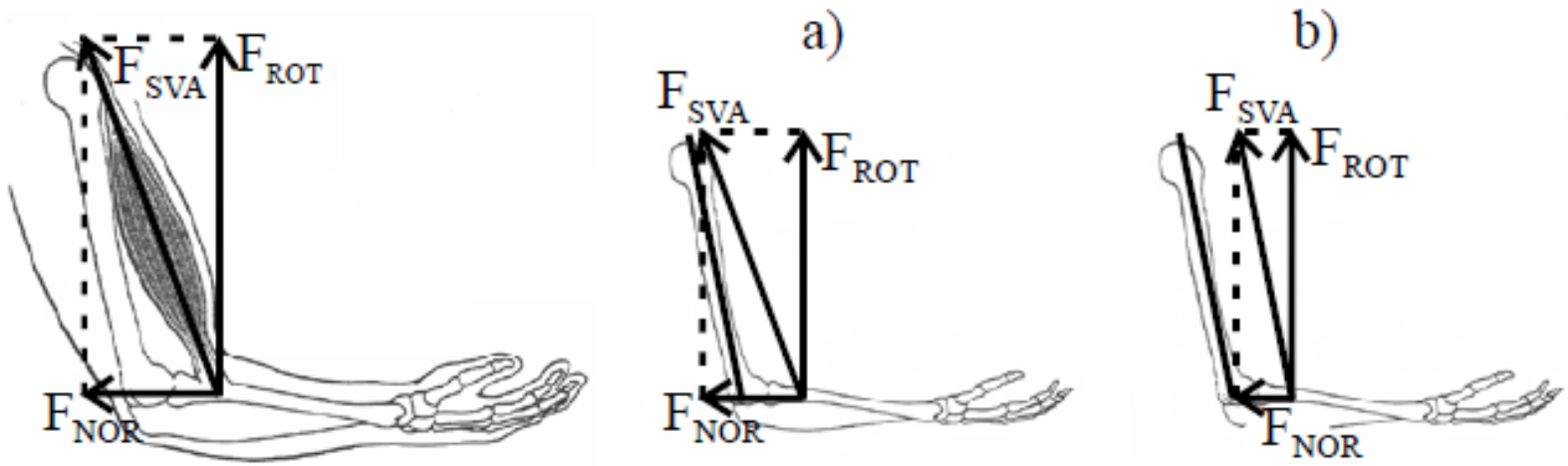
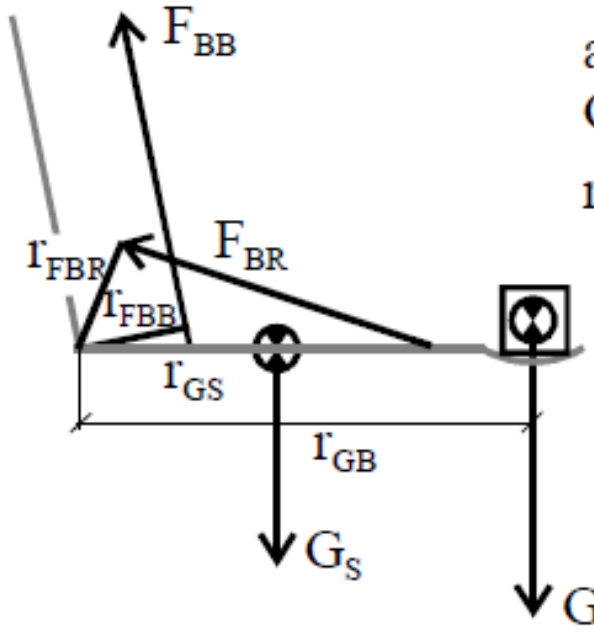


F_{SVA} – svalová síla, F_{ROT} – rotační složka síly,
F_{NOR} – normálová složka síly

Obr. 6.3 Rozklad svalové síly m. biceps brachii při flexi v loketním kloubu

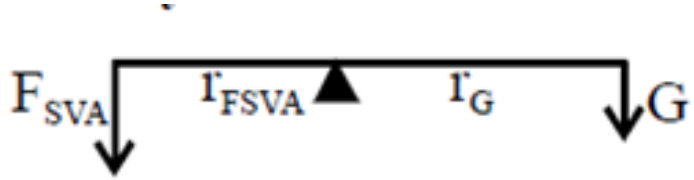
Jestliže předpokládáme působení další zátěže a zapojení dalších svalů (viz obr. 6.8) je momentová rovnice ve tvaru

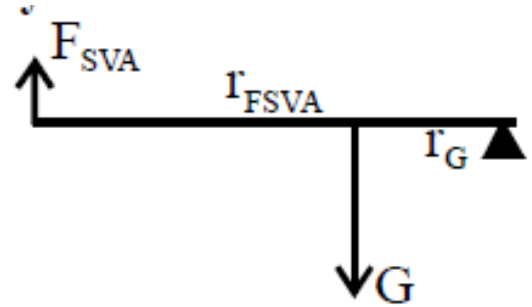
$$M = M_{GS} + M_{GB} + M_{FBB} + M_{FBR} =$$
$$= G_S \cdot r_{GS} + G_B \cdot r_{GB} + F_{BB} \cdot r_{FBB} + F_{BR} \cdot r_{FBR}$$

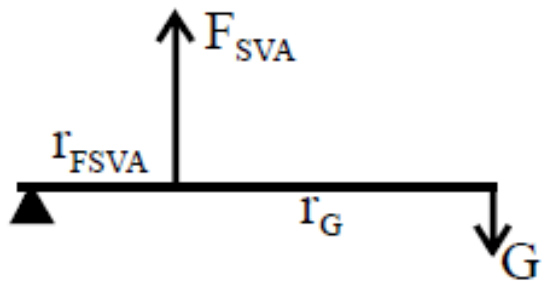


F_{BB}, F_{BR} – svalová síla m. biceps brachii
a m. brachioradialis
G_S, G_B – tíhová síla segmentu, tíhová síla břemene

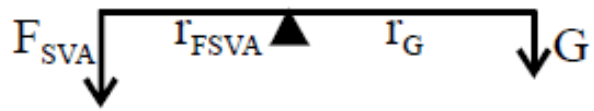
r_{FBB}, r_{FBR}, r_{GS}, r_{GB} – ramena těchto sil

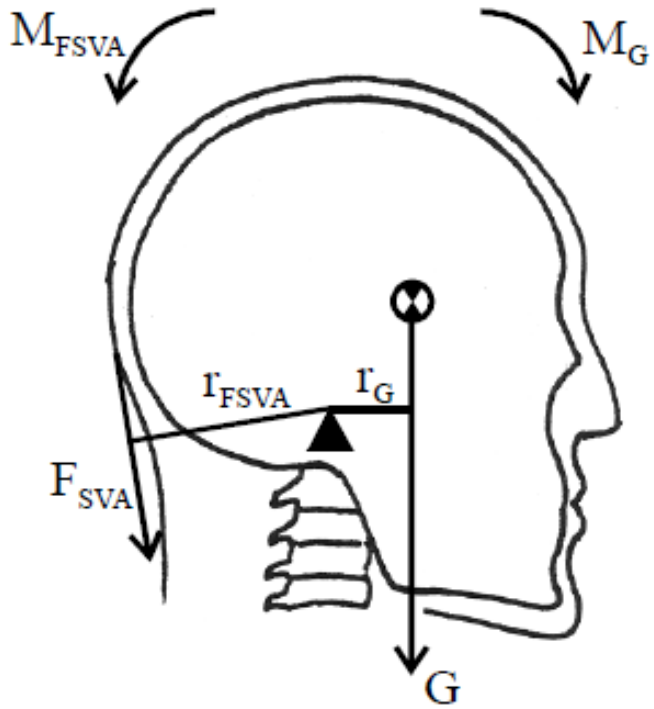

F SVA
r FSVA
r G
G


F SVA
r FSVA
r G
G


F SVA
r FSVA
r G
G

Páka prvního druhu – dvojzvratná, **páka rovnováhy**
Bod otáčení se nachází mezi působícími silami; příkladem je spojení lebky a páteře (obr. 6.9).



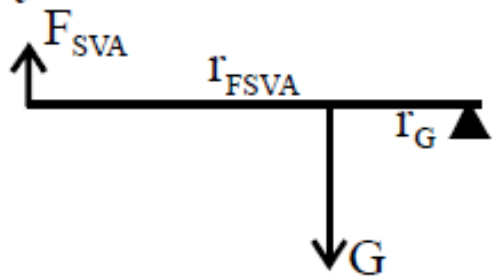


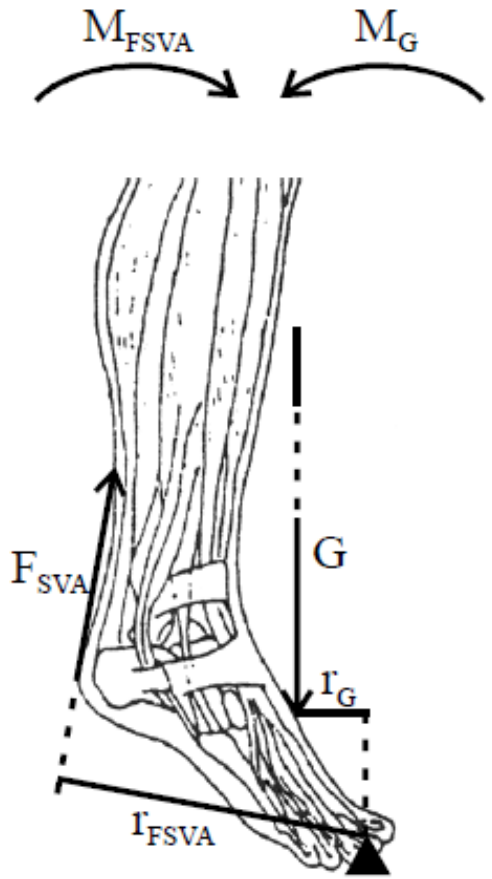
F_{SVA} – svalová síla šíjového svalstva
G – tíhová síla hlavy
r_{FSVA}, r_G – ramena působících sil
M_{FSVA}, M_G – momenty působících sil

Obr. 6.9 Příklad dvojzvratné páky (I. druhu)

Páka druhého druhu – jednozvratná, **páka síly**

Vektor tíhové síly se nachází mezi bodem otáčení a vektorem svalové síly; příkladem je pohyb v metatarzofalangeálním kloubu při plantární flexi (obr. 6.10).

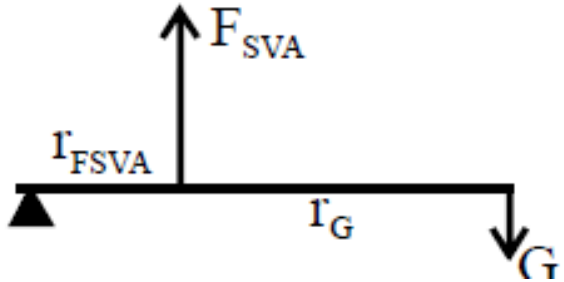




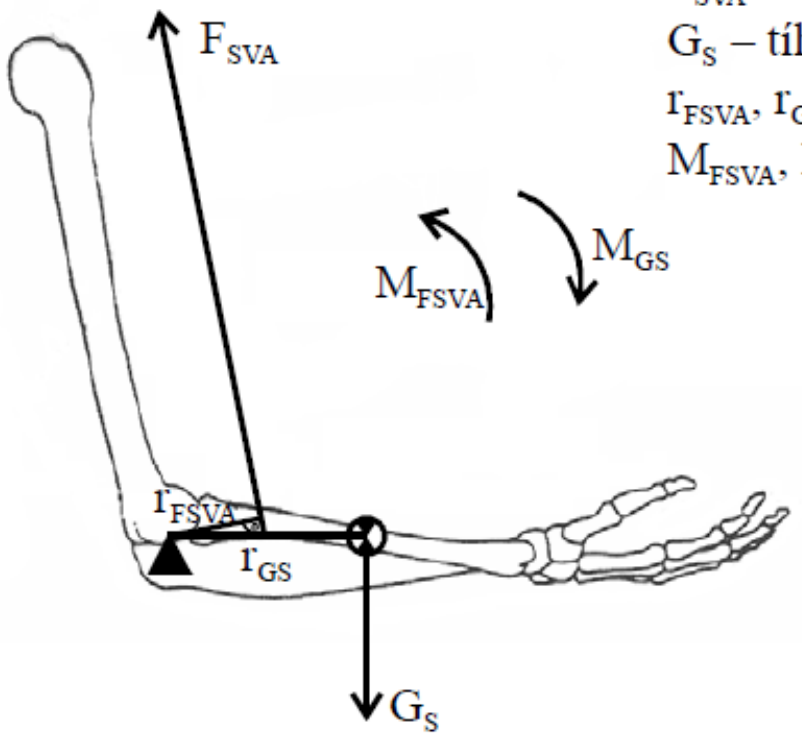
F_{SVA} – svalová síla m. triceps surae
G – tíhová síla těla
r_{FSVA}, r_G – ramena působících sil
M_{FSVA}, M_G – momenty působících sil

Obr. 6.10 Příklad jednozvratné páky (II. druhu)

Páka třetího druhu – jednozvratná, **páka rychlosti**
Vektor svalové síly se nachází mezi bodem otáčení a vektorem tíhové síly; příkladem je funkce m. biceps brachii při flexi v loketním kloubu (viz obr. 6.6).



F_{SVA} – svalová síla svalu
G_S – tíhová síla segmentu
r_{FSVA}, r_{GS} – ramena působících sil
M_{FSVA}, M_{GS} – momenty sil



Obr. 6.6 Grafické znázornění momentu síly a jeho aplikace na oblast loketního kloubu

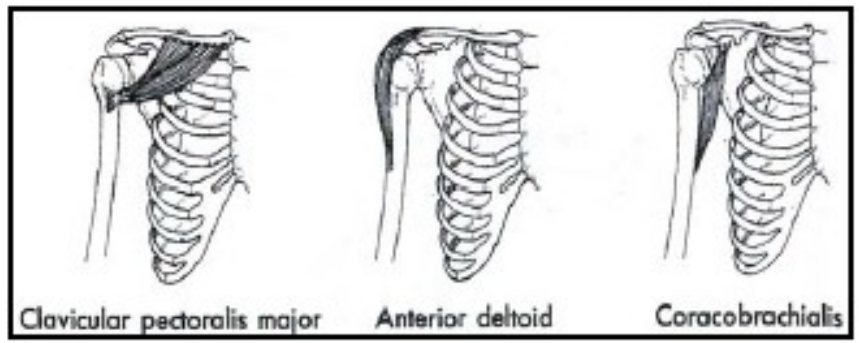
Anatomie

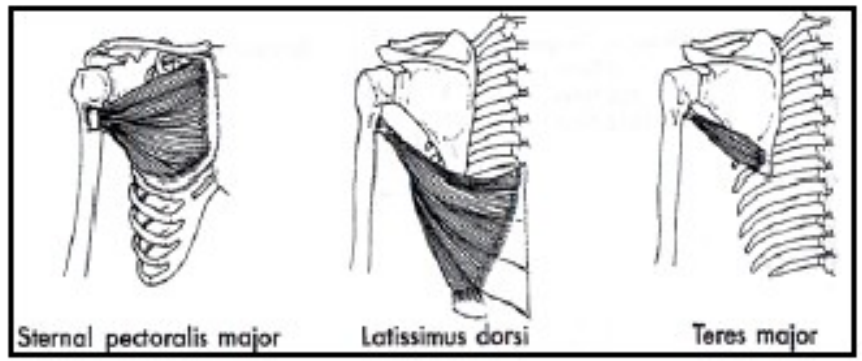
– kulový kloub volný

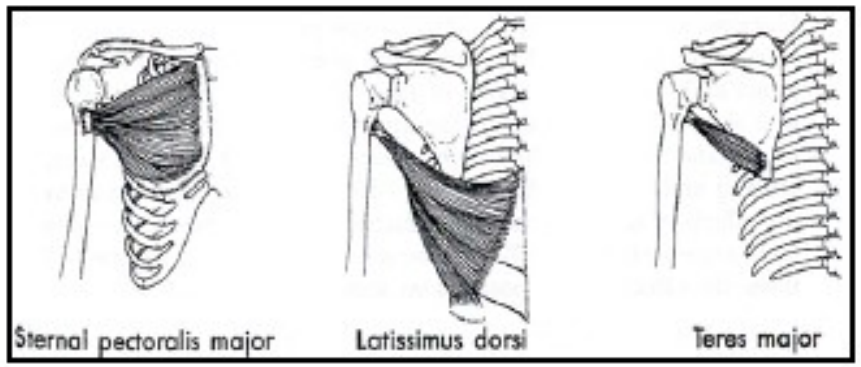
– spojení mezi pažní kostí a lopatkou

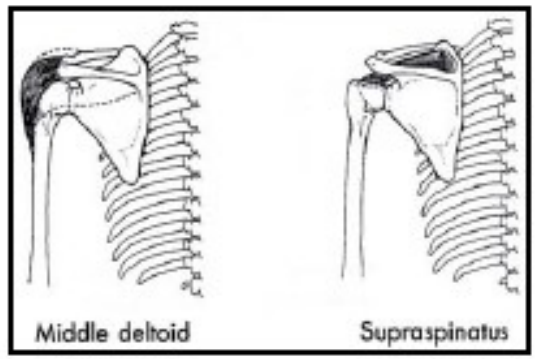
– 3 vazy (A. neutrální poloha, B. abdukce 45°, C. abdukce 90°, D. abdukce 90° a vnější rotace, E. abdukce 90° a vnitřní rotace)

– pohyblivost: flexe 120°, extenze 50°, abdukce 120° (s vytočení lopatky až 180°), addukce do základí polohy, rotace vitřní/vnější 90°



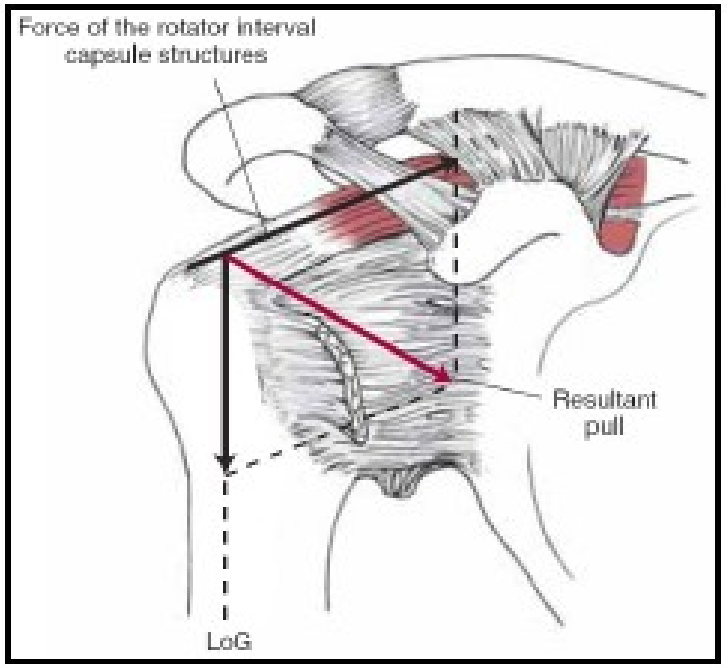


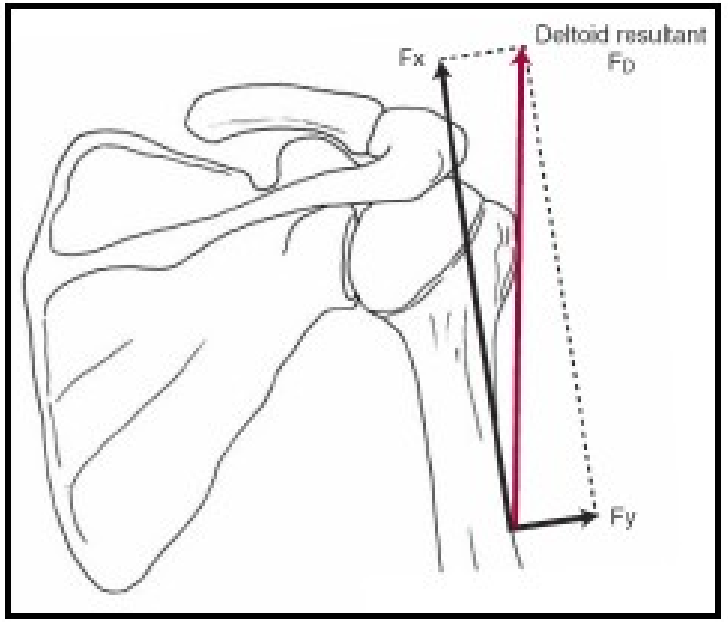


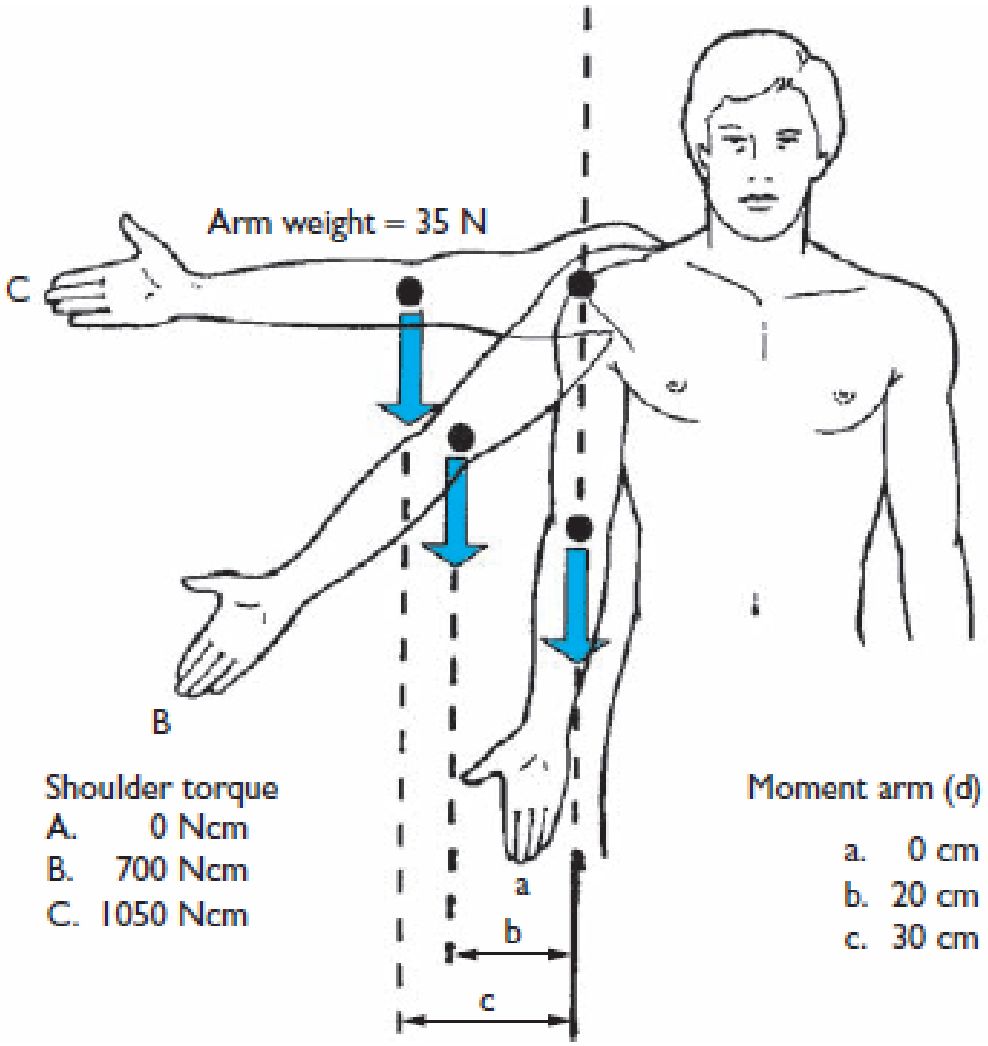


– síly působící na kloub

- flexe 1,25 x BW
- abdukce 0,85 x BW
- vnější rotace při 90° flexi 0,29 x BW
- točení volantem (jedna 1,25 x BW, obě 0,78 x BW)
- česání 0,58 x BW
- zatloukání hřebíku v úrovni hlavy 1,08 x BW
- držení 10 kg zátěže podél těla 1,02 x BW
- chůze s jednou fr. berlí 1,05 x BW

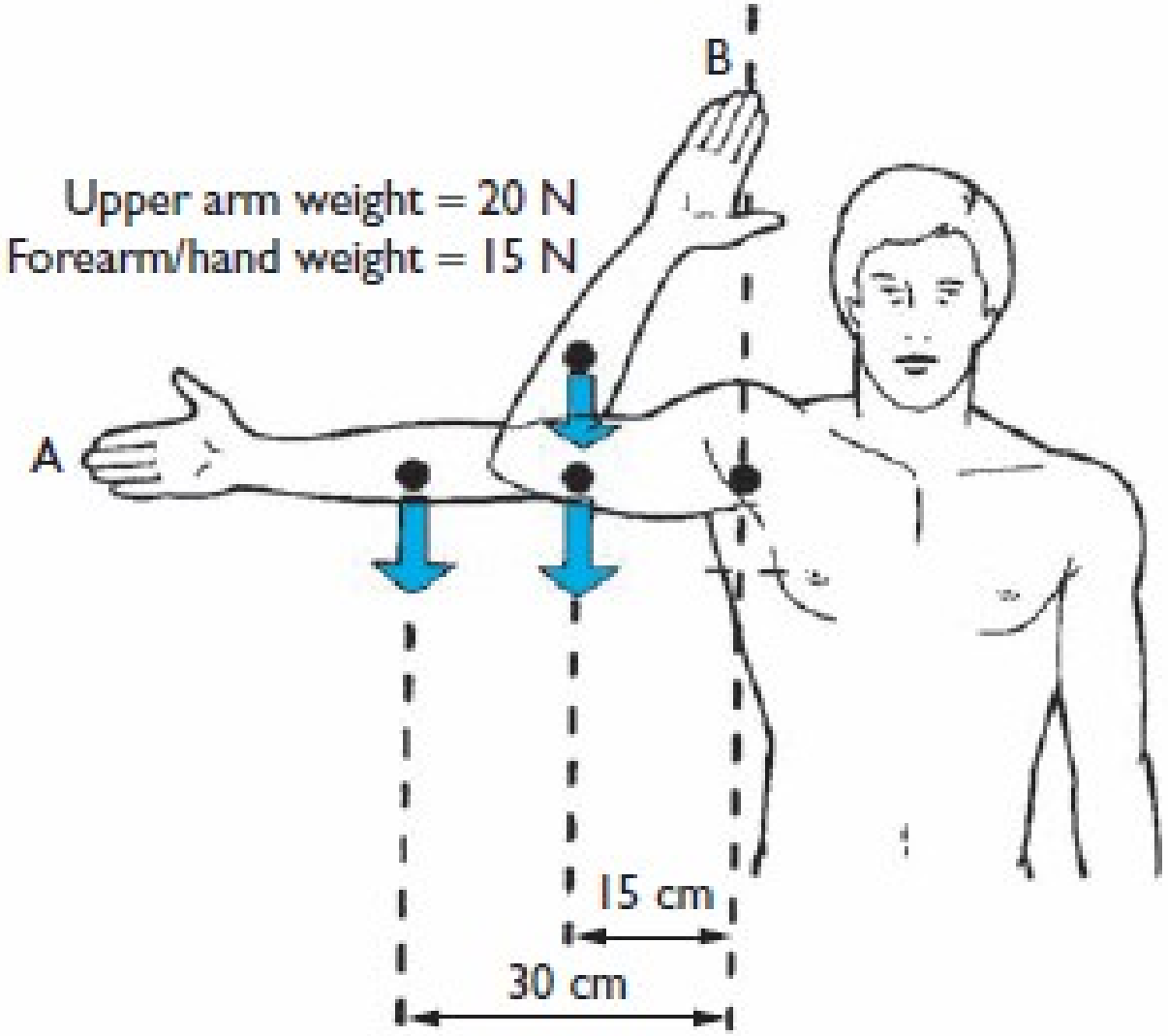




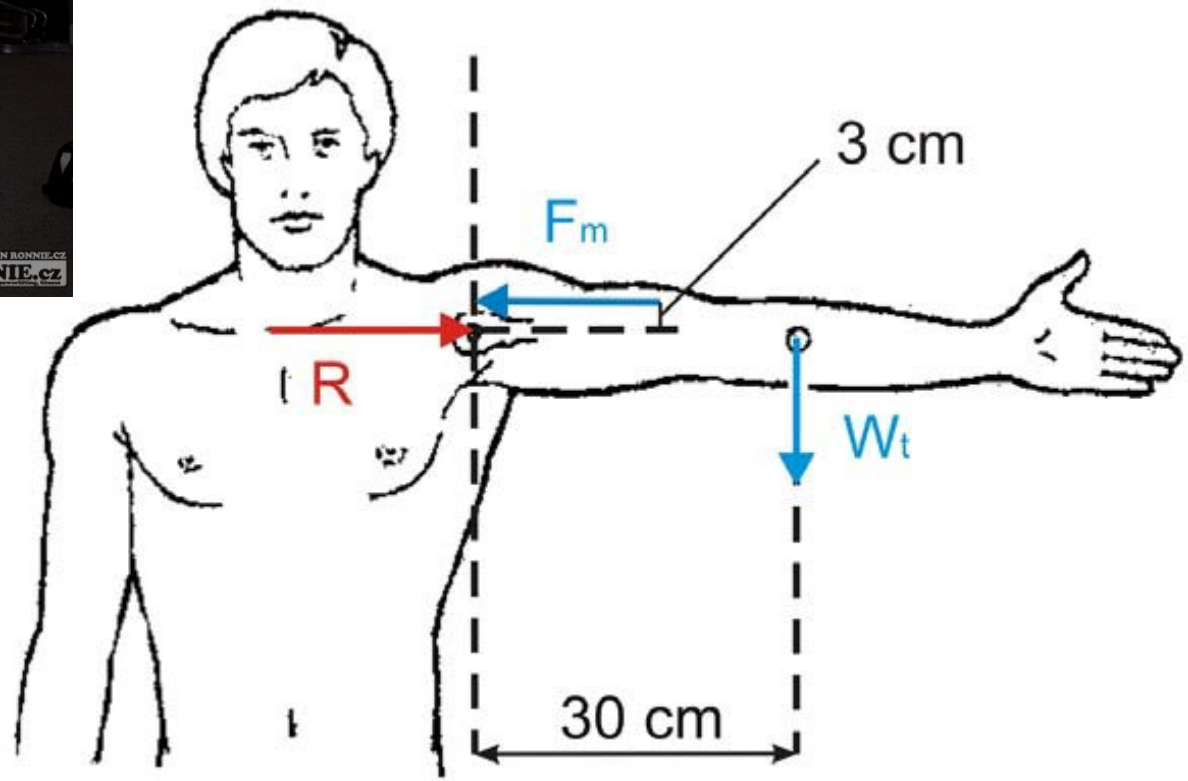


Shoulder torque
A. 0 Ncm
B. 700 Ncm
C. 1050 Ncm

Moment arm (d)
a. 0 cm
b. 20 cm
c. 30 cm



6KG
6KG
INTERNETOVÝ MAGAZÍN RONNIE.CZ
RONNIE.CZ


3 cm
Fm
R
Wt
30 cm

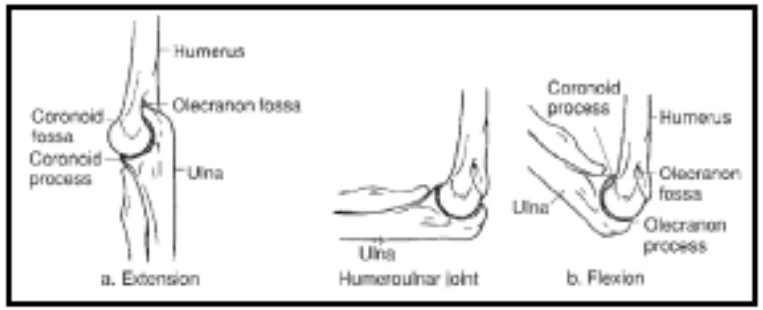
Anatomie

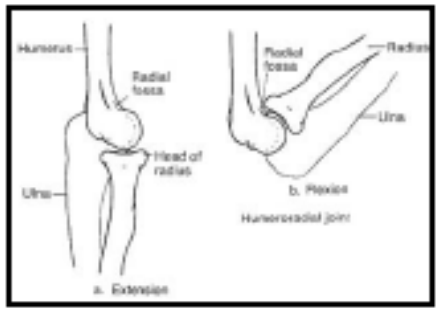
– složený kloub kladkový (humerus – ulna) a kulový (humerus – radius)

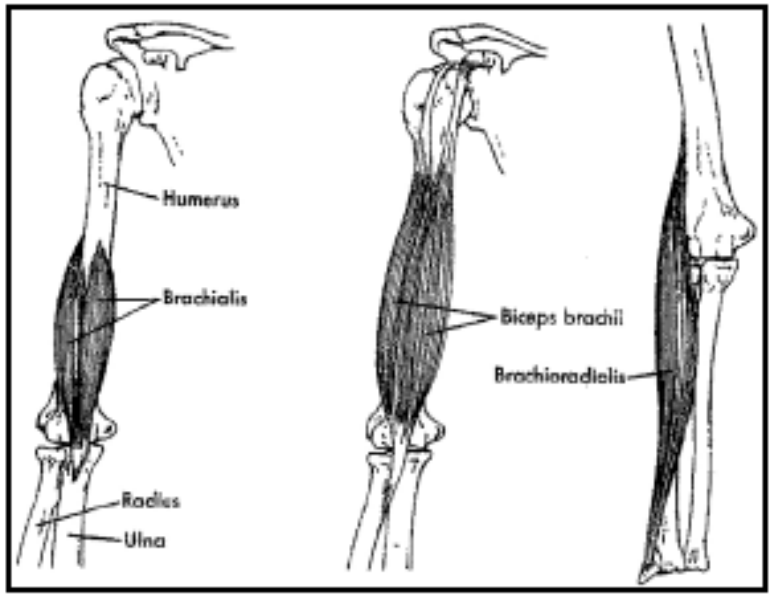
– spojení mezi humerusem, ulnou a radiem

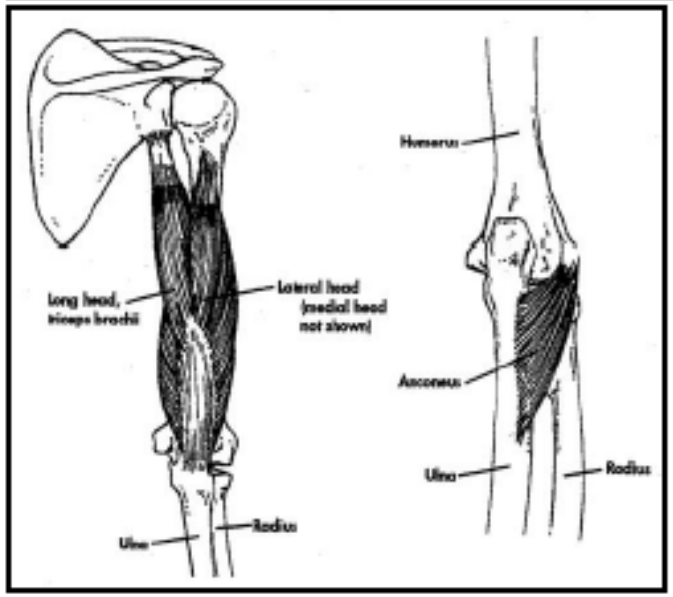
– 3 vazy

– pohyby: flexe až 145°, extenze do plného napnutí









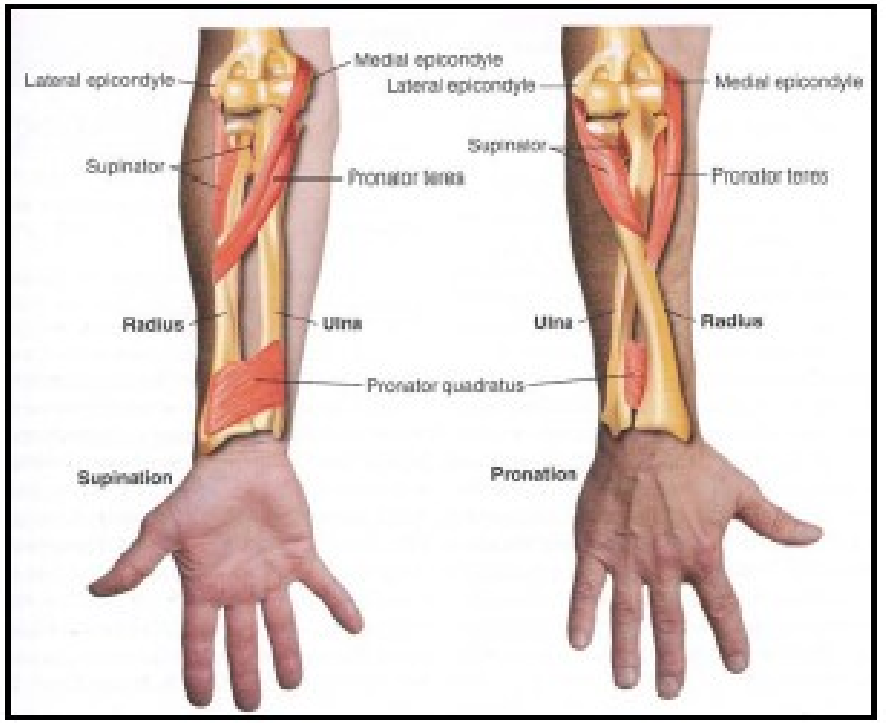
Anatomie

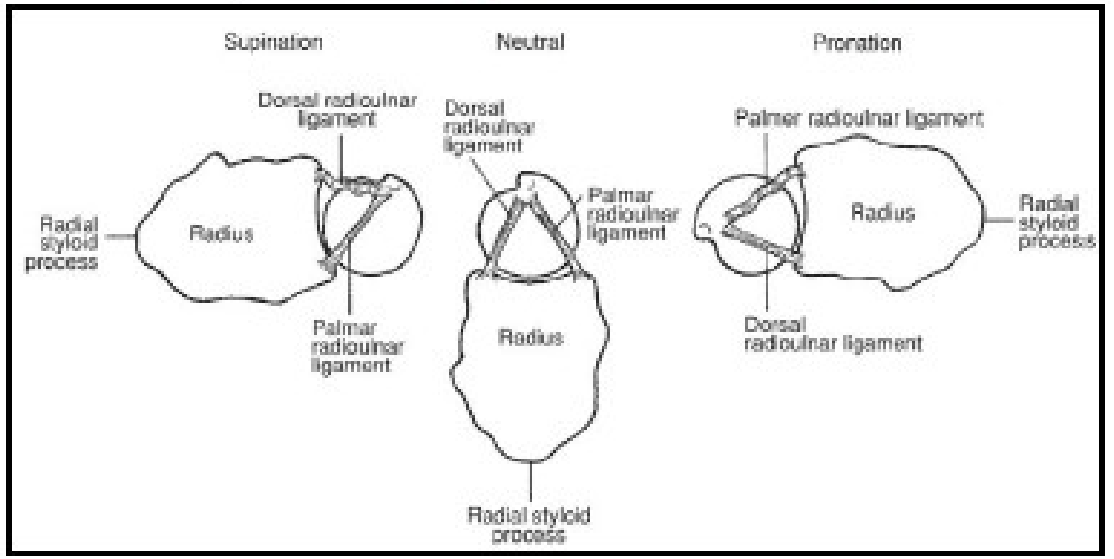
– složený kloub kladkový (humerus – ulna) a kulový (humerus – radius)

– spojení mezi humerusem, ulnou a radiem

– 3 vazy

– pohyby: flexe až 145°, extenze do plného napnutí, pronace 80° a supinace 90°





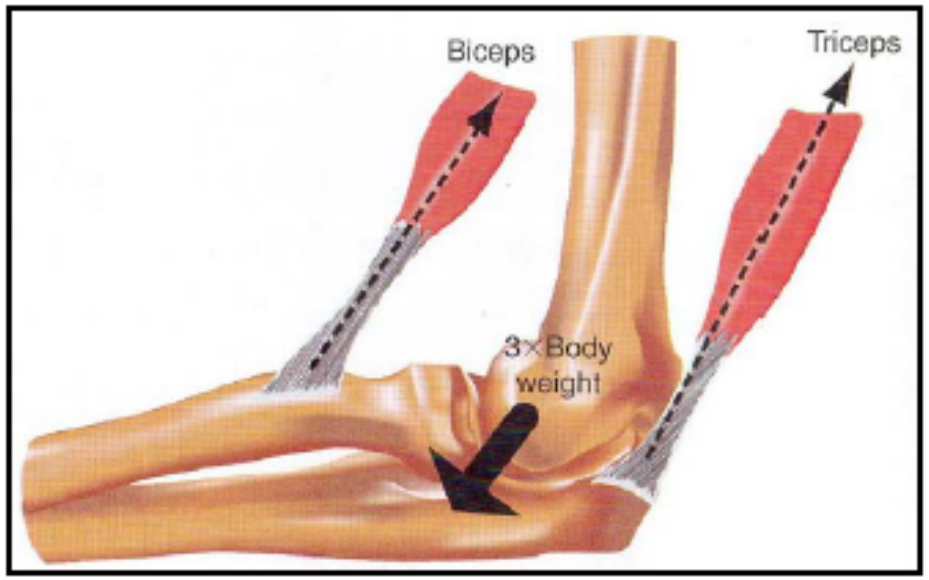
Biomechanika

– statická zátěž kloubu v tahu je minimální (svalová aktivita)

– zátěž v tlaku (opora, pád,..) F_{max} cca 5 x BW

– zátěž kloubu při aktivitách

- oblékání, jídlo cca 300 N
- při držení zábradlí během chůze do schodů cca 1 700 N
- běžné denní aktivity F_{max} cca 0,5 x BW
- maximální isonetrická síla m. biceps F_{max} 3 x BW



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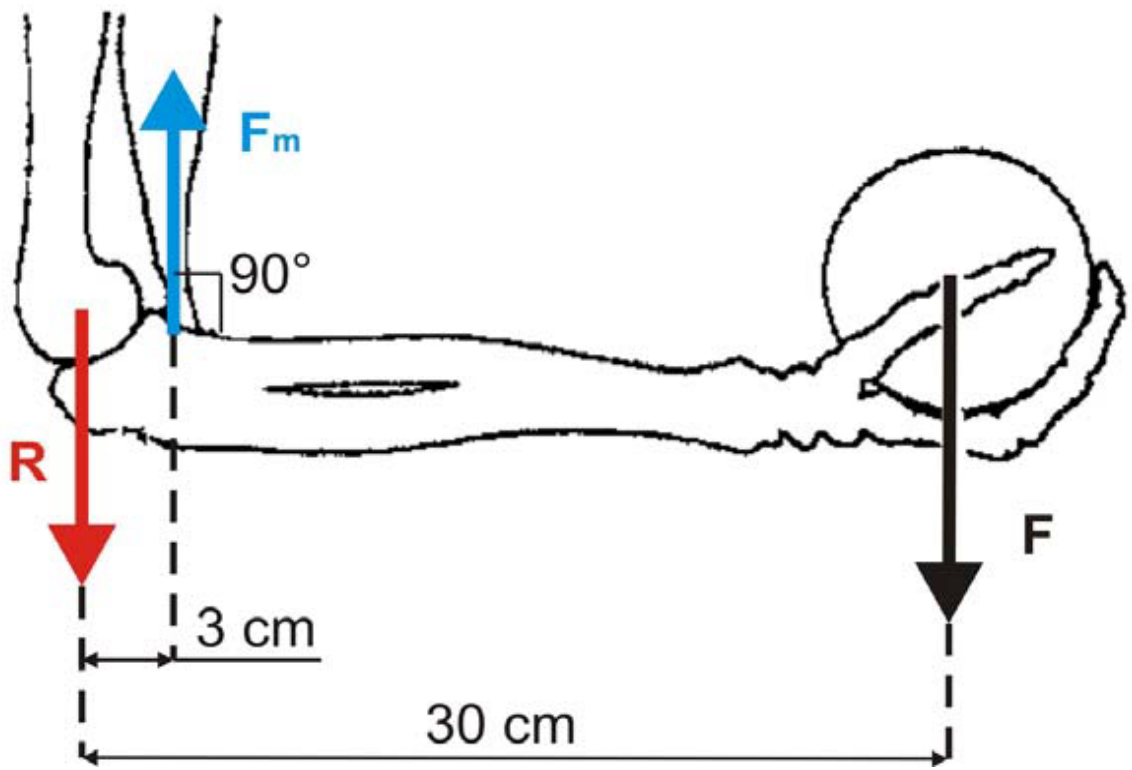
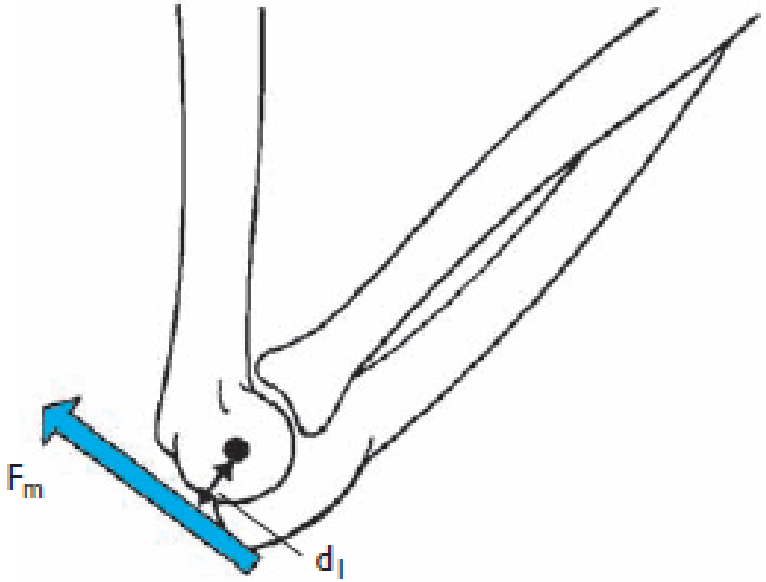
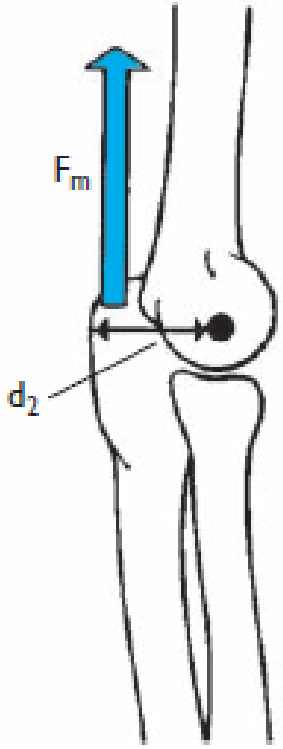
RONNIE.cz

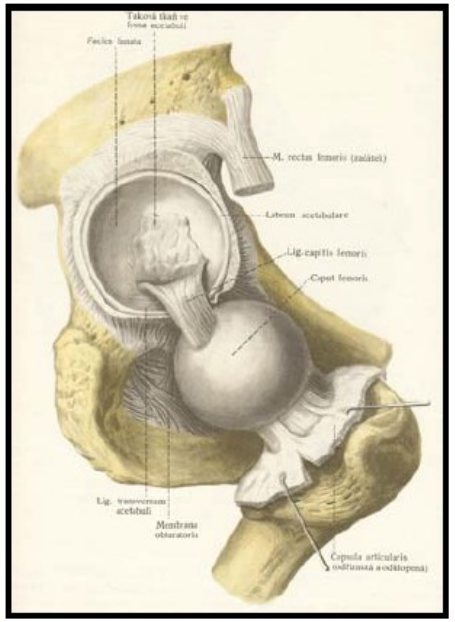

Fm
90°
R
F
3 cm
30 cm

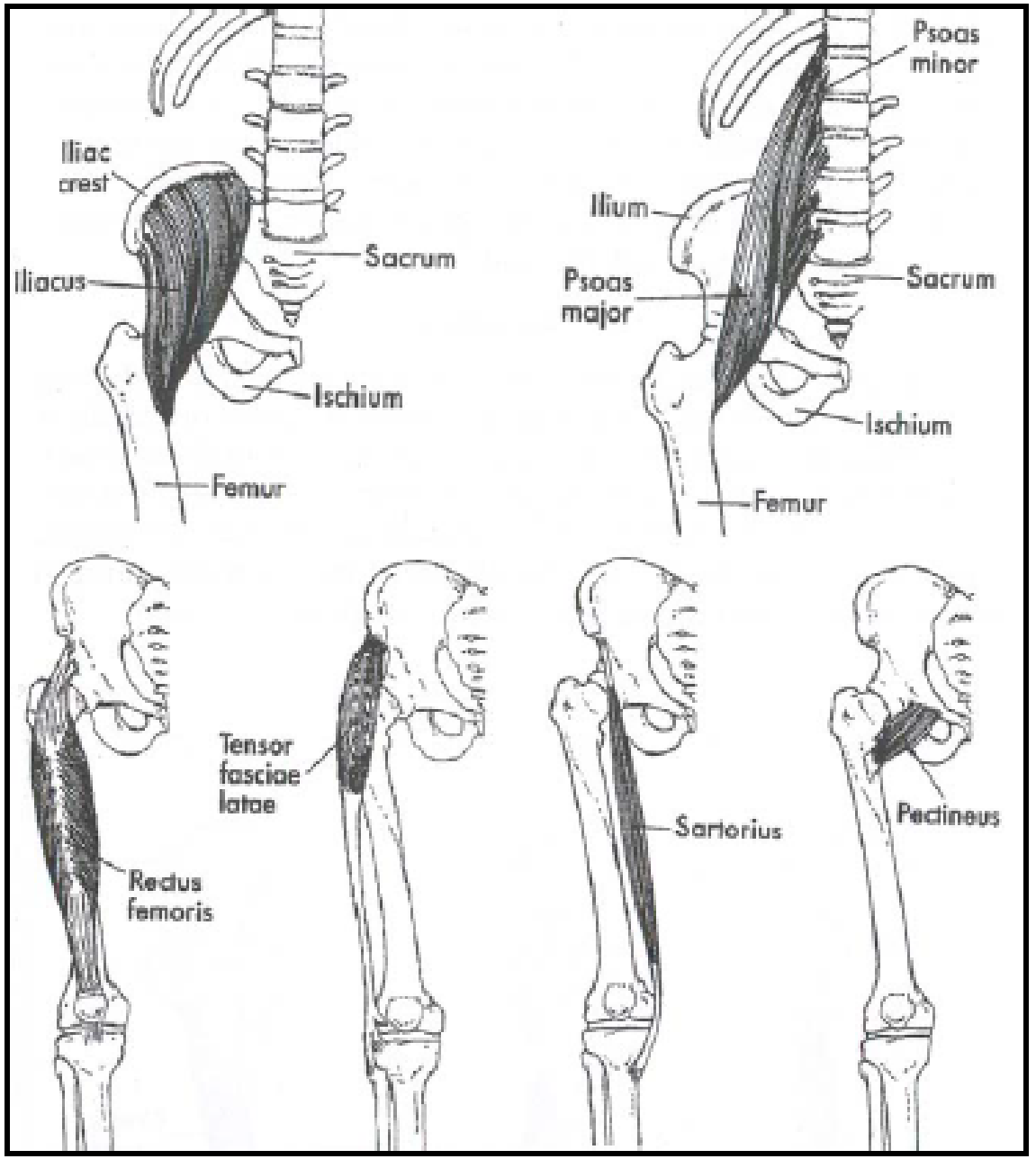

F_m
d_1


F_m
d_2

Anatomie

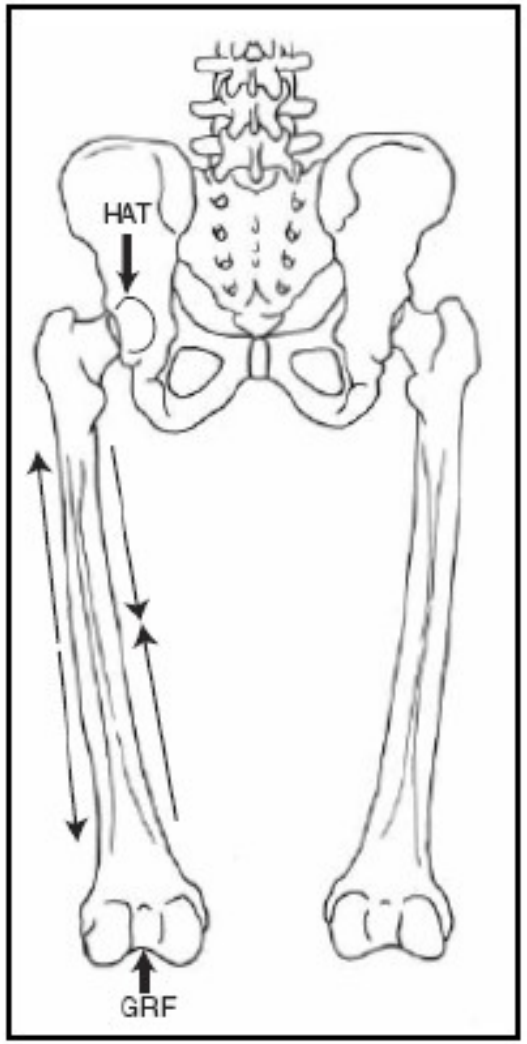
- kulový kloub
- kontakt stehenní kosti s pánví
- kloubní chrupavky
- 1 vnitřní + 4 vnější vazy a pouzdro
- 16 svalů podílejících se na pohybu

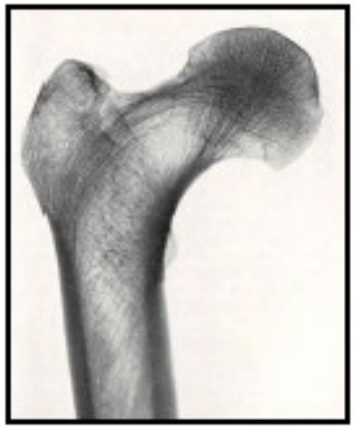


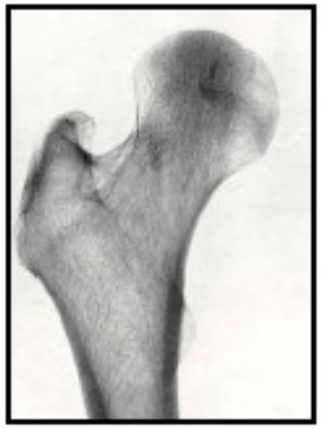


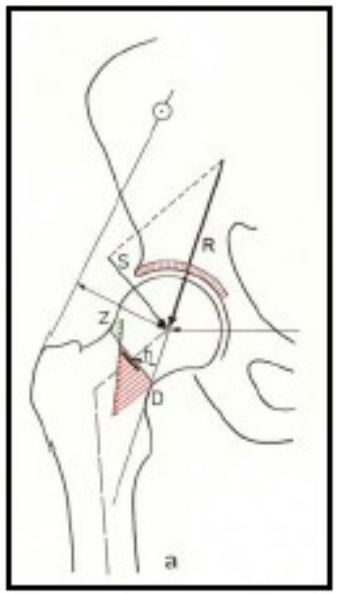
Biomechanika

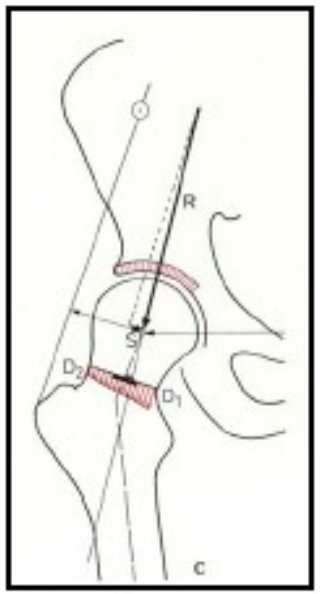
– namáhání kostních tkání

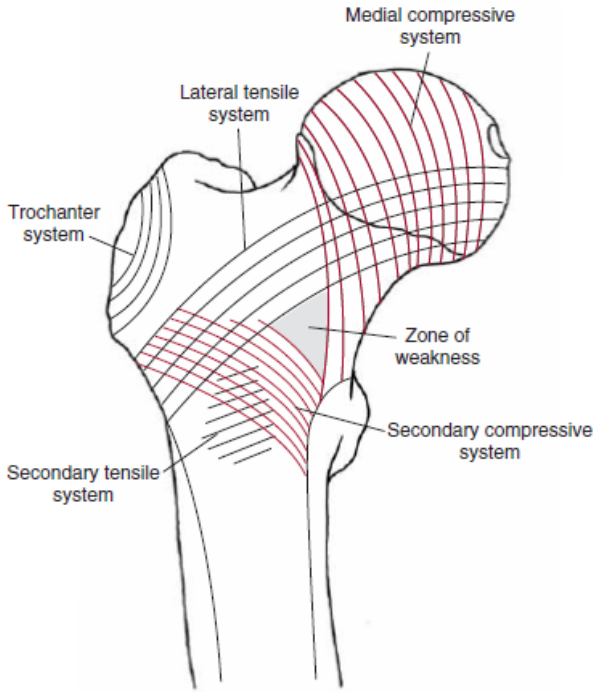






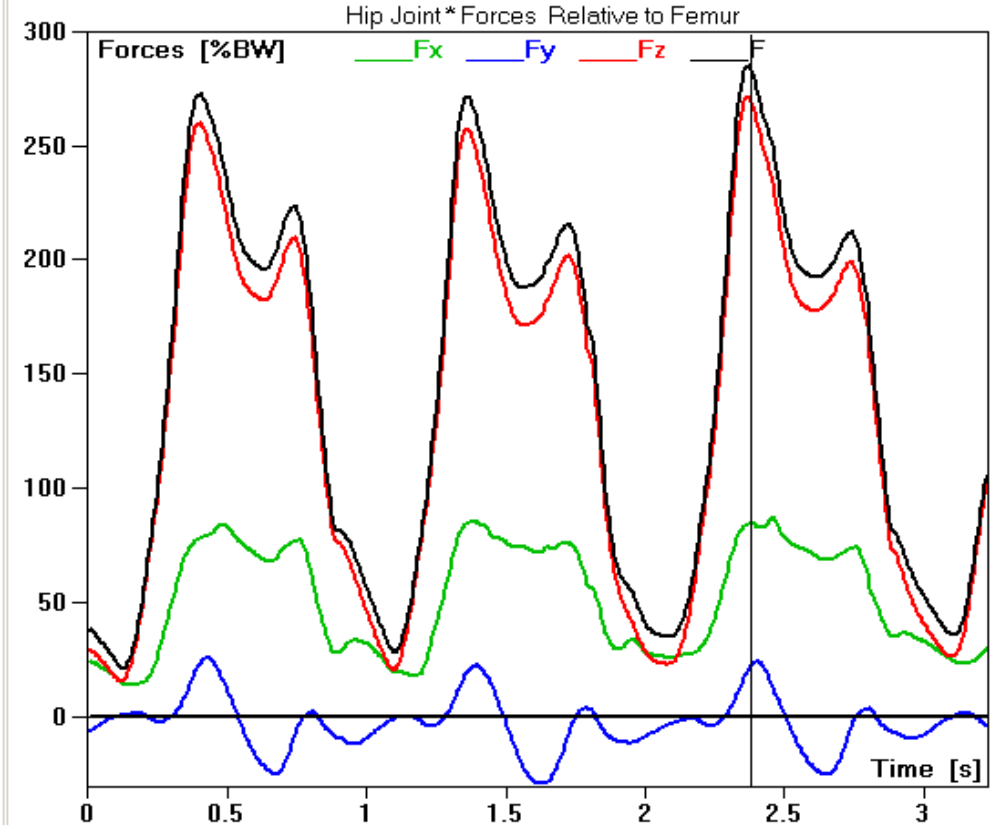






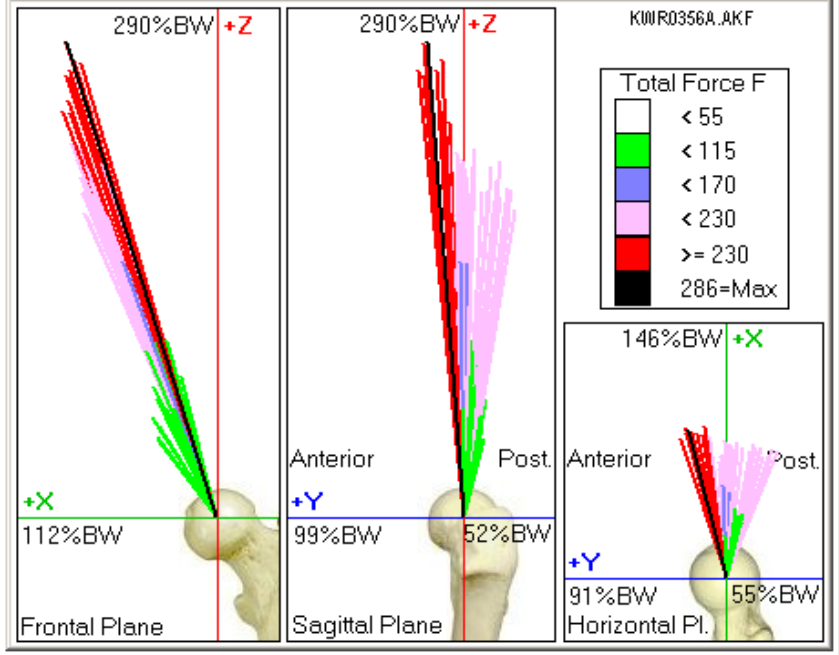
www.orthoload.com * Charité Berlin * Show Implant Loads and Videos

www.orthoload.com * Charité Berlin



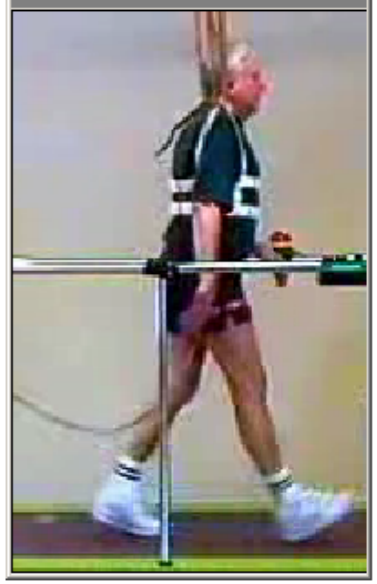
HIP JOINT Walking on Treadmill: constant Speed 5 km/h
Pat: KWR, Side: Right, 20 Month PO
KWR0356A.AKF

www.orthoload.com * Charité Berlin * Vectors Relative to Bone



286

www.orthoload.com * KWR035...



Loads (Seconds, %BW, N*m)

	No.	Time	Fx	Fy	Fz	F	Mx	My	Mz	M	Mrk
Min	1	0,0	14	-29	15	21	0	0	0	0	0
Max	648	3,238	87	26	272	286	0	0	0	0	0
Now	476	2,376	85	21	272	286	0	0	0	0	0

Info Patient

Body Weight:	740.0 N		
Rotation Bone to Implant around			
Axis:	1. Z	2. X	3. Y
Degree:	-2.0	9.0	0.0

Video

	No.	Time
Min	0	0.00
Max	82	3,28
Now	59	3,2

biomechaniklabor

Orthoload

Biomechanika

– namáhání kostních tkání

– velikost působících sil

Chůze

– normální F_{max} cca 2,5 x BW

– rychlá (8 km/h) F_{max} cca 5,0 x BW

Schody

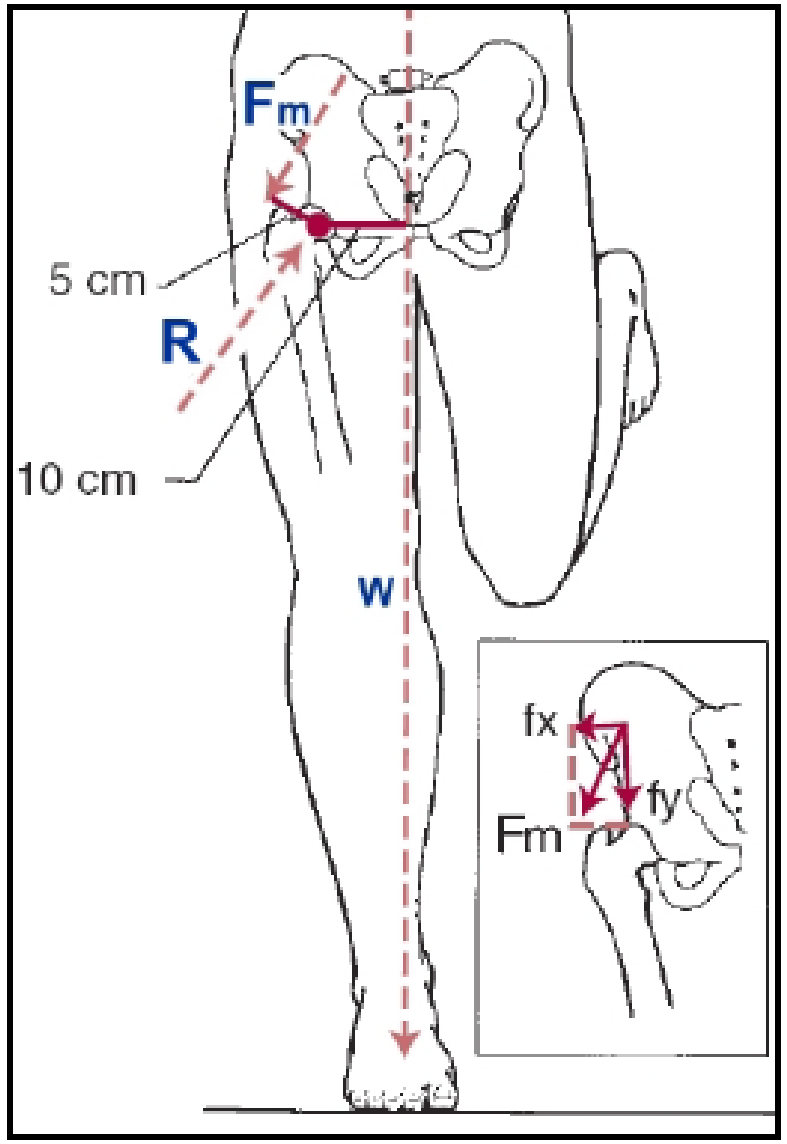
– dolu F_{max} cca 3,5 x BW

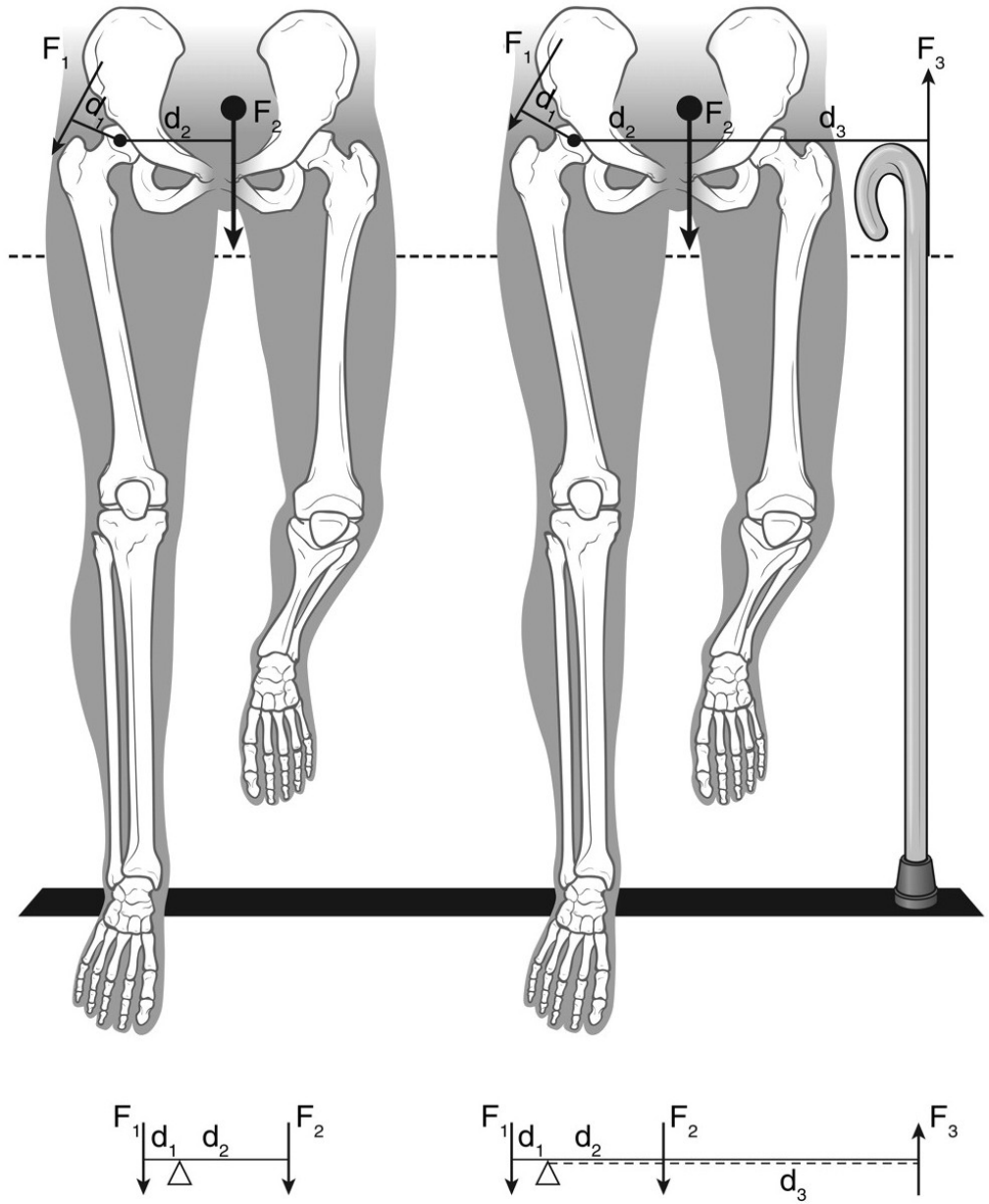
– nahoru F_{max} cca 3,0 x BW

Skákání na trampolíně

– obě nohy F_{max} cca 2,5 x BW

– jedna noha F_{max} cca 4,5 x BW


Fm
5 cm
R
10 cm
W
fx
fy
Fm


F1
d1
d2
F2
F1
d1
d2
F2
d3
F3
F1
d1
d2
F2
F1
d1
d2
F2
d3
F3

Anatomie

– kloub složený (femur, tibie a patela)

– mezi styčnými plochami kloubu jsou menisky

– 2 vnější + 4 vnitřní vazy a kloubní pouzdro

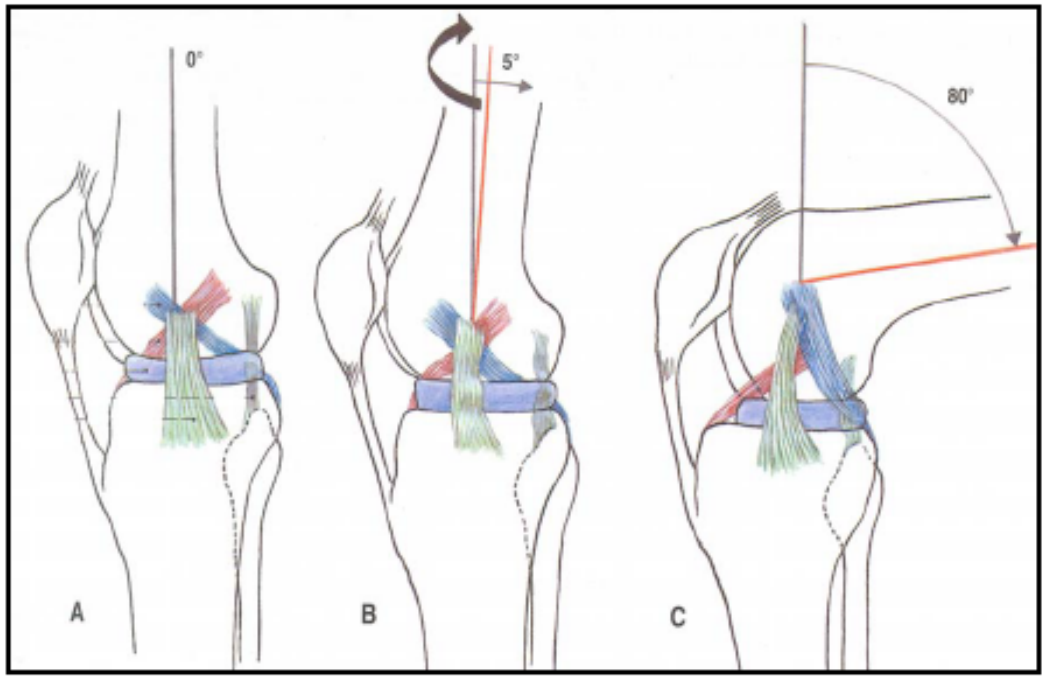
– pohyb kloubu: flexe, extenze (a rotace)

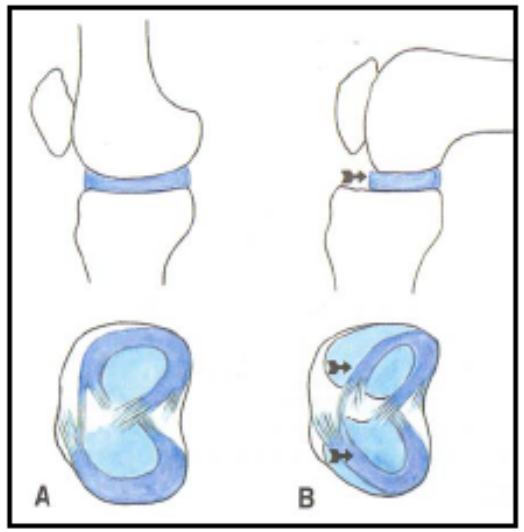
flexe 130° – 160°

extenze 5°

vnitřní rotace 5° - 10° (s flexí)

zevní rotace 30° - 50° (s flexí)





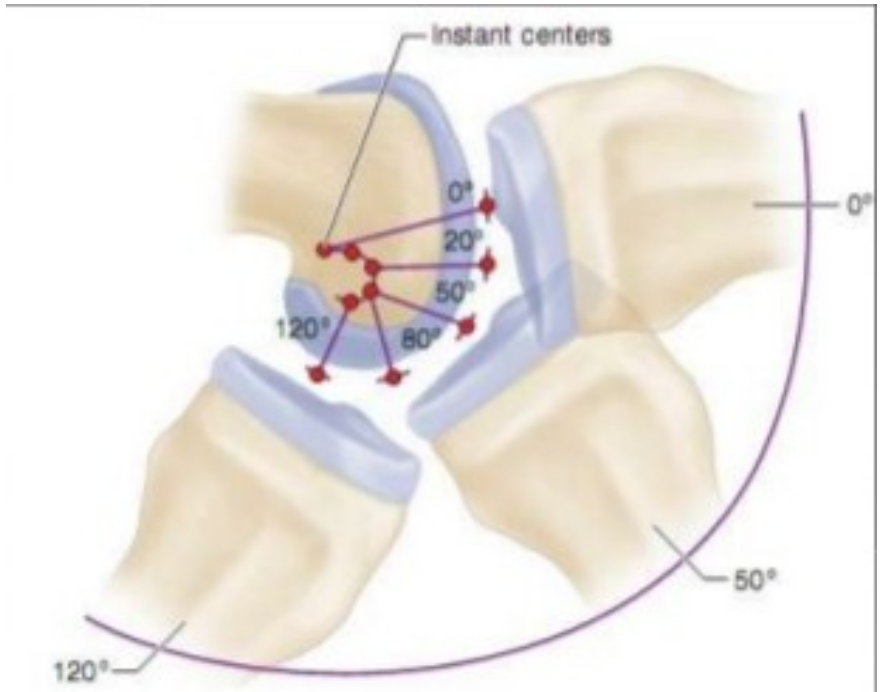
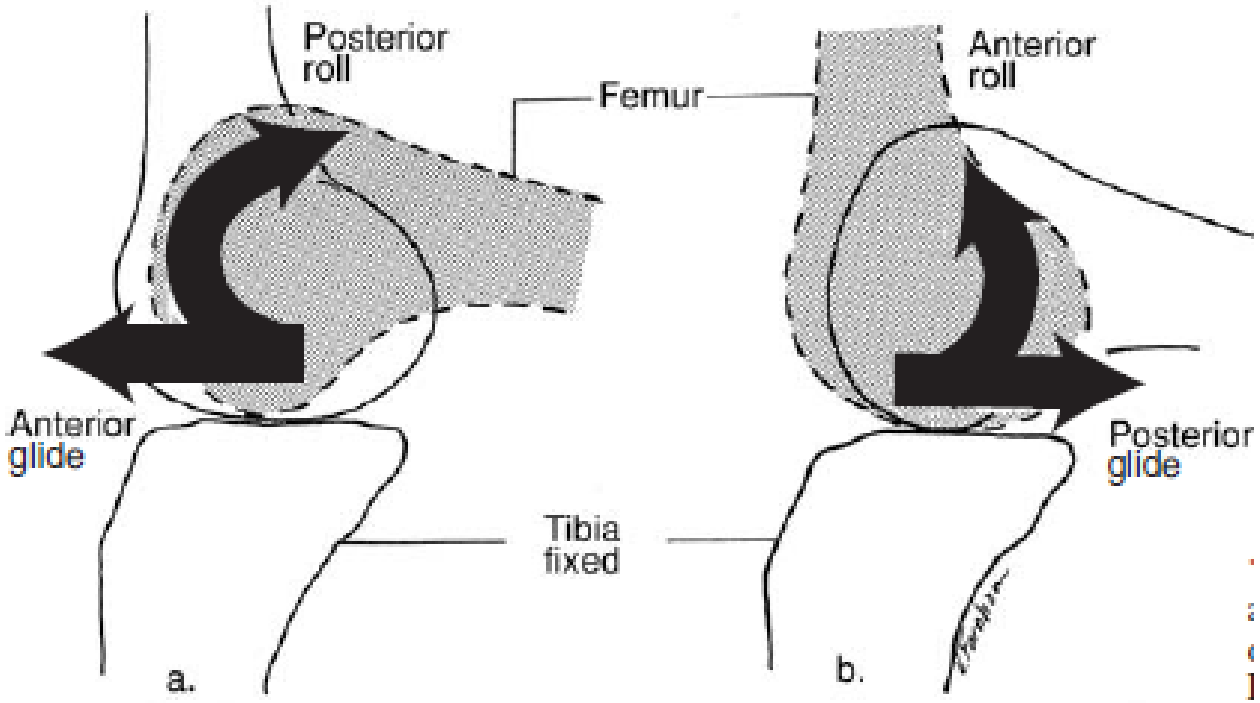
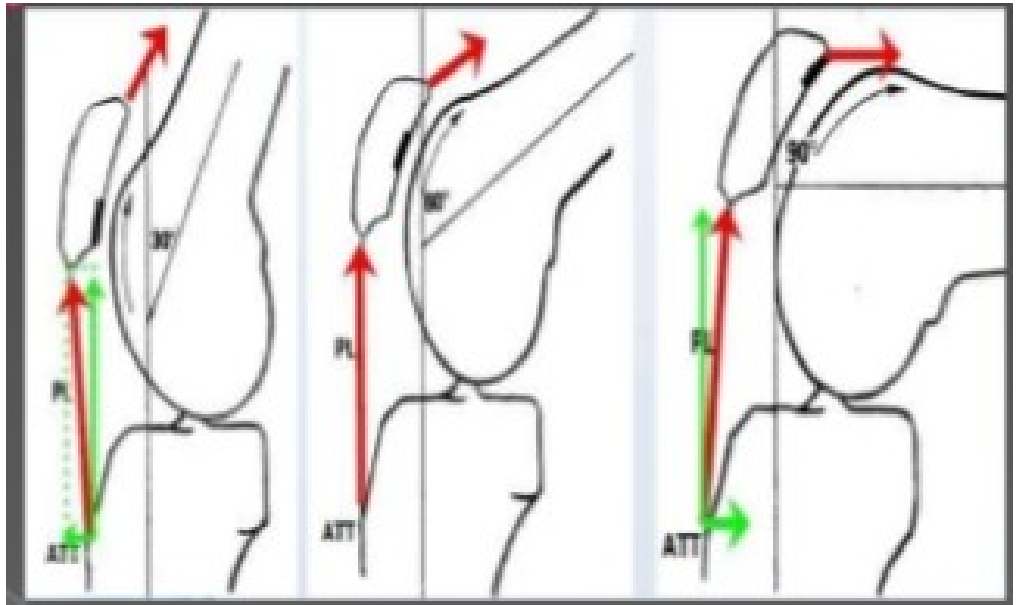


FIGURE 7-11 Transverse axis of flexion and extension of kne
constantly changes and describes J-shaped curve around femor
condyles.

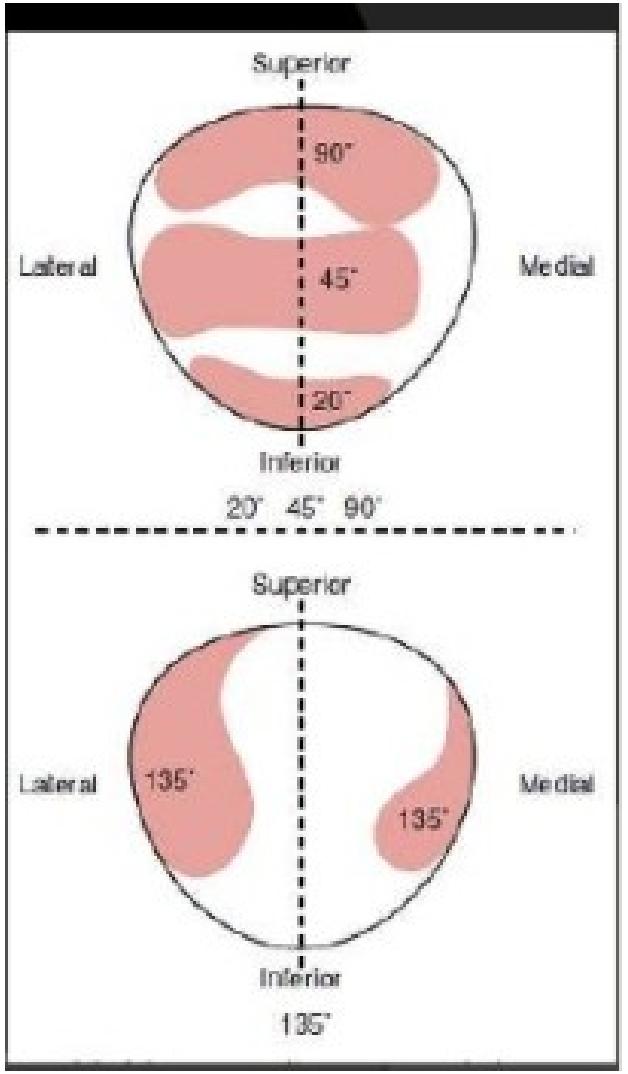


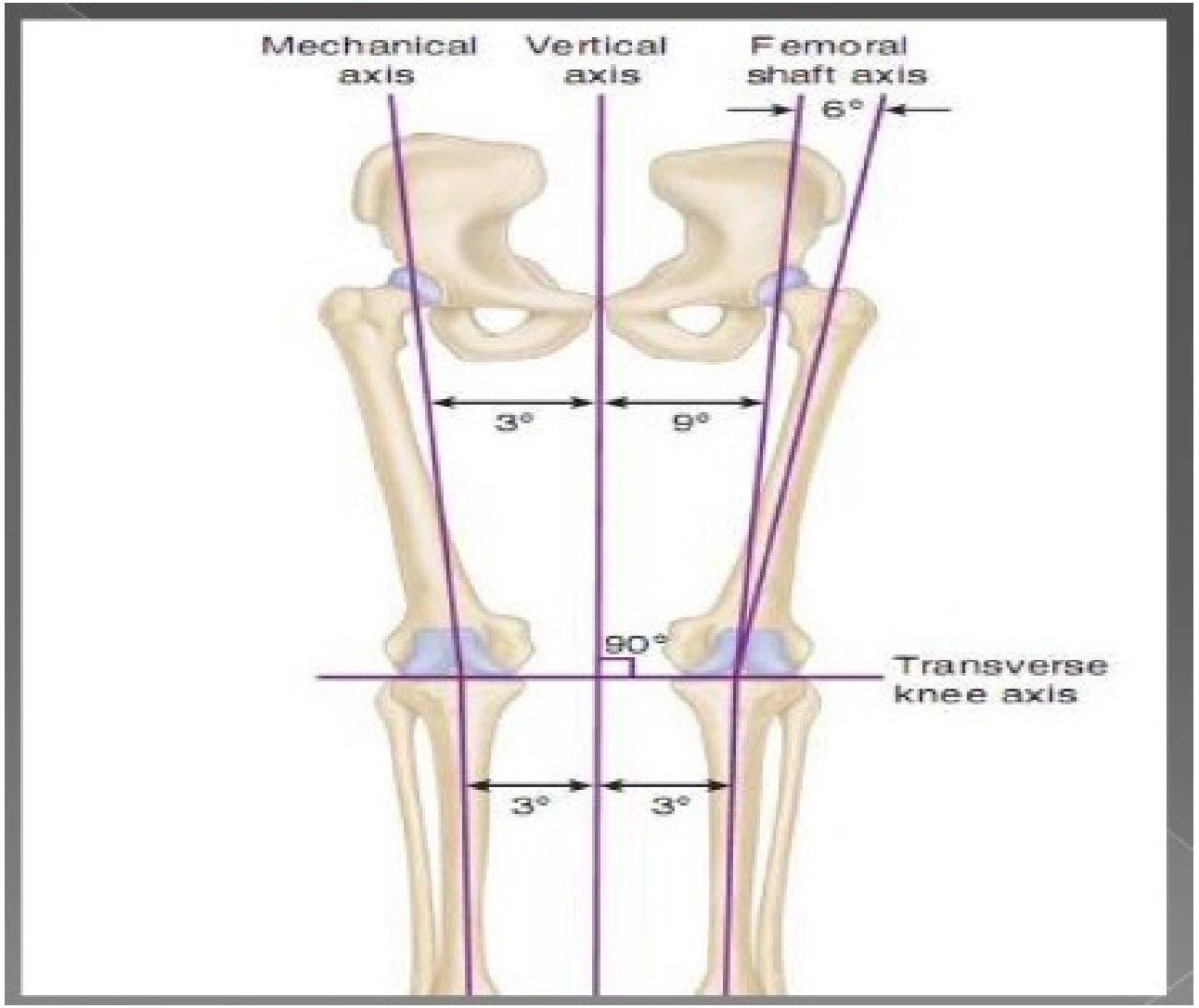
Motion of the femoral condyles during flexion

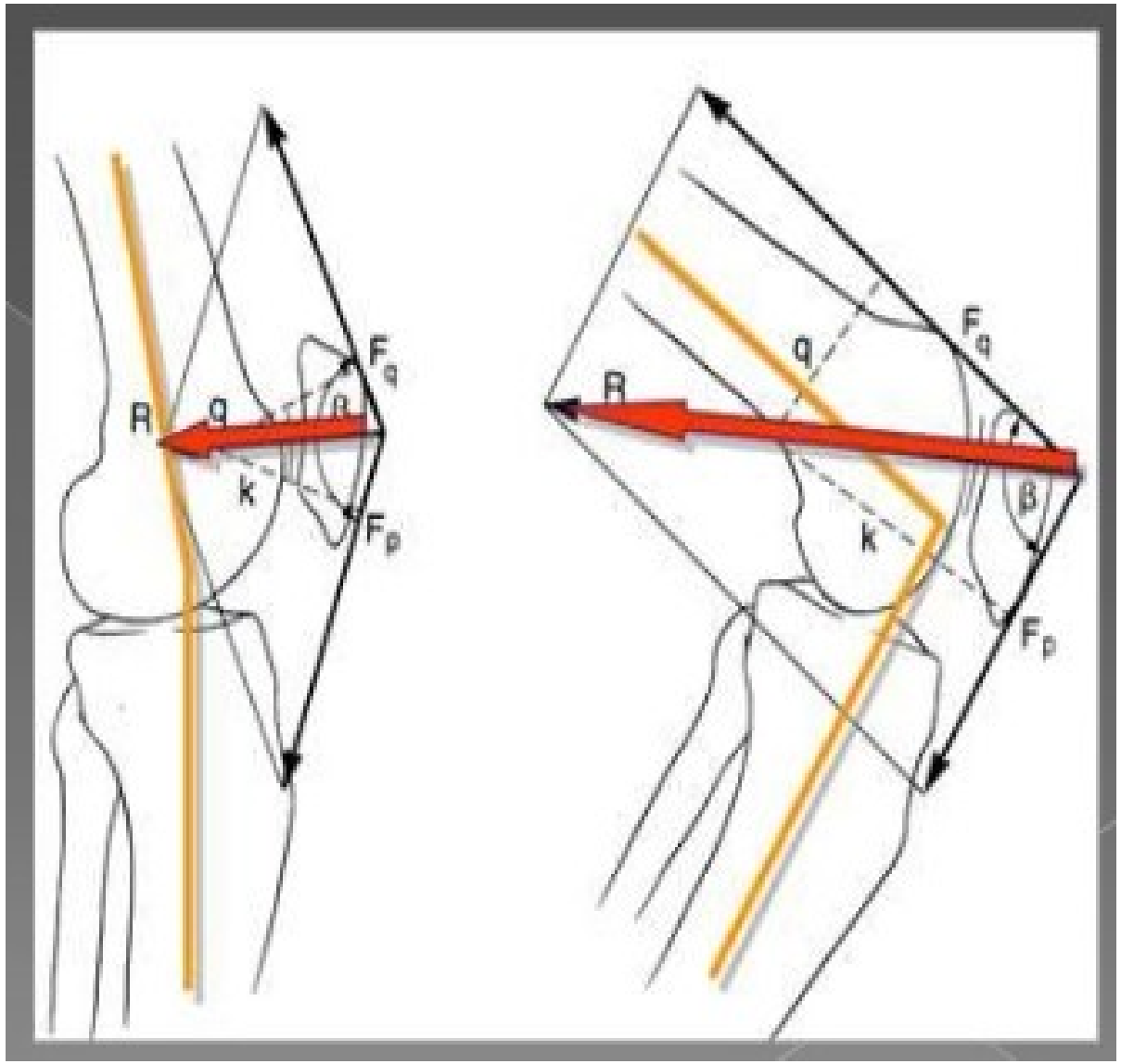
Motion of the femoral condyles during extension

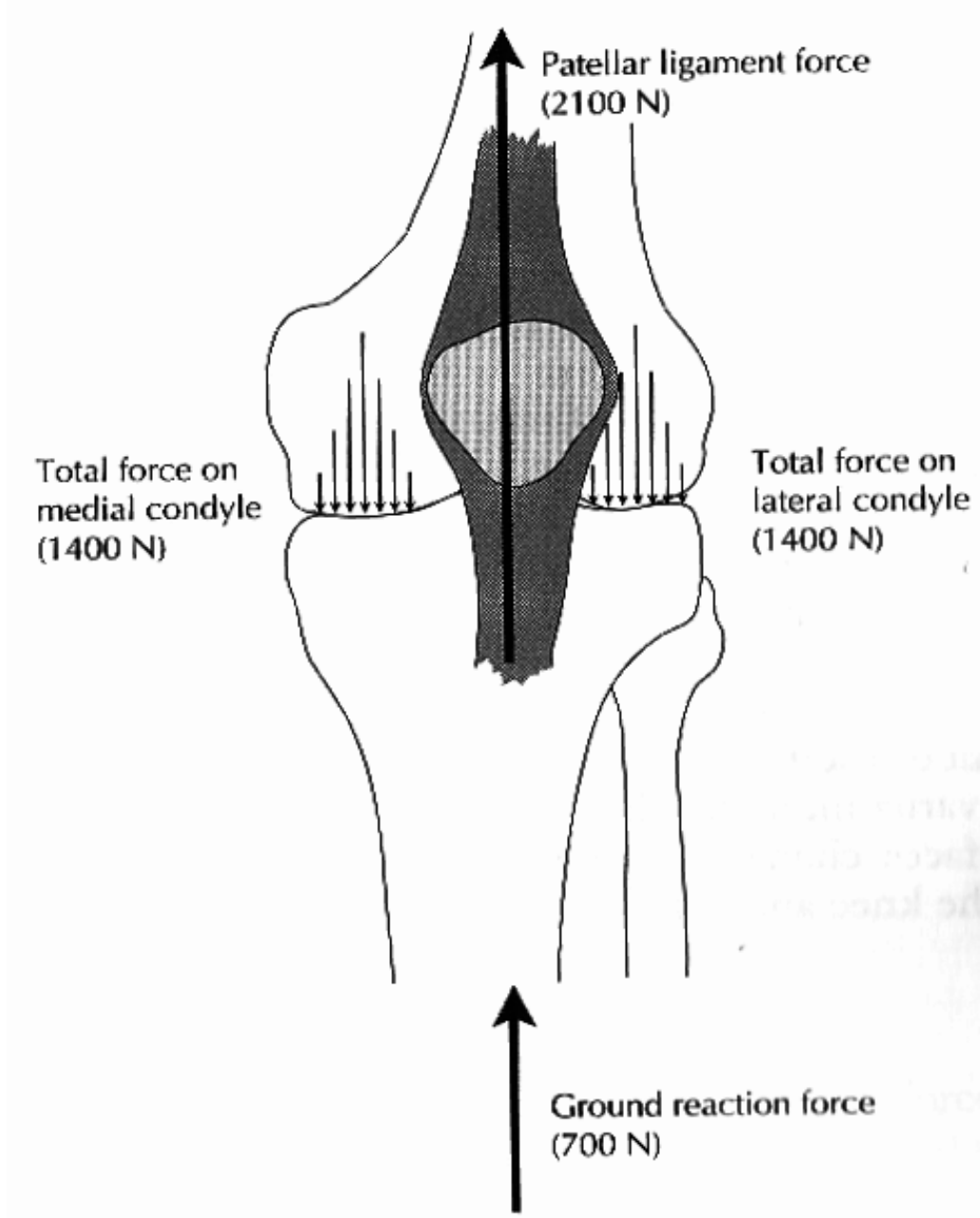


Patella acts to lengthen extensor lever arm displacing force vectors of quadriceps and patellar tendons aw from center of rotation (COR) of knee. Length of extensor le arm changes with varying amounts of knee flexion.




Mechanical axis
Vertical axis
Femoral shaft axis
6°
3°
9°
90°
Transverse knee axis
3°
3°

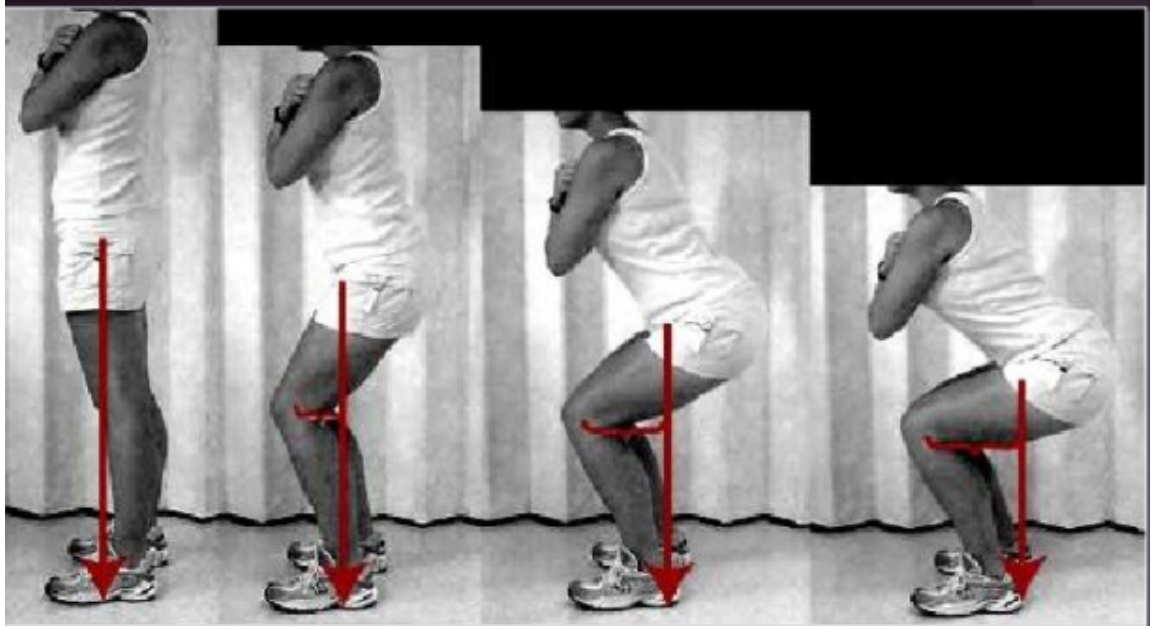

R
q
α
F_q
k
F_p
R
q
F_q
β
k
F_p


Patellar ligament force
(2100 N)
Total force on
medial condyle
(1400 N)
Total force on
lateral condyle
(1400 N)
Ground reaction force
(700 N)

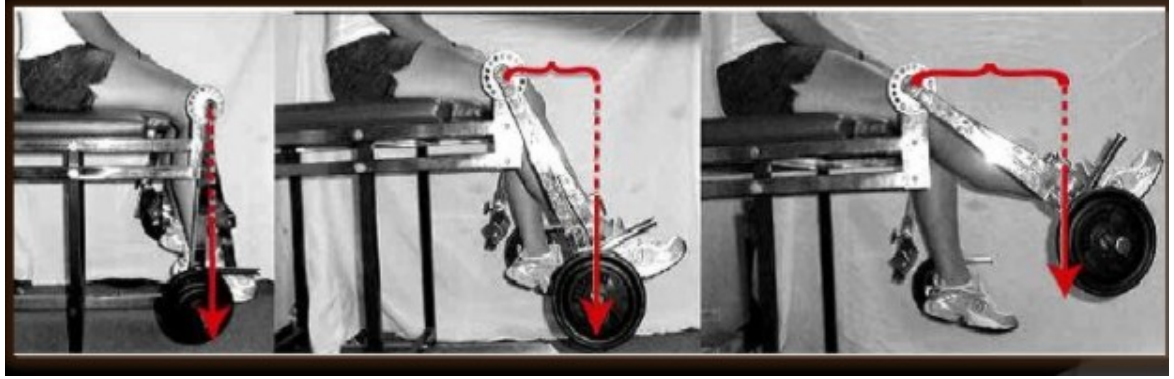
Activity	Patellofemoral joint		Tibiofemoral joint (compression)		Tibiofemoral joint (anterior shear)	
	Knee angle (°)	Force (× BW)	Knee angle (°)	Force (× BW)	Knee angle (°)	Force (× BW)
Walking	10	0.5	15	3.0–3.5	5	0.4
Squatting	140	6.0–7.6	140	5.0–5.6	140	2.9–3.5
Rising from a chair	120	3.1	120	3–7	120	2.3
Stair climbing/descent	60	3.3	45–60	3.8–4.3	5	0.6

CYBEX
VR1

LOG & MOVEMENT ARM (MA) DURING SQUATTING



LOG & MOVEMENT ARM (MA) DURING NON-WEIGHT BEARING



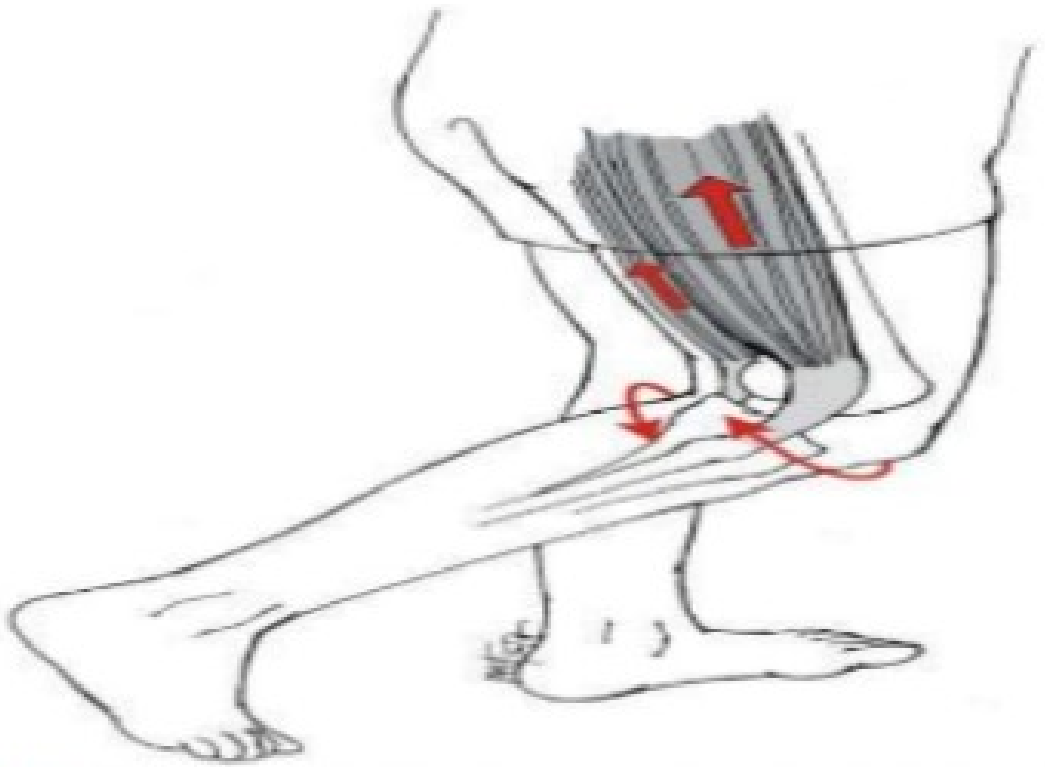


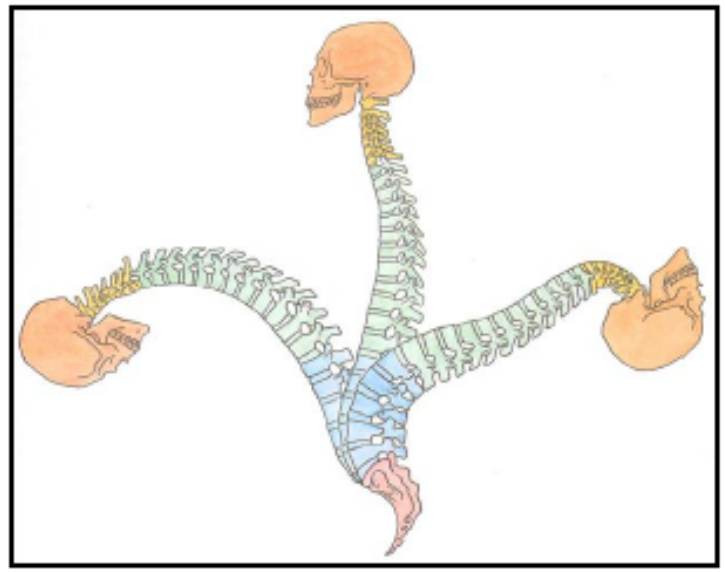
Figure 42.11: When contracting alone, the medial hamstrings produce medial rotation of the knee with knee flexion; the lateral hamstrings produce lateral rotation with knee flexion.

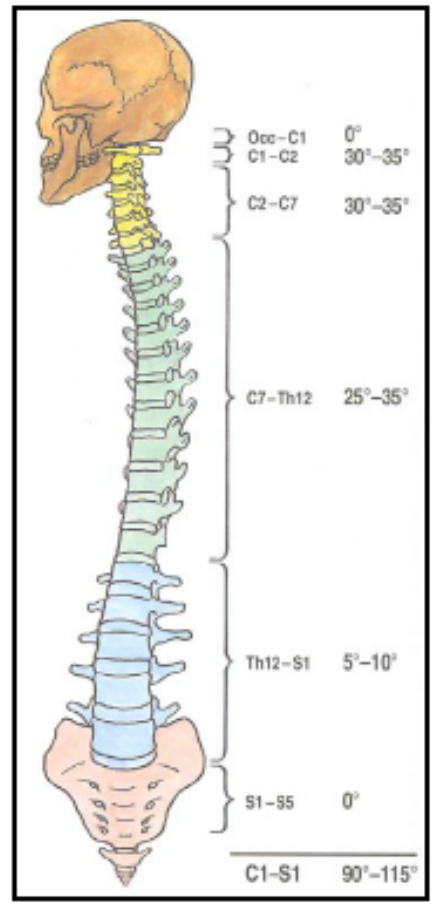
Anatomie

– 7 krčních, 12 hrudních, 5 bederních, 5 křížových (srostlé) a 4-5 kostrčních obratlů

– zakřivení (lordóza, kyfóza)

– pohyblivost: flexe / extenze (90° / 90° krční, 10° / 5° hrudní, 23°/90° bederní); lateroflexe (30° krční, 4° hrudní, 35° bederní); rotace (35° krční, 35° hrudní, 10° bederní)



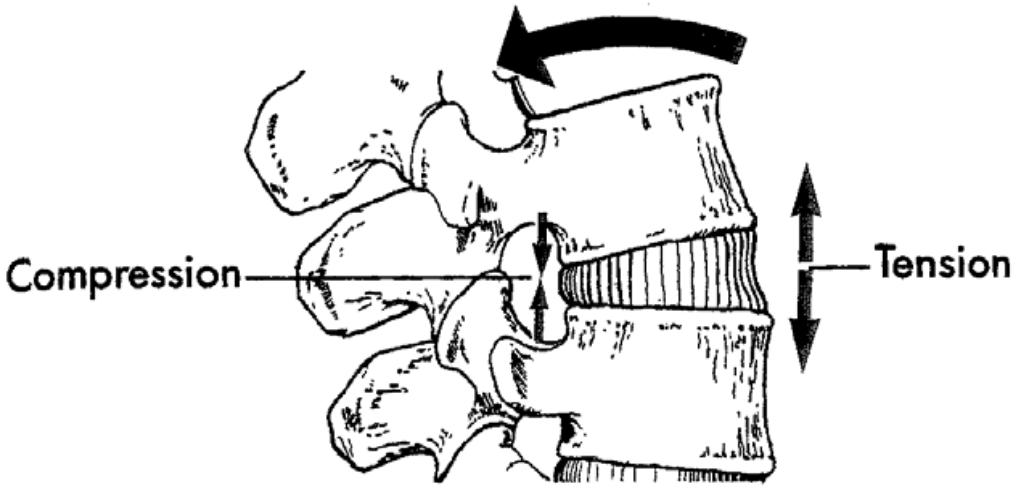


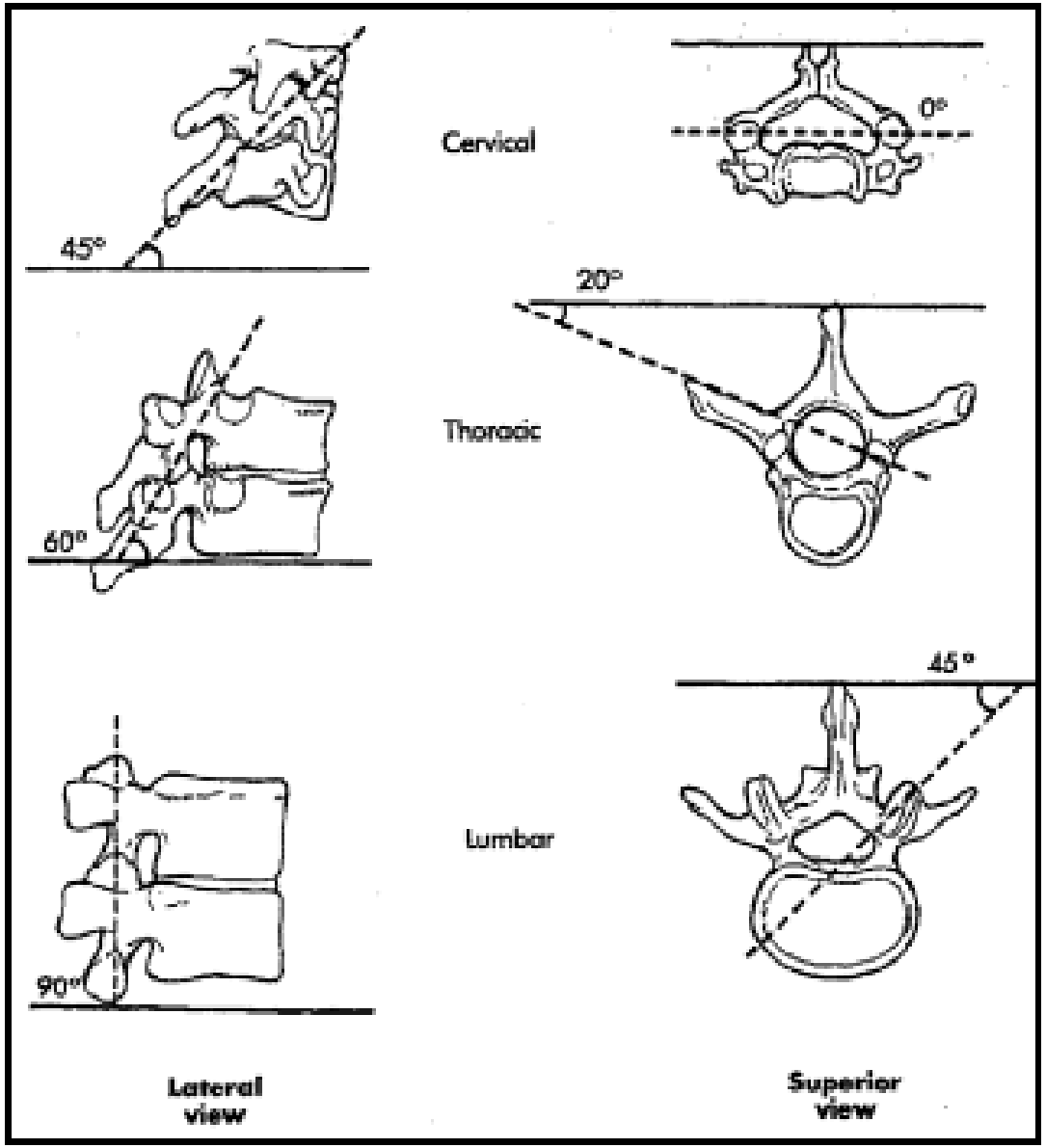
Anatomie

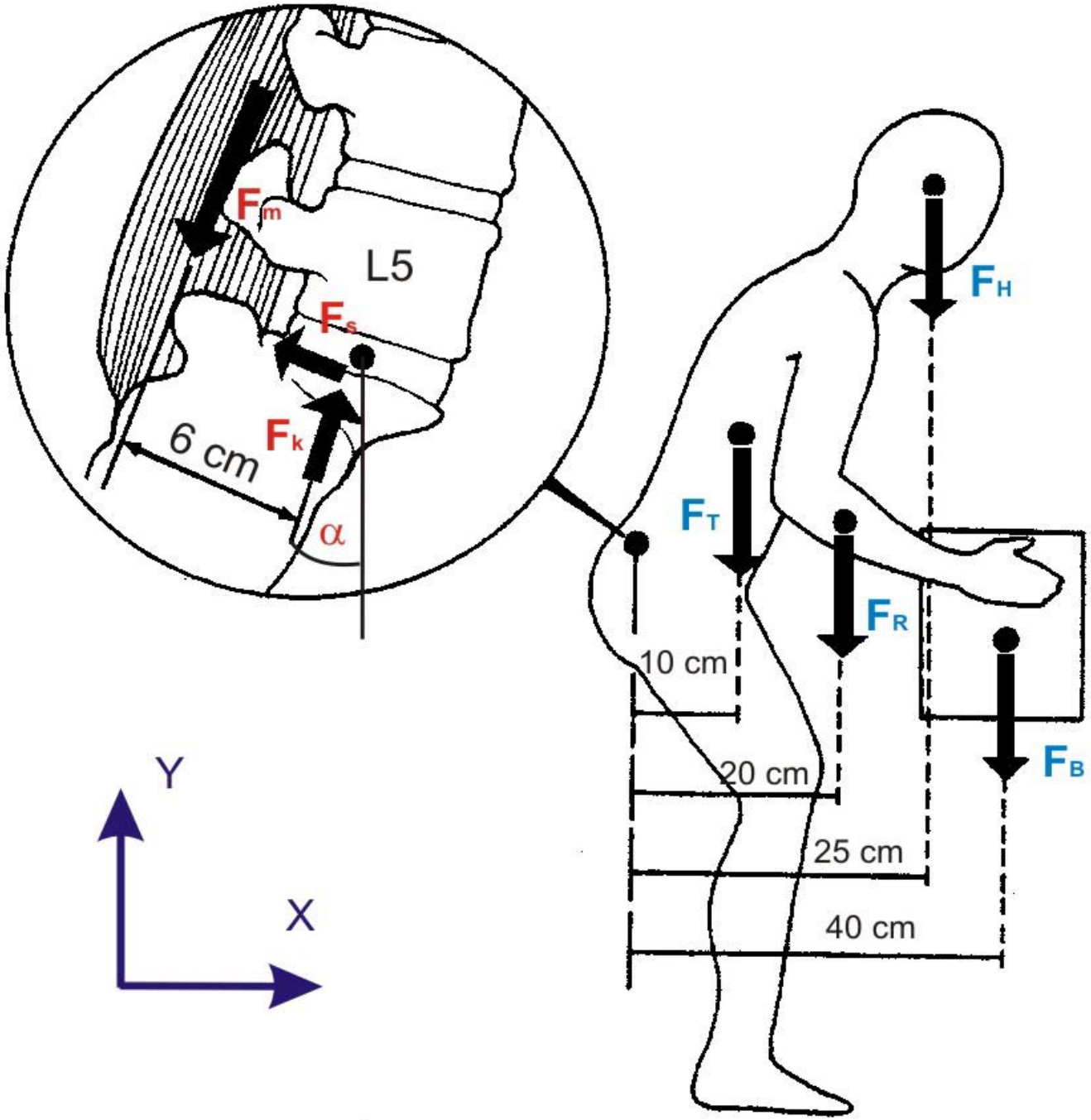
– obratlové tělo + výběžky

– kloubní plochy

– v každé části páteře jiná stavba obratle






F_m
L5
F_s
F_k
6 cm
α
F_H
F_T
F_R
F_B
10 cm
20 cm
25 cm
40 cm
Y
X

Biomechanika

Meziobratlové tělo

– vstání ze židle F_{max}= 479 N, M_{max}= 2,2 Nm

– předpažení obou paží o 90° v sedě F_{max}= 723 N, M_{max}= 3,1 Nm

– předpažení obou paží o 90° ve stoji F_{max}= 465 N, M_{max}= 1,1 Nm

– „narovnání se“ v sedě F_{max}= 368 N, M_{max}= 1,4 Nm

– laterální úklon ve stoji F_{max}= 487 N, M_{max}= 4,1 Nm

– chůze F_{max}= 512 N, M_{max}= 2,4 Nm

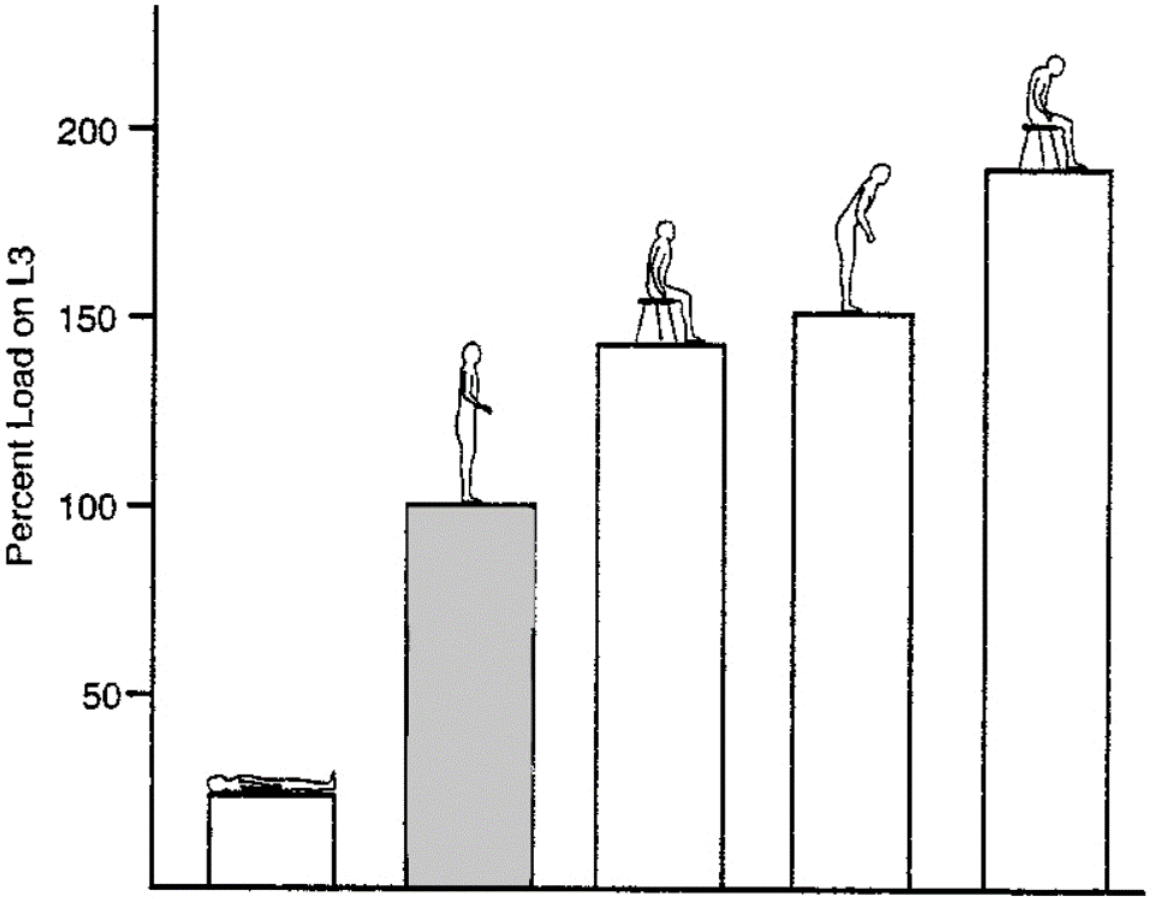
– chůze do schodů F_{max}= 624 N, M_{max}= 3,4 Nm

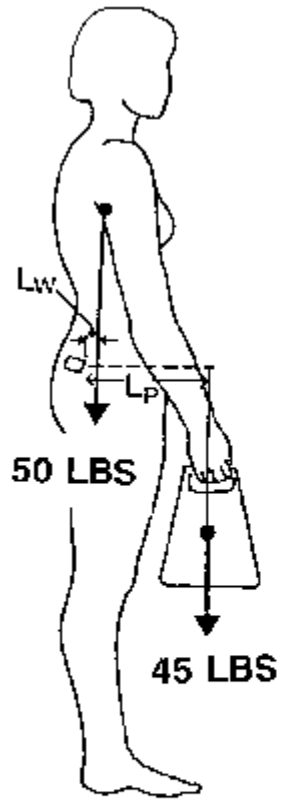
Externí fixátory

– dosednutí na židli F_{max}= 109 N, M_{max}= 6,7 Nm

– předpažení obou paží o 90° ve stoji F_{max}= 77 N, M_{max}= 6,4 Nm

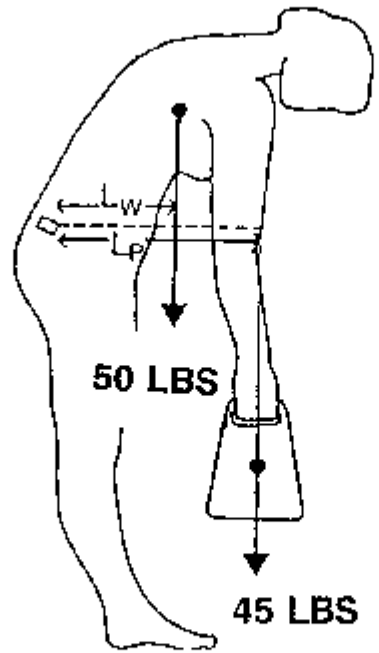
– chůze F_{max}= 77 N, M_{max}= 6,3 Nm





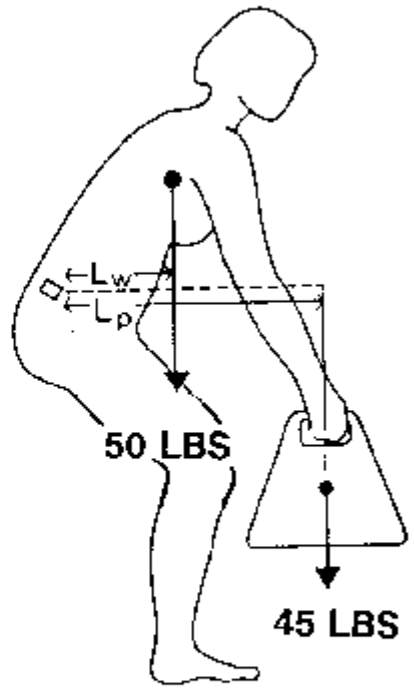
L_W = 1 IN
L_P = 12 IN

FLEXION MOMENT
= 590 IN*LBS



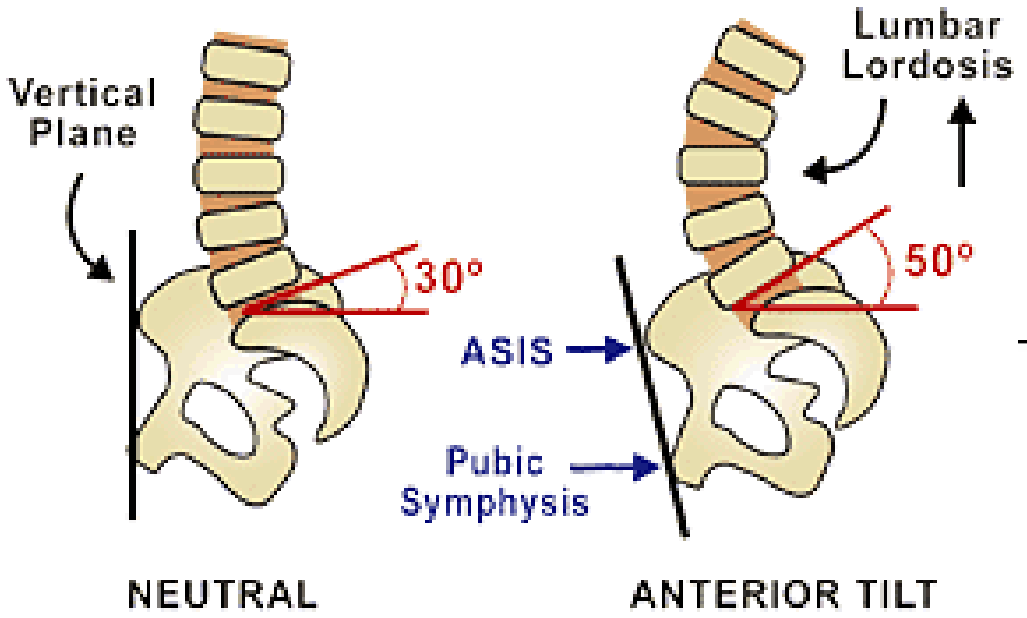
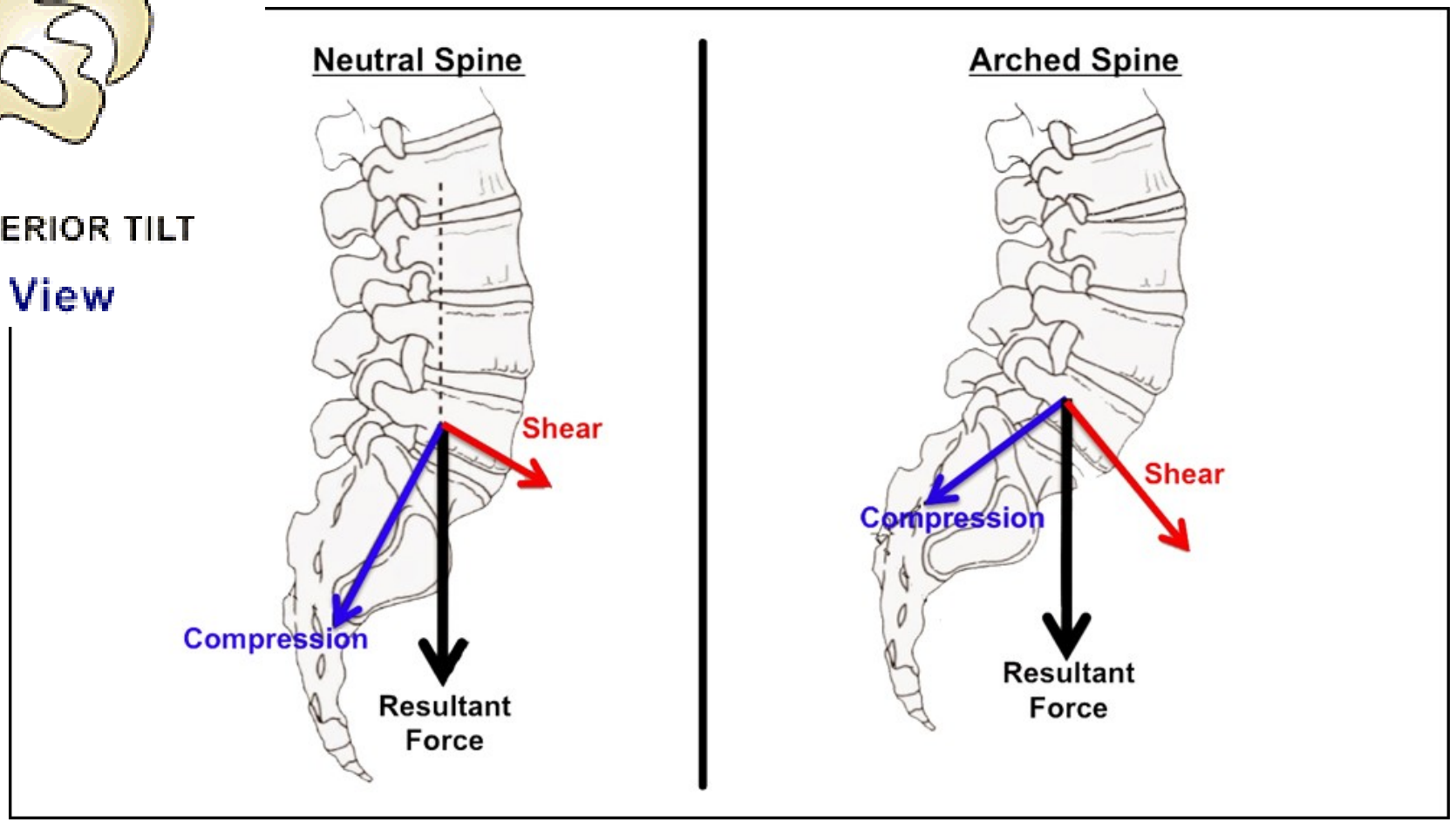
L_W = 10 IN
L_P = 16 IN

FLEXION MOMENT
= 1220 IN*LBS



L_W = 7 IN
L_P = 14 IN

FLEXION MOMENT
= 980 IN*LBS



Sacral Angle, Lateral View