

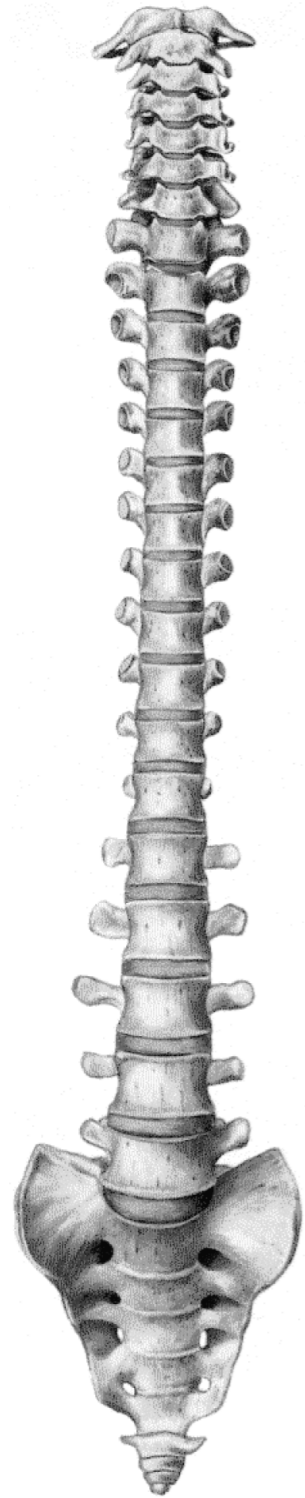


STRESS DISTRIBUTION + MOTION SEGMENT

Hakan BOZKUS, MD
American Hospital
Department of Neurosurgery



Balans of Spine



Coronal view

Lordosis

Kyphosis

Lordosis



Plumb line

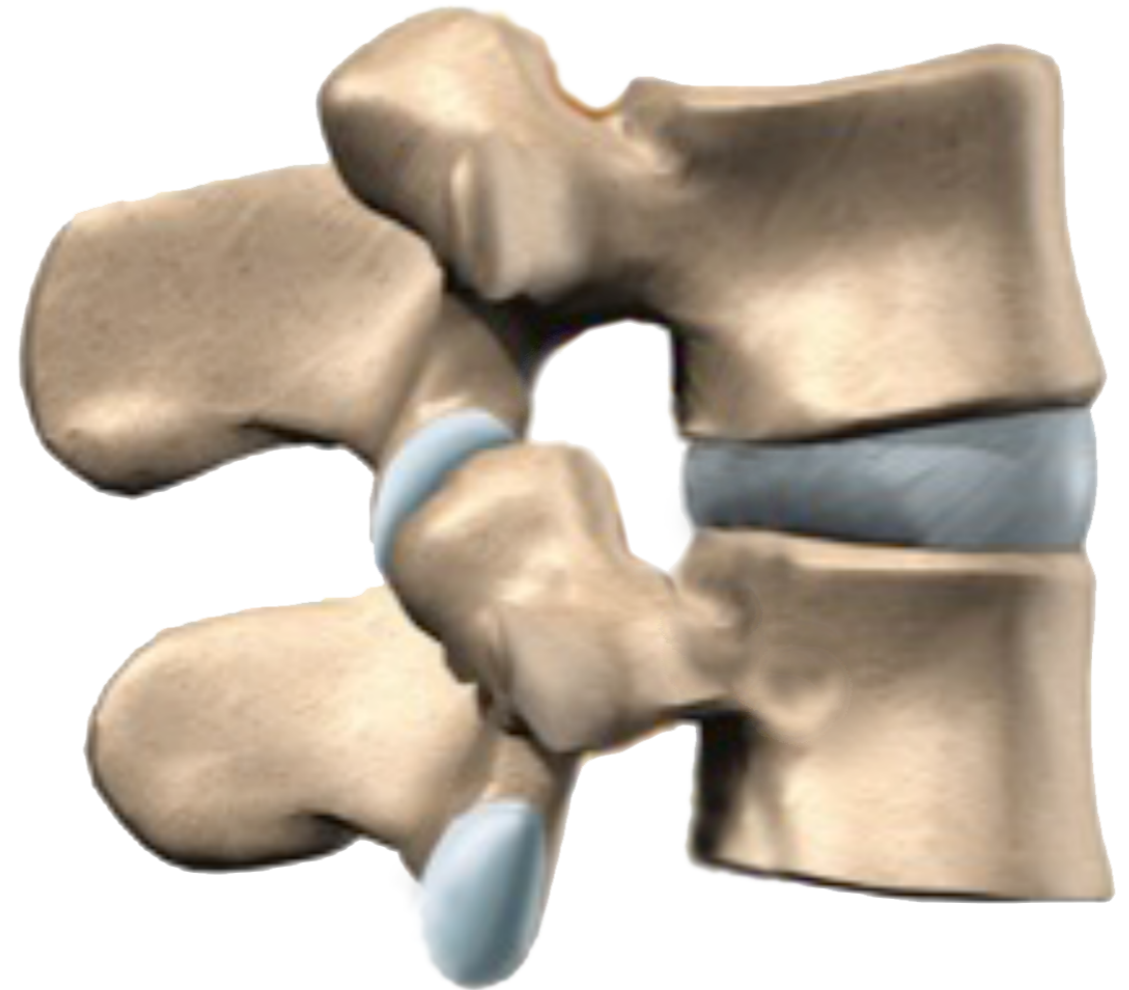
Sagittal view



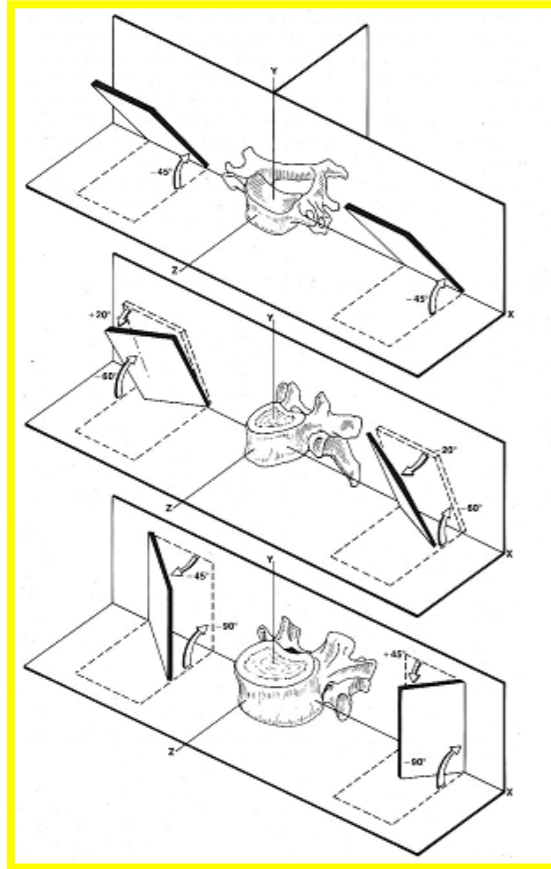
FSU

Functional Spine Unit

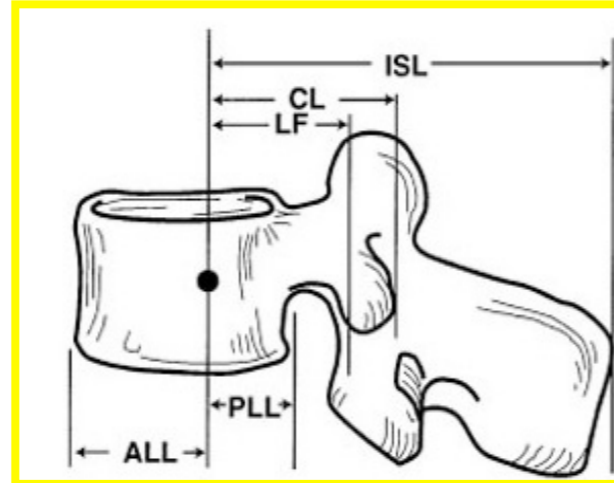
- Two adjacent vertebral bodies
- The facet joints
- The intervertebral disc
- Soft tissues (ligaments)



Structures



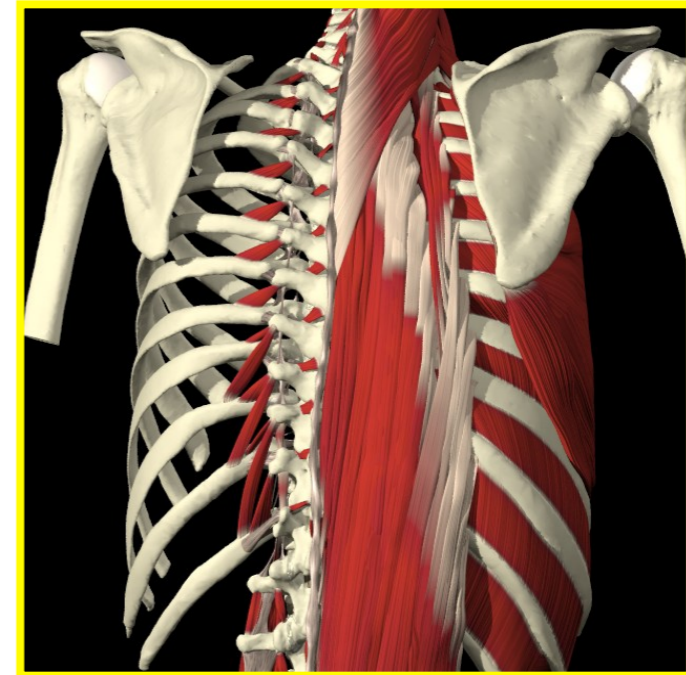
Facets



Ligaments

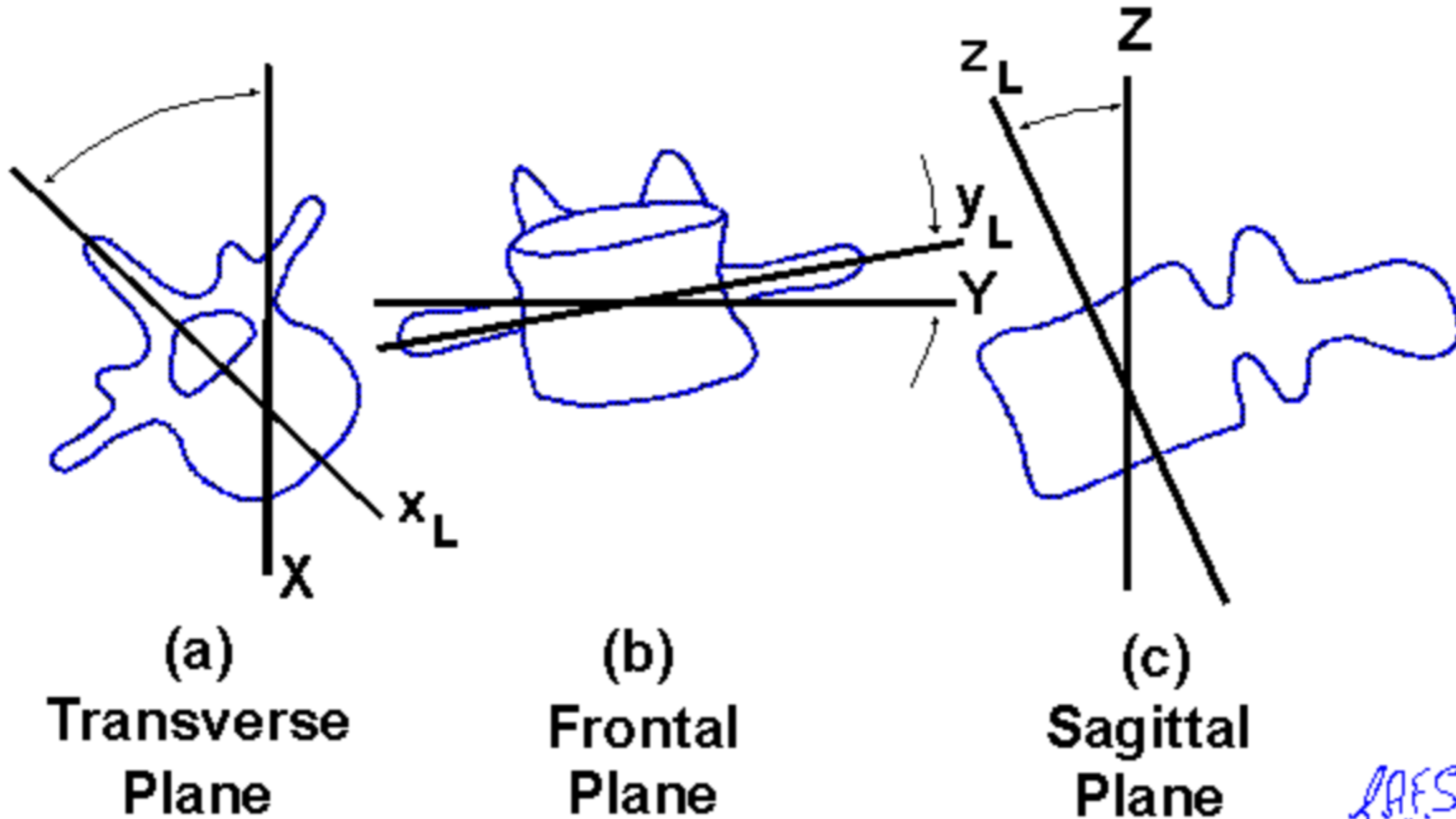


Intervertebral disc

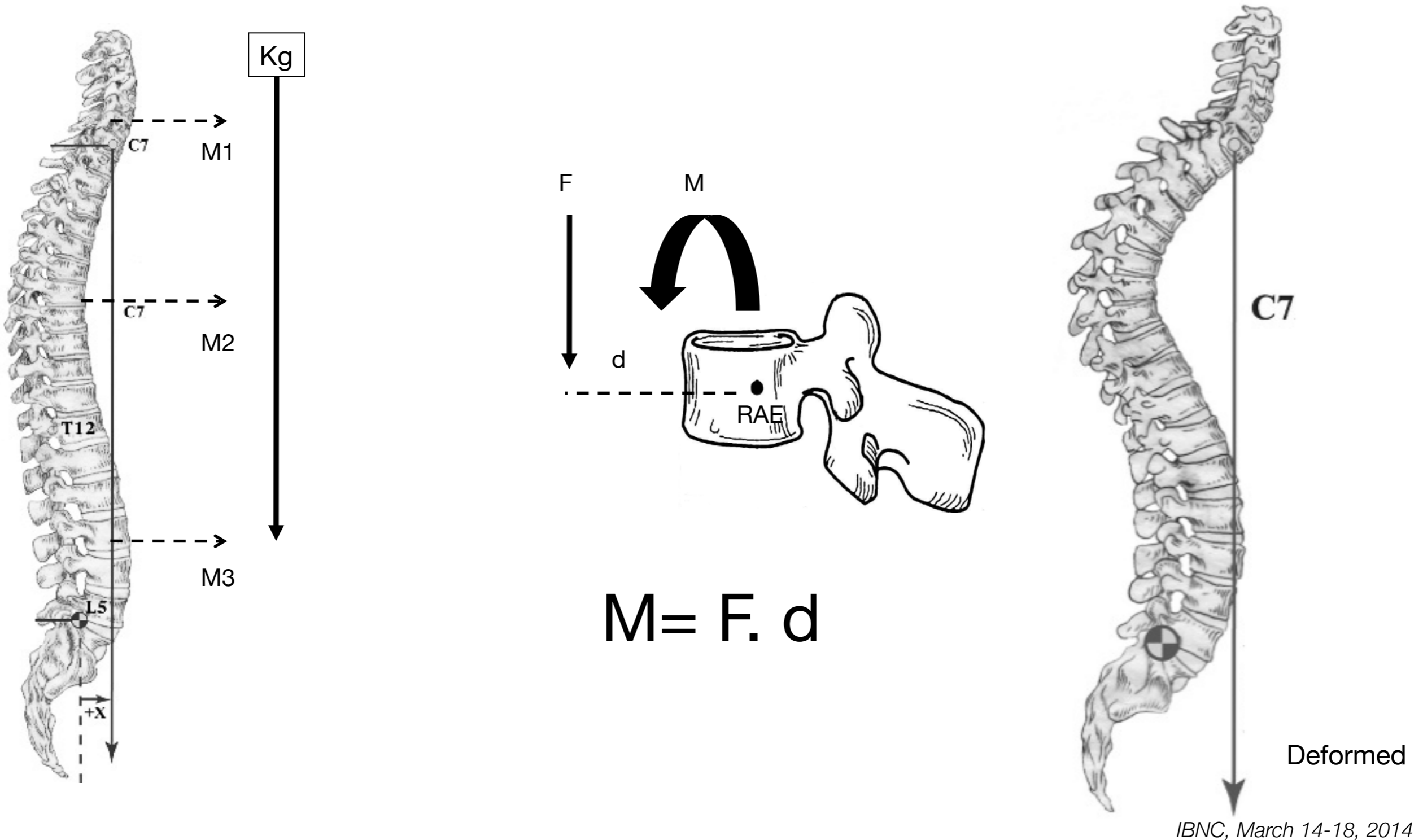


Muscles

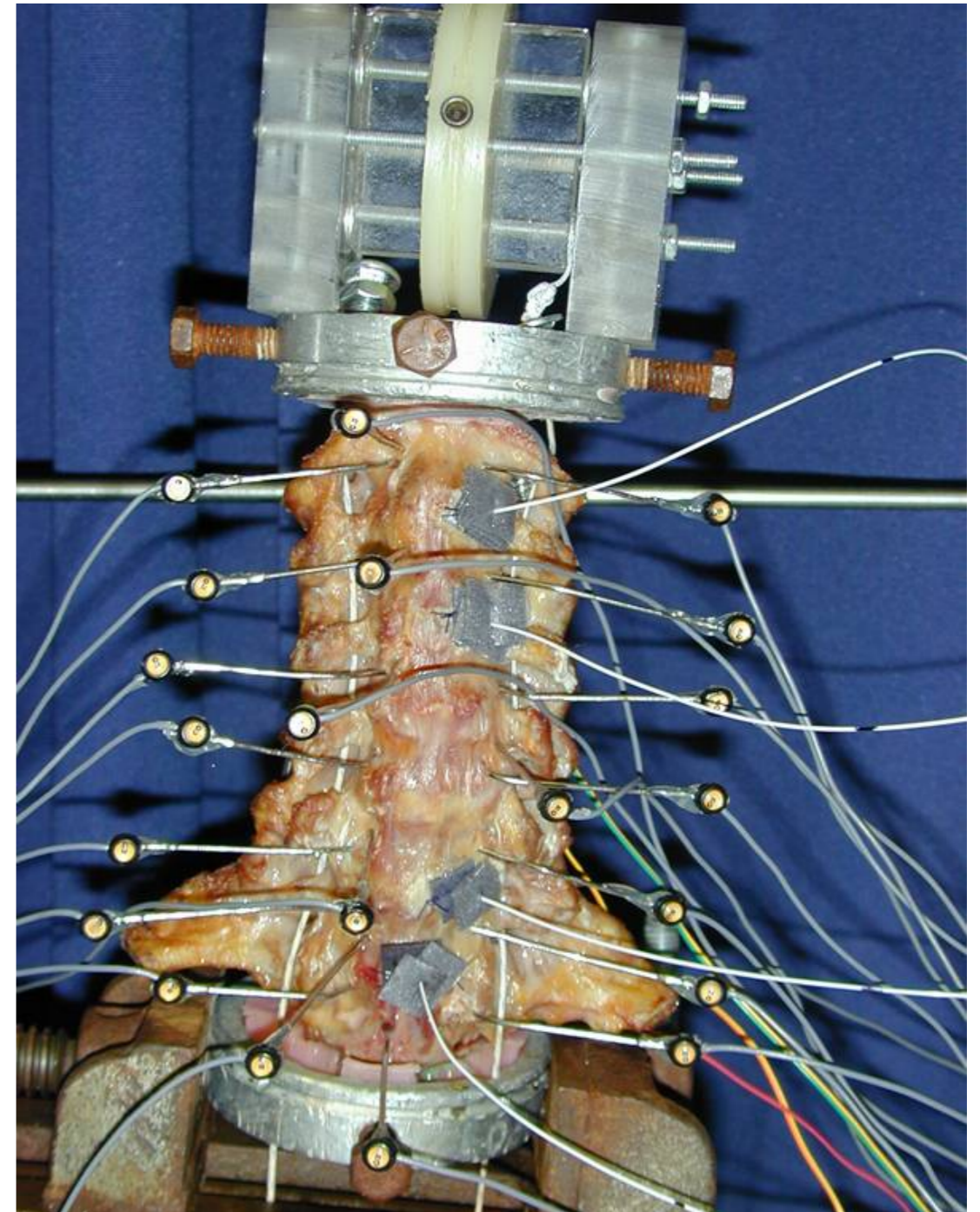
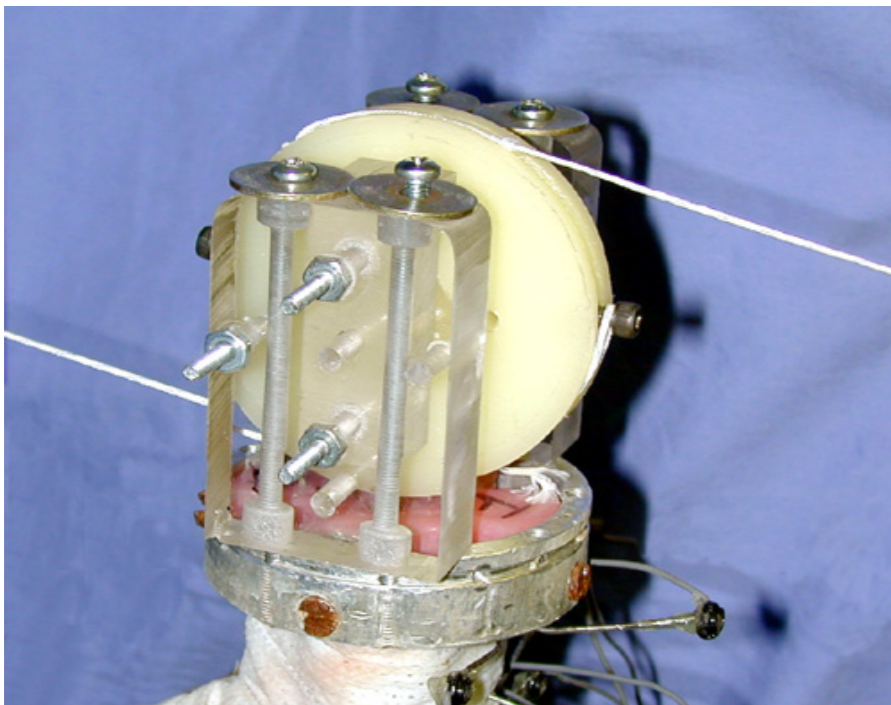
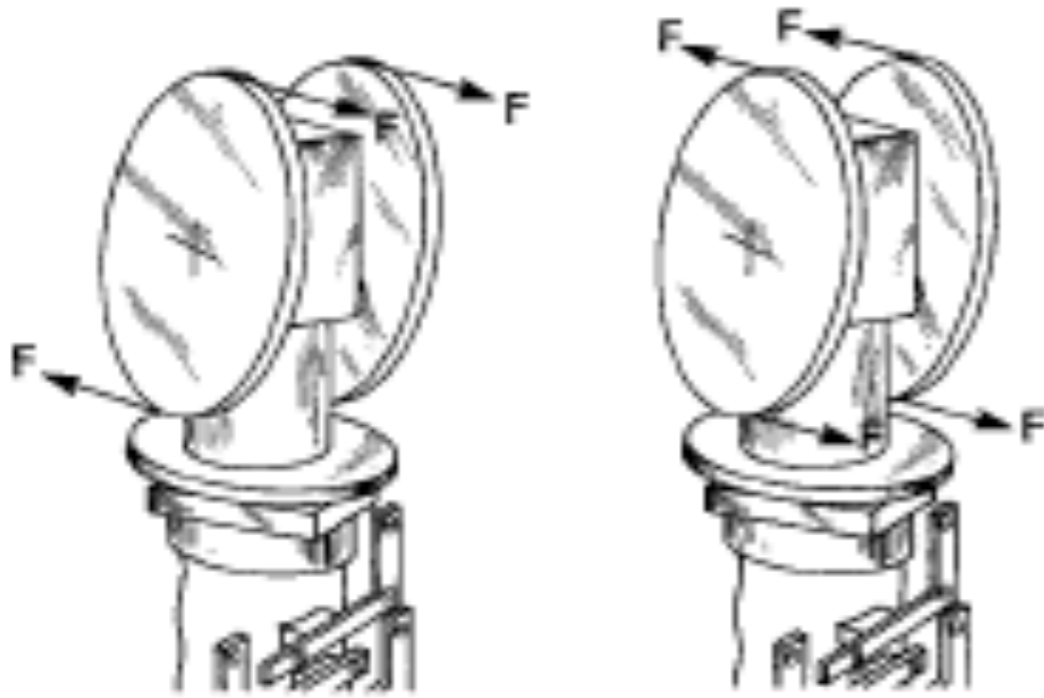
Planes



Moment



Moment Loading





Terms

- IAR (Instantaneous axis of Rotation)
- ROM (Range of Motion)



IAR

Instantaneous Axis of Rotation

- When a spine segment moves, there is an axis passing through, or close to, the vertebral body that does not move ; this is the axis about which the vertebral body rotates.



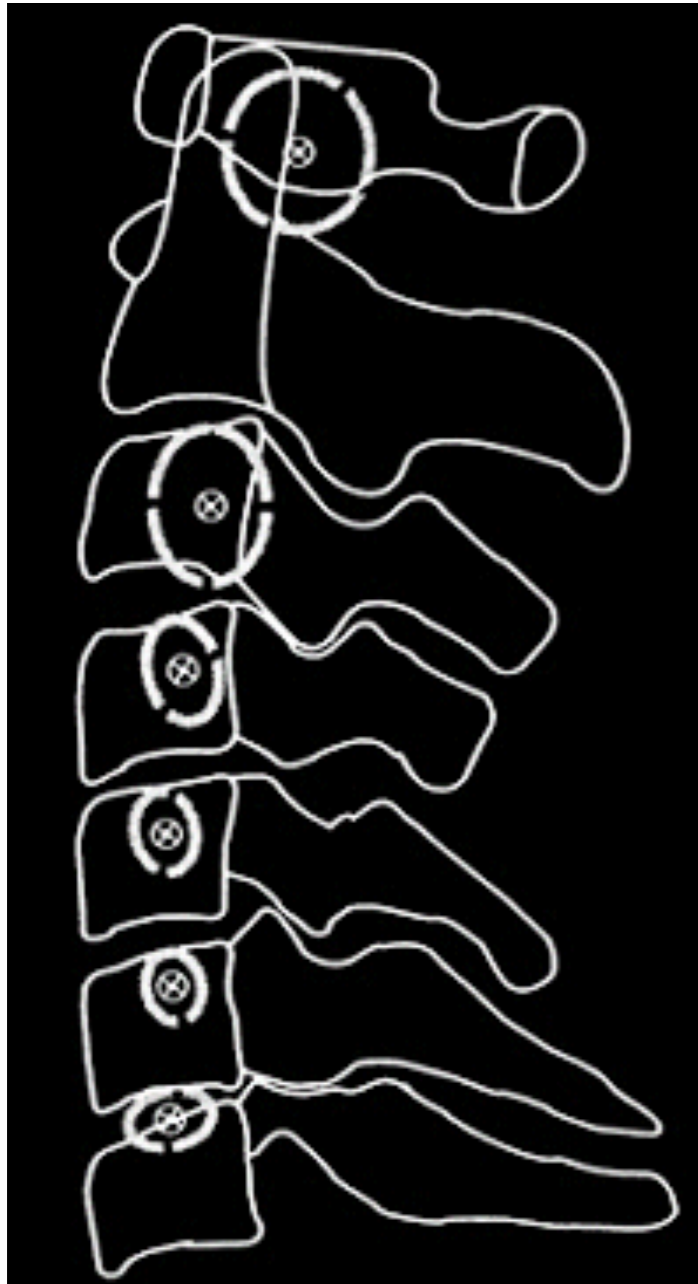
PLANAR IAR

2 translation vectors,
1 rotational angle

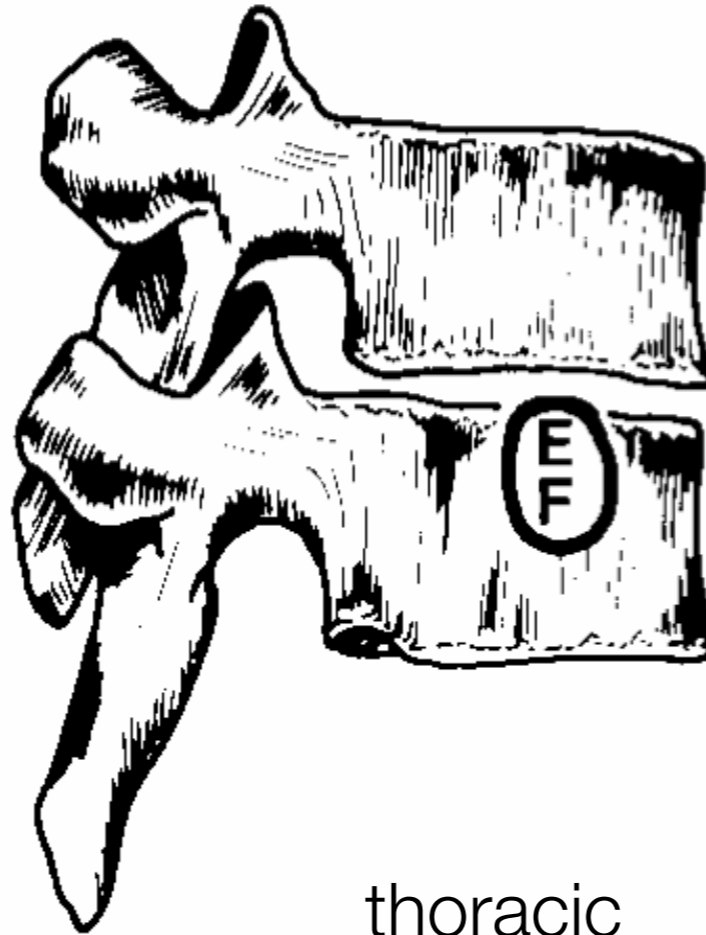


IAR

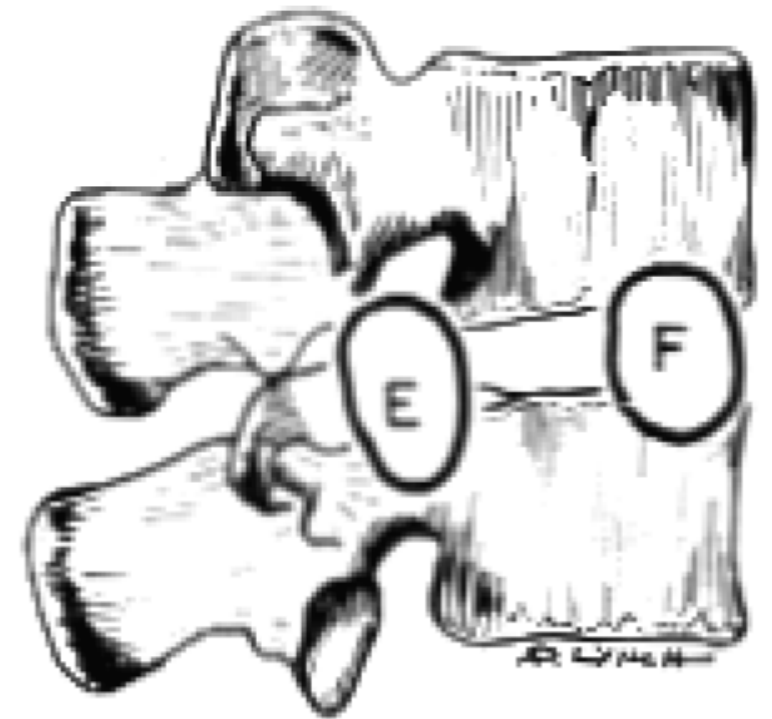
(Sagittal Plane)



cervical



thoracic

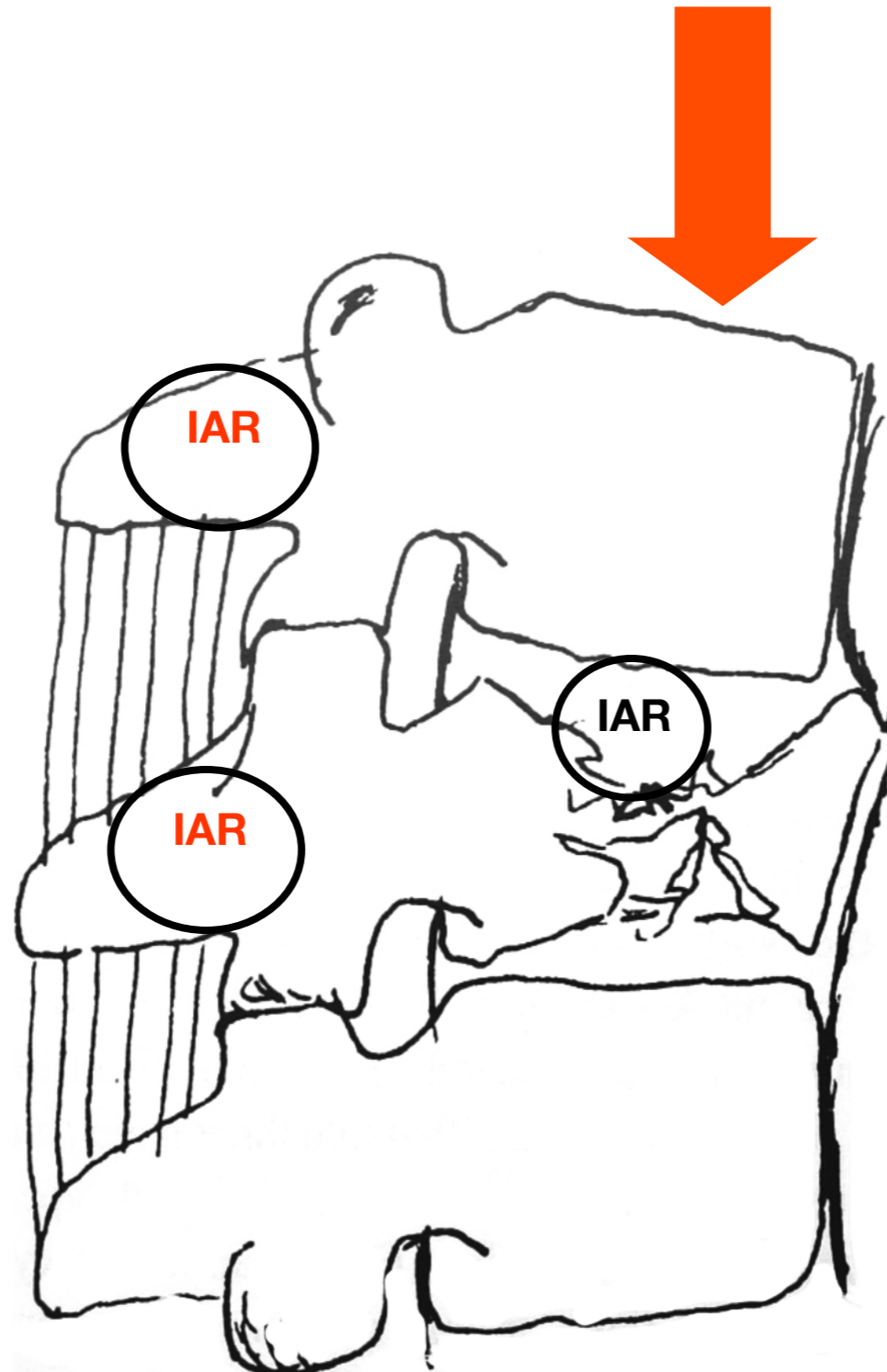


lumbar



Shifting IAR

Trauma



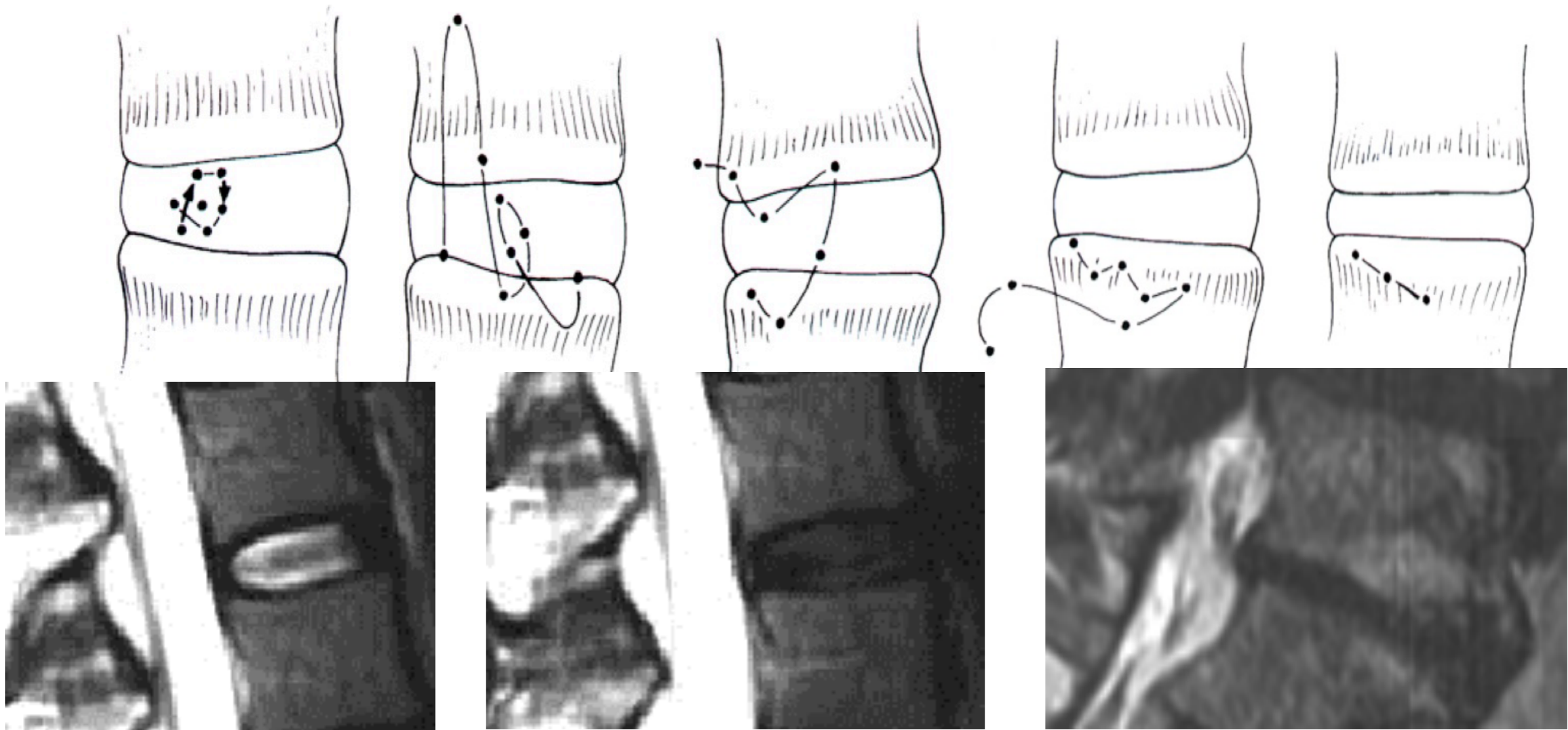
Unstable conditions !



Shifting IAR

Disc degeneration

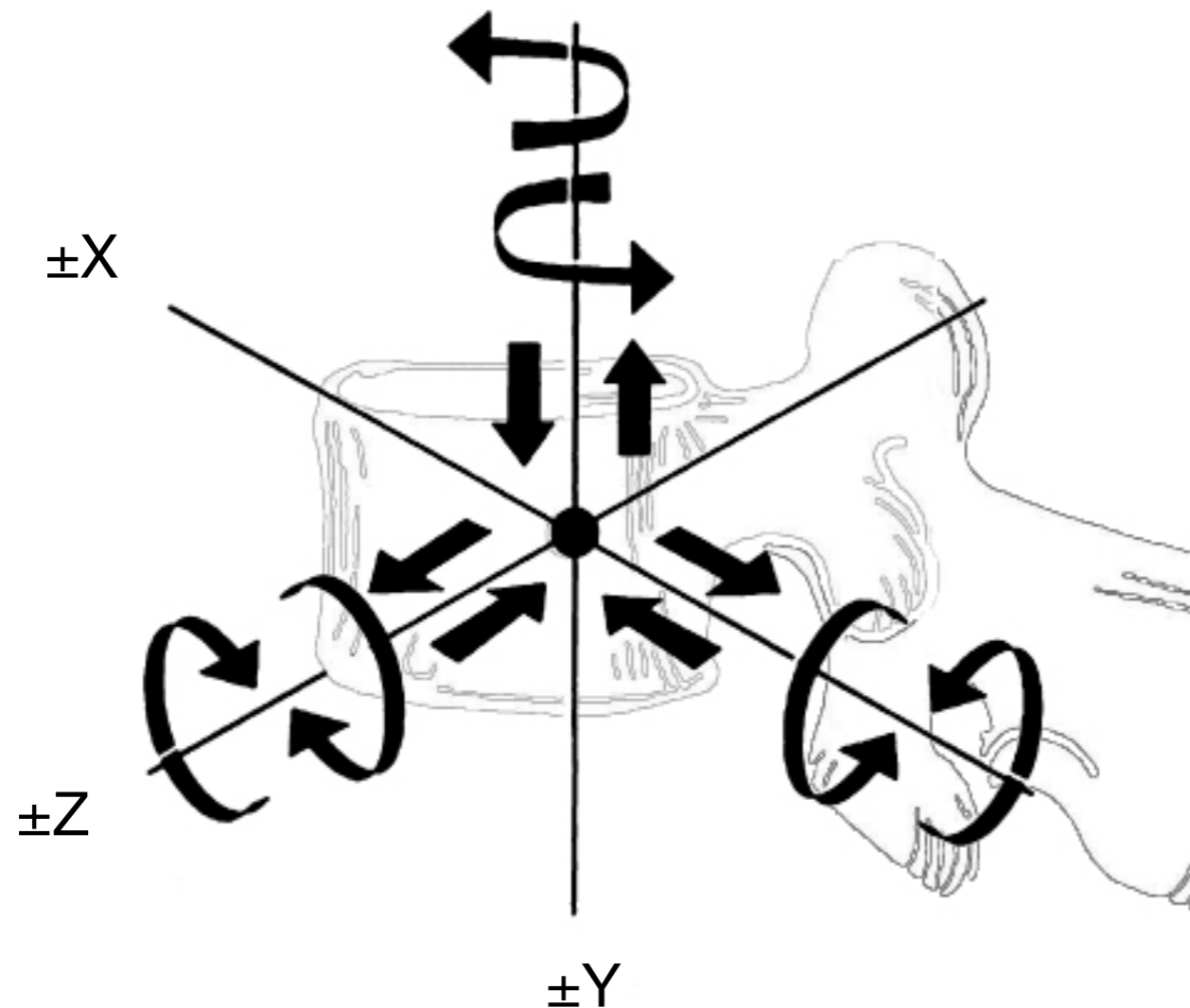
Sagittal plane of lumbar spine



ROM

(Range of Motion)

This is a potential of movement of each FSU



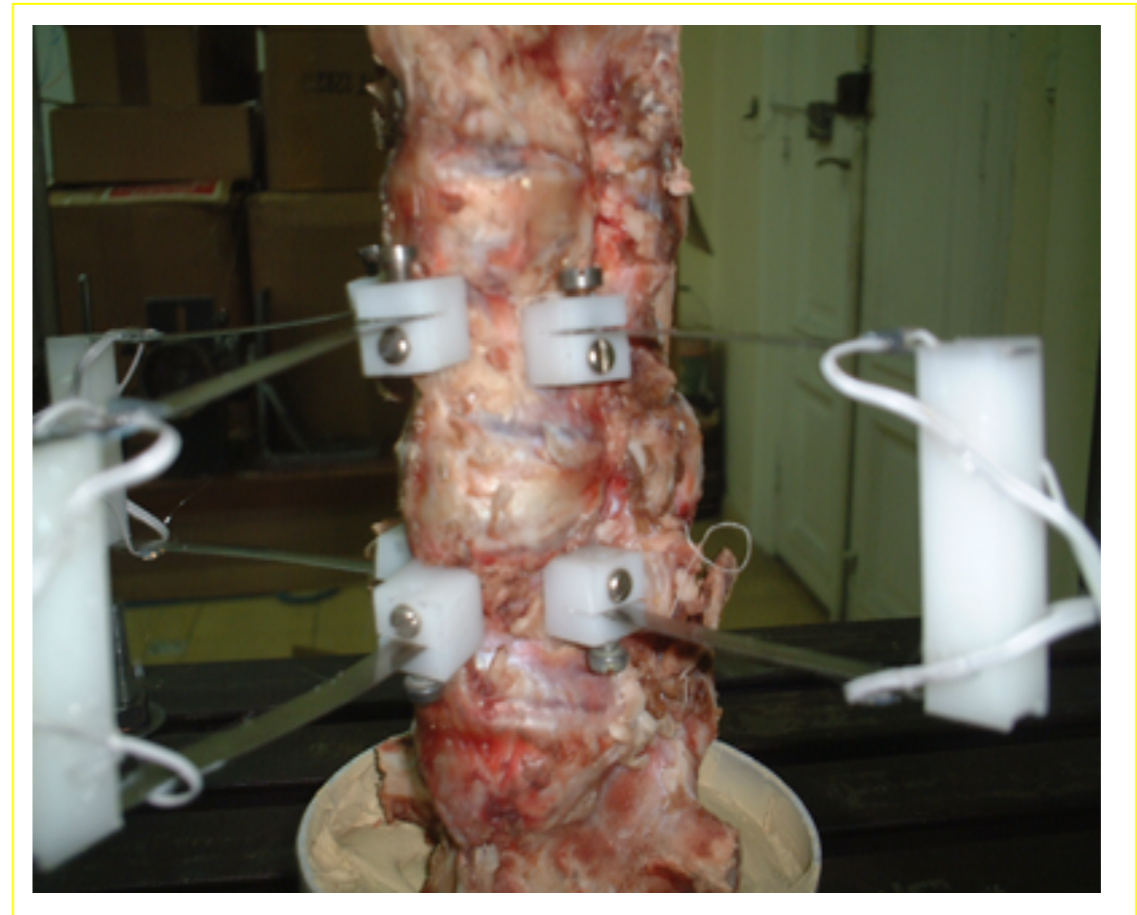
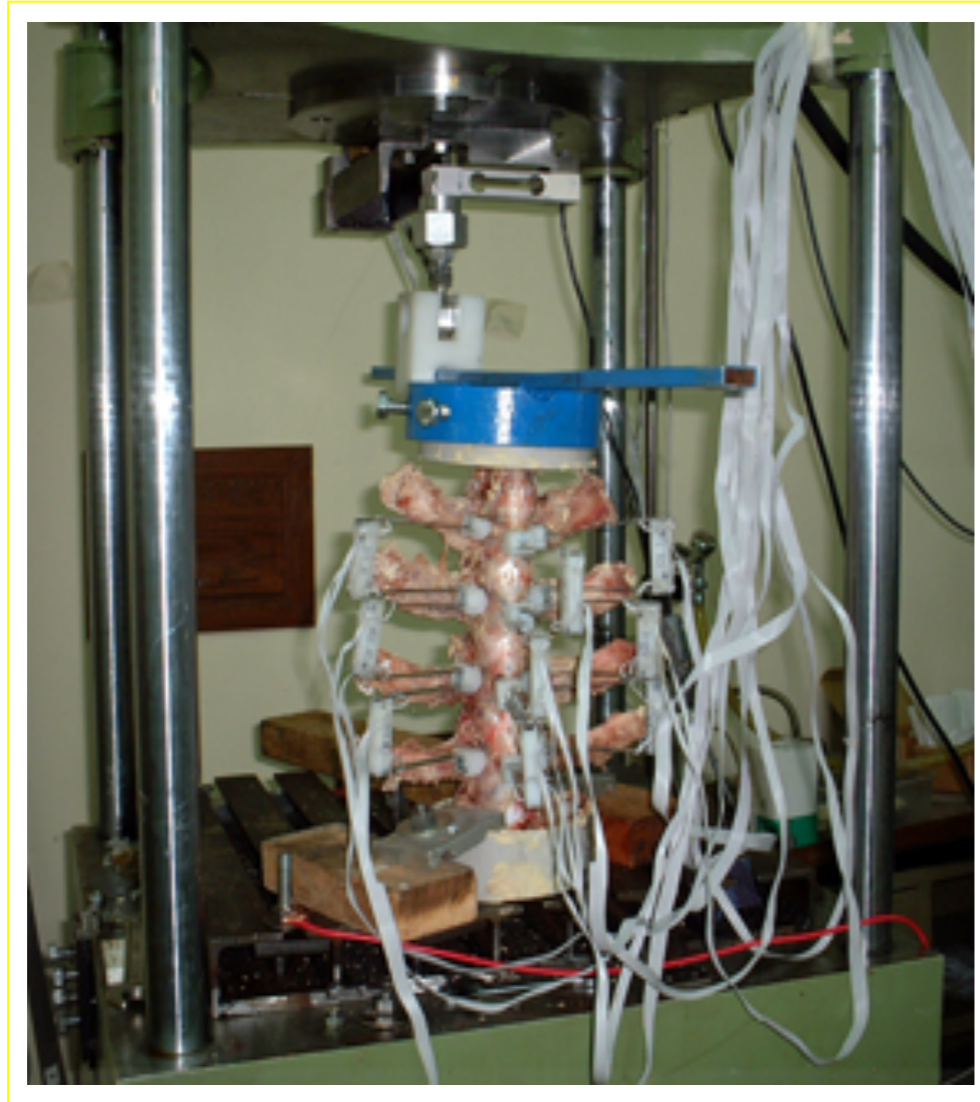
Koronal plan (\pm YX)
Sagittal plan (\pm YZ)
Aksiyal plan (\pm XZ)

3 rotations
3 translations

6 degrees of freedom



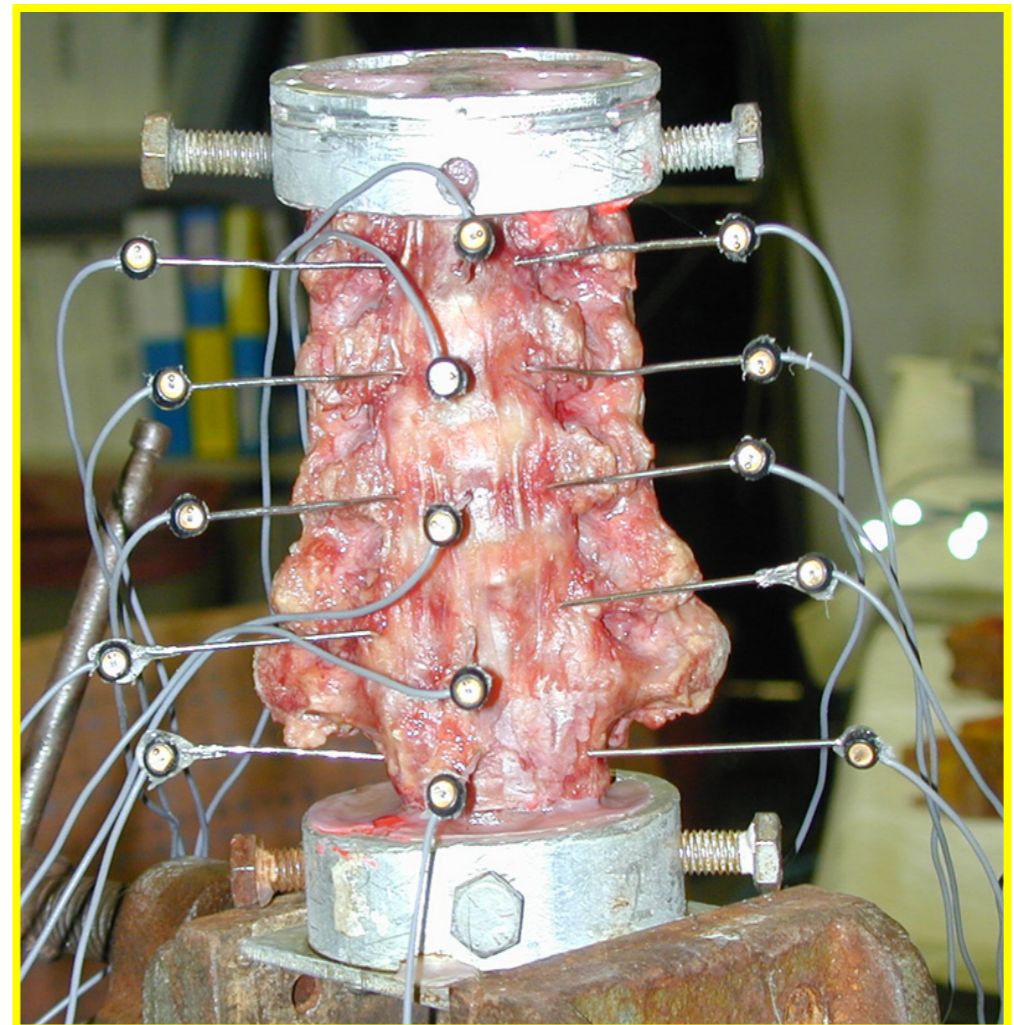
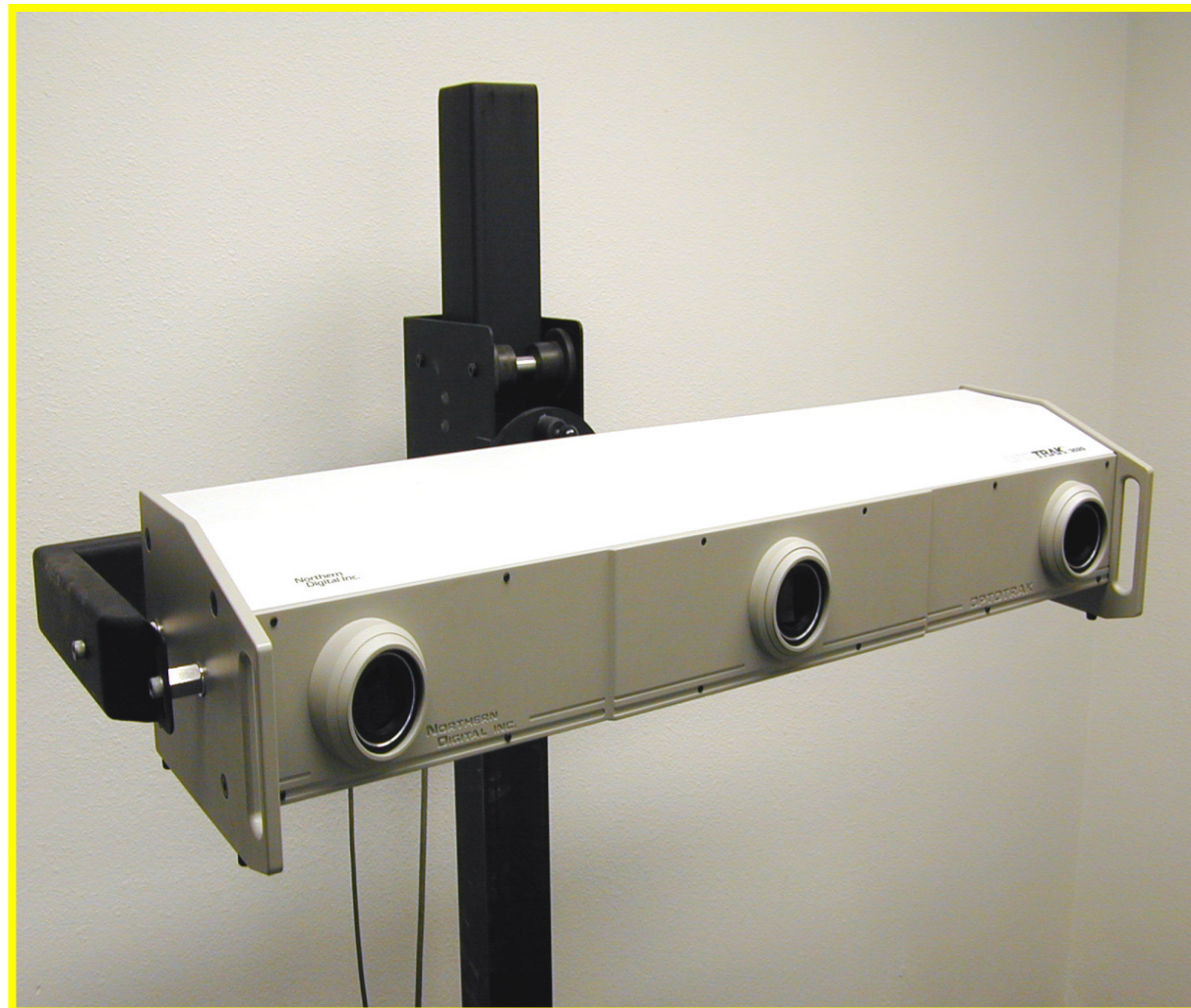
Measurement of ROM



Extensometer



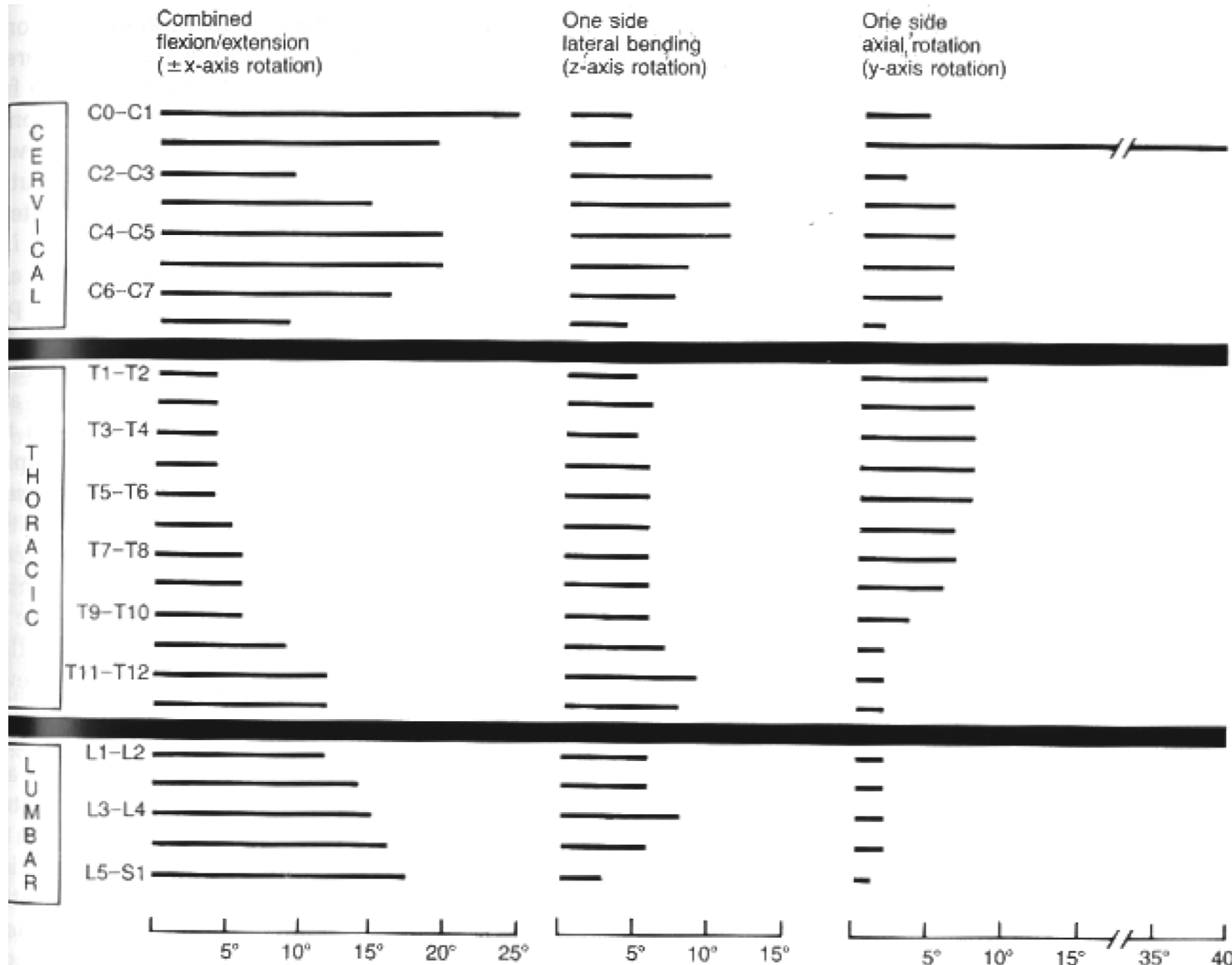
Measurement of ROM



Sterephotogrammetry



ROM





Mechanical Terms

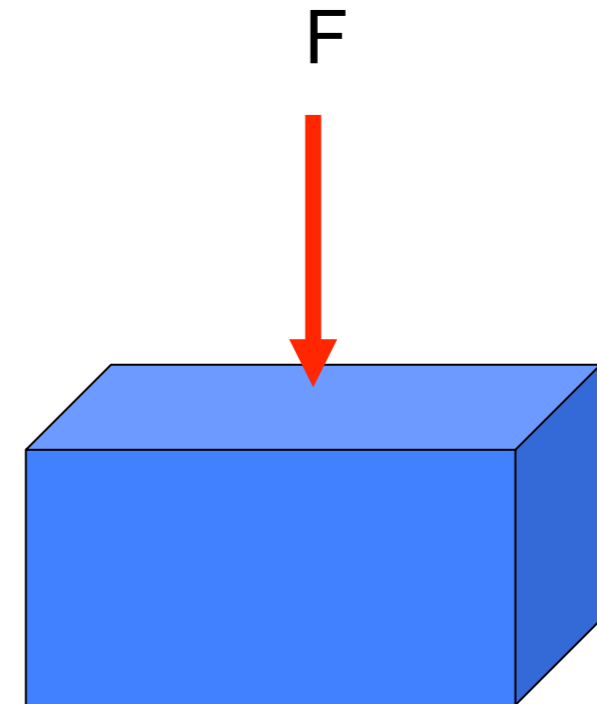
- Stress
- Strain
- Pressure
- Load



Stress (σ)

- The force per unit area ($\text{Pa} = \text{N}/\text{m}^2$)
- $\text{Stress} = \text{Force} / \text{Area}$

1. Compressive stress
2. Tensile stress
3. Shear stress





Strain (ϵ)

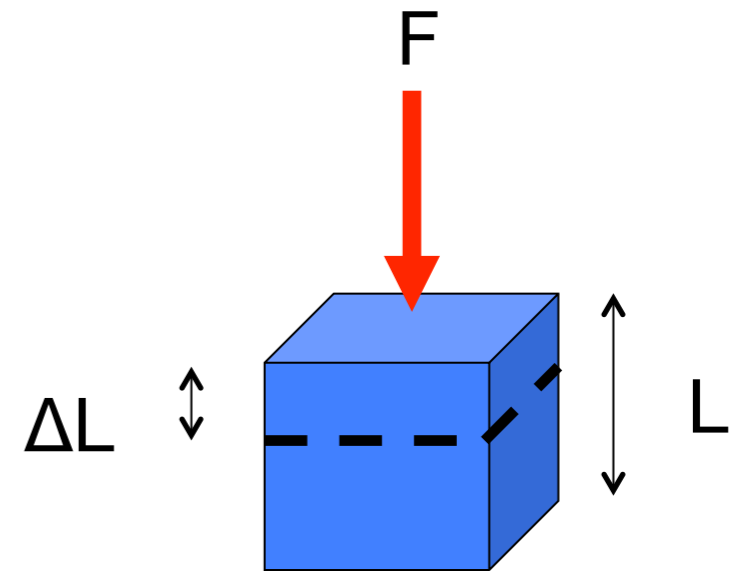
- The number that describes relative deformation or change in geometry of material under applied forces (UNITLESS)

- Strain= $(\Delta L / L)$

1. Compressive strain

2. Tensile strain

3. Shear strain



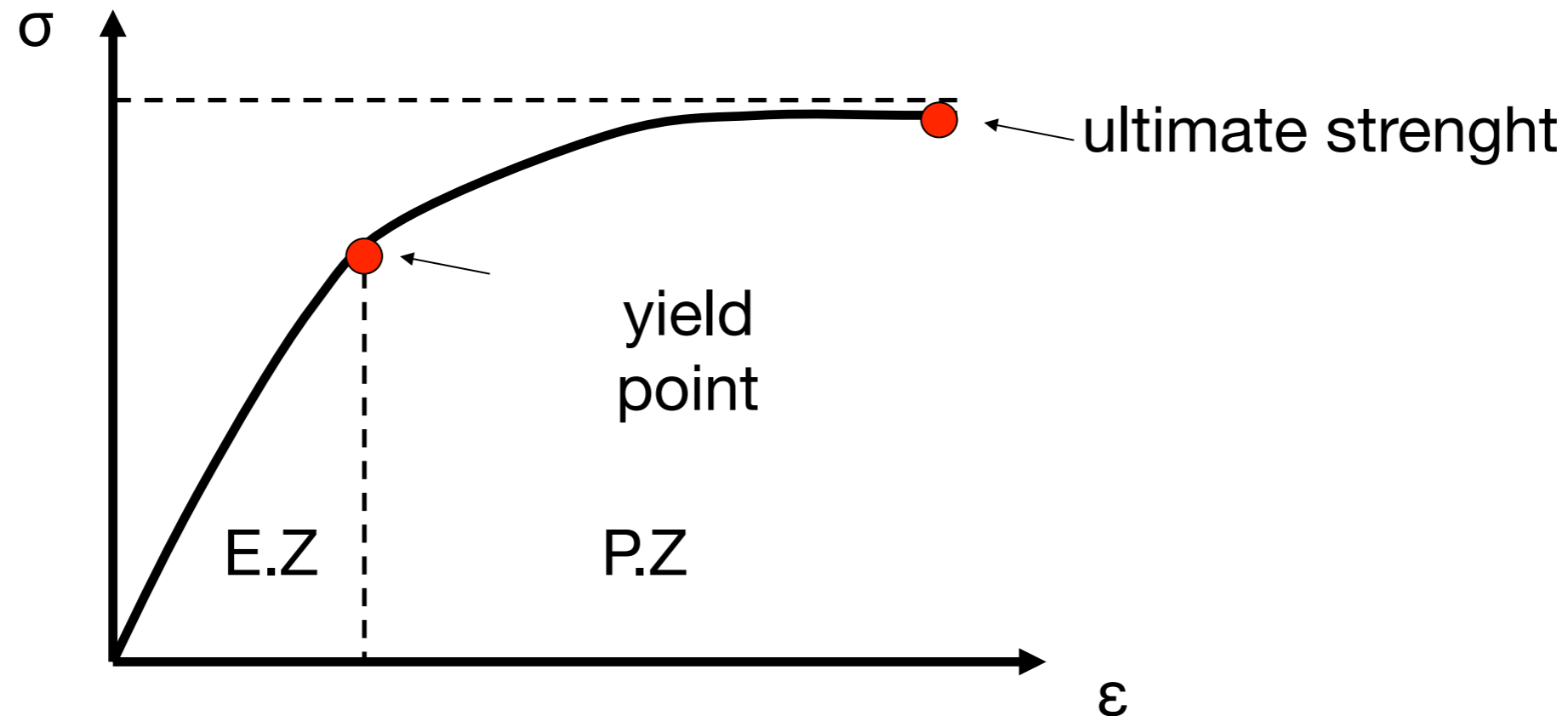
$$\epsilon = \frac{\Delta l}{l}$$



Stress/ Strain

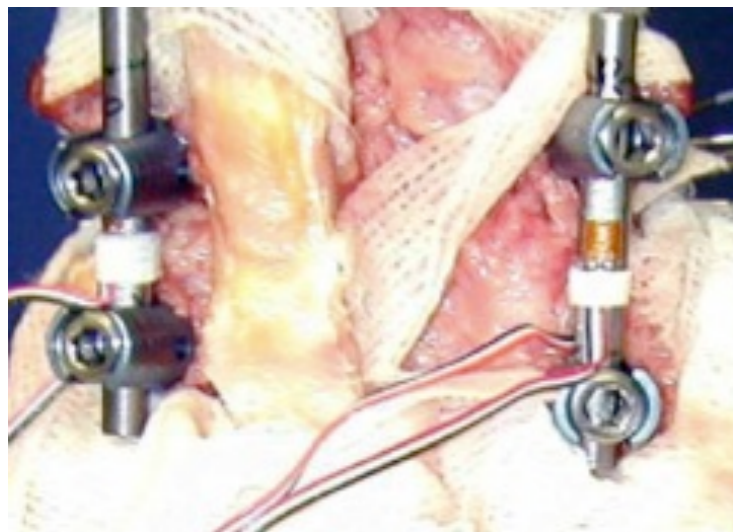
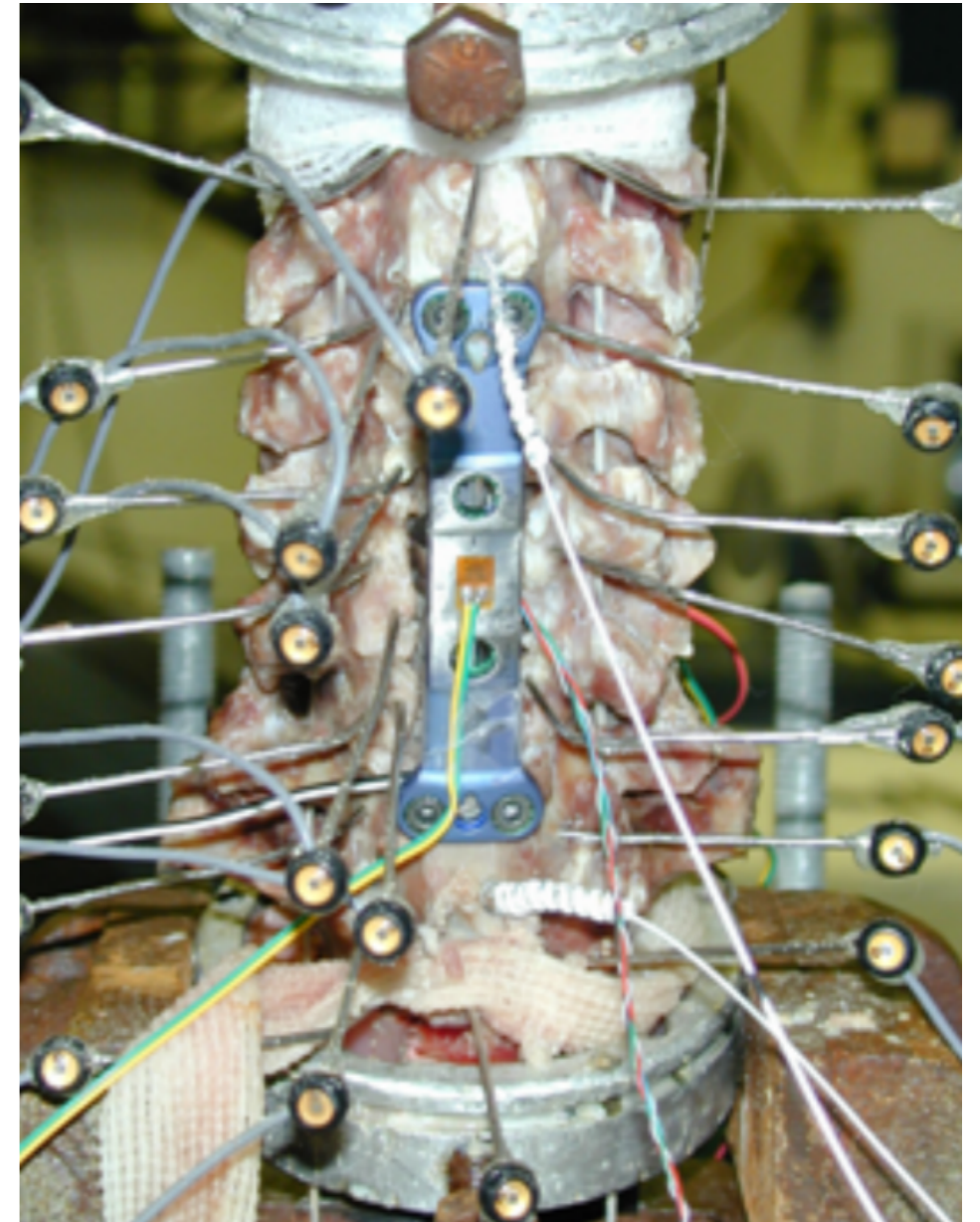
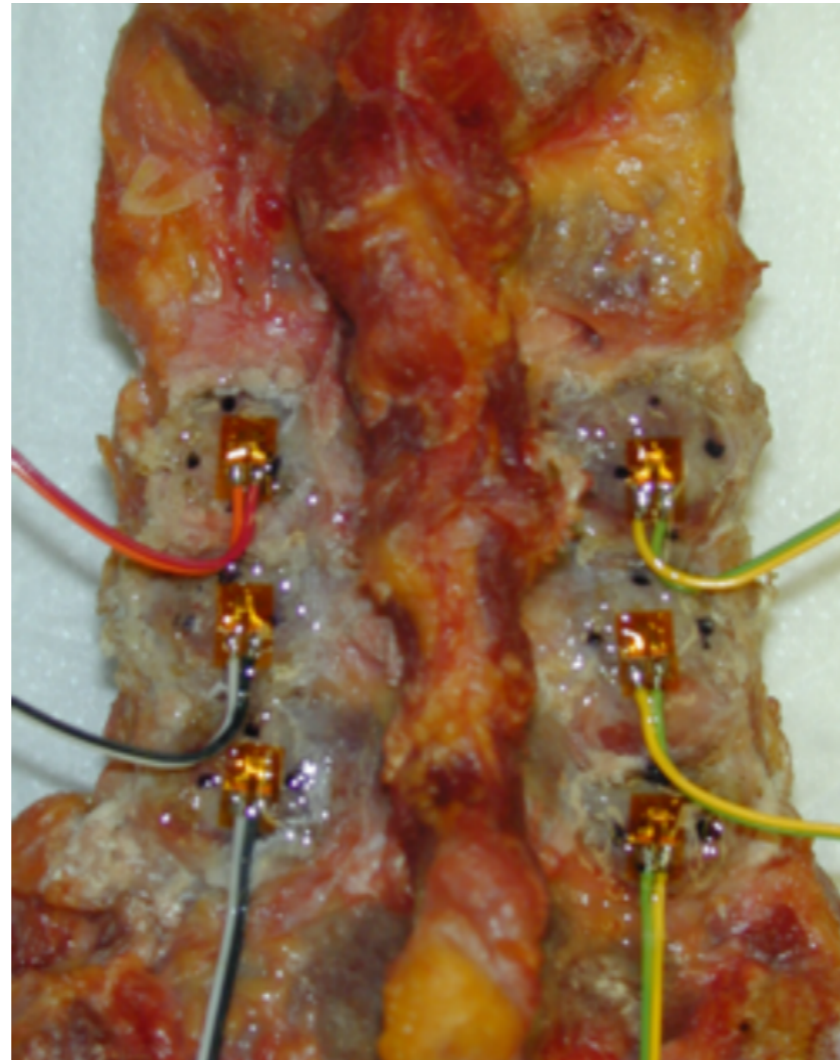
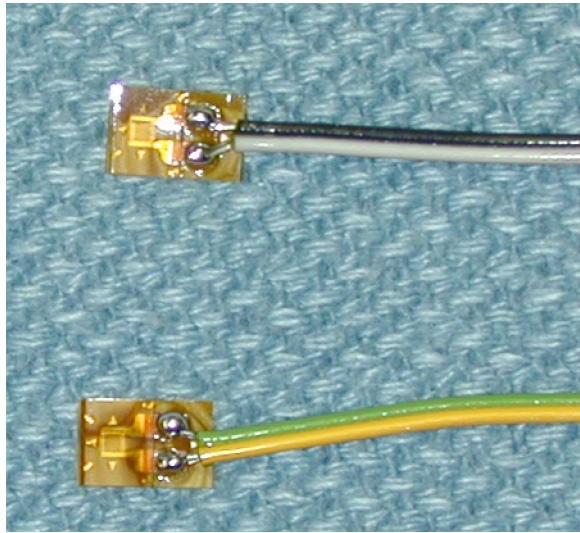
$$\text{Modulus of elasticity (Young Modulus)} = (\sigma / \epsilon)$$

- The slope of stress/strain curve in the elastic deformation region



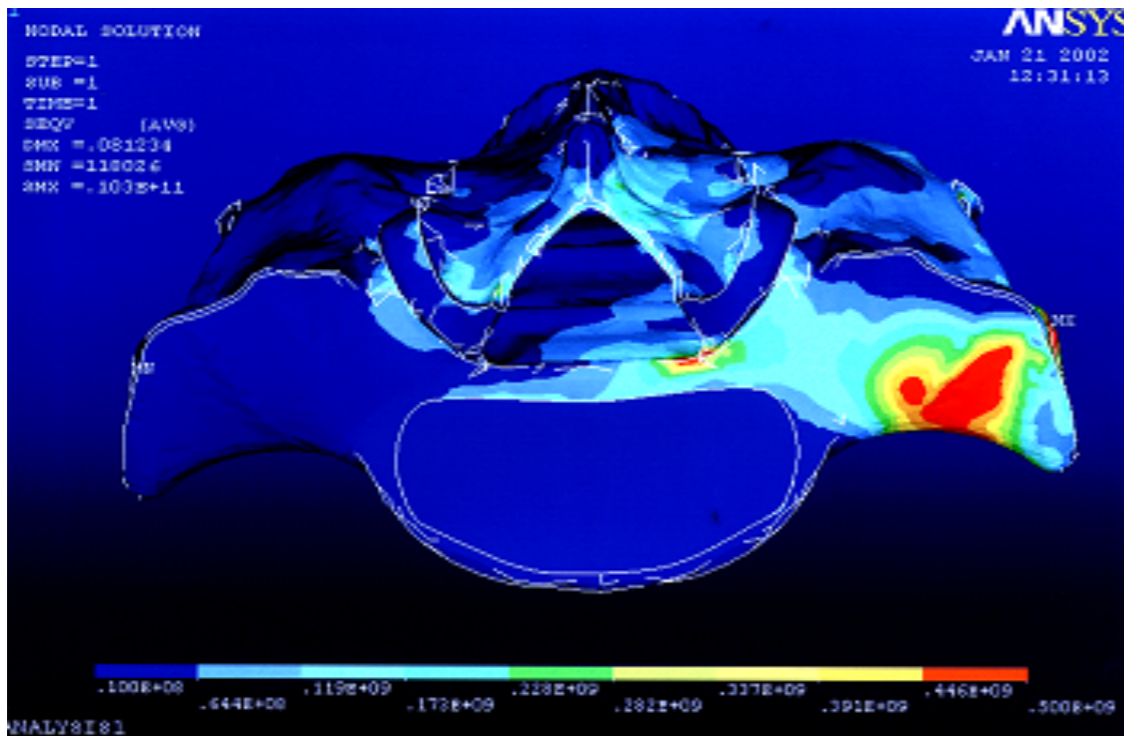
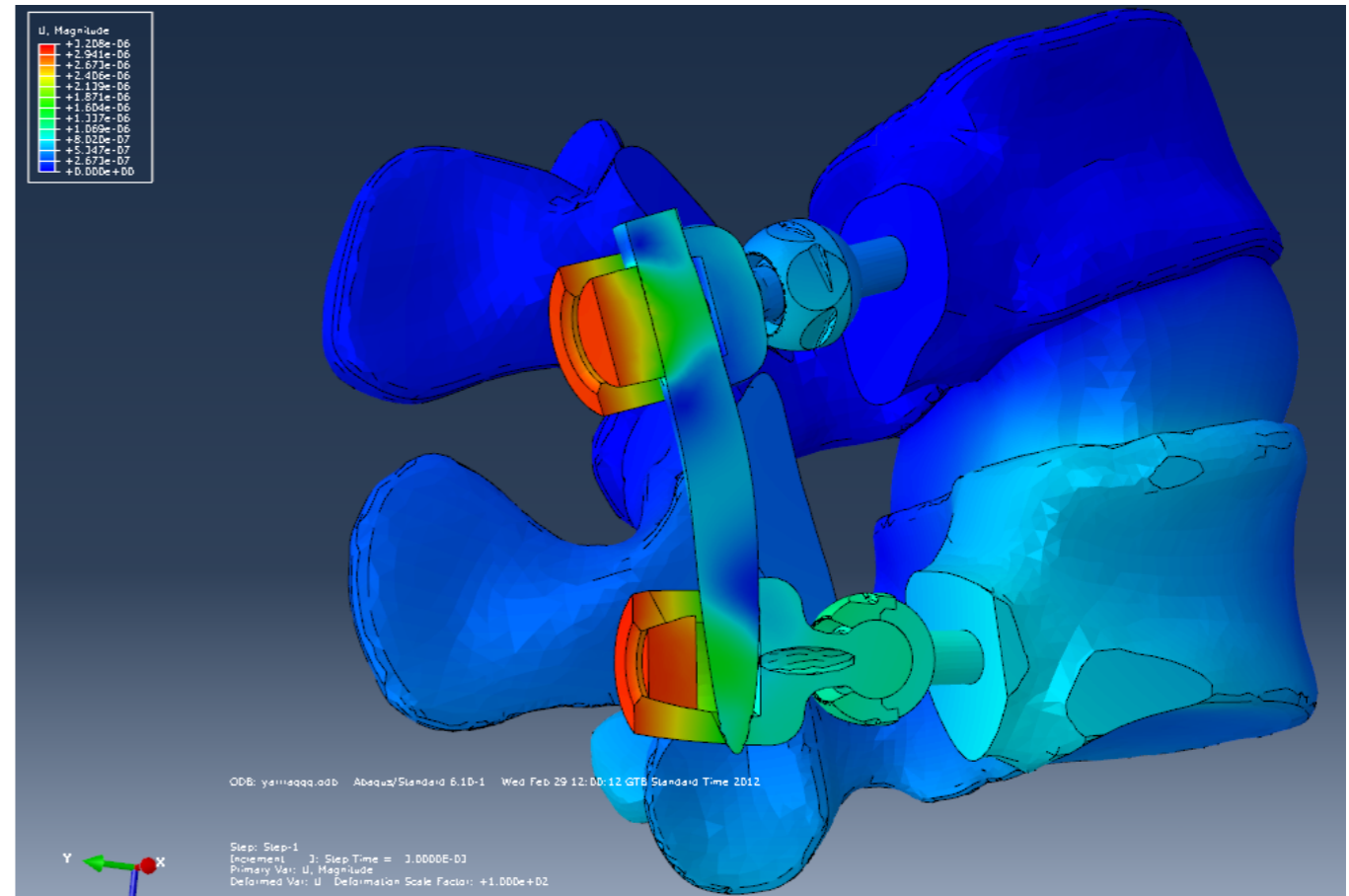
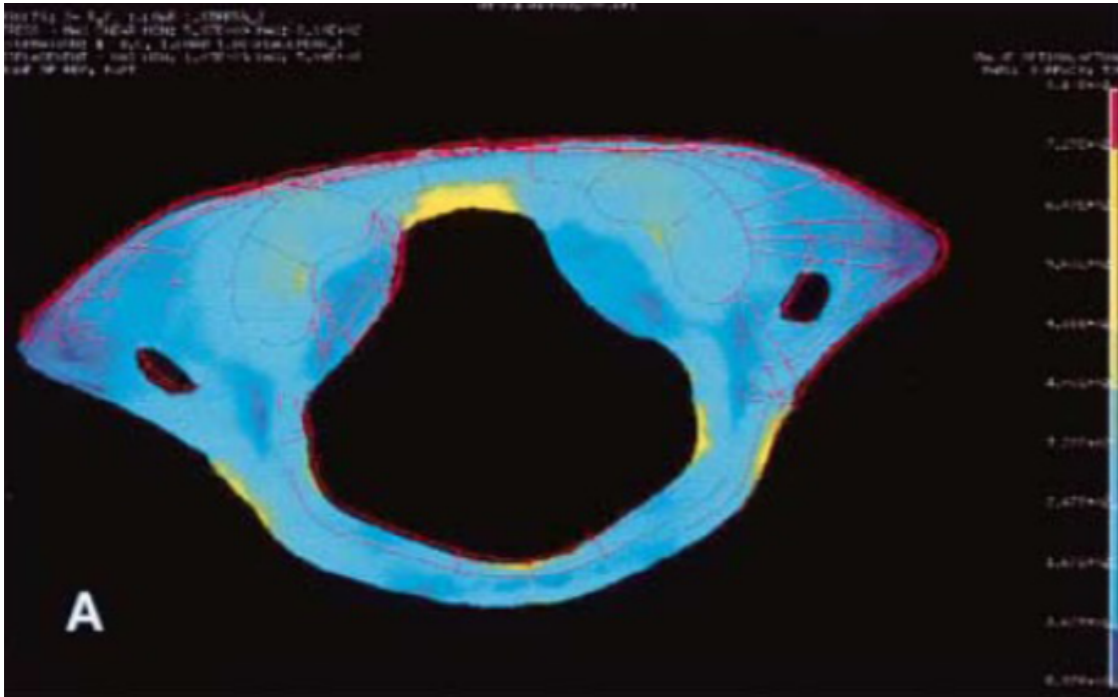


Measuremet of Stress or Strain (strain gage)



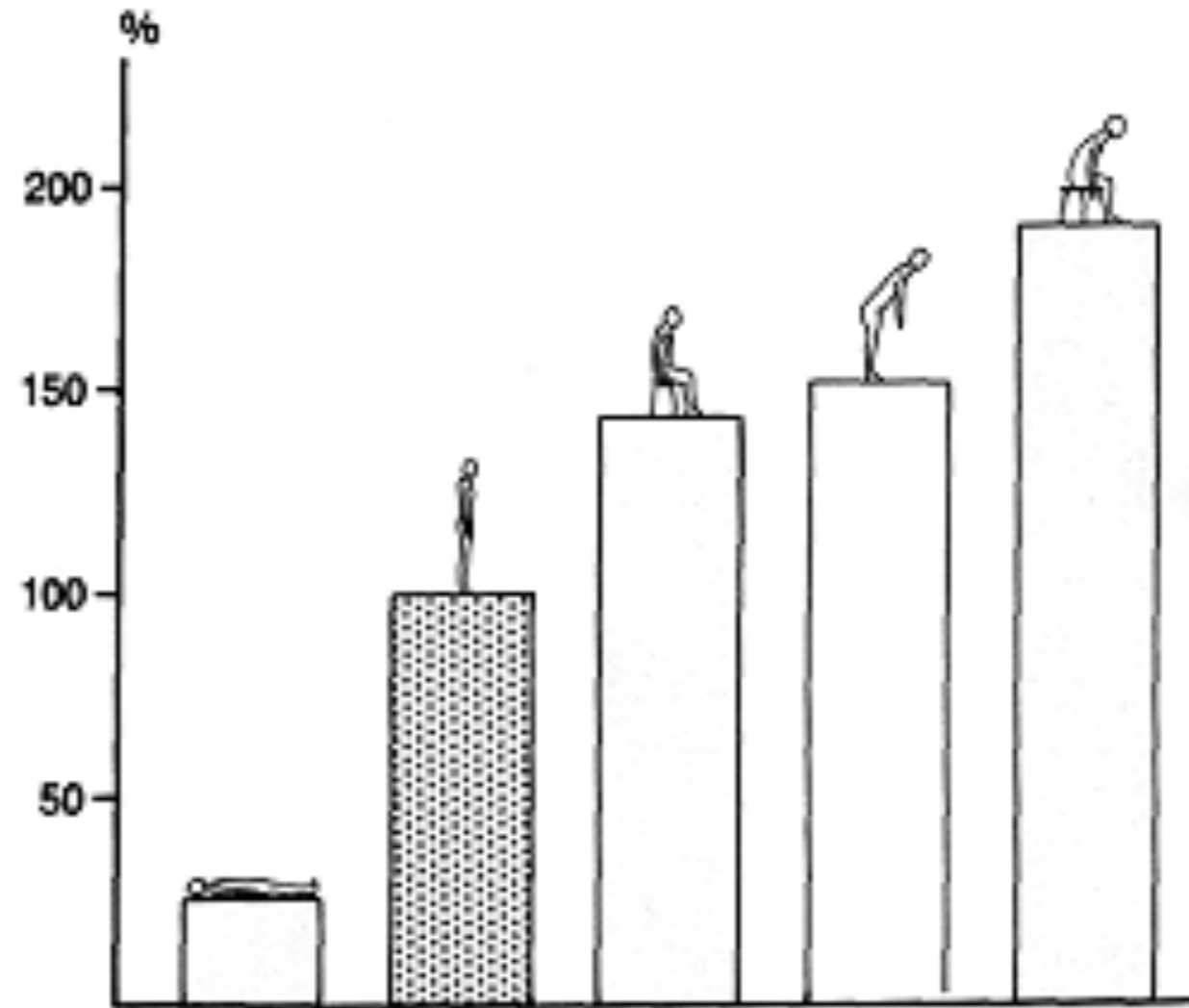


Measurement of Stress or Strain (FEM)





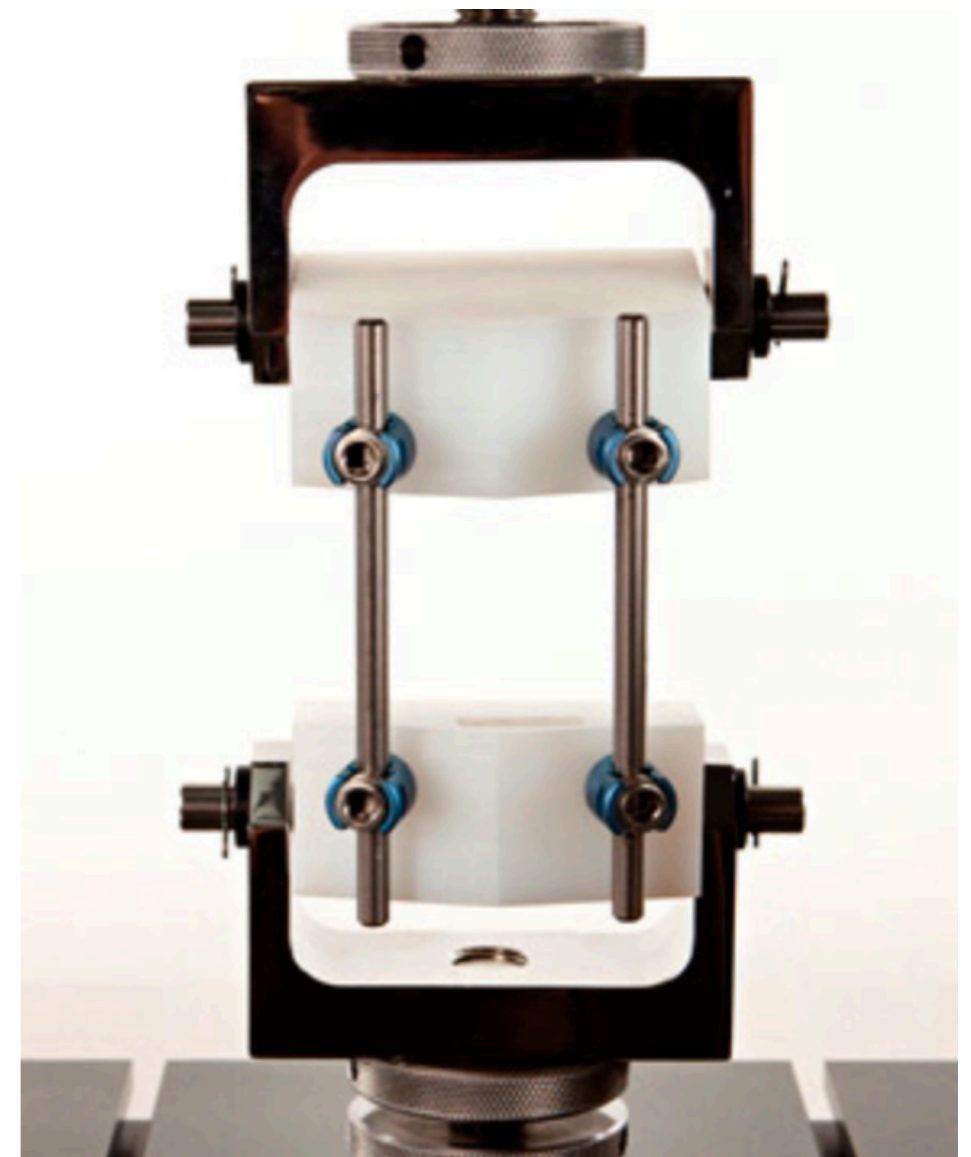
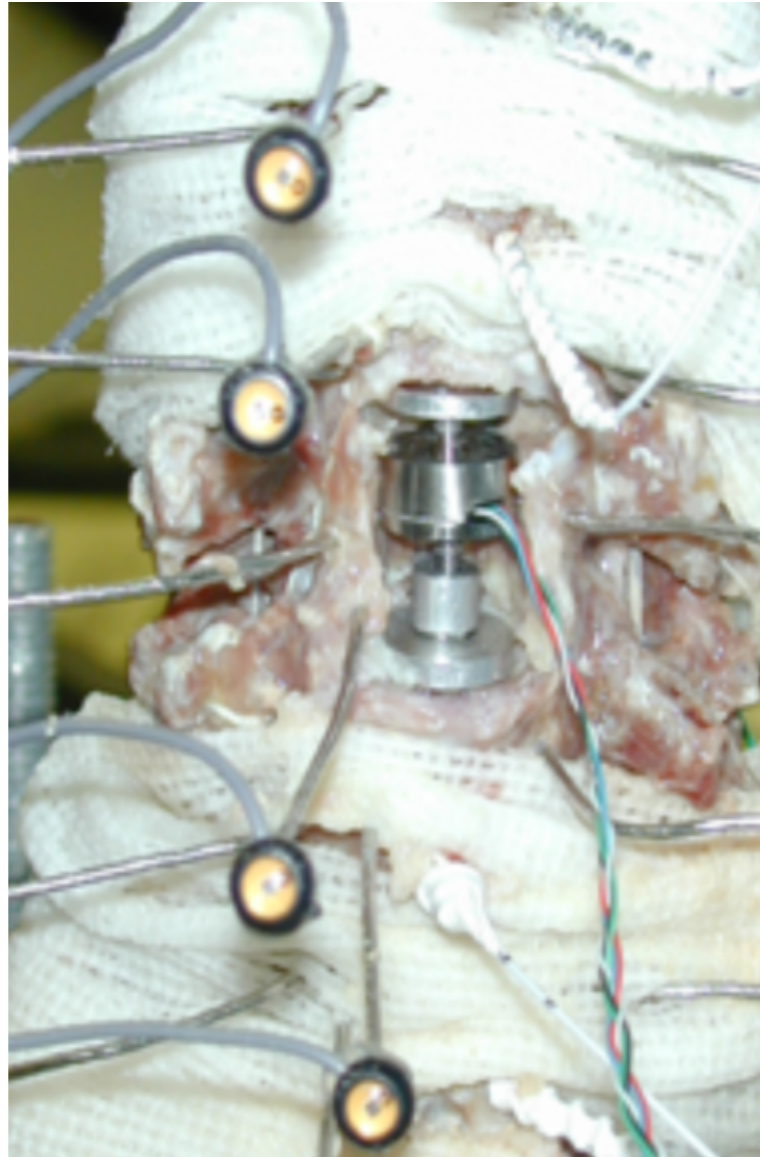
Intradiscal Pressure



Load



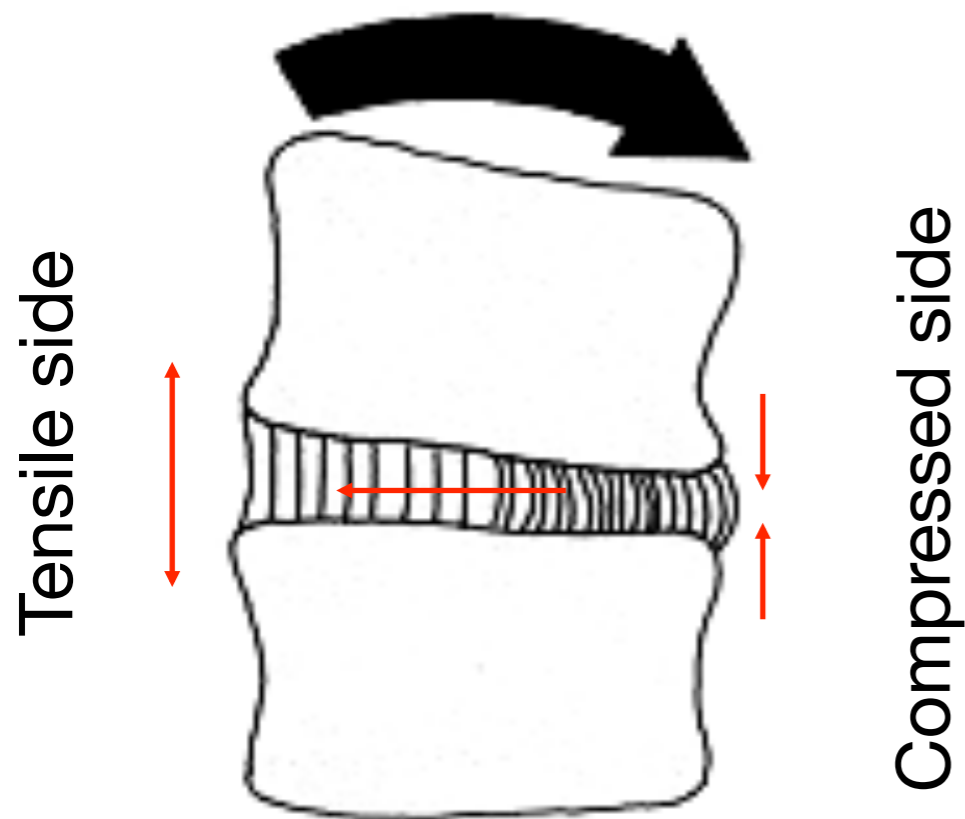
Load cell



Material testing

Load in Disc

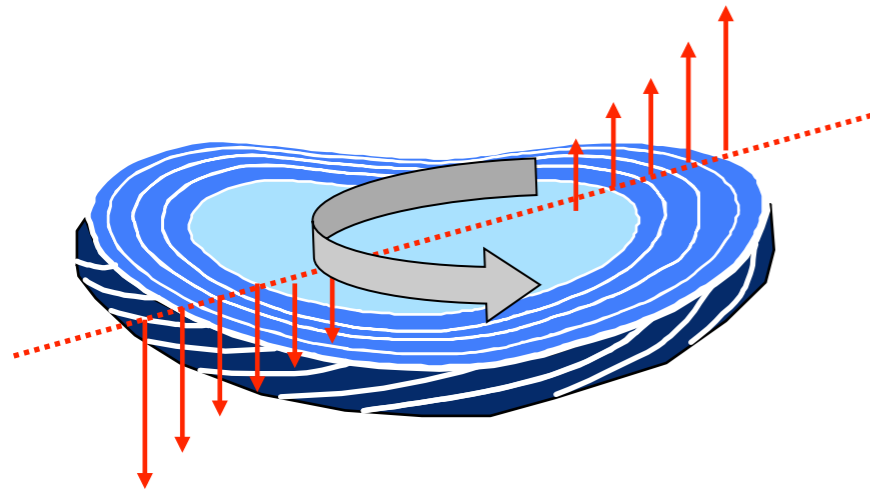
Flexion/ Extension/ Lateral Bending



- Annulus fibers carries more stress at compressed side
- Nucleus moves to tensile side (uncompressed side)

Load in Annulus

Axial rotation

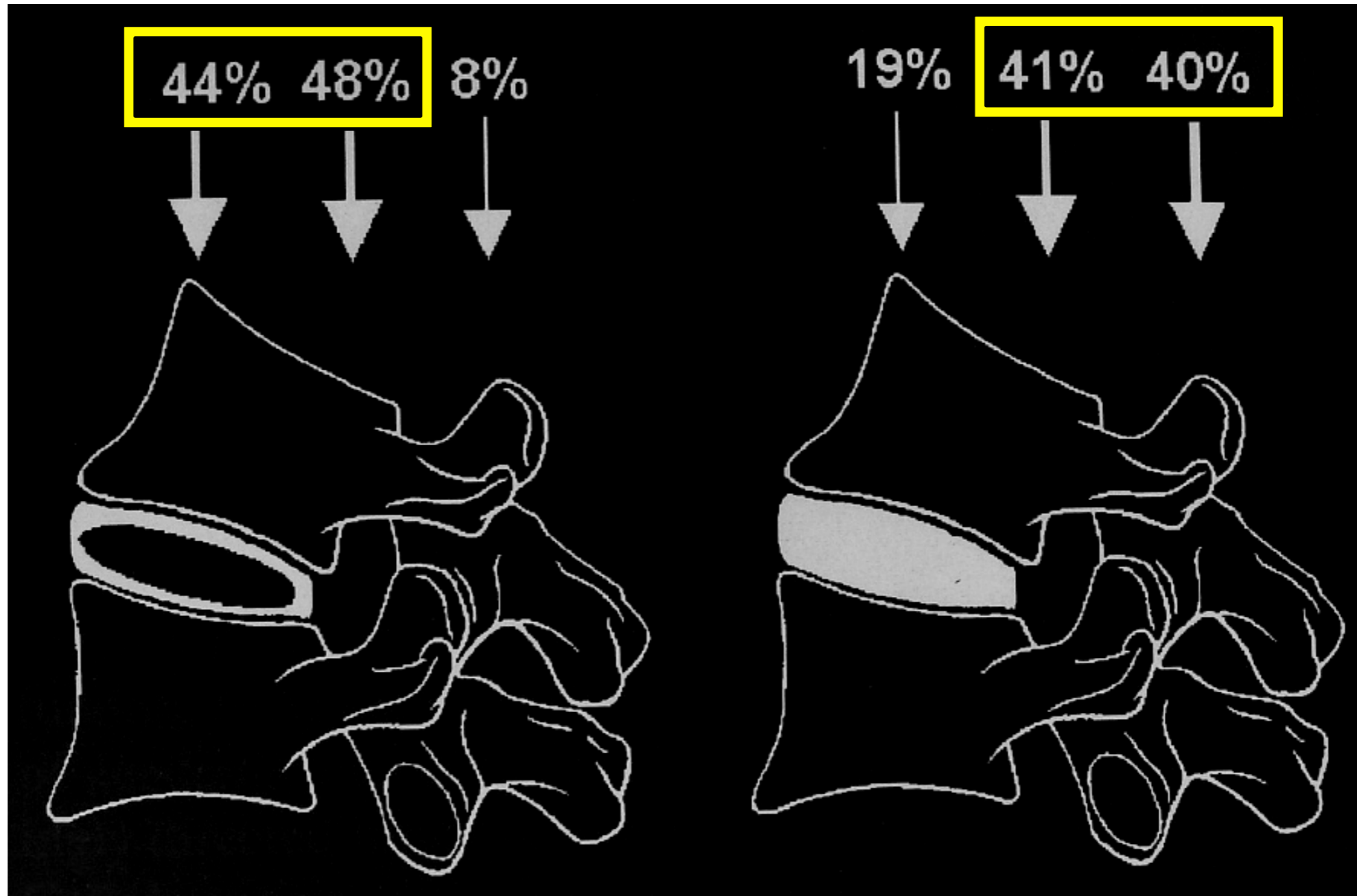


- Shear stress is max. at posterolateral annulus side.
- This side prone to rupture and herniation





Load Distribution

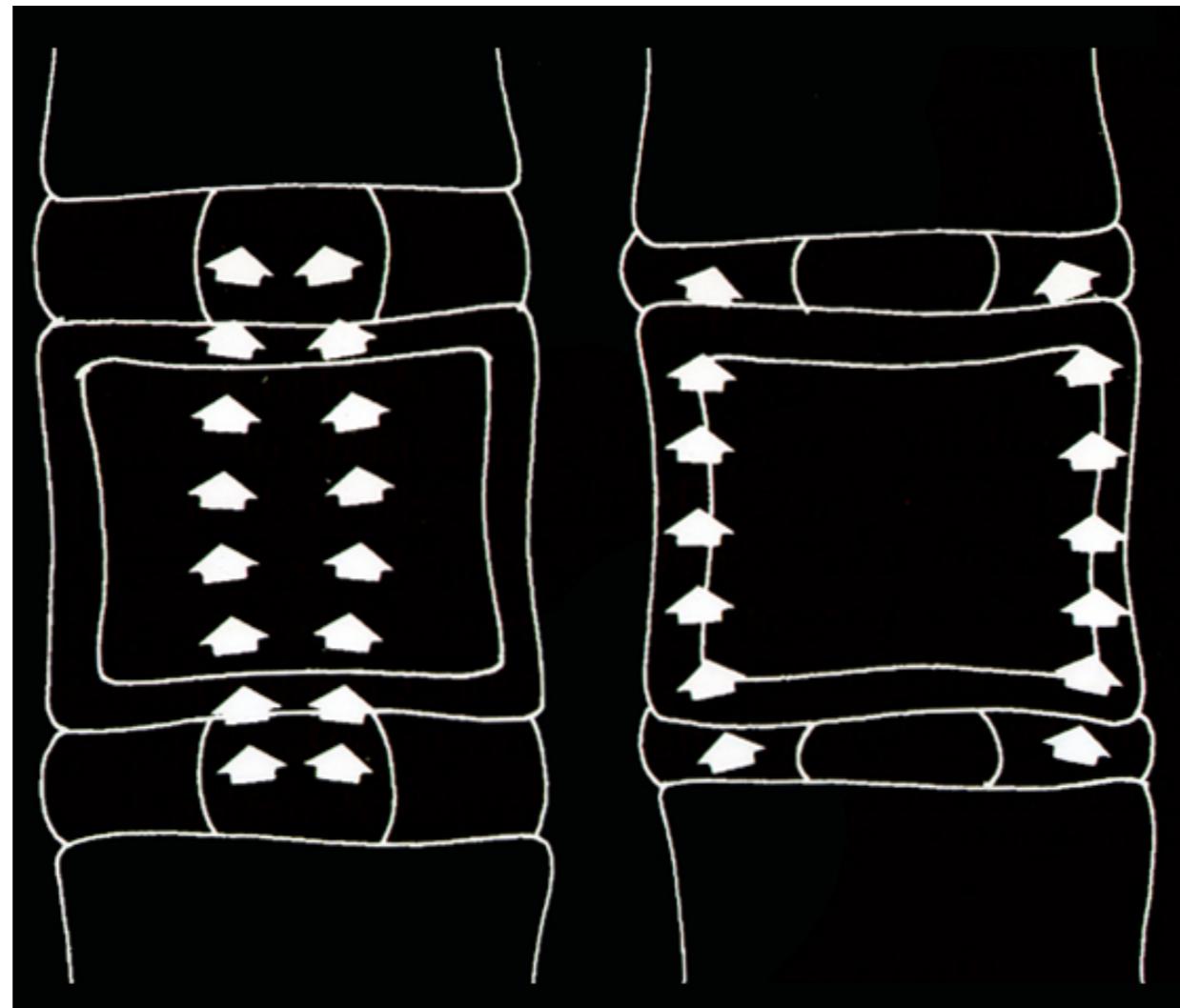


Normal

Degenerated

Disc degeneration

- Annulus carries more load than nucleus



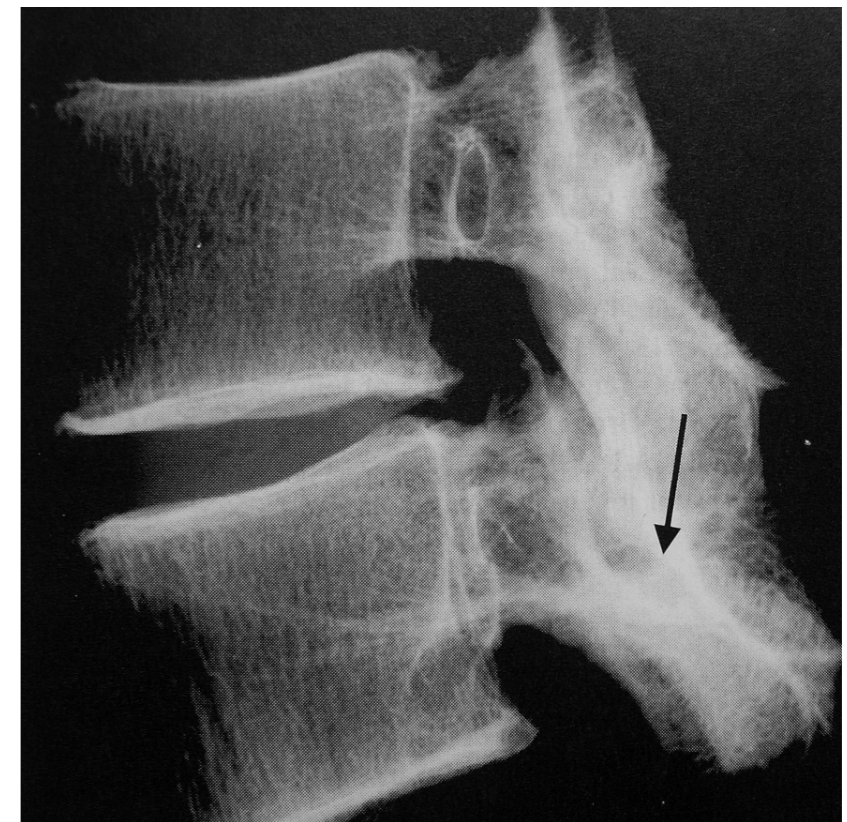
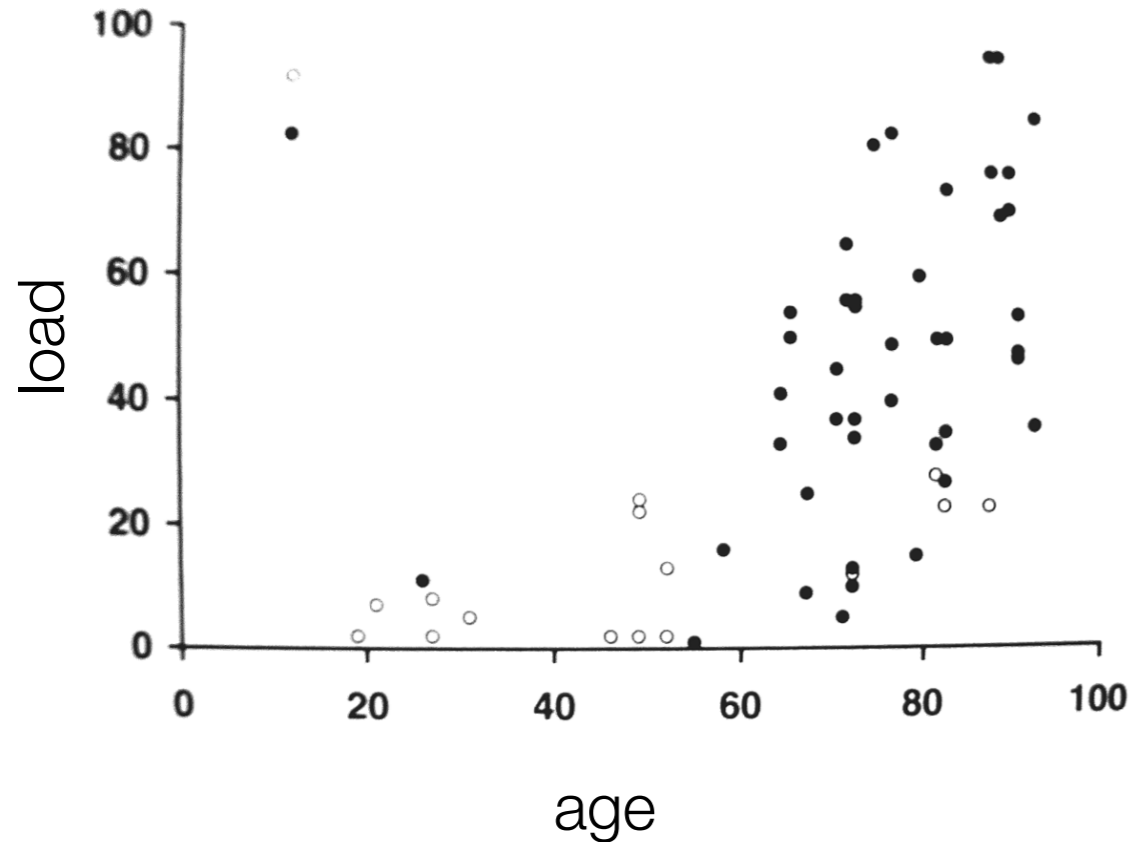
Normal

Degenerated



Aged Spine

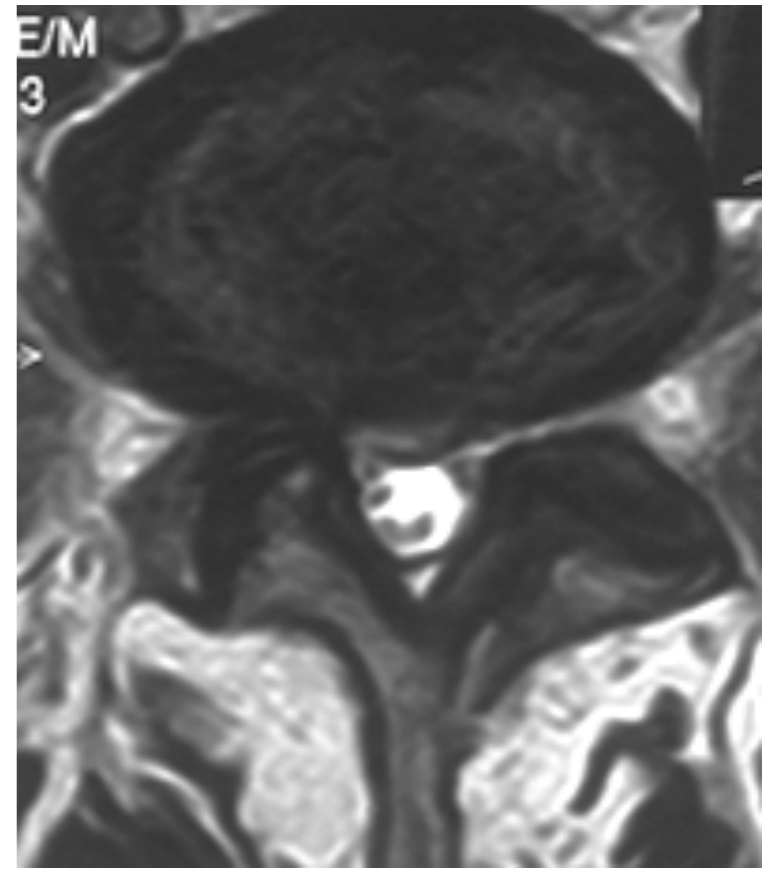
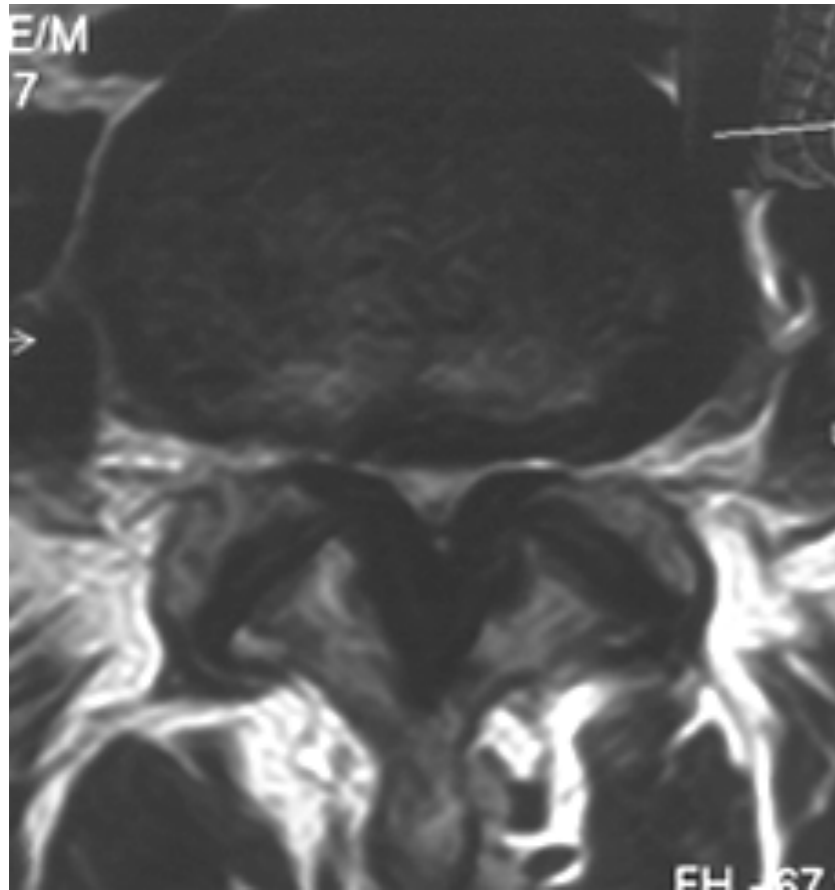
- Neural arc carries $> 50\%$ load after 70 years old





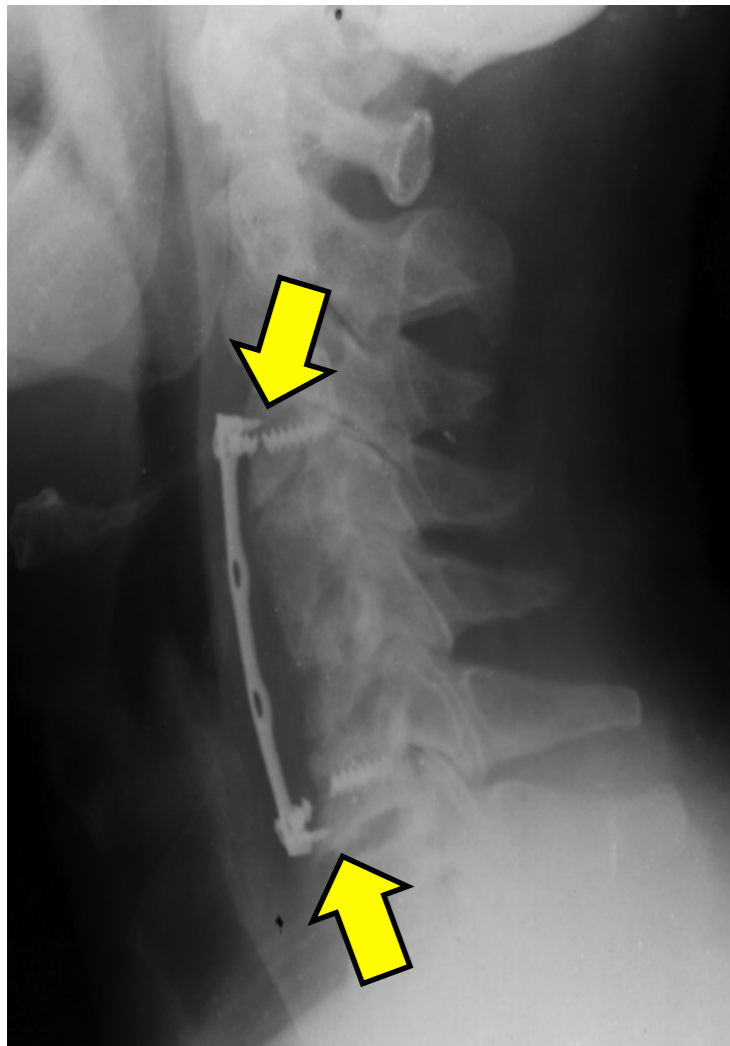
Facet Degeneration

- It occurs after intervertebral disc degeneration





I AM A SURGEON NOT AN ENGINEER !



Screw fracture



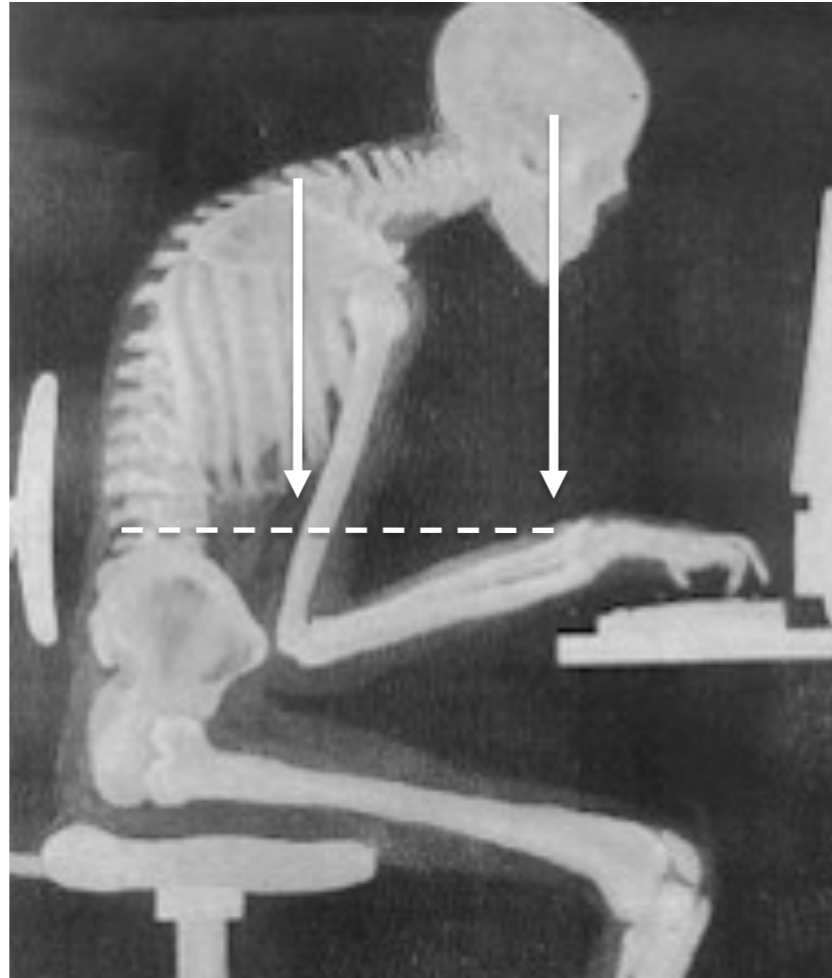
Inadequate
stabilization



Adjacent segment
disease



Thank You



Slides of the presentation

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TITLE

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