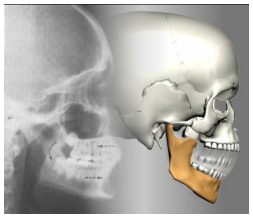
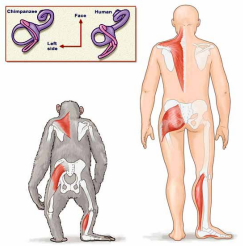


Dental Biomechanics





Types of motion

translation + rotation

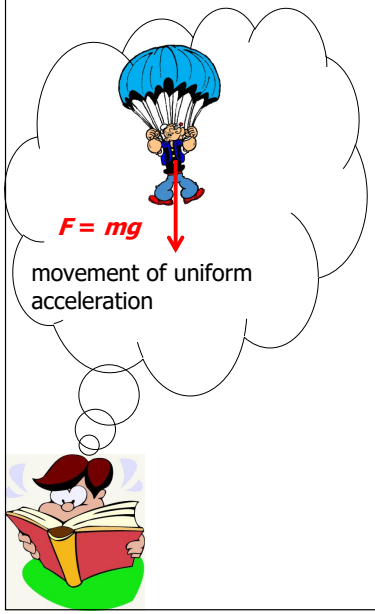
translation

Forces!

rotation

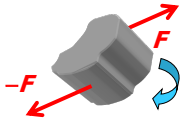
Torques!

Force and torque

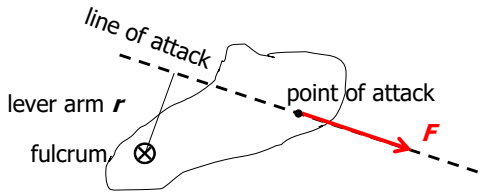


For rigid bodies:

rotation occours if torque is present (even without translation)



$$\sum \vec{F}_i = 0$$

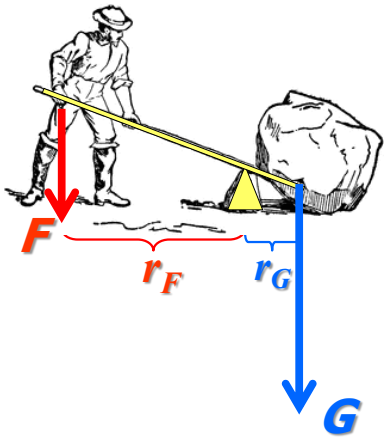


Torque (τ):

$$\tau = F \cdot r \quad \text{(Nm)}$$

The concept of a lever

equilibrium $\Leftrightarrow \Sigma F_i = 0$ and $\Sigma \tau_i = 0$

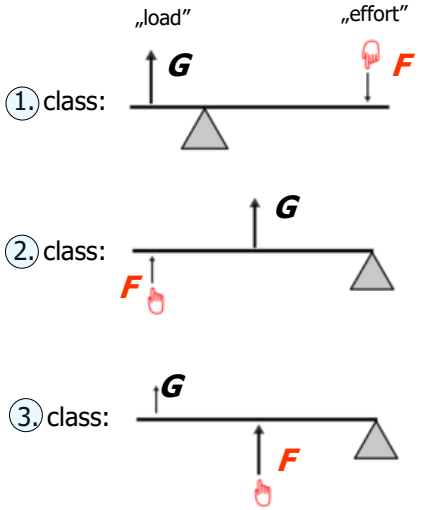


$$r_G \cdot G = \tau_G = \tau_F = r_F \cdot F$$

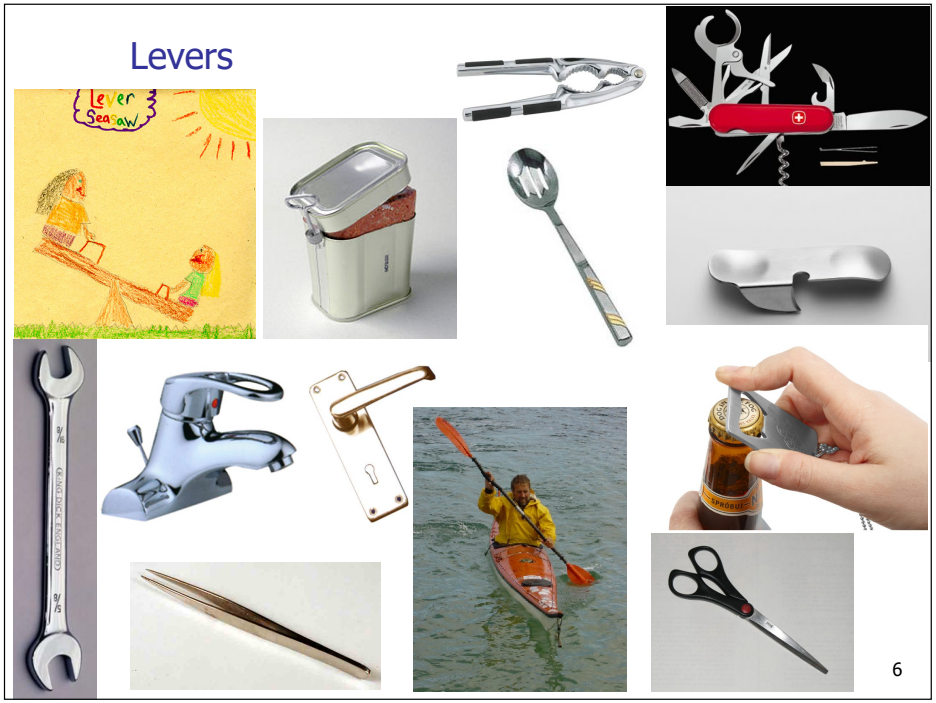
$$\frac{F}{G} = \frac{r_G}{r_F}$$

force amplification

Types of levers



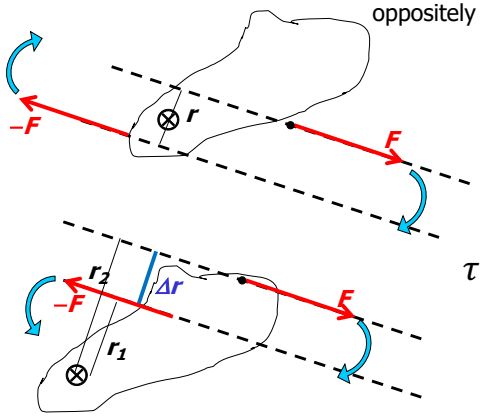
Levers



Dental levers

Force couple

Couple: a pair of forces, equal in magnitude, oppositely directed, and perpendicularly displaced.



Resultant force: 0

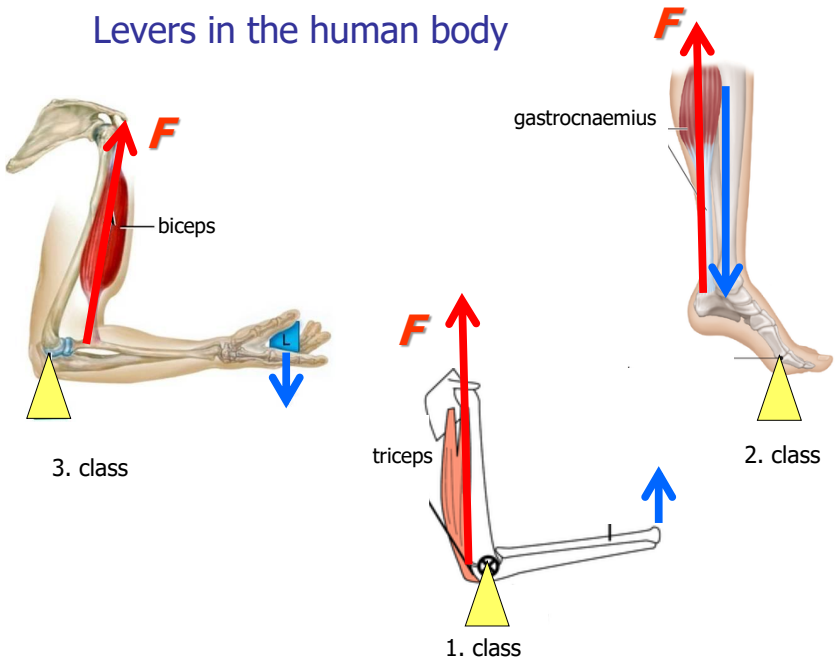
Resultant torque (τ):

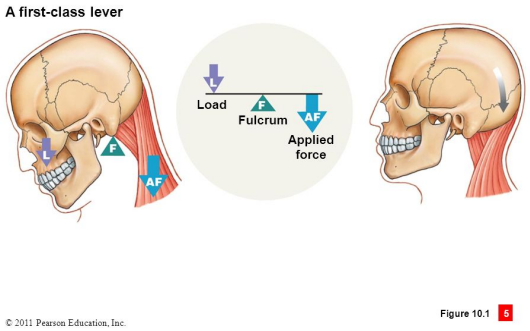
$$\tau = F \cdot (r_2 - r_1) = F \cdot \Delta r$$

⇒ „couple = torque"

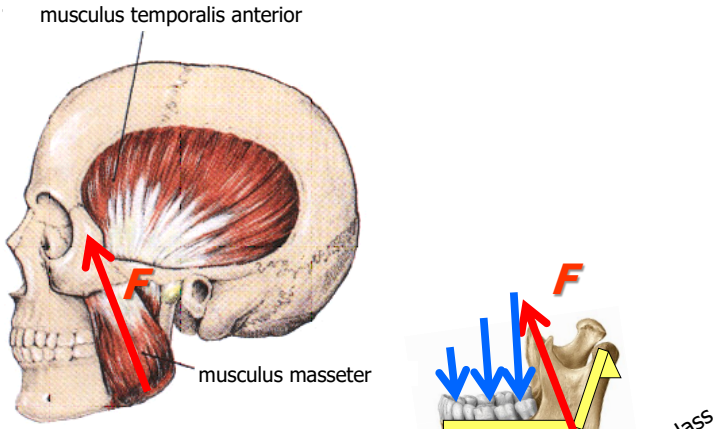
Any set of forces on a body can be replaced by a single force and a single couple.

Levers in the human body



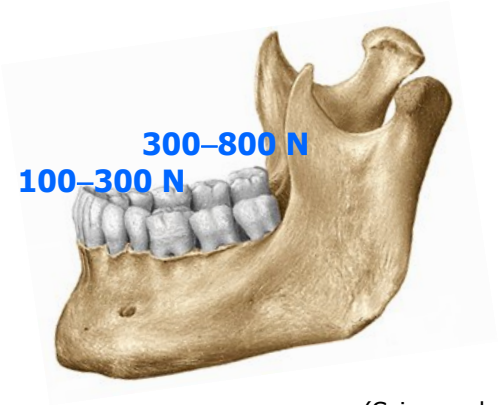


The mandible as a lever



mandible

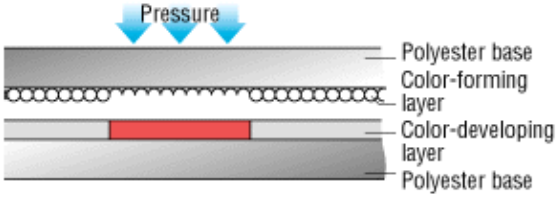
Masticatory forces



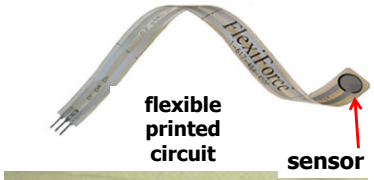
(Guinness: human - 4000 N)

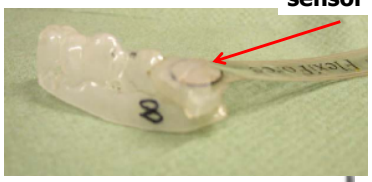
Measuring masticatory forces

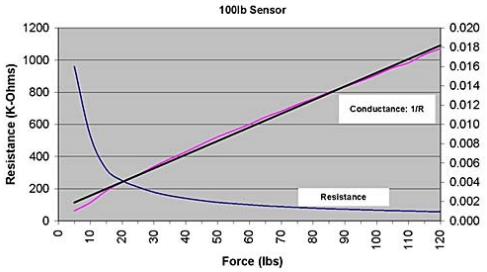
Pressure indicator film:

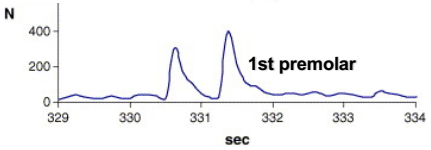


piezoelectric sensor:



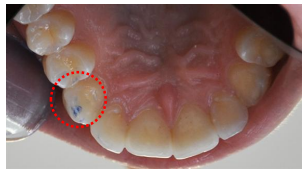






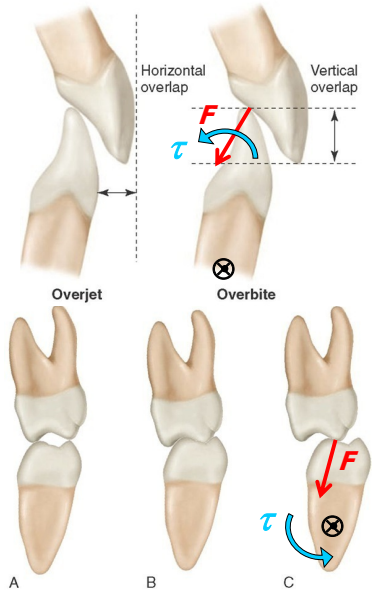
other (sunjective) methods:

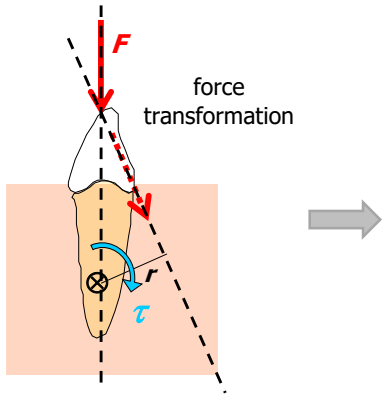
Pressure values of mastications



$p \leq 300$ MPa !

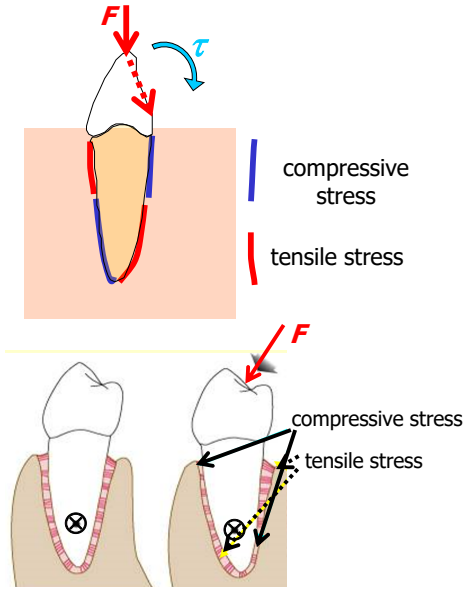
Torque of mastication





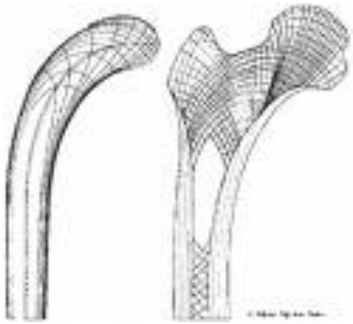
$$\tau = F \cdot r$$

Consequences of torque



Bone remodeling

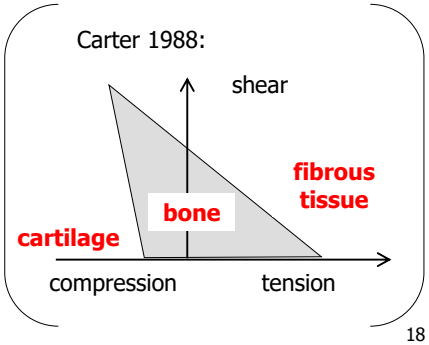
Wolff's law 1870



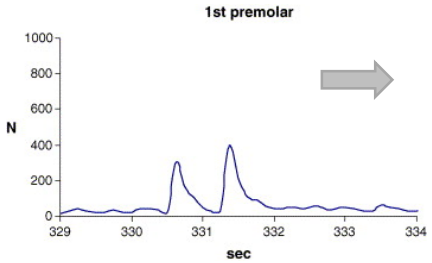
Every change in the function of a bone is followed by certain definite changes in its internal architecture and its external conformation.

compressive stress ⇒ resorption

tensile stress ⇒ formation



Masticatory forces



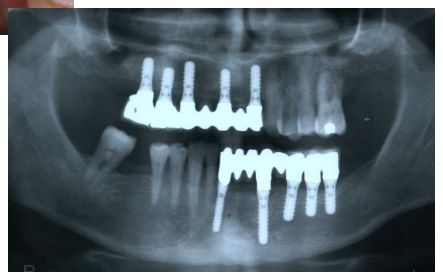
***F* = 100–800 N**

***t* ≤ 1 s**

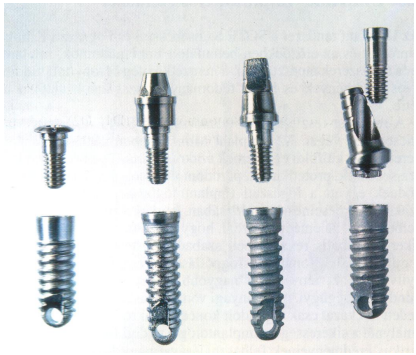
If the force would be constant

3–5 seconds	⇒	pain
≈ hours	⇒	tissue damage
7–14 days	⇒	loosening of teeth

Physical bases of implantology



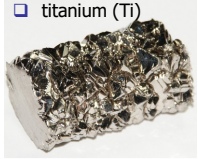
Dental implants



ImImplant materials

metals

- titanium (Ti)

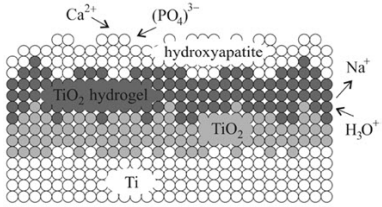


- titanium alloys (Ti-6Al-4V)
- kCobalt alloys (Co-Cr-Mo)

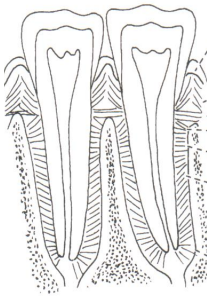
ceramics

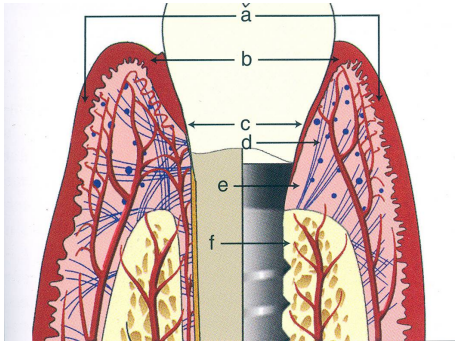
- aluminium-oxide
- zirconia (zirconium-dioxide)
- HAP
- bioüglasses

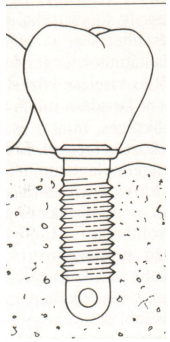
metals with ceramic coating



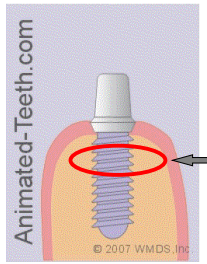
Tooth vs. implant





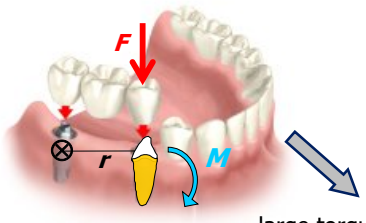


Force transition of implant



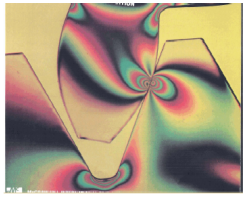
after integration

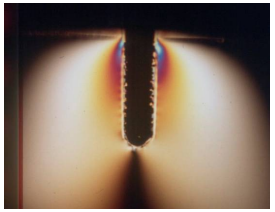
concentrated compression

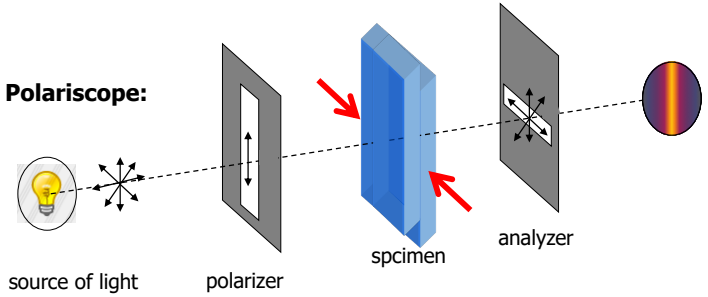


large torque

Optical method for stress analysis

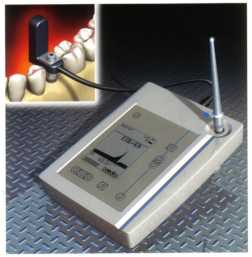






Methods for testing implant stability

- Resonant Frequency Analysis (RFA)



- Periotest