

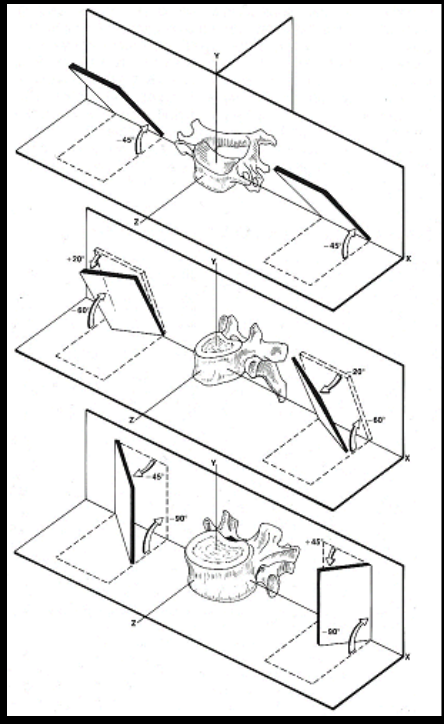
BİYOMEKANİK ve TEMEL KAVRAMLAR

Dr.Hakan BOZKUŞ

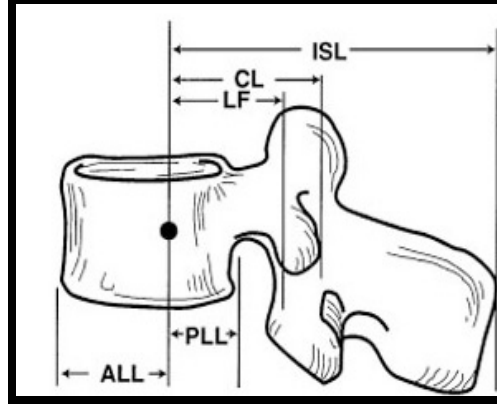
Biyomekanik Kavramlar

- Rotasyonun Anlık Ekseni (RAE, IAR)
- Hareket aralığı (ROM)
- Mekanik Terimler
- Materyel Özellikleri

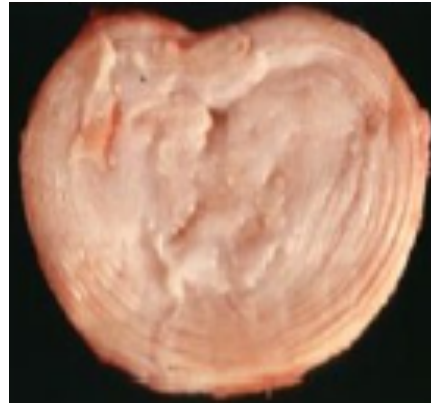
Hareketi Saęlayan Yapılar



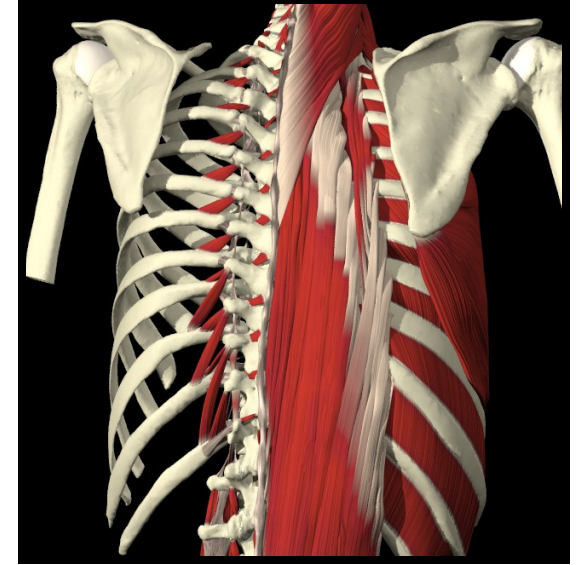
Fasetler



Ligamanlar

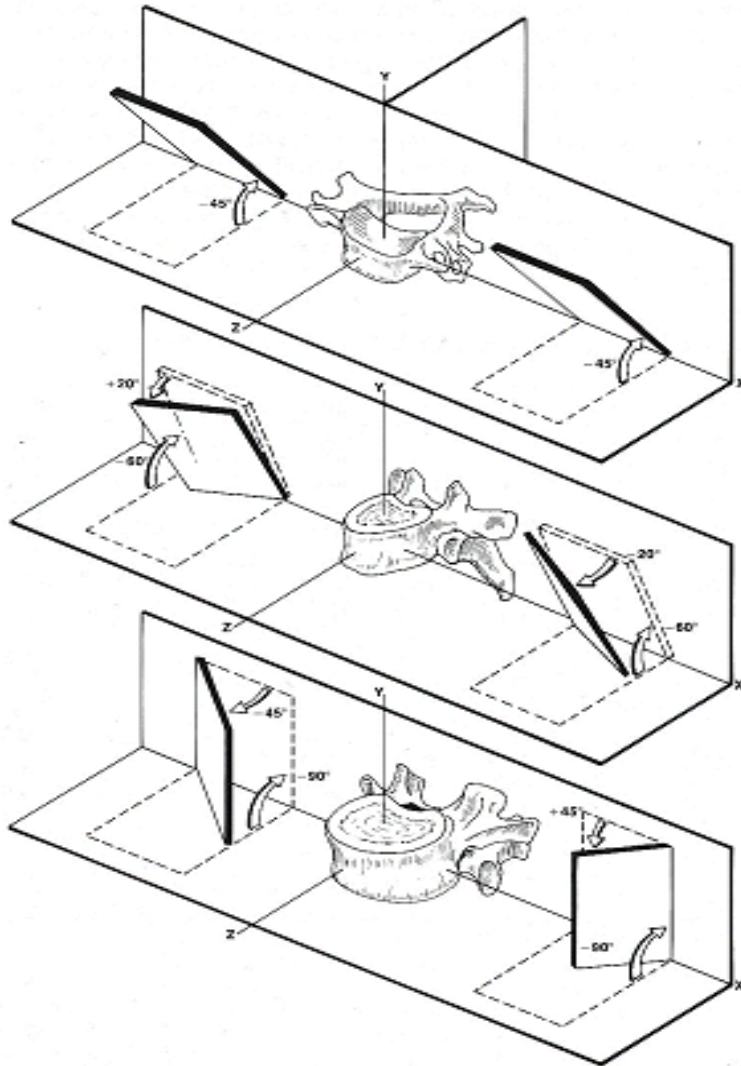


İntervertebral disk



Adaleler

Fasetler



koronal



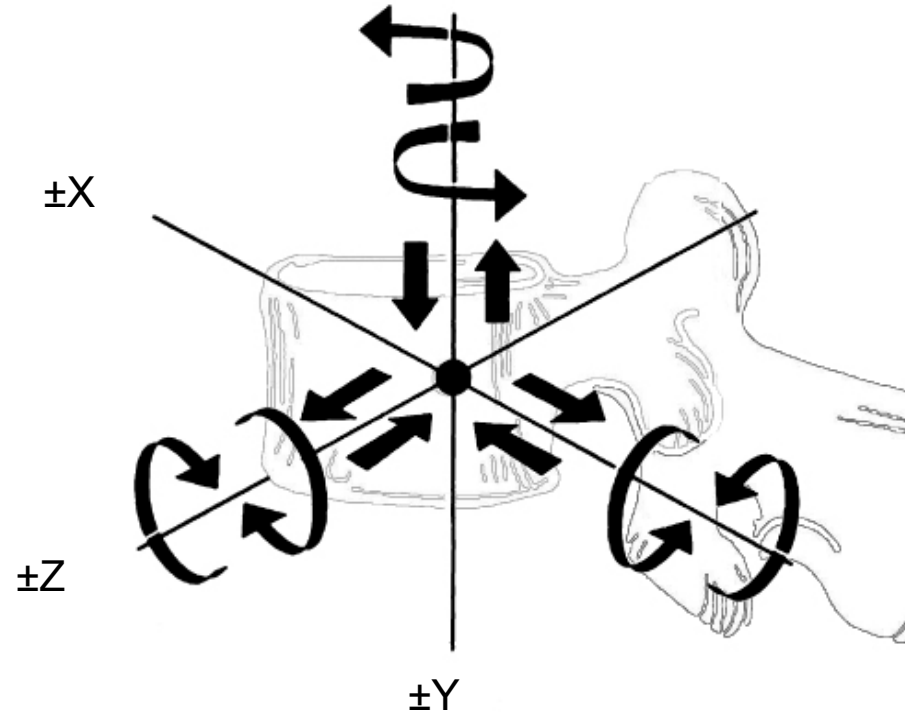
Koronal
+
sagittal



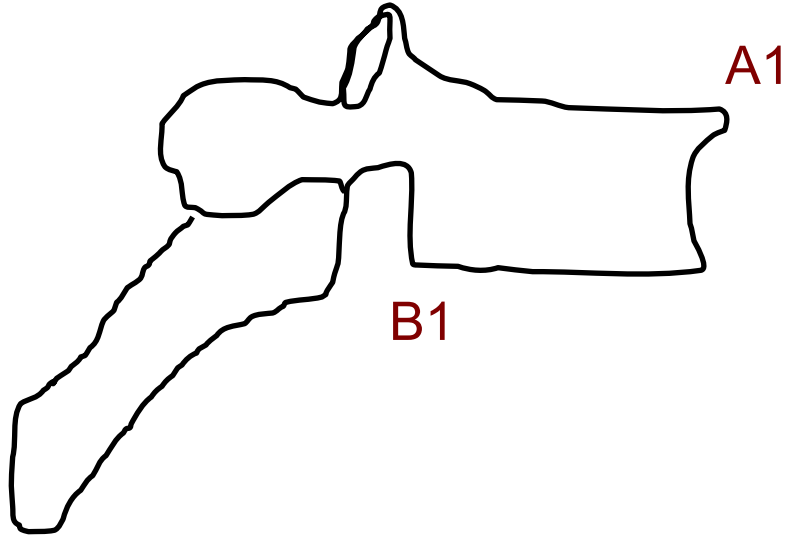
sagittal

Hareket Serbestliđi

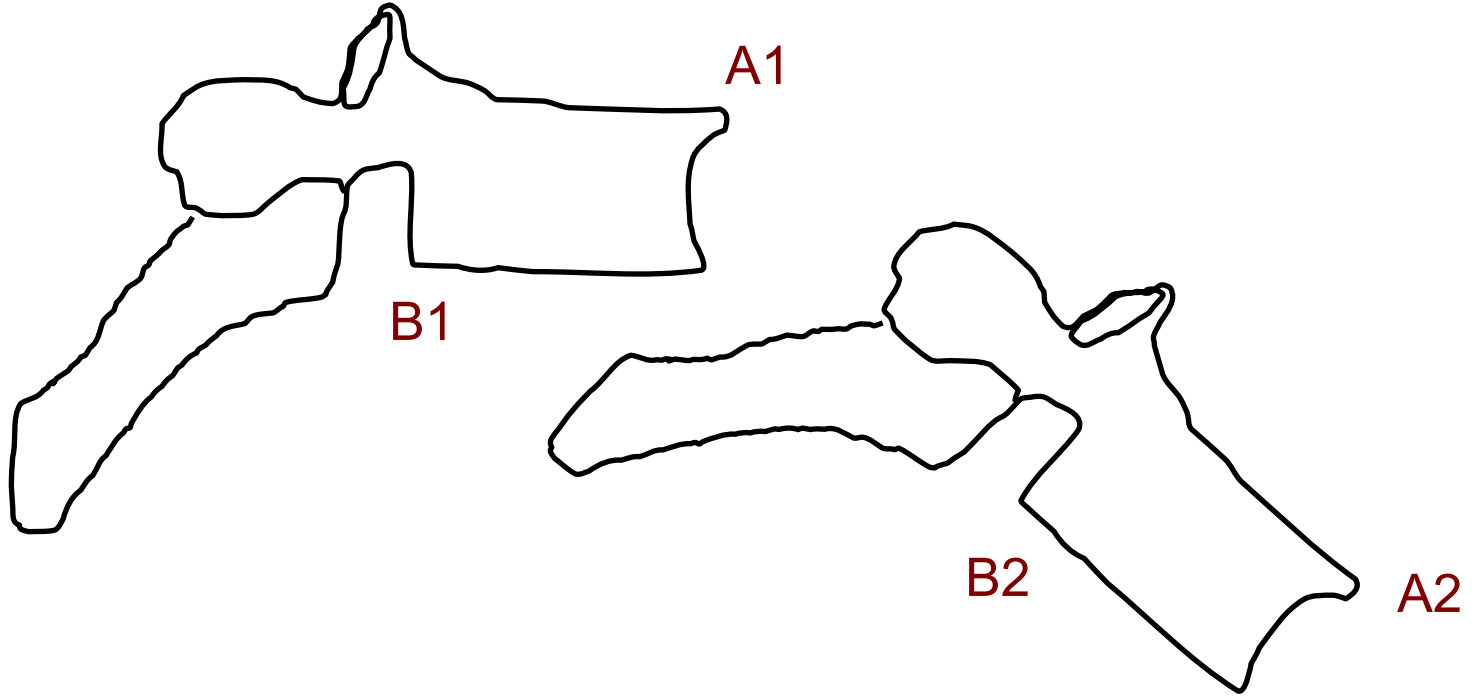
6 yönde hareket serbestliđi



Rotasyonun Anlık Ekseni (RAE, IAR)

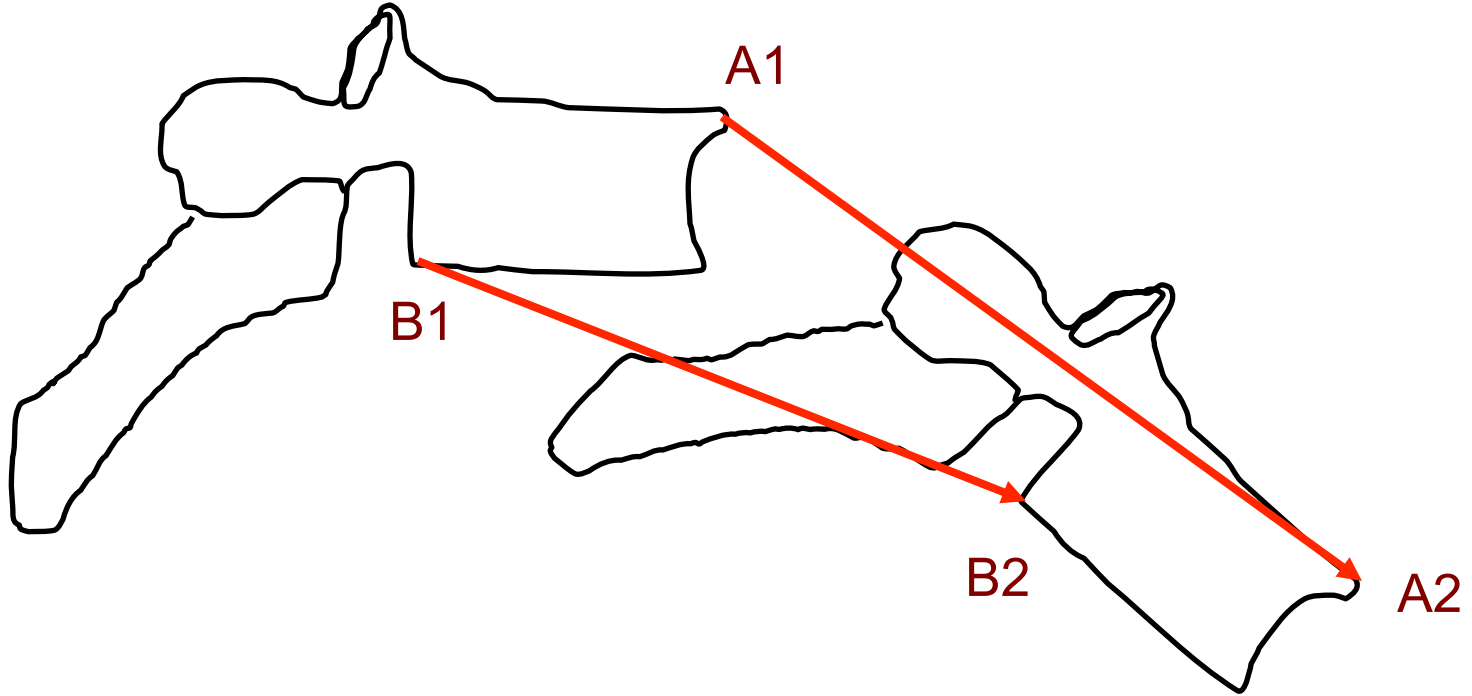


Rotasyonun Anlık Ekseni (RAE, IAR)



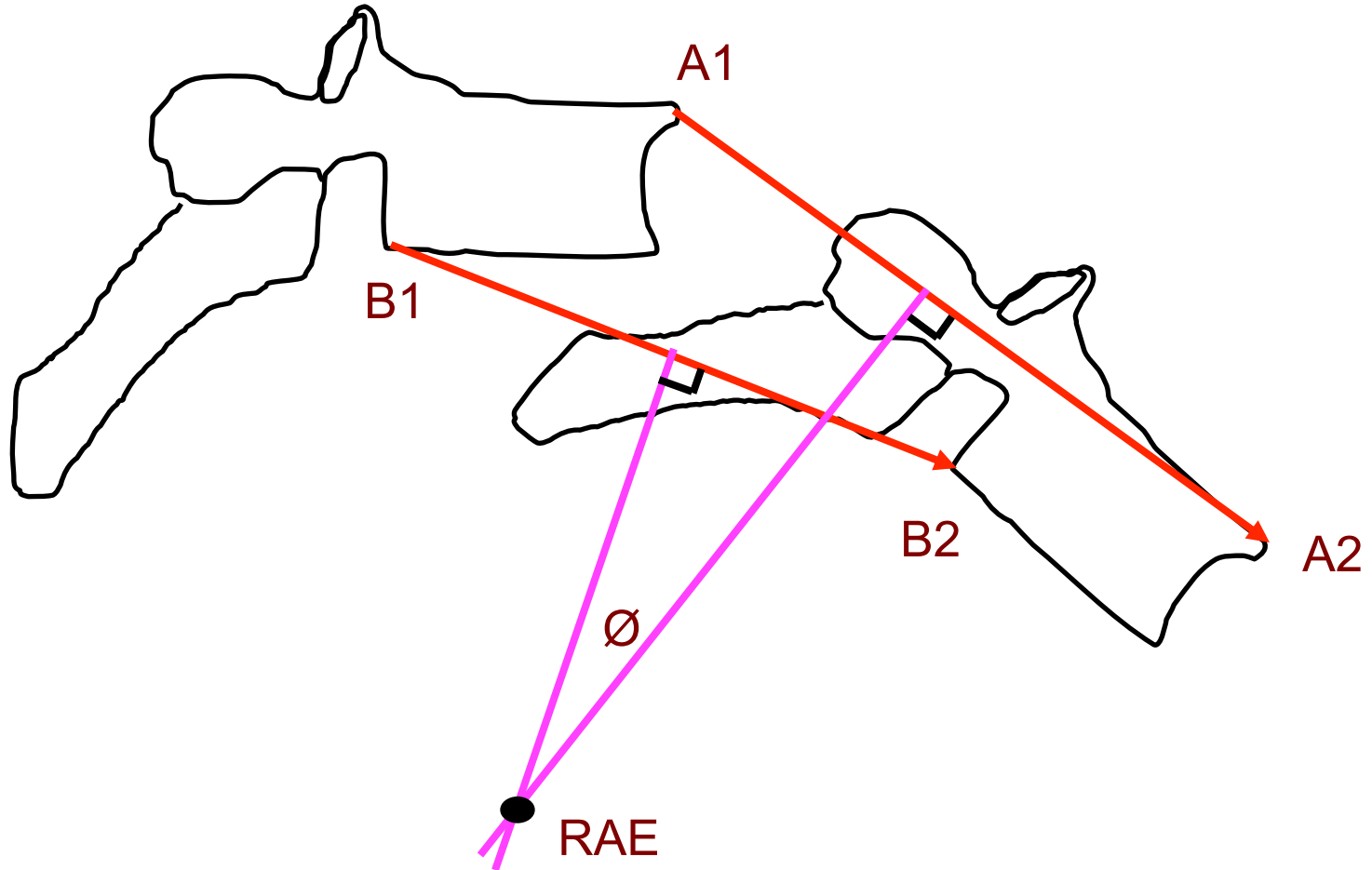
Rotasyonun Anlık Ekseni (RAE, IAR)

2 translasyon vektörü



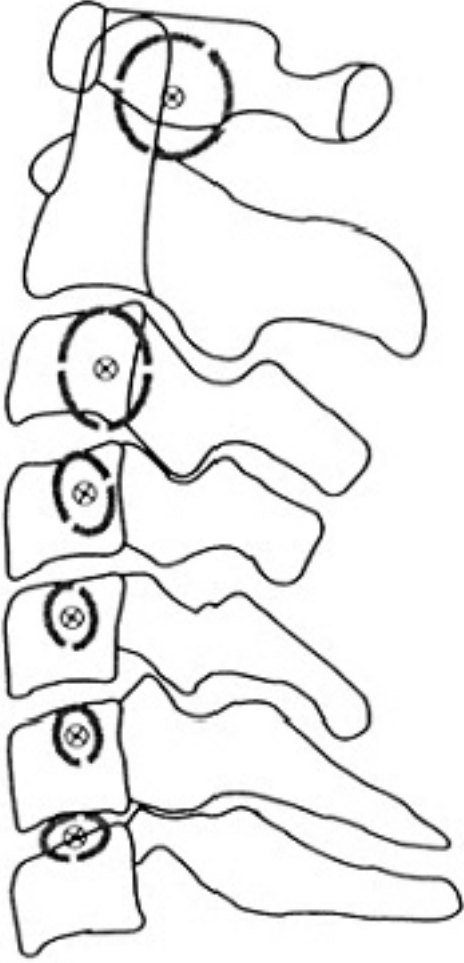
Rotasyonun Anlık Ekseni (RAE, IAR)

2 translasyon vektörü, 1 rotasyon açısı

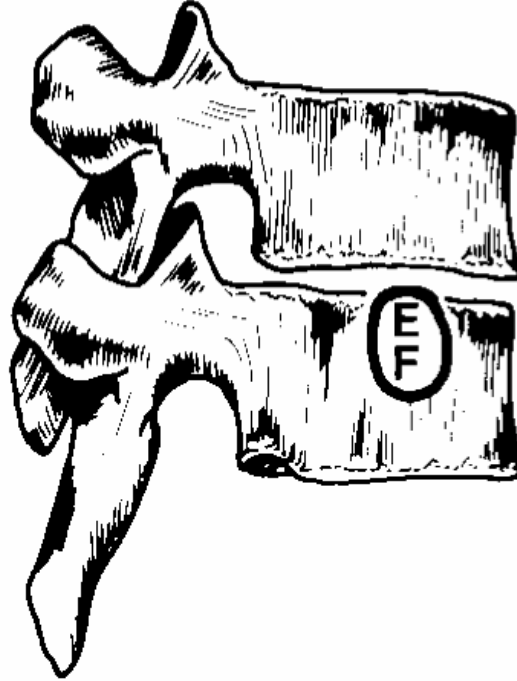


Rotasyonun Anlık Ekseni

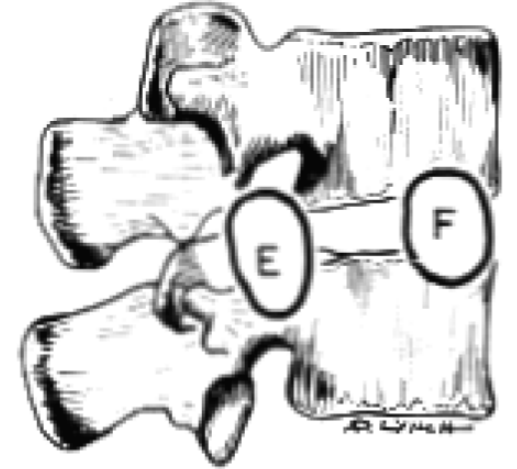
Sagittal Plan



Servikal

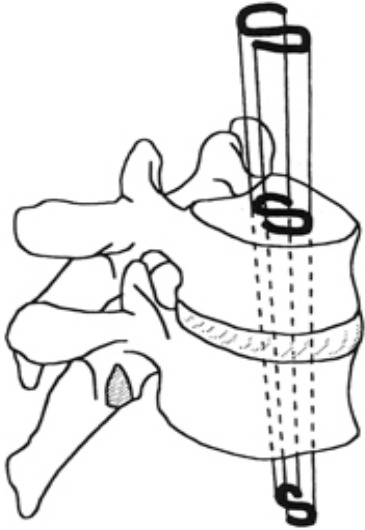


Torakal



Lomber

RAE İfade Şekilleri



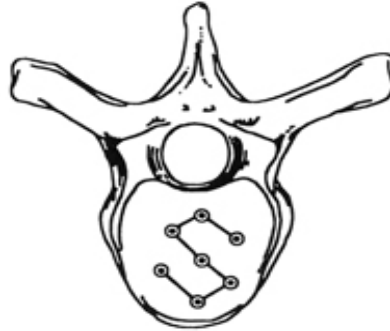
A

3 boyutlu



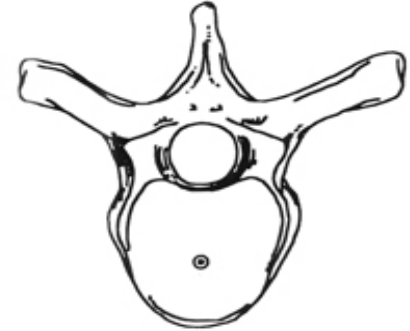
B

2 boyutlu



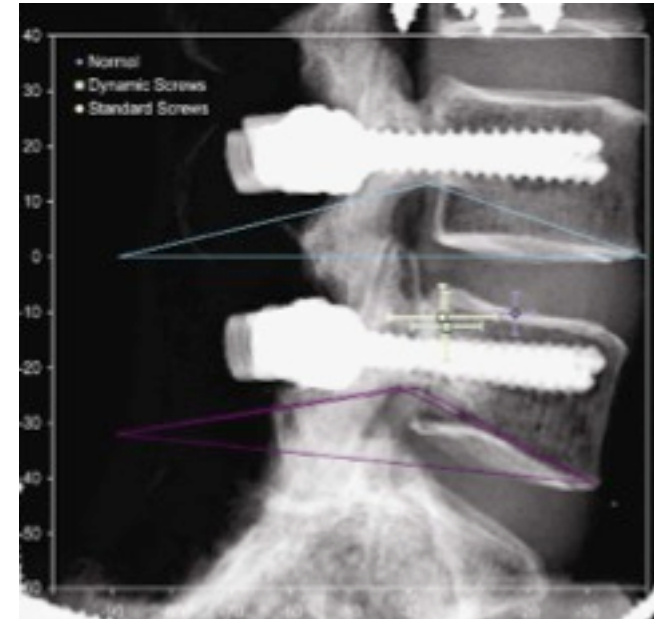
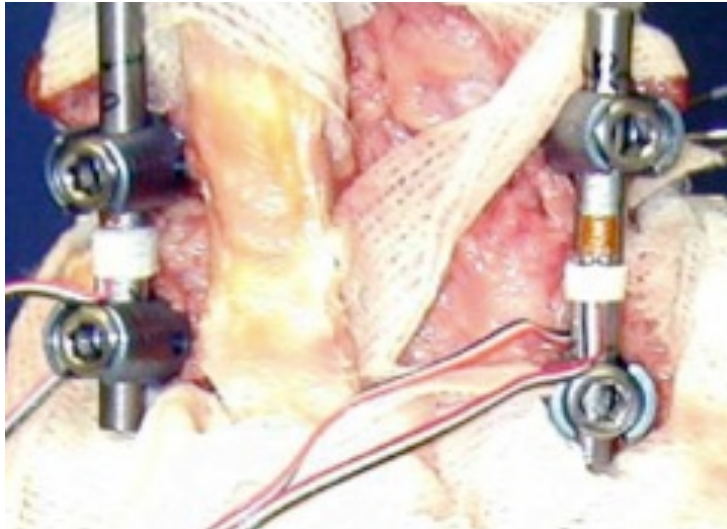
C

en az 7 nokta
(finite axes of rotation)

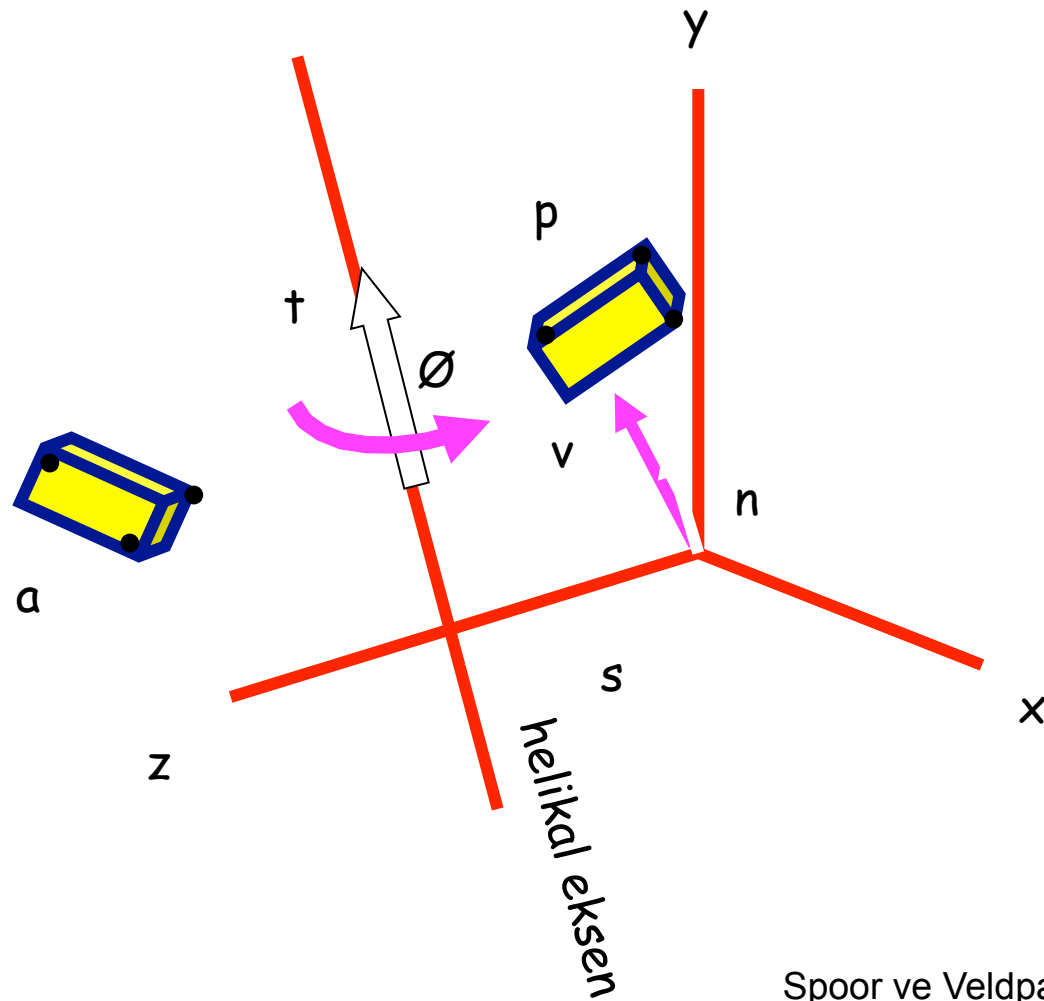


D

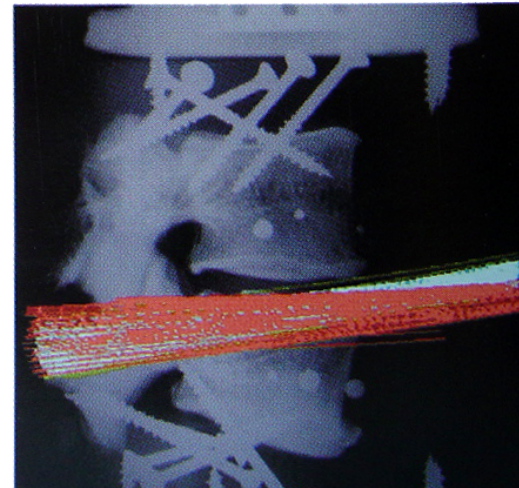
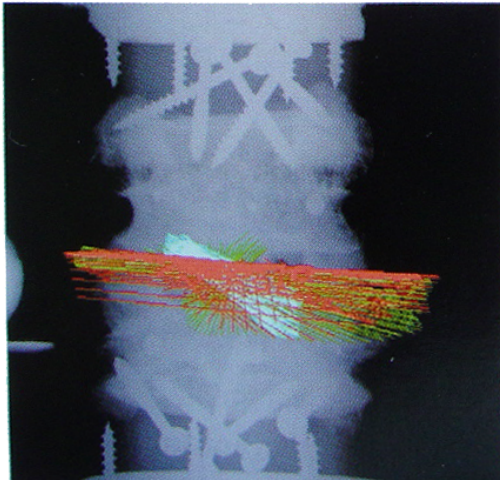
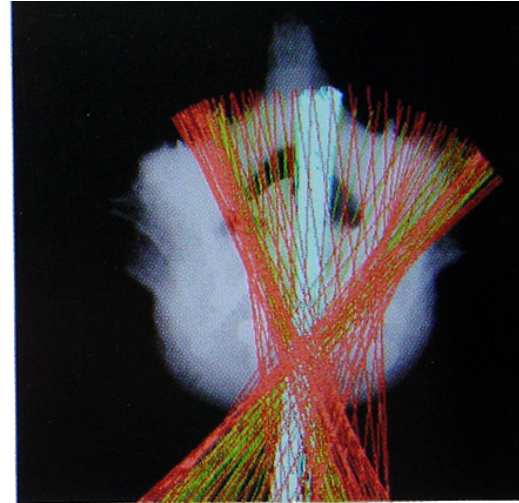
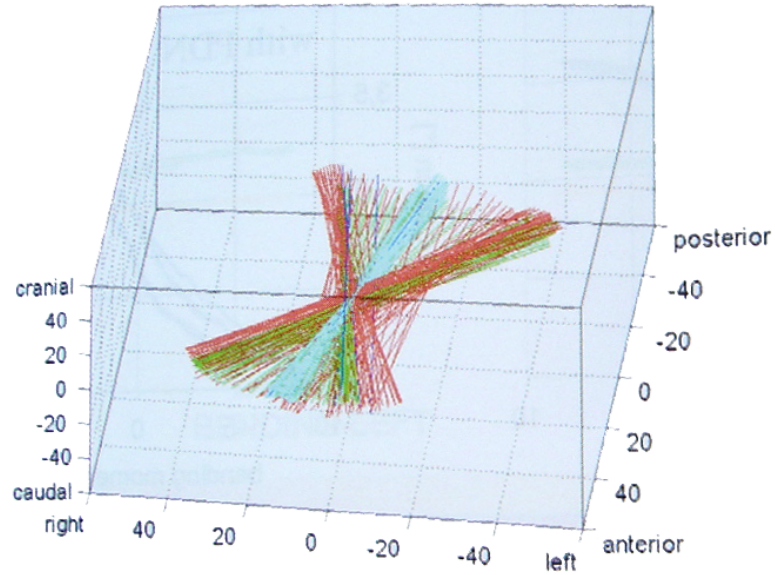
noktasal



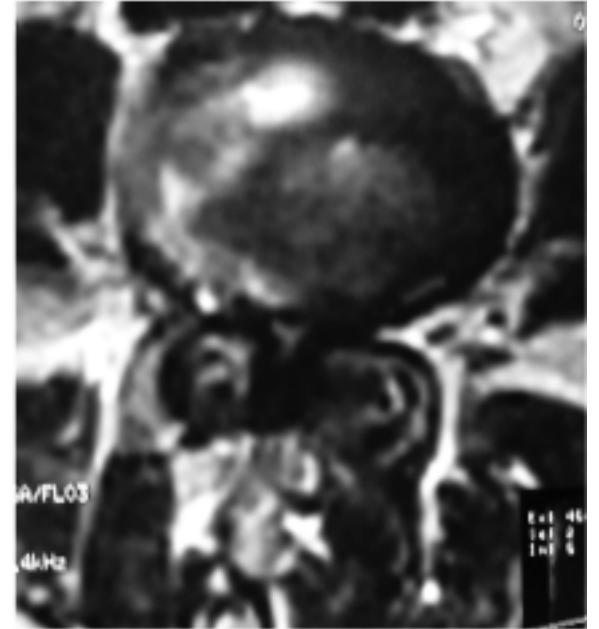
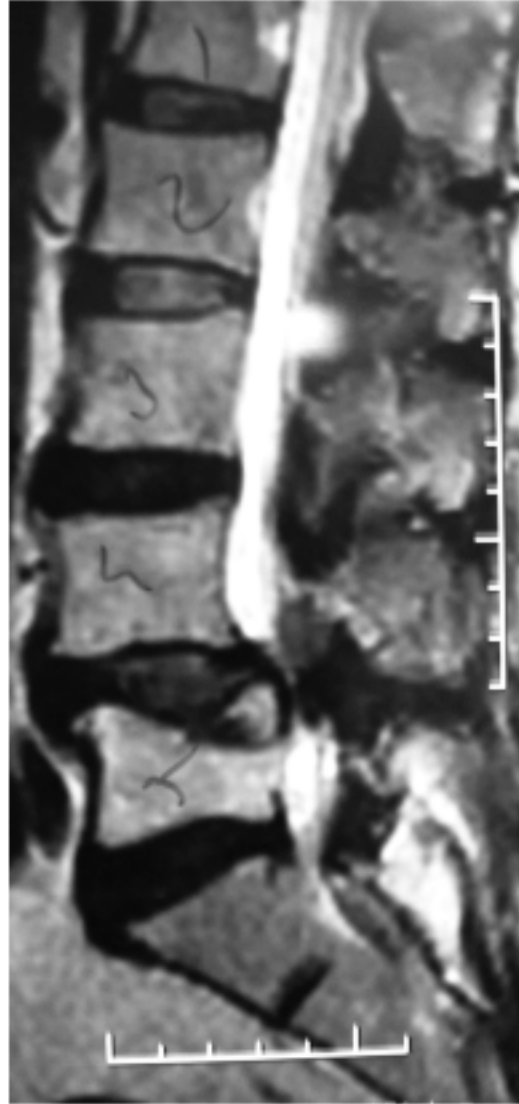
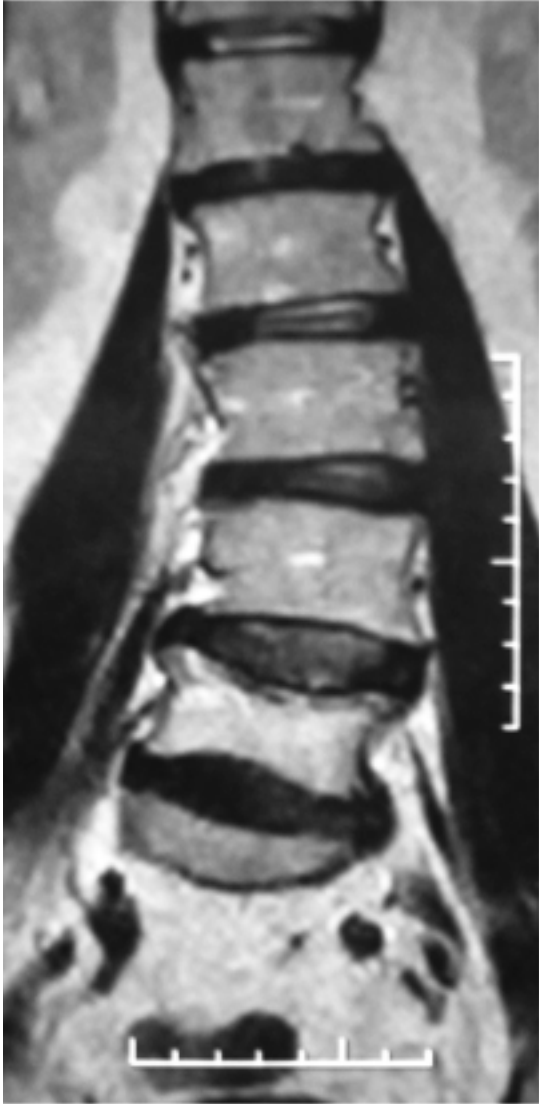
Helikal Rotasyon Ekseni



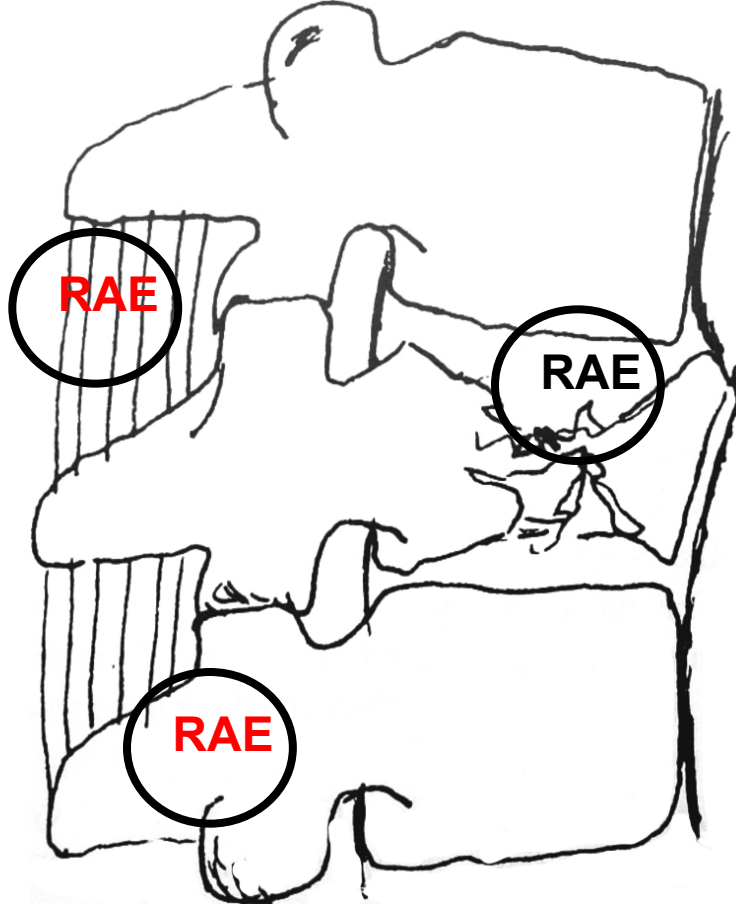
Helikal Eksen Hareketi



3 Planda Dejenerasyon 3 Planda RAE Deęiřimi

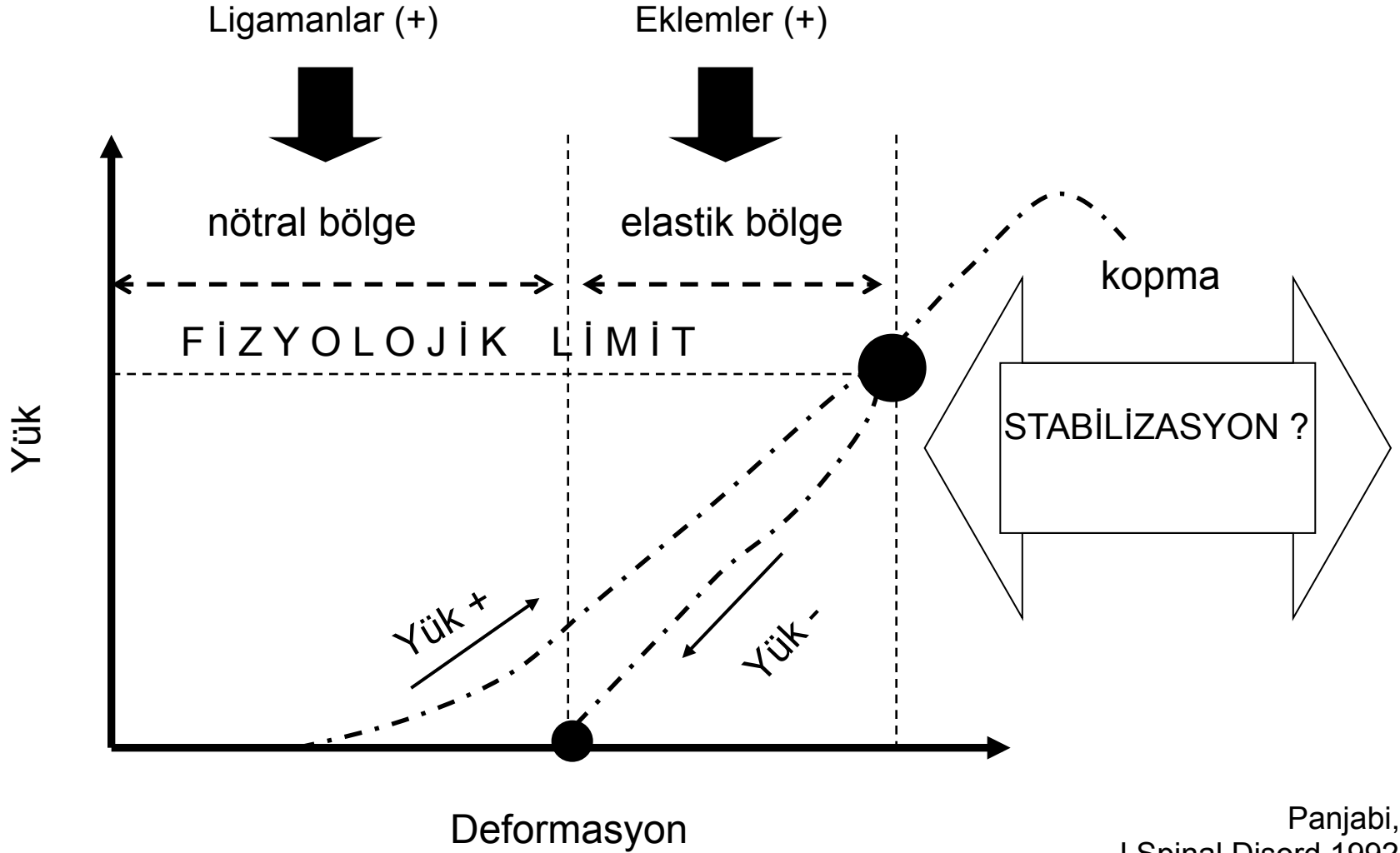


RAE Yer Deęiřimi



Stabilizasyon
bozulması

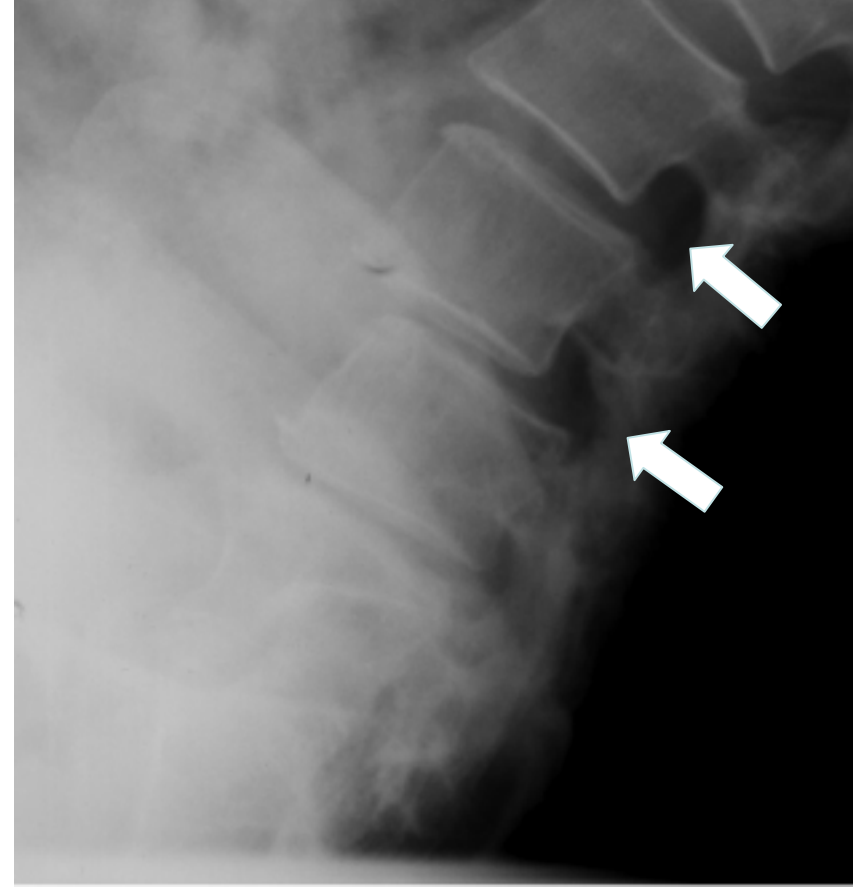
Hareket Aralığı (ROM)



Hareket Aralığı

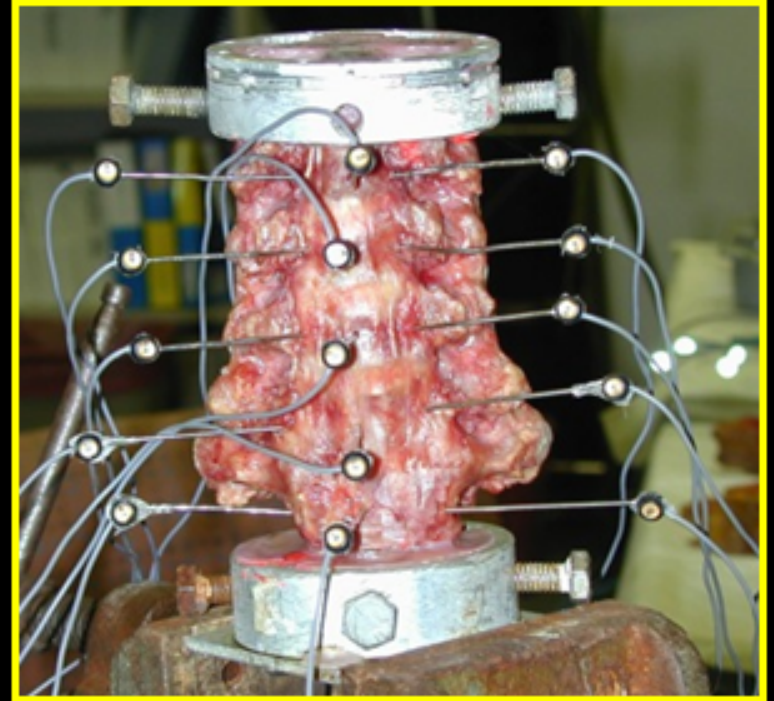


Hiperfleksiyon



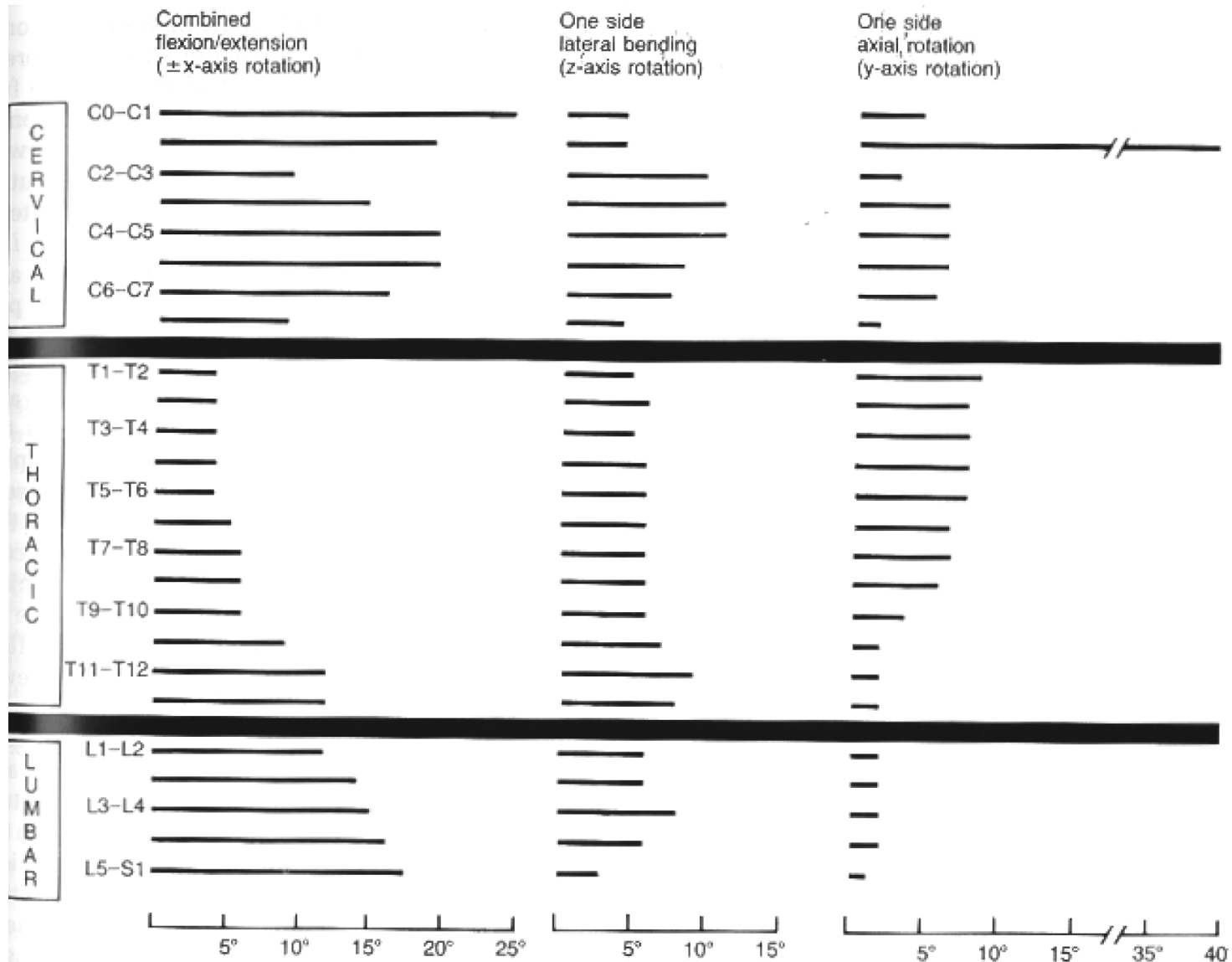
Hiperekstansiyon

Hareket Aralığı Ölçümü



Sterofotogrametri

Hareket Aralığı (°)



Mekanik Terimler

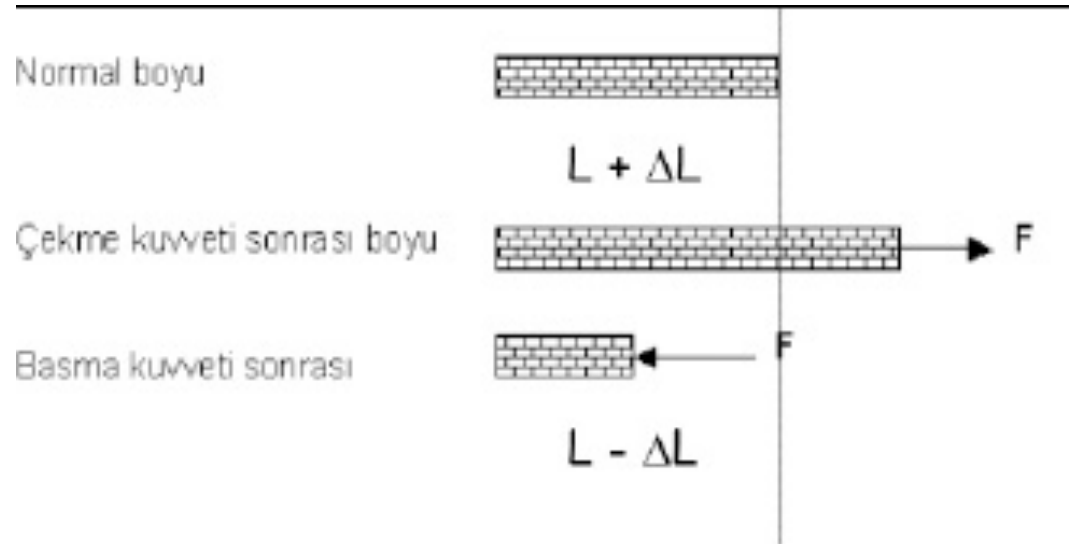
- Strain= Birim Şekil değişikliği
- Stress= Gerilme
- Elastisite modülü= Young Modülü

Birim Şekil Değişirme (Strain, ϵ)

- Geometride oluşan şekil değiştirmenin (uzama, kısalma, kayma) ilk duruma oranı (BİRİMSİZDİR!)

Birim şekil değişirme = $(\Delta L / L)$

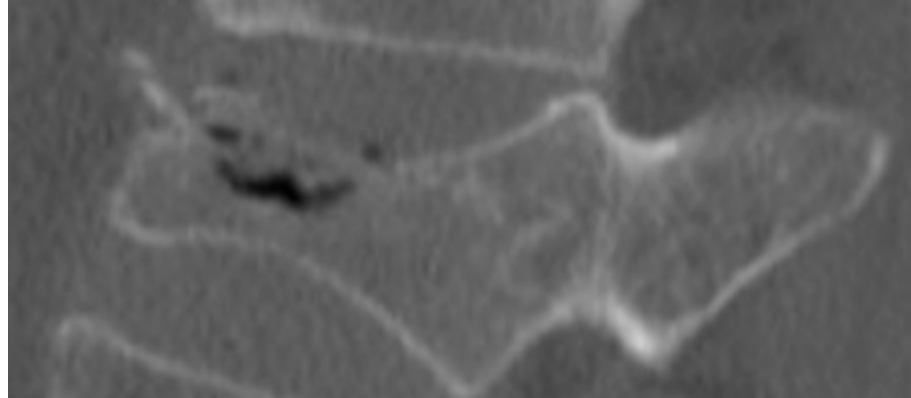
- Basma (compressive)
- Çekme (tensile)
- Kayma (shear)



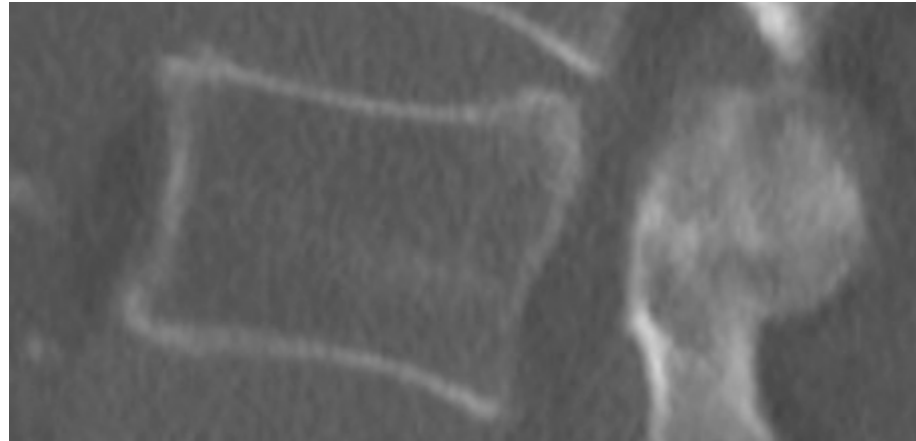
$$\epsilon = \Delta L / L$$

Birim Şekil Değişirme (Strain, ϵ)

ΔL



L



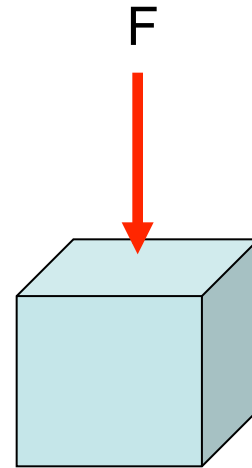
$$\epsilon = \Delta L / L$$

Gerilme (Stress, σ)

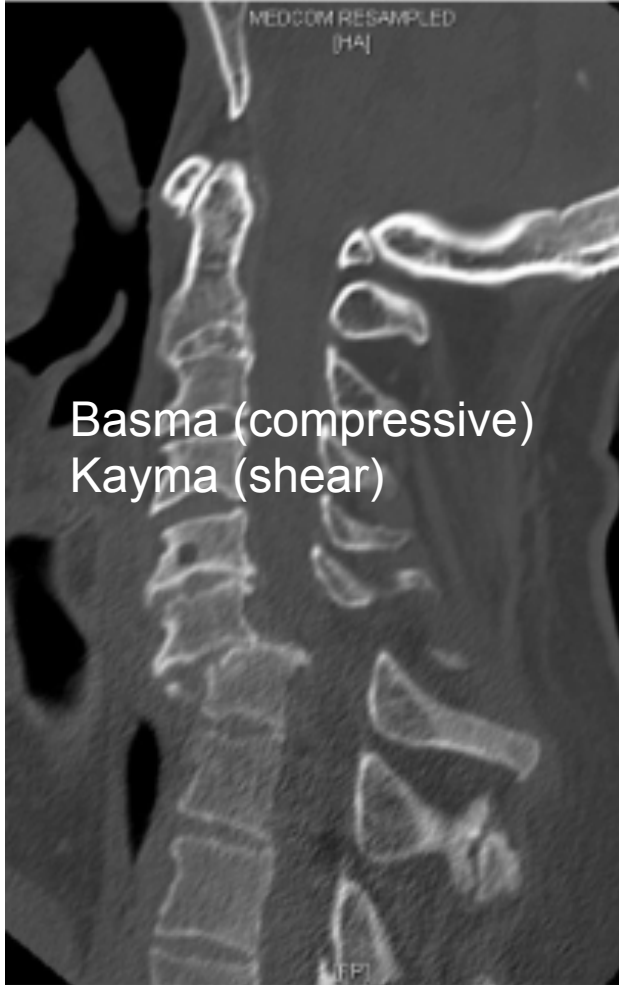
- Birim alana gelen kuvvet ($\text{Pa} = \text{N/m}^2$)

Gerilme = Kuvvet / Alan

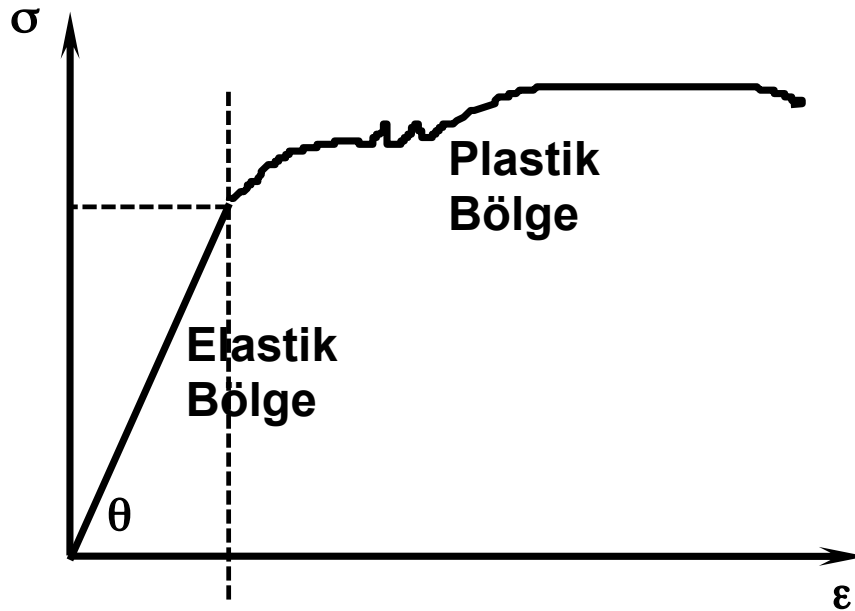
- Basma (compressive)
- Çekme (tensile)
- Kayma (shear)



Gerilme (Stress, σ)



Elastik bölge, Hooke kanunu

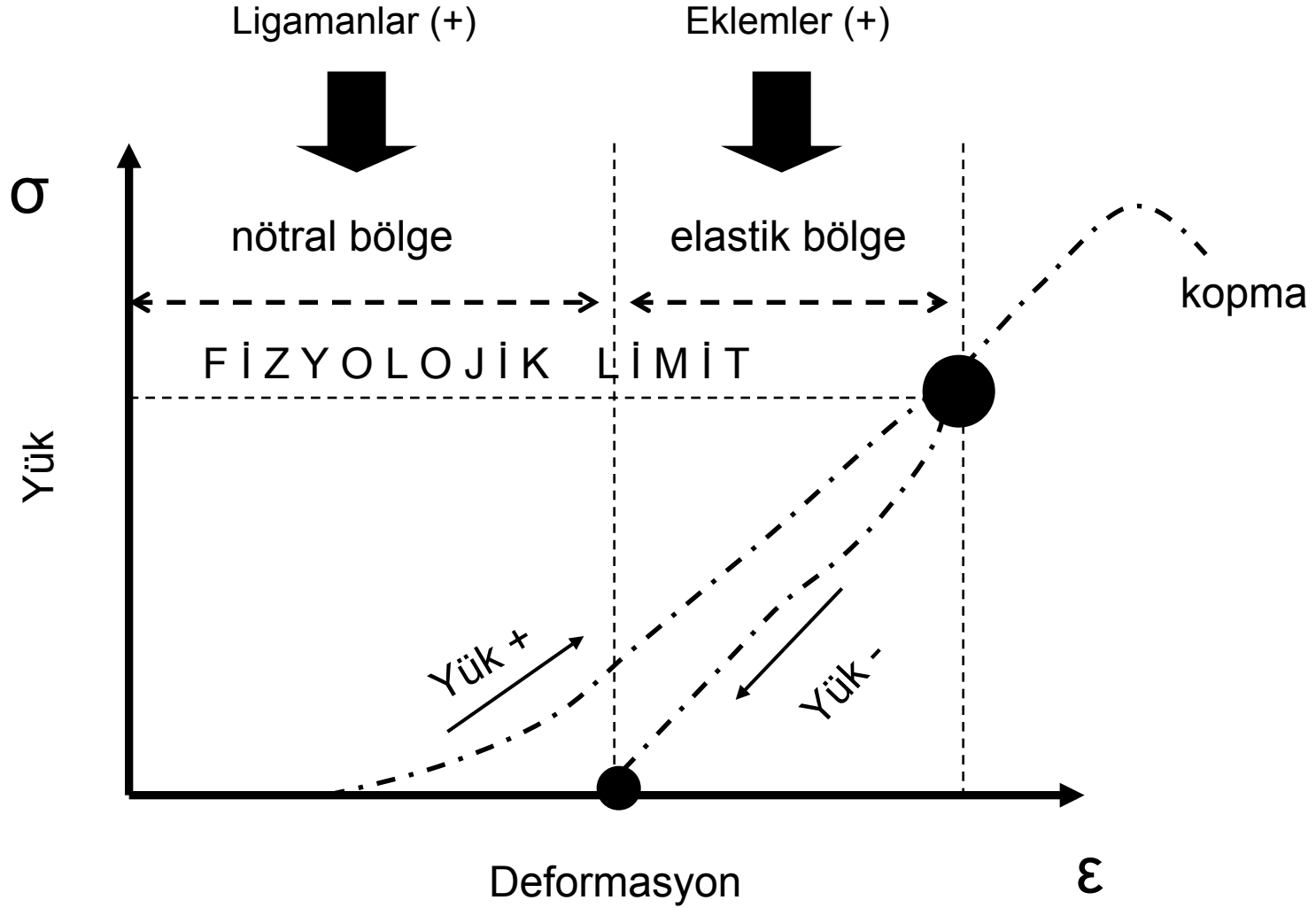


$$\epsilon = \frac{\Delta l}{l}$$

$$\sigma = E \cdot \epsilon$$

Elastisite modülü (Young Modülü) = (σ / ϵ)

Elastik Bölge



Materiyel Özellikleri

Elastisite Modülü: Gerilmenin birim şekil değişikliğine oranıdır.

Elastisite modülü yüksekse cisim daha fazla dayanımlıdır.

$$E = \sigma / \varepsilon$$

Poisson Oranı: Çaptaki strain'in boydaki strain'e oranı

$$\varepsilon_x / \varepsilon_y$$

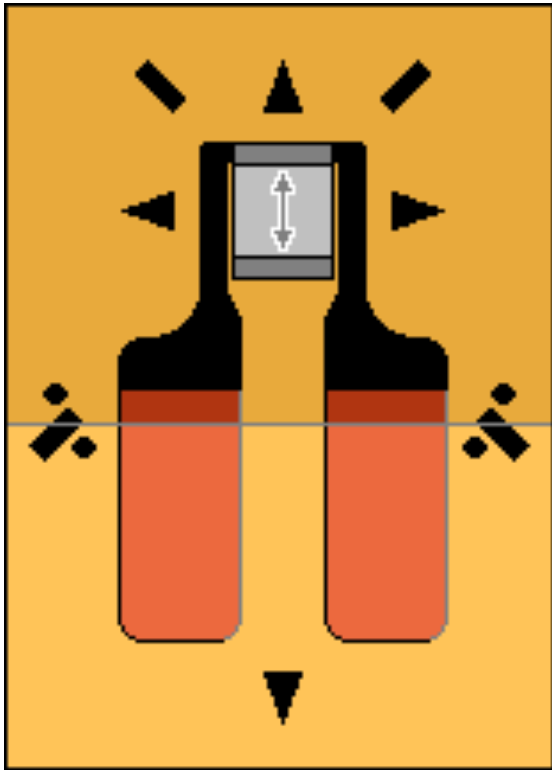
Materyel Özellikleri

| Anatomik bölge | Young's modülü (Mpa) | Poisson's oranı |
|--------------------------------|---------------------------------|------------------------|
| Kortikal kemik | 10000 | 0.29 |
| Trabeküler kemik | 100 | 0.29 |
| Endplate | 500 | 0.40 |
| Lamina, spinoz proses | 3500 | 0.29 |
| Disk annulusu | 3.4 | 0.40 |
| Disk nukleusu | 3.4 | 0.49 |
| Anterior longitudinal ligaman | 11.9 | 0.39 |
| Posterior longitudinal ligaman | 12.5 | 0.39 |
| İnterspinoz ligaman | 3.4 | 0.39 |
| Ligamentum flavum | 2.4 | 0.39 |
| Kapsular ligaman | 7.7 | 0.39 |

Strain (birim şekil deęiřtirme) ölçüm teknikleri

- Gevrek kaplama
- Fotoelastisite
- Termografi
- Elektrik rezistans strain gage teknięi
- Sonlu eleman yöntemi

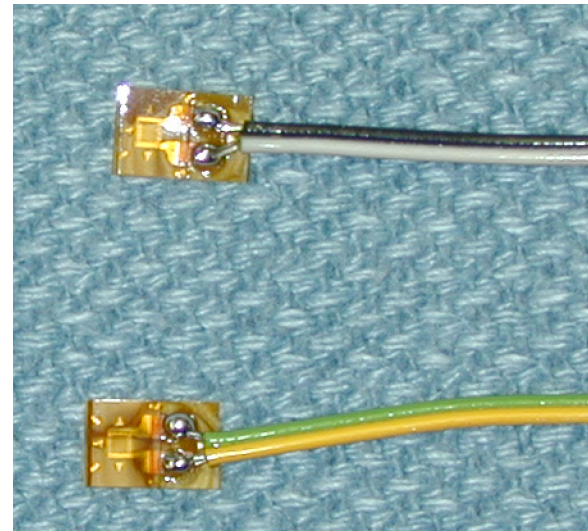
Strain Gage



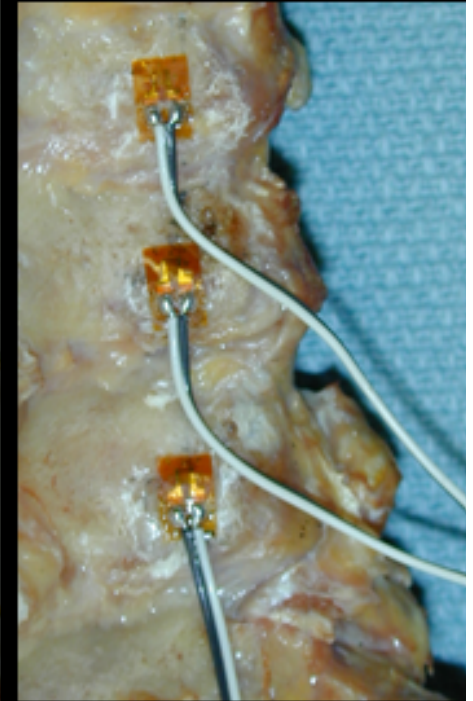
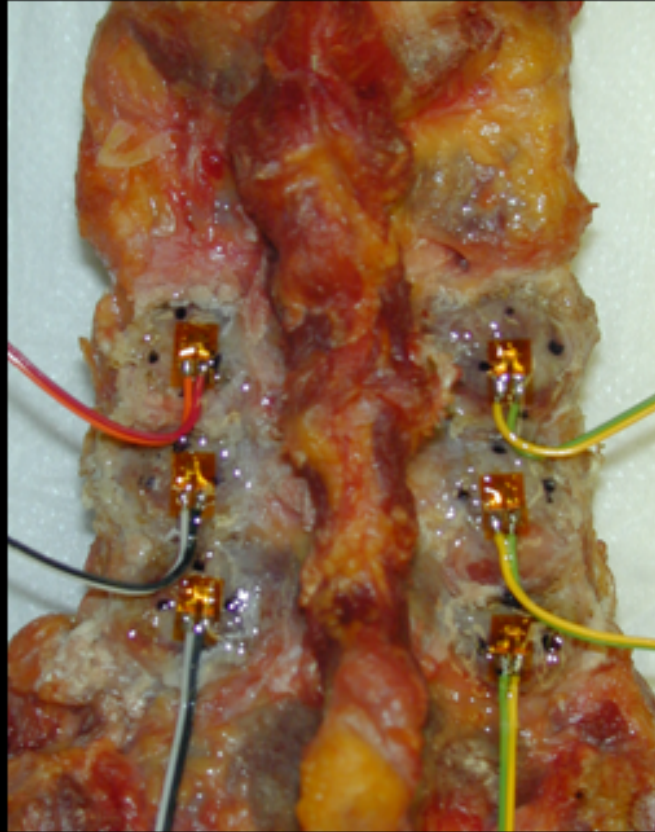
4.8 mm

6.9 mm

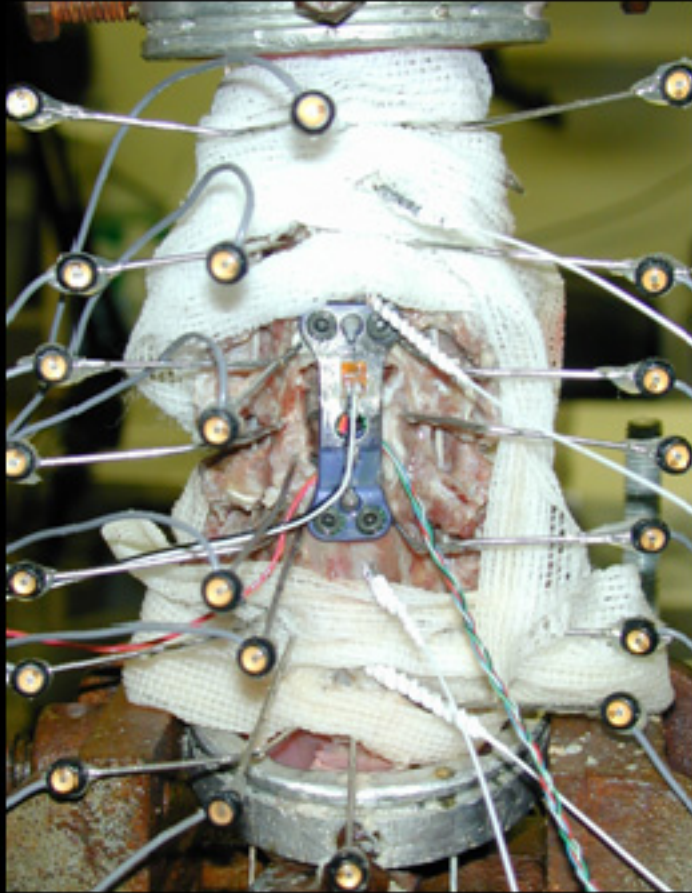
- Tek eksenli strain gage
- Statik ve dinamik gerilme analizi.



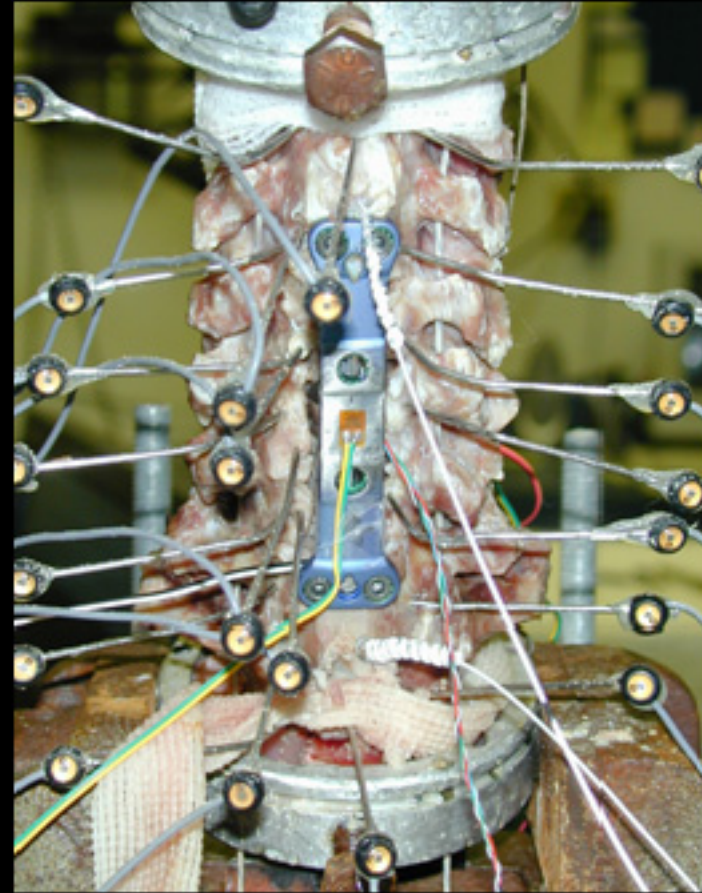
Lateral mass' lara strain gage yapıştırılması



Servikal plak strain gage yerleřtirilmesi



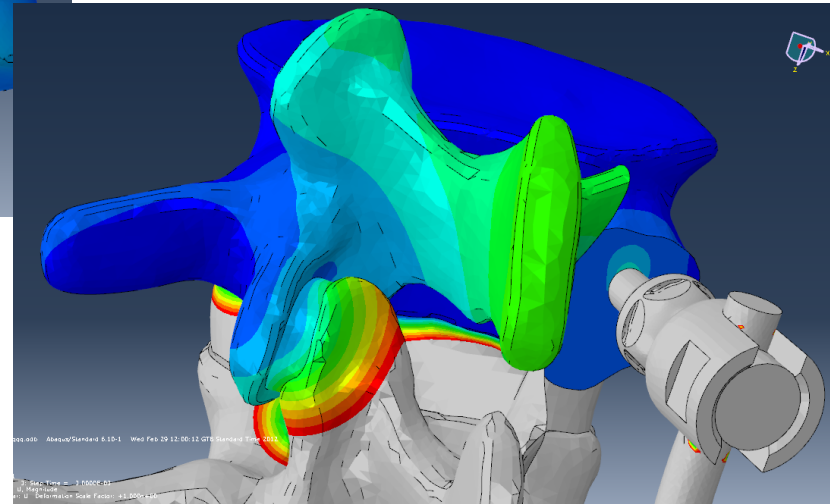
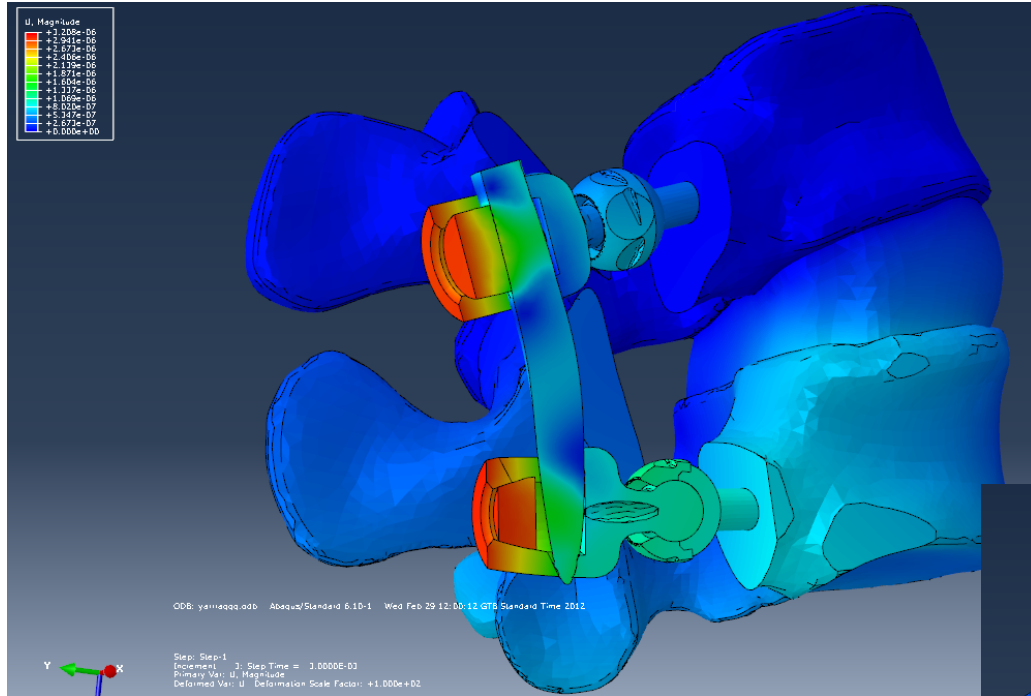
C5 anterior plak



C4-5-6 anterior plak

FEM Kesitsel Von Misses Stress

Dinamik Pedikül Vida+ Rijit Rod



Son Söz

- Klinik olarak RAE sıklıkla sagittal planda değerlendiriliyor (yakınsama)
- RAE dejenerasyon veya travma ile yer değiştirebilir
- Hareket aralığı derecesi “geçiş bölgelerinde” değişiyor
- Elastisite Modülü stresin strain' e oranıdır
- Elastisite Modülü yüksek olan dokular daha sert materyellerdir

Konuřmanın slaytları

www.hakanbozkus.com

adresinden alınabilir

Teřekkür ederim