

# TREATMENT OF SPINAL TRAUMA

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# CONTENT:

I. Revision of Anatomy

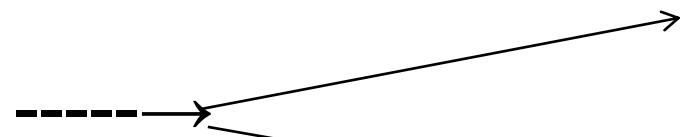
II. Biomechanics of spine  
Mechanisms of trauma,

III. AO classification

IV. Spinal cord injury + examination



Treatment



A. CONSERVATIVE

B. SURGICAL

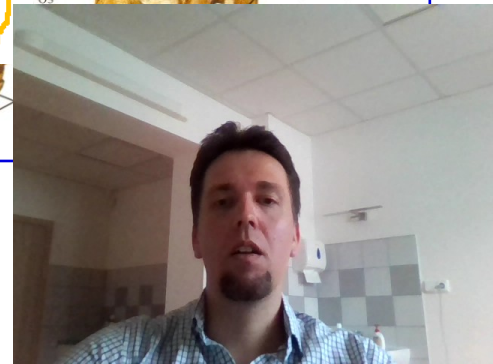
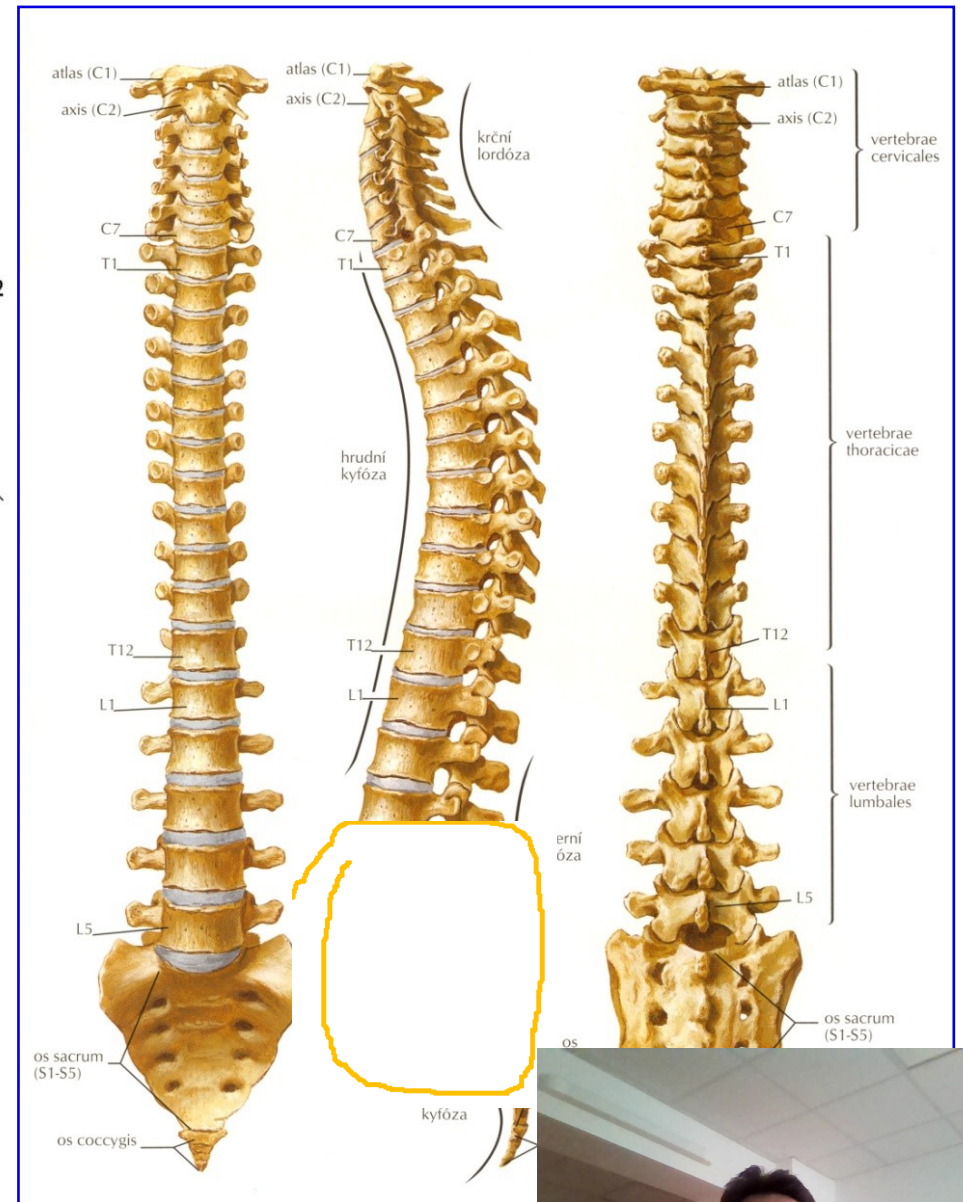
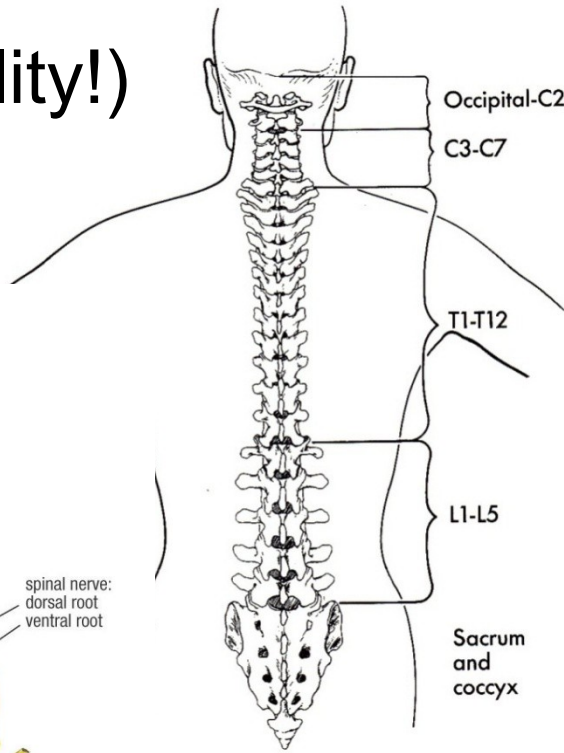
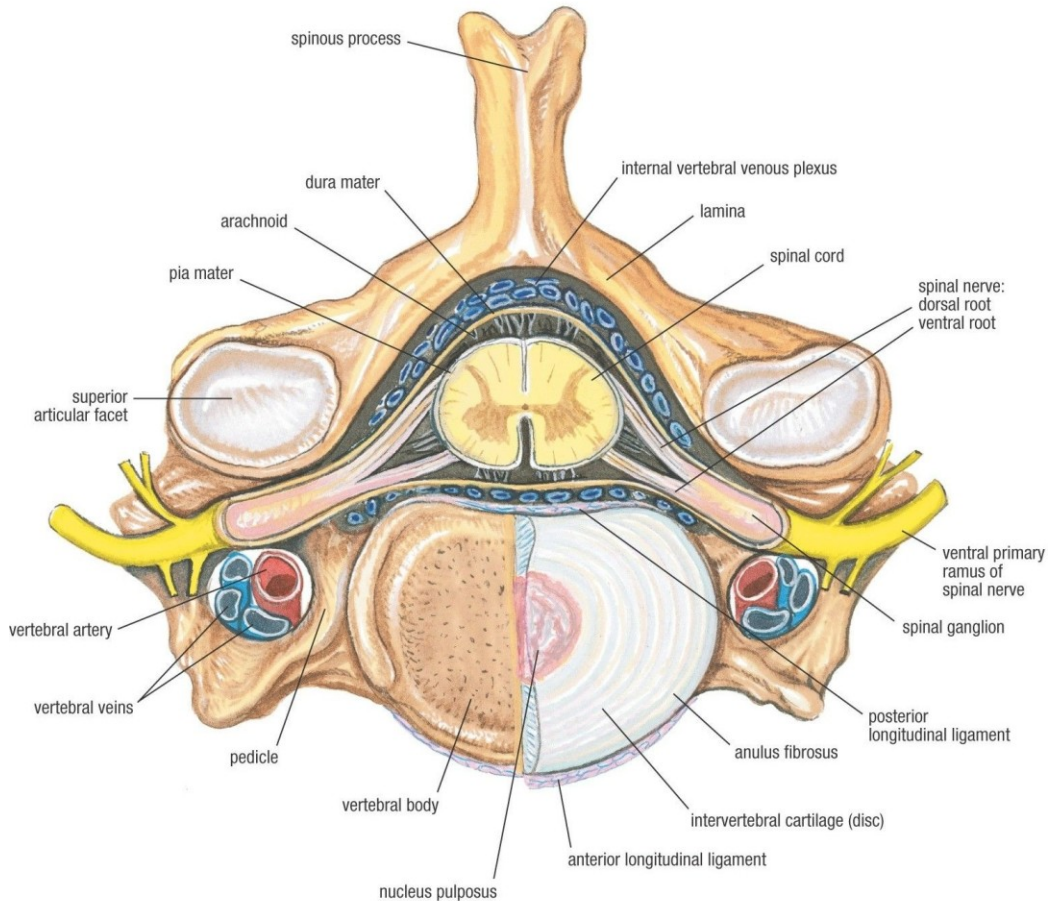
Instrumentation of the spine

- trauma vs. degenerative goals & treatment

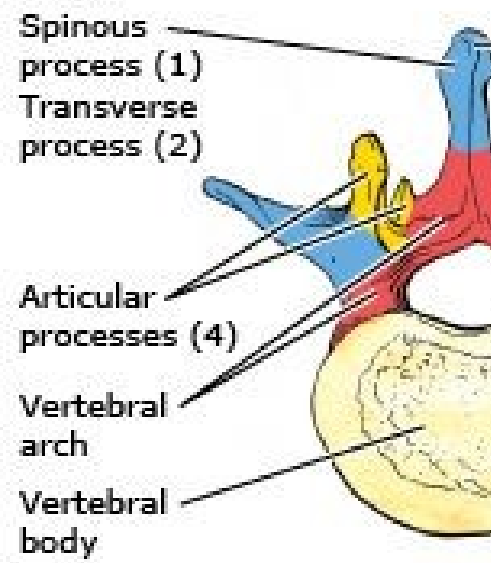


# I. Revision of Anatomy - SPINE

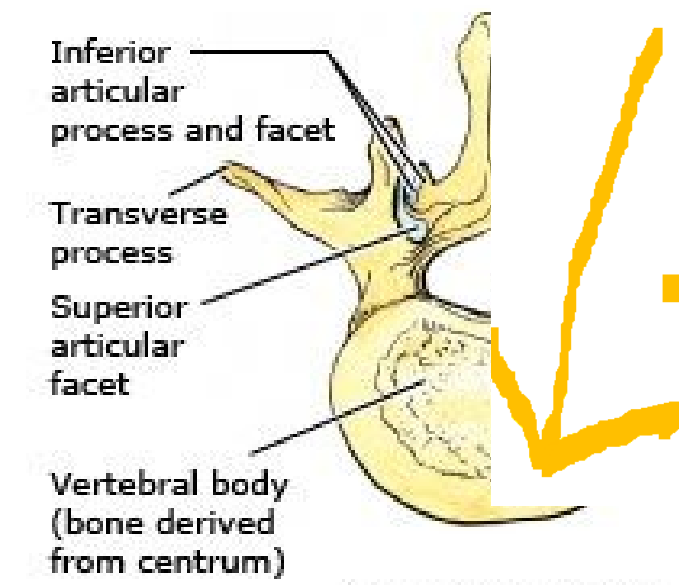
- count of vertebrae (variability!)
- spine curvatures
- neuro-vascular structures!



**Parts:**



**A**



**Superior views**

**B**

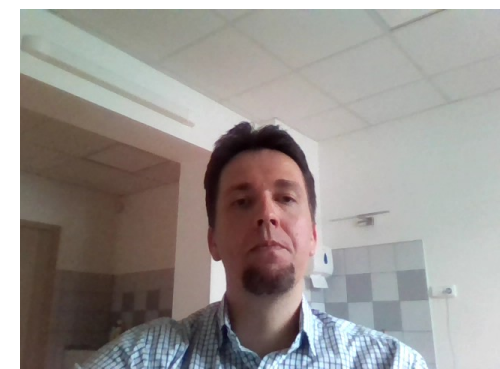
derived from zygapophysial (facet) joint

**D**

**Lateral views**

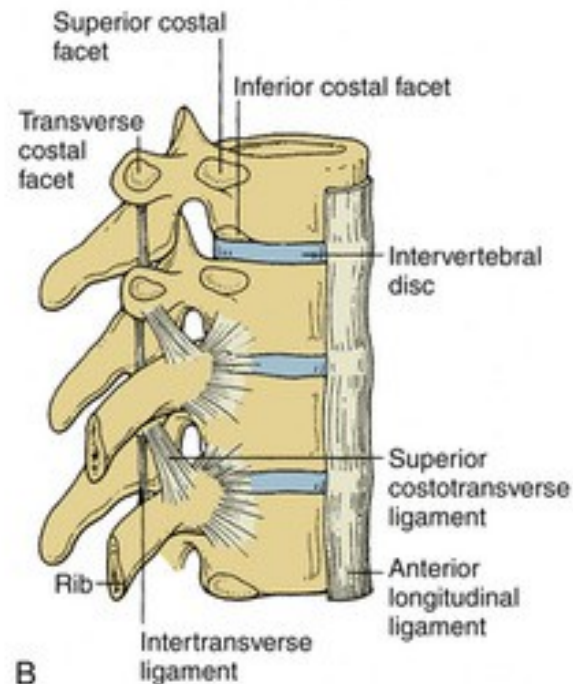
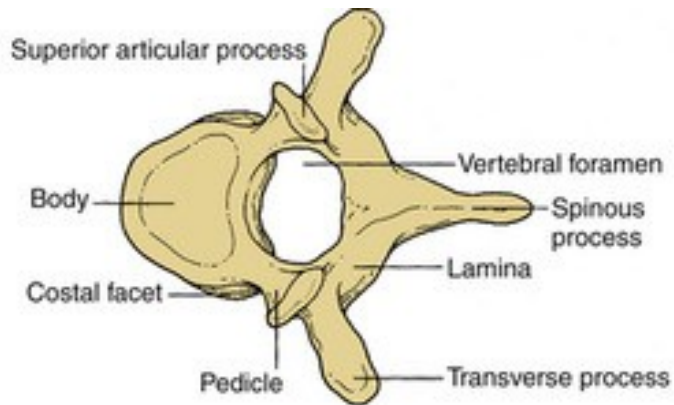
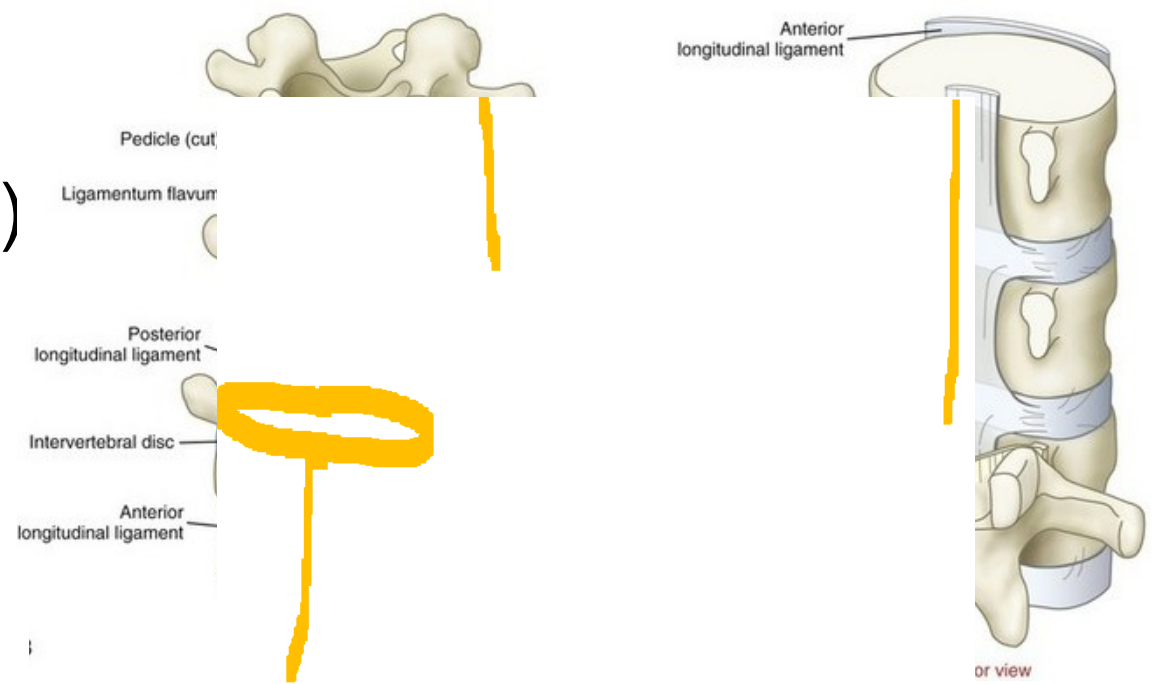


ngle

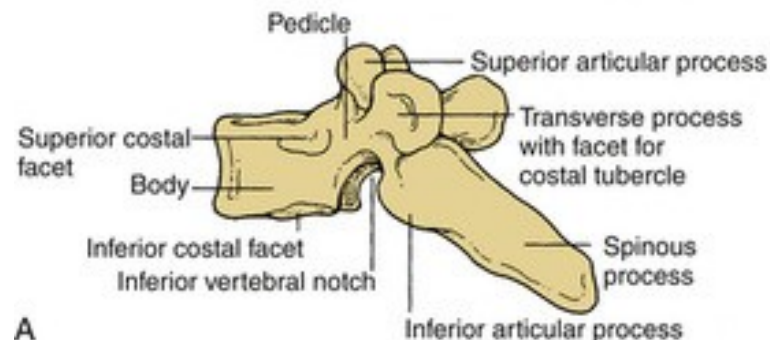
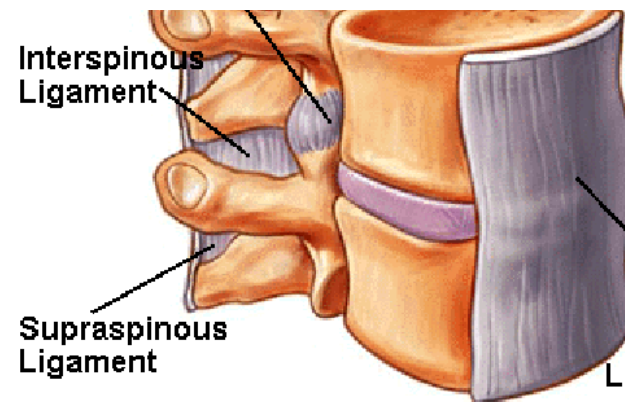


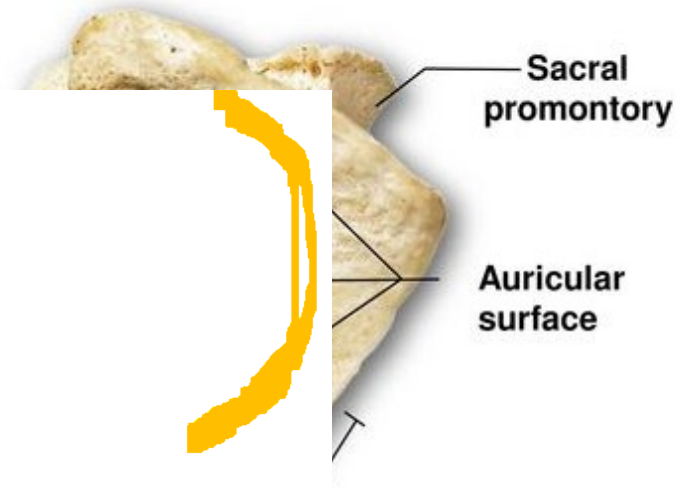
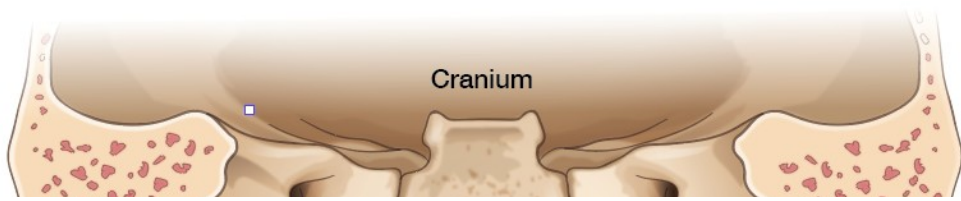
**-Synarthrosis „joints“**  
 (connection by cartilage/ligament/bone)

**-Diarthrosis (synovial) joints**  
 (articular surfaces, joint capsule, cavity, synovial fluid ...)

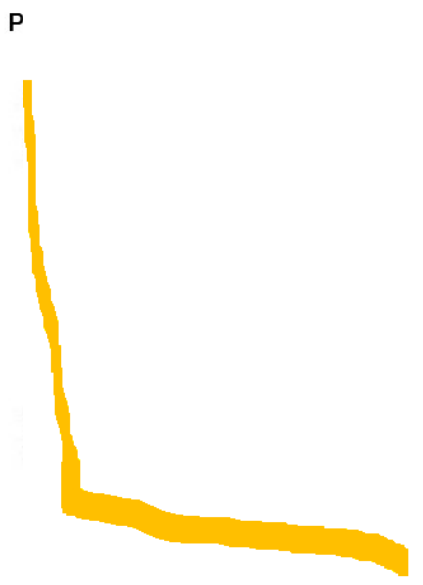
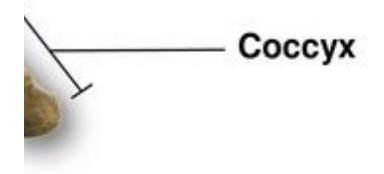


**Facet Capsul Ligame**

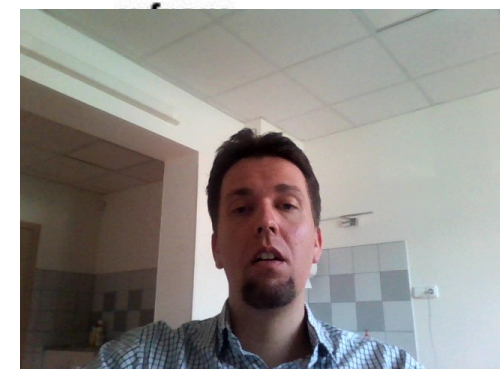




Sacral curve



(c) Atlantoaxial joint

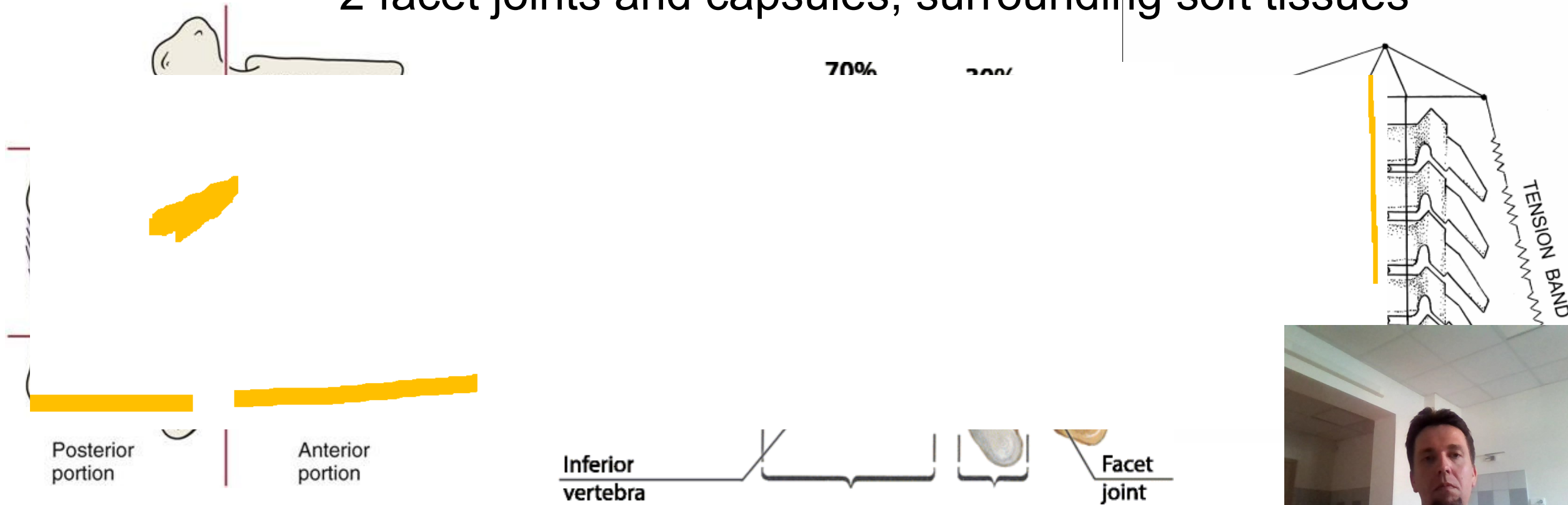


# II. Biomechanics - Functional Spinal Unit (FSU)

= smallest mobile segment of the spine

- Composed of: 2 adjacent vertebrae, intervertebral disc, ligaments

2 facet joints and capsules, surrounding soft tissues



## II. Incidence of spinal trauma

- 3-6 % of all injuries
- 70 % thoracic and lumbar
- 30 % cervical
- 20 % presence of neurological deficit

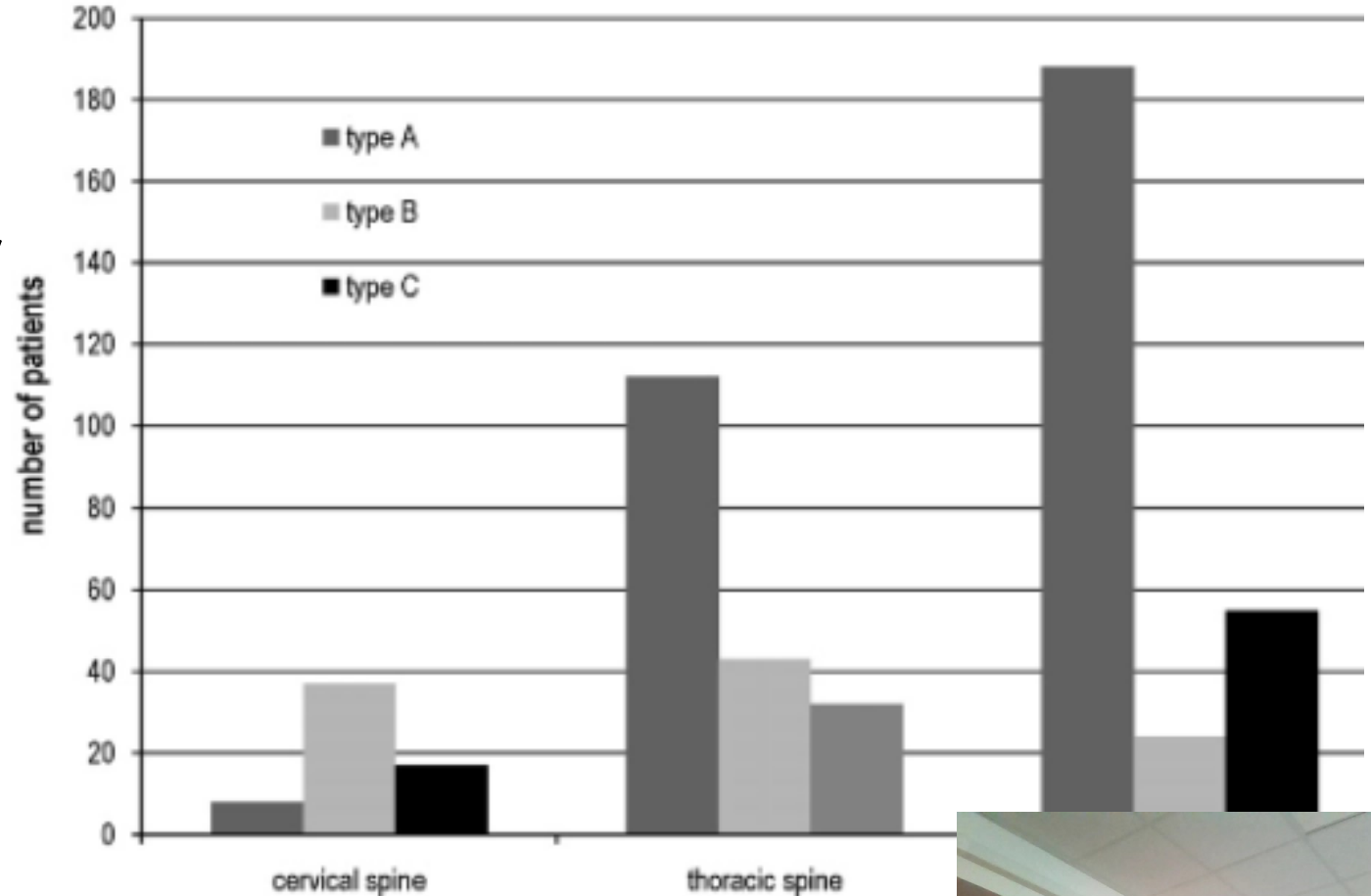
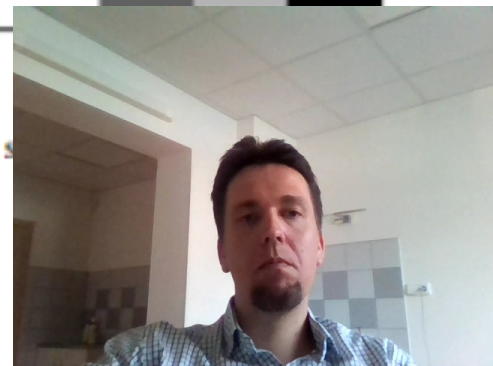


Fig. 5. Incidence of fracture mechanism in each s

*Leucht et al. 2009*





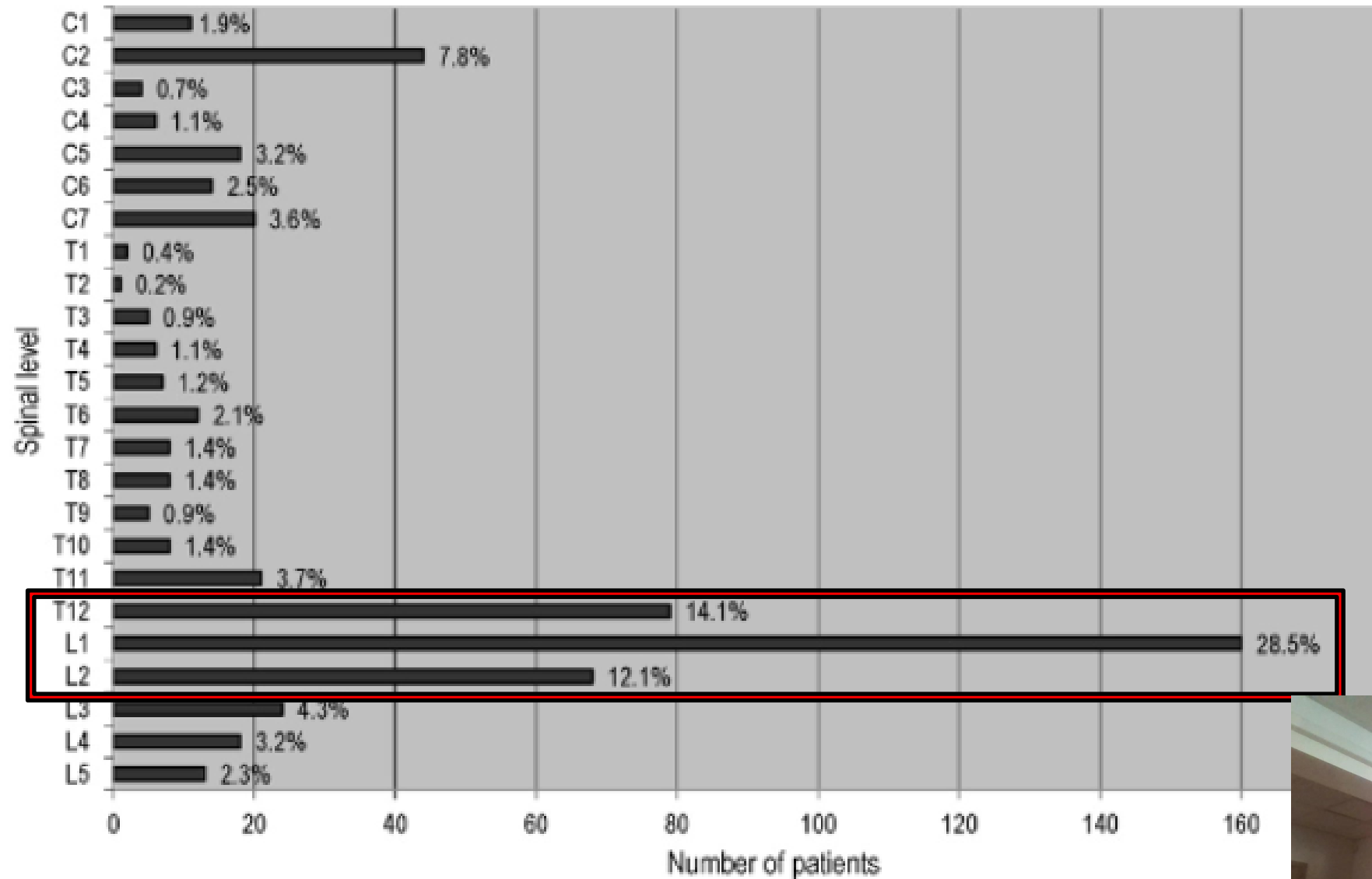
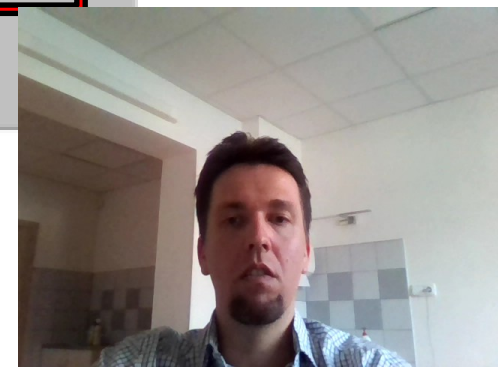


Fig. 4. Distribution of spine fractures for each vertebra.



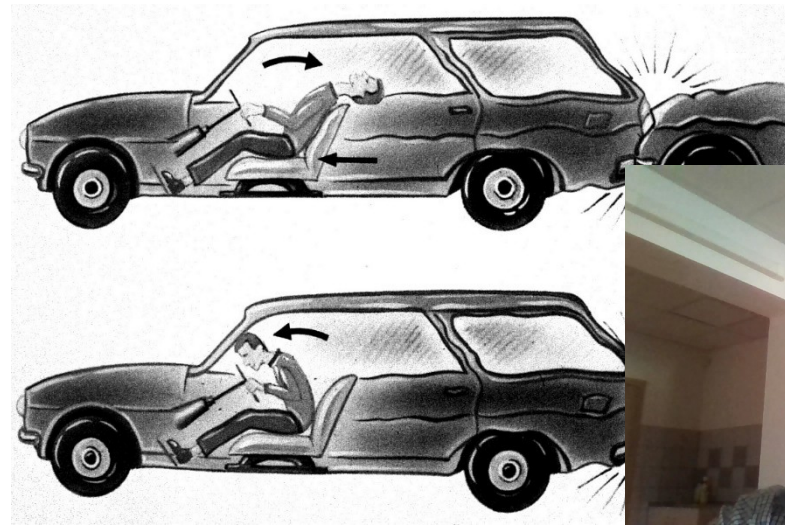
# Etiology of spinal trauma

- High energy trauma – youth
- Low energy trauma – over 60 yo (osteoporotic fx.)
- Falls
- Traffic accidents  
- **whiplash** injury
- Sport
- Combinations

**Table 3**

Relationship between cause of accident and fracture localisation.

Cause of accident	Fracture localisation				
	C1-2	C3-7	T1-10	T11-L2	L3-5
High-energy fall	18 (8.2%)	14 (6.4%)	15 (6.8%)	150 (68.5%)	22 (10%)
Simple fall	11 (9.6%)	9 (7.9%)	5 (4.4%)	75 (65.8%)	14 (12.3%)
Traffic	21 (14.1%)	26 (17.4%)	30 (20.1%)	58 (38.9%)	14 (9.4%)
Sports	3 (10.3%)	9 (31%)	4 (13.8%)	12 (41.4%)	1 (3.4%)
Miscellaneous	2 (3.9%)	4 (7.8%)	8 (15.7%)	33 (64.7%)	4 (7.8%)
<b>Total</b>	<b>55 (9.8%)</b>	<b>62 (11%)</b>	<b>62 (11%)</b>	<b>328 (58.4%)</b>	<b>55 (9.8%)</b>

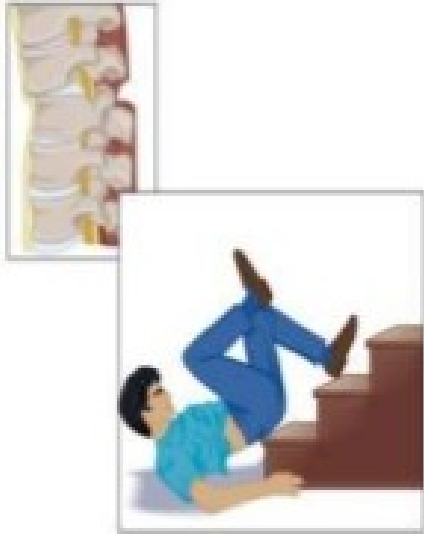


*Leucht et al. 2009*

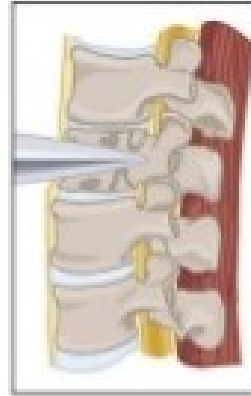


# Spinal trauma- mechanisms

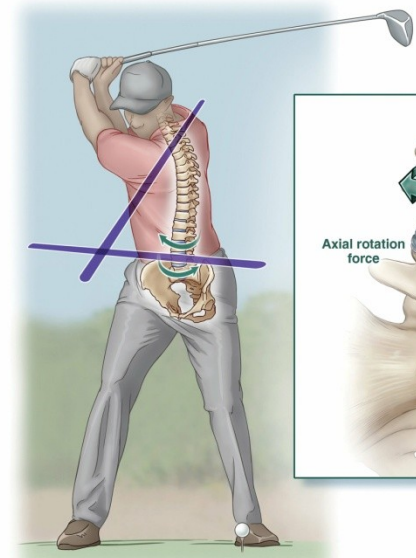
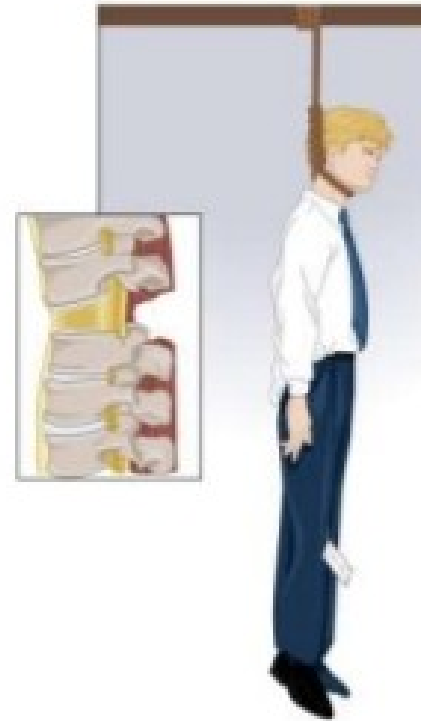
FLEXION INJURY



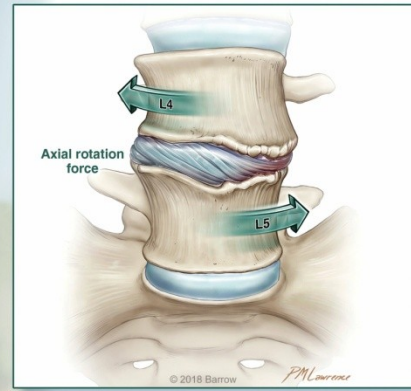
PENETRATION INJURY



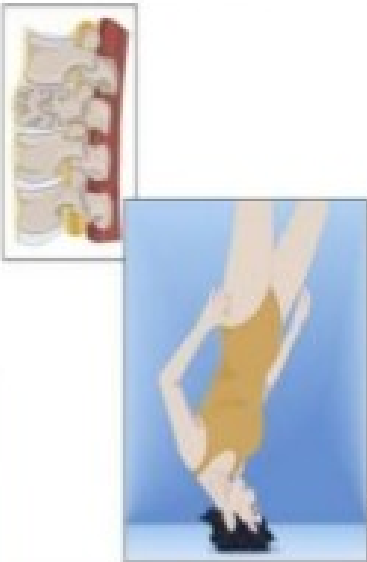
DISTRACTION INJURY



Top of the Back Swing: "X-Factor"



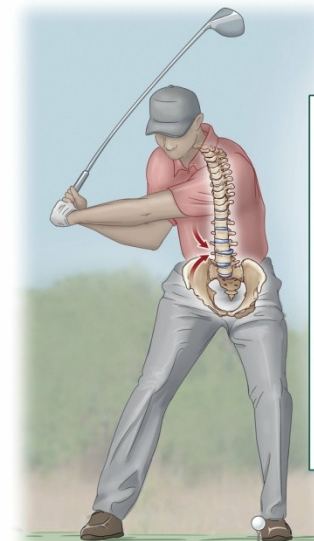
COMPRESSION INJURY



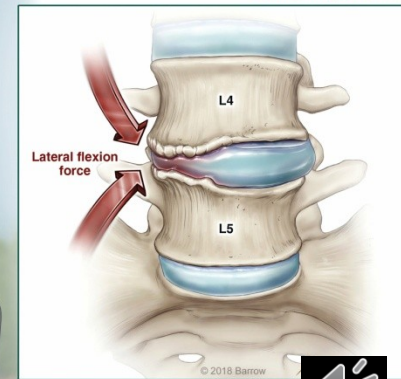
HYPEREXTENSION INJURY



FLEXION-ROTATION INJURY

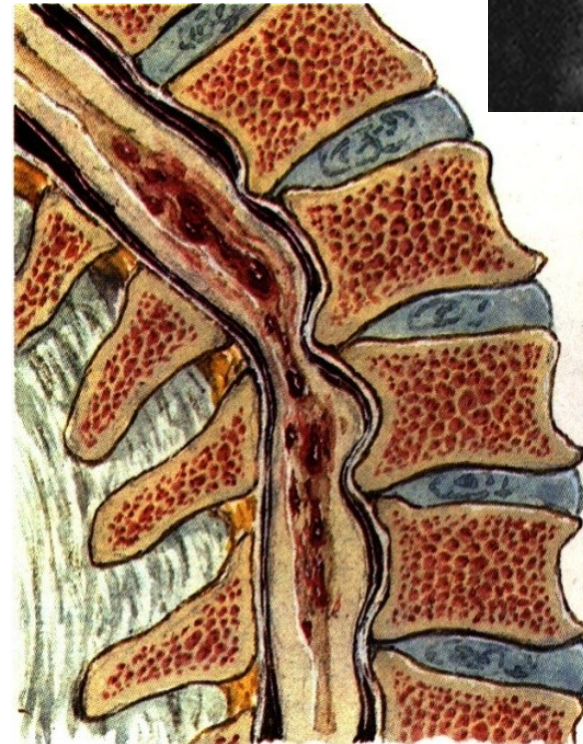
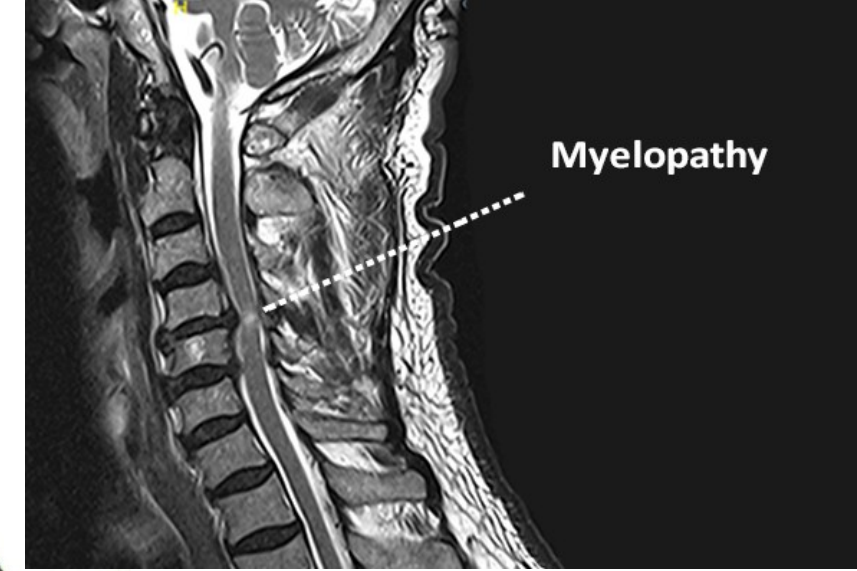
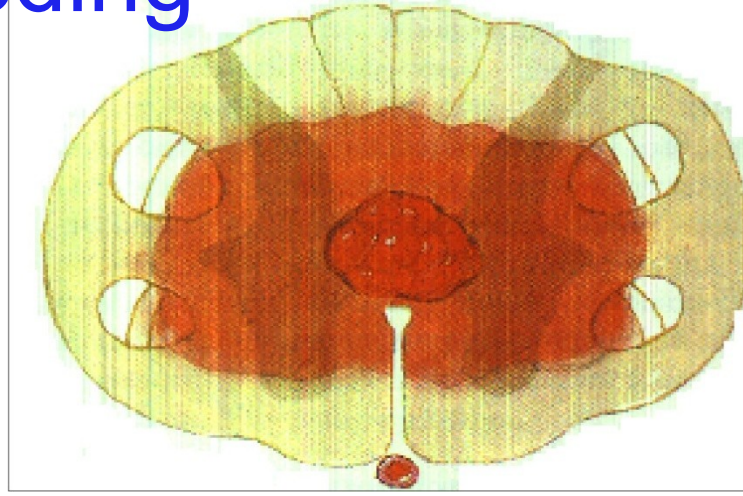
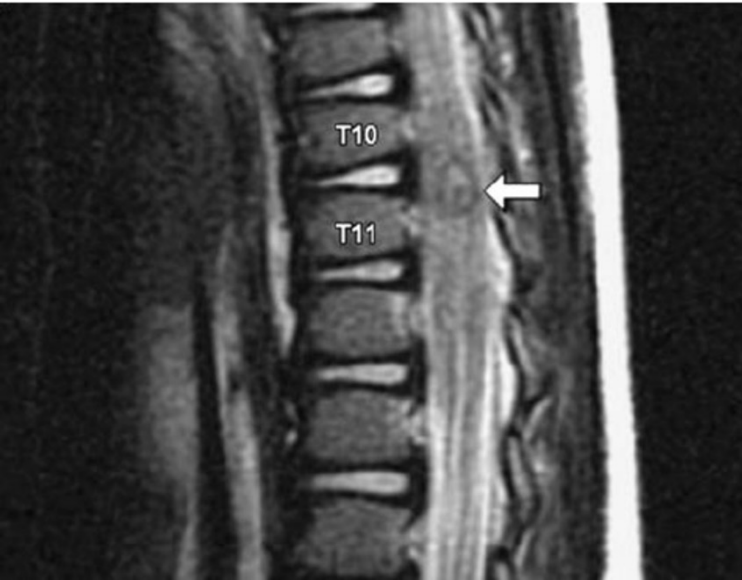


Down Swing: "Crunch"



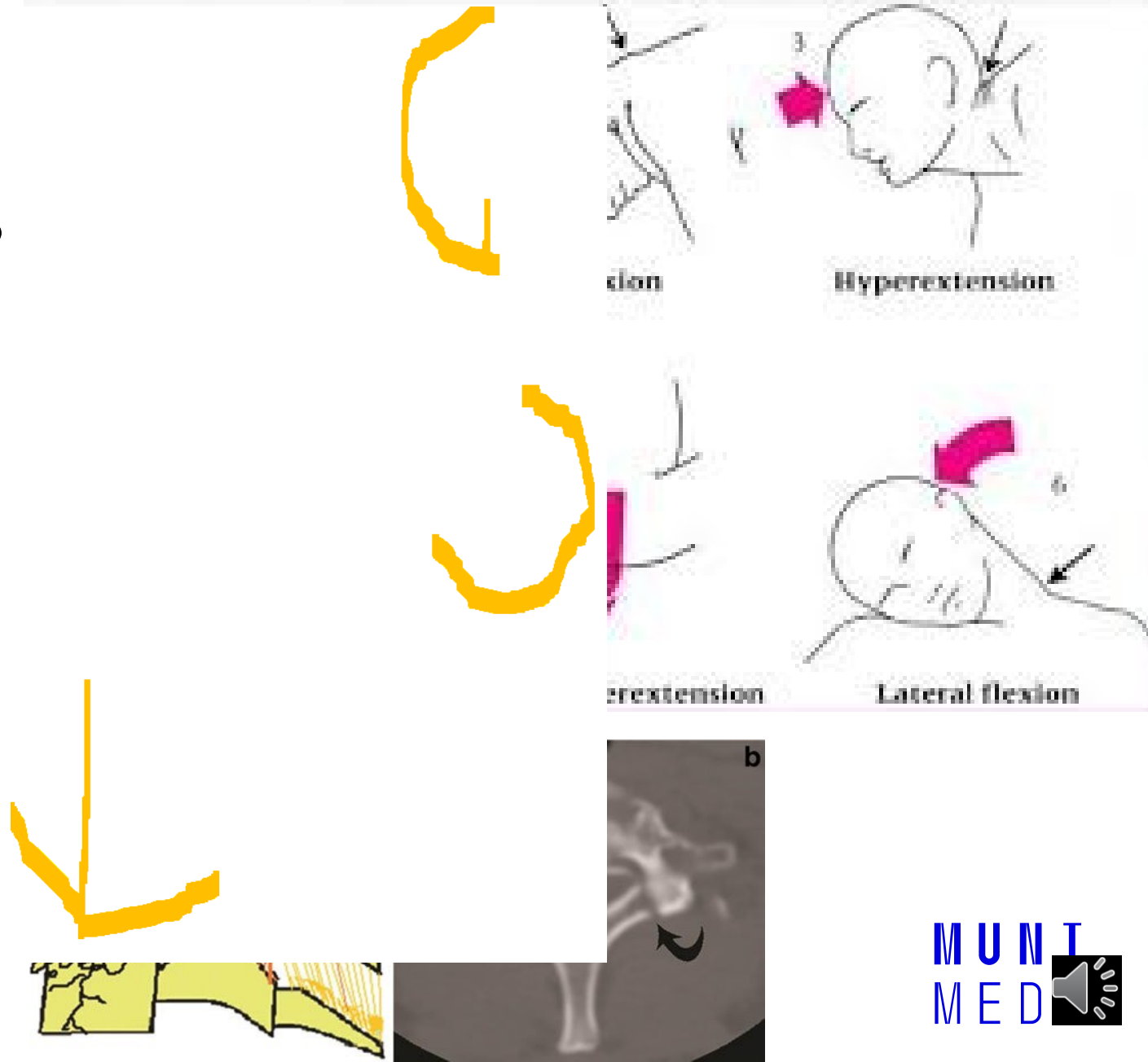
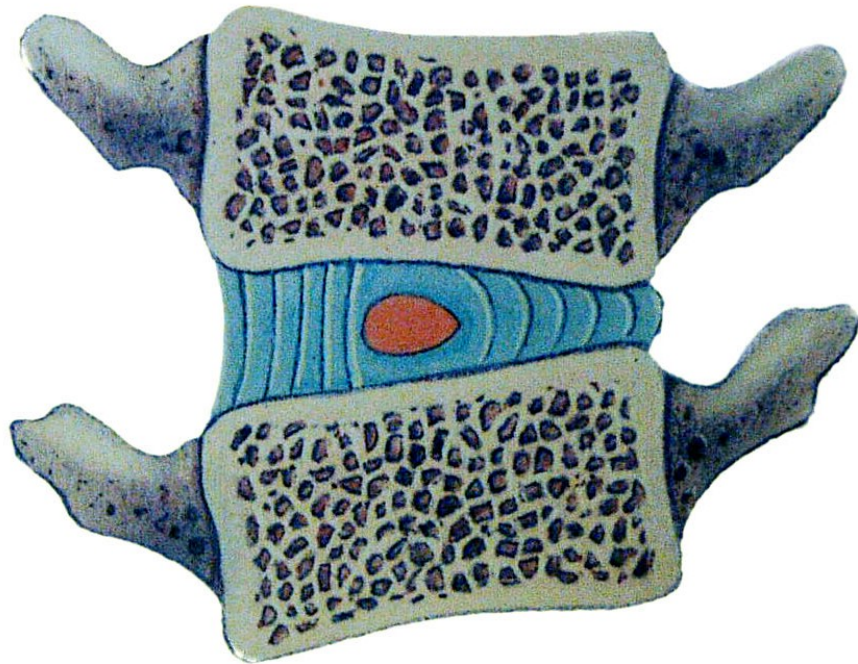
Hematomyelia=bleeding

Myelopathy=pressure



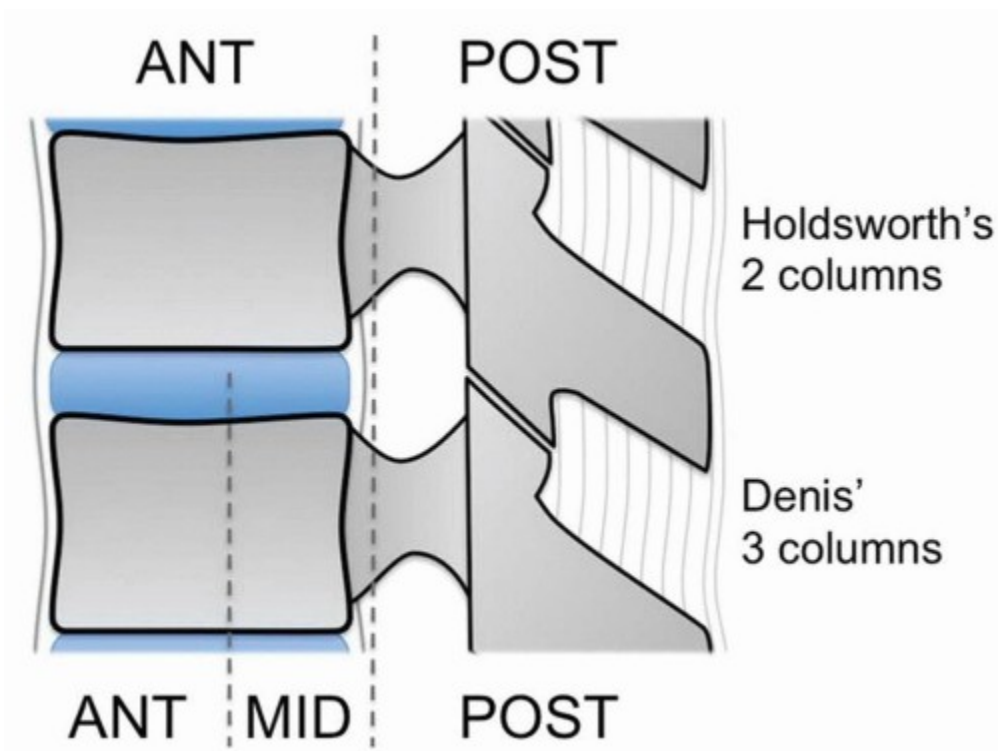
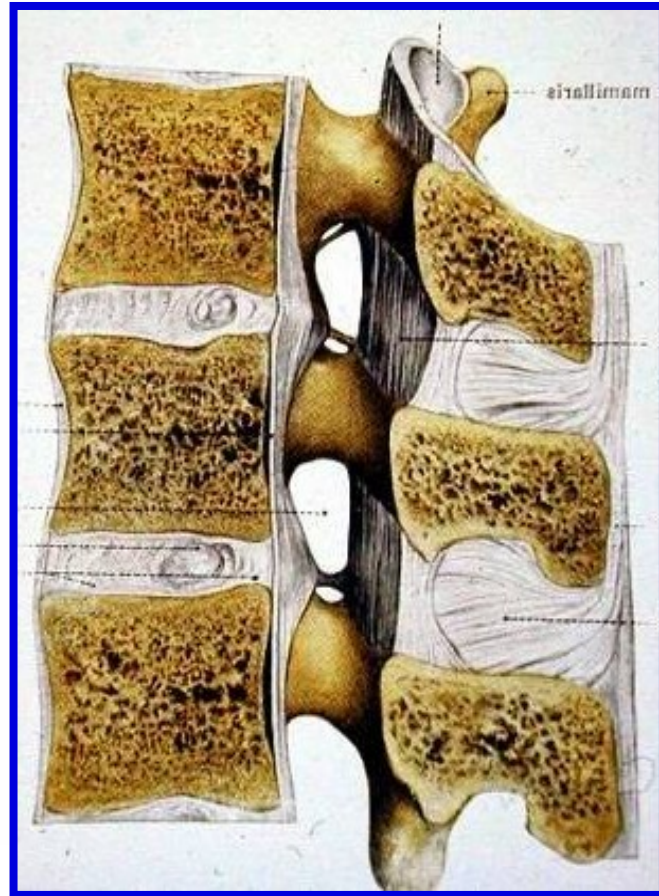
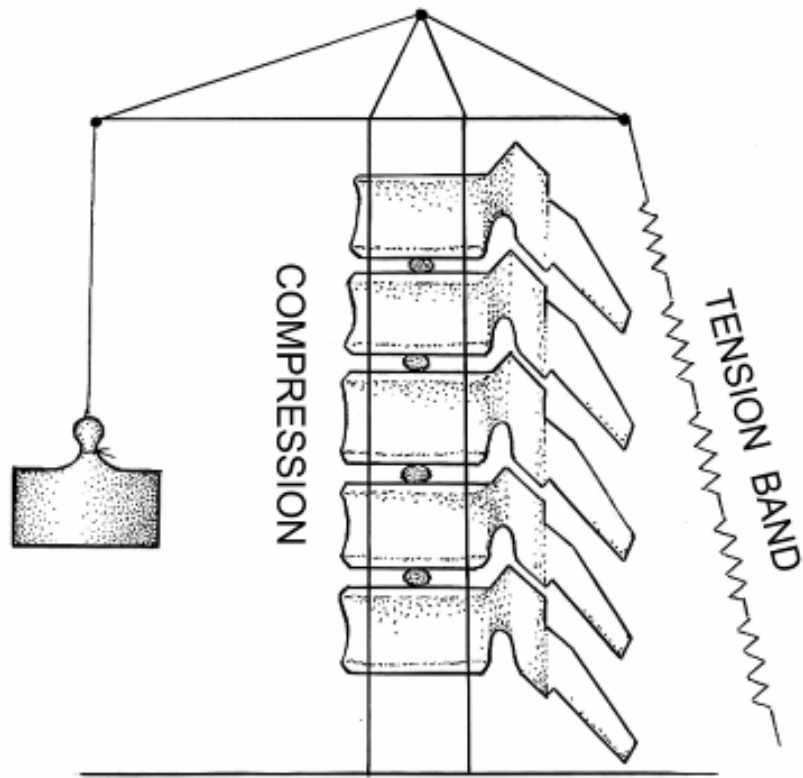
# Types of injuries

- Axial load forces
- Flexion-Extension forces
- Rotation forces
- Combination



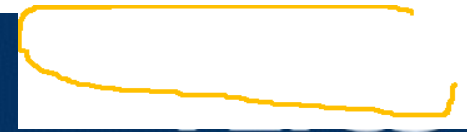
# III. SPINE TRAUMA CLASSIFICATION

2 column theory (Holdsworth) vs. ~~3 column theory (Denis)~~



# Denis

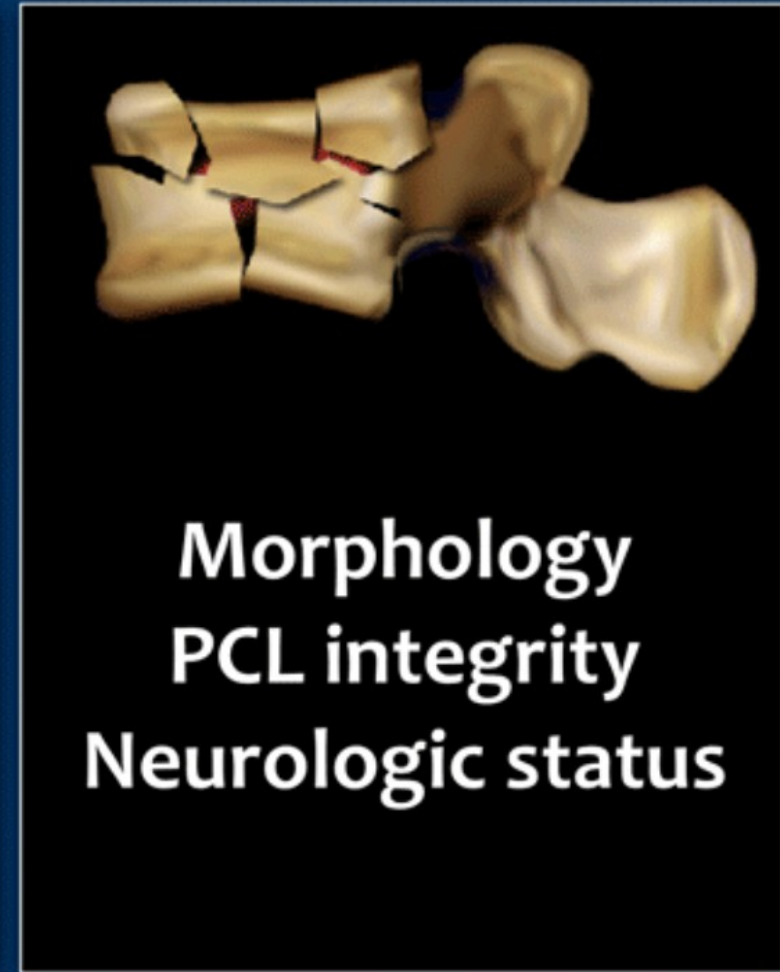
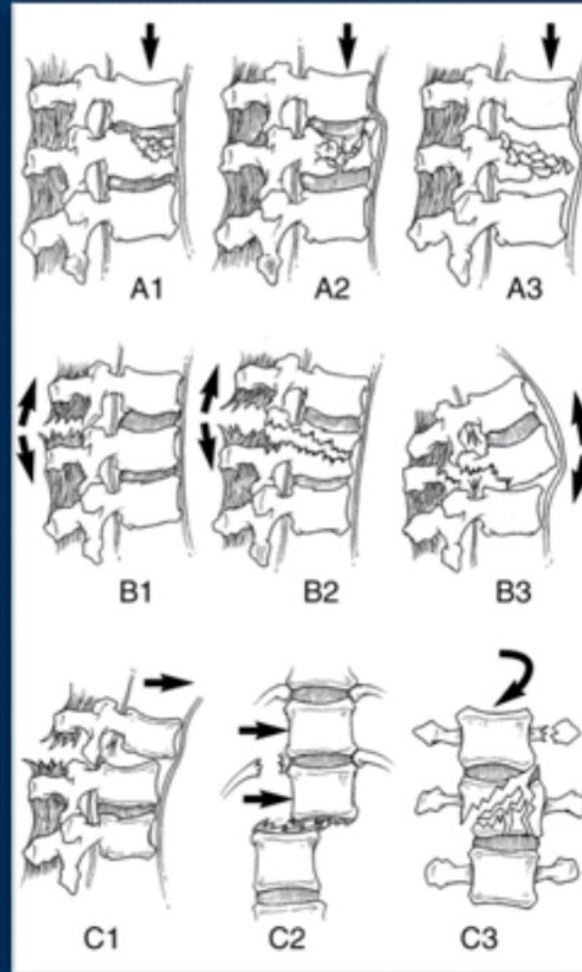
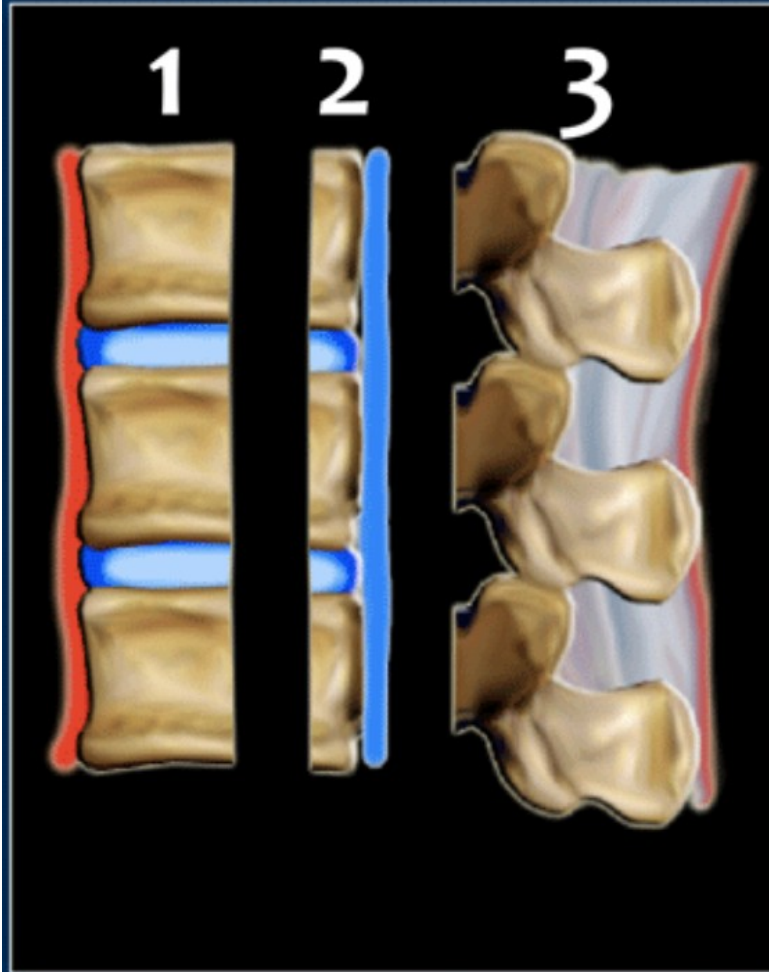
# AO



3-column classification

classification

classification



# TLICS Classification - Thoraco-Lumbar Injury Classification and Severity score

TLICS		3 independent predictors	
1			radiographs
2			radiographs
3			clinical examination
			surgical decision

**CT features** of PLC pathology are:

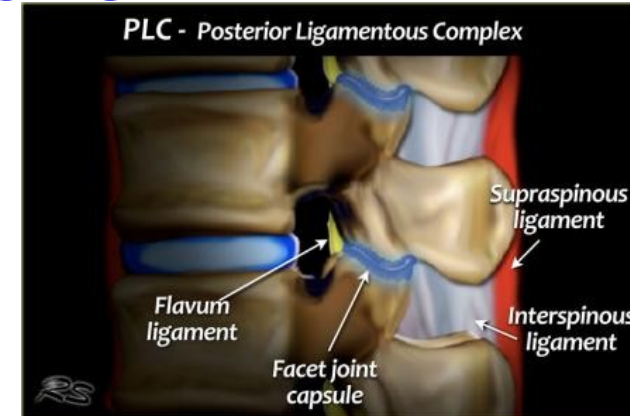
- Widening of the interspinous space.
- Avulsion fractures or transverse fractures of spinous processes or articular facets.
- Widening or dislocation of facet joints.
- Vertebral body translation or rotation.

When the PLC is definitely injured on CT, it can already be scored as 3.

Since the integrity of the PLC depends mostly on ligamentous structures, MR is sometimes needed to adequately diagnose pathology of the PLC, especially when there is no dislocation or disruption on CT.

**MRI features** of PLC pathology are:

- *Definite: 3 points*
- Loss of normal low signal intensity of the ligamenta flava or supraspinous ligaments on T1 and T2.
- *Indeterminate: 2 points*
- Edema without clear rupture; high signal intensity of the interspinous ligaments or along the facet joints on T2 SPIR or STIR.

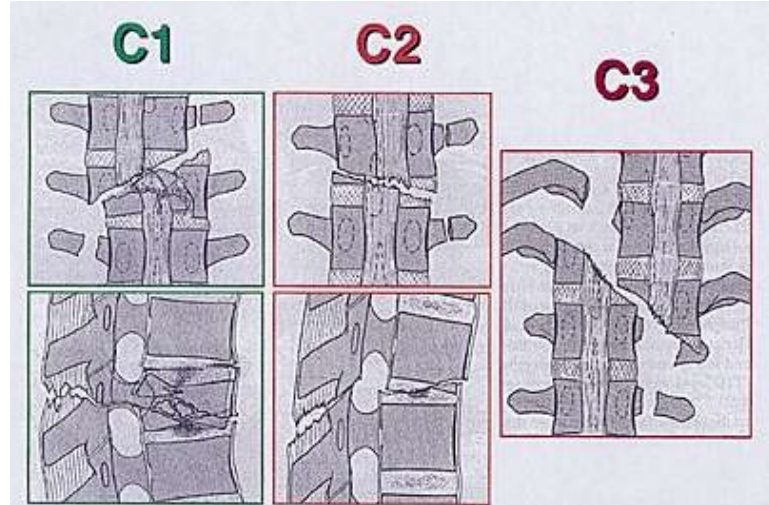
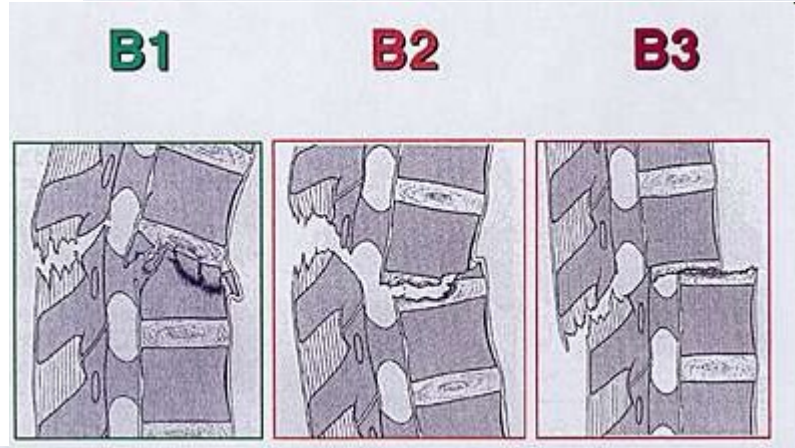
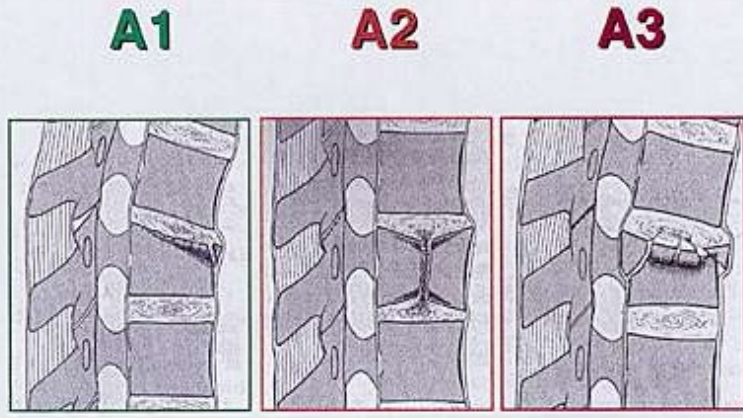
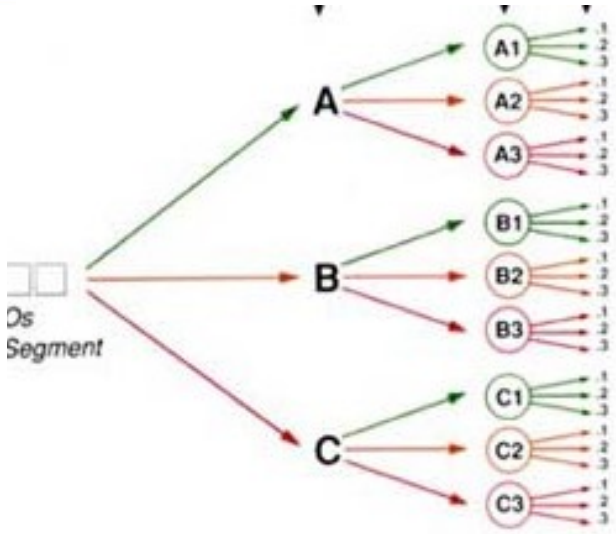
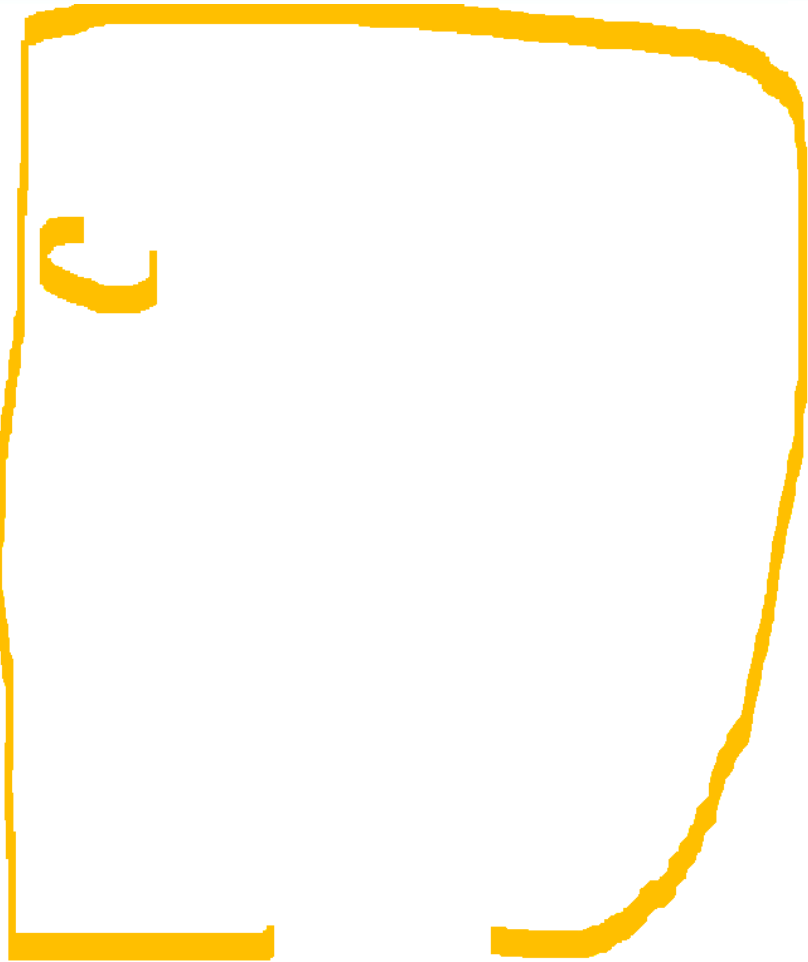




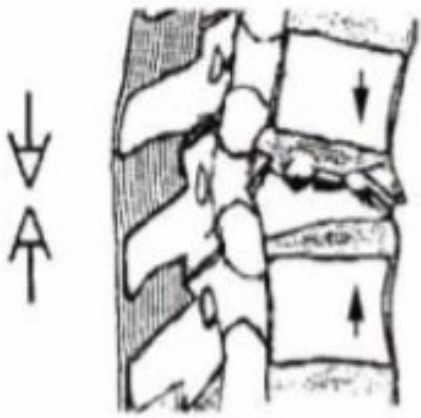
# AO classification (Magerl 1994)

AO Surgery Reference Authors

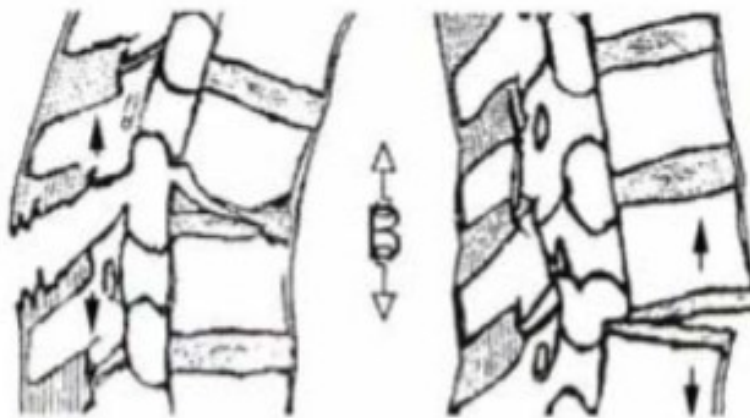
Please select an anatomical area



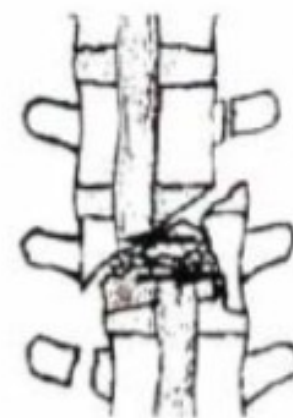




**A**



**B**



**C**

Vertebral body injury  
*with compression*

Anterior and posterior elements injury  
*with distraction* ----- *with rotation*

impaction  
fx

split fx


burst fx

posterior injury

anterior  
injury

rotational  
shear

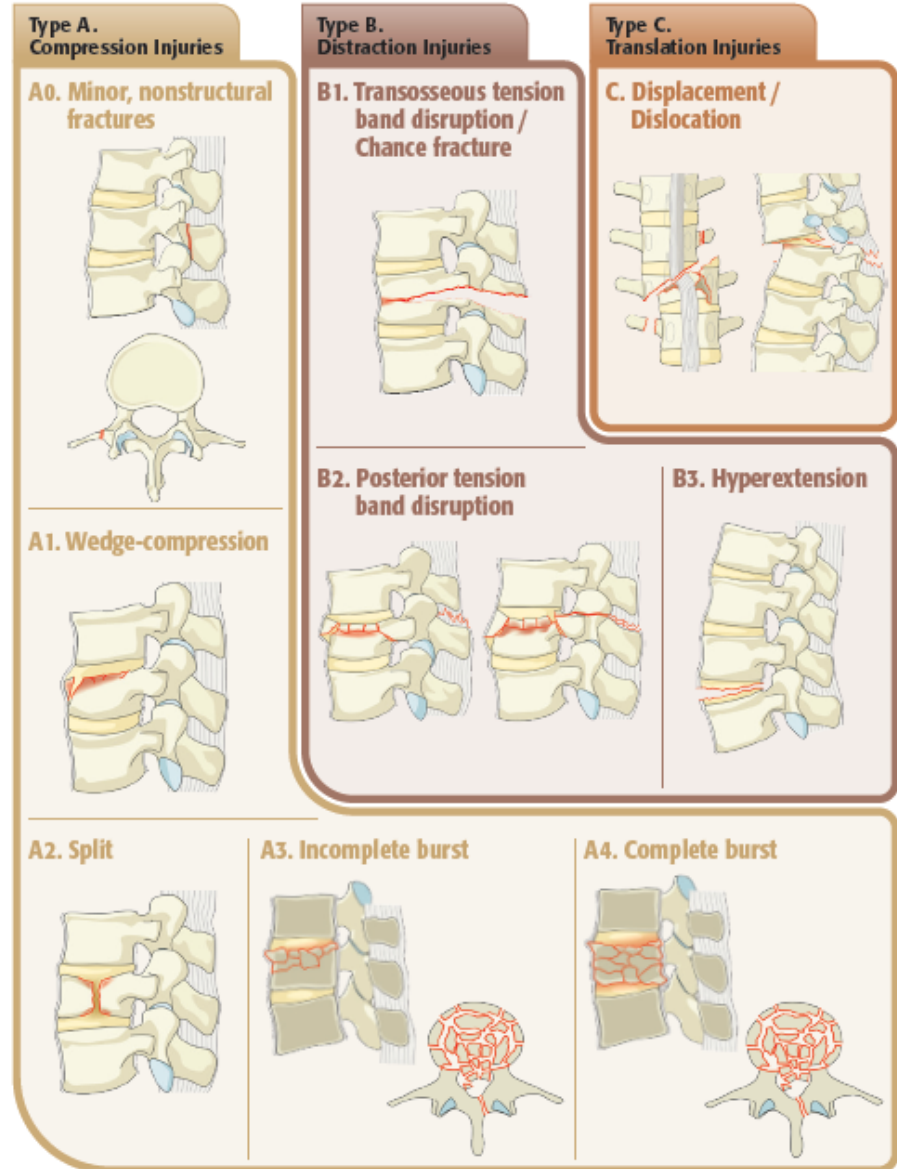


↓ predominantly ↓  
ligamentous  s  
through the disc

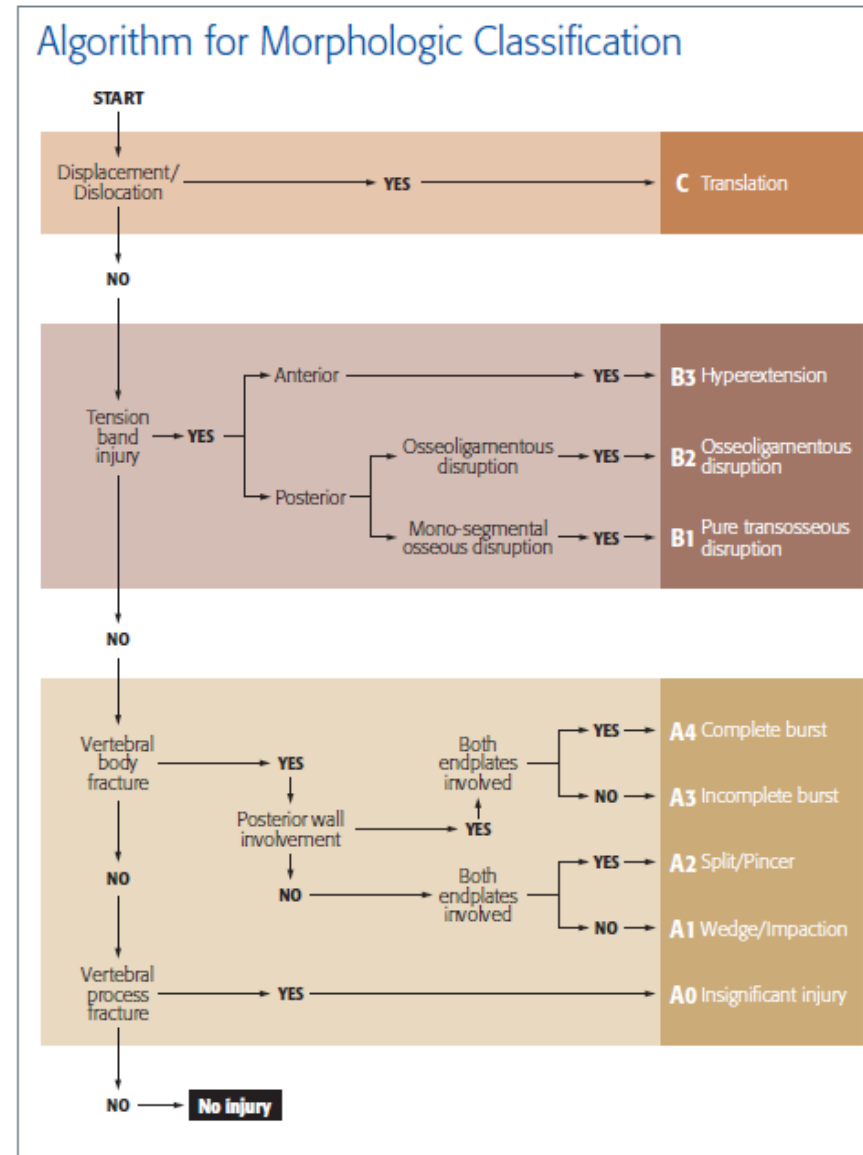
Type A

Type B

# AOSpine Thoracolumbar Classification System



# AOSpine Thoracolumbar Classification System




# AOSpine Upper Cervical Classification System


# AOSpine Subaxial Classification System

**I. Occipital Condyle and Craniocervical junction**


**Type A.** Isolated bony injury (condyle)



**Type B.** Non-displaced ligamentous injury (craniocervical)

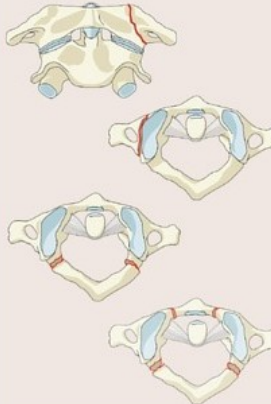


**Type C.** Any injury with displacement on spinal imaging

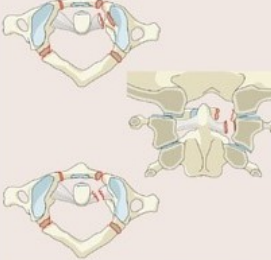


**II. C1 Ring and C1-2 Joint**

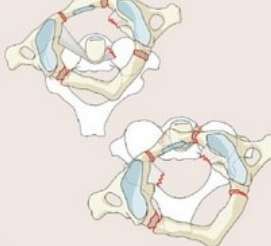
**Type A.** Isolated bony only (arch)



**Type B.** Ligamentous injury (transverse atlantal ligament)

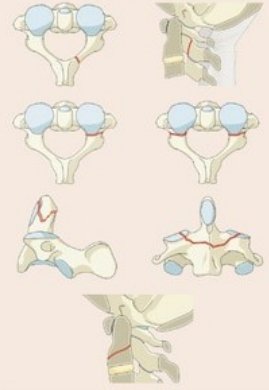


**Type C.** Atlantoaxial instability / Translation in any plane

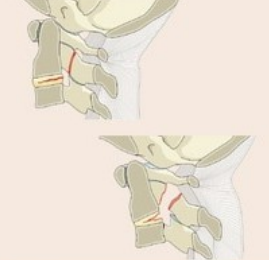


**III. C2 and C2-3 Joint**


**Type A.** Bony injury only without ligamentous, tension band, discal injury



**Type B.** Tension band / Ligamentous injury with or without bony injury



**Type C.** Any injury that leads to vertebral body translation in any directional plane



**Type A. Compression Injuries**

**A0.** Minor, nonstructural fractures



**A1.** Wedge-compression



**A2.** Split



**A3.** Incomplete burst

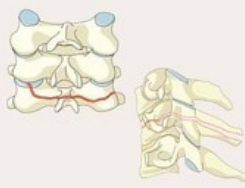


**A4.** Complete burst

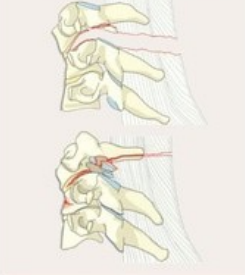


**Type B. Distraction Injuries**


**B1.** Posterior tension band injury (bony)



**B2.** Posterior tension band injury (bony capsulo-ligamentous, ligamentous)



**B3.** Anterior tension band injury



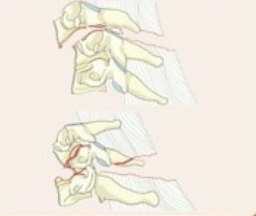
**BL. Bilateral Injuries**

**BL.** Bilateral injury




**Type C. Translation Injuries**

**C.** Translational injury in any axis-displacement or translation of one vertebral body relative to another in any direction




**Type F. Facet Injuries**


**F1.** Nondisplaced facet fracture




**F2.** Facet fracture with potential for instability



**F3.** Floating lateral mass



**F4.** Pathologic subluxation or perched/dislocated facet



# Spine INSTABILITY

- numerous definitions...

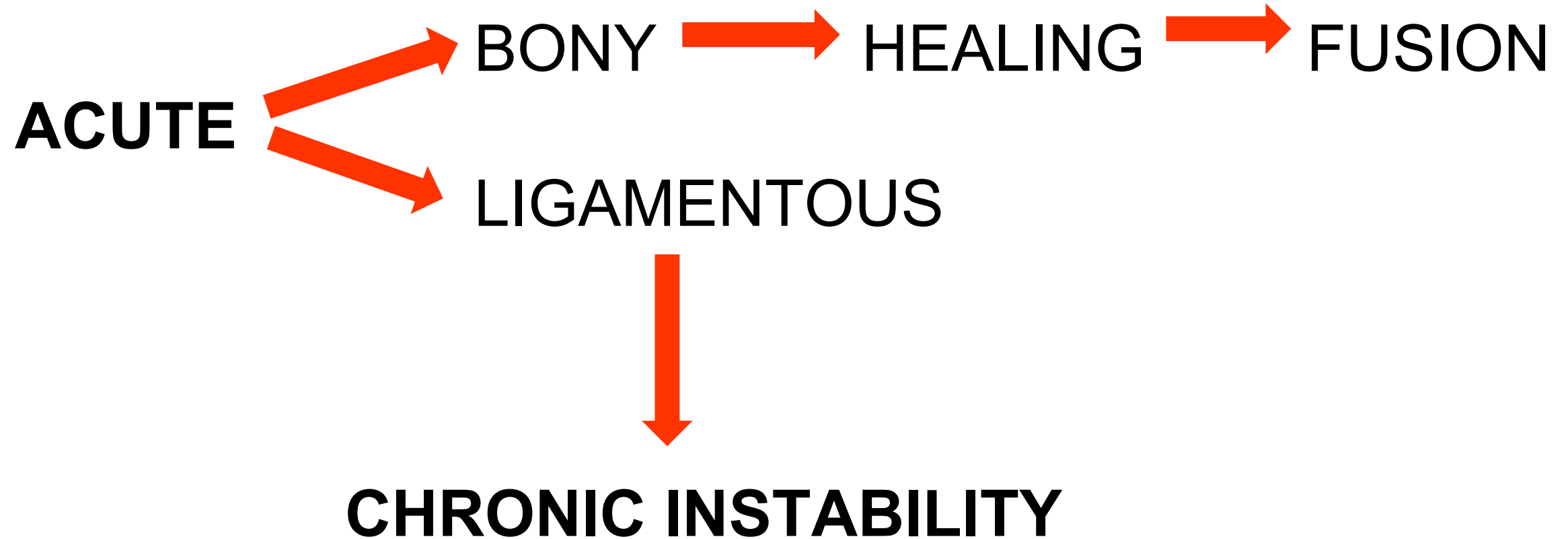
(Louis, Roy-Camille, **White and Panjabi**, Frymoer and Krag)

## SPINE IS INTOLERANT OF PHYSIOLOGICAL LOADING...

*“Clinical instability is defined as the loss of the spine’s ability under physiologic loads to maintain its patterns of displacement, so as to avoid initial or additional neurologic deficits, incapacitating deformity and intractable pain.”*

White and Panjabi 1987

# Spine INSTABILITY



# LIGAMENTOUS INSTABILITY

- conservative treatment cannot lead to healing
- result is chronic progressive instability
- pseudoarthrosis or kyphotic deformity may occur
- can only be repaired by **fusion of affected segment**





# Instability of C-spine

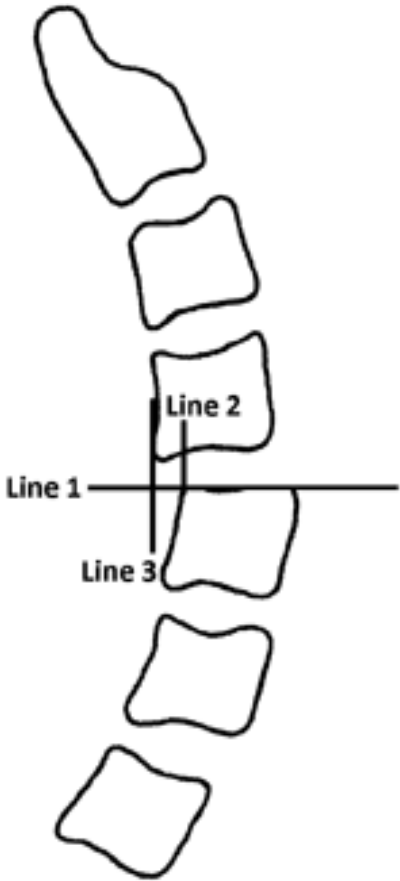


Figure 1: Extension Lateral

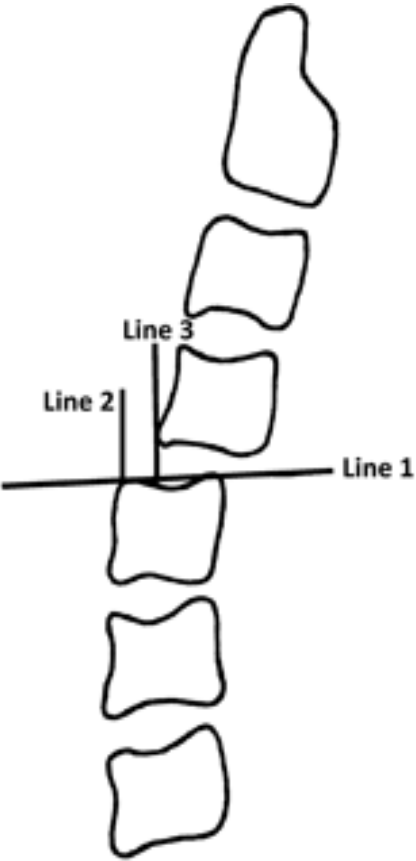
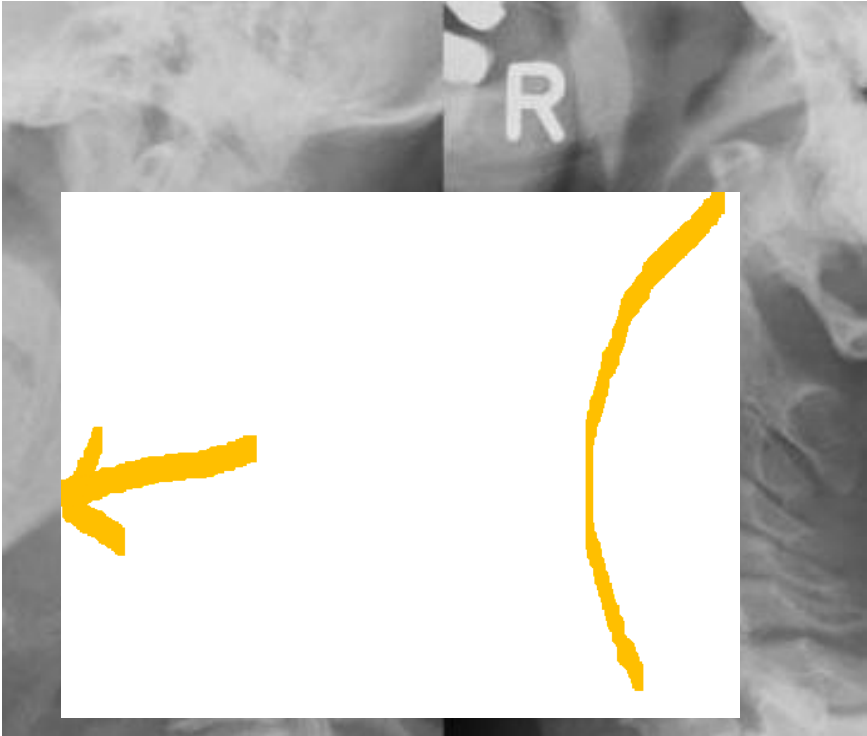


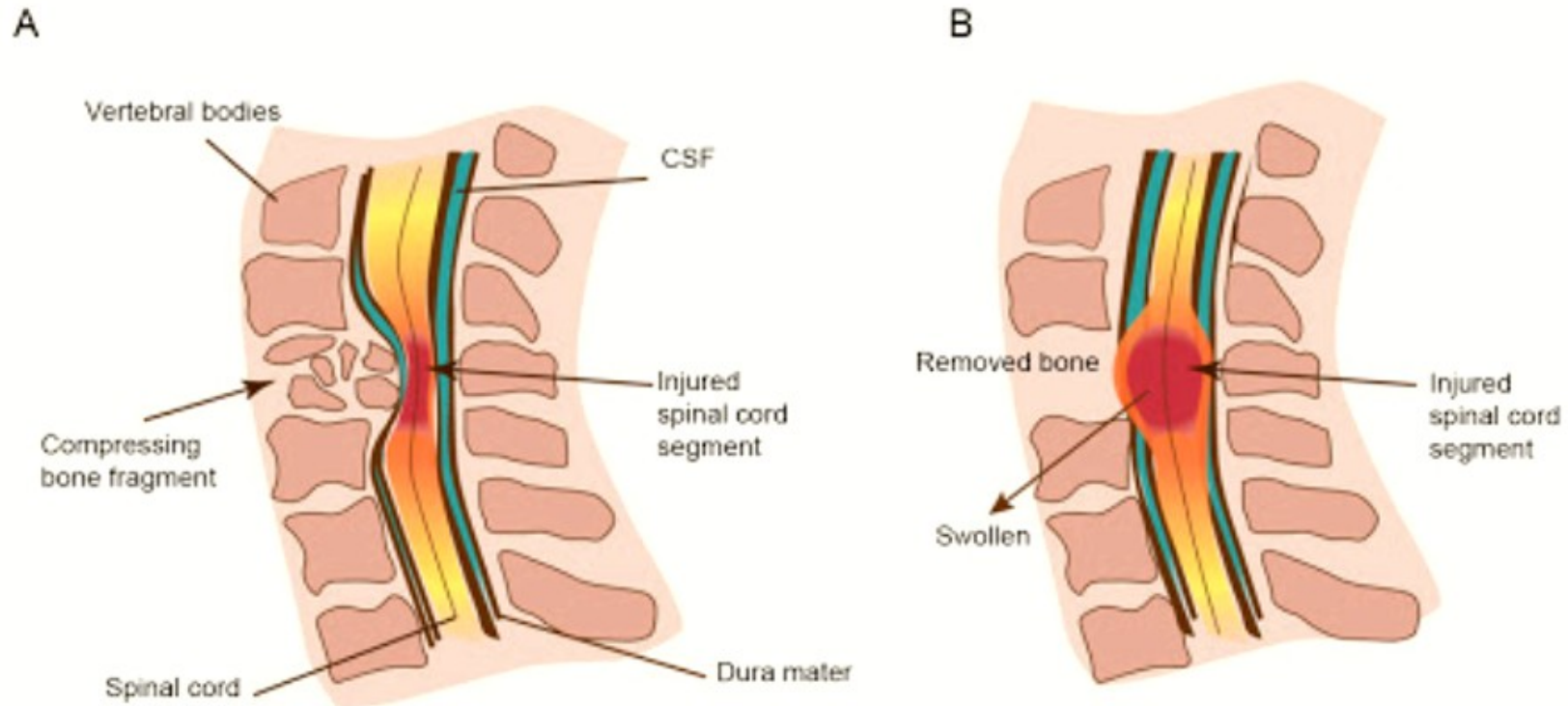
Figure 2: Flexion



# Neurological deficit

**Immediate (A)** onset caused mechanically in case of injury (fragment in the spinal canal, dislocations of the joint, kyphotization, translation, etc.).

**Gradual (B)** onset caused by edema or ischemia.



# IV. Spinal Cord Injuries (SCI)

Spinal cord impairment causing temporary or permanent changes in motor, sensory, or autonomous spinal cord functions.

1) type :                    **A) primary**                    **B) secondary**

2) degree:                    **A) complete**                    **B) incomplete**

# 1A) Primary SCI

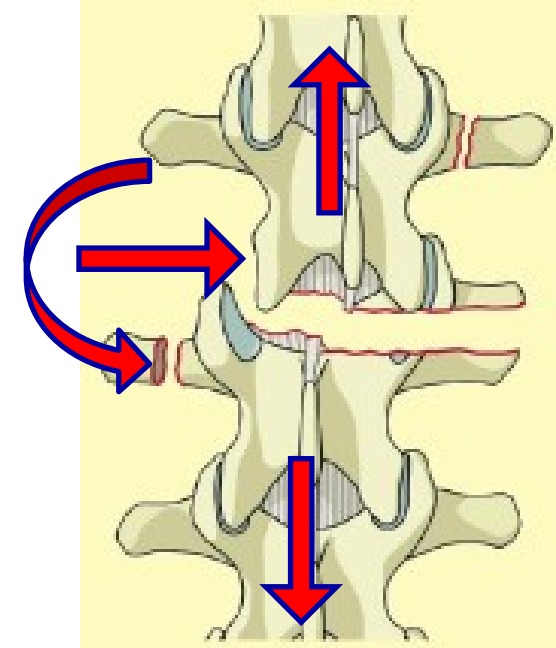
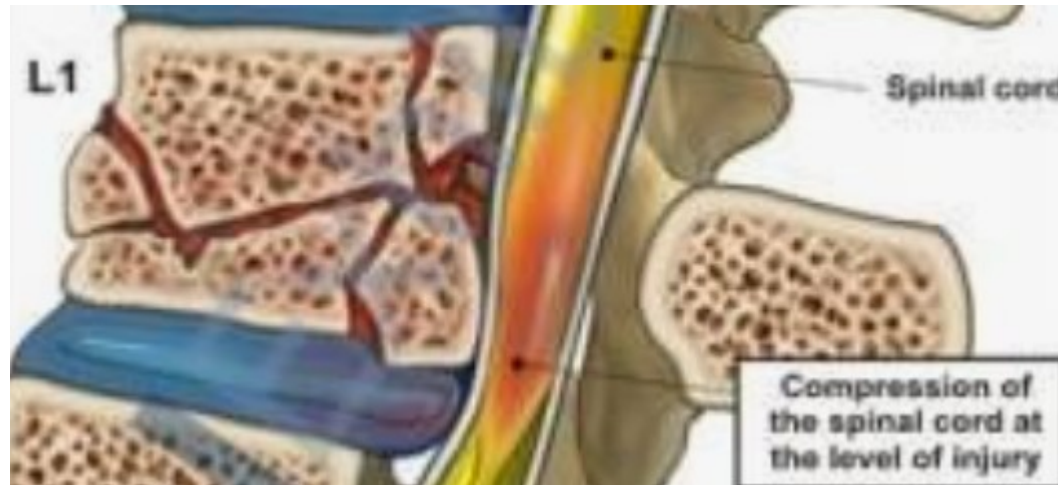


Spinal cord compression by bone fragments, hematoma, herniated intervertebral disc.

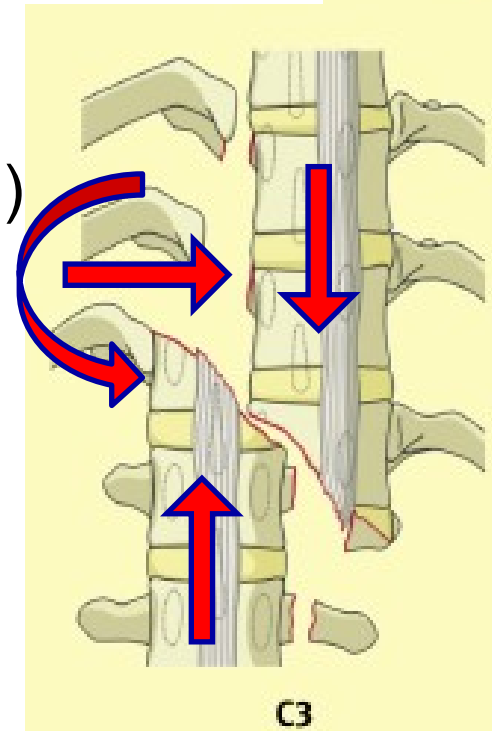
Torsion, distraction, (shear forces = unfavorable prognosis)

Ischemia

Penetrating injury

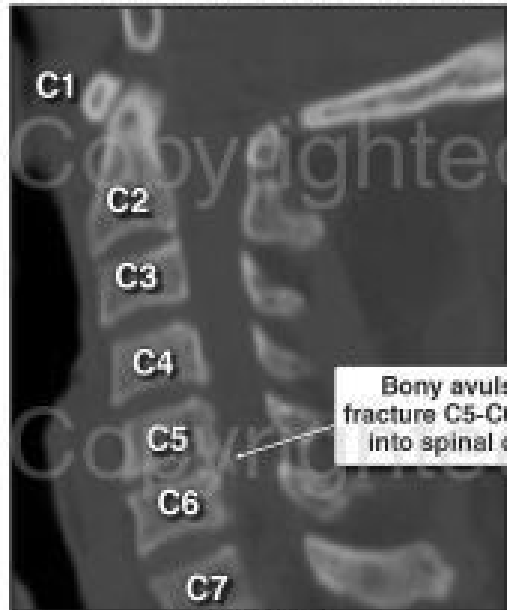


C2



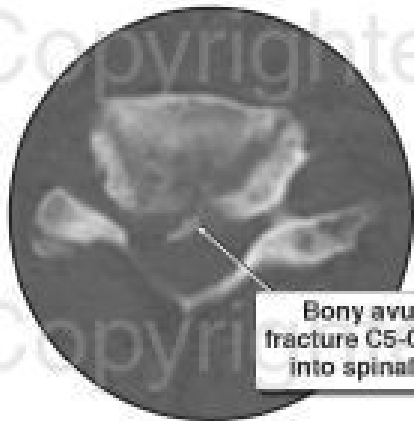
C3

**Kadlec Study**  
CT SCAN OF THE CERVICAL SPINE



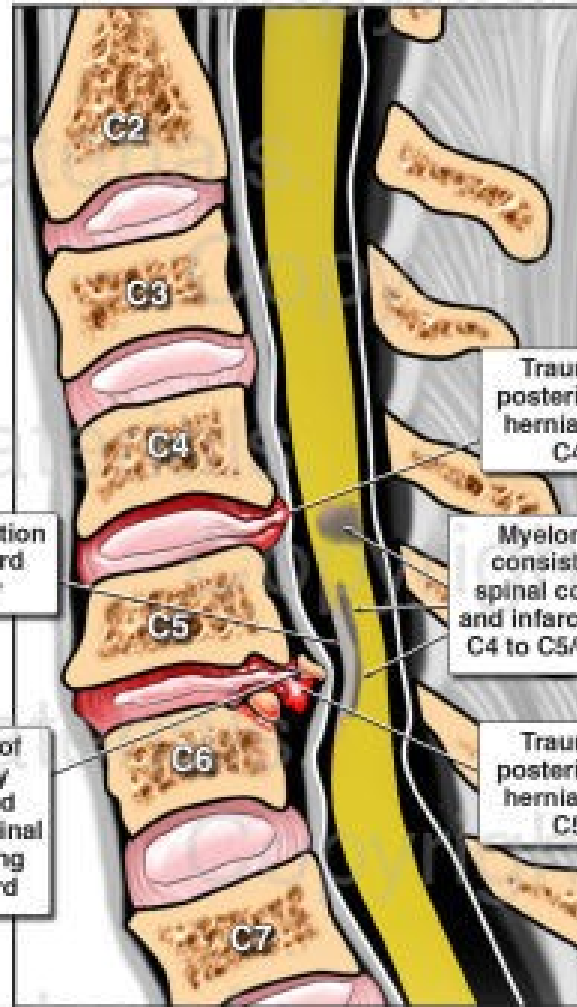
Sagittal view

CT SCAN OF THE CERVICAL SPINE

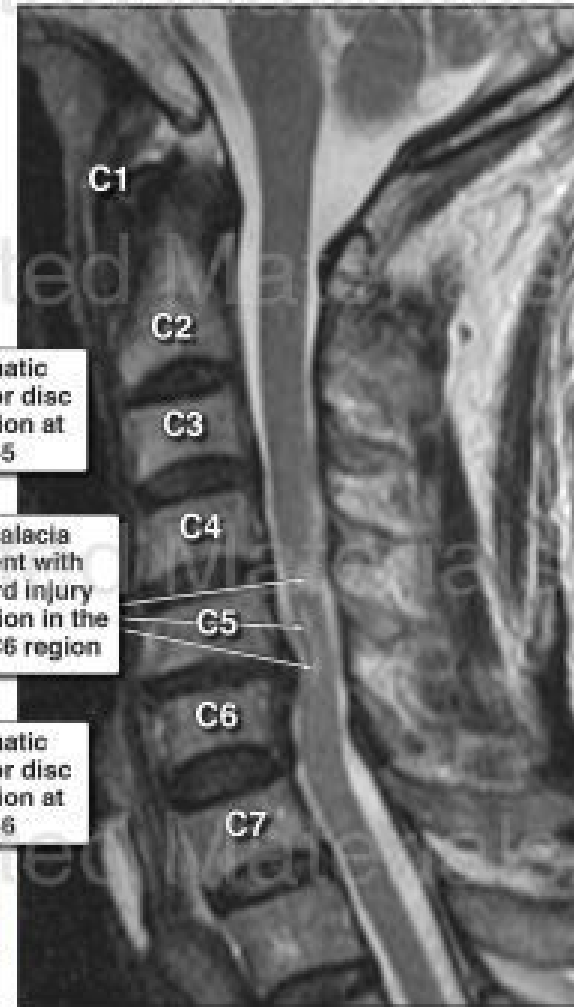


Axial view

**ILLUSTRATION**

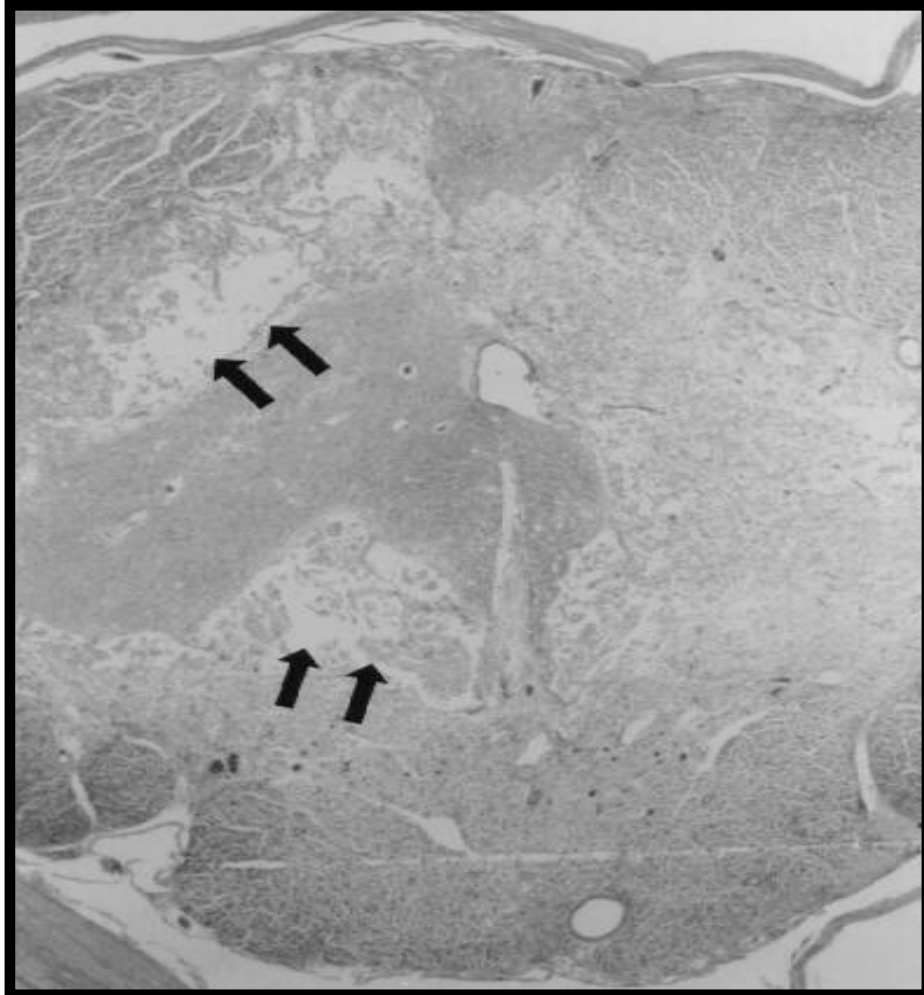


**MRI OF THE CERVICAL SPINE**



Sagittal view

# 1B) Secondary SCI



- Vascular changes :
  - reduced flow
  - thrombosis
  - vasospasm
  - hemorrhagia
- electrolyte changes
- free O<sub>2</sub> radicals
- Inflammatory reaction

=> the result is neuronal necrosis !!

# 1B) Secondary SCI

## Possibilities of its influence :

- oxygenation, optimal BP
- pharmacotherapy (anti-oedematous treatment -corticoids ?)
- **surgical treatment** (decompression of neural structures + instrumentation of the spine for its stabilization)



# 2) Degrees of SCI

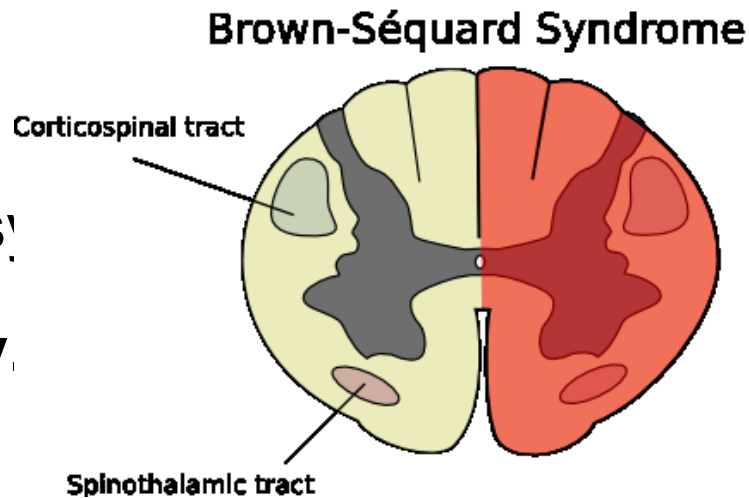
**complete lesion** /according to the height of the injury/

cervical quadriplegia  
thoracic paraplegia

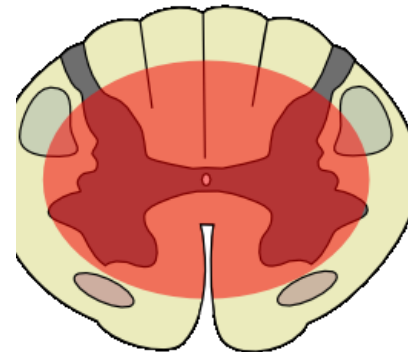
**incomplete lesion** /specific syndromes

anterior cord sy.  
central cord sy.  
posterior cord sy.  
Brown-Sequard sy.

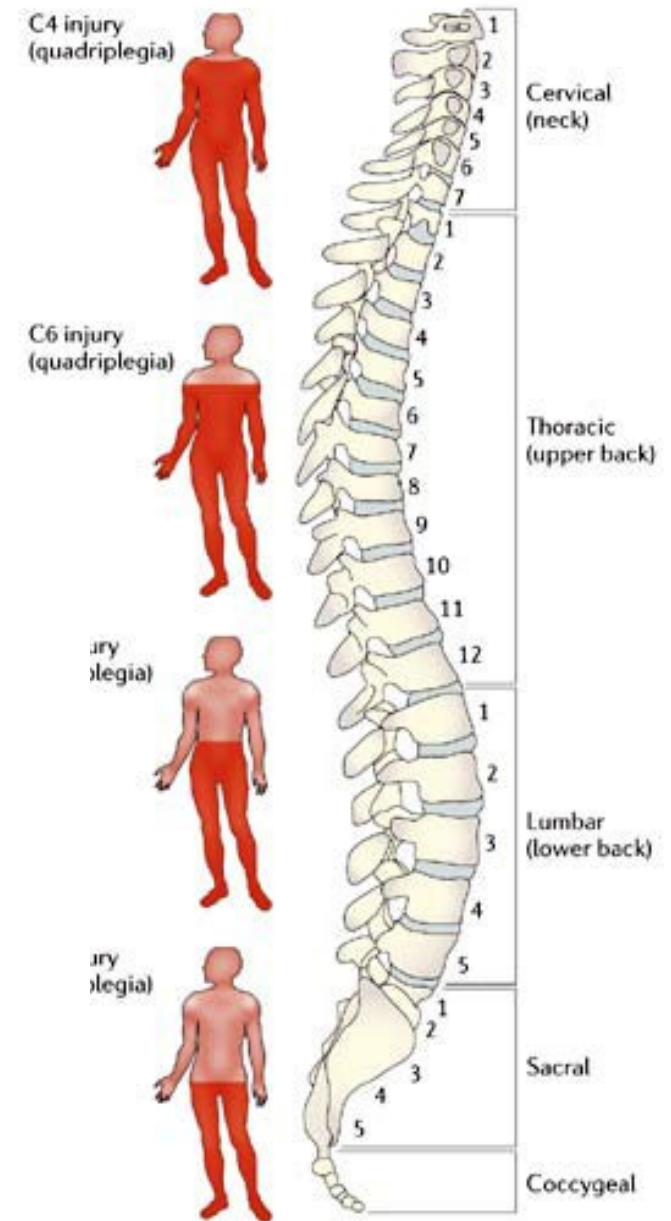
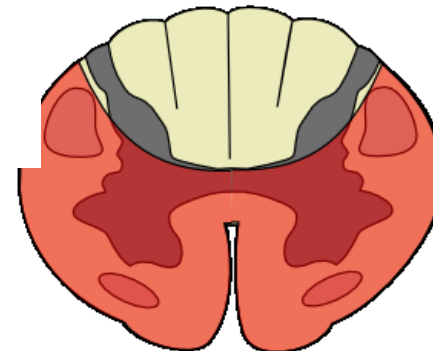
cauda equina sy.



**Central Cord Syndrome**



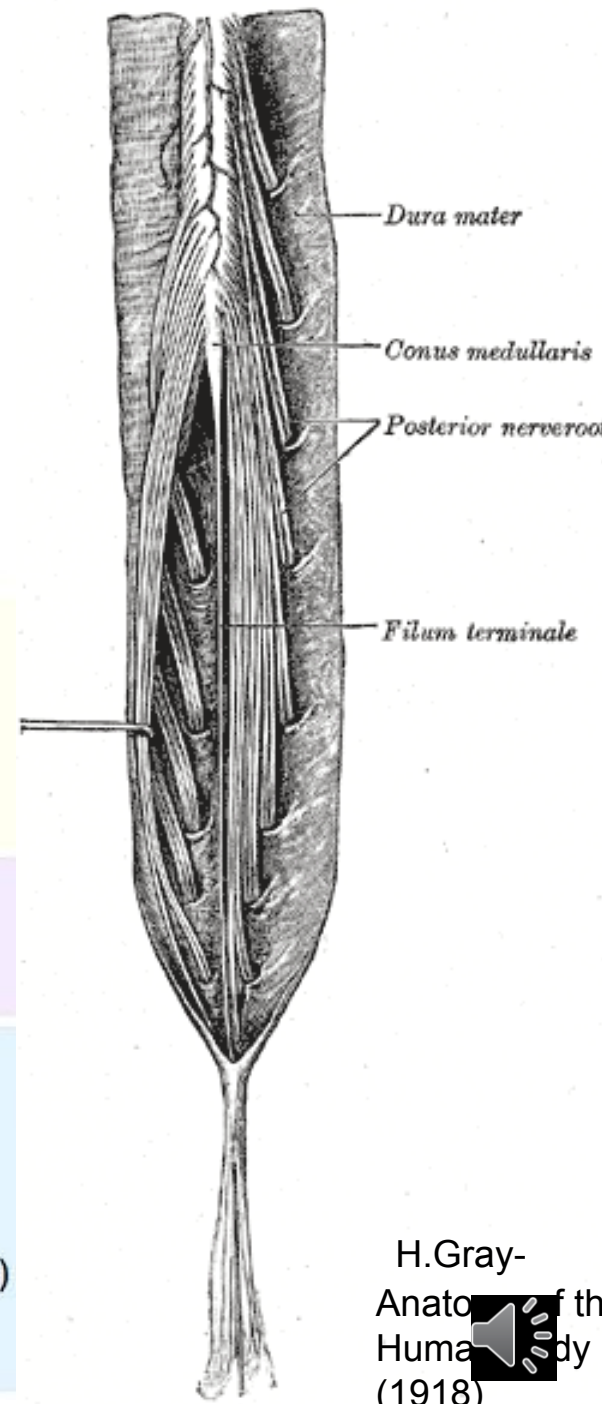
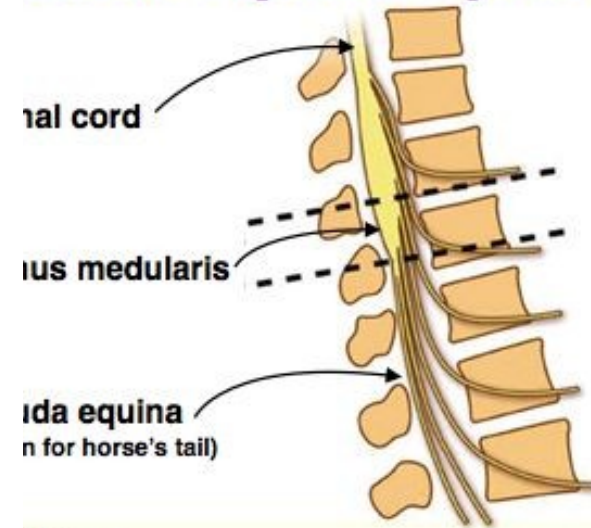
**Anterior Cord Syndrome**





# SPLINEN

## Cauda Equina Syndrome



**Etiology**  
Compression of cauda equina by:  
- herniated disk  
- tumor  
- abscess

**Dagnosis**  
- Clinical suspicion  
- MRI or CT myelogram

**Clinical**  
**Urinary retention** (most sensitive) followed by incontinence  
Post-void residual urine vol > 100 mL

- Bowel retention
- Saddle anesthesia
- Flaccidity of lower extremities (lower motor neuron symptoms)
- Loss of deep tendon reflexes (DTRs)
- Loss of rectal tone

Any of the above symptoms could be a sign of Cauda Equina Syndrome – please contact your GP or A & E department immediately – without urgent treatment the damage can become permanent.

# Evaluation of spinal cord injury

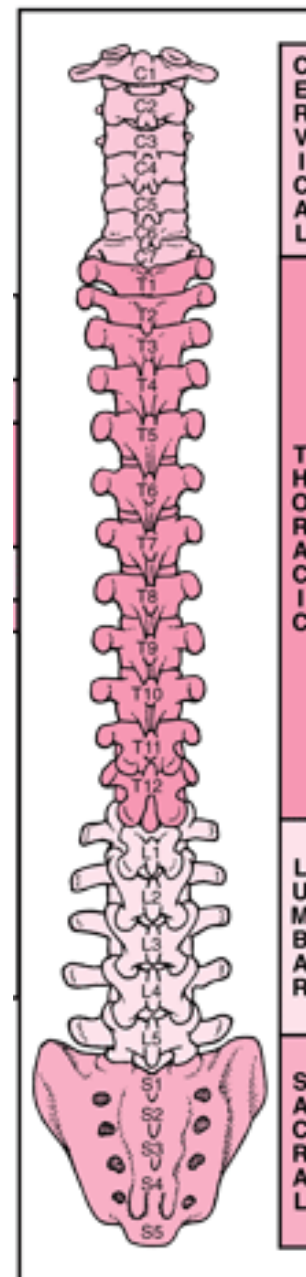
## 3 functions:

- motoric
- sensoric
- spinal reflexes

The purpose of the evaluation is to **determine the height and type of lesion.**

Nerve root	Test
C5	Elbow flexion
C6	Wrist extension
C7	Wrist flexion, finger extension
C8	Finger flexion
T1	Finger abduction
L1,2	Hip abduction
L3,4	Knee extension
L5,S1	Knee flexion
L5	Great toe extension
S1	Great toe flexion

## Effects of Spinal Injury



Level of Injury	Effect*
<b>CERVICAL</b>	
Between C1 and C5	Paralysis of some or all muscles used for breathing and all arm and leg muscles Typically, fatal unless a ventilator is used
Between C5 and C6	Paralysis of the legs, trunk, hand, and wrist Weakness of the muscles that move the shoulder and elbow
Between C6 and C7	Paralysis of the legs, trunk, and part of the wrists and hands Normal movement of the shoulders and elbows
Between C7 and C8	Paralysis of the legs, trunk, and hands
<b>THORACIC</b>	
C8 to T1	Paralysis of the legs and trunk Weakness of the muscles that move fingers and hands Horner's syndrome (with a drooping eyelid, a constricted pupil, and reduced sweating on one side of the face) Possibly normal movement of the shoulders and elbows
T2 to T4	Paralysis of the legs and trunk Loss of sensation below the nipples Normal movement of the shoulders and elbows
T5 to T8	Paralysis of the legs and lower trunk Loss of sensation below the rib cage
T9 to T11	Paralysis of the legs Loss of sensation below the navel
T11 to L1	Paralysis of and loss of sensation in the hips and legs
<b>LUMBAR</b>	
L2 to S2	Various patterns of leg weakness and numbness, depending on the precise level of injury
<b>SACRAL</b>	
S3 to S5	Numbness in the perineum

\* At any level of the spinal cord, severe injury cause loss of bladder and bowel control.



# Evaluation of spinal cord injury

## Classification of Neurological Function

### Frankel Classification Grading System

	Sensory	Motor
A	Absent	Absent
B	Present	Absent
C	Present	Active but not useful (grade 2-3)
D	Present	Active and useful (grade 4)
E	Normal	Normal

Patient Name \_\_\_\_\_

Examiner Name \_\_\_\_\_ Date/Time of Exam \_\_\_\_\_



# STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY



## MOTOR

KEY MUSCLES  
(scoring on reverse side)

	R	L	
C5	<input type="checkbox"/>	<input type="checkbox"/>	Elbow flexors
C6	<input type="checkbox"/>	<input type="checkbox"/>	Wrist extensors
C7	<input type="checkbox"/>	<input type="checkbox"/>	Elbow extensors
C8	<input type="checkbox"/>	<input type="checkbox"/>	Finger flexors (distal phalanx of middle finger)
T1	<input type="checkbox"/>	<input type="checkbox"/>	Finger abductors (little finger)
UPPER LIMB TOTAL (MAXIMUM) <input type="checkbox"/> + <input type="checkbox"/> = <input type="checkbox"/> (25) (25) (50)			

Comments:

L2	<input type="checkbox"/>	<input type="checkbox"/>	Hip flexors
L3	<input type="checkbox"/>	<input type="checkbox"/>	Knee extensors
L4	<input type="checkbox"/>	<input type="checkbox"/>	Ankle dorsiflexors
L5	<input type="checkbox"/>	<input type="checkbox"/>	Long toe extensors
S1	<input type="checkbox"/>	<input type="checkbox"/>	Ankle plantar flexors

Voluntary anal contraction (Yes/No)

LOWER LIMB TOTAL (MAXIMUM)  +  =  (25) (25) (50)

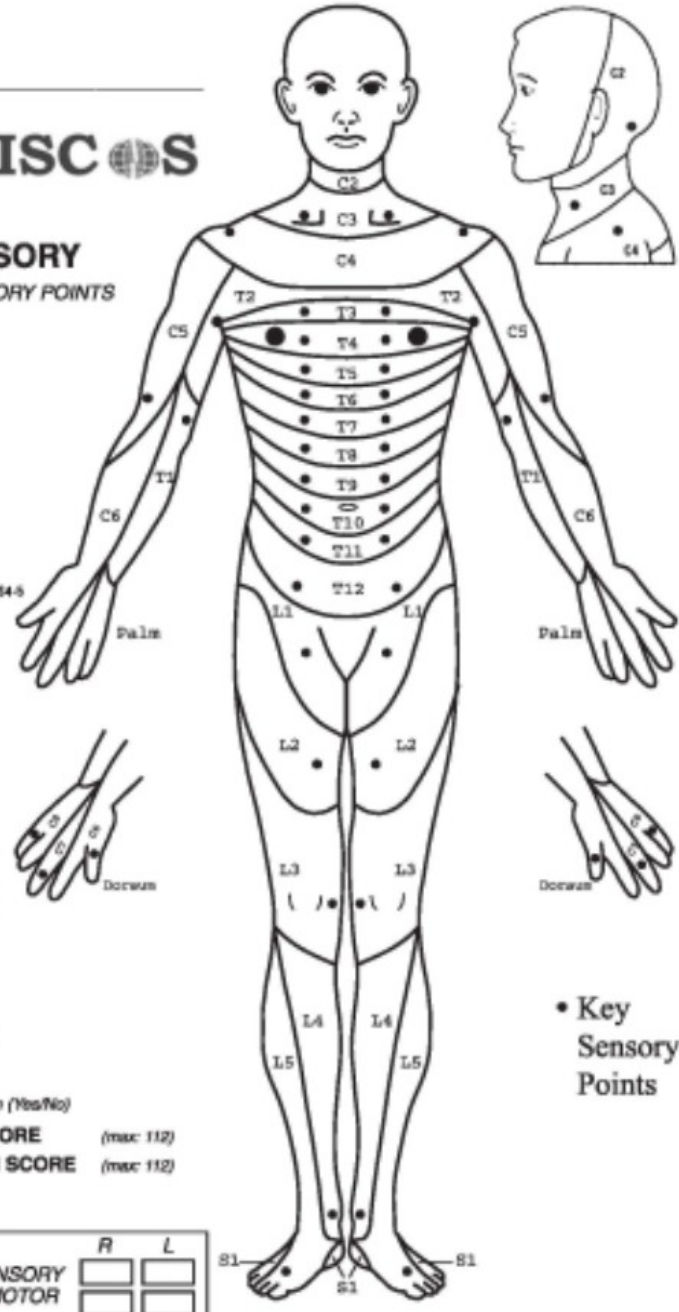
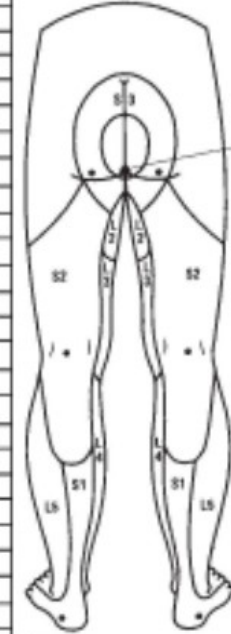
NEUROLOGICAL LEVEL The most caudal segment with normal function	SENSORY	R	L	COMPLETE OR INCOMPLETE? Incomplete = Any sensory or motor function in S4-S5	ZONE OF PARTIAL PRESERVATION Caudal extent of partially innervated segments	SENSORY	R	L
	MOTOR	<input type="checkbox"/>	<input type="checkbox"/>			MOTOR	<input type="checkbox"/>	<input type="checkbox"/>
ASIA IMPAIRMENT SCALE				<input type="checkbox"/>				

## SENSORY

KEY SENSORY POINTS

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

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

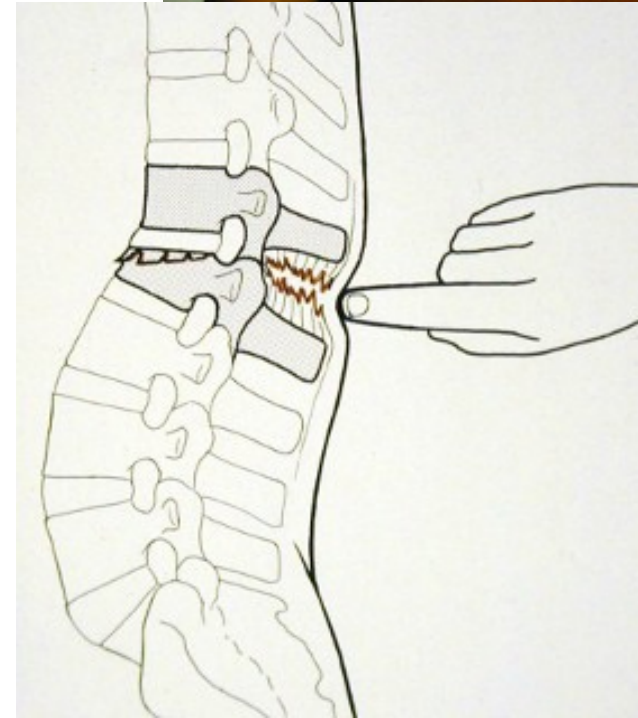


• Key Sensory Points



# CLINICAL EXAMINATION

- **Aspection** (defiguration, hematoma ...)
- **Palpation** (rate and spreading of pain)
- **Basic neurological assessment**  
(Frankel scale, **ASIA score**)



# EXAMINATION - imaging methods

Anamnesis

Clinical examination

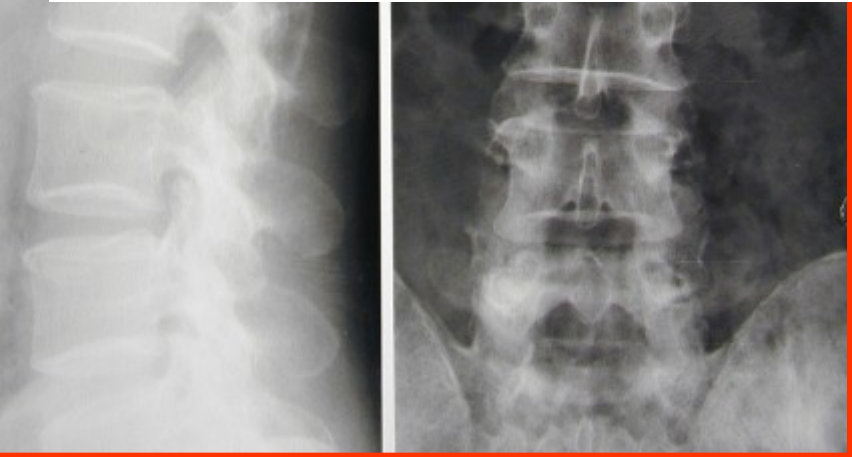
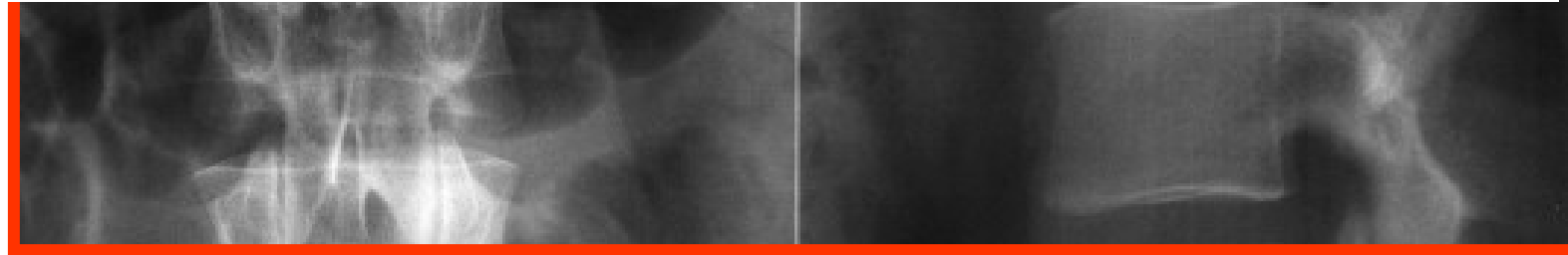
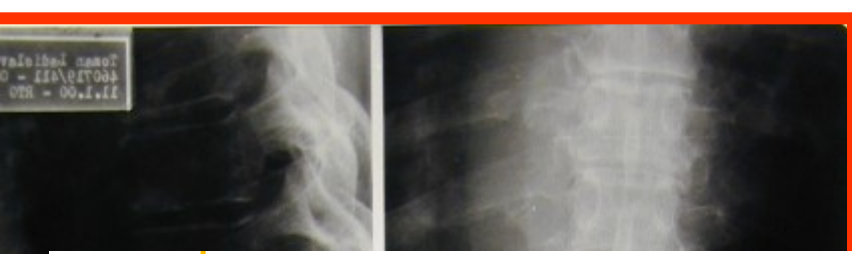
Neurological status

X-ray

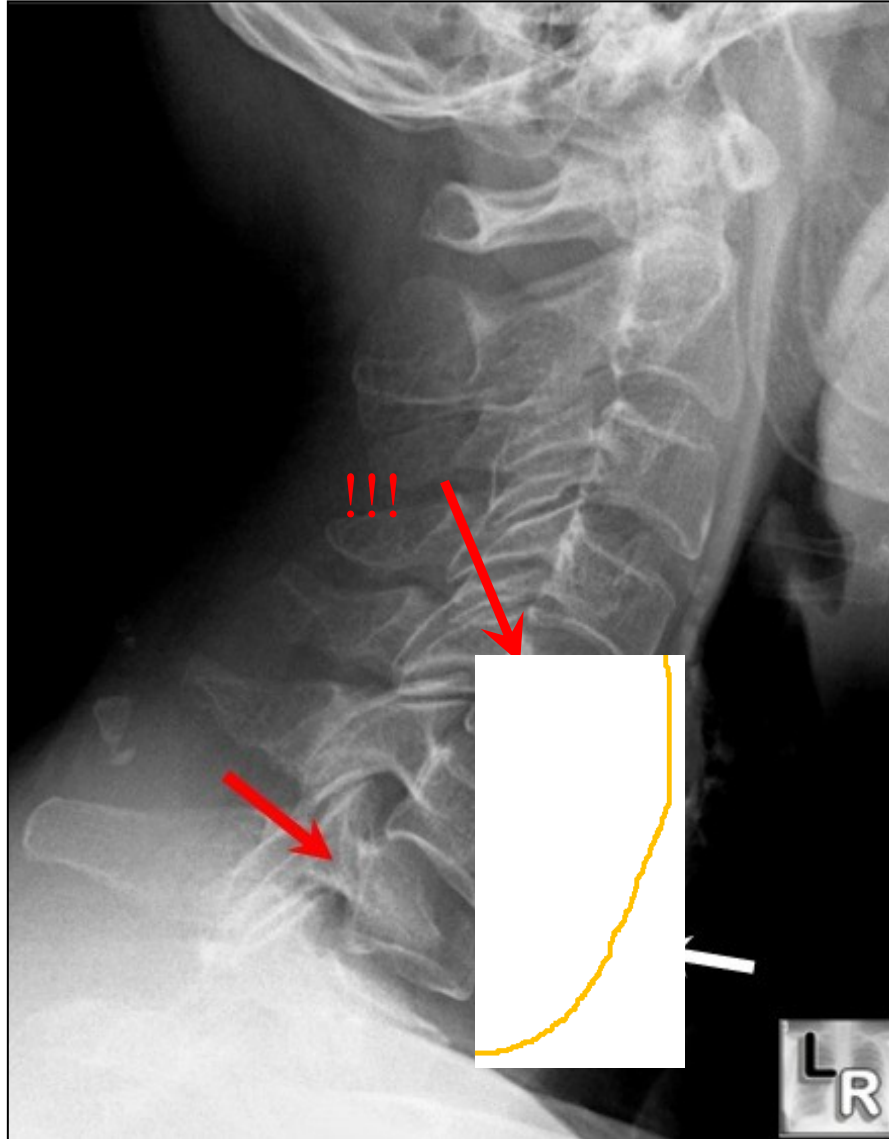
CT

MRI

# X-ray

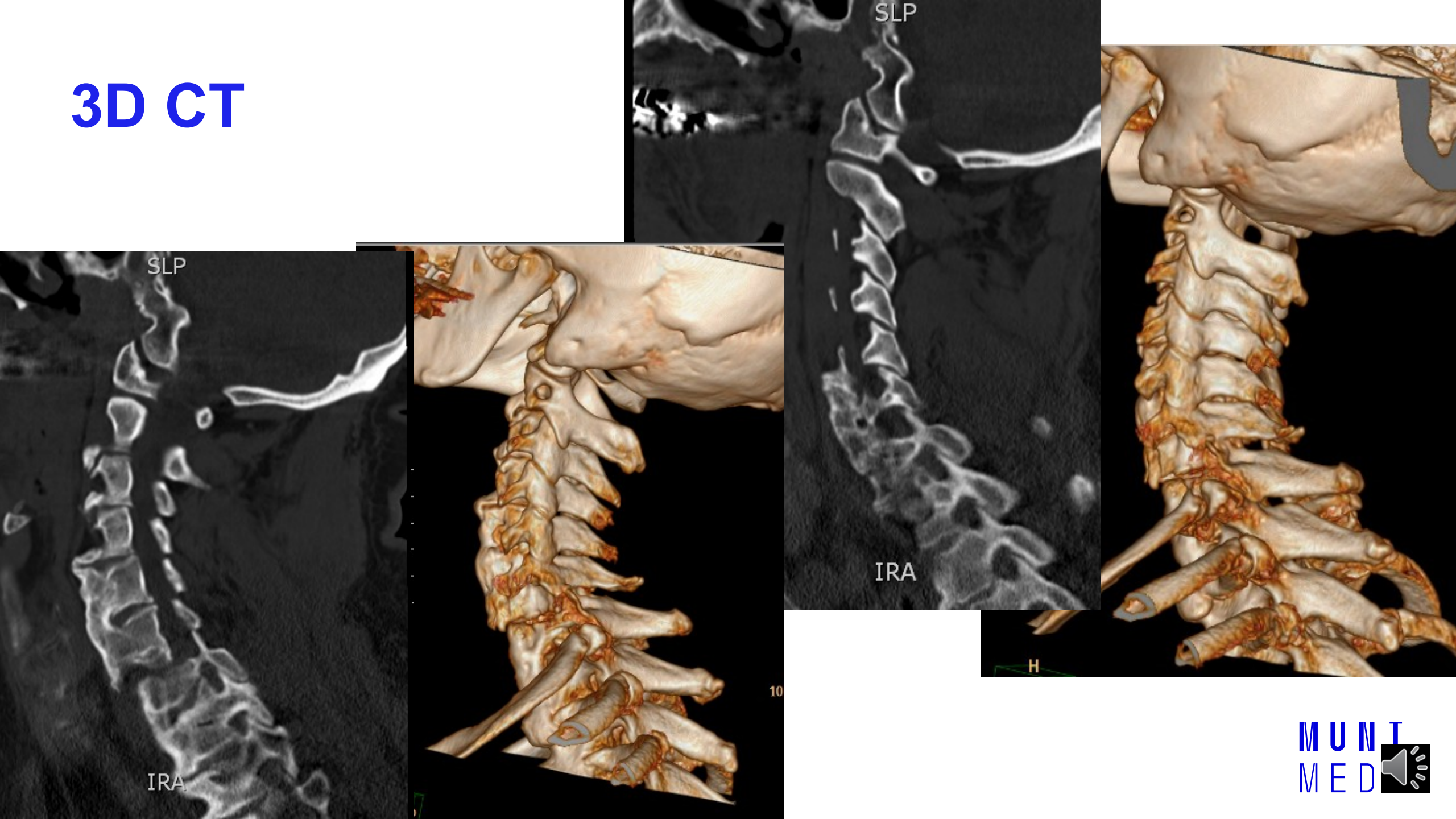


Fracture of the body and preventrtebral **hematoma** !





# 3D CT



# MRI



# OBJECTIVES OF THERAPY

PAINLESSNESS

FUNCTIONALITY (movement)

STABILITY

# V. THERAPY

ervative

s, corsets

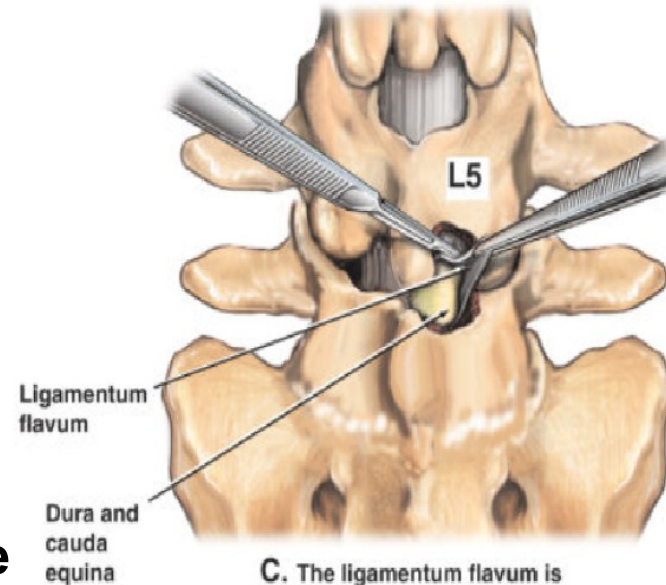
cal

Decompression of spinal cord and nerve structures + **stabilization of the fracture** by specific instrumentation

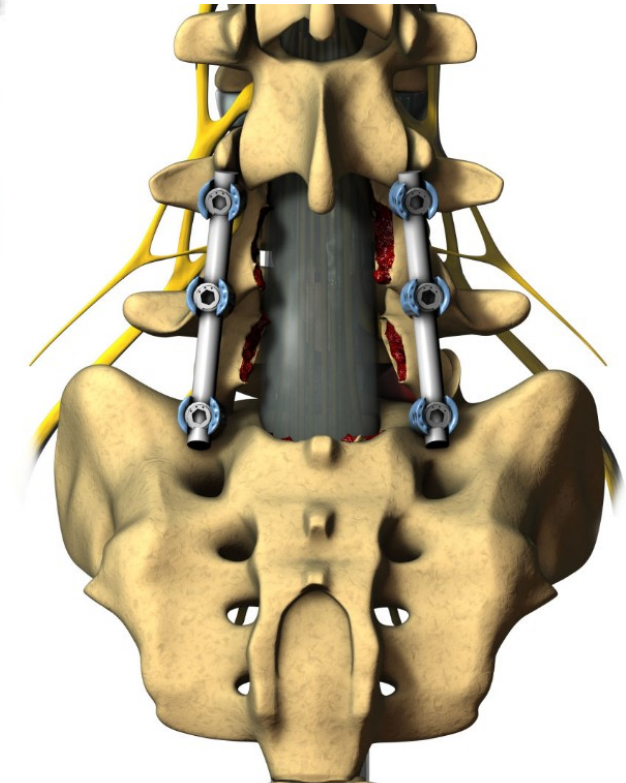
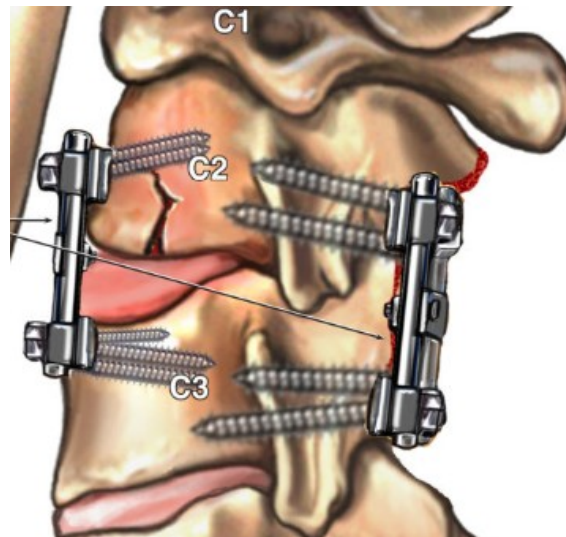
**Dorsal procedure**

Ventral procedure

Combined



C. The ligamentum flavum is removed exposing the neural elements.



Nucleus Medical Media (2020). *Posterior spinal fusion* [Digital image]. Retrieved from <https://ebSCO.smartimagebase.com/posterior-spinal-fusion/view-item?ItemID=68987>

# FIRST AID

1)FIXATION OF THE CERVICAL SPINE

2)EXCLUDE MOVEMENT OF T & L SPINE DURING MANIPULATION

3)TRANSPORT TO SPINAL CARE DEPARTMENT

# 1) Fixation of C-spine



## 2) Immobilization of T & L spine during transport

*„in line position“* – minimize patient handling !

Head fixation

Body and limbs fixation

Surface for transport

- „**back board**“ risk of pressure ulcers
- **vacuum mattresses** - suitable for longer transport



## 2) „Log-roll“ manuever

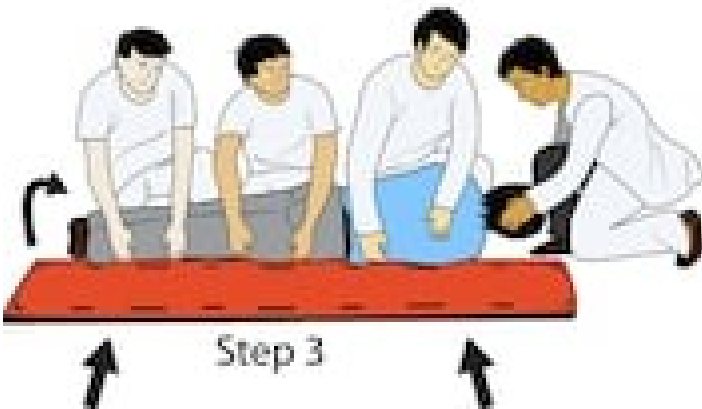


Step 1

### Logroll method



Step 2



Step 3



Step 4





# 3) Transport



# THERAPY

**conservative vs. surgical**

- ❖ TYPE of fracture
- ❖ grade of INSTABILITY
- ❖ NEUROLOGICAL find



# CONSERVATIVE TREATMENT

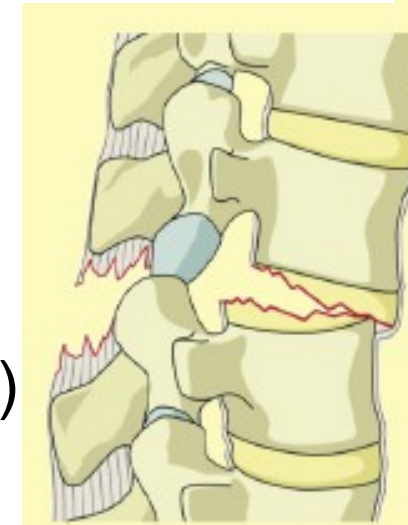
## CONTRAINDICATIONS:

! unstable "burst" fr. (A3 + A4)

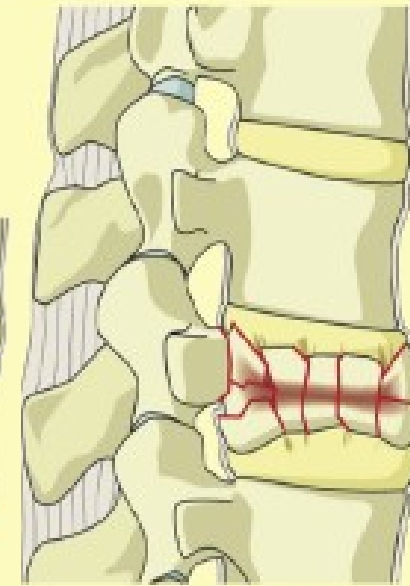
According to AO)

According to AO)

(Surgery is **necessary within 6 hours !!**)



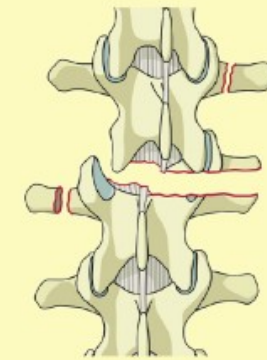
B1



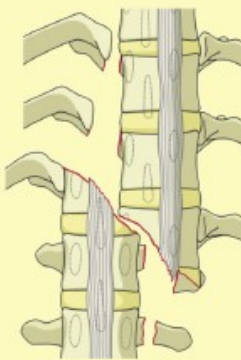
A3



C1



C2



C3

=> **SURGICAL TREATMENT !!**

# V.A) CONSERVATIVE TREATMENT

Rest regime

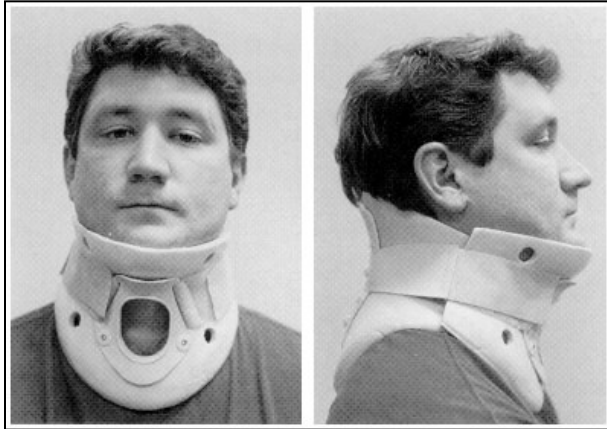
- Collars
- foam
  - Philadelphia



# Mobility of C-spine



100 %



40-45 %



30-35 %



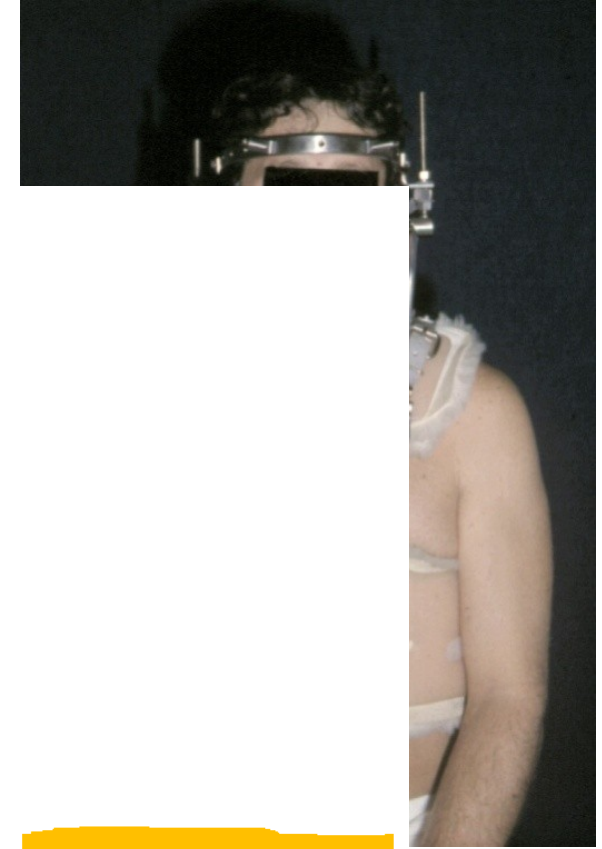
5-10 %

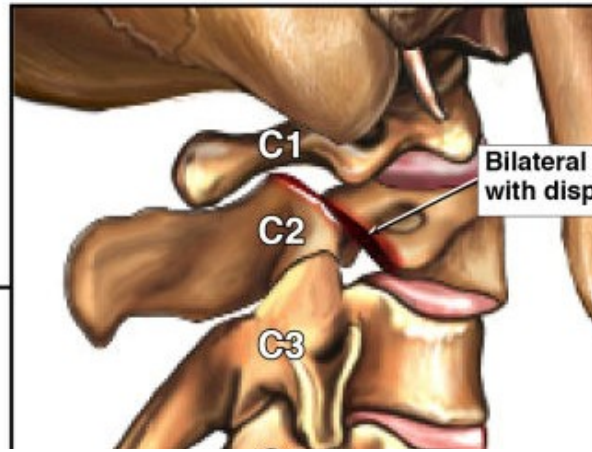
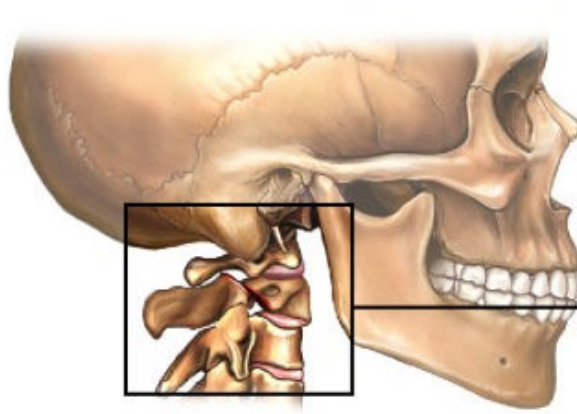


# CONSERVATIVE TREATMENT

## CERVICAL spine

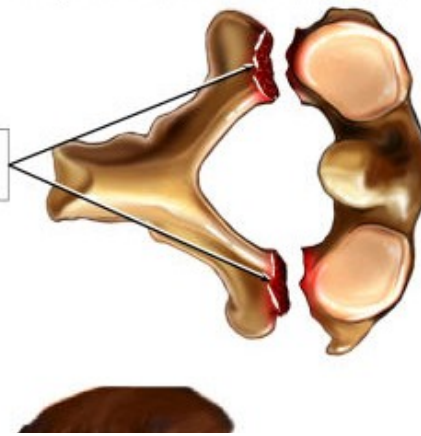
- halo-cast, halo-vest
- Minerva





Bilateral fracture of C2 with displacement

Superior view of second cervical vertebra



A halo ring and frame are attached to the screws to stabilize the fracture.

Nucleus Medical Media (2020). *Cervical spine fracture with application of halo ring stabilization* [Digital image]. Retrieved from <https://ebSCO.smartimagebase.com/cervical-spine-fracture-with-application-of-halo-ring-stabilization/view-item?ItemID=73352>



# Fitting the HALO traction



# CONSERVATIVE TREATMENT



## THORACO – LUMBAR spine

- **Jewett** (hyperextension) **brace**
  - featuring 3 support points: suprapubic, dorsolumbar and sternal
  - it consists of mass-produced parts, but MUST BE individually adapted to the patient's needs and dimensions!

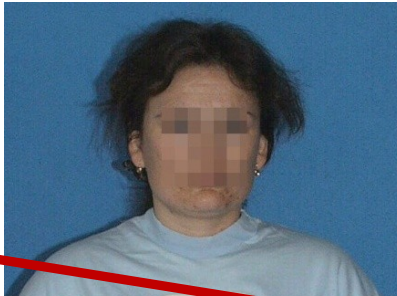


# CONSERVATIVE TREATMENT

## Modifications of THORACO – LUMBAR fixation

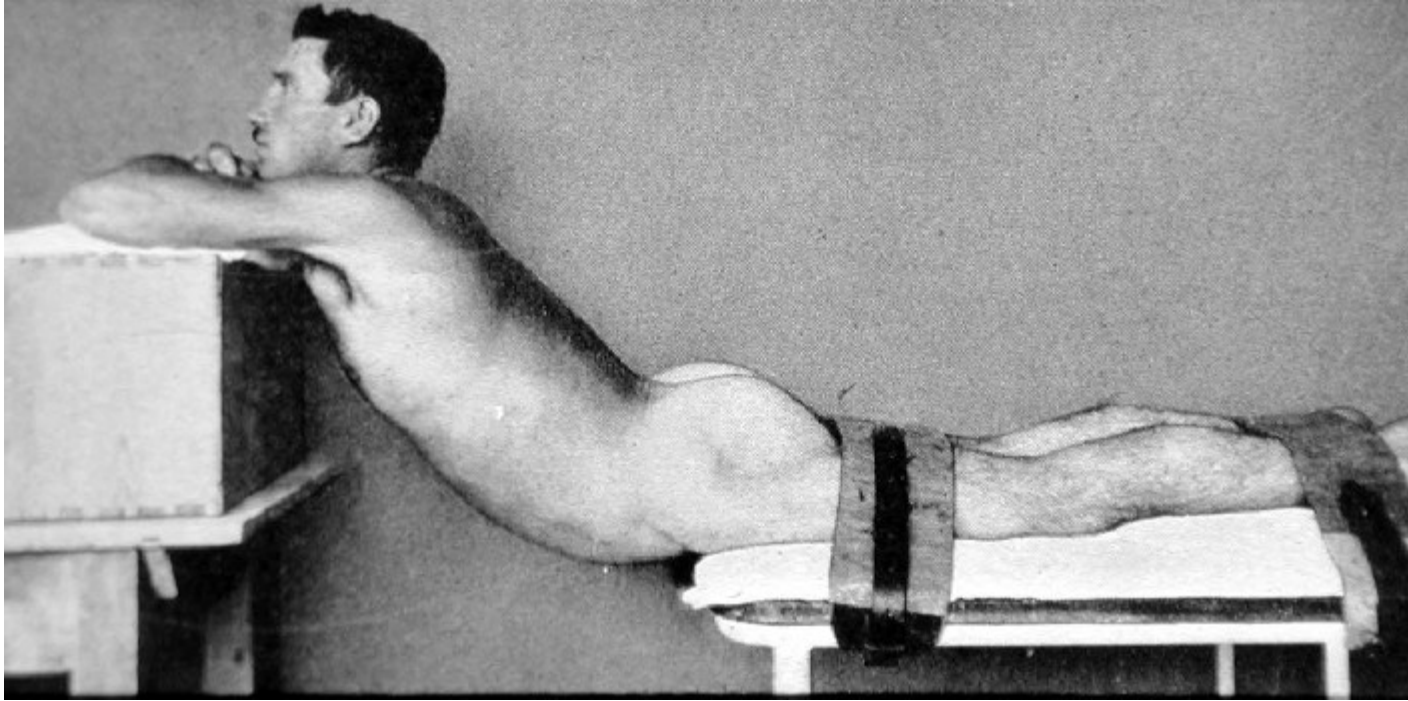
– according to the **height of the injury** :

- From **Th 6 ABOVE**
- **Th6 – L3**

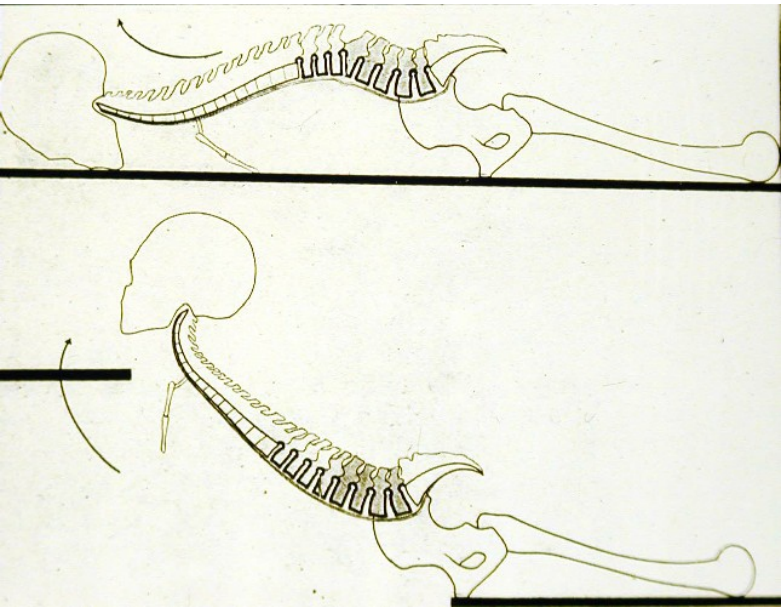


Jewett brace with **cervical extension**





**Böhler's method**  
of corection in  
hyperextension

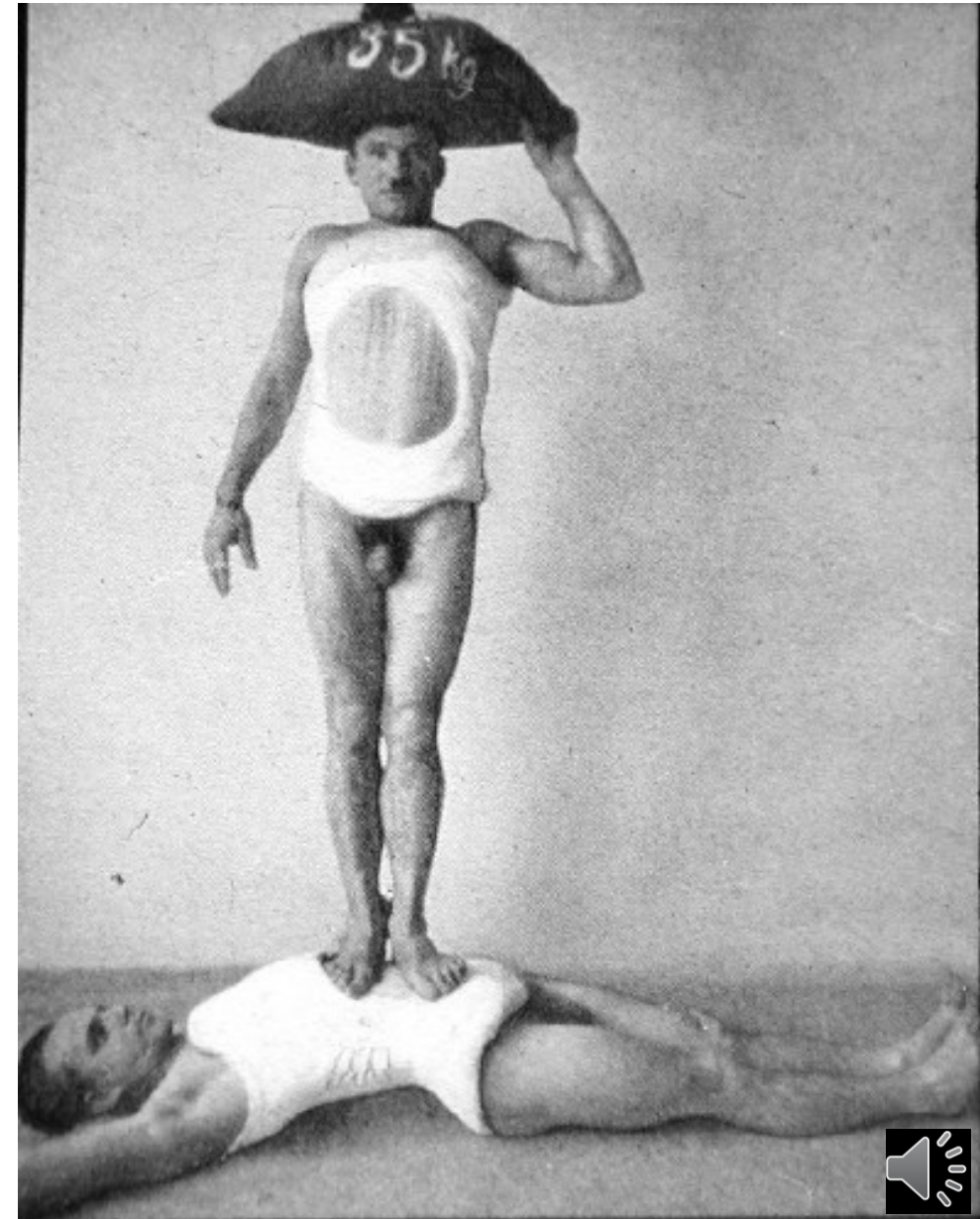


**Cotrel's EDF frame**

(Elongation, Derotatin, Flection)



# CONSERVATIVE TREATMENT – history: plaster corsets



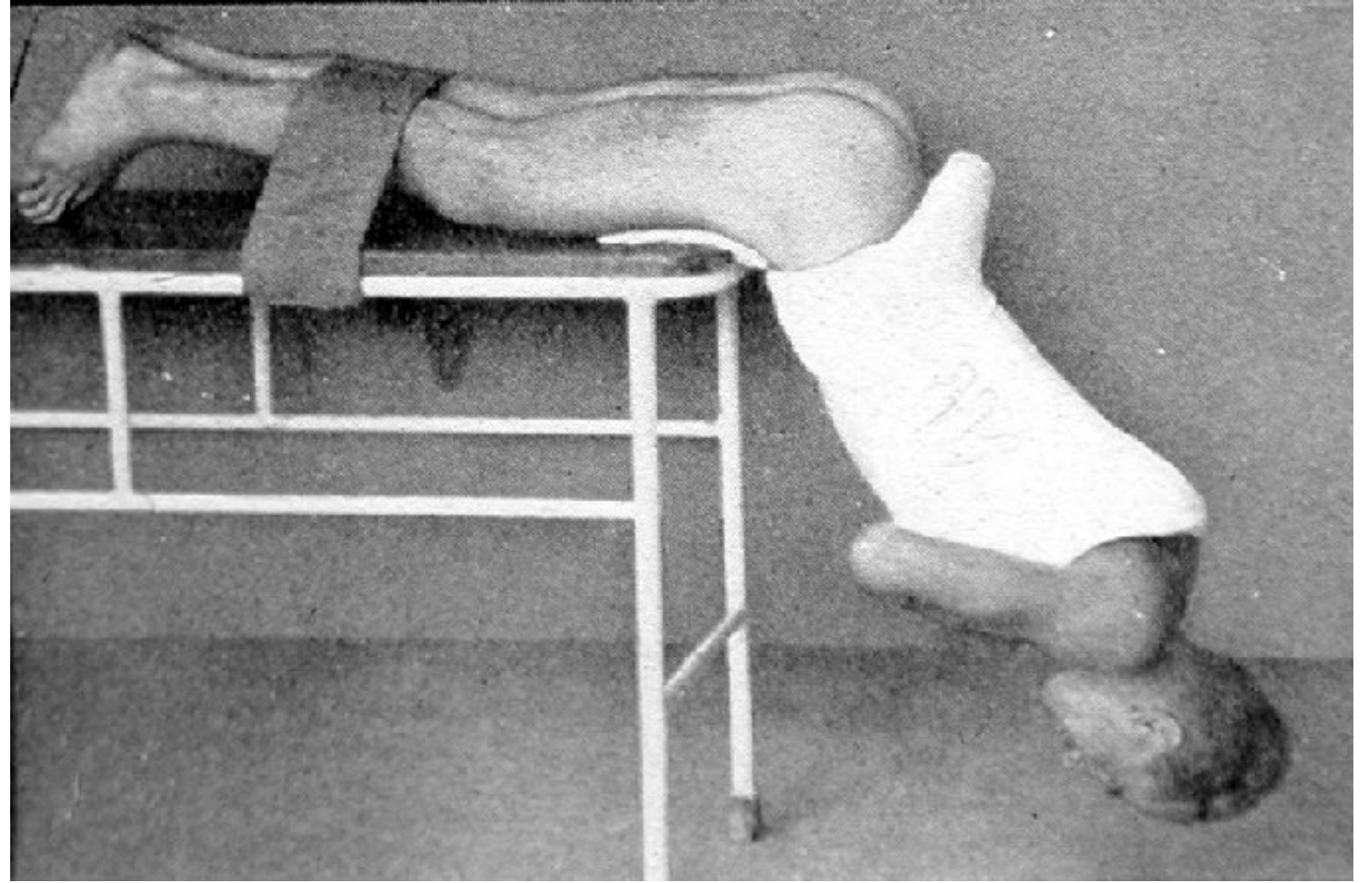
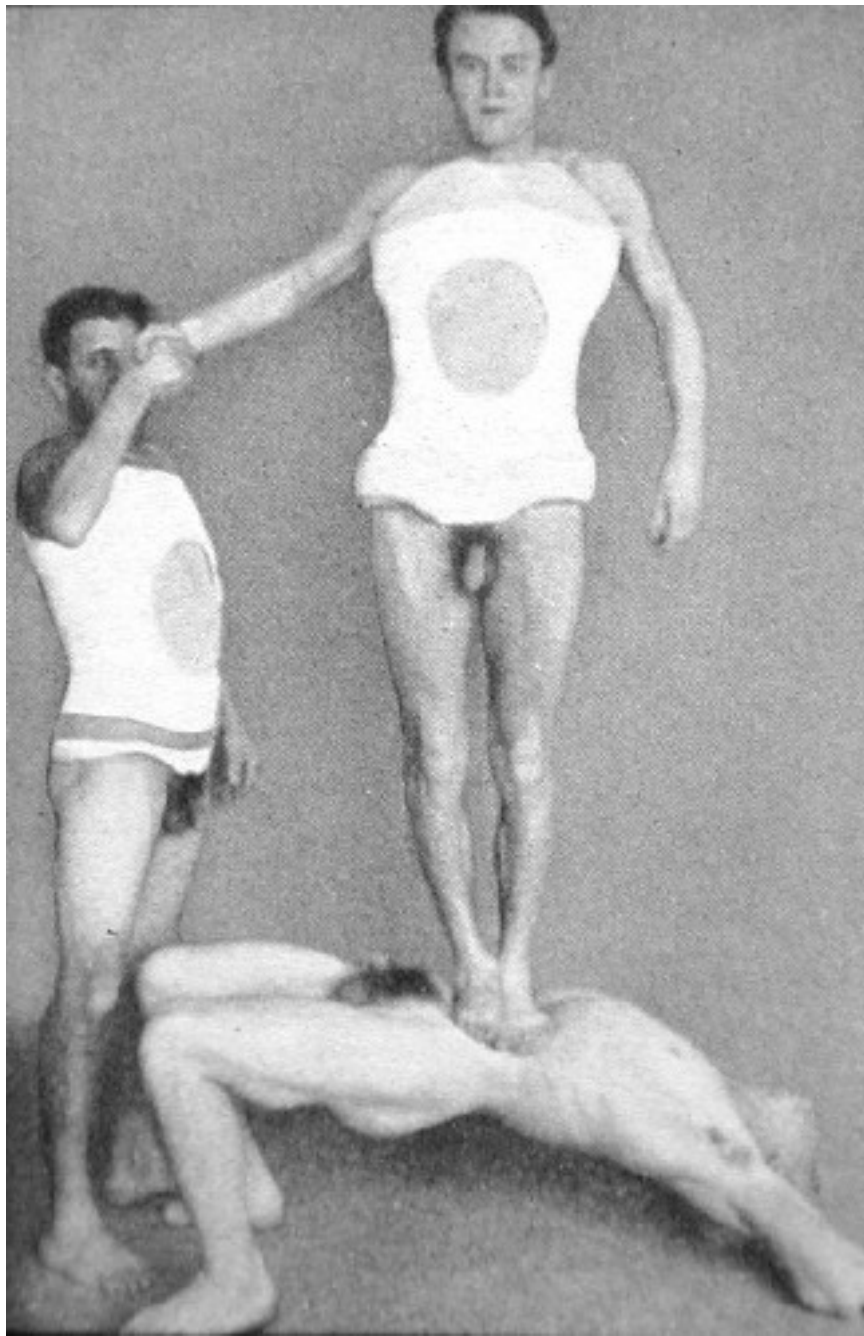
Indications of corsets (except traumatic):

- m. Scheurmann
- Scoliosis (infantile e.g.)

Others:

- incomppliance of pts (luxation of THA e.g.)



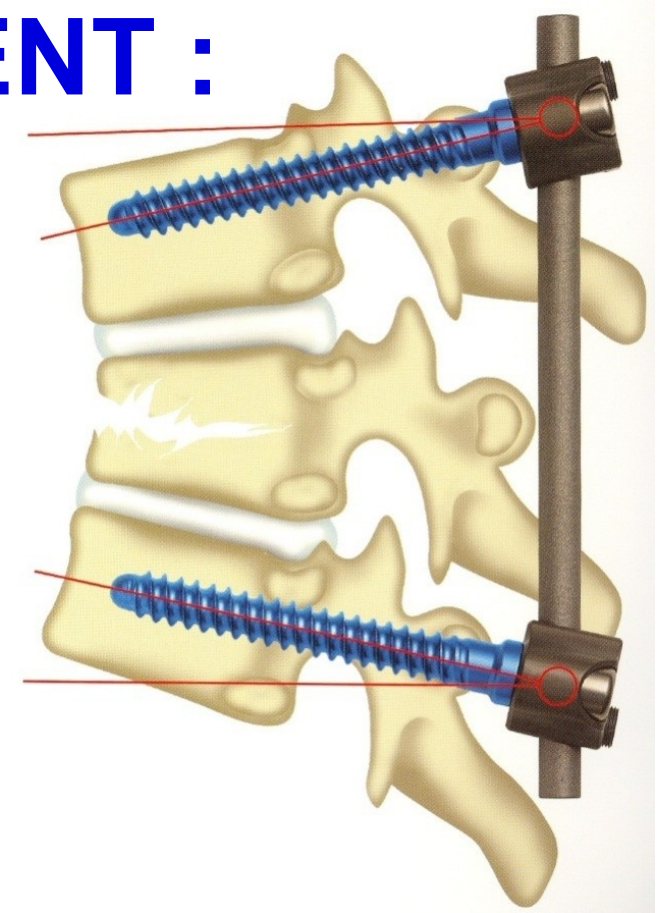






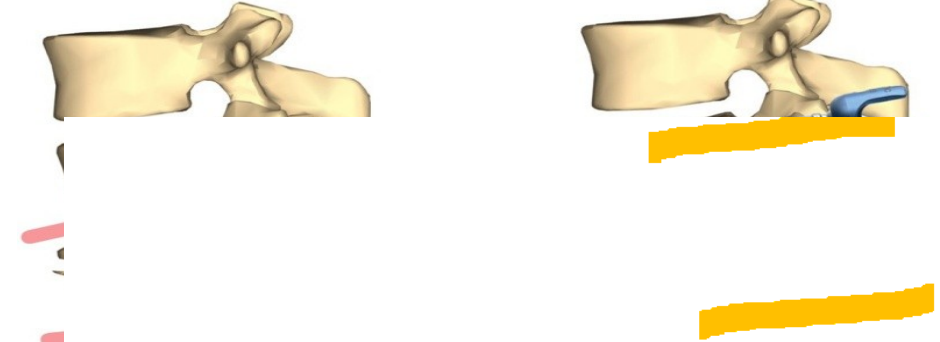
## V.B) goals of SURGICAL TREATMENT :

- **CORRECTION OF DEFORMITY**
  - restore sagittal balance of segment
- **STABILIZATION**
  - anatomical shape of vertebra
  - anterior support if it's necessary
- **INTERVERTEBRAL FUSION**
  - if it's necessary
- **DECOMPRESSION OF NEURAL STRUCTURES**
  - direct or indirect (ligamentotaxis)



# V. SURGICAL TREATMENT – posterior approach – principles of REPOSITION:

1) Dorsal (trans-pedicular) fixation (B)



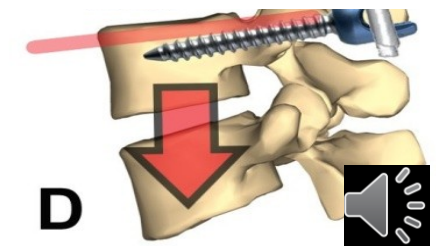
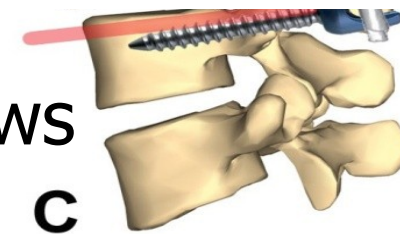
2) Lordotisation (C)



3) Distraction (D)



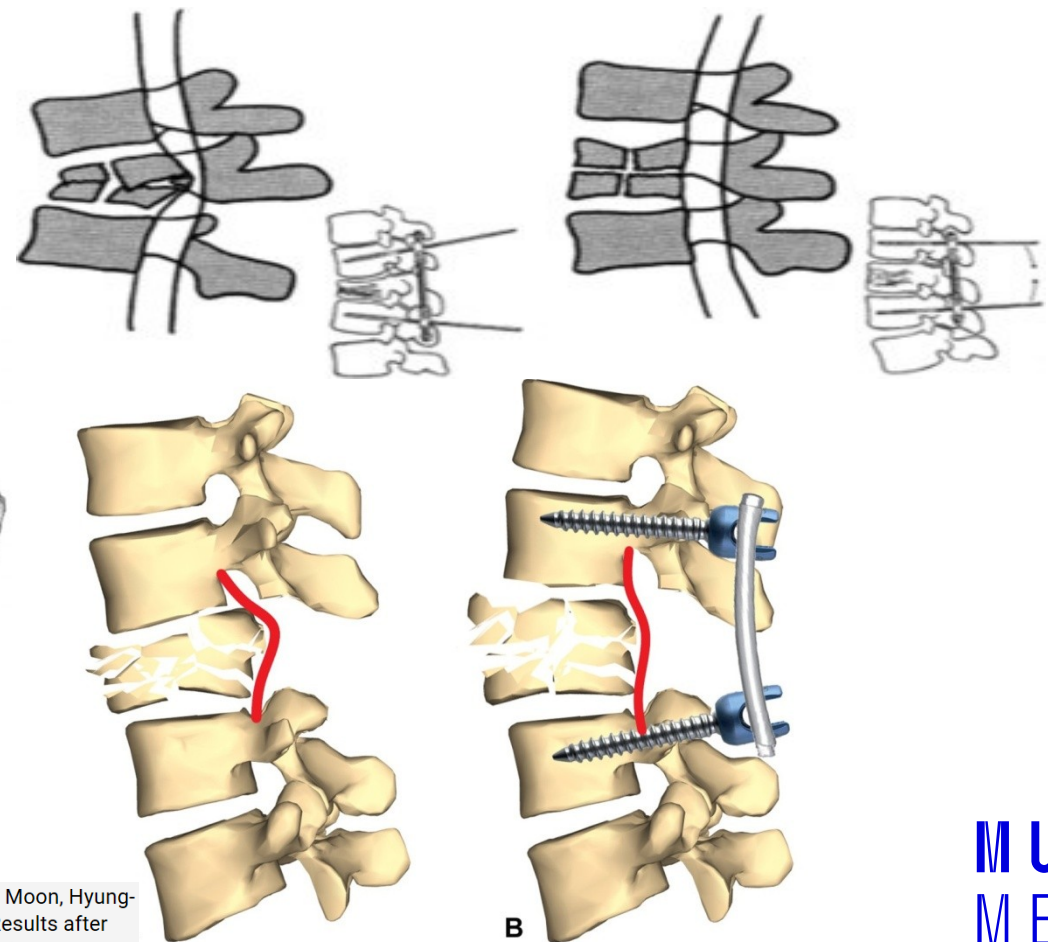
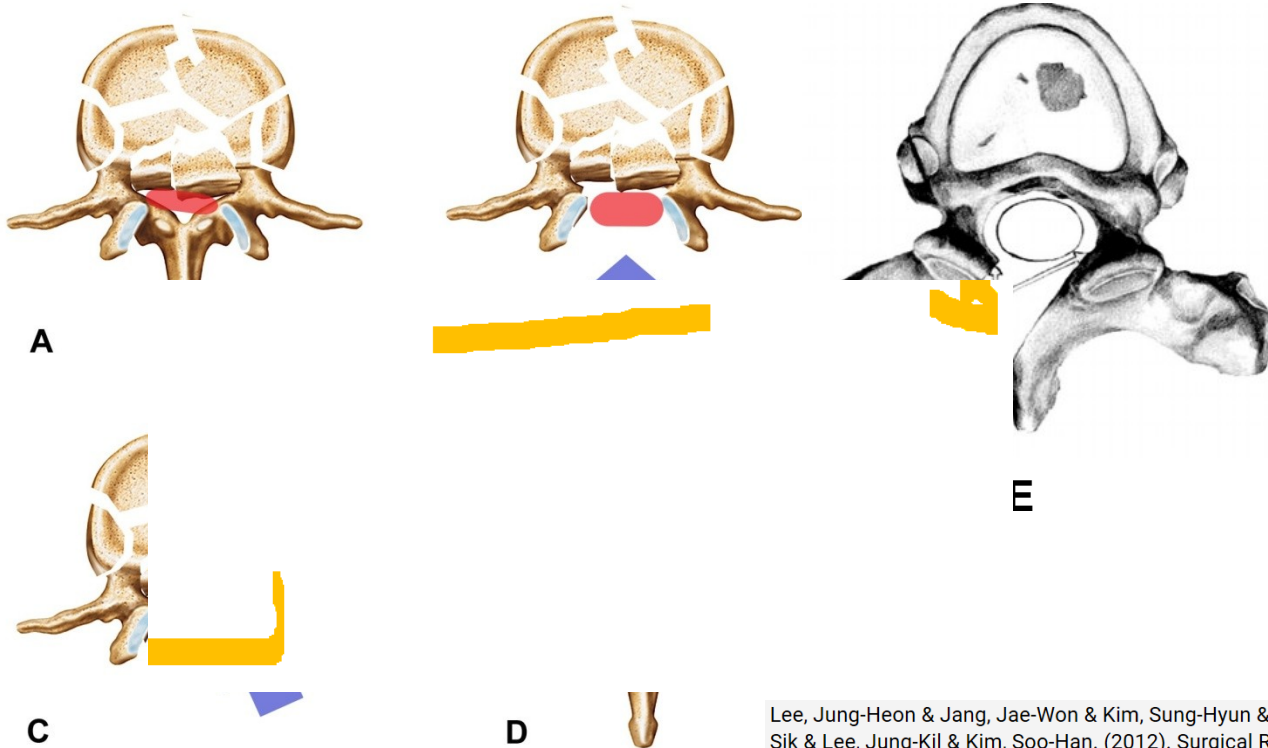
4) Stabilization - tightening the heads of screws



# V. SURGICAL TREATMENT – posterior approach – principles of DECOMPRESSION of spinal canal:

DIRECT = LAMINECTOMY (B)  
HEMI-LAMINECTOMY with (C)  
or without facetectomy (E)  
ANTERIOR DECOMPRESSION (D)

INDIRECT = LIGAMENTOTAXIS

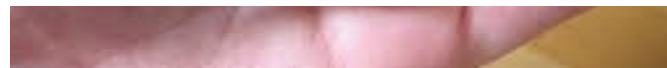
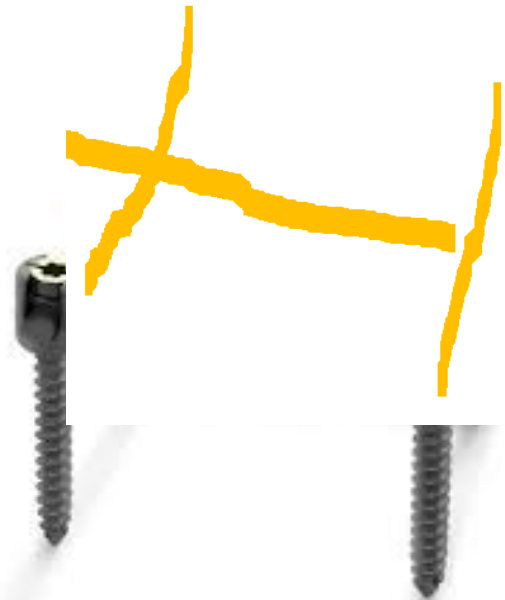
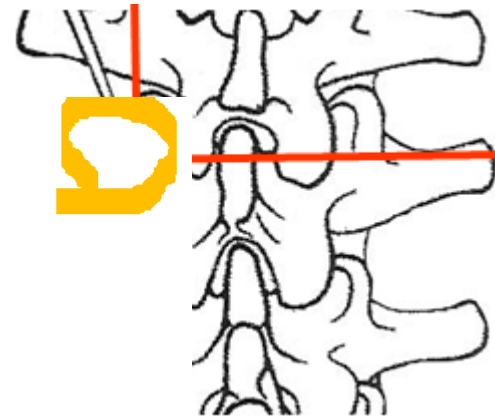


Lee, Jung-Heon & Jang, Jae-Won & Kim, Sung-Hyun & Moon, Hyung-Sik & Lee, Jung-Kil & Kim, Soo-Han. (2012). Surgical Results after Unilateral Laminectomy for the Removal of Spinal Cord Tumors. Korean Journal of Spine. 9. 232. 10.14245/kjs.2012.9.3.232.

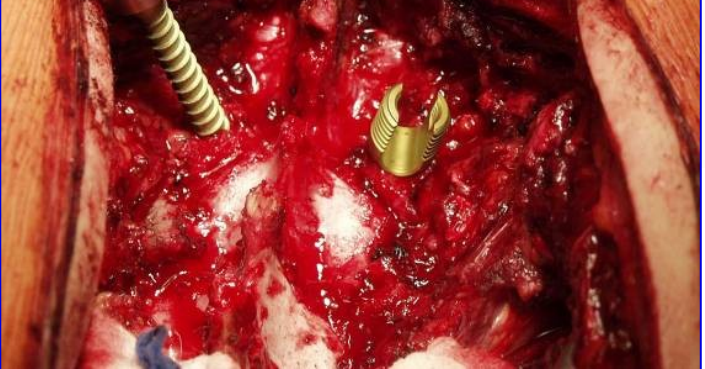
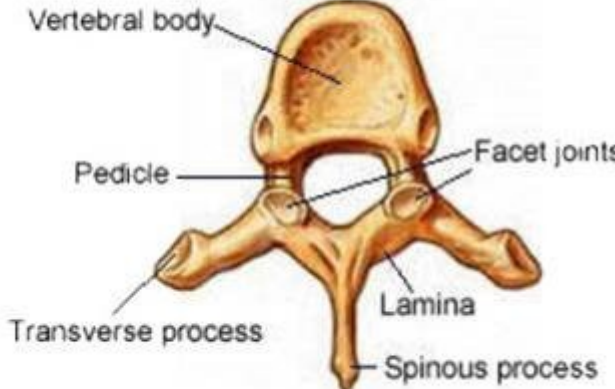
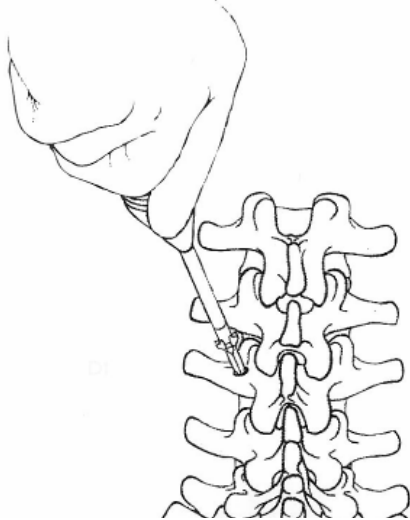
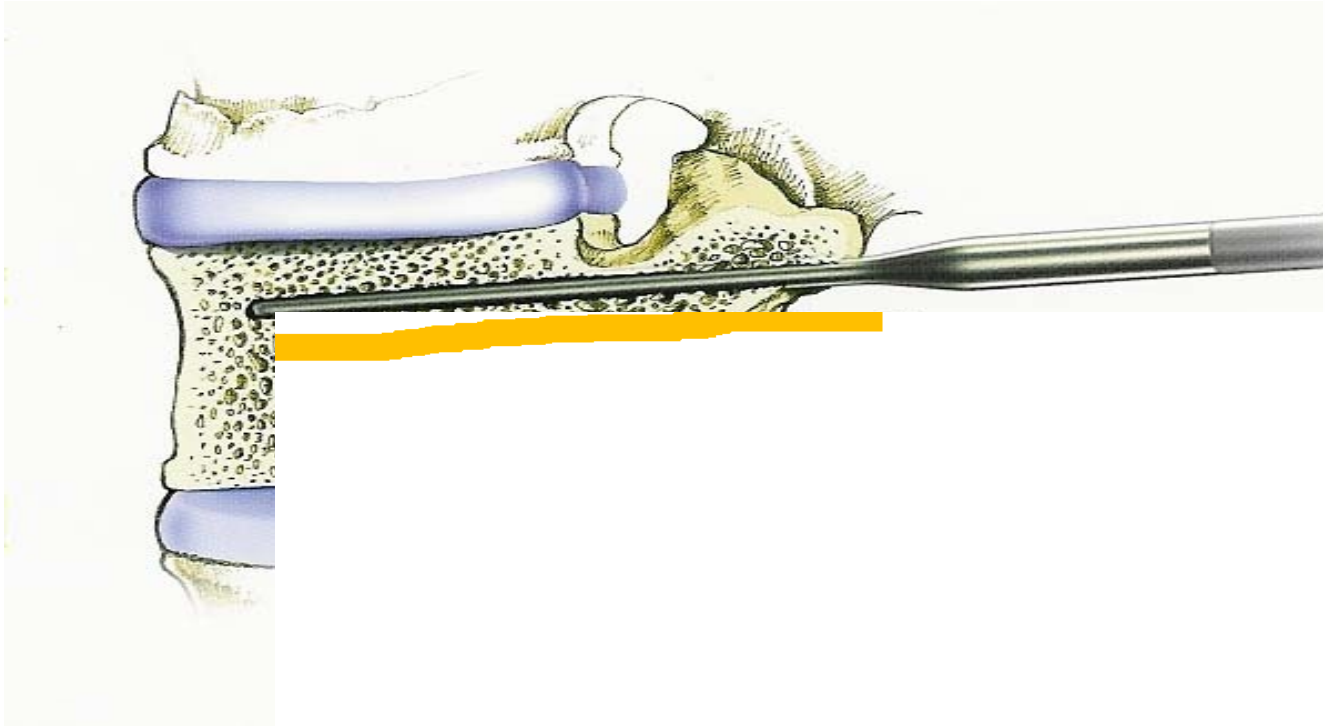
# V. SURGICAL TREATMENT – posterior approach

## – principles of TRANSPEDICULAR fixation:

- Transpedicular screws → targeting the screws
- Rods



# Inserting the TP screws



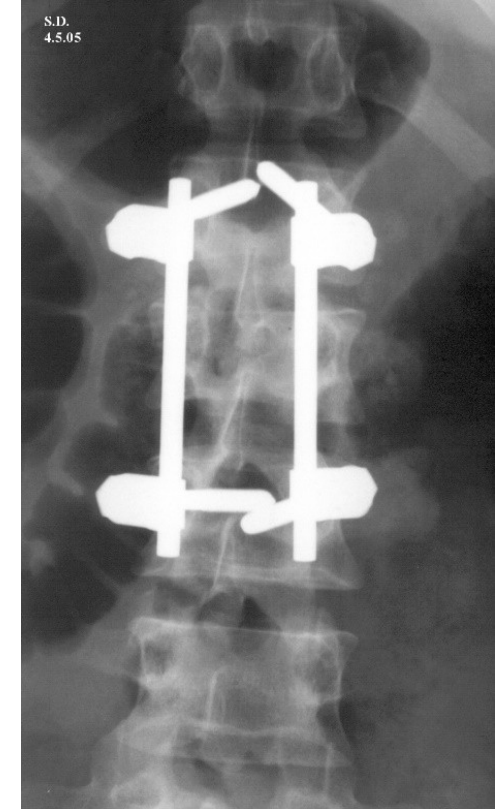
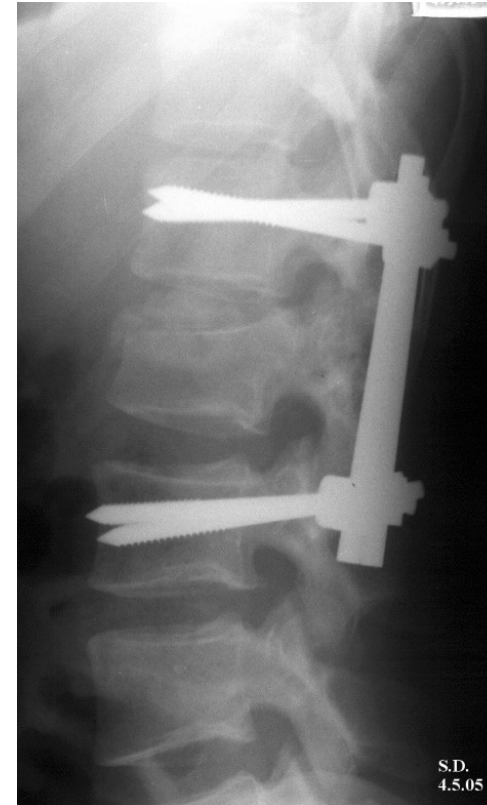
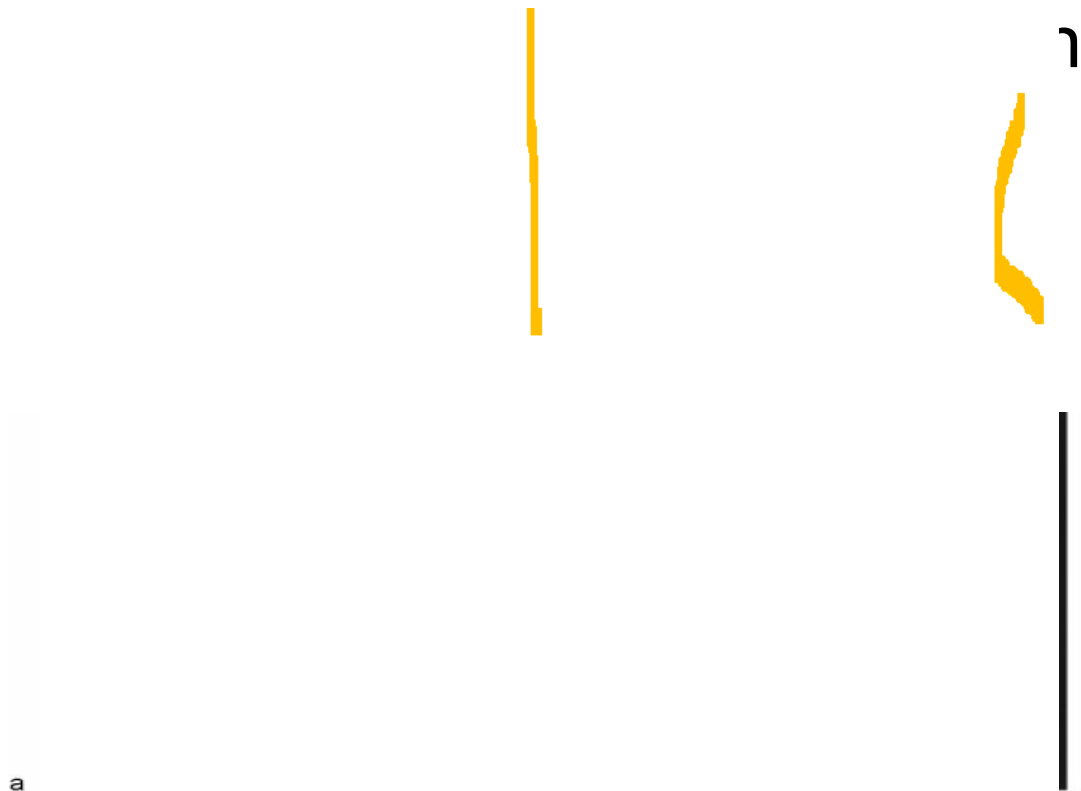
# TRANSPEDICULAR SCREWS:

CT scan of correctly inserted screws *in situ*.



# V. SURGICAL TREATMENT – posterior approach

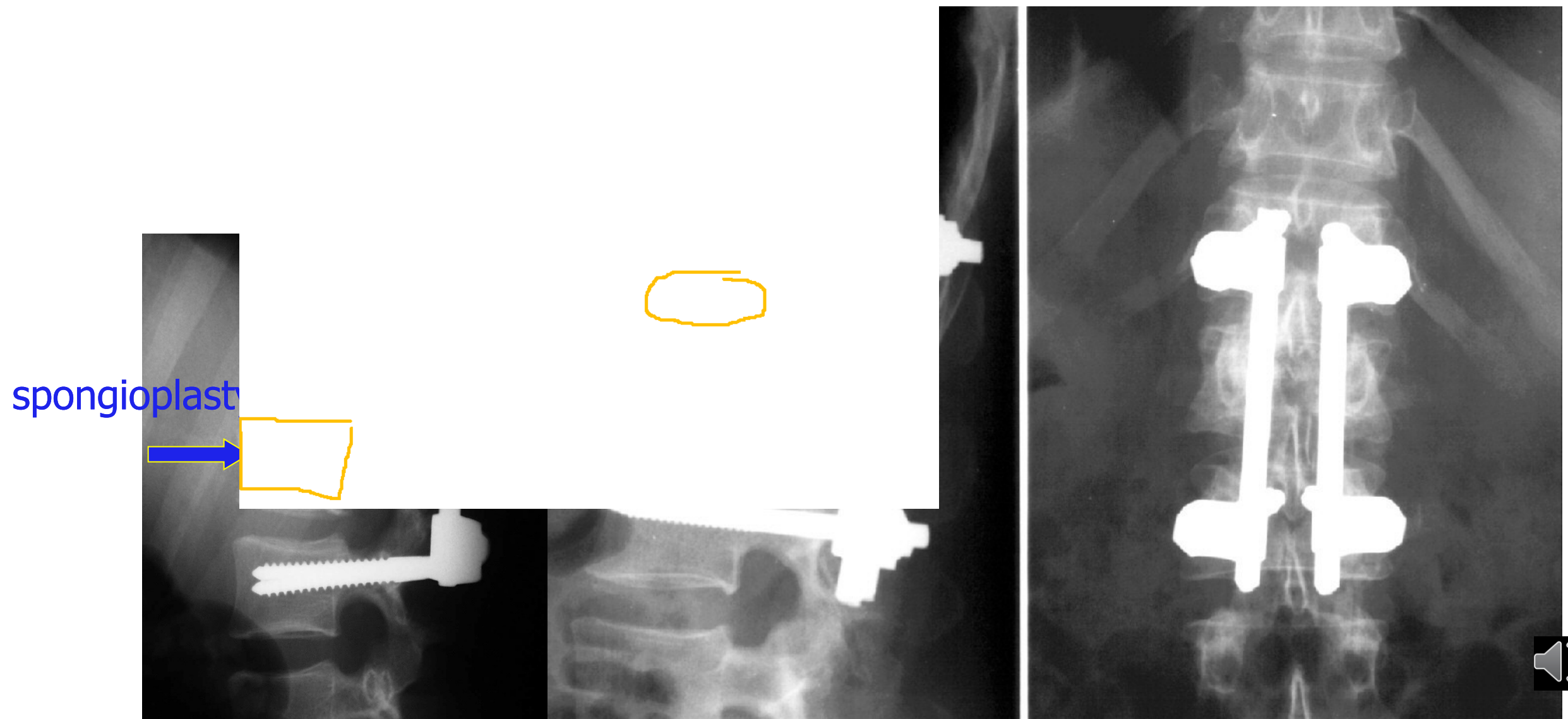
## – principles of TRANSPEDICULAR fixation:



longer than parallel !

# V. SURGICAL TREATMENT T-L SPINE – posterior approach

– dorsal instrumentation + spondylolplasty:

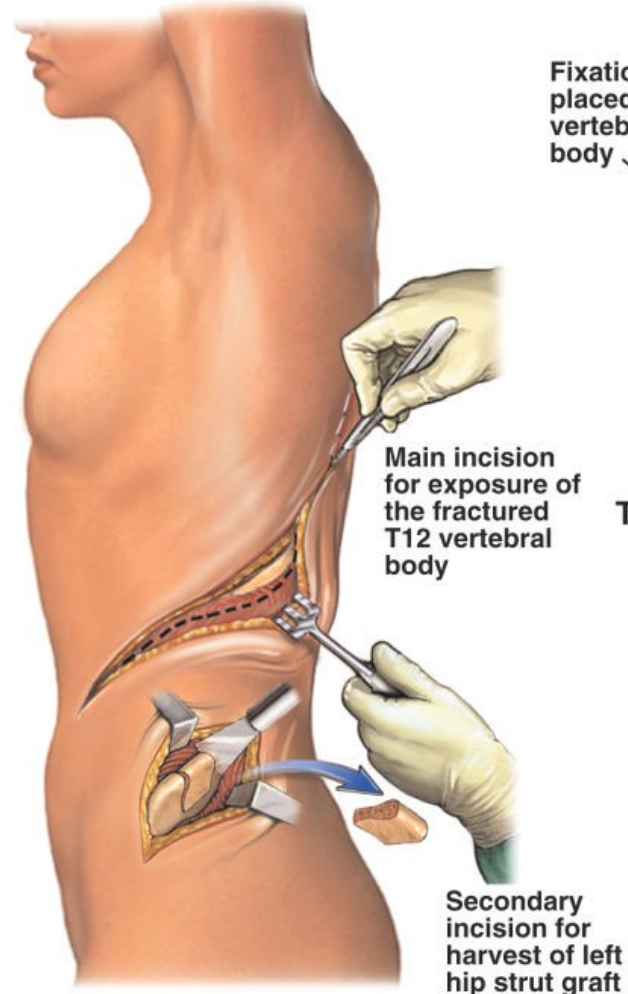






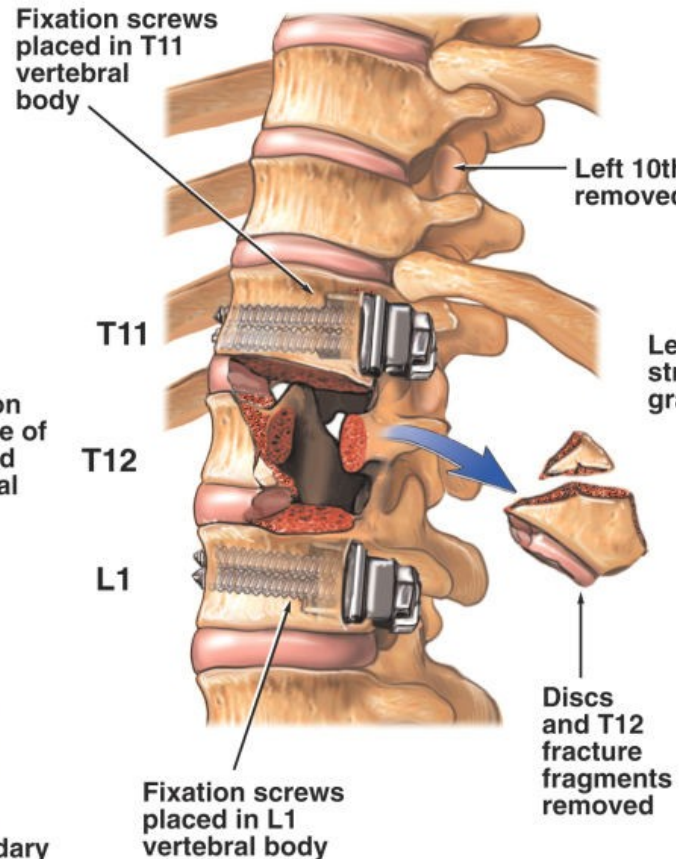
# V. SURGICAL TREATMENT T-L SPINE – combined approach – dorsal instrumentation + ventral spondylolysis + one strutgraft:

**A.** Incisions are made to expose the T12 vertebral burst fracture and left hip strut graft harvest site.

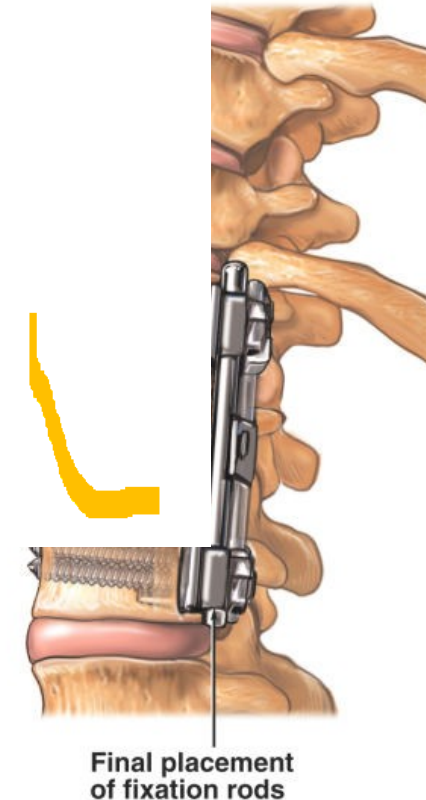


Lateral View

**B.** T11-L1 are exposed for placement of fixation screws, excision of disc material and removal of T12 bone fragments.



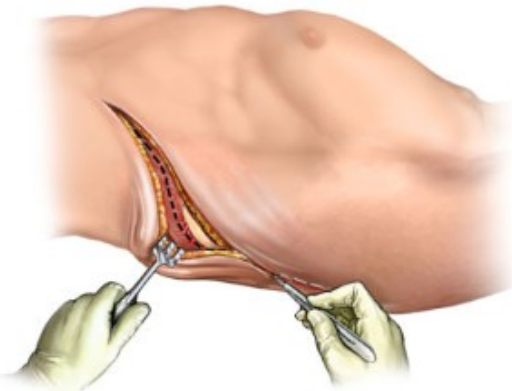
fused utilizing graft and rare.



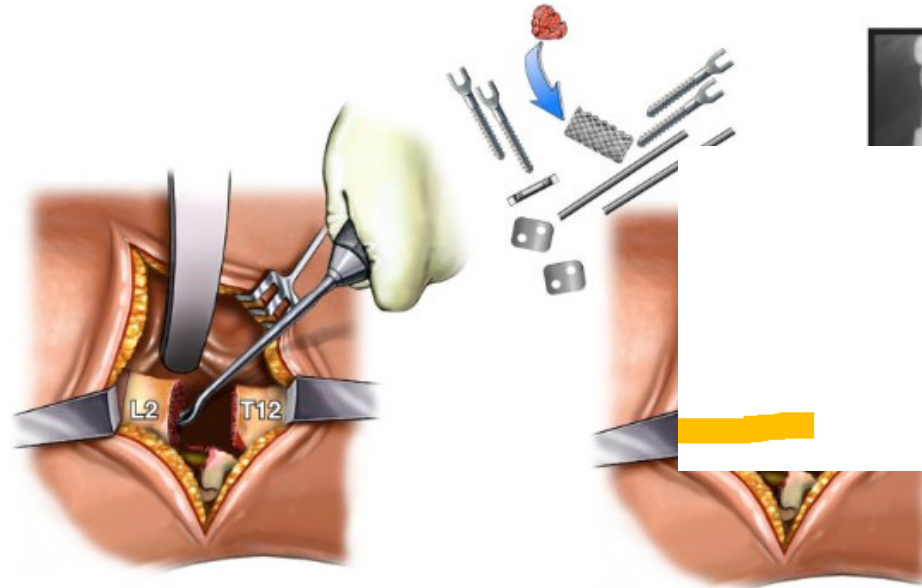
Nucleus Medical Media (2020). *Surgical decompression and stabilization of the spine* [Digital image]. Retrieved from <https://ebSCO.smartimagebase.com/surgical-decompression-and-stabilization-of-the-spine/view-item?ItemID=76291>

# V. SURGICAL TREATMENT T-L SPINE – anterior approach

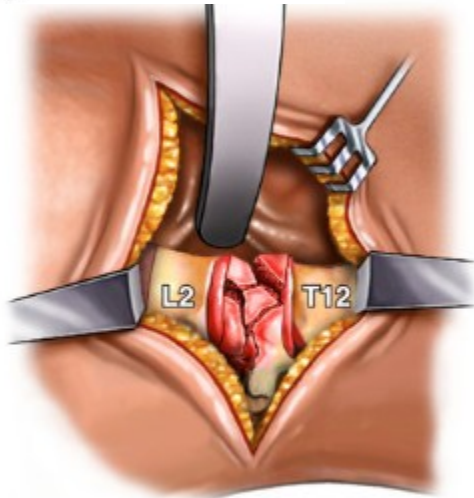
– ventral instrumentation + augmentation of ventral column (Harm's cage vs. Implant):



A. An incision is made over the eleventh rib on the left side of the body.



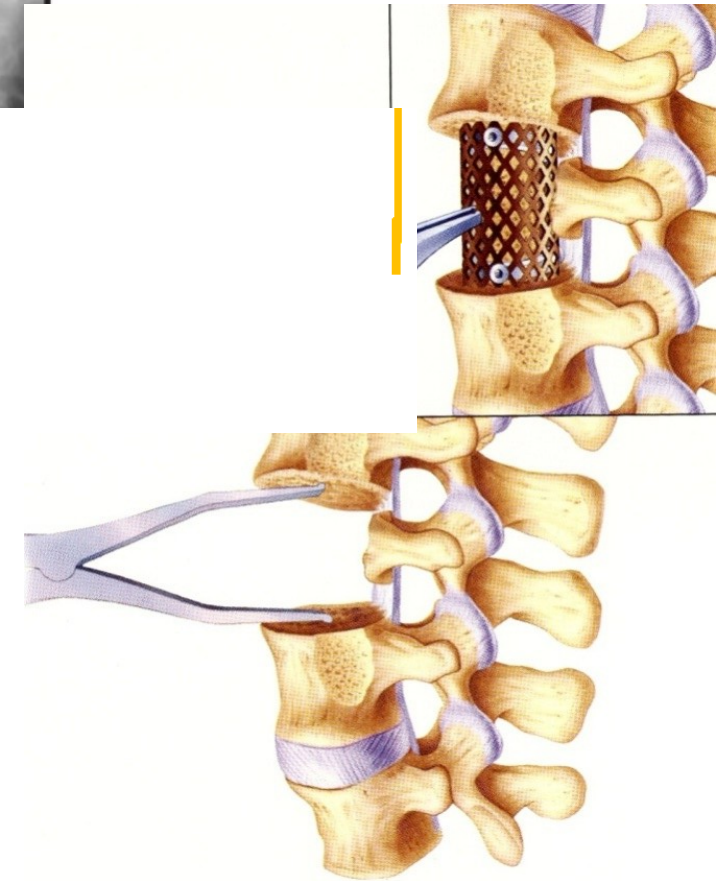
C. The fractured vertebral body of the first lumbar vertebra is removed. The endplates of the adjacent vertebrae are scraped with a curette.



B. The rib is resected and the first lumbar vertebra is exposed.



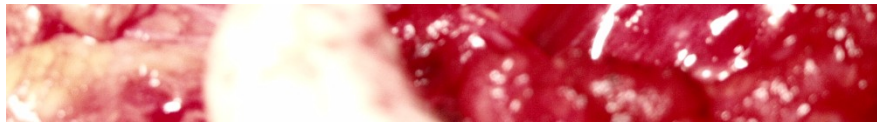
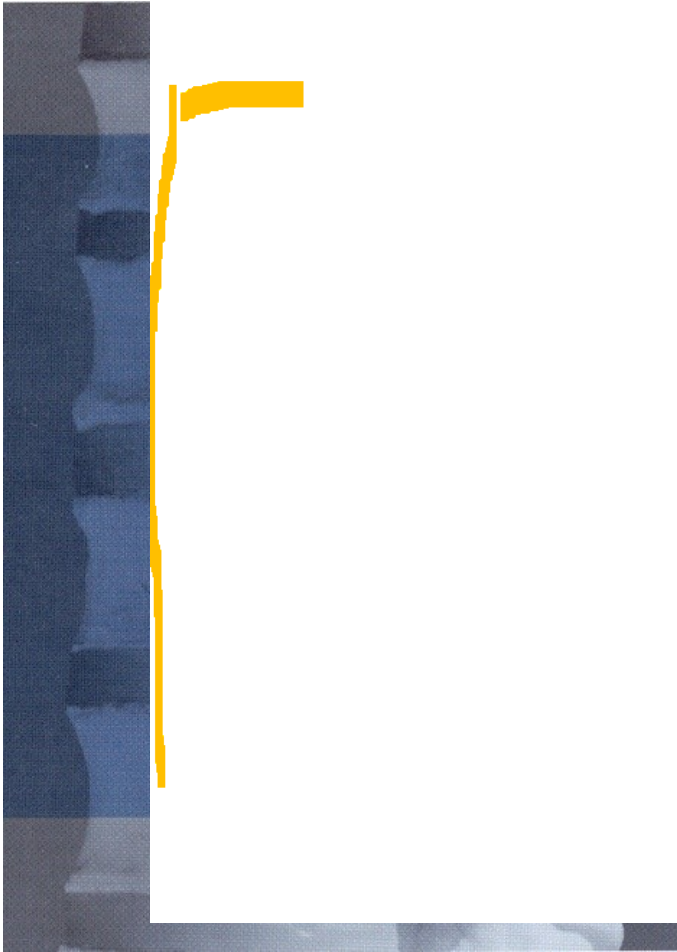
D. A cage is filled with bone graft. The cage is inserted into the L1 disc space. Plates, rods and screws are then inserted to connect the L2 vertebra to the T12 vertebra.



Nucleus Medical Media (2020). *Lumbar spine fracture with surgical repair* [Digital image]. Retrieved from <https://ebSCO.smartimagebase.com/lumbar-spine-fracture-with-surgical-repair/view-item?ItemID=11652>

# V. SURGICAL TREATMENT T-L SPINE – anterior approach

– ventral instrumentation + augmentation of ventral column (Harm's cage vs. Implant):



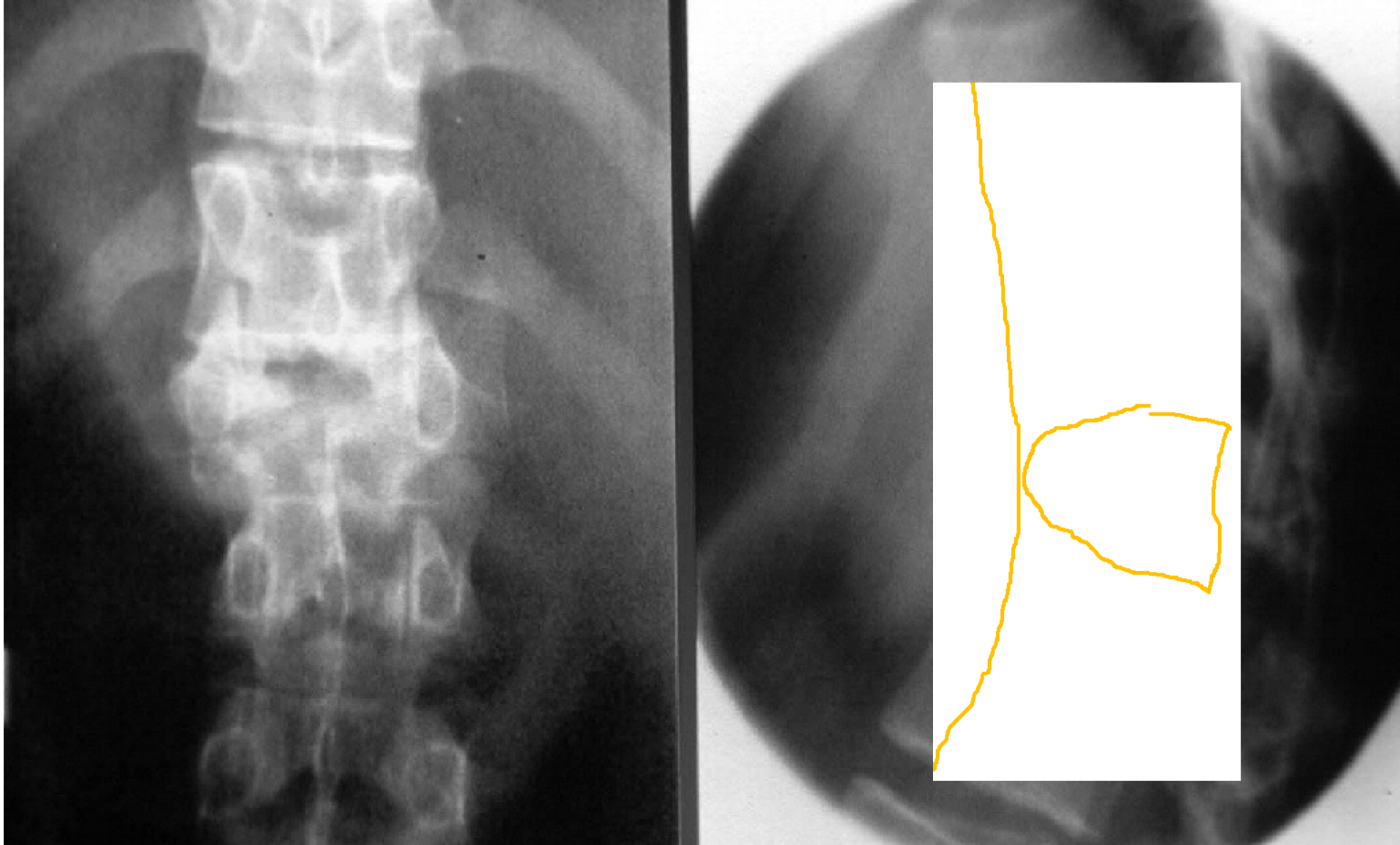
Instruments and implants  
approved by the AO Foundation

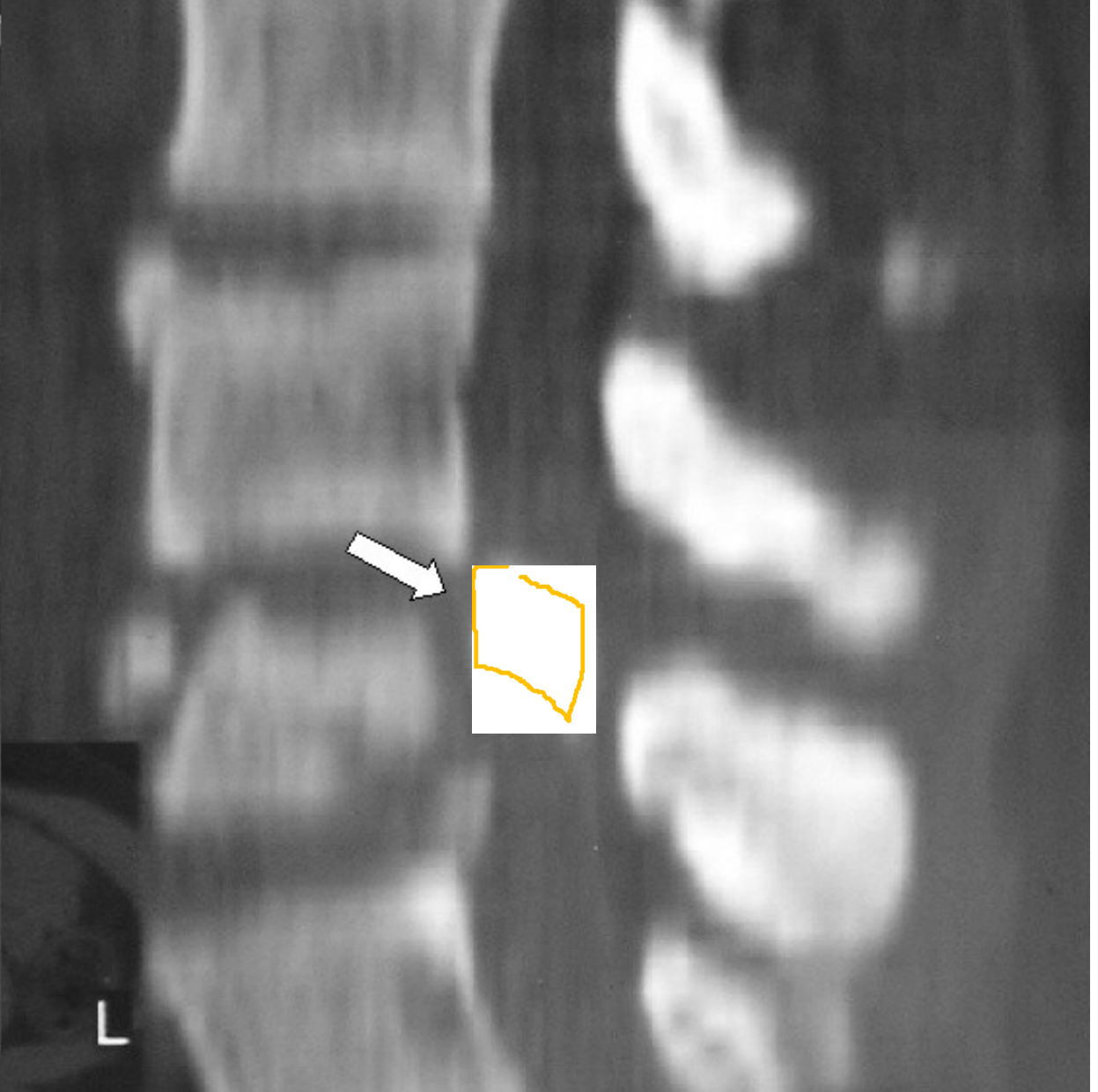
**SYNTHES**  
Spine

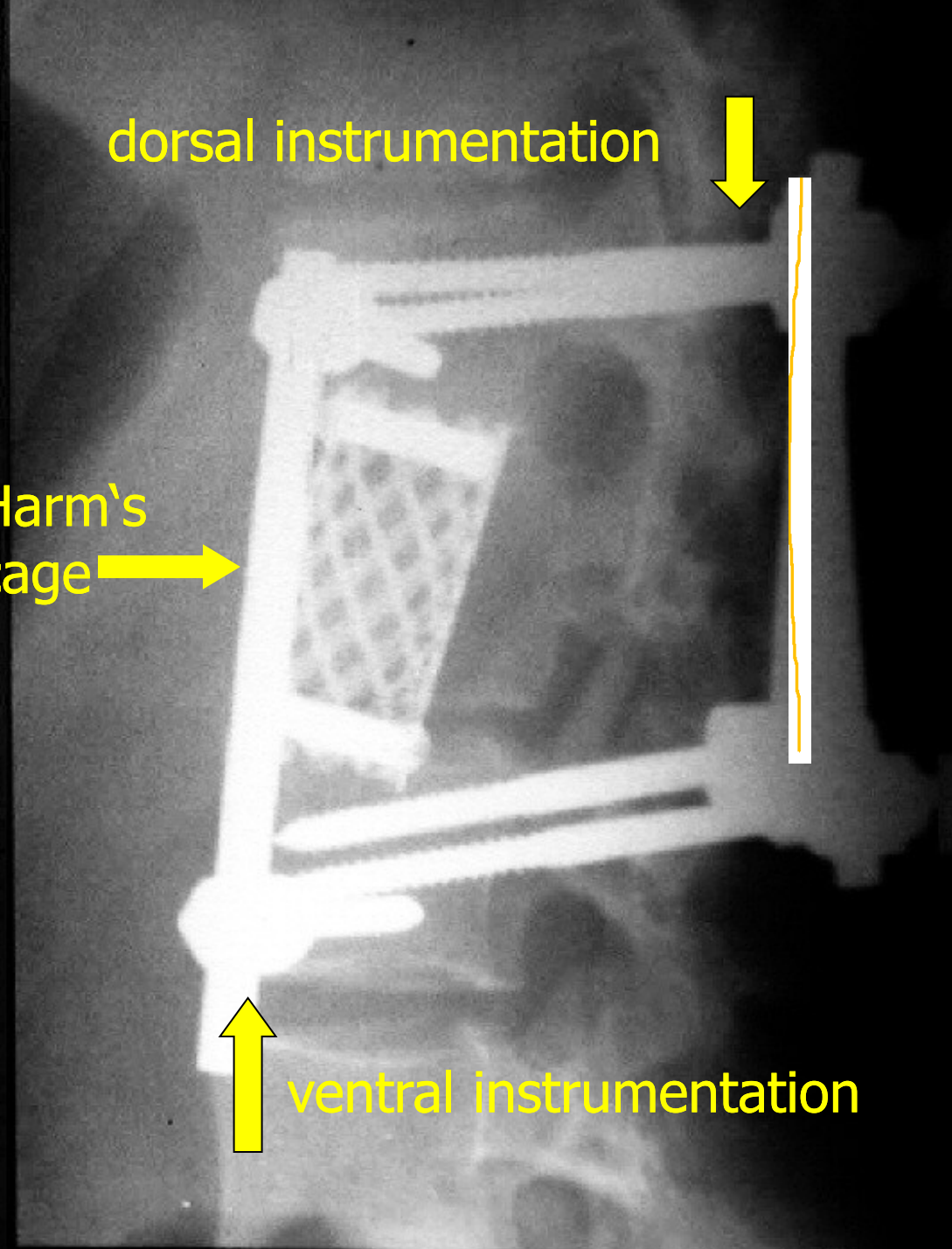
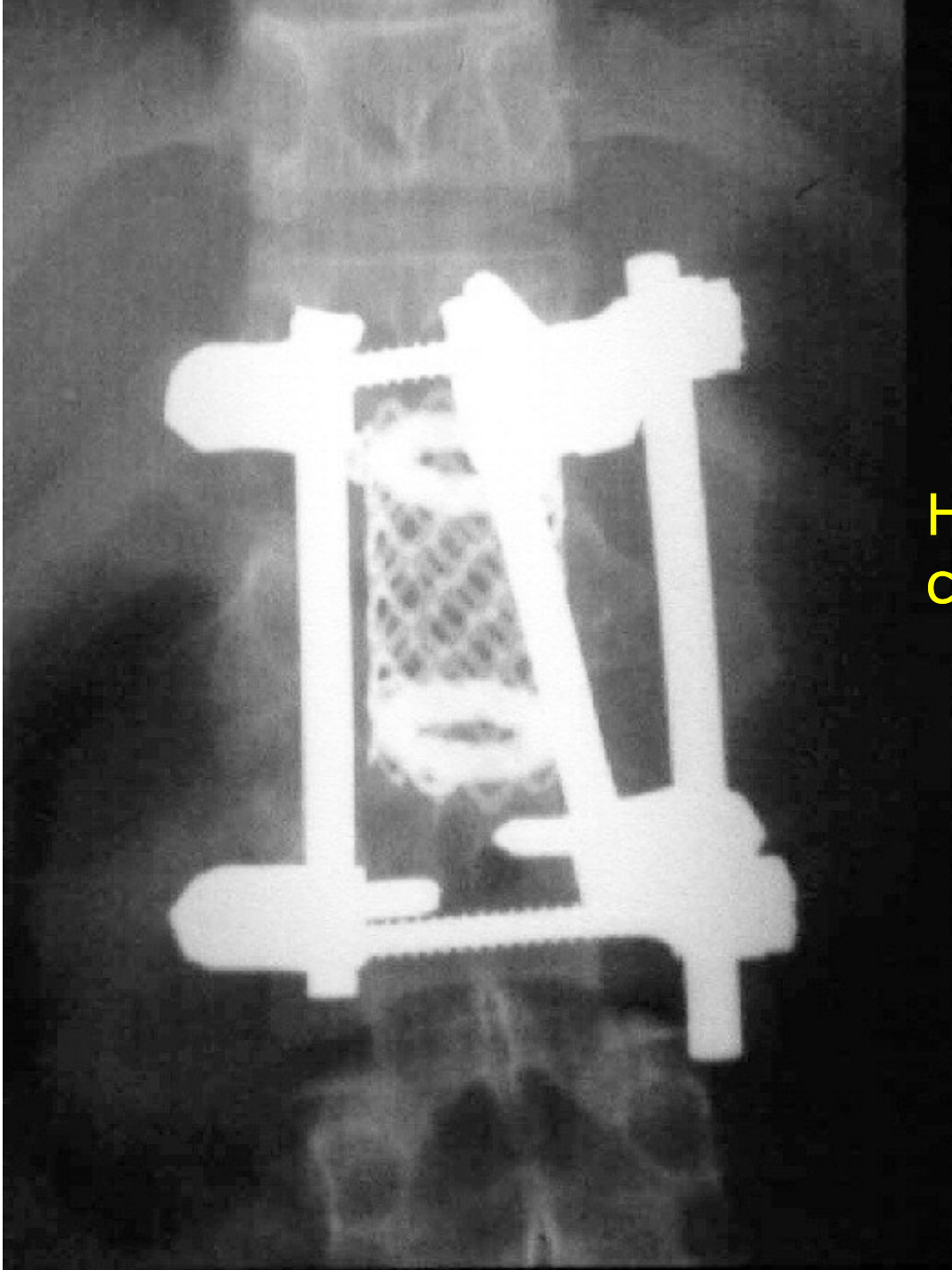
MUNT  
MED 

# V. SURGICAL TREATMENT T-L SPINE – combined approach

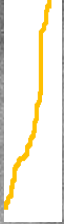
– dorsal + ventral instrumentation + ventral column augmentation:



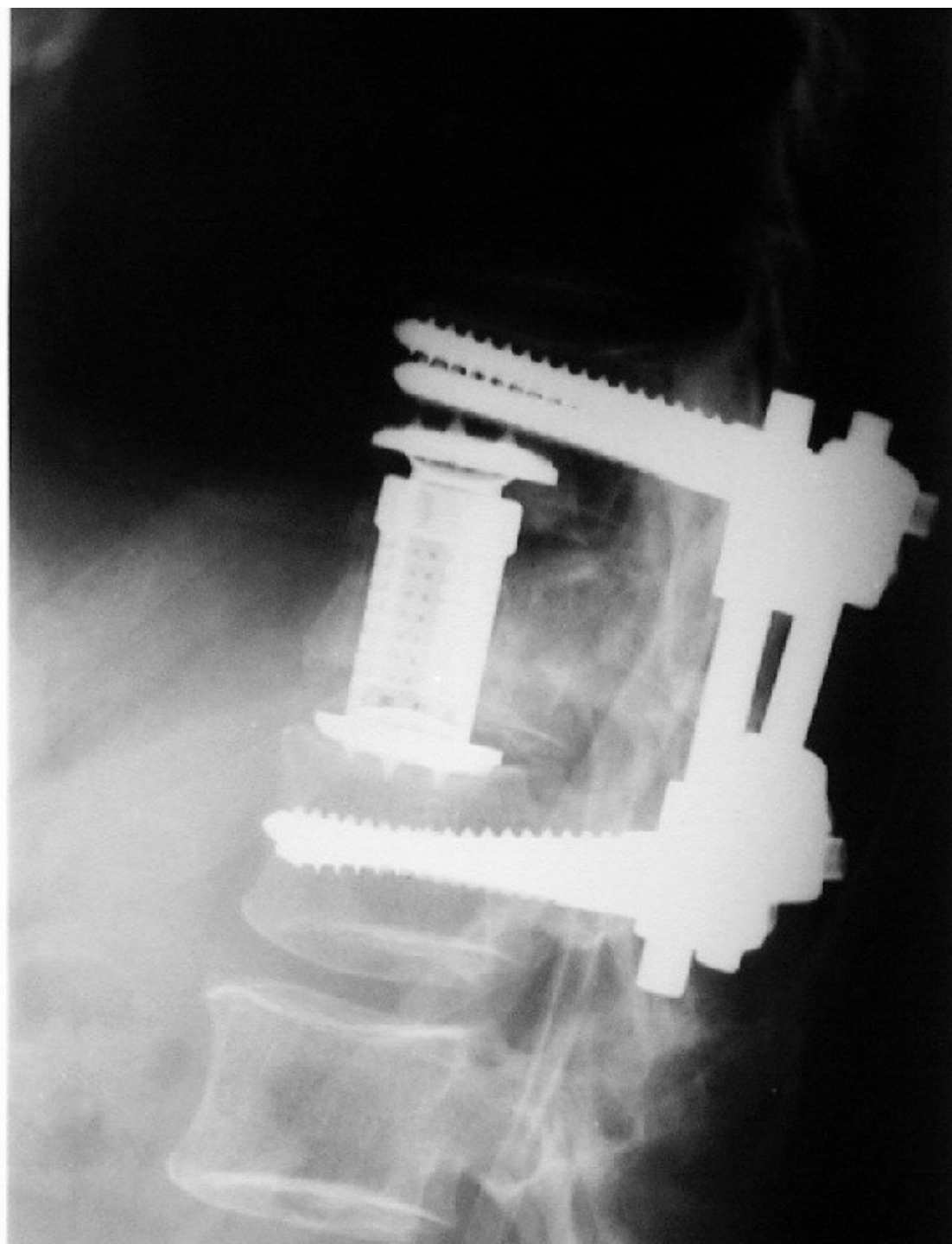
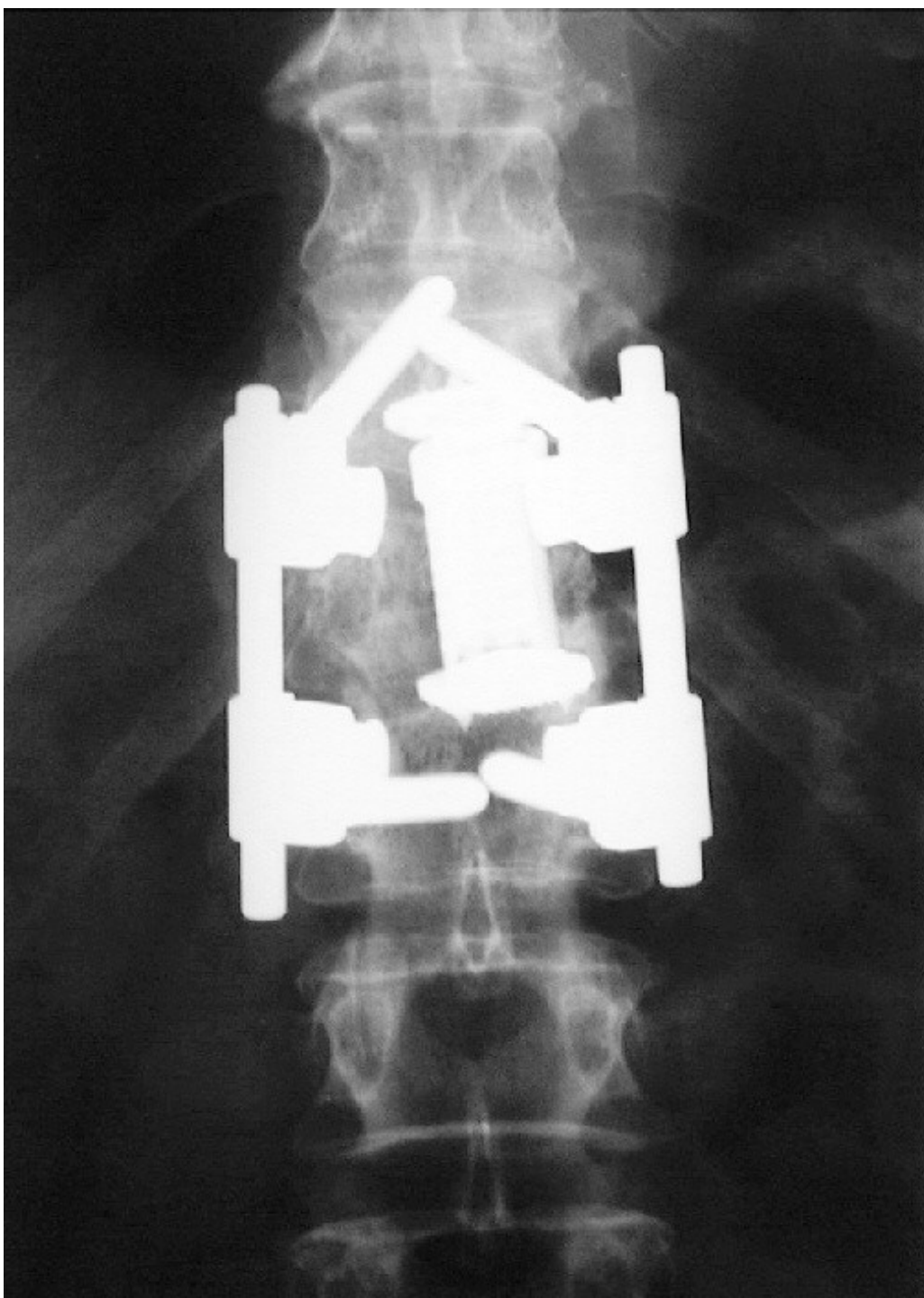




Synex -  
expandable  
implant

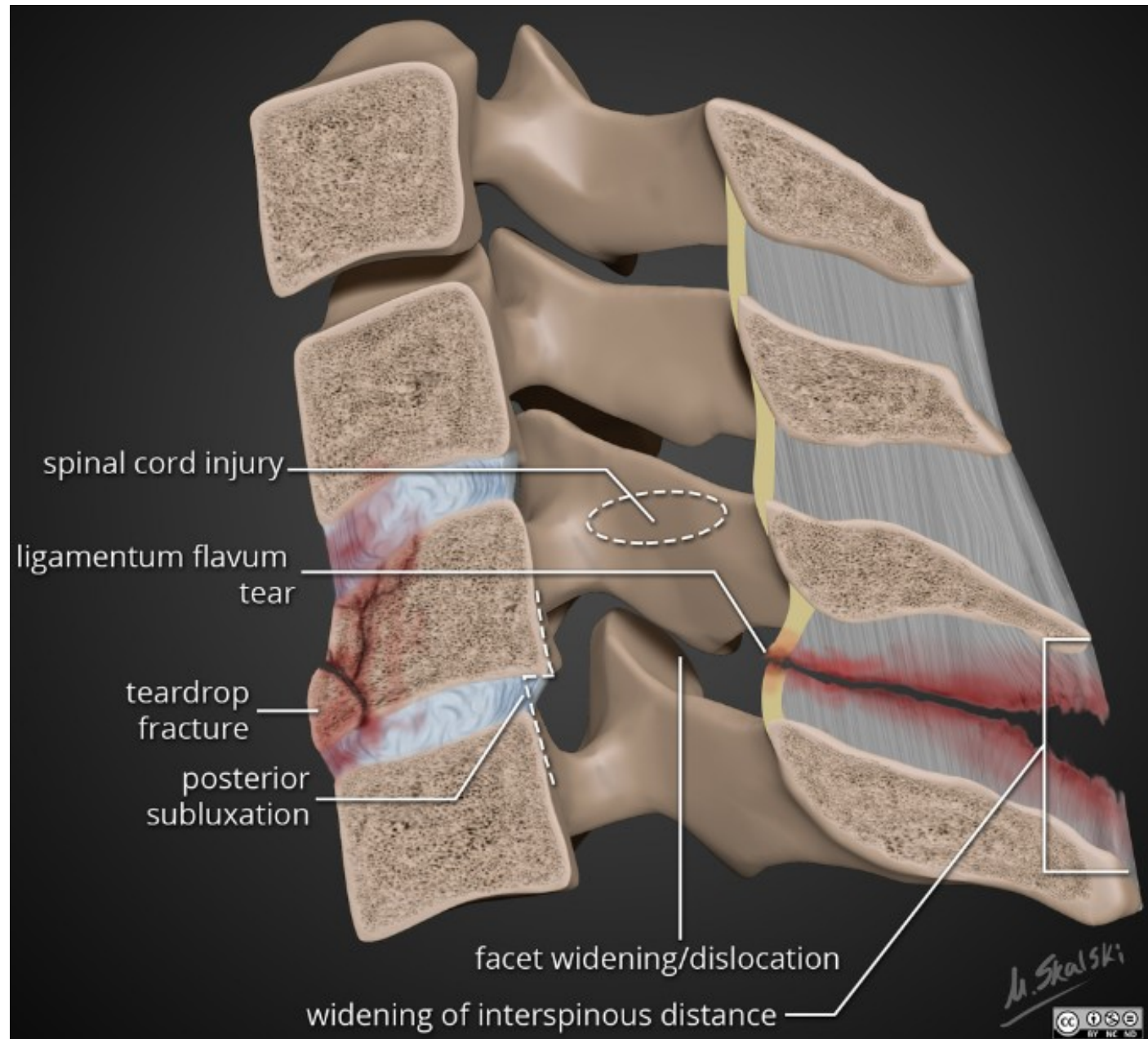






# CERVICAL SPINE INJURY

- Comminutive fr. of the body
- discoligamentous lesions  
disks and ligament
- Combined - tear drop



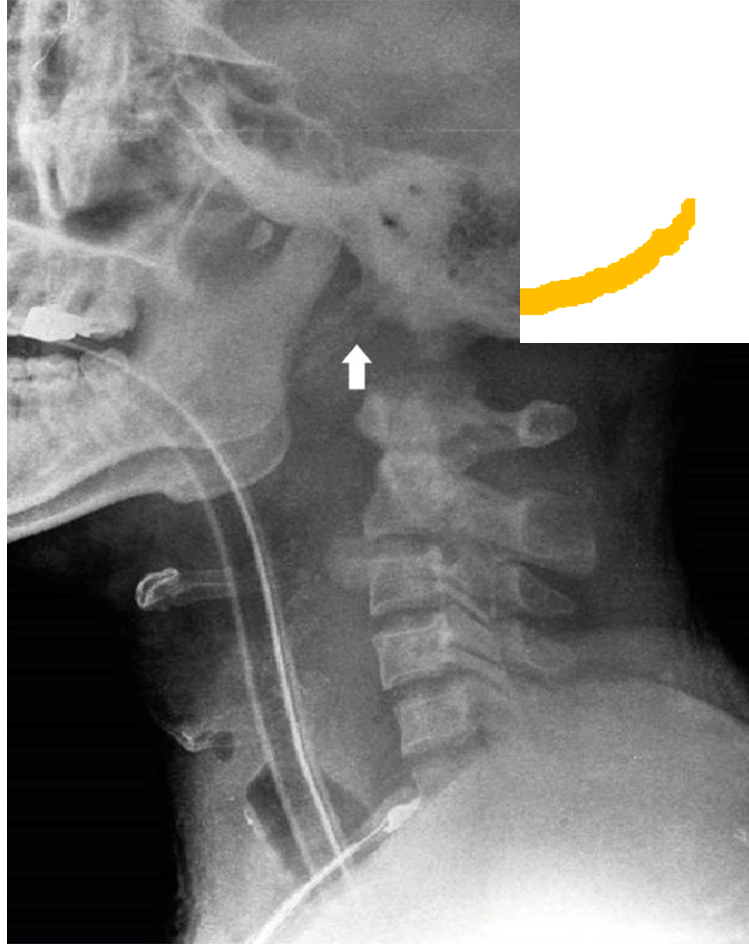
[radiopaedia.org/cases/flexion-teardrop-fracture-illustration?lang=us](http://radiopaedia.org/cases/flexion-teardrop-fracture-illustration?lang=us)

# INJURY OF THE UPPER C-SPINE

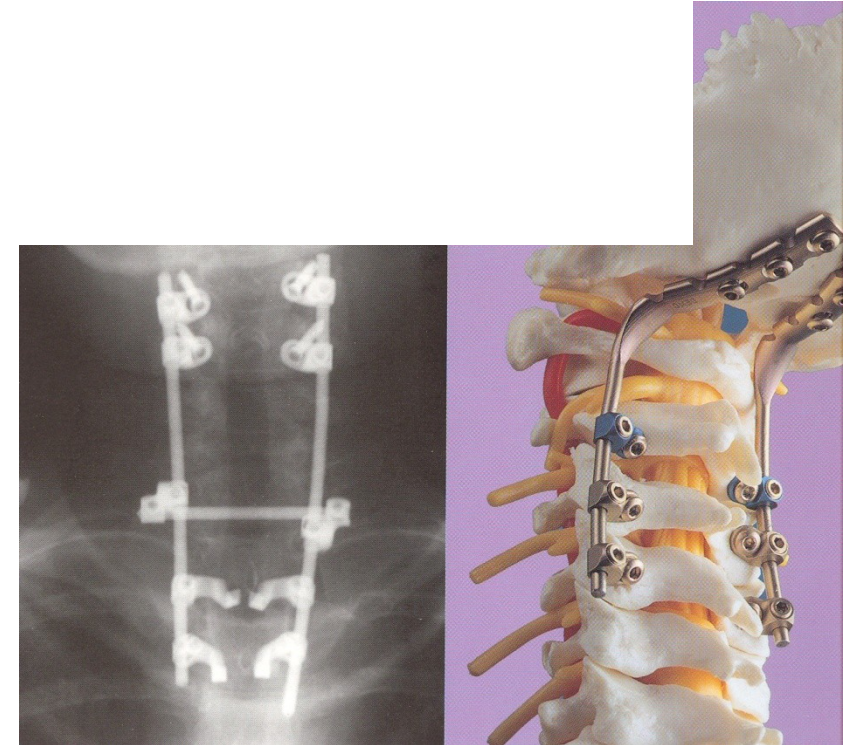
- fractures of condyles of occipital bone (C0)
- atlantooccipital dislocations (C0-C1)
- atlas fractures (C1)
- atlantoaxial dislocations (C1-C2)
- fractures of the epistropheum (C2)

# V. SURGICAL TREATMENT – UPPER C- SPINE

## – atlantooccipital dislocation : **Dorsal O-C fusion**



Korean J Neurotrauma. 2019 Apr;15(1):55-60.  
<https://doi.org/10.13004/kjnt.2019.15.e3>



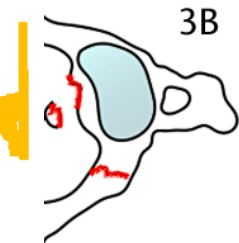
Synthes  
CerviFix

# V. SURGICAL TREATMENT UPPER C- SPINE:

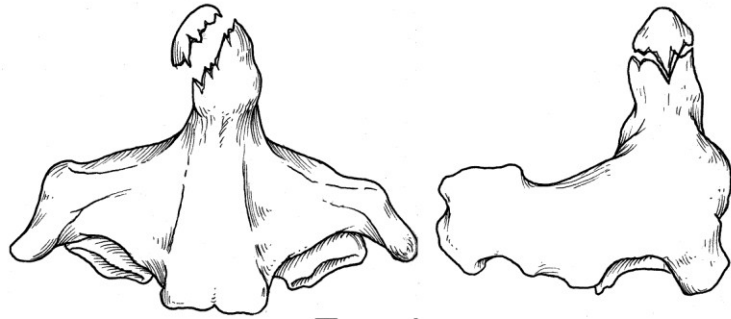
– atlas fractures (disruption of transvers ligamnet):

**atlantoaxial screw fixation and fusion (Magerl C1 and C2 transfacet screw technique)**

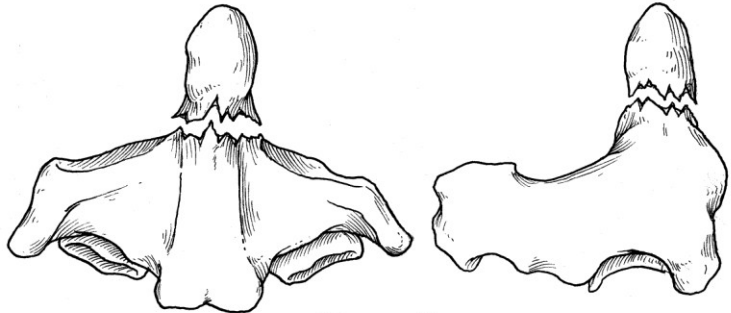
[980)



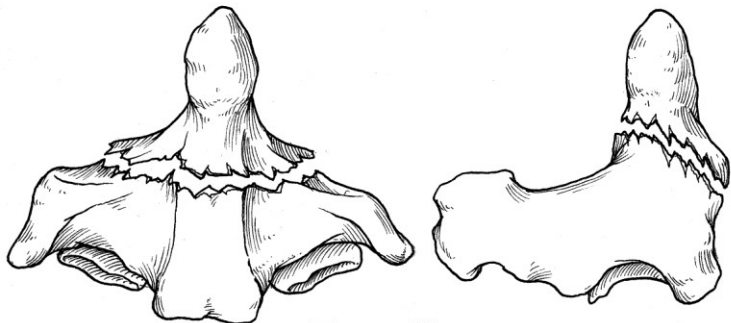
# ODONTOID FRACTURES OF C2



Type I



Type II



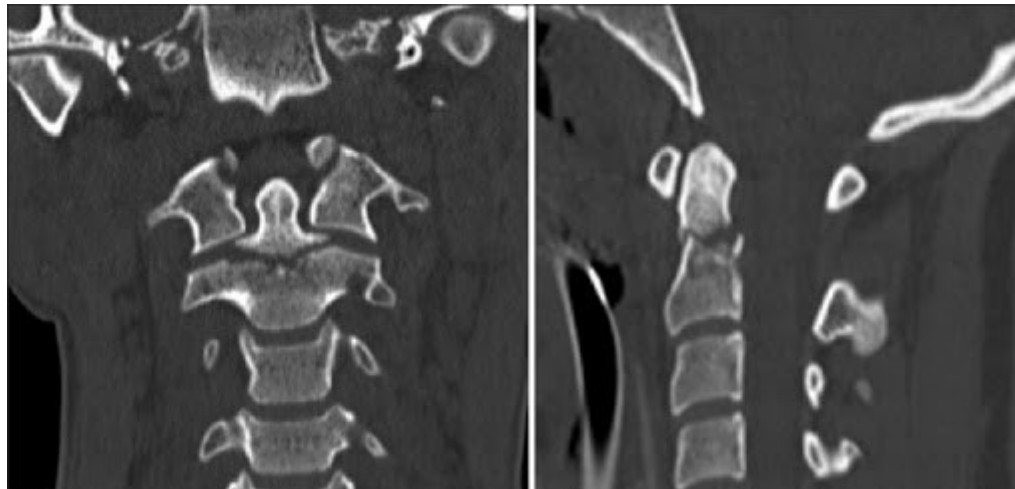
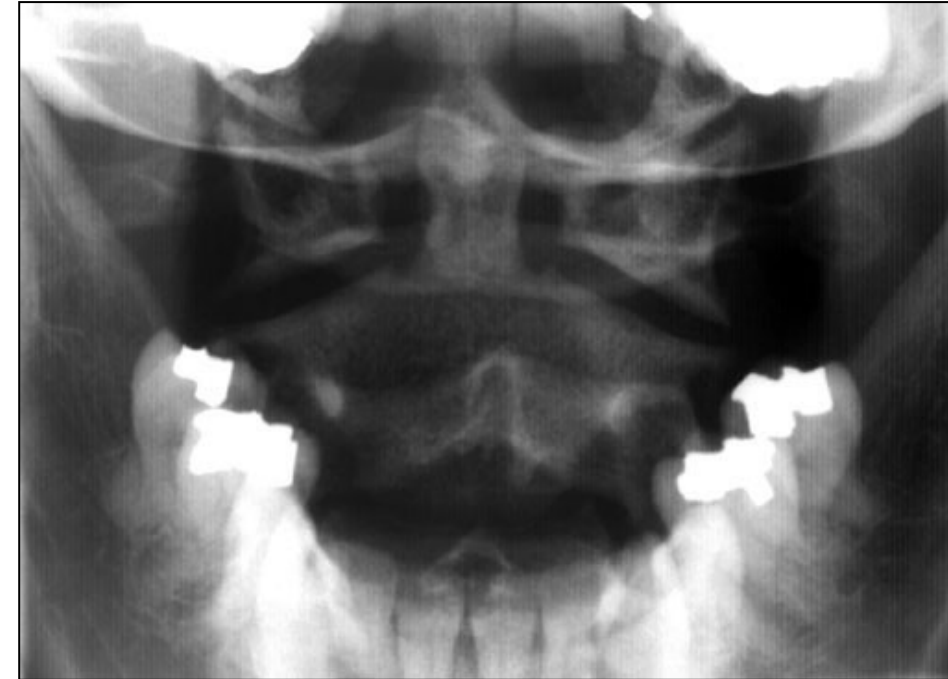
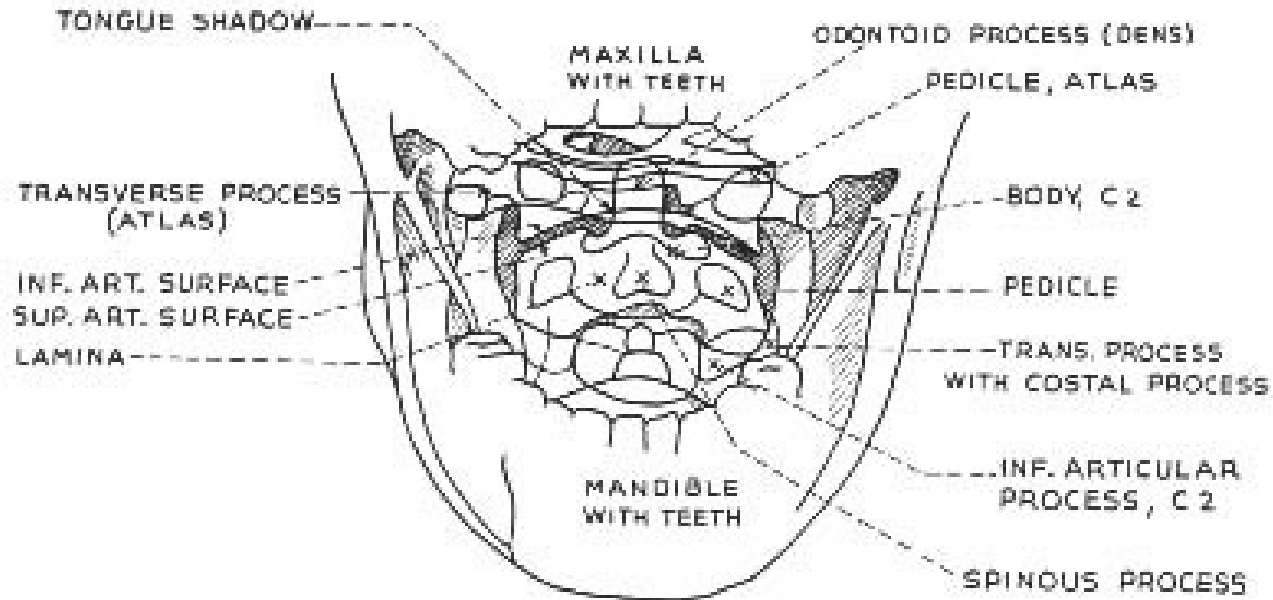
Type III

## Anderson and D'Alonzo Classification of Odontoid Fractures

Type II = NECESSITY OF SURGERY especially:

- In pts age > 50 (high risk of non-union)
- Fracture displacement  $\geq$  5mm
- Neurological deficit
- Comminution

# Transoral (Sandberg) projection

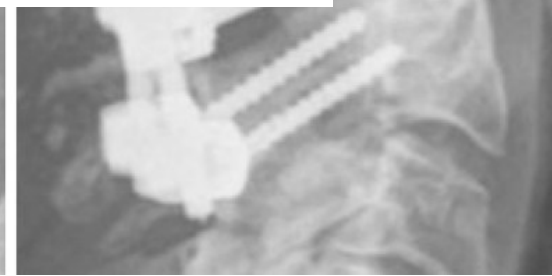
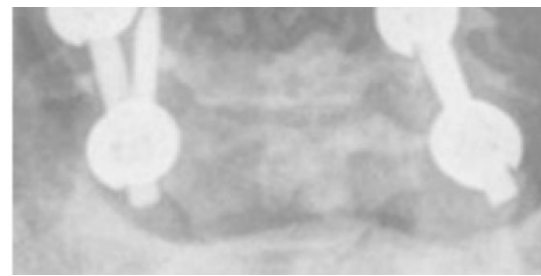
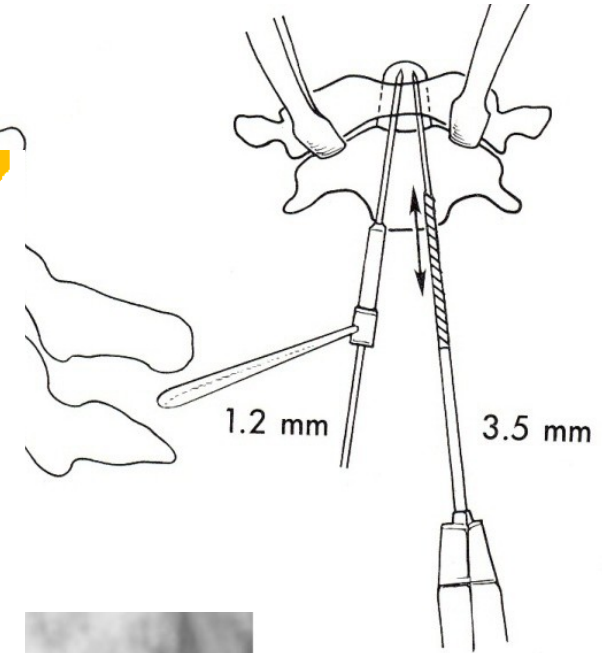
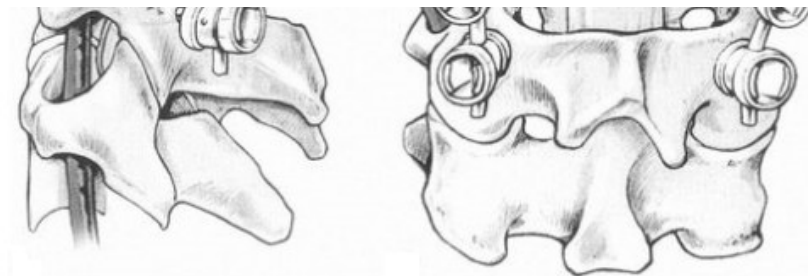


# V. SURGICAL TREATMENT UPPER C- SPINE

– fractures of the epistropheum : dorsal / ventral approach

## ODONTOID FRACTURES OF C2

Harn  
cons

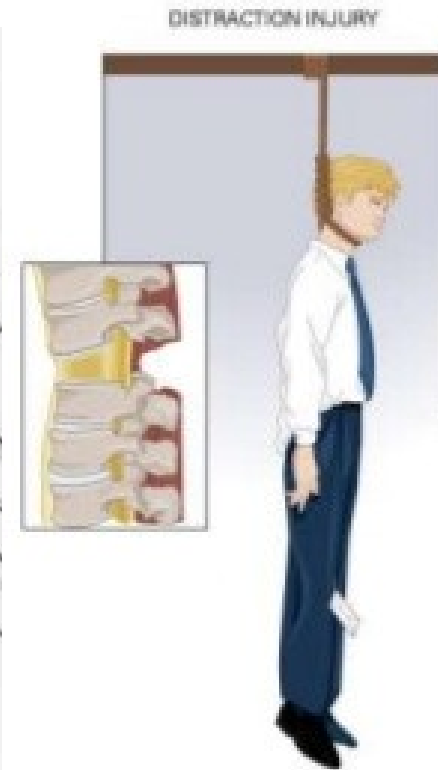
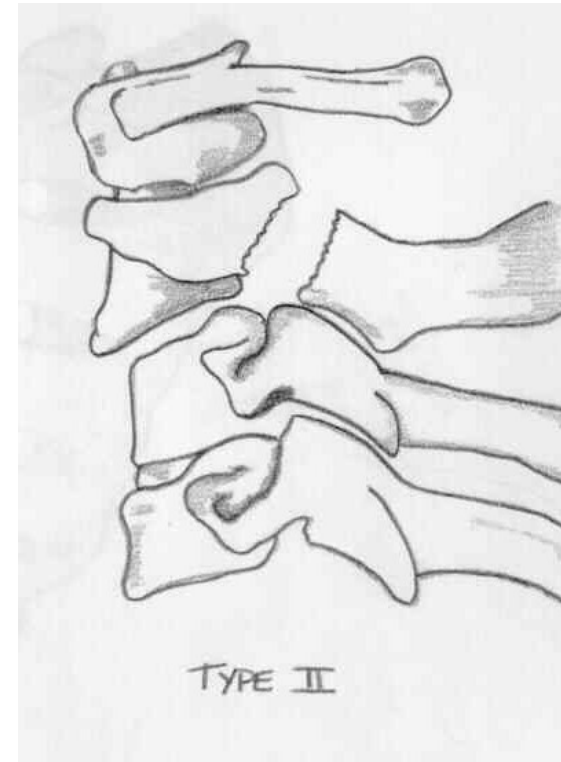
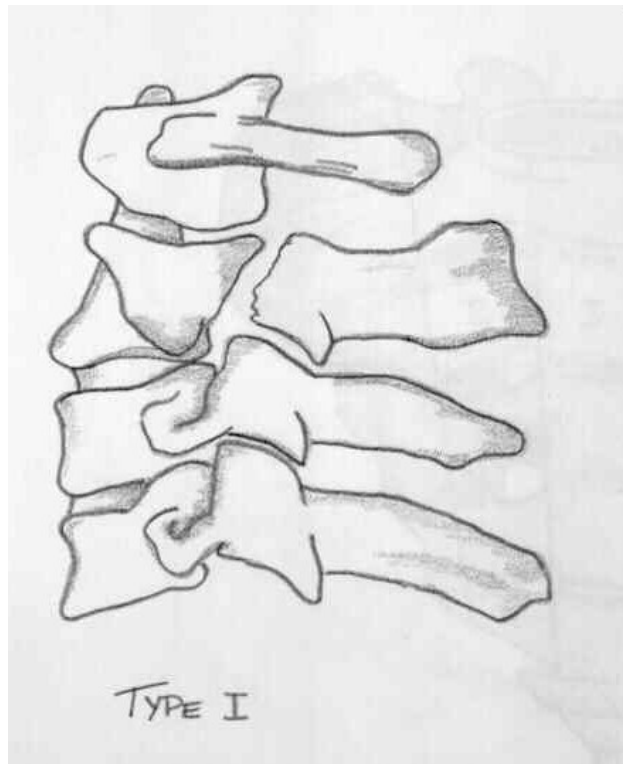


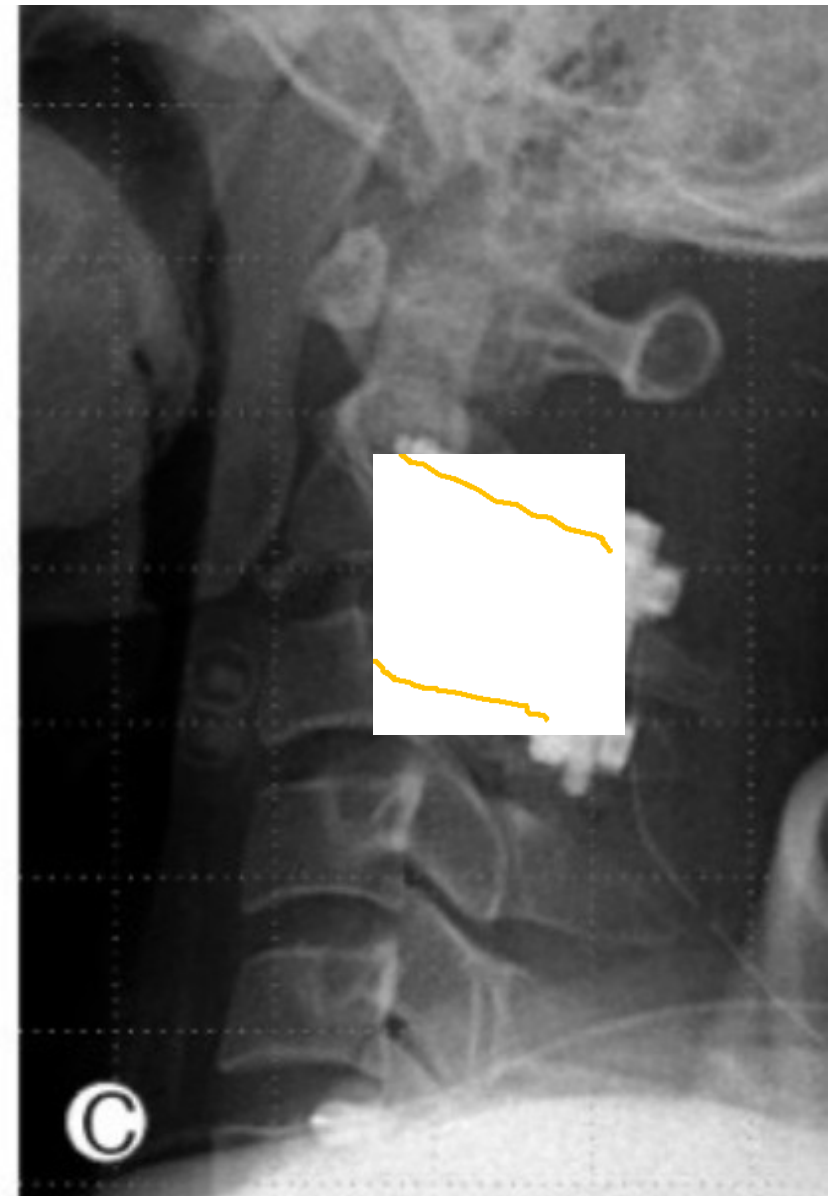


# V. SURGICAL TREATMENT UPPER C- SPINE

– fractures of the epistropheum : **dorsal / ventral approach**

**HANGMAN FRACTURE** – traumatic olisthesis C2





## Dorsal – TP fixation

Jeong DH, You NK, Lee CK, Cho KH, Kim SH. Posterior C2-C3 Fixation for Unstable Hangman's Fracture. Korean J Spine. 2013 Sep;10(3):165-9. doi: 10.14245/kjs.2013.10.3.165. Epub 2013 Sep 30. PubMed PMID: 24757480

09:26:16  
No.1



09:41:28  
No.2



# Ventral - ACDF

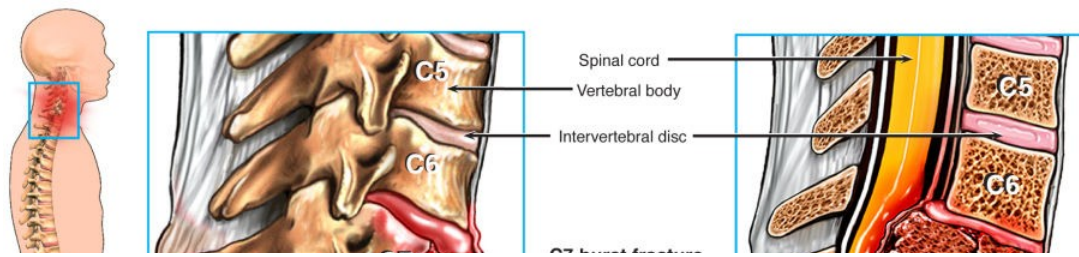
No.1



No.2



ACDF =



Nucleus Medical Media (2020). *Surgical decompression and stabilization of the spine* [Digital image]. Retrieved from <https://ebSCO.smartimagebase.com/surgical-decompression-and-stabilization-of-the-spine/view-item?ItemID=76291>

# V. SURGICAL TREATMENT LOWER C- SPINE

## – ventral / dorsal approach

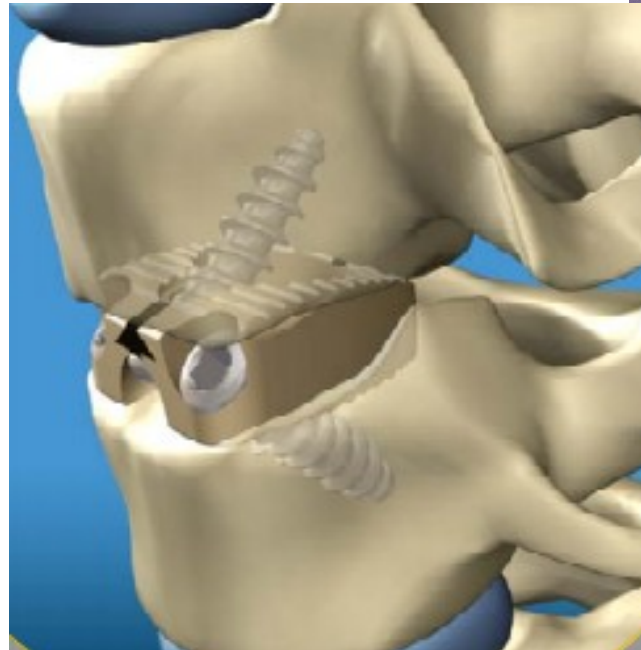
### Ventral procedures

- Plating
- Discs / vertebral bodies replacement

### Dorsal procedures

- TP stabilizations

### Combinations

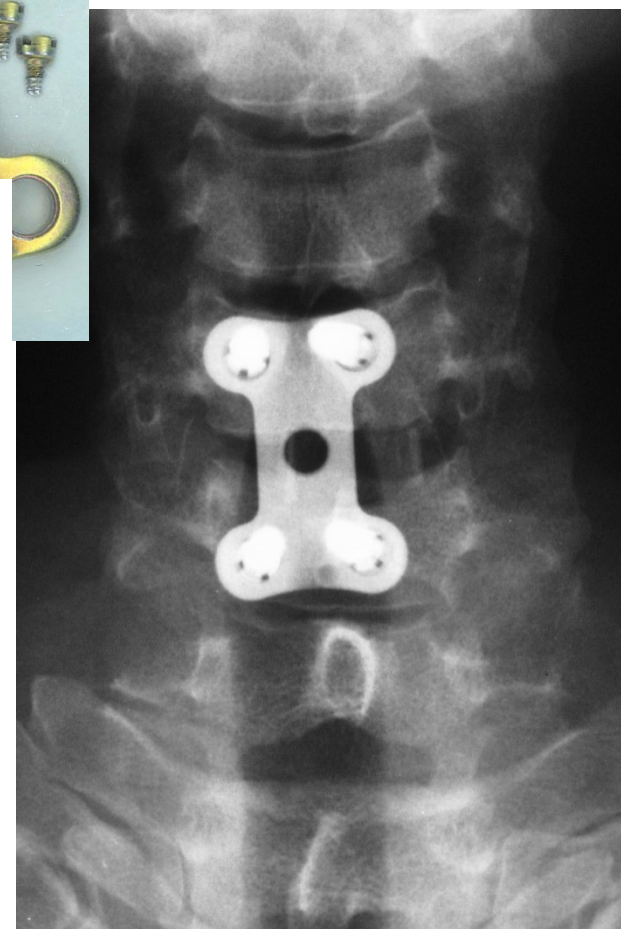
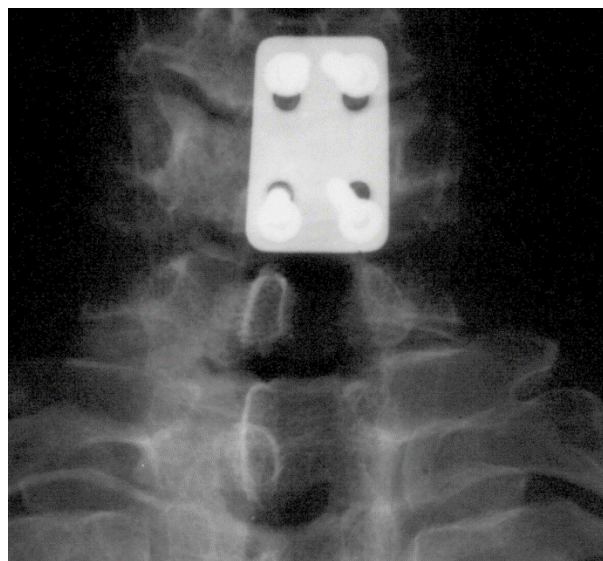
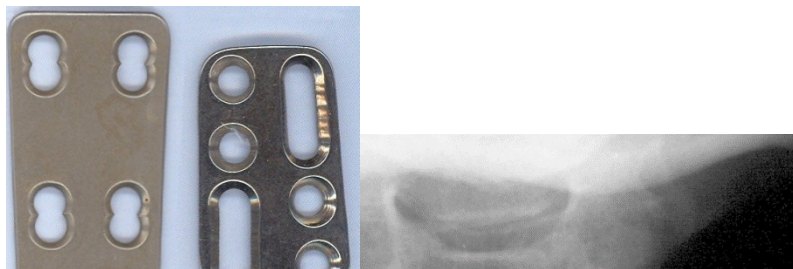


[www.bbraun.com/content/dam/bbraun/global/website/products-and-therapies/degenerative-spinal-disorders/O85002\\_Aesculap\\_XP.pdf.bb-95195616/O85002\\_Aesculap\\_XP.pdf](http://www.bbraun.com/content/dam/bbraun/global/website/products-and-therapies/degenerative-spinal-disorders/O85002_Aesculap_XP.pdf.bb-95195616/O85002_Aesculap_XP.pdf)

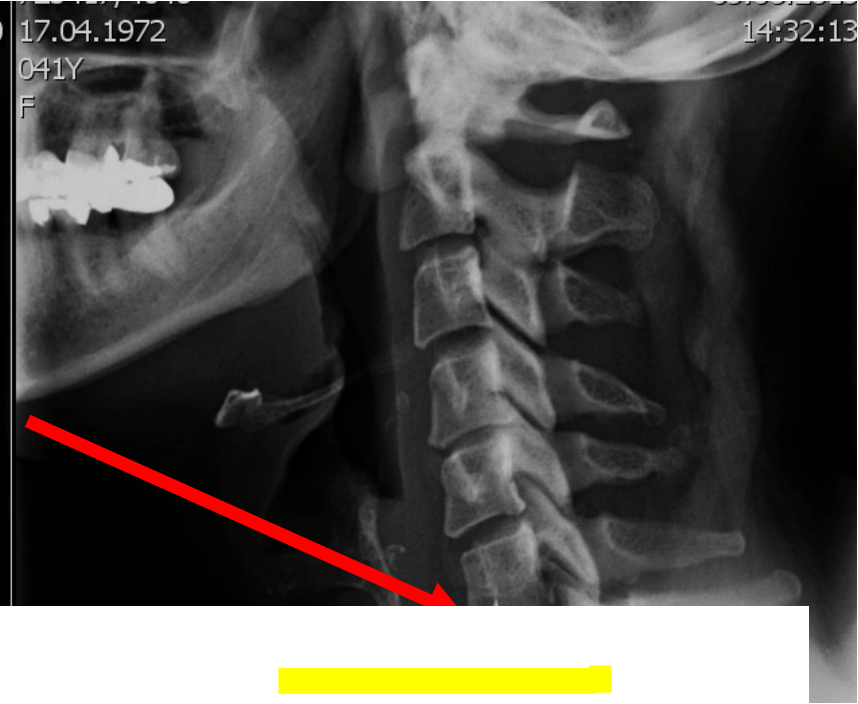
# CERVICAL PLATES - ventral stabilization

CASPAR

SYNTHESES

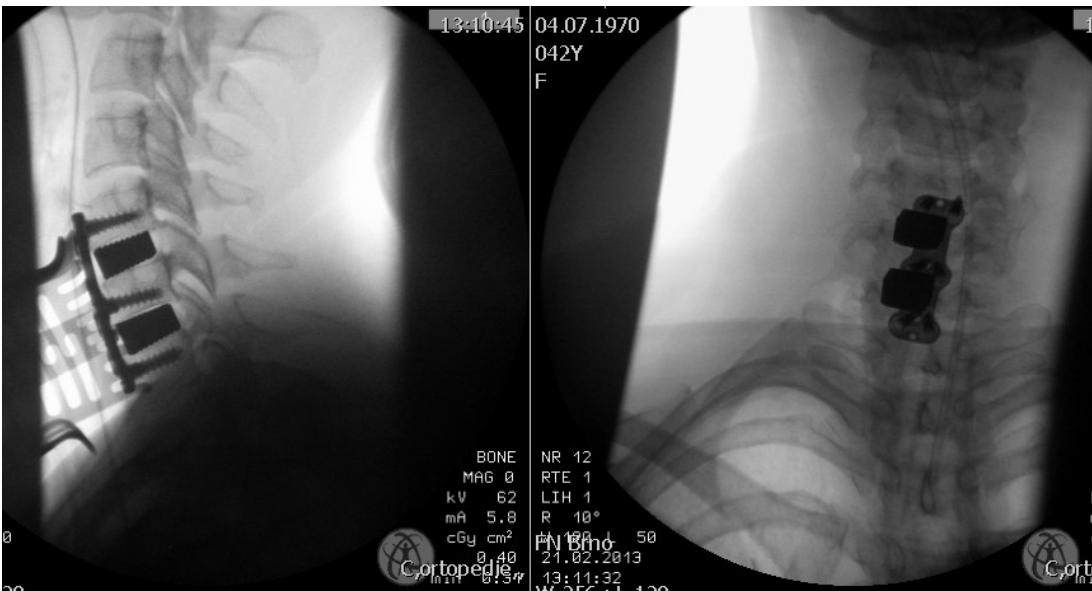


# INTERSOMATIC FUSION C6/7

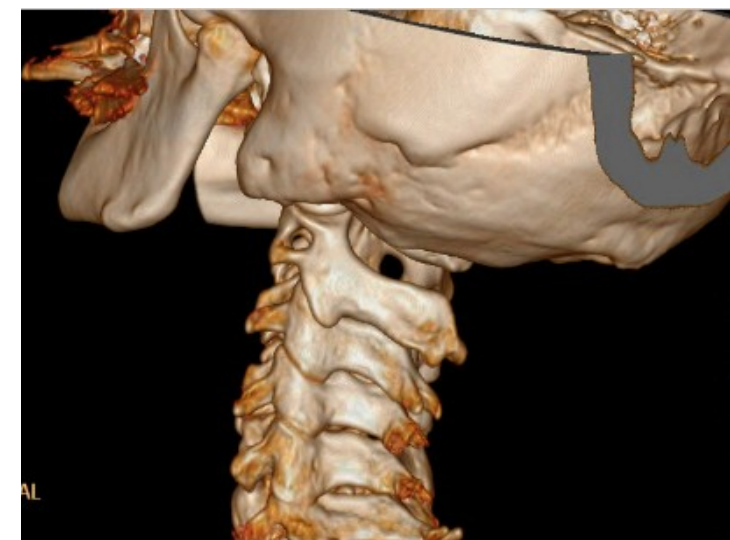


<https://www.zimmer-biomet/mec-cervical-cage/R/C%20Product%2>

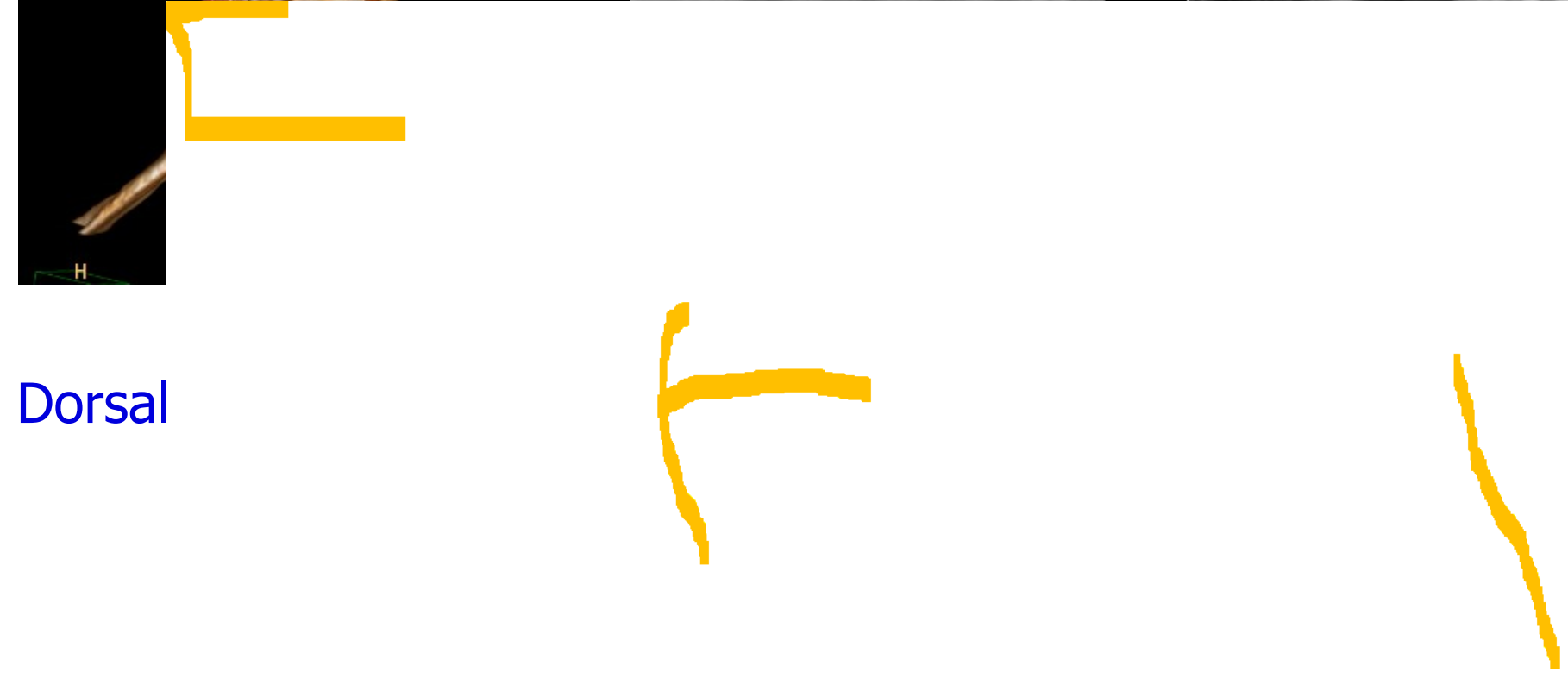








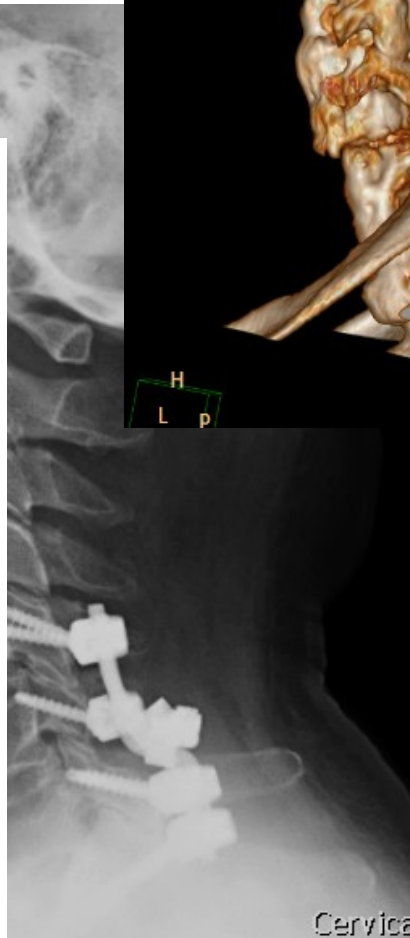
SE:8128 SIPKA,LUBOMIR,  
IM:1 ACCES#1965301  
24.10.2012 511220/100



Dorsal



C<sub>III</sub> W 16383 : L 8192



# MISS (Mini Invasive Spine Surgery)

## VERTEBROPLASTY

- pain reduction 70-90%
- fracture stabilization
- does NOT adjust vertebral height
- HIGH pressure cement application !
- HIGH risk of **leaking cement** (65%) !!

could be outpatient



Vertebroplasty

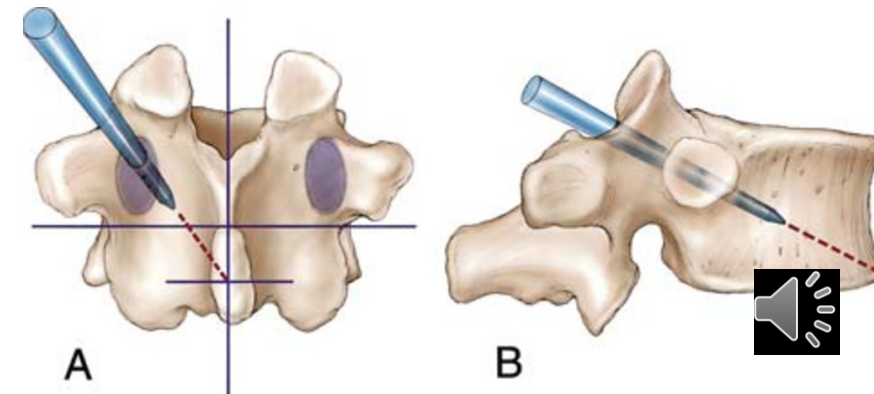
## KYPHOPLASTY

- pain reduction 90%
- fracture stabilization
- **adjustment** of vertebral height especially in **acute** fractures
- creation of cavity **reduces the risk** of leakage (10%)
- **general anaesthesia**



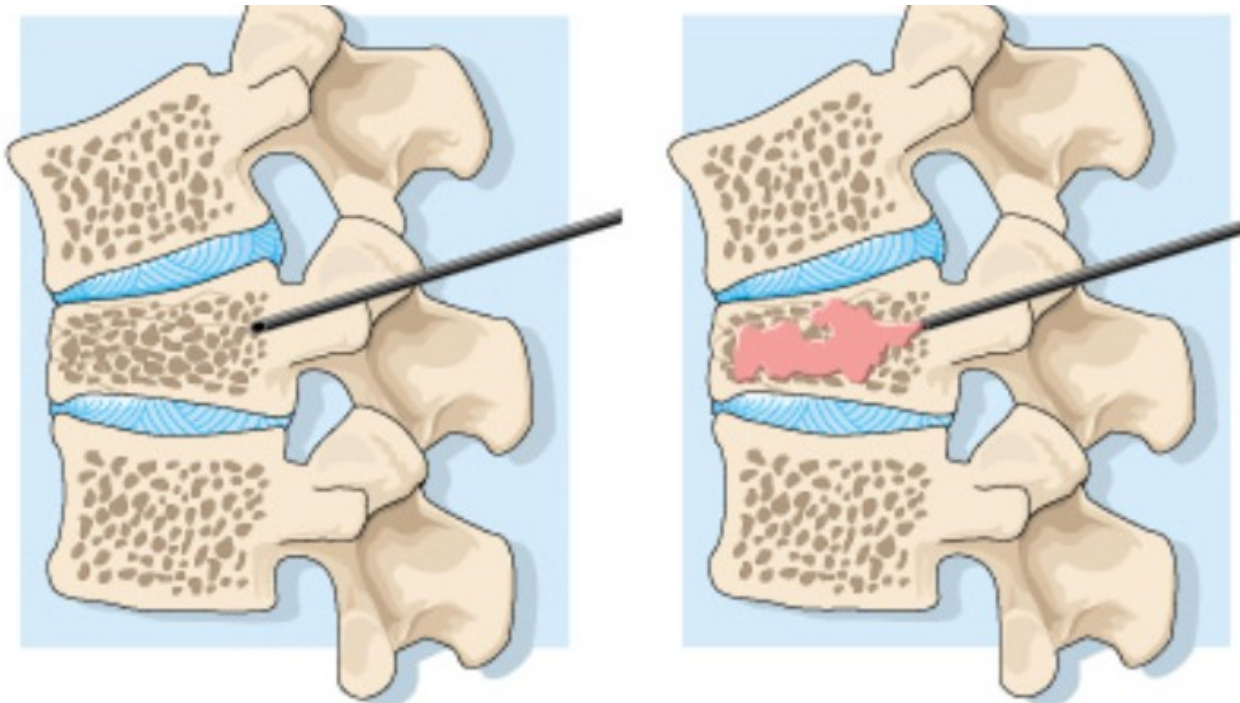
Kyphoplasty

Fourney DR, Schomer DF, Nader R, Chlan-Fourney J, Suki D, Ahrar K, Rhines LD, Gokaslan ZL. Percutaneous vertebroplasty and kyphoplasty for painful vertebral body fractures in cancer patients. J Neurosurg. 2003 Jan;98(1 Supl):21-30.



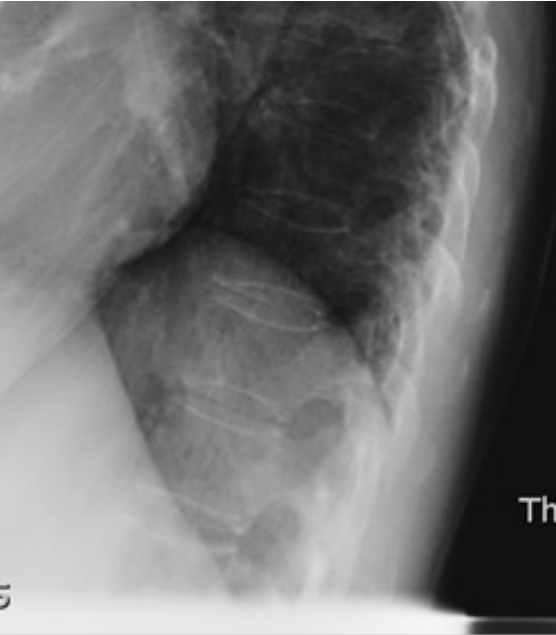
# VERTEBROPLASTY – potential risks

- Allergic reactions to medications
- Infection (occurs in less than 1 per 15,000 injections)
- Post-injection flare (nerve root irritation with pain several hours after treatment, which may last days or weeks)
- Depigmentation (a whitening of the skin)
- Local fat atrophy (thinning of the skin)
- Destruction of a motor or sensory nerve in the path of the needle
- Bleeding, nerve injury, organ injury and death are rare but possible
- **Cement leakage is possible.** The cement used in vertebroplasty is in a liquid form and is squeezed into the fractured vertebra under high pressure. Some of the cement commonly leaks out of the vertebra, but this usually doesn't cause any problems. Only rarely does a cement leak cause pressure on the spinal cord or nearby nerves. In these cases, surgery may be required to remove the pressure.

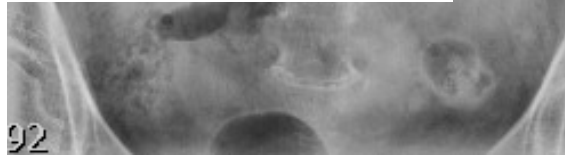
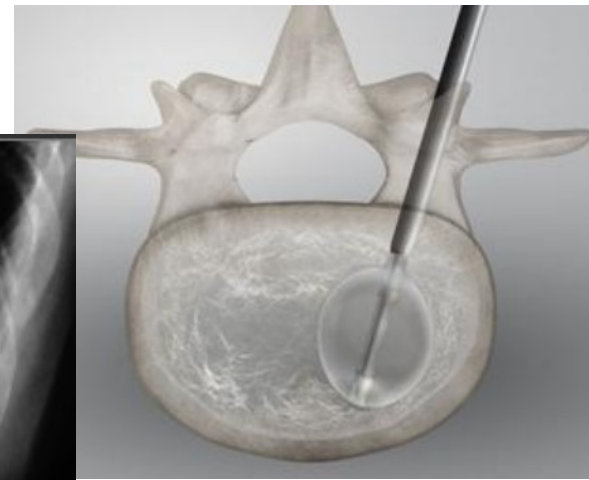
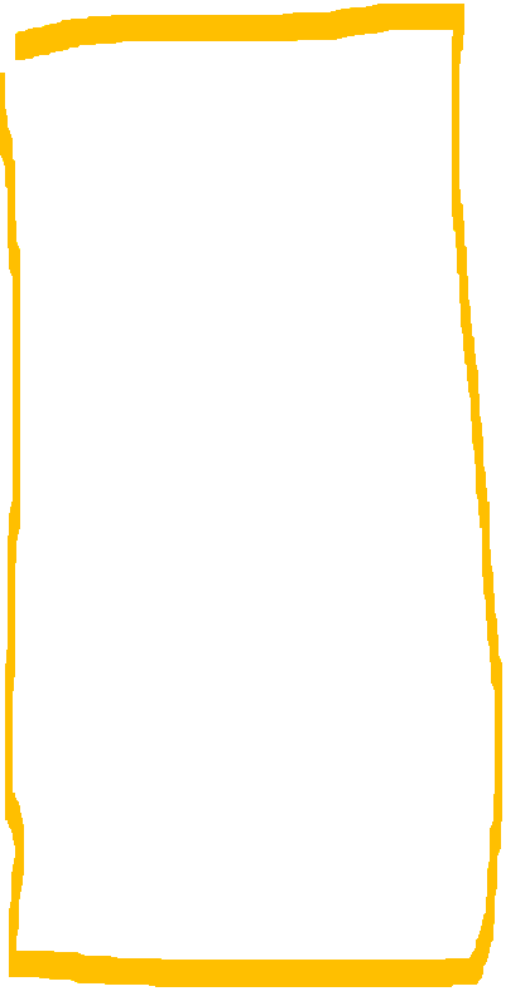


<http://www.painmanagementexperts.com/vertebroplasty-for-compression-fractures/>

# VERTEBROPLASTY

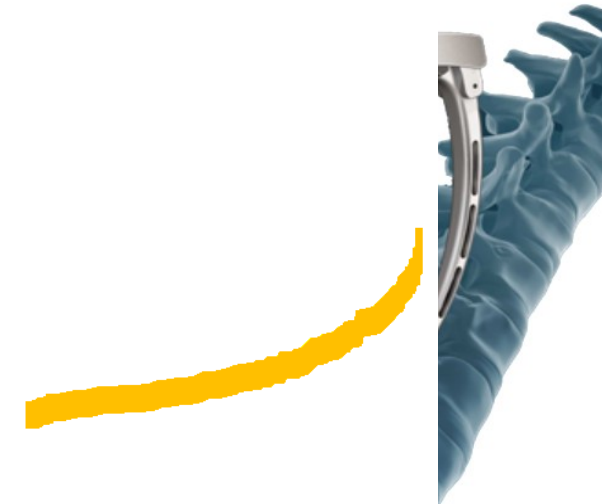


# KYPHOPLASTY



# MISS (Mini Invasive Spine Surgery)

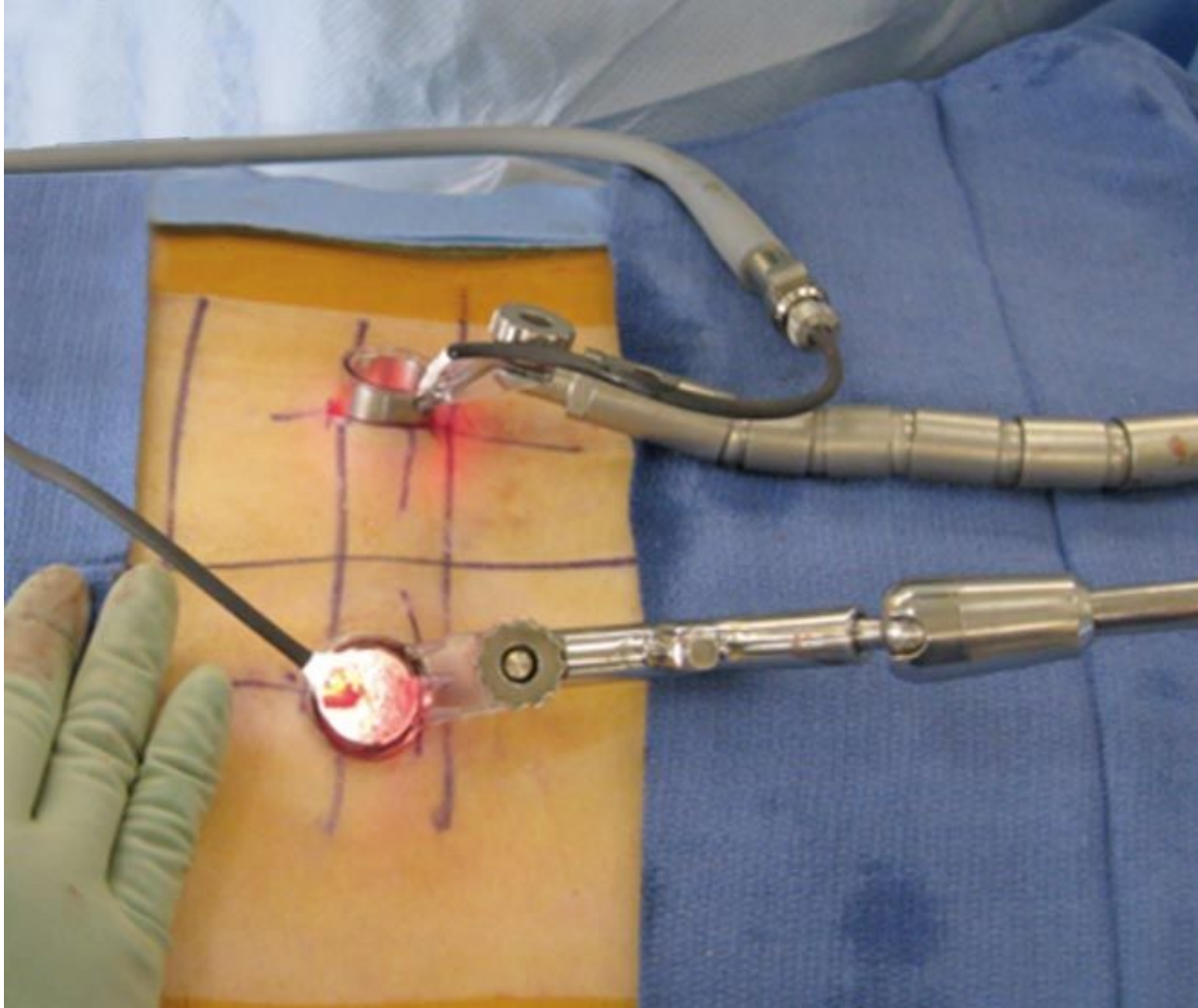
## PERCUTANE FIXATION & DECOMPRESSION



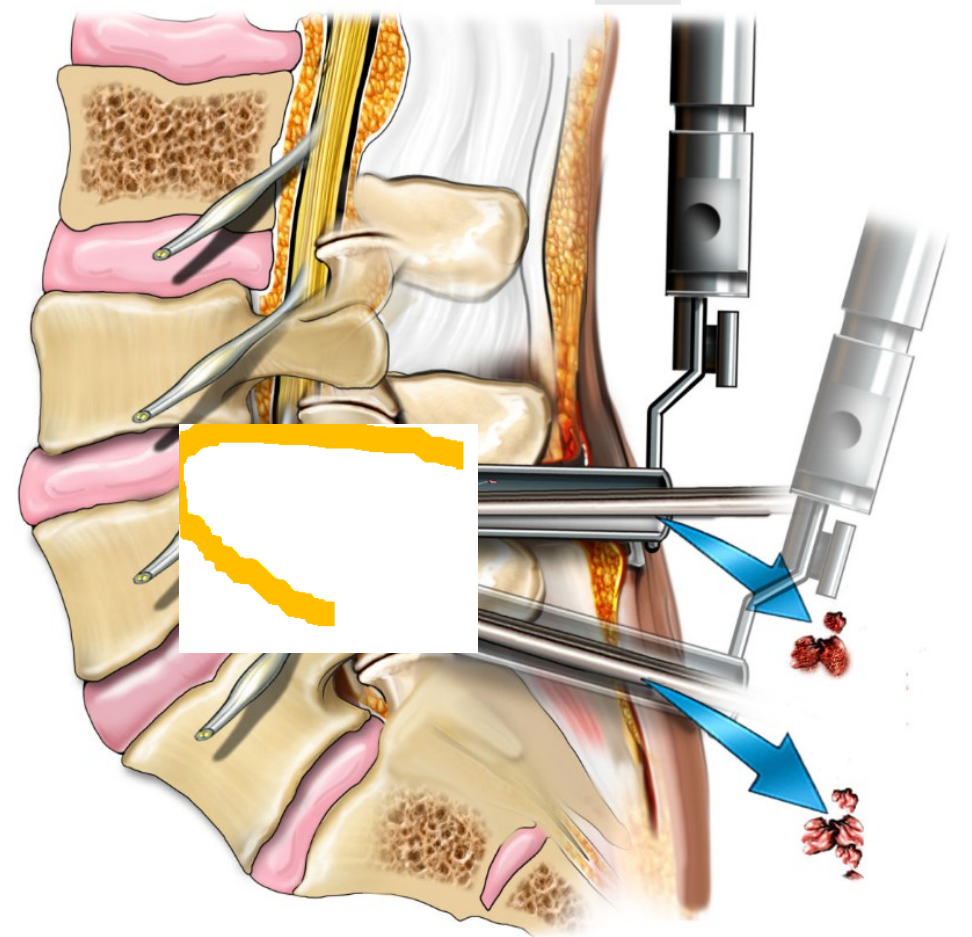
Sehmi S, Strasser E, Gahr RH, Haslam J, Strasser E, Gahr RH. Role of early minimal-invasive spine fixation in acute thoracic and lumbar spine trauma. Indian J Orthop. 2007 Oct;41(4):374-80. doi: 10.4103/0019-5413.37003.

# MISS (Mini Invasive Spine Surgery)

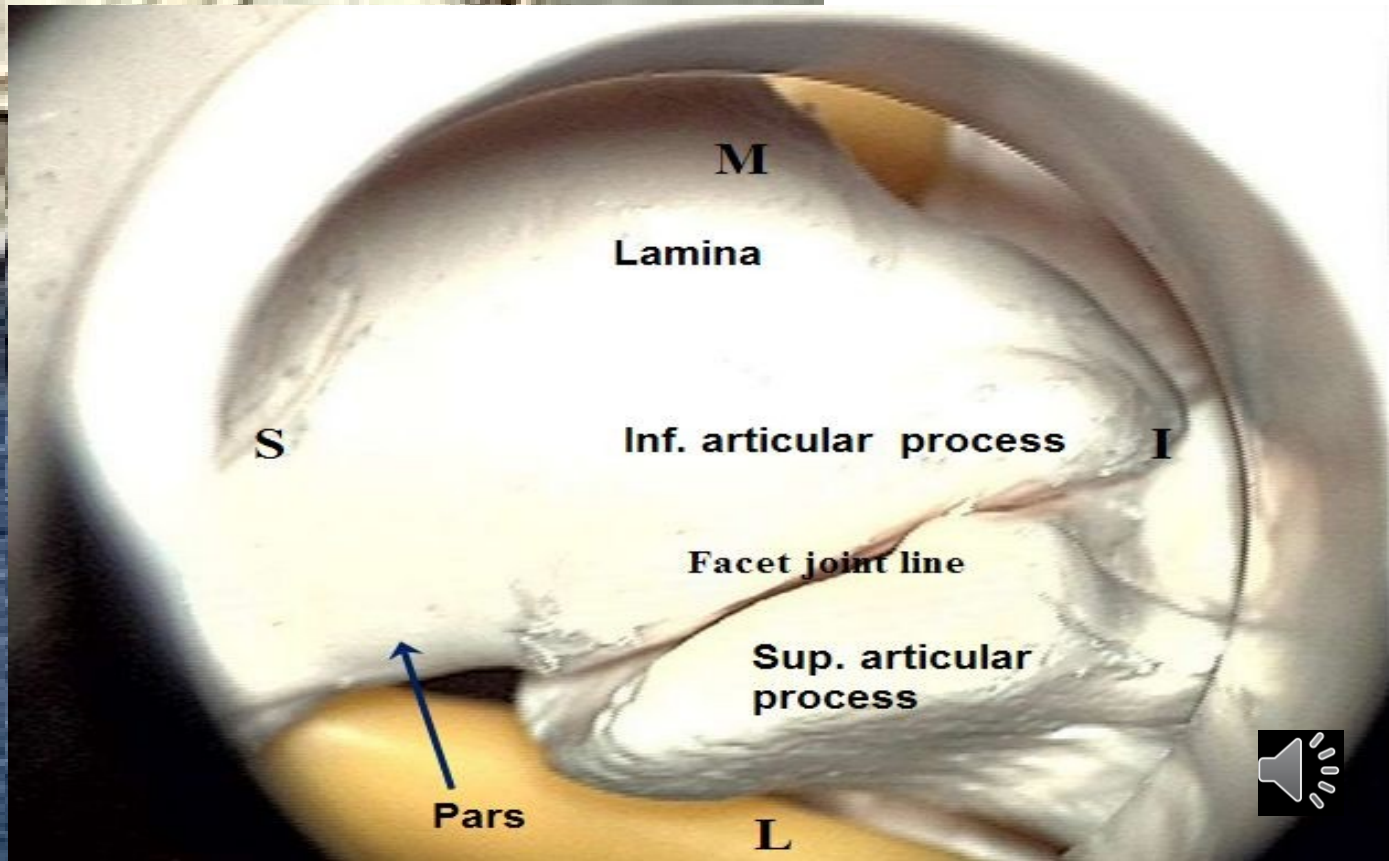
## PERCUTANE FIXATION & DECOMPRESSION



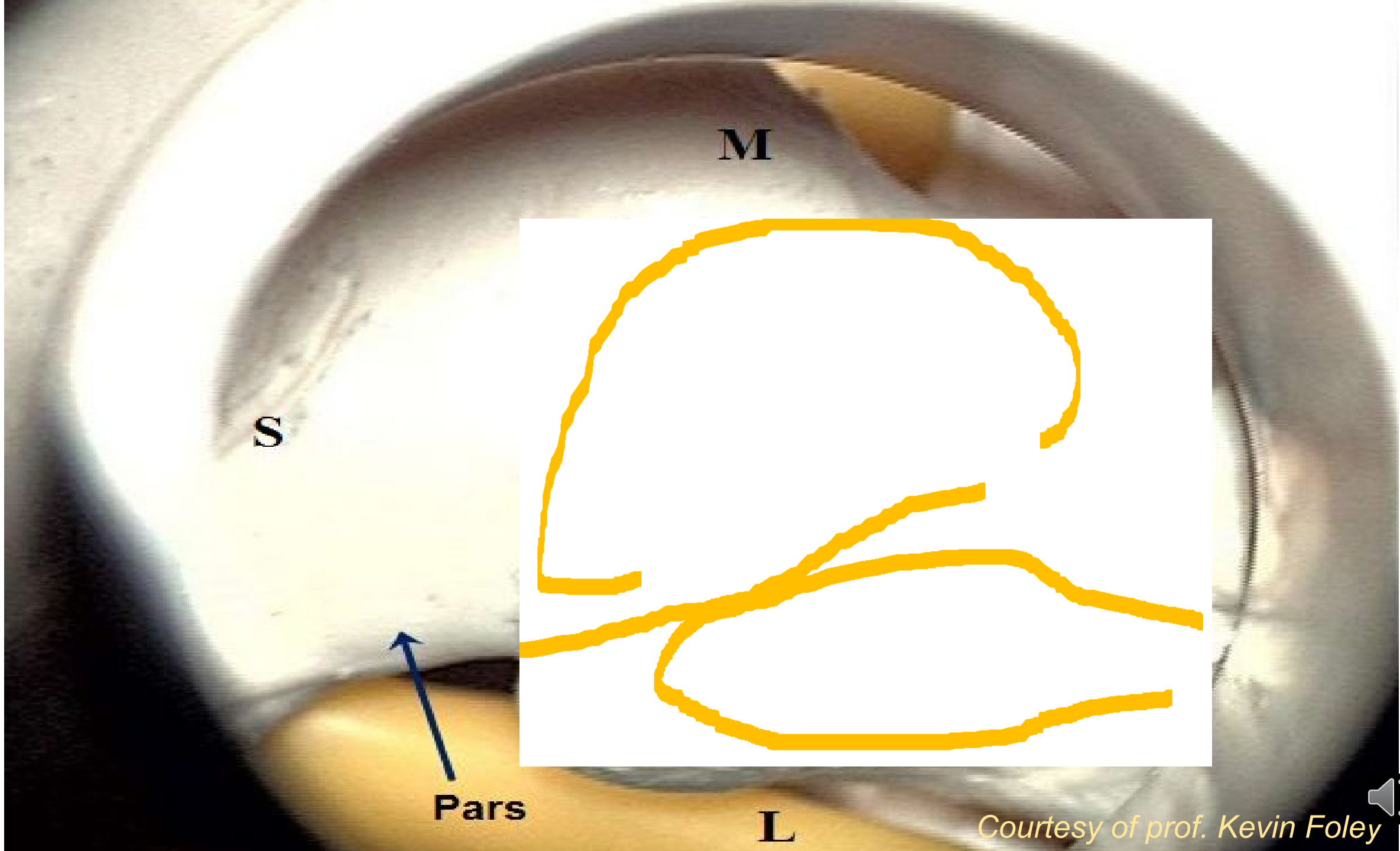
Kim C, Siemionow K, Anderson D, Phillips F: The current state of minimally invasive spine surgery, in Egol K, Tornetta III P, eds: Instr Course Lect, 60. Rosemont, IL, American Academy of Orthopaedic Surgeons, 2011, 353-370.



Nucleus Medical Media (2020). *Minimally invasive disc removal* [Digital image]. Retrieved from <https://ebSCO.smartimagebase.com/minimally-invasive-disc-removal/view-item?ItemID=22128>







**M**

**S**

**Pars**

**L**

*Courtesy of prof. Kevin Foley*



**Traversing  
nerve root**

**Caudal**

**Exiting nerve root**

**Lateral**

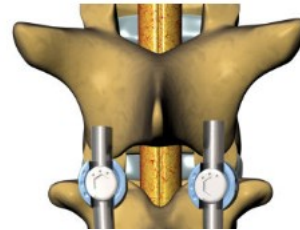
*Courtesy of prof. Kevin Foley*



# VI. INSTRUMENTATION OF THE SPINE

## TRAUMATIC

□ Instrumentation should to



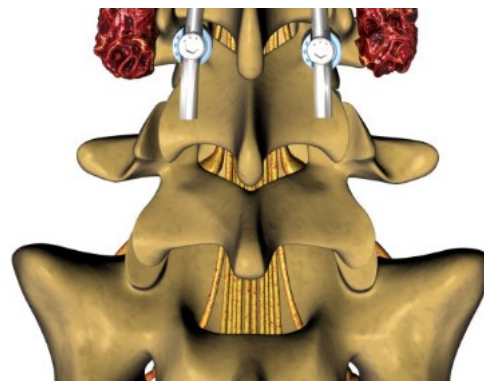
□ The instrumentation is usually **removed** after fractures have healed

Nucleus Medical Media (2020). *Posterior spinal fusion* [Digital image]. Retrieved from <https://ebSCO.smartimagebase.com/posterior-spinal-fusion/view-item?ItemID=69744>

## DEGENERATIVE & DEFORMITY

□ The instrumentation helps to create

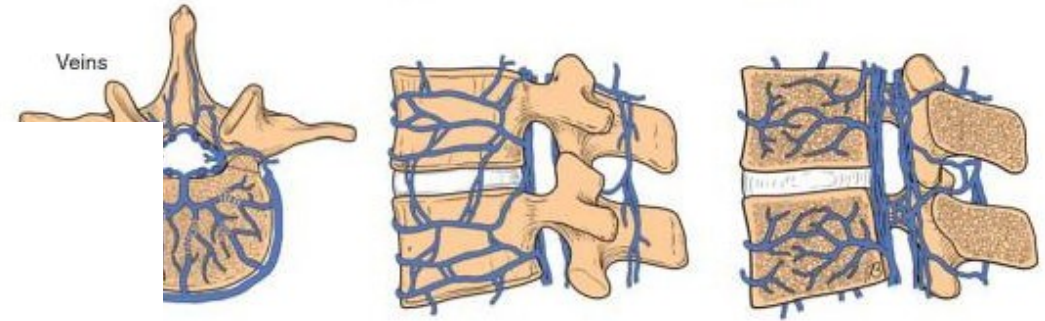
l  
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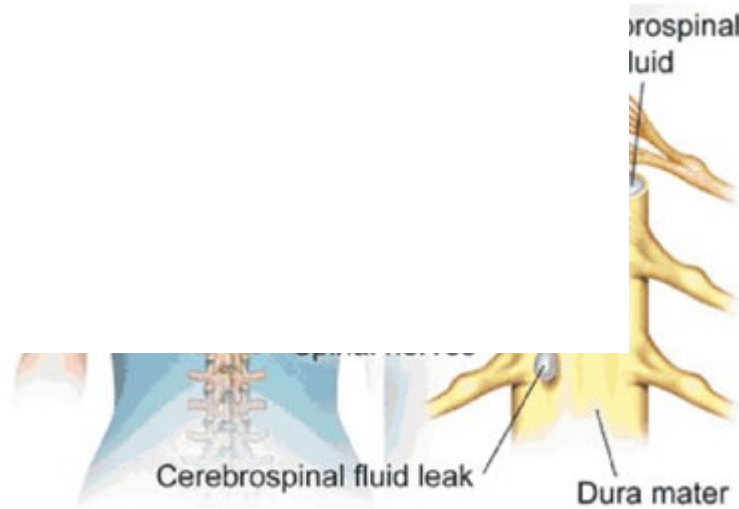
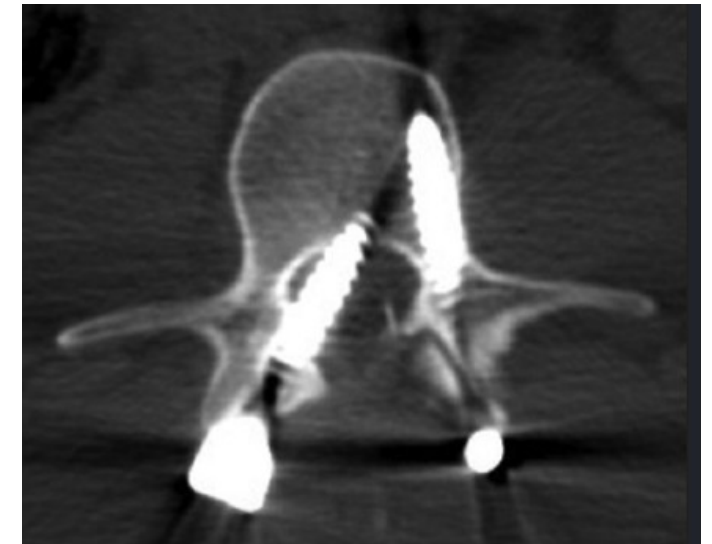
(= **immobilization of operated extent!**)

□ Instrumentarium **stays** in the body for **rest of life**

# Complications of surgical treatment



n)



- early, late

[www.pauljeffordsmd.com/understanding-the-risks-of-spine-surgery](http://www.pauljeffordsmd.com/understanding-the-risks-of-spine-surgery)



*Thank you for your attention*