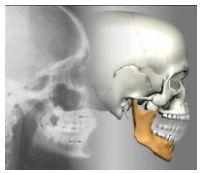


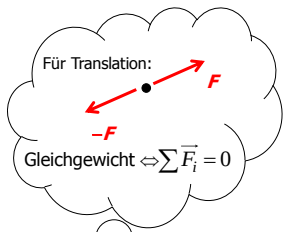
Biomechanik



Physikalische Grundlagen der zahnärztlichen Materialkunde 13.

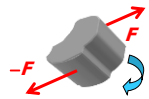
Statik – Drehmoment

Für Translation:

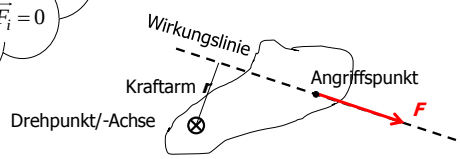


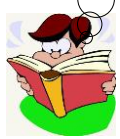
Gleichgewicht $\Leftrightarrow \sum \vec{F}_i = 0$

Für Rotation:



$\sum \vec{F}_i = 0$,
doch ist Rotation möglich!

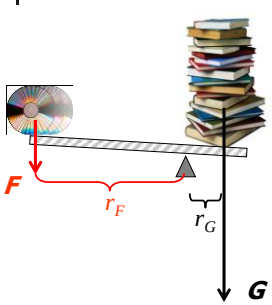




Drehmoment (M): $M = r \cdot F$ (Nm)

Gleichgewicht $\Leftrightarrow \sum \vec{F}_i = 0$ und $\sum M_i = 0$

Hebel



Im Gleichgewicht:

$\sum M_i = 0$

$r_G \cdot G = M_G = M_F = r_F \cdot F$

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

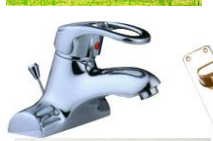
⇒ Kraftvervielfachung

Beispiele

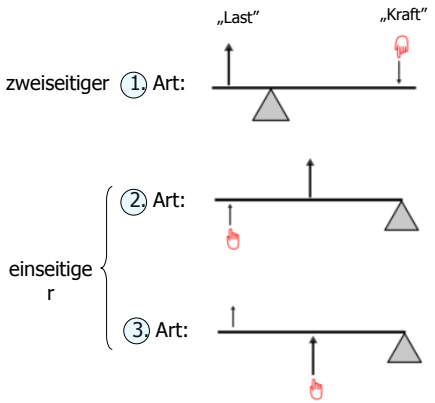






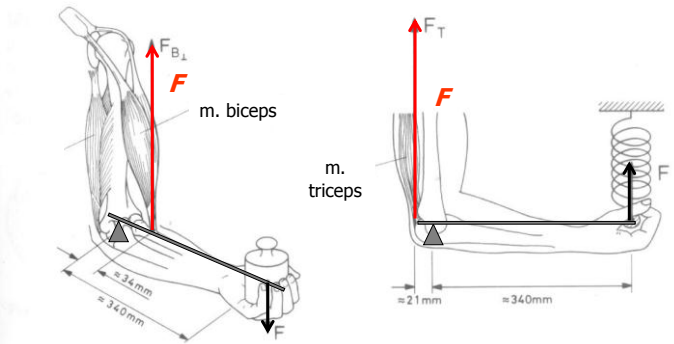


Hebelarten

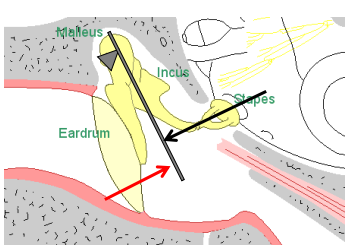


Hebel im Körper

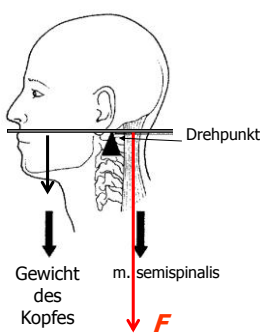
Arm:

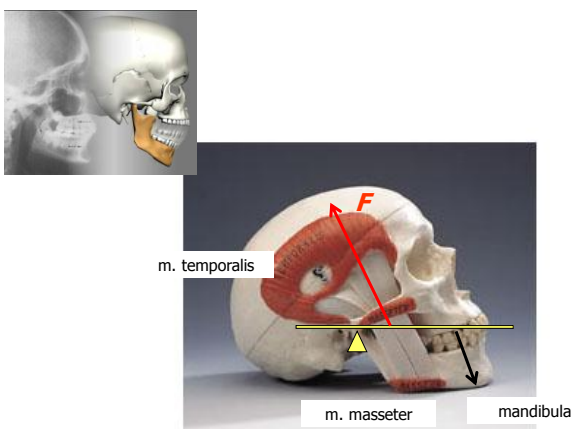


Gehörknöchelchen:

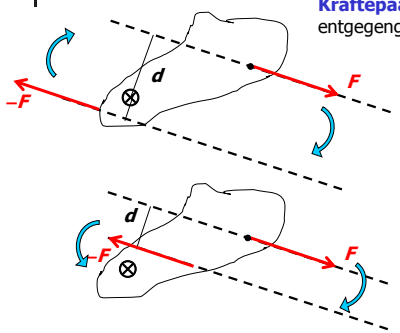


Kopfhaltung:





Kräftepaar, Ersetzung eines Kraftsystems



Kräftepaar: zwei gleich große Kräfte in entgegengesetzten Richtungen

Resultierende Kraft: 0

Resultierendes Drehmoment (M):

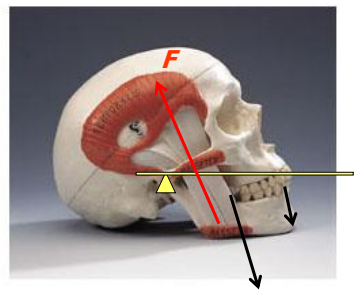
$$M = d \cdot F$$

(unabhängig von der Drehachse)

Jedes Kraftsystem kann mit einer Kraft und einer Kräftepaar ersetzt werden.

Kaukräfte

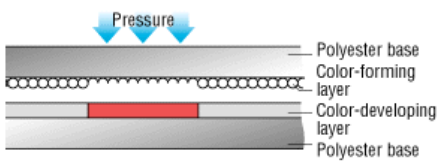
(Guinness: bei Mensch - 4000 N)



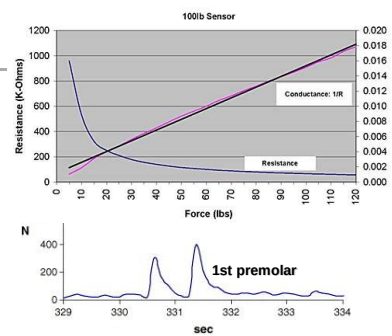
kb. 10 000 N

Messung der Kaukräfte

Farbstoff-Folie:

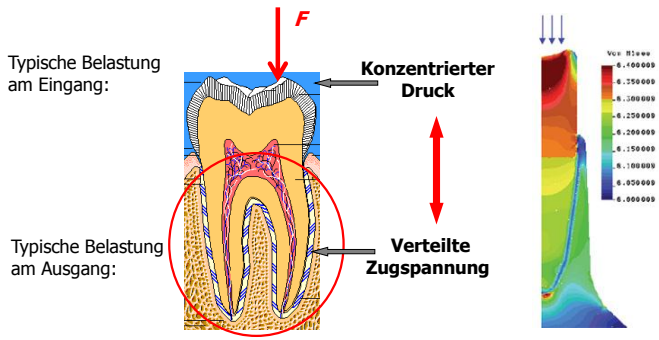


Piezoelektrischer Sensor:



Sonstige (subjektive) Methoden:

Übermittlung der Kaukräfte

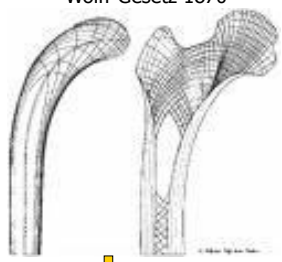


Konstruktive Wirkung auf das Knochen!

13

Knochenumbau (remodeling)

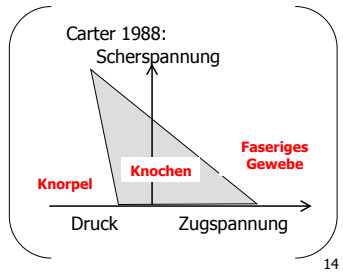
Wolff-Gesetz 1870



Rolle der mechanischen Belastung

Druck ⇒ Abbau

Zugspannung ⇒ Aufbau



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Mechanismus des Knochenumbaus

mechanische Belastung

↓

elektrisches Signal (Piezoelektrisches/Strömungspotenzial)

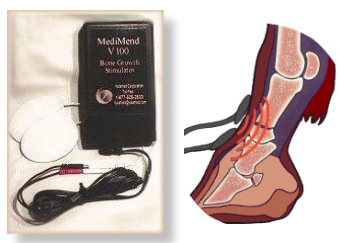
↓

Regulierung des Osteogenesis

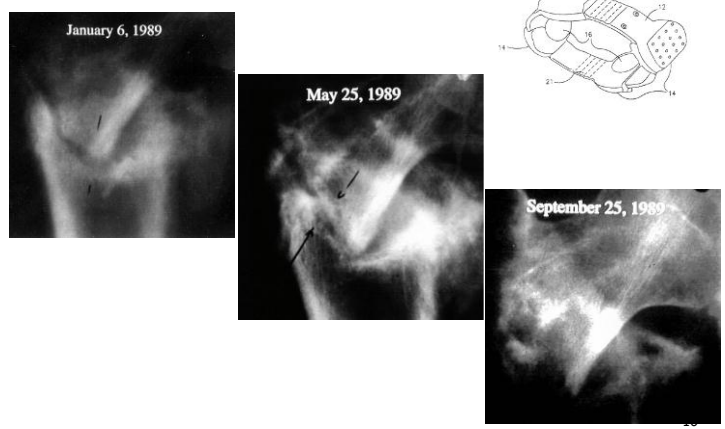
↓

mechanische Adaptation

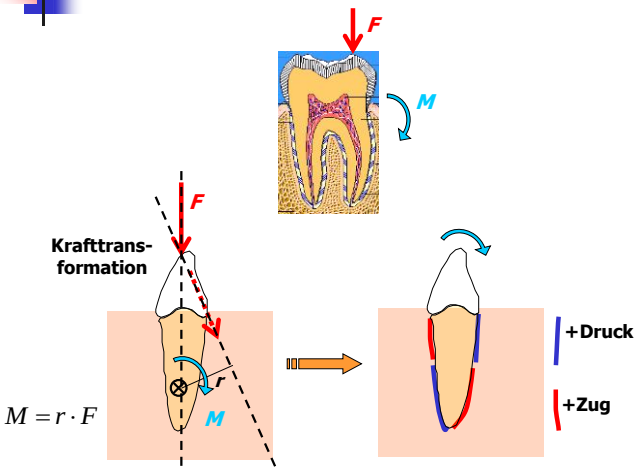
Anwendung von elektrischen Feldern für beschleunigung der Knochenheilung: Elektrotherapie



15



Drehmoment der Kaukräfte



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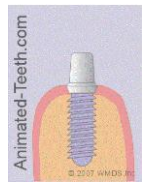
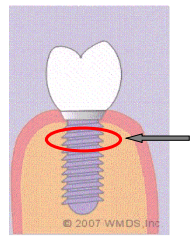
Kraftübermittlung von Implantaten

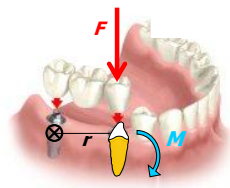
Osseointegration → Druck!

Keine Verteilung!





Spannungs-
konzentration



→ nagy forgatónyomaték

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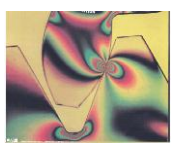
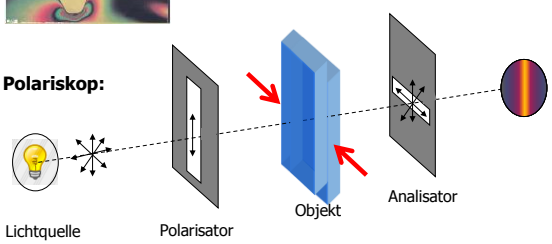
Untersuchungsmethoden in der Implantologie



● Spannungsoptik

● Finite-Elemente-Methode

Polariskop:



⟹ Spannungsverteilung

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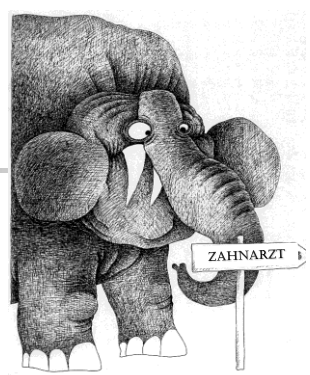
Physikalische Grundlagen der Kieferorthopädie



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Orthodontie

21

Physiologische Kräfte im Mund

Kaukräfte:

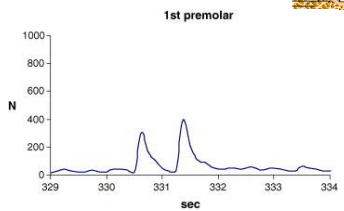
Starke, aber kurzzeitige Kraftwirkung:

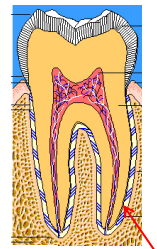
***F* = 100–800 N**

***t* ≤ 1 s**

3–5 s: Schmerz

7–14 Tage: Lockerung des Zahnes





Ruhekräfte:

Schwache, aber dauerhafte Kraftwirkung:

***F* = 1–10 cN**

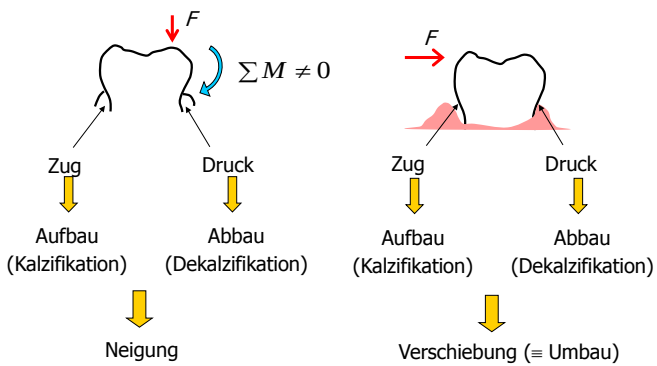
PDL

periodontales Ligament

22

Folgen der dauerhaften Kraftwirkungen

F > 10 cN:



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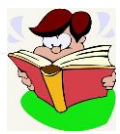
Bewegungsformen

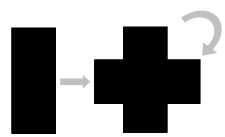


Translation

Rotation

Zusammengesetzte Bewegung

= Translation+ Rotation



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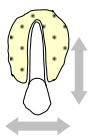
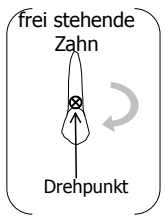
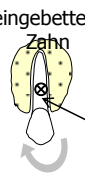
Bewegungen der Zahn

Translation **Rotation**





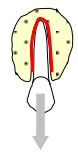


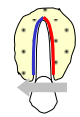
Drehpunkt

(center of resistance - CR)

Mechanismen der Bewegungen

Verlängerung Verkürzung Translation

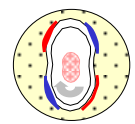




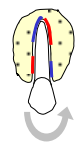
Knochenaufbau

Knochenabbau

Rotation

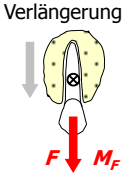


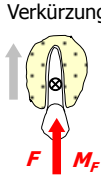
Kippung



Kräfte, Drehmomente

Verlängerung Verkürzung Rotation

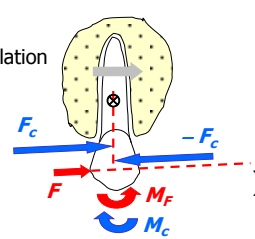




Einzelkraft

Kräftepaar

Translation

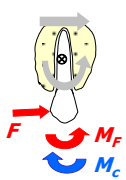


Kraft+Kräftepaar

$\sum F = F$
$\sum M = 0$
} Nur Translation

- $M_c/M_F = 1$

Kippung



Kraft	Kräftepaar	$\sum F$	$\sum M$	
–	✓	**0**	M_c	→ Rotation
✓	–	F	M_F	→ **Kippung** Tranlation+ Rotation ($M_c = 0$)
✓	✓	F	$M_F - M_c$	→ **kontrollierte Kippung** Translation+ Rotation

- **$0 < M_F - M_c$** ($M_c/M_F < 1$)
- **$M_F - M_c < 0$** ($1 < M_c/M_F$)