremity
– Deformity to patients head, neck or spine [Fracture].
– Injuries to the head
– Loss of bladder or bowel control [autonomic function]
↳ hypothalamus.
– Labored breathing with little or no chest rise

⊛ Tracts: * parasympathetic ⟶ sacral, hiatus.
* sympathetic → thoracic From T1 - L2 → vasodilation cause neurogenic shock.
* phrenic nerve → $C_3 - C_5$

*intercostal → below (C5)

hypotension

Epidemiology

-450,000 people live with SCI in USA.

-10,000 new case\year.

-82% are males between 16-30 years.

-45% are complete spinal damage.

-50% involve the cervical spine c5-c6.

->50% result in quadriplegia.

-Co-morbidity

Limb fractures - 67%

Intrathoracic - 53%

Head injury - 33%

causes

1. traumatic SCI

(car accident, gunshot, falls, etc.)

2. non-traumatic SCI (ex: infection)

(polio, spina bifida, Friedreich's Ataxia, etc)

Traumatic SCI

- Mechanisms

✓ MVC 48% motor vhicle accident.

✓ Falls 21%

✓ Assaults 15%

✓ Sport-related 14%(majority diving)

-The spinal cord does not have to be severed in order for a loss of functioning to occur.

مش ضروري يكون قوي.

✓ -SCI is very different from back injuries such as ruptured disks, vertebral fractures or spinal stenosis.

Spinal And Spinal Cord Injury

bone, ligament, muscle.

Spinal injury

- With or without cord injury
- Fractures
- Dislocation
- Facet lock
- Tx: reduction, fixation and fusion

may occur without Fracture [soft tissue, hematoma], contusion, central cord syndrome

Spinal cord injury

- With of without spinal injury
- Neuronal injury
- SCIWORA
- Tx: decompression, then waiting spinal cord repair ???!!!

- **Neurological injuries is not always immediate and may occur or be aggravated only if and when there is movement or displacement of vertebral fracture or dislocation (primary vs. secondary)**

. immobilisation ← trauma

*to prevent secondary injury

*ongoing compression (prolonged → ischemia)

Accordingly, spinal injuries classified as:

- stable: not displaced by normal movements.
-unstable: significant risk of displacement and neural damage.

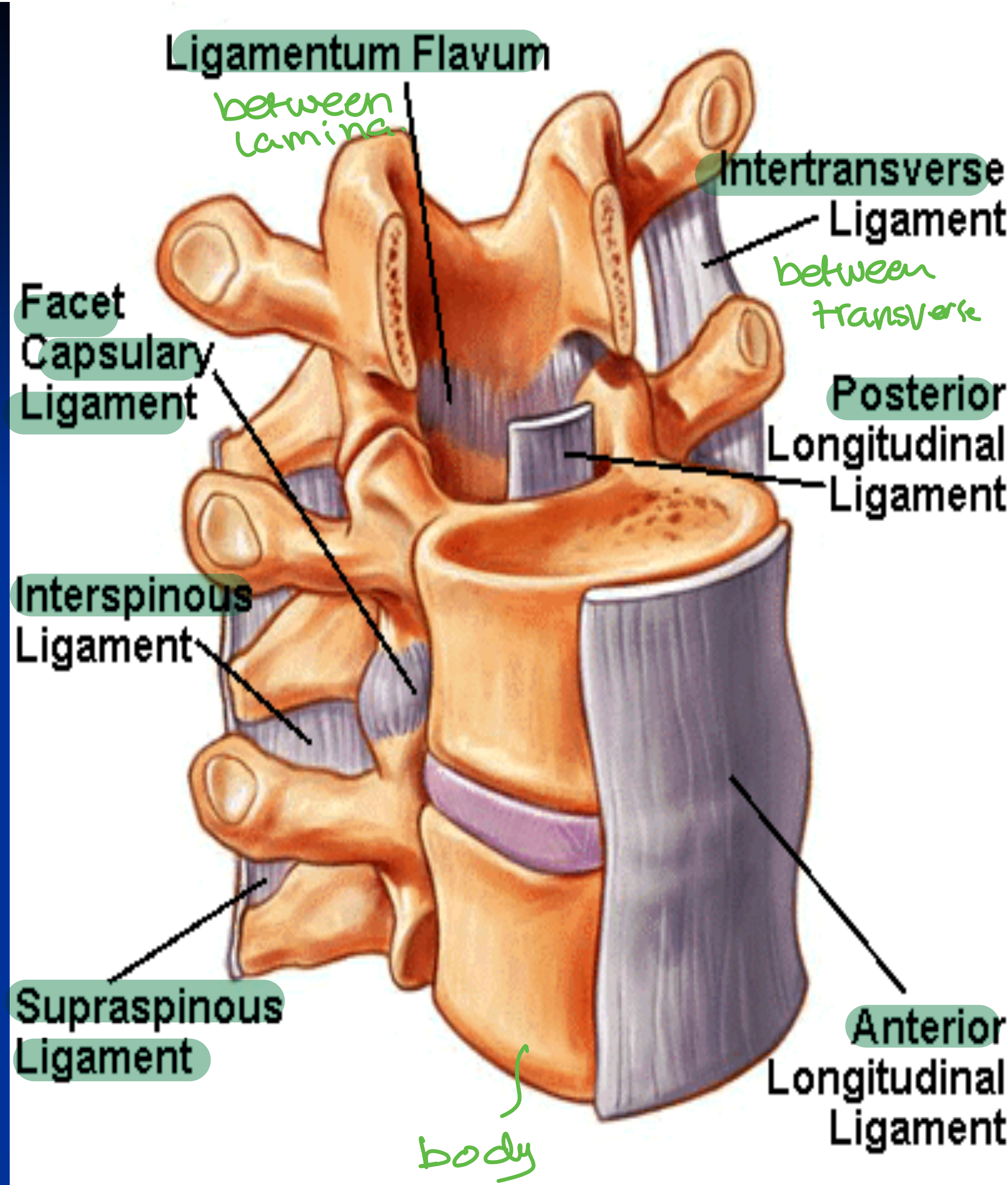
so do decompression

*Free radicals.

give steroid.

Generally, it requires damage to both the ligaments and the bony column to produce unstable spine

*ال ligaments قوية جداً، لانها بتمسك ال bone مع بعض.



Principles of diagnosis and management:

- -inappropriate movements during examination can change the outcome to the worse.

- -immobilization is abandoned only after serious spinal injuries has been excluded by clinical and radiological assessment.

History:

-high index of suspicion-signs and symptoms may be minimum.

-every patient with blunt injury above the clavicle ,head injury or loss of consc.

-fall from height, crushing accident or high speed deceleration accident.

-lesser injuries if followed by pain in the neck ,back or neurological symptoms in the limbs.

* يتوقع مريض ال trauma عنده spinal injury ، مريض ال LOC
كانه في injury الى ان تثبت العكس ← ينقل الله immobilization و دجور.

⊛ any high energy trauma, suspect spine injury until

proven otherwise.

Examination (look, feel but not move!).

[in orthopedic]

-inspect the head and the face for bruises.

-exam the neck for deformity, bruising or penetrating injuries.

-the bones and soft tissues of the neck are palpated ;tenderness bogginess or abnormal space between adjacent spinous processes (suggest unstable spin).

Back: in 2ry survey :-

- log-rolled. → immobilization
- inspect and palpate the back

tenderness ← كو في اي

Full neurological examination:

-carried out and repeated several time during the first few days.

Test each dermatome, myotome and reflex.

the unconscious patient:

*if the patient have Fracture in calcaneus - tibia, femur, pelvis ⟶ high suspetion of spinal Fracture. [axial Fracture]

Features suggesting spinal cord lesion:

-hx of fall or rapid deceleration.

-head injury.

-diaphragmatic breathing.

-flaccid anal sphincter.

-hypotension with bradycardia.

-pain response above but not below the clavicles.

Imaging

-X-ray

Cervical spine:AP,lateral(c1 to t1) and open mouth.

-ct-scan.

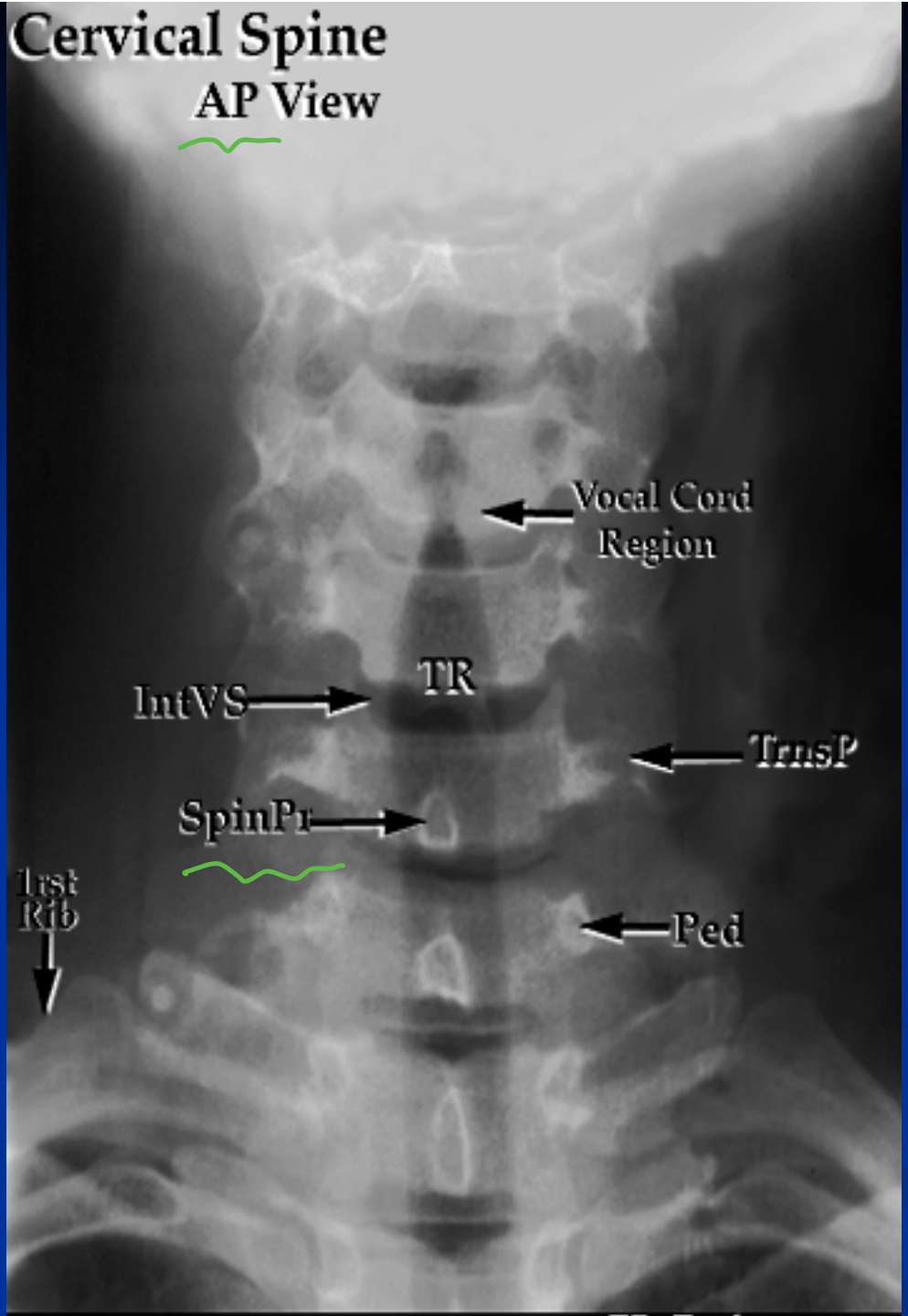
for difficult area (lower cervical and upper thoracic), damage to individual vertebra and displacement of bone fragments.

-MRI.

Intervertebral disc, lig.flavum and neural structures

Cervical Spine

AP View

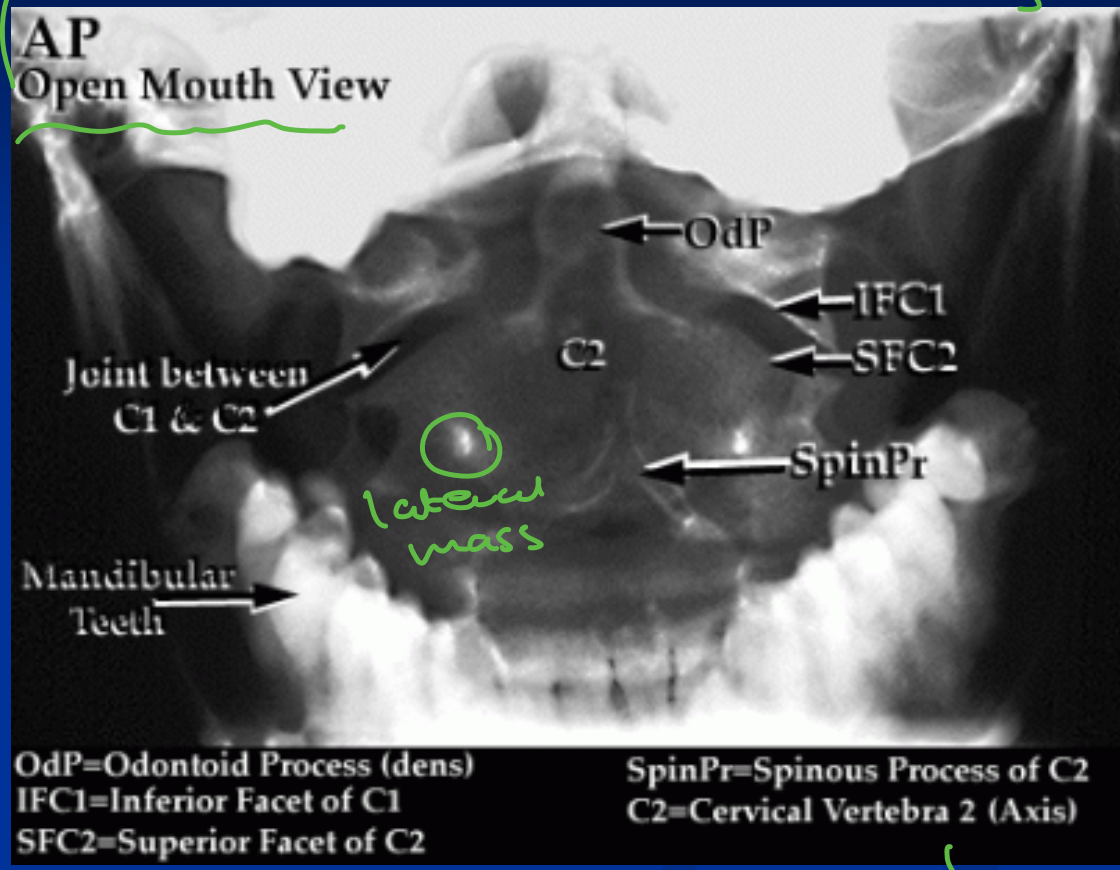


IntVS=Intervertebral Disk Space
SpinPr=Spinous Process (of C6)
TrnsP=Transverse Process (Lateral Body of C6)
TR=Trachea
Ped=Pedicle (of C7)

AAAtl=Anterior Arch of Atlas
PAAtl=Posterior Arch of Atlas
OdP=Odontoid Process (dens)
SpinPrC6=Spinous Process of Cervical Vertebra 6
TrnsP=Transverse Process (Lateral Body) of C4
LamC5=Lamina of Cervical Vertebra 5
IntVS=Interverteral Disk Space
TR=Trachea
IFC2=Inferior Facet of C2
SFC3=Superior Facet of C3
Ver=Vertebral Body C7
Ped=Pedicle

Lateral view.

For C1, C2 [odontoid + atlas]



OdP=Odontoid Process (dens)
IFC1=Inferior Facet of C1
SFC2=Superior Facet of C2
SpinPr=Spinous Process of C2
C2=Cervical Vertebra 2 (Axis)

لو الإزاحة أكثر من 7mm

بتخرج على الـ alignment

على نفس الاستقامة.

Cervical spine injuries.

-hx: fall from height, diving accident, MVA in which the neck is forcibly moved.

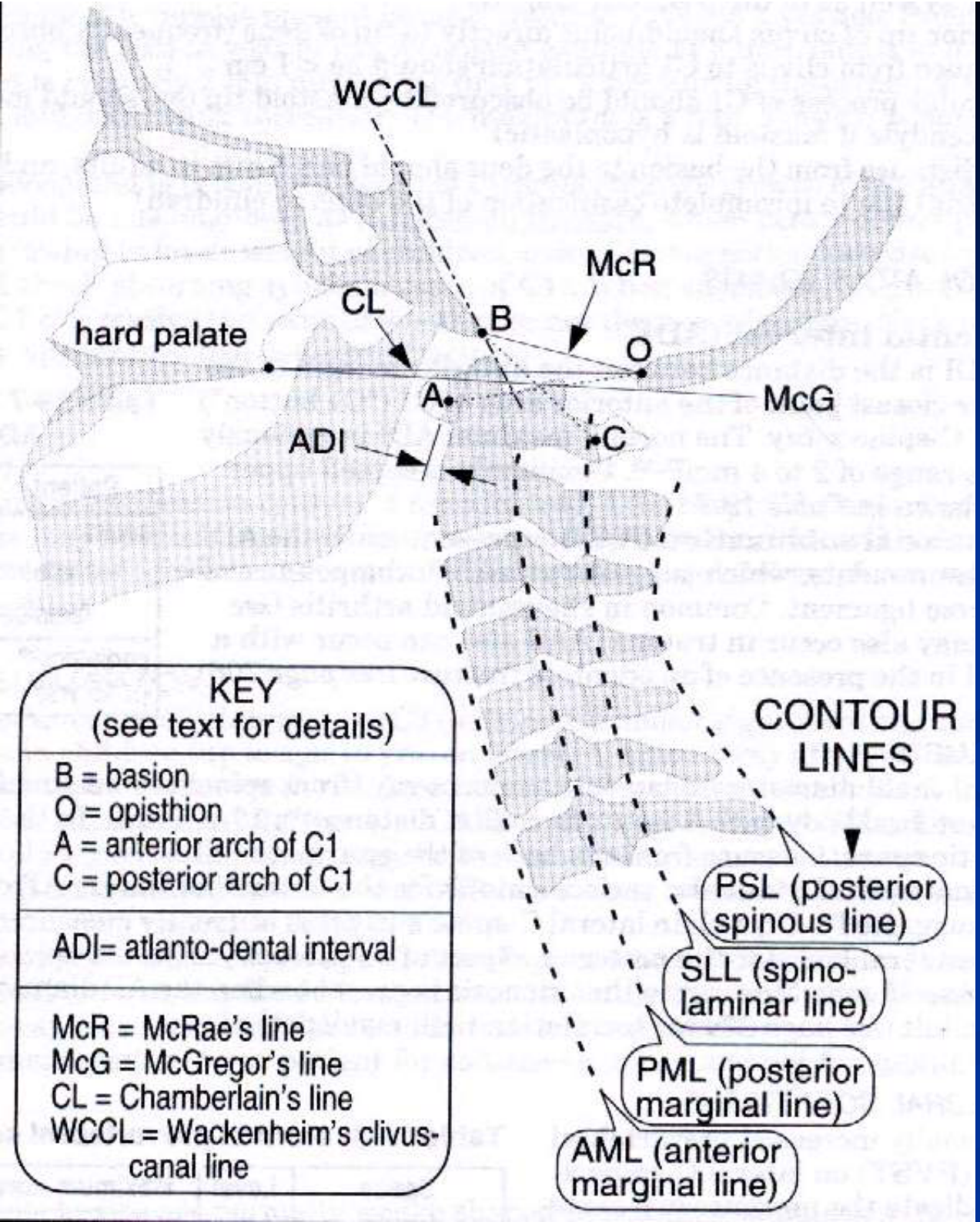
- examination: abnormal position of the neck, tenderness, pain and parasthesia.

-imaging:

-AP view: the lateral outline should be intact, spinous process and tracheal shadow at the midline.

-lateral view: from c1-to t1.

- open mouth for odontoid fractures.



alignment—
if no continuity
↳ displacement.

Fracture of C1.”jefferson’s fracture”.

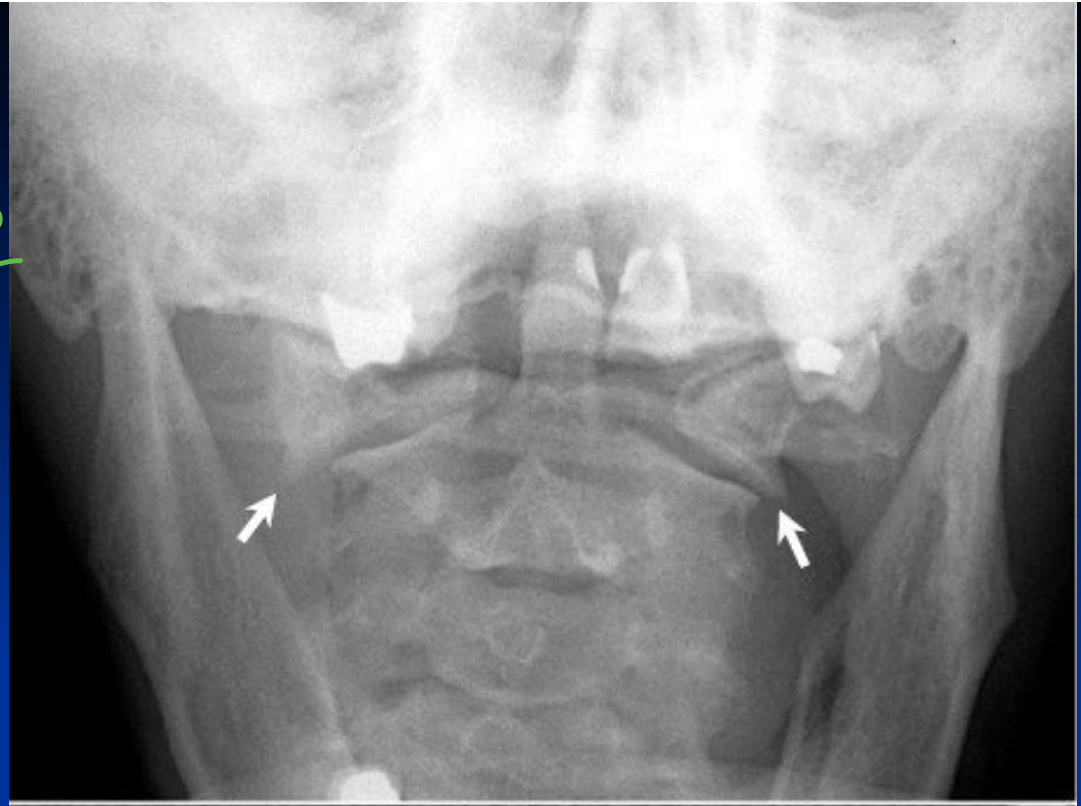
-result From sudden severe load from on the top of the head.
-no encroachment of the neural canal ,usually no neurological damage.
-open mouth view : spreading of the lat.masses away from the odontoid peg.

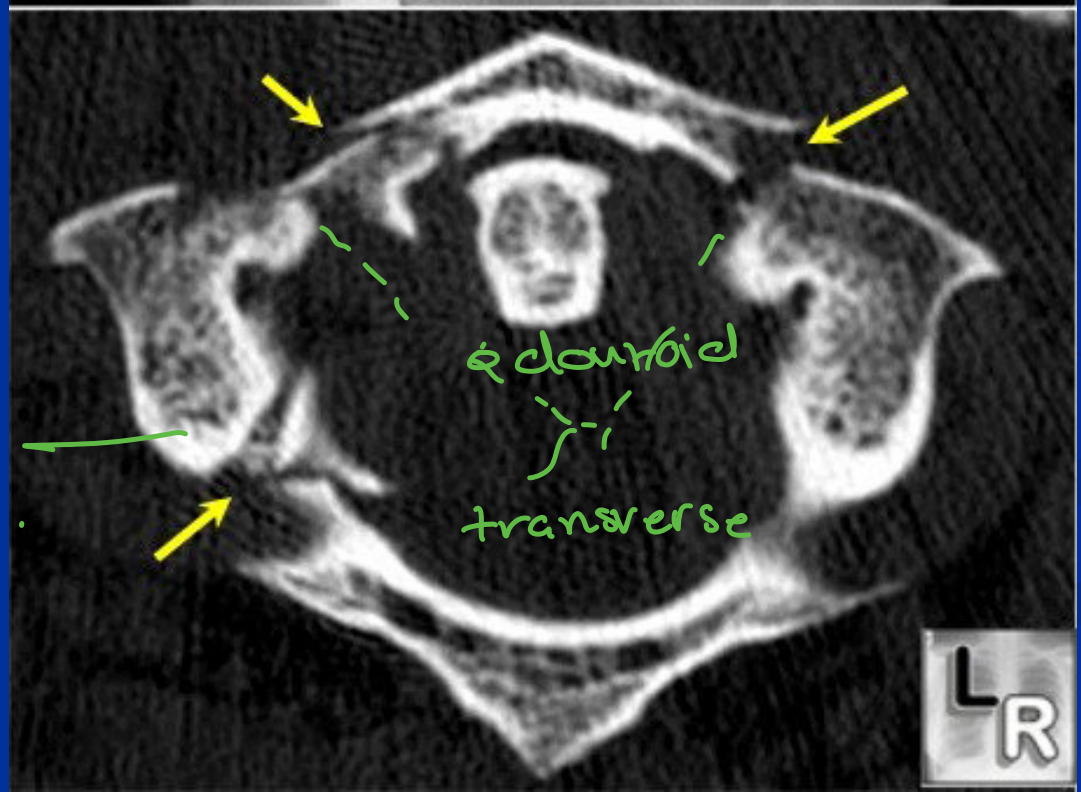
Treatment:
-stable, undisplaced fractures : rigid collar until the fracture unites.
-unstable, sideway spreading of the lat.masses:
skull-traction, halo body orhtosis followed by semi rigid collar.

AP view

*crush Fracture of C1

transverse atlantal injury





Fractured pedicle of C2 "hangman's"

-fracture of c2 pedicle with torn ~~c1\c2~~ disc.

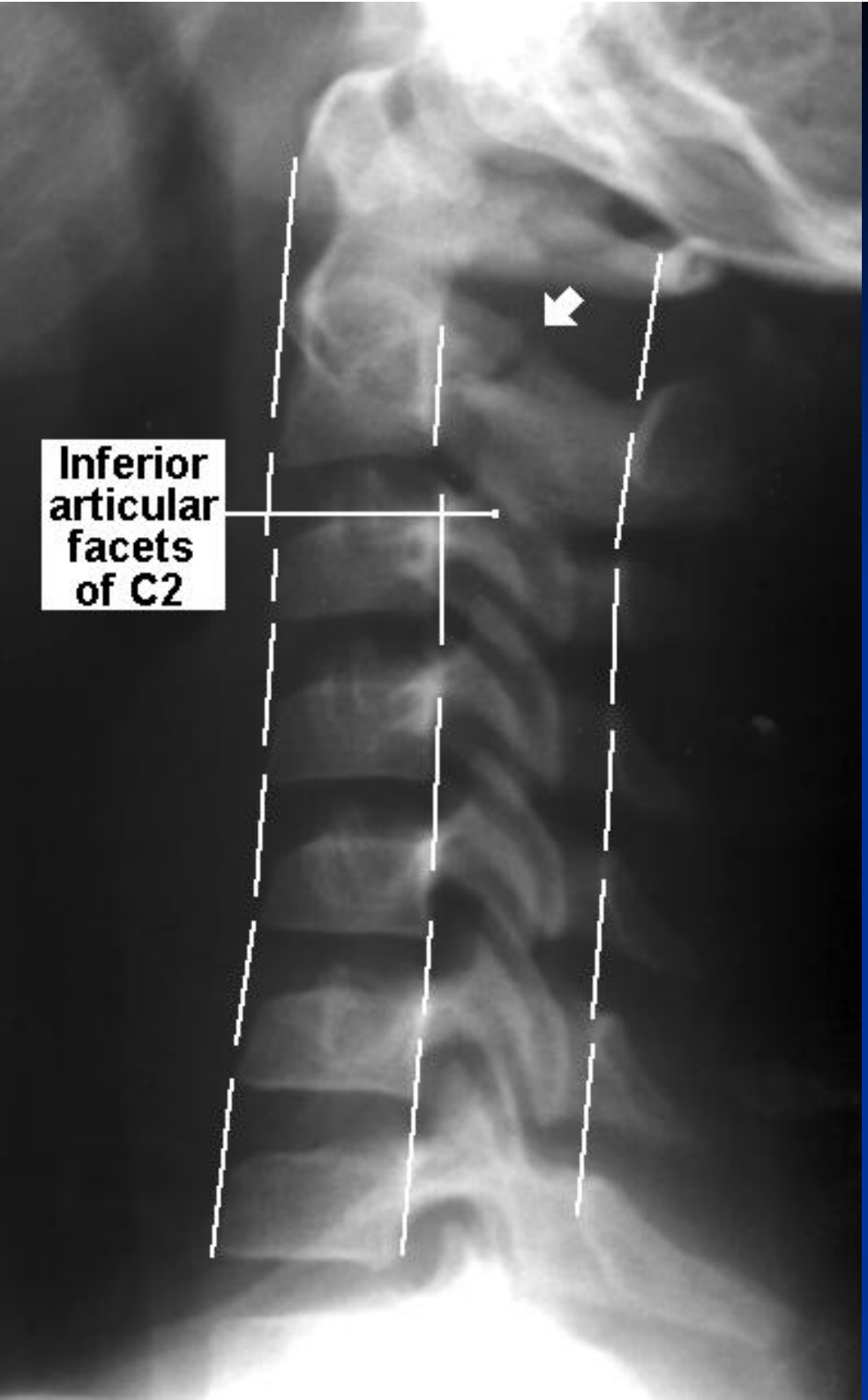
C2/C3

traumatic spondylolisthesis at

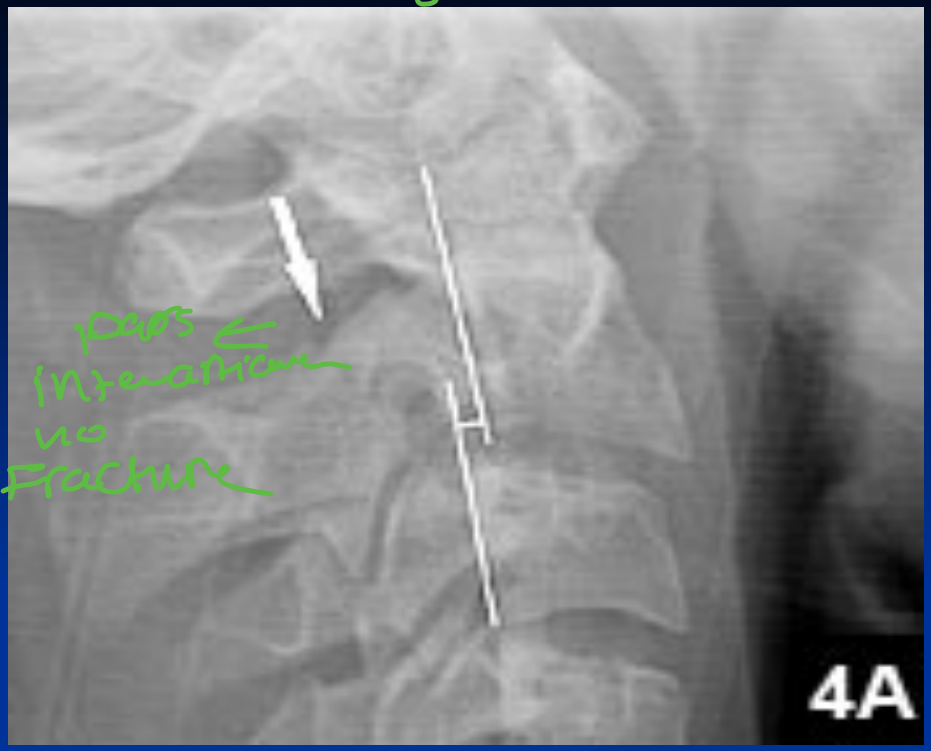
-extension with distraction. MVA when the forehead strike the dashboard.

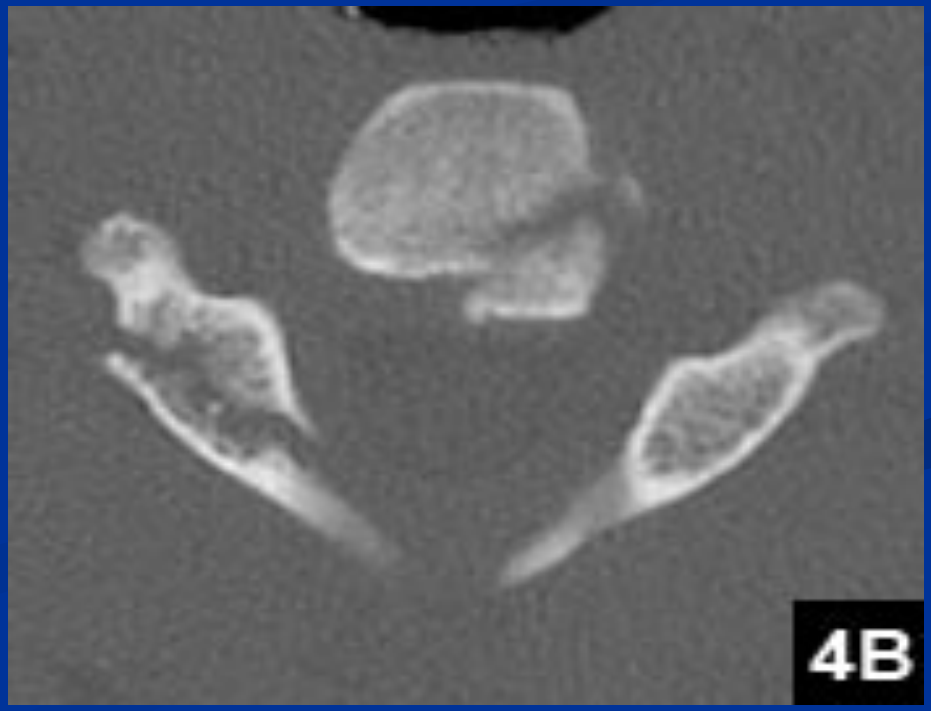
-treatment:

- Undisplaced fracture: semi rigid collar or halo-vast until united.
- Displaced fracture: reduction then halo-vast for 12-weeks.



$C_2 - C_3$.





Fracture of the odontoid process.

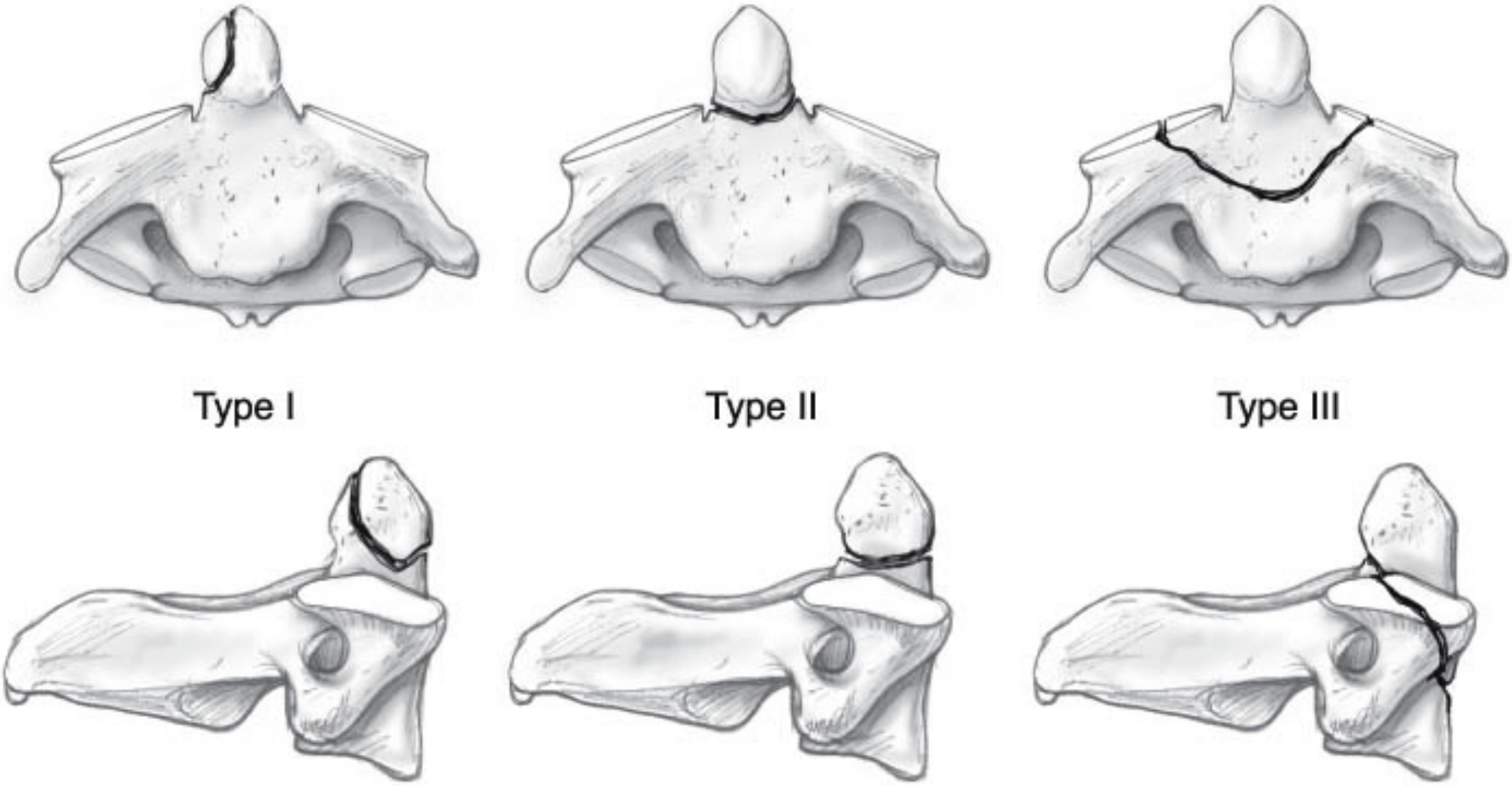
-flexion injury due to high velocity accident or falls.

-1\4 neurological involvement.

-of three types:

1. Evulsion of the tip.
2. Through the junction of the odontoid peg and body.
3. Through the body

C2 Odontoid Fracture Classification



From Makary MA. *General Surgery Review* 2nd ed.
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Wedge-compression fractures

↳anterior part

-pure flexion injury causes compression of the anterior part of the vertebral body

-stable injury ,comfortable collar for 6-8 weeks.

↳normal spinal cord

C5 ?

Burst fracture.

-axial compression of the cervical spine. (usually in diving or athletic accident).

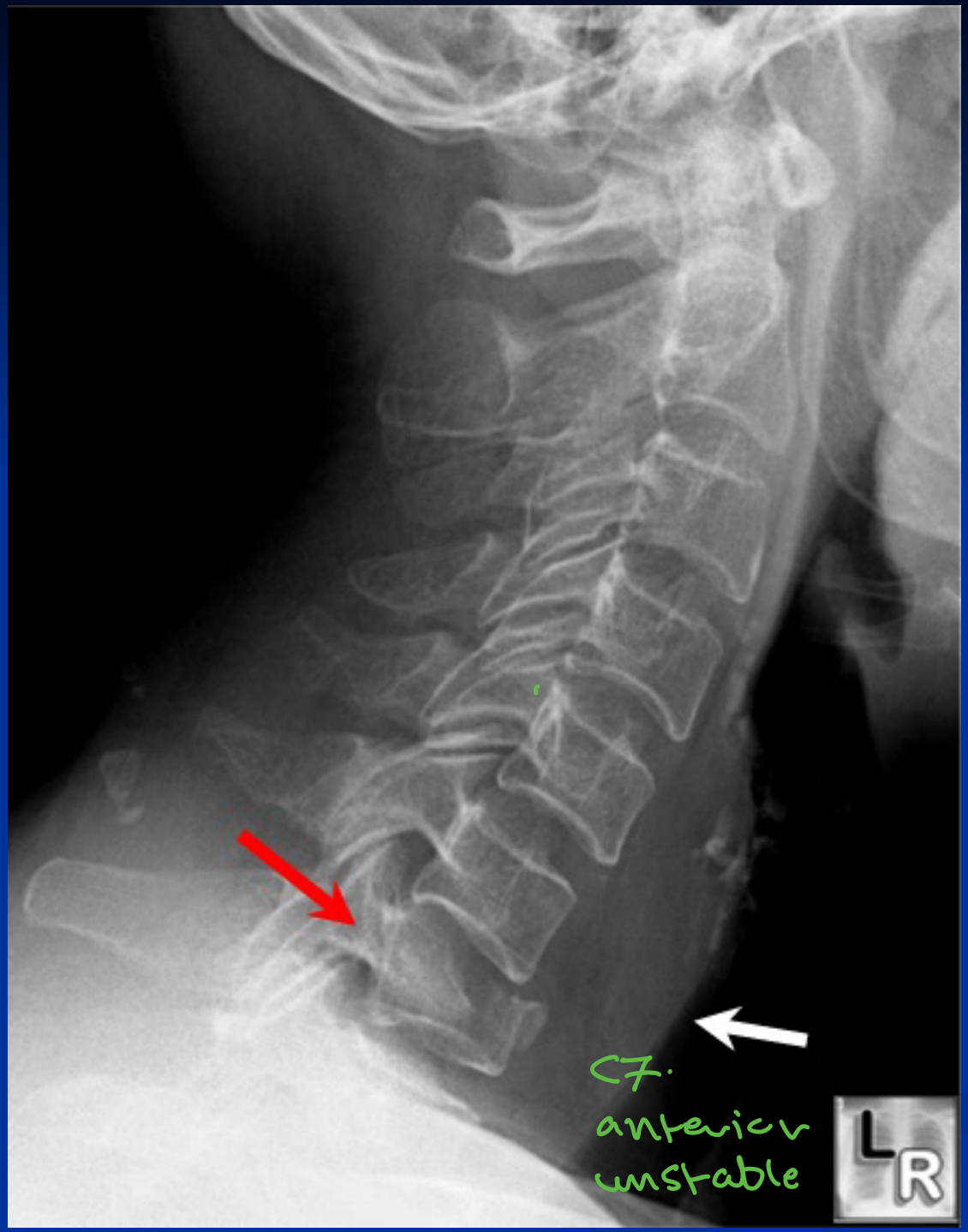
-persistent neurological injury is common.

Treatment:

Neurological deficit call for urgent ant. decompression.

Burst fracture, C7

Lateral view of the cervical spine demonstrates a comminuted vertical fracture through the body of C7. The posterior surface of C7 is displaced posterior toward the spinal canal (red arrow) while there is slight soft tissue swelling anteriorly (white arrow).



Thoracic spine injuries.

-hyperflexion injuries.

-wedge compression fracture are relatively common, mechanically stable but may lead to progressive kyphosis.

-t11-t12 carry high risk of cord damage.

Thoracolumbar and lumbar injuries.

-transition zone between the relatively fixed thoracic spine and relatively mobile lumbar spine.

-stable vs. unstable.

1. post.osteoligamentus complex (posterior column).
2. Middle column.
3. ant.column.

All fracture involving the middle column and at least one other should be regarded as unstable.

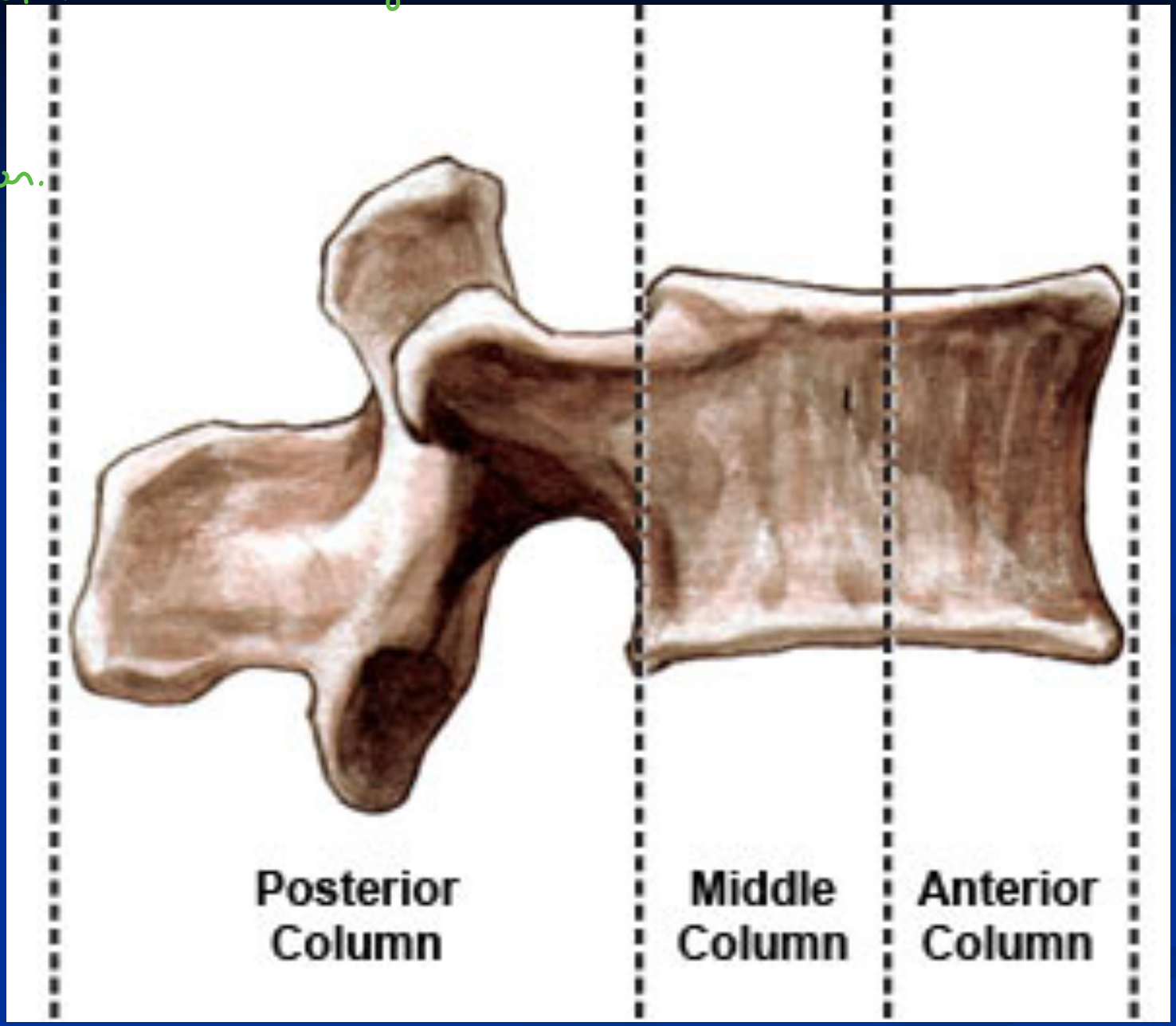
* denis classification.

* 2 columnes → un stable
* anterior → wedge compression

3 column
↙
dislocation.

*anterior + middle
↙
unstable

*posterior
↙
stable



pedicle
Facet
Spinous process

posterior 1/2 of body

anterior 1/2 of vertebral body

+ posterior ligament

+ anterior L

- wedge fractures. → anterior

↳ kyphosis → do surgery

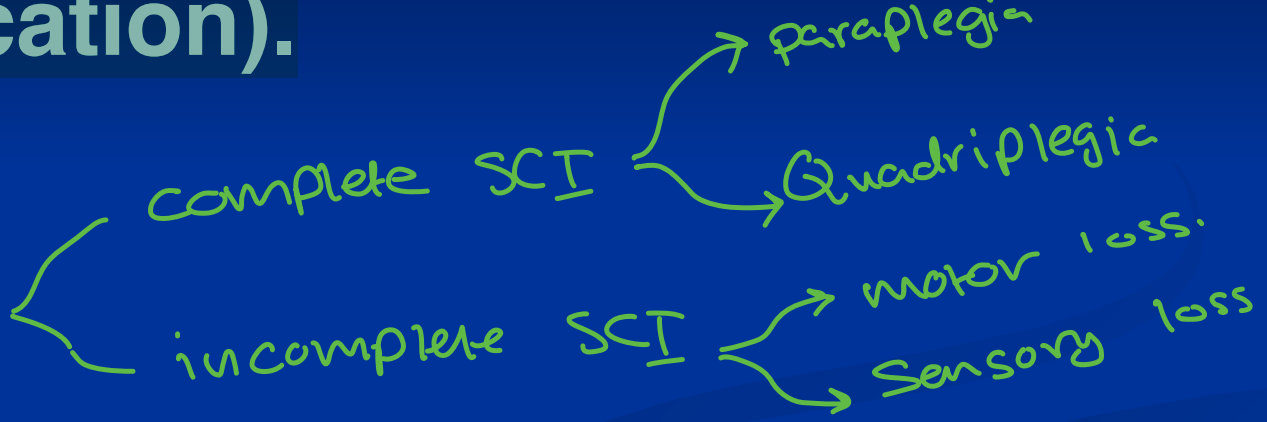
- burst fractures.

- fracture dislocation

· 3 columns.

injuries to the spine may be complicated with spinal cord damage (burst fracture and fracture dislocation).

which result in:



1. complete transection (paraplegia or quadriplegia).
2. incomplete transection (partial motor or sensory loss).

*complete → M+S.

*Complete SCI

motor + sensory

-Loss of all function below the level of the lesion

-Typically associated with spinal shock

loss of the intrinsic function temporeraly.

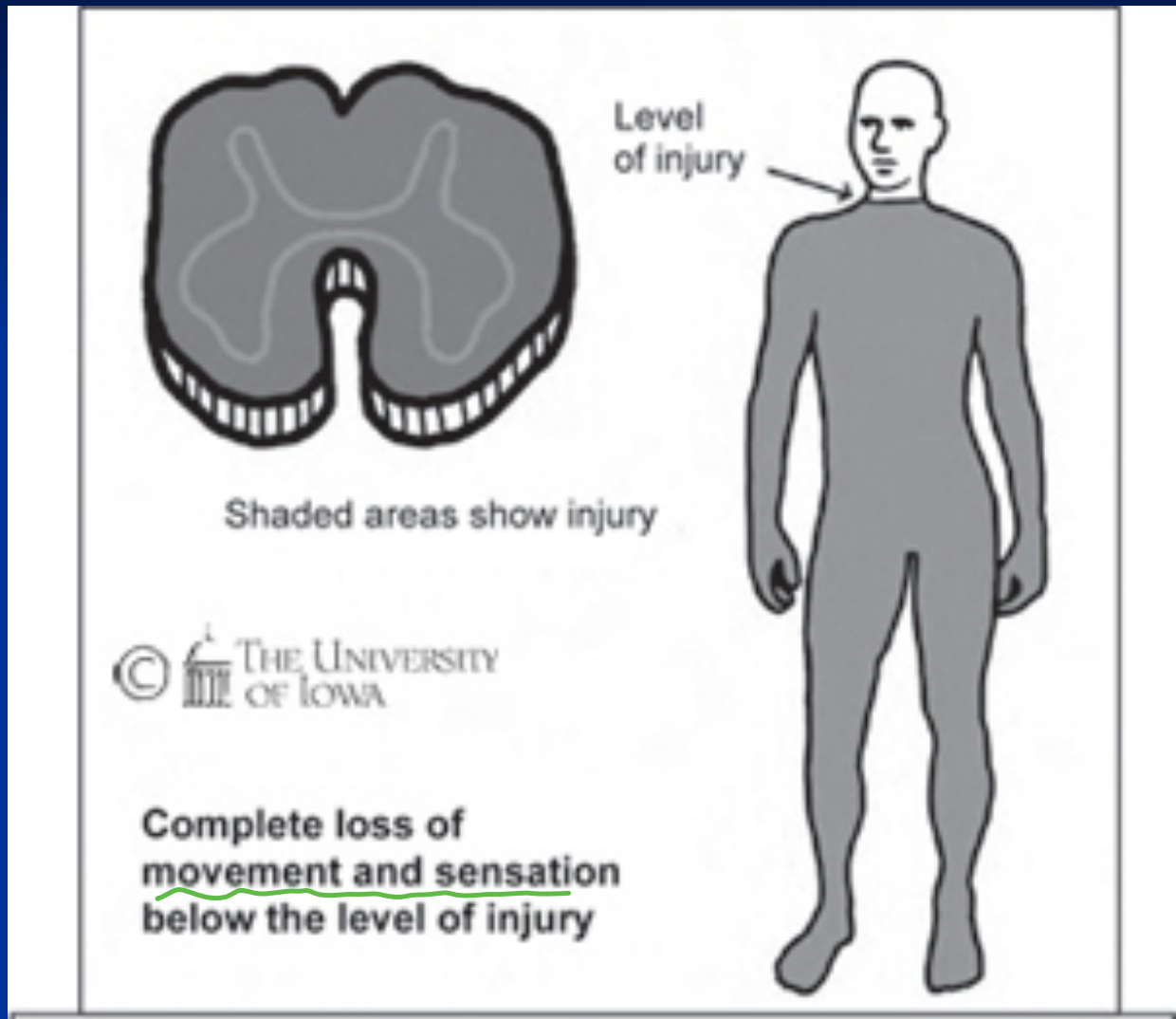


Figure 9. Complete Spinal Cord Injury

Incomplete SCI

- -Central cord syndrome
- -Anterior cord syndrome
- -Brown-Sequard syndrome
- -Spinal cord injury without objective radiologic abnormality (SCIWORA)

Anterior cord syndrome

* loss of : movement
pain
Temperature

* ✓ vibration
✓ touch
✓ position.

-flexion-compression injuries, damage the ant.spinal artery cutting off the blood supply to the ant 2\3 of the spinal cord.

-herniated Intervertebral disc.

* vibration + proprioception normal

✓ paralysis.

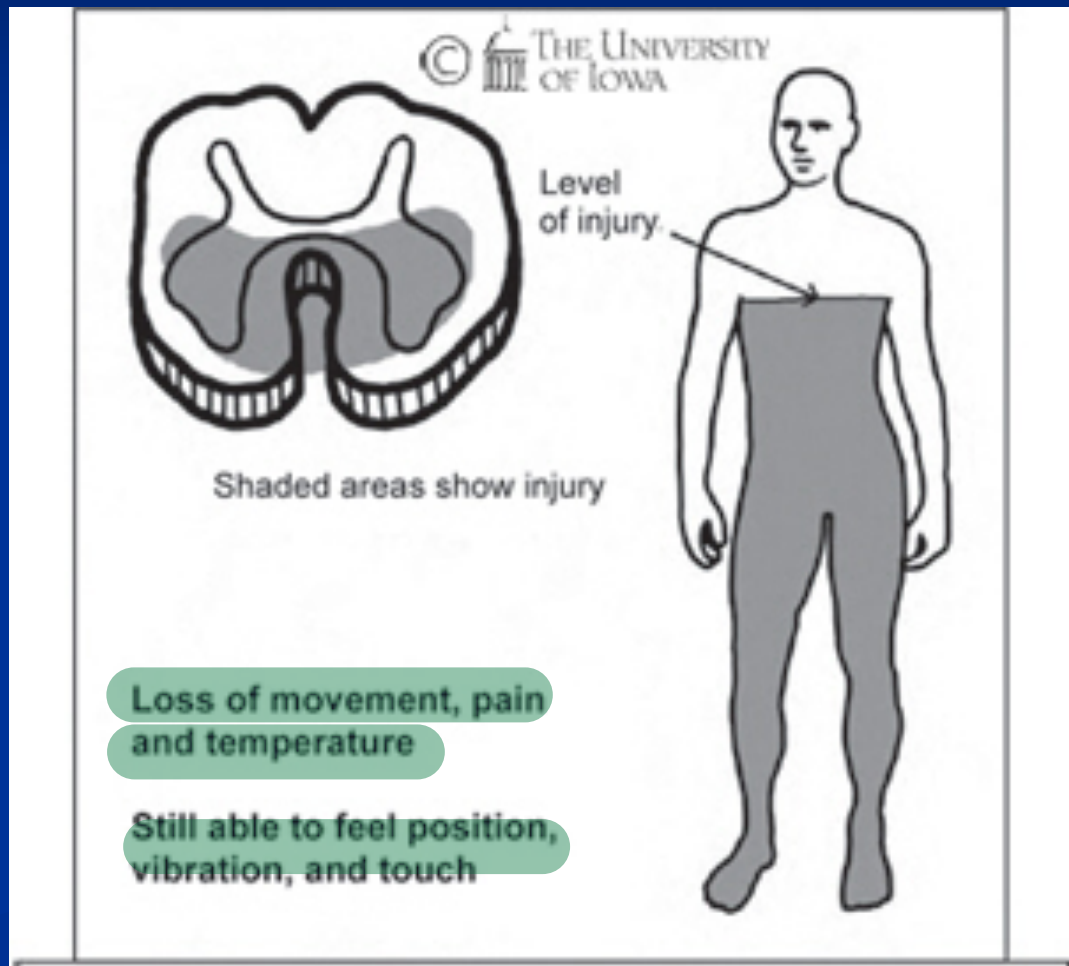


Figure 10. Anterior Cord Syndrome

Central cord syndrome

-hyperextension cause the cord to be pressed between the body anteriorly and the bulging lig.flavum posteriorly.

affect.

* only upper limb / normal lower limb

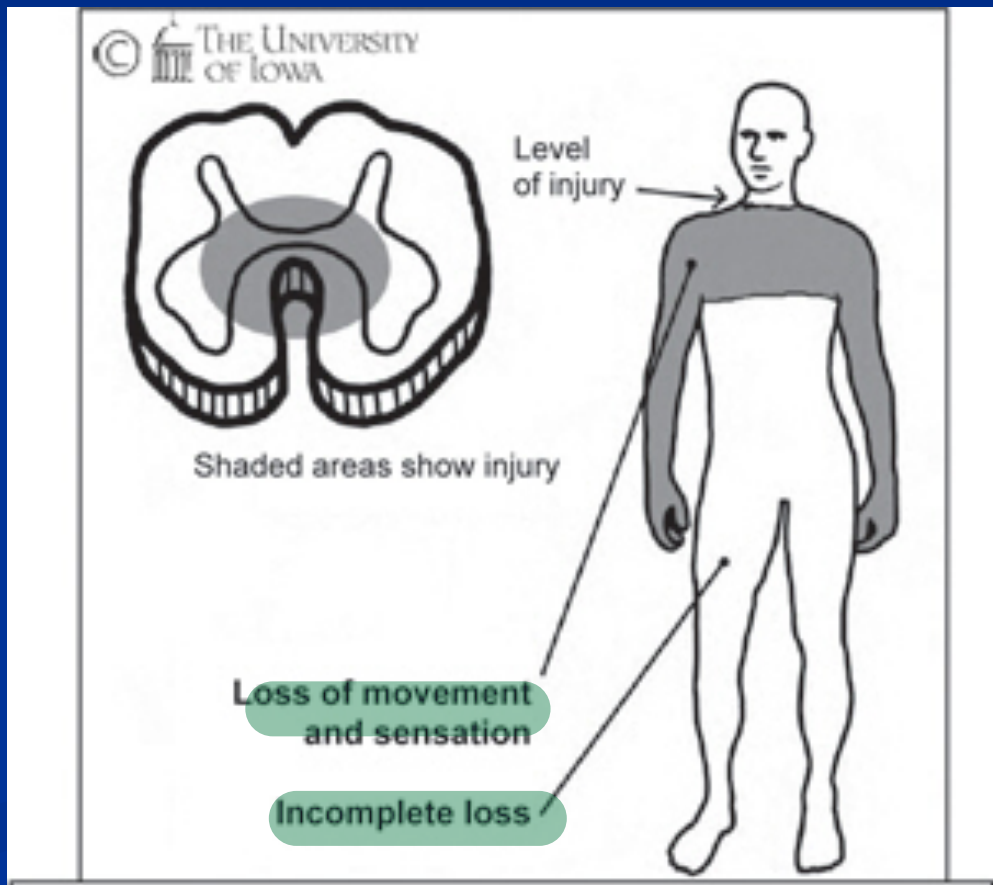


Figure 11. Central Cord Syndrome

Brown-Sequard syndrome

-fracture dislocation, bullet or stab wound or by expanding tumor.

segment نخاع

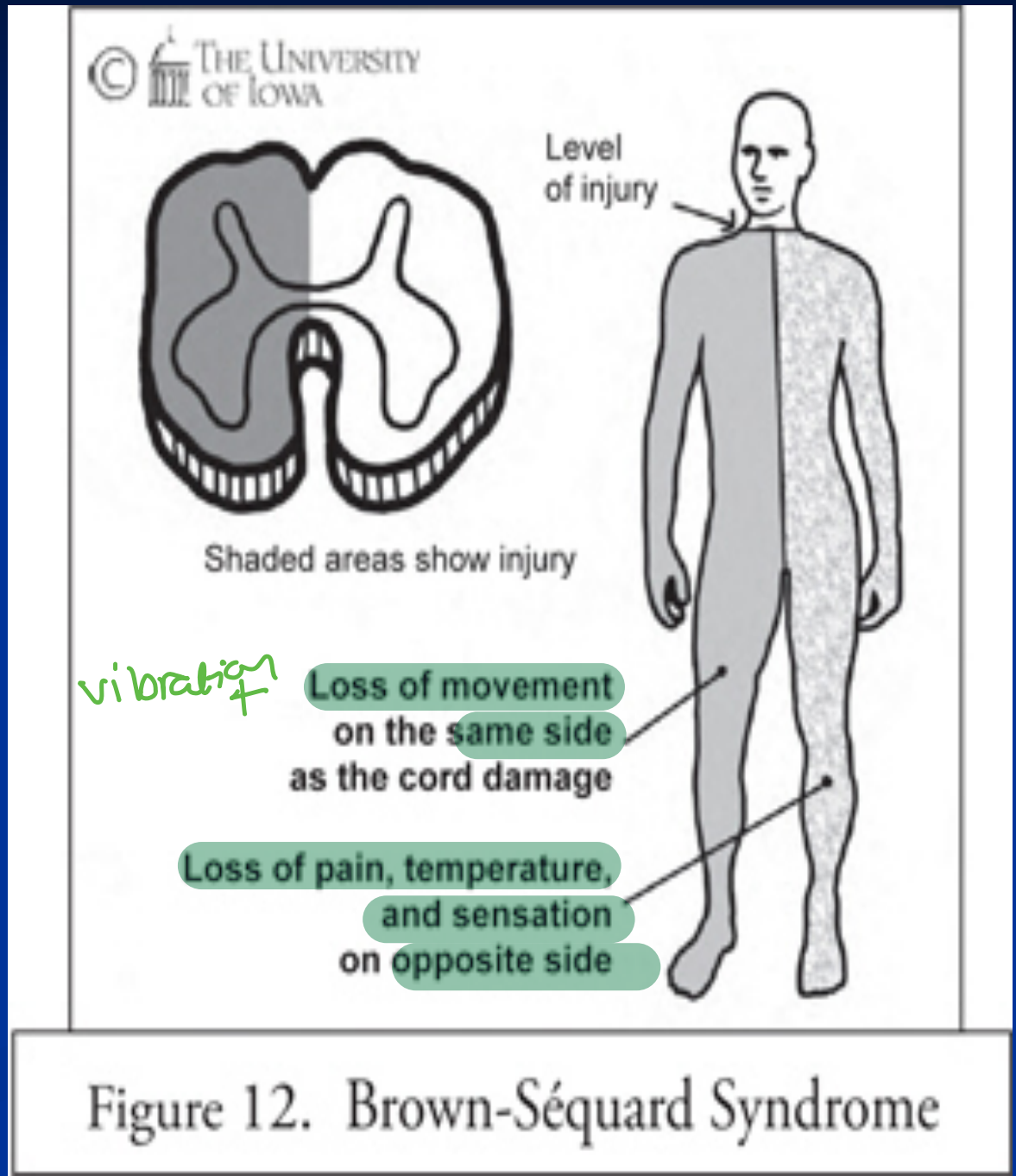
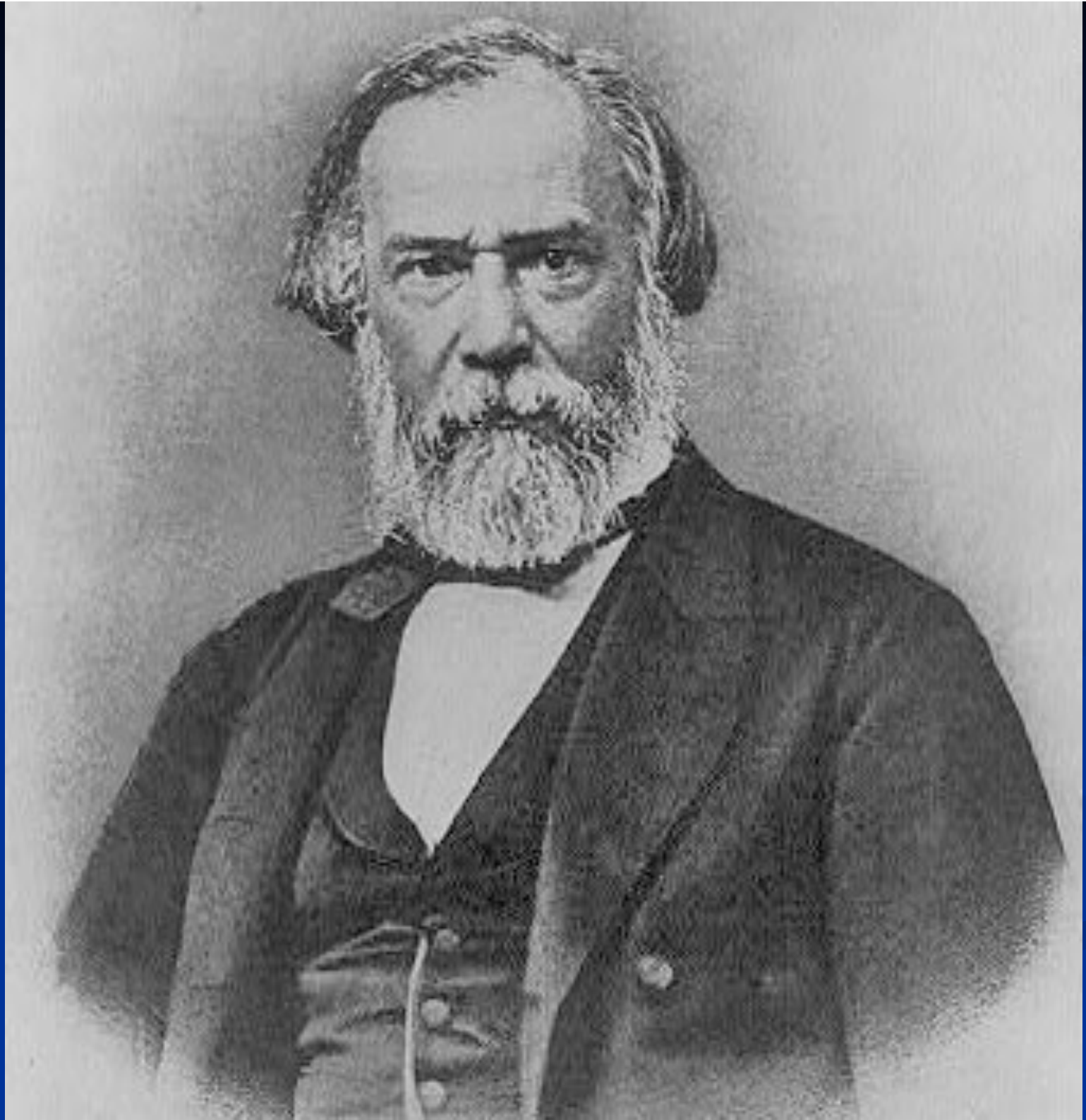


Figure 12. Brown-Séquard Syndrome



Spinal cord injury without radiologic abnormality (SCIWORA)

in children.

- No bony abnormalities on plain film or CT
  - MRI may show abnormalities
- Usually in children; symptoms may be transient at first
- Should probably lead to immobilization to prevent subsequent development of cord damage

Secondary injury

- After the initial macroscopic injury, secondary injuries are an important cause of disability
  - Movement of unstable spine.
  - Vascular insufficiency
  - Free radical induced damage

⊛ motor → power [0-5] → * each joint alone
* and each move alone

✓ [dermatome / myotomes] . Dir
✓ [spinal cord segment / spinal vertebral body level

STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

MOTOR

	R	L	KEY MUSCLES
C2			
C3			
C4			
C5			Elbow flexors
C6			Wrist extensors
C7			Elbow extensors
C8			Finger flexors (distal phalanx of middle finger)
T1			Finger abductors (little finger)
T2			
T3			
T4			
T5			
T6			
T7			
T8			
T9			
T10			
T11			
T12			
L1			
L2			Hip flexors
L3			Knee extensors
L4			Ankle dorsiflexors
L5			Long toe extensors
S1			Ankle plantar flexors
S2			
S3			
S4-5			

power.

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, gravity eliminated
3 = active movement, against gravity
4 = active movement, against some resistance
5 = active movement, against full resistance
NT = not testable

antigravity.

☐ Voluntary anal contraction (Yes/No)

TOTALS ☐ + ☐ = ☐ **MOTOR SCORE**
(MAXIMUM) (50) (50) (100)

LIGHT TOUCH / PIN PRICK

	LIGHT TOUCH R	LIGHT TOUCH L	PIN PRICK R	PIN PRICK L
C2				
C3				
C4				
C5				
C6				
C7				
C8				
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
T10				
T11				
T12				
L1				
L2				
L3				
L4				
L5				
S1				
S2				
S3				
S4-5				

0 = absent
1 = impaired
2 = normal
NT = not testable

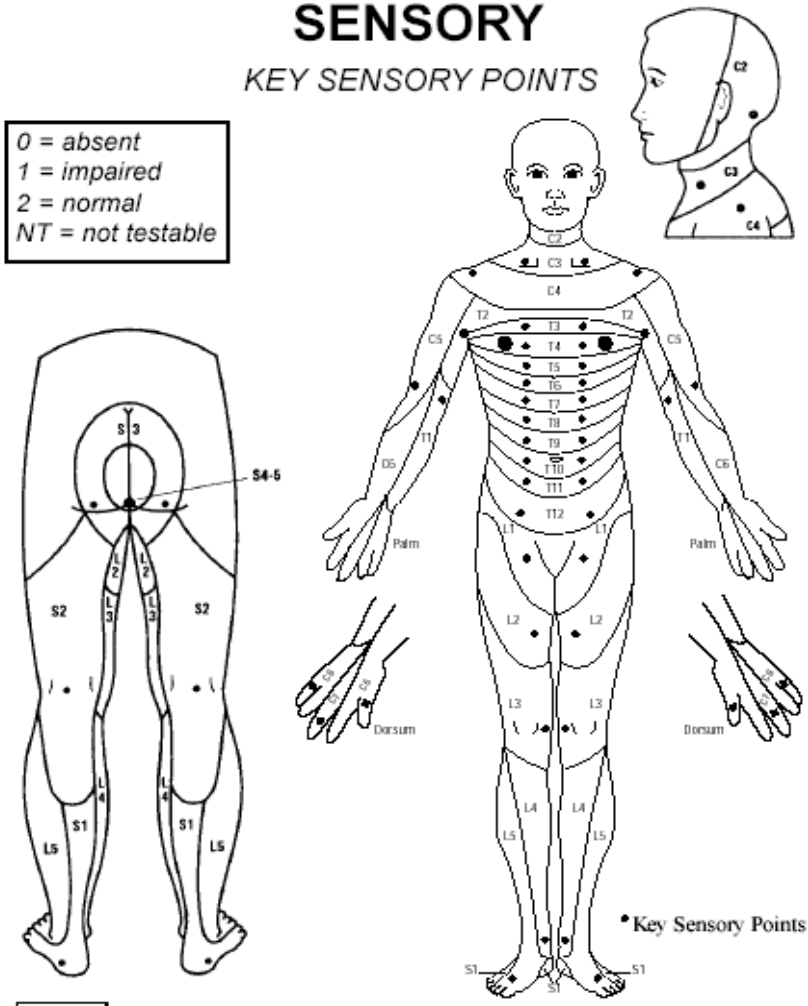
☐ Any anal sensation (Yes/No)

TOTALS ☐ + ☐ = ☐ **PIN PRICK SCORE** (max: 112)
(MAXIMUM) (56) (56) (56) (56)

= ☐ **LIGHT TOUCH SCORE** (max: 112)

SENSORY

KEY SENSORY POINTS



NEUROLOGICAL LEVEL
The most caudal segment with normal function

SENSORY ☐ ☐ (R L)
MOTOR ☐ ☐

COMPLETE OR INCOMPLETE? ☐
Incomplete = Any sensory or motor function in S4-S5

ASIA IMPAIRMENT SCALE ☐

ZONE OF PARTIAL PRESERVATION
Caudal extent of partially innervated segments

SENSORY ☐ ☐ (R L)
MOTOR ☐ ☐

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. power
- ☐ **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. power
- ☐ **E = Normal:** motor and sensory function are normal

For prognosis

A → <1% بتحسن

B → % 50 % C → 70%.

CLINICAL SYNDROMES

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

injury بنزل وقت

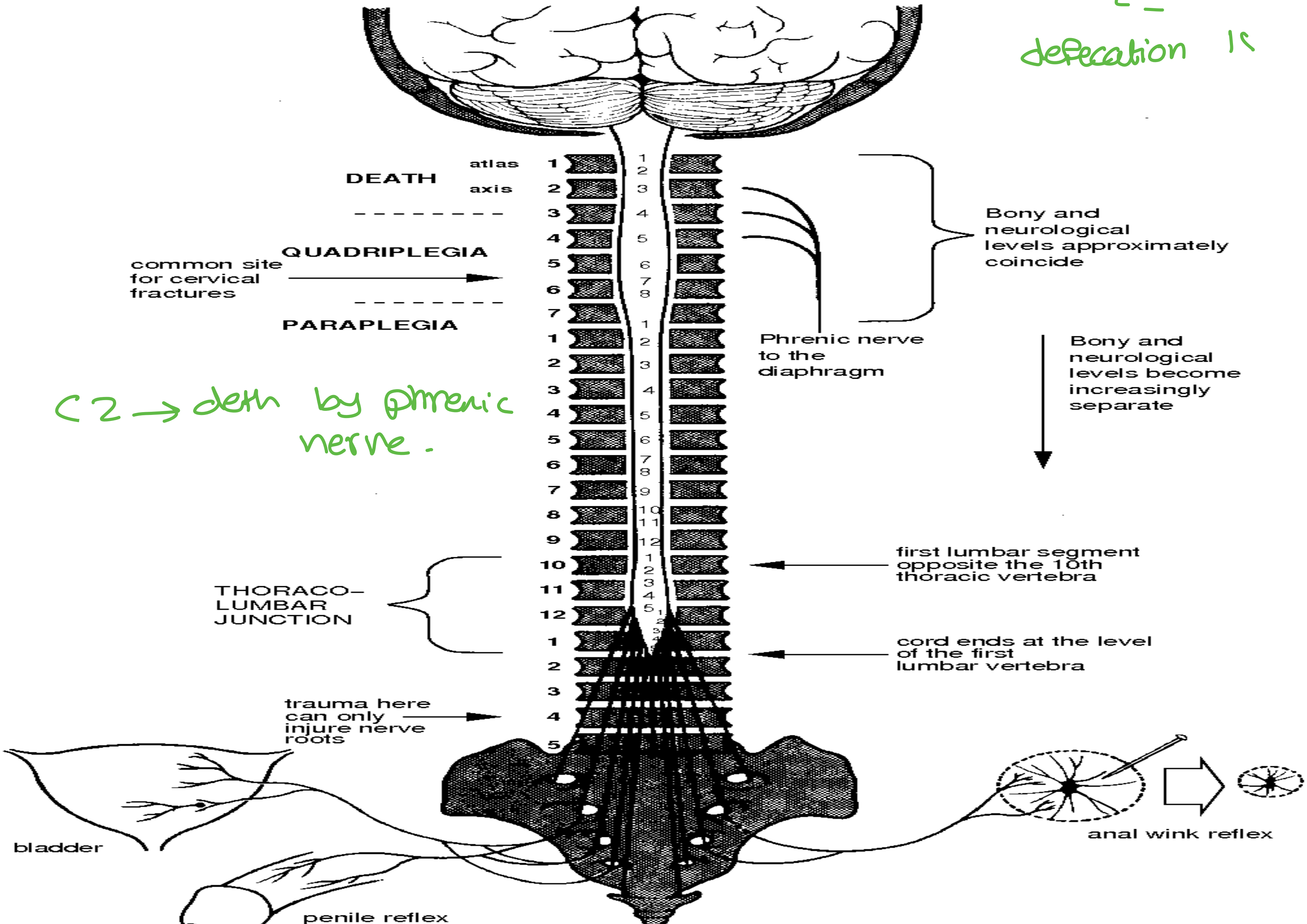
pulpo cavernous reflex.

* DRF → sacrococcygeal segments.

[sensory / tone / power / reflex]

LEVELS OF SPINAL INJURY

كانه يمنع ال defecation



C2 → deth by phrenic nerve.

Neural control of blood pressure and blood flow

-Complete lesions above T1 will eliminate all sympathetic outflow.

-Lesions between T1 and T6 will preserve sympathetic tone in the head and upper extremities but deny it to the adrenals and the lower extremities.

-Lesions between T6 and the lumbar cord will preserve adrenal innervations but denervate the lower extremities

‘Spinal’ shock’

temporeraly -

-Actually refers to the acute loss of segmental tendon reflexes , muscle tone and sensation below the level of a spinal cord lesion.

-in most patients it persist for 24-hours, in others it may persist for as long as 1-4 weeks. as the shock diminishes the neuron regain there excitability and the effect of upper motor neuron loss will make there appearance.

-Hypotension in spinal shock is typically accompanied by bradycardia, reflecting loss of cardiac sympathetic efferents and unopposed vagal tone.

-Neurogenic pulmonary edema is common in patients with cervical spinal cord lesions, complicating their management

Hypotension [circulatory shock]
distributive shock

management

Volume resuscitation cannot be guided solely by physical findings

Hypotension and bradycardia will persist regardless of the volume of saline or colloid administered

-Replace the missing adrenergic tone with [?]-agonists (phenylephrine or norepinephrine depending on heart rate)

α adrenergic → neurogenic

β beta agonist → cardiogenic shock.

Spinal perfusion pressure management

- Developed by analogy to cerebral perfusion pressure management
  - Attempt to prevent cord ischemia by raising blood pressure
    - Assumes that the same secondary injury mechanisms (hypotension and hypoxia) worsen the outcome from spinal cord injury as in head injury

Management

-ABCs

If intubation needed, use in-line stabilization

Direct laryngoscopy vs. fiberoptic

Maintain blood pressure with volume, packed RBCs, vasopressors as needed

- Prevent secondary injury

Log-rolling

- Consider concomitant head injury

Management

Pharmacologic:

- Methylprednisolone 30 mg/kg bolus then 5.4 mg/kg/h for 23 – 47 hours depending on latency from the injury
  - Although there is still debate about its efficacy, this is the ‘standard of care’

Blood pressure

No standards or guidelines

Options:

- ✓ Avoid or correct hypotension (systolic BP < 90 mmHg)
- ✓ Maintaining MAP between 85 and 90 mmHg for the first seven days is recommended

Remember…

When a patient is unconscious and immobilized…they cannot protect their own airway…

THIS BECOMES YOUR RESPONSIBILITY!

Acute non-traumatic spinal cord injuries.

1. Disc
2. Tumor
3. Infection
4. Hemorrhage
5. Iatrogenic.

Cervical Disc with Myelopathy

Clinical Features:

- -Neck Pain
- -Hand Numbness.
- -Weakness
- -Unsteadiness
- -Hyperreflexia
- -Usually Not Emergent

Fig 2. RNM mostrando extrusão discal com acentuada compressão da medula, em T1, a esquerda. À direita, em T2.

Lumbar Disc

Clinical Features:

-Low back pain

-Sphincter disturbance – retention, incontinence, rectal tone.

-Saddle anesthesia

-Radicular symptoms (multiple roots) – pain, weakness

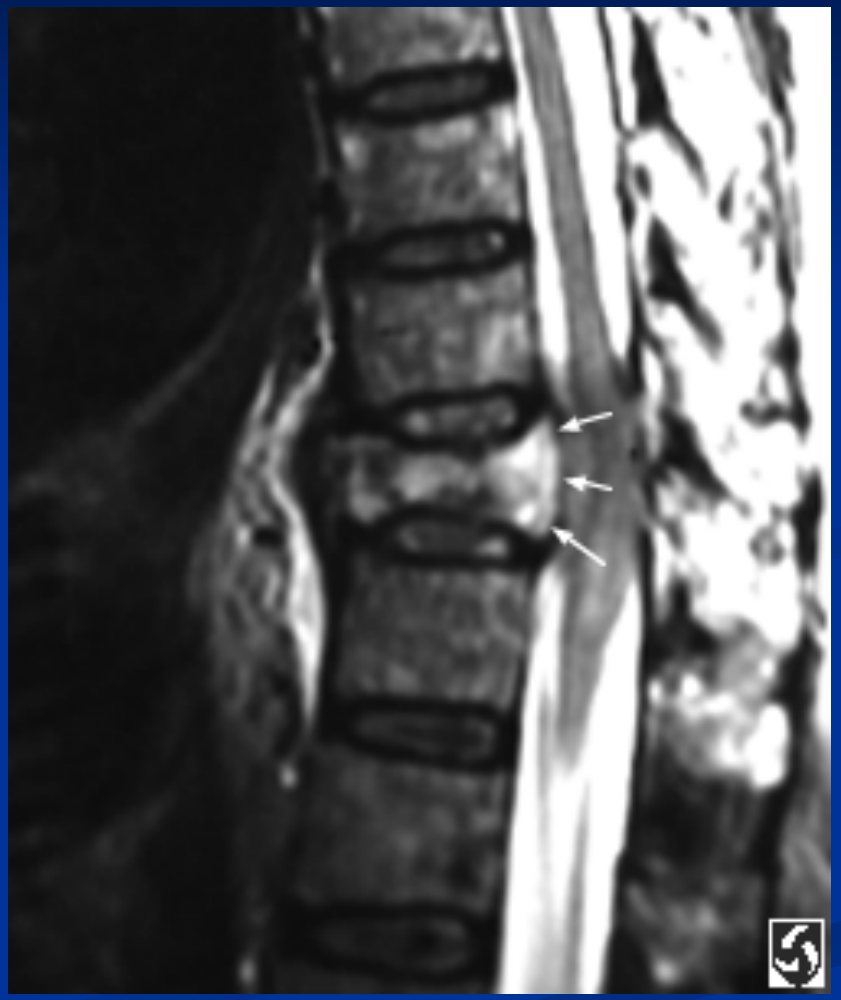
Spinal Metastases

Clinical Features:

-Cancer patient with back pain

-10% of cancer patients

-Lung, breast, GI, Prostate, melanoma, lymphoma, kidney



Spinal Epidural Abscess

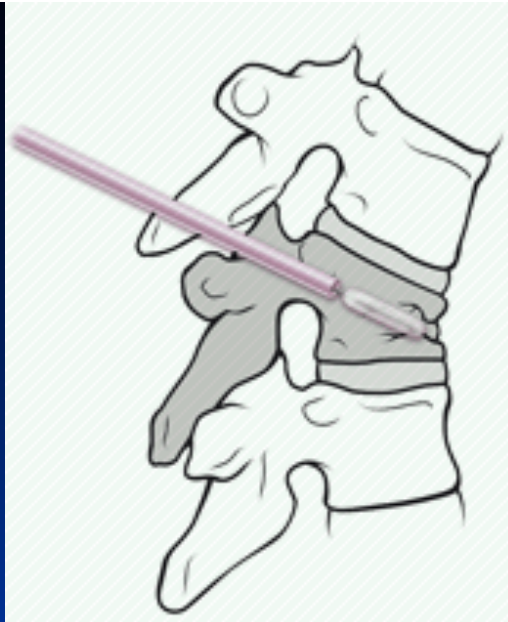
Clinical Features:

-Back Pain, Fever, Tenderness

-DM, IVDA, CRF….

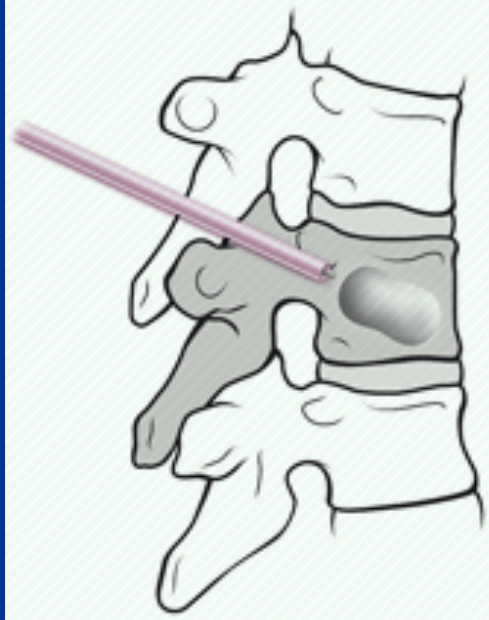
-WBC may be normal

Iatrogenic:



1. Balloon Placement

2. Balloon Inflation



3. Balloon Deflation and Removal

4. Internal Cast

Thank you all