Joints of the lower limb

Joints of the lower limb
Juncturae membri inferioris

Joints of the pelvic girdle (*juncturae cinguli membri inferioris*)

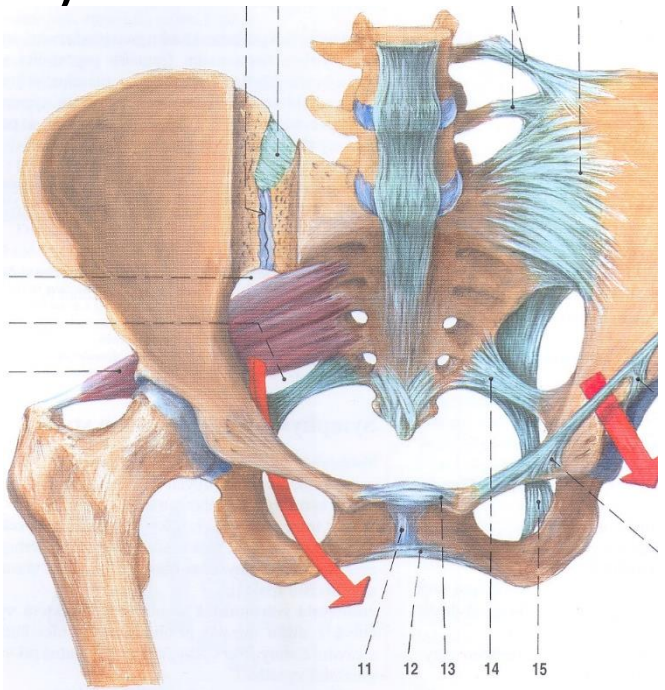
- articulatio sacroiliaca (sacro-iliac joint)
- symphysis pubica (pubic symphysis)

Joints of the freelower limb (*juncturae membri inferioris liberi*)

- art. coxae (hip joint)
- art. genus (knee joint)
- art. talocruralis (ankle joint)
- joints of foot

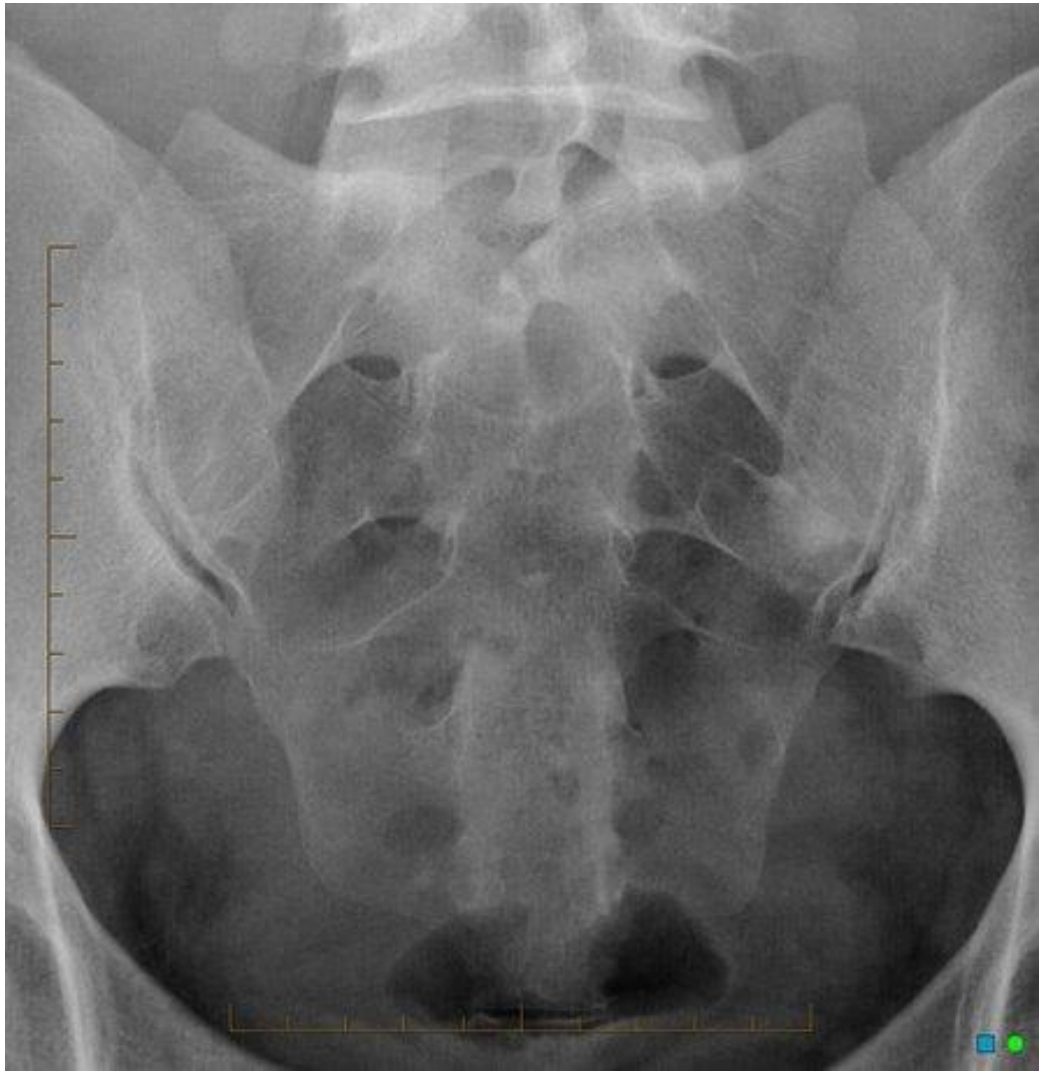
Joints of the pelvic girdle
Juncturae cinguli membri inferioris

- articulatio sacroiliaca (sacro-iliac joint)
- synarthroses cinguli pelvici
  - symphysis pubica (pubic symphysis)
  - syndesmoses
    - membrana obturatoria
    - lig. sacrospinale et sacrotuberale
    - lig. inguinale (*Pouparti*)



Čihák Radomír, Anatomie 1, Druhé, upravené a doplněné vydání, Grada Publishing 2001

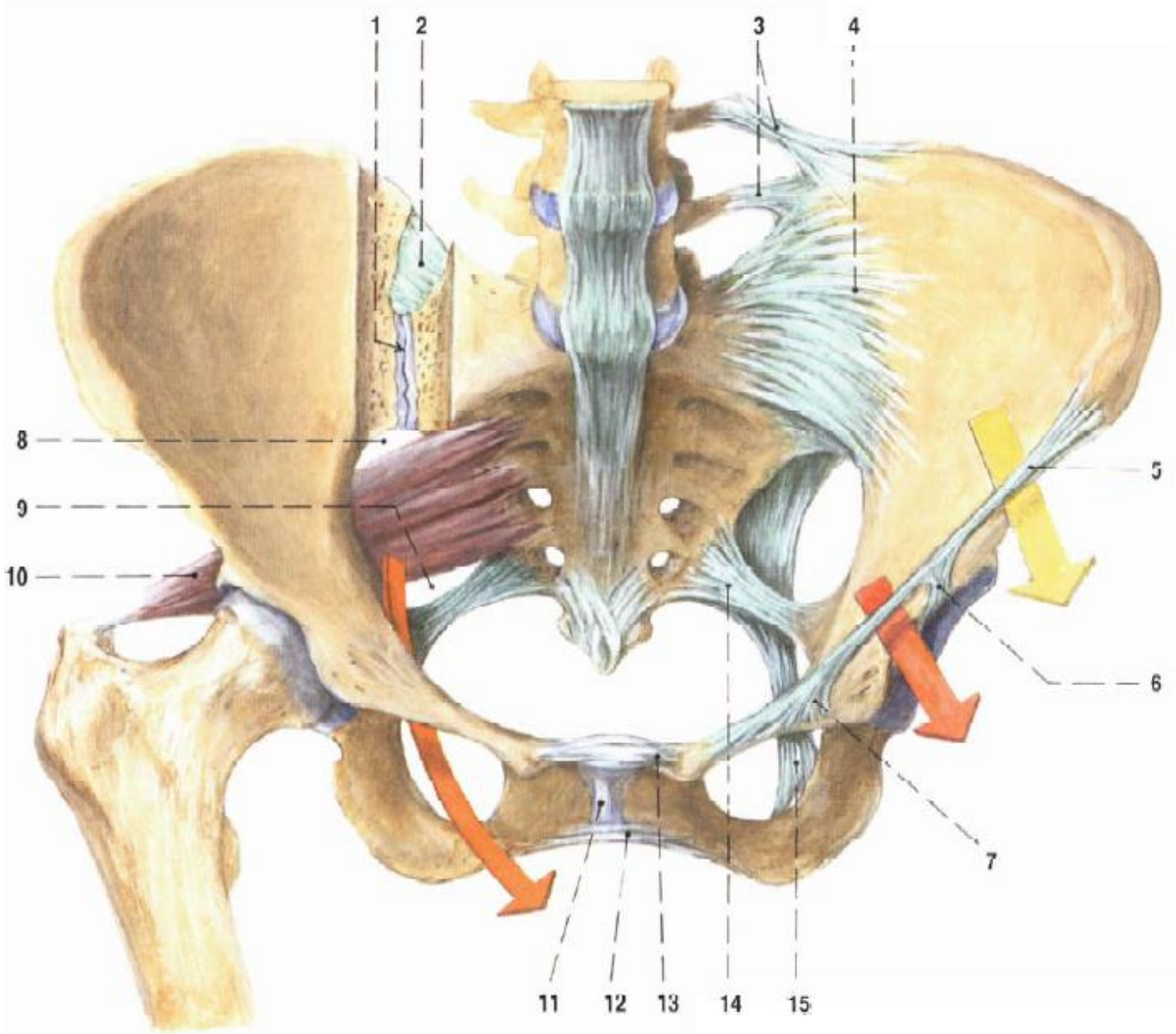
Sacroiliac joint
Articulatio sacroiliaca



http://flickrhivemind.net/Tags/xraycost

Sacroiliac joint (*Articulatio sacroiliaca*)

Type	simple, 3-axial, plane, stiff (amphiarthrosis)
Head	facies auricularis ossis sacri (we do not distinguish head and cavity)
Fossa	facies auricularis ossis ilii (we do not distinguish head and cavity)
Articular capsule and ligaments	lig. sacroiliacum anterius, posterius et interosseus (between tuberositas iliaca et tuberositas ossis sacri), lig. iliolumbale
Movements	minimal, ventrodorsal and nutation around S2, for example when walking and jumping change of gravity center – change of pelvis position (pelvis inclination)
Neutral position	= basic position
Notes	non-corresponding articular surfaces – reduction of movement extent with ageing – overload of back muscles – pain in lumbar vertebrae with irradiation into the thigh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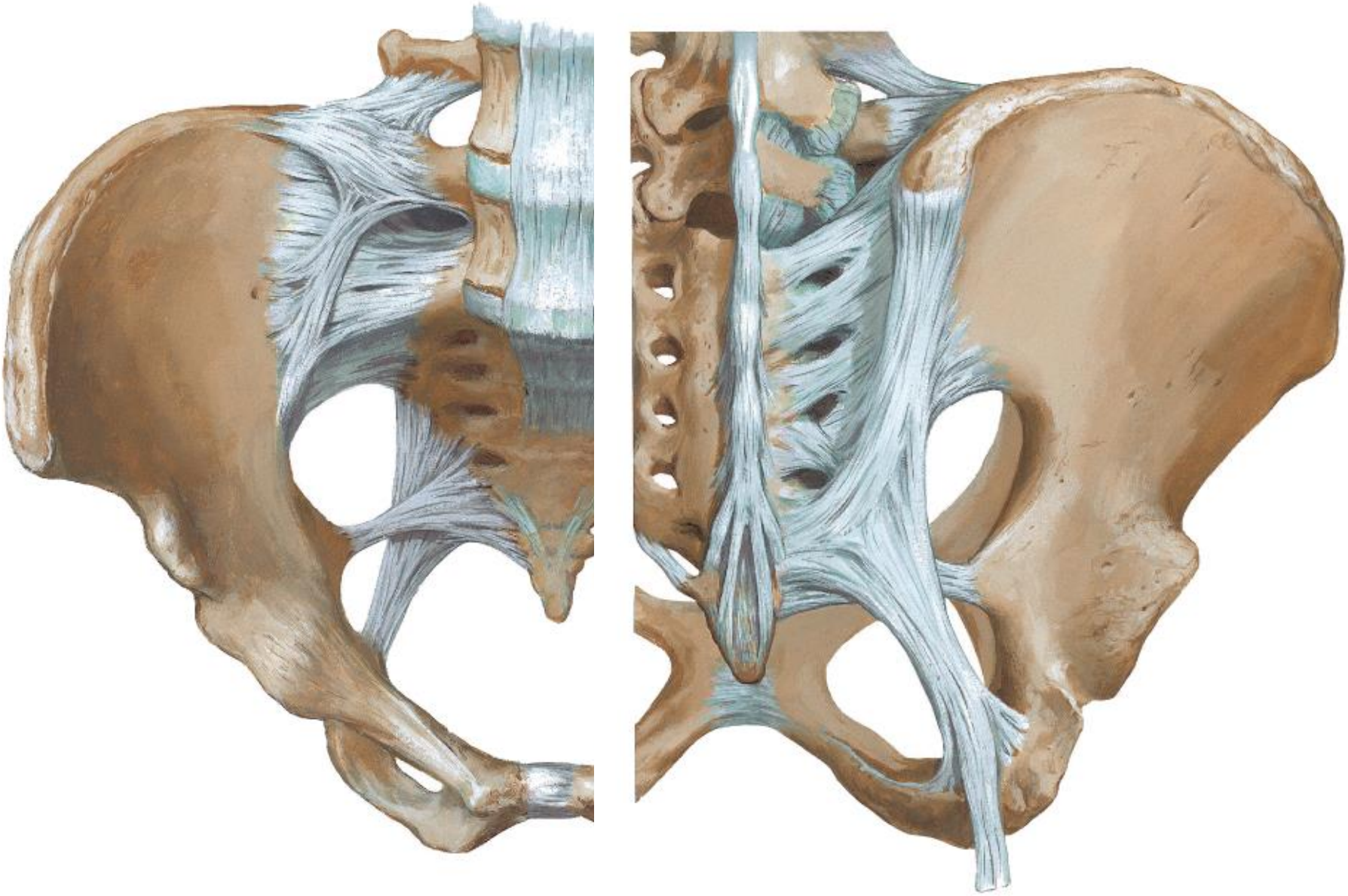
Ligaments of sacroiliac joint



CT of sacroiliac joint

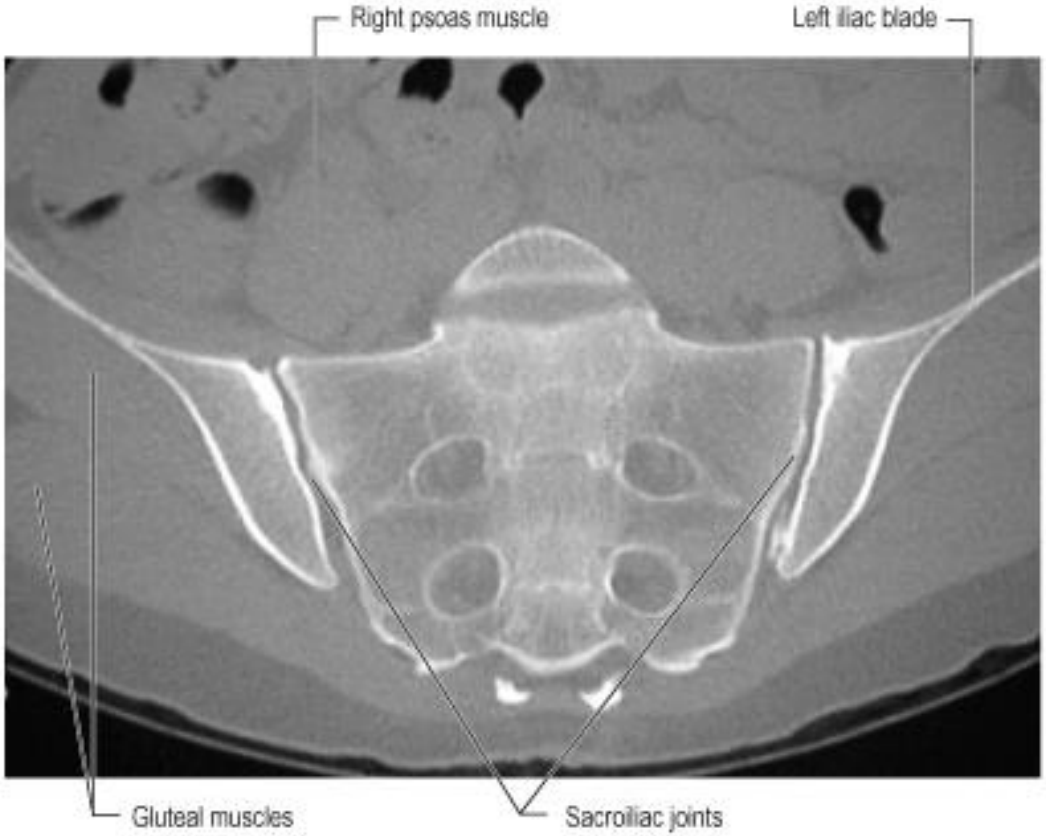
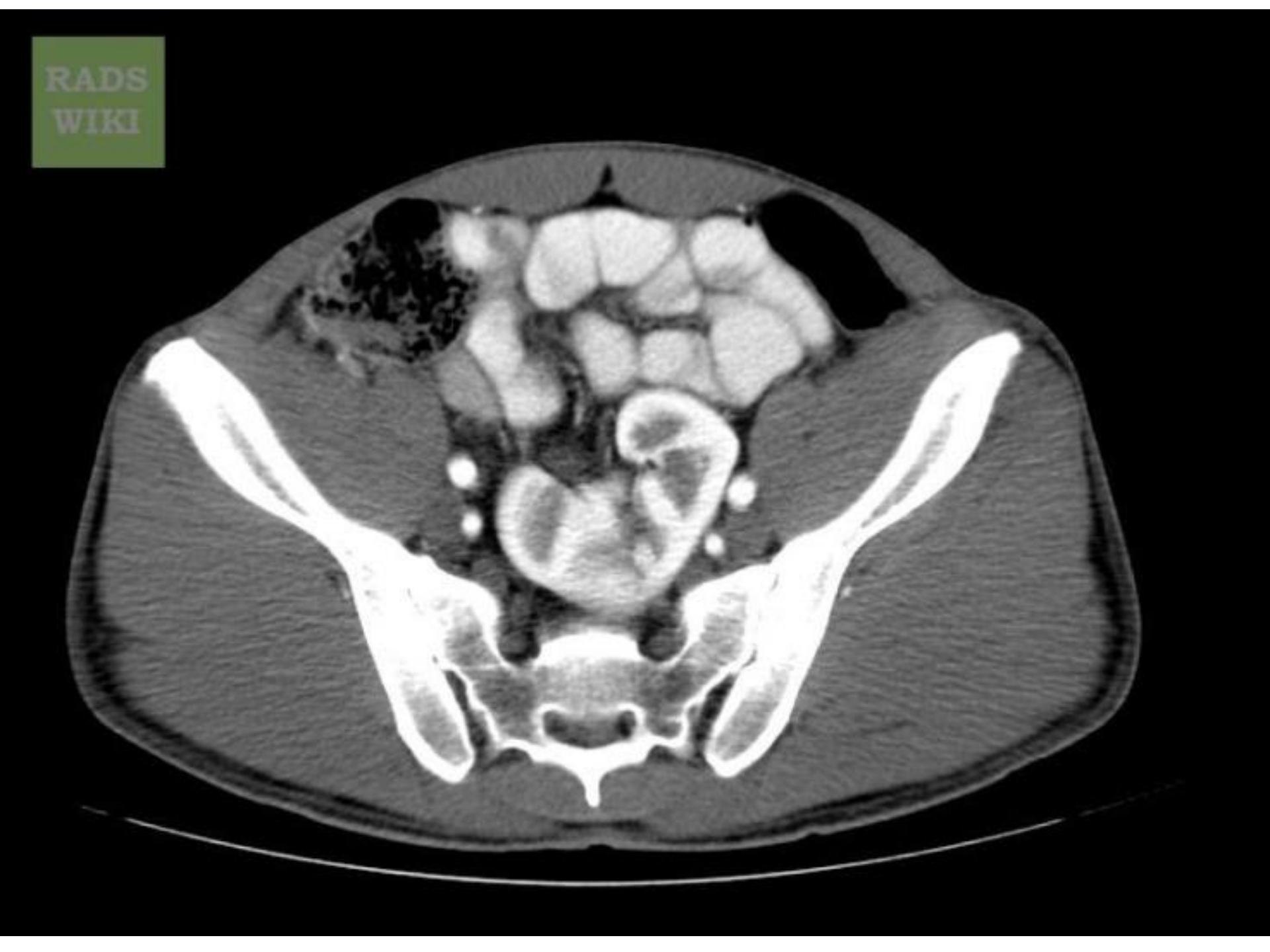
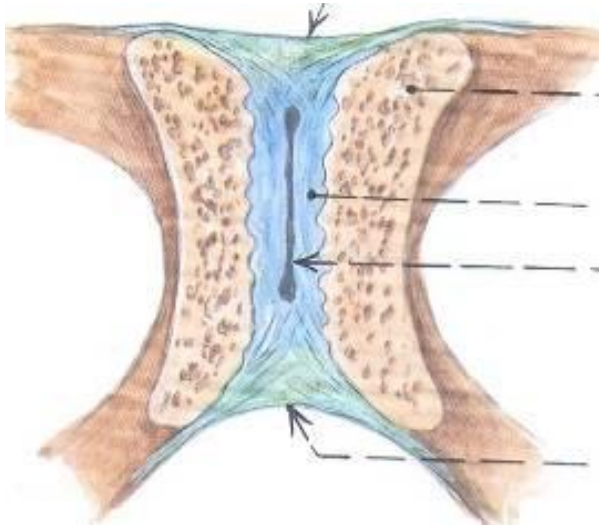


Figure 111.23 Multislice CT of the sacroiliac joints in an adult female, reformatted in the coronal plane. (By kind permission from Dr Justin Lee, Chelsea and Westminster Hospital, London.)


RADS
WIKI

Pubic symphysis (*Symphysis pubica*)

- facies symphysialis ossis pubis bilaterally
- discus interpubicus (width 4-5 mm)
  - **fibrous** cartilage, hyaline at margins, inside may be a cavity
- eminentia retropubica
  - protrudes dorsally into lesser pelvis
  - palpable per vaginam
- lig. pubicum superius et inferius
  - inferior ligament very strong!
- almost no movements
  - relaxes during gravidity due tohormone relaxine



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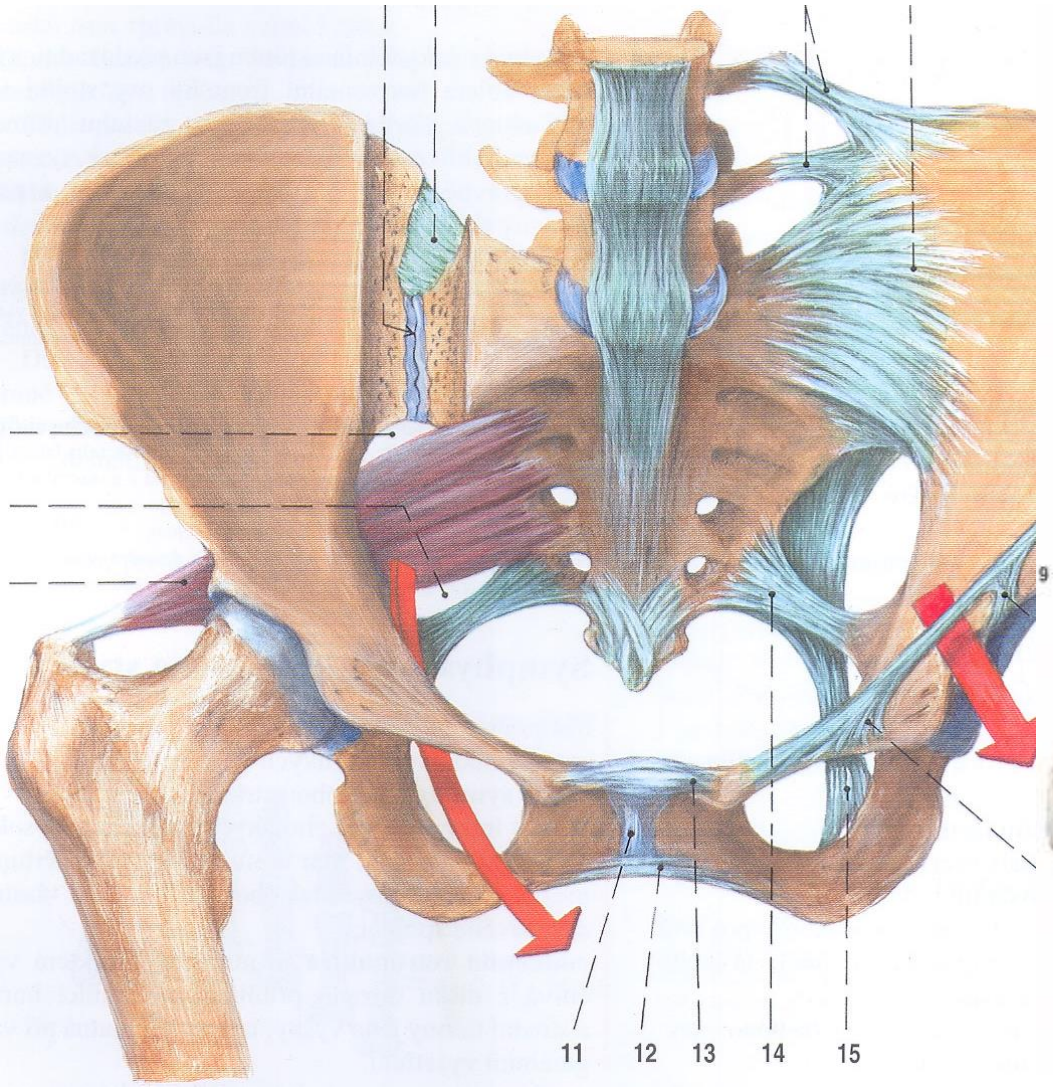
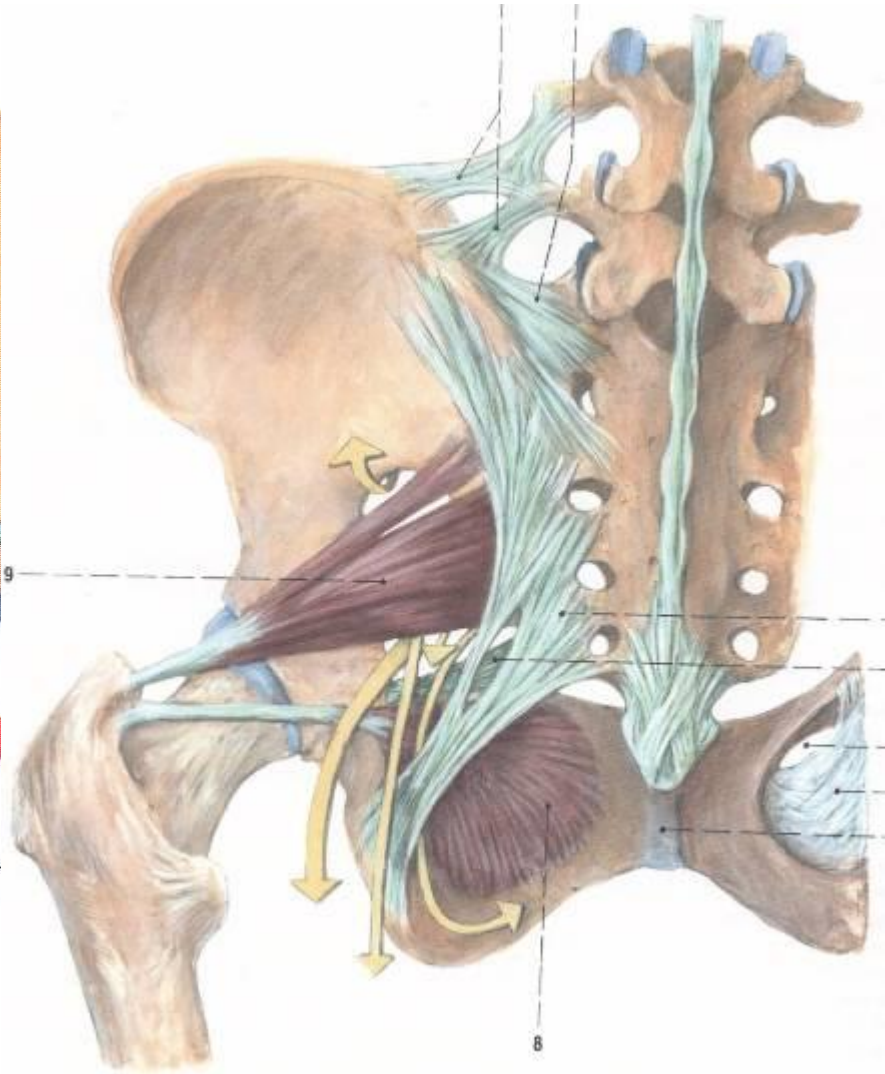
Diastasis of pubic symphysis („open book“ fracture)

http://en.wikipedia.org/wiki/File:Diastasis_symphysis_pubis_1300500.JPG

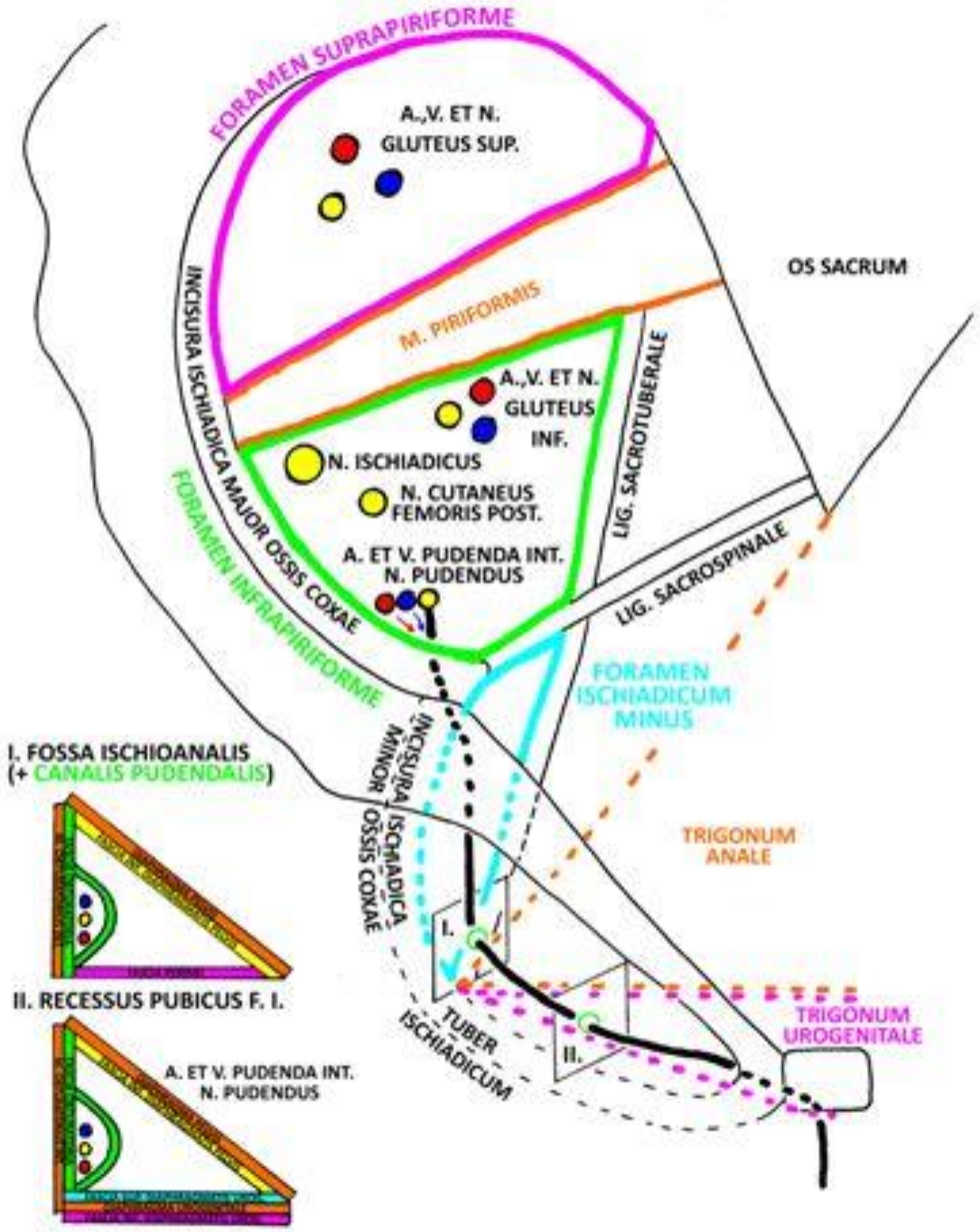
Syndesmoses of pelvic girdle

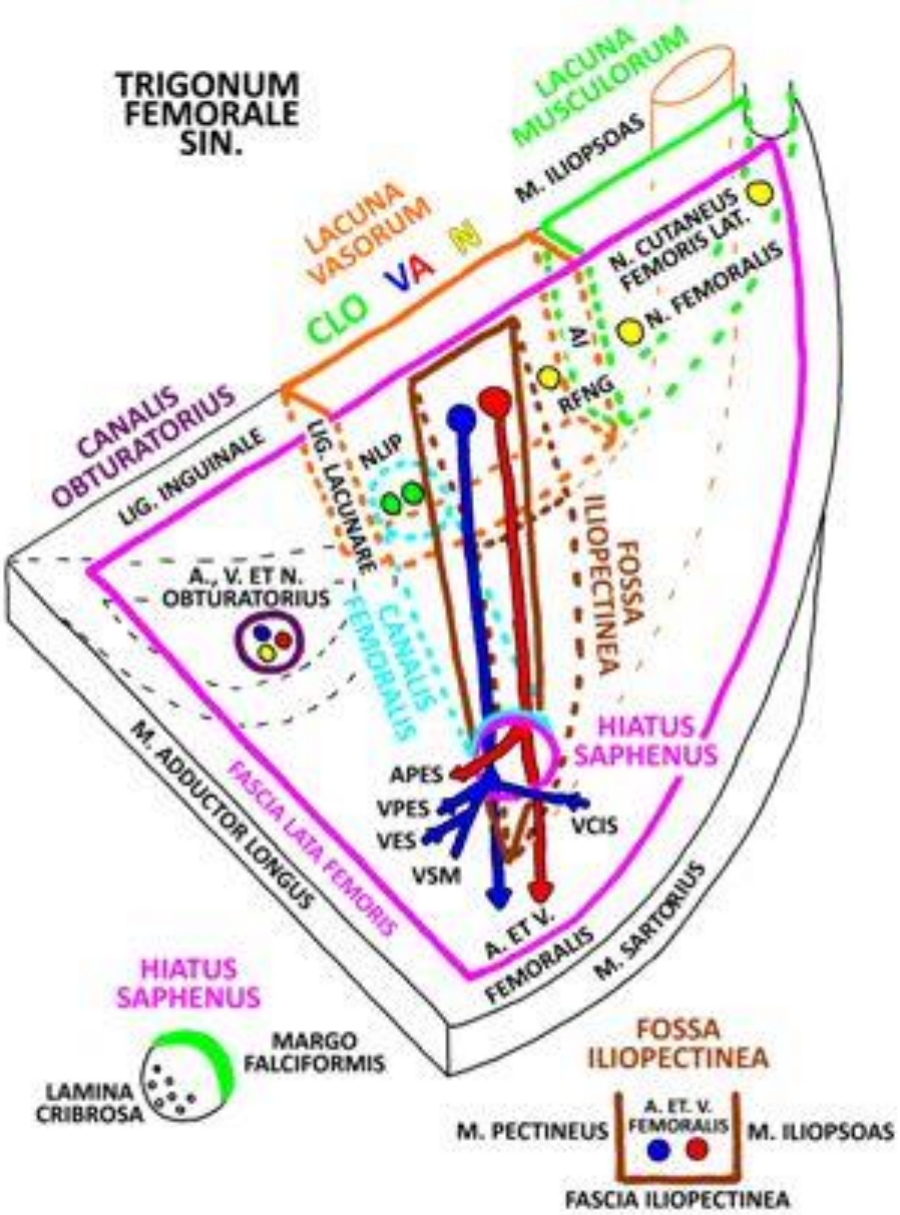
- ***ligamentum inguinale* Pouparti (inguinal ligament)**
  - between spina iliaca anterior superior and tuberculum pubicum
  - false ligament = caudal margin of aponeurosis (flat tendon) of musculus obliquus externus abdominis
  - under ligament topographic sites: *lacuna vasorum et musculorum* (passages for vessels and muscles)
- **ligamentum sacrospinale et sacrotuberale**
  - stability of pelvis
  - form topographic sites: foramen ischiadicum majus et minus
- **membrana obturatoria**
  - canalis obturatorius





Čihák Radomír, Anatomie 1, Druhé, upravené a doplněné vydání, Grada Publishing 2001


FORAMEN SUPRAPIRIFORME
A.,V. ET N.
GLUTEUS SUP.
M. PIRIFORMIS
OS SACRUM
INCISURA ISCHIADICA MAJOR OSSIS COXAE
A.,V. ET N.
GLUTEUS
INF.
N. ISCHIADICUS
N. CUTANEUS
FEMORIS POST.
A. ET V. PUDENDA INT.
N. PUDENDUS
FORAMEN INFRAPIRIFORME
LIG. SACROTUBERALE
LIG. SACROSPINALE
FORAMEN
ISCHIADICUM
MINUS
INCISURA
ISCHIADICA
MINOR
OSSIS COXAE
TRIGONUM
ANALE
I.
II.
TUBER
ISCHIADICUM
TRIGONUM
UROGENITALE
I. FOSSA ISCHIOANALIS
(+ CANALIS PUDENDALIS)
II. RECESSUS PUBICUS F. I.
A. ET V. PUDENDA INT.
N. PUDENDUS

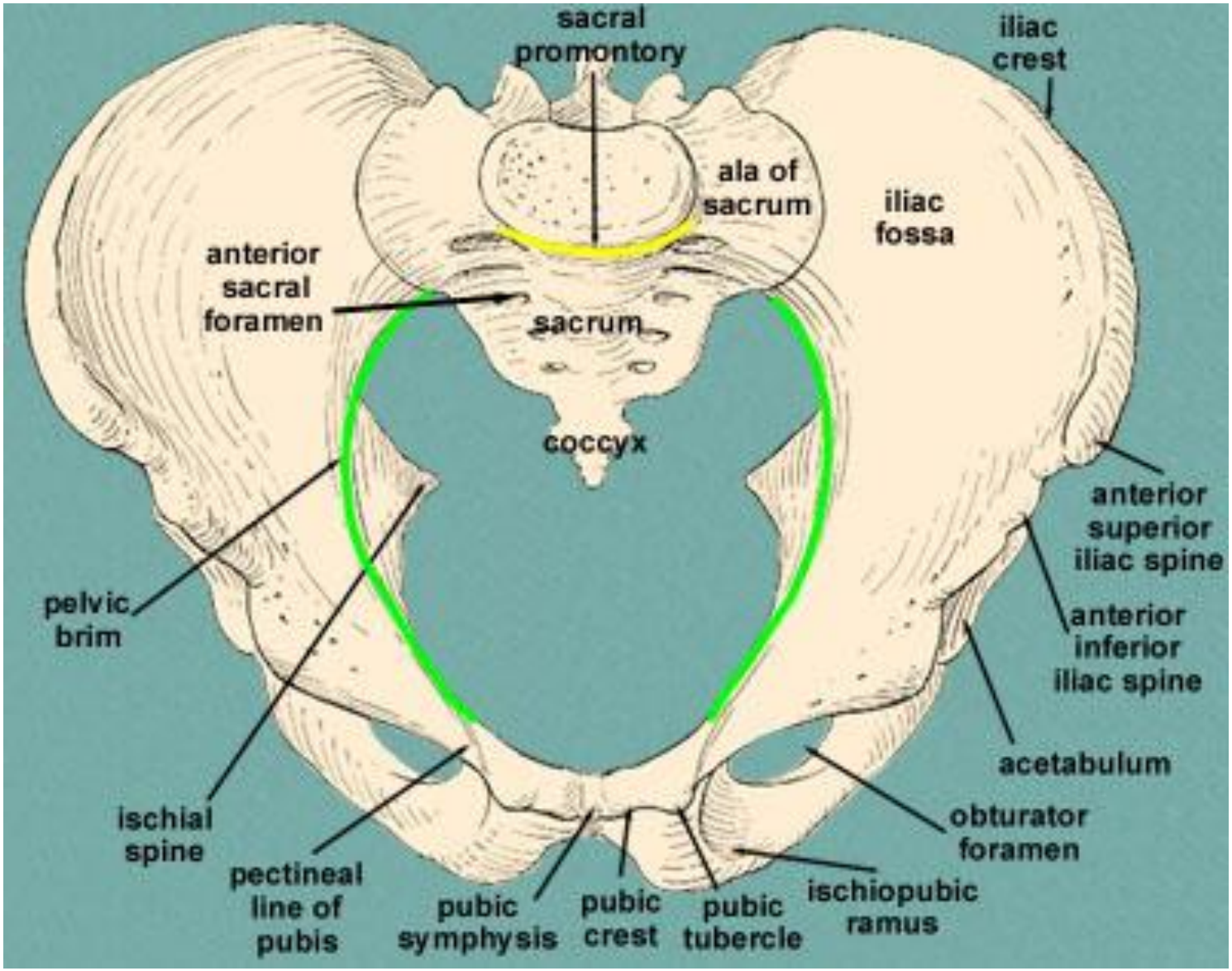


NLIP = NODI LYMPHOIDEI INGUINALES PROFUNDI
AI = ARCUS ILIOPECTINEUS
RFNG = R. FEMORALIS N. GENITOFEMORALIS
APES = A. PUDENDA EXTERNA SUPERFICIALIS
VPES = V. PUDENDA EXTERNA SUPERFICIALIS
VES = V. EPIGASTRICA SUPERFICIALIS
VSM = V. SAPHENA MAGNA
VCIS = V. CIRCUMFLEXA ILIUM SUPERFICIALIS

Pelvis as a whole

- composed of paired *os coxae* and unpaired *os sacrum*
- *inclinatio pelvis* (inclination) = 60°
- pelvic circle – tough and elastic complex of bones and ligaments transferring weight of trunk on lower limbs
- *linea terminalis* – circular line running via: *promontorium ossis sacri* → *linea arcuata* → *eminetia ilopubica* → *pecten ossis pubis* → superior margin of *symphysis pubica*
  - separates *pelvis major* and *pelvis minor*

Linea terminalis



http://home.comcast.net/~wnor/pelvis.htm

Pelvis as a whole

- *pelvis major* (greater pelvis)
  - small intestine and a part of large intestine
- *pelvis minor* (lesser pelvis)
  - urinary bladder and urethra, prostate ♂ / ovarium, uterine tube, uterus, vagina ♀ and rectum
- weight of the trunk tilts the upper part of *os sacrum* ventrally
- movement axis runs horizontally via the articular surfaces of sacroiliac joint
- lower part of *os sacrum* tilts dorsally and stabilizes the pelvis in ventrodorsal direction
- *lig. sacrospinale et sacrotuberale* limit tilting movements of the lower part of *os sacrum* dorsally

Clinical notes

***Articulatio sacroiliaca* (sacroiliac joint, SI joint)**

- very strong ligaments, only small tilting movements, very important for pelvis inclination change (*inclinatio pelvis*) when changing the gravity center
- overload of SI joint (sport, work in bending position, arthrotic changes) leads to pain syndrome – local pain + irradiation into the thigh
  - result of the spasm (spasmic contraction) of surrounding muscles stabilizing the overloaded joint

***Symphysis pubica* (pubic symphysis)**

- *eminentia retropubica* – decreases ventrodorsal diameter of pelvic aditus, palpable in vaginal (obstetric) examination
- tissue of symphysis is during delivery relaxed by ovarian hormone relaxine – enlargement of space for fetus passage (and coccyx moves dorsally)
- strenthened by ligaments – even in case of symphyseolysis the *lig. pubicum inferius* holds bones together

Joints of free lower limb

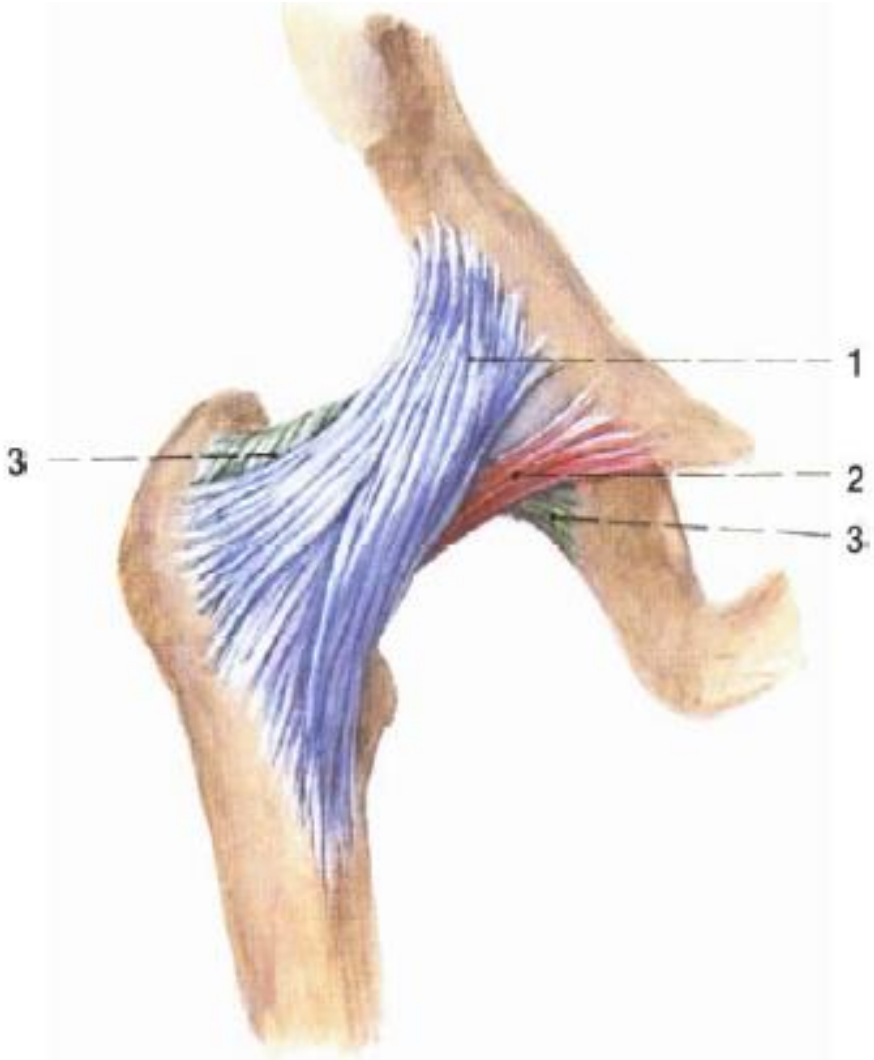
Juncturae membri inferioris liberi

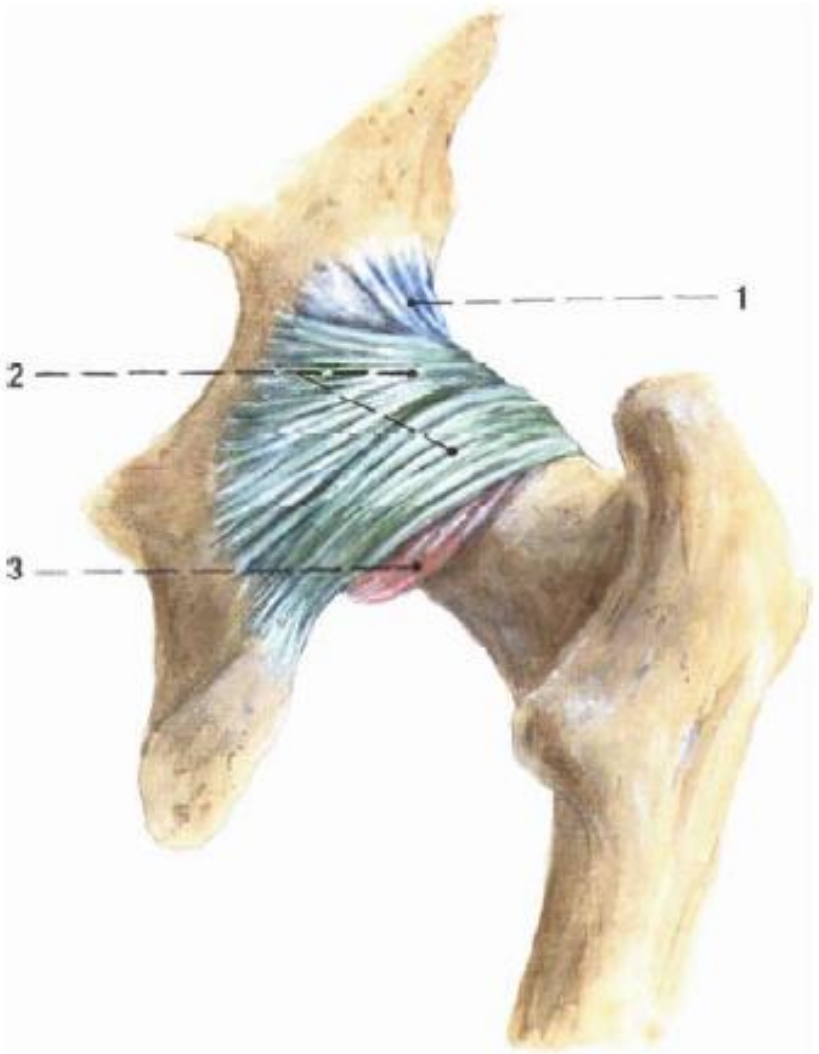
- **diarthroses**
  - articulatio **coxae** s. coxofemoralis (hip joint)
  - articulatio **genus** (knee joint)
  - articulatio **tibiofibularis**
  - articulationes pedis
    - art. **talocruralis** (ankle joint)
    - art. **subtalaris** s. talocalcanea (subtalar joint)
    - art. **tarsi transversa** (Choparti)
      - art. talocalcaneonavicularis
      - art. calcaneocuboidea
    - art. **cuneonavicularis**
    - articulationes intercuneiformes
    - articulationes tarsometatarsales
    - articulationes intermetatarsales
    - articulationes metatarsophalangeae
    - articulationes interphalangeae pedis
- **synarthroses**
  - **syndesmosis tibiofibularis**
    - membrana interossea cruris
    - lig. tibiofibulare anterius et posterius

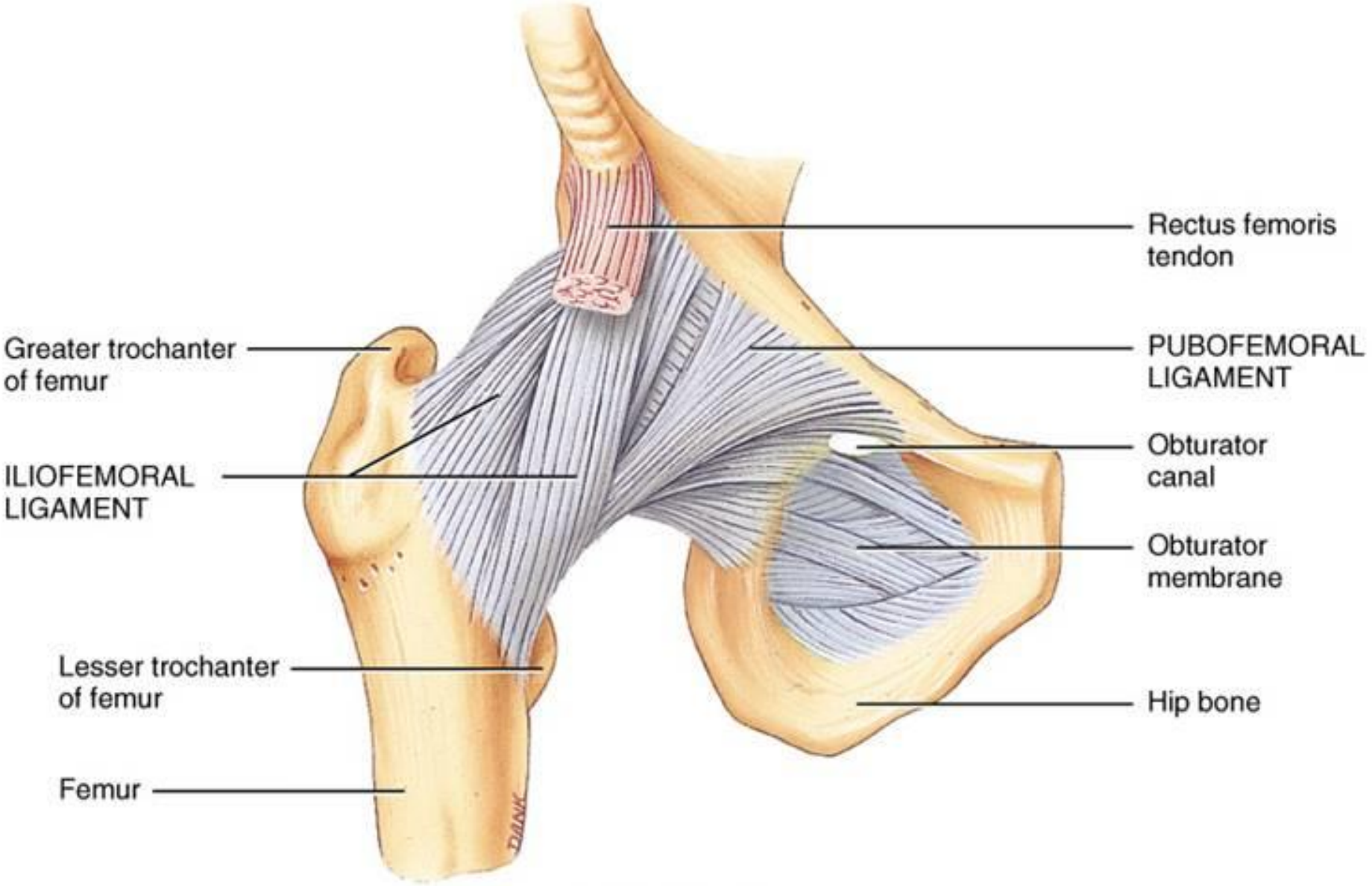
Hip joint (*Articulatio coxae*)

Type of joint	simple, 3-axial, limited ball-and-socket (art. cotylica), mobile
Head	caput femoris
Fossa	acetabulum: facies lunata + labrum acetabuli
Articular capsule and its ligaments	capsule: ventrally as far as linea intertrochanterica, dorsally in 2/3 of collum femoris lig. iliofemorale (*Bigellowi*) – thickest ligament in human body**,** lig. ischiofemorale, lig. pubofemorale, zona orbicularis, lig. capitis femoris, lig. transversum acetabuli retinacula *Weibrechti* – blood supply to capit femoris (branches of a. circumflexa femoris medialis)
Special structures	labrum acetabuli, pulvinar acetabuli, lig. capitis femoris (false intra-articular ligament covered with synovial membrane)
Movements	flexion-extension (=dorsal flexion), adduction-abduction, (+hyperadduction), internal-external rotation, circumduction
Neutral position	mild flexion, slight abduction and external rotation
Notes	lig. iliofemorale limits extension lig. pubofemorale limits abduction and external rotation lig. ischiofemorale limits adduction and internal rotation CCD (capitocolodiaphyseal) angle = 126° developmental joint dysplasia (developmental dysplasia of hip joint) – most common defect of locomotion system

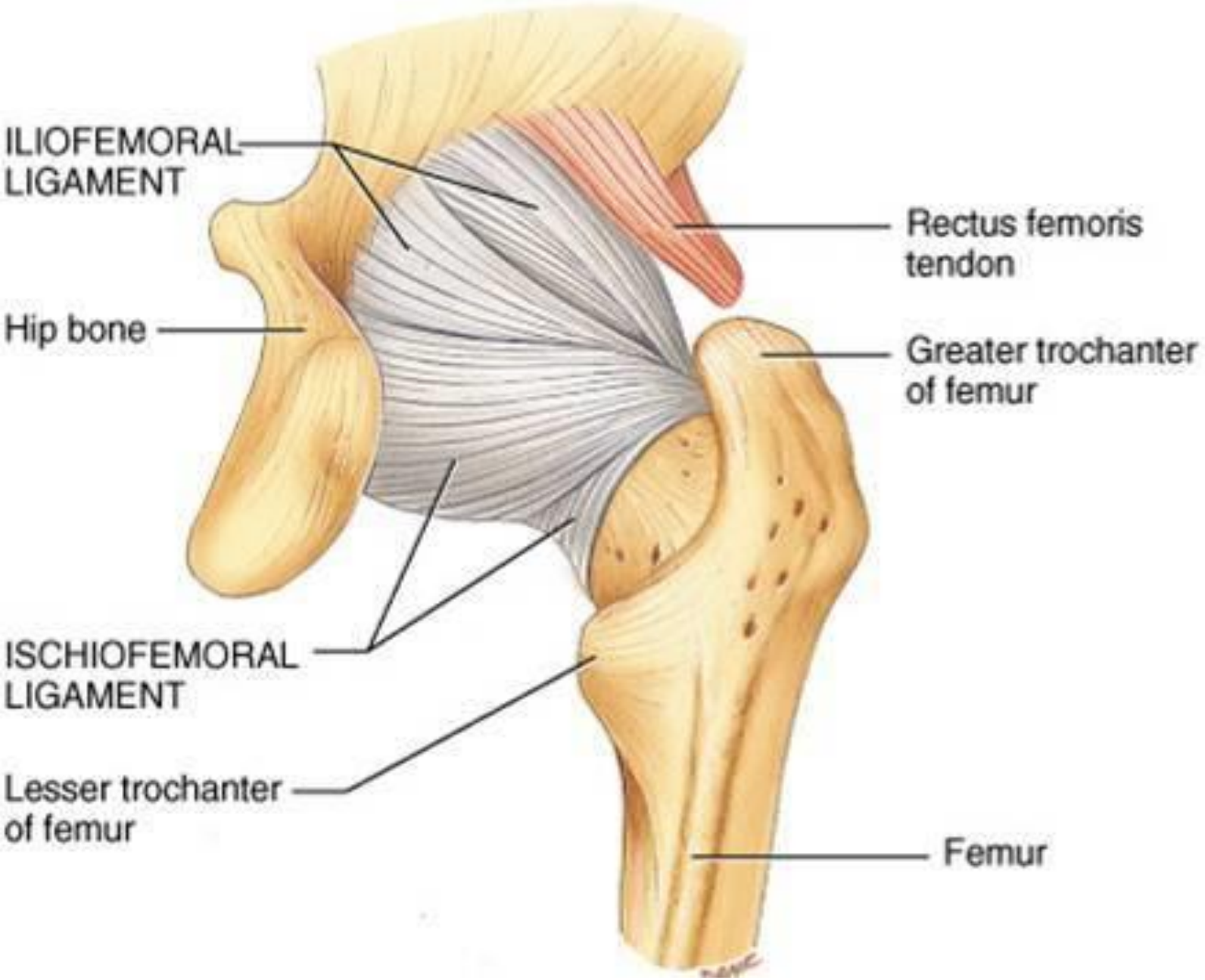
Ligaments of hip joint





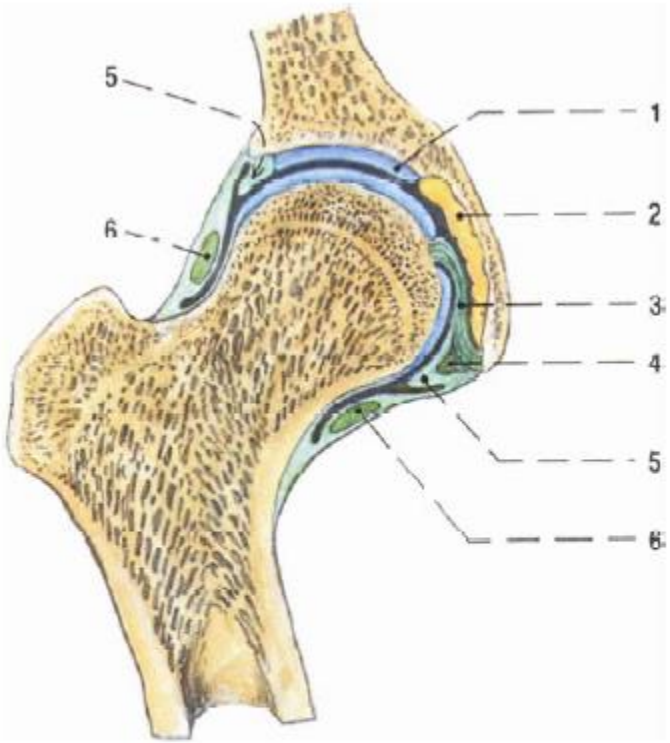


http://pds.exblog.jp/pds/1/200511/02/86/a0057586_14531191.jpg

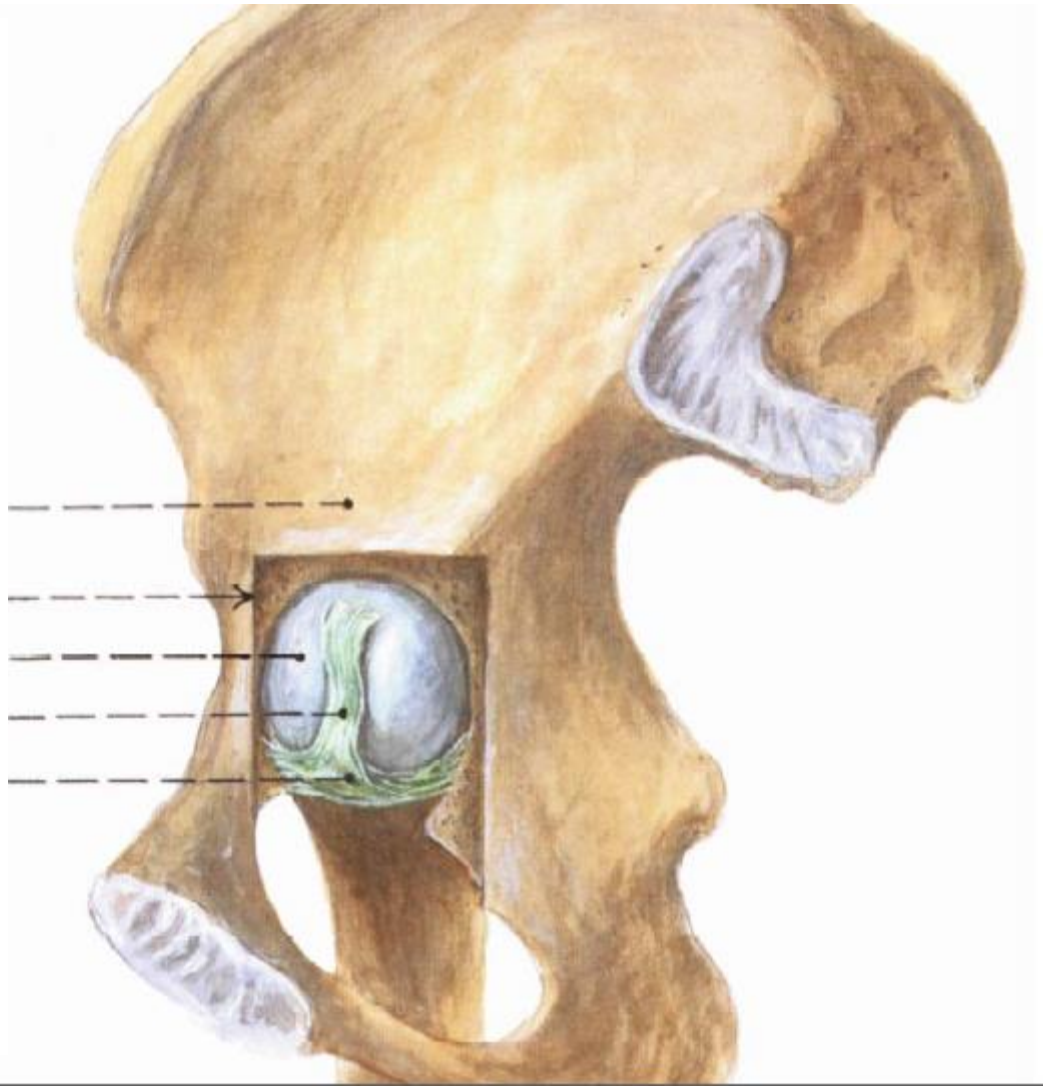


http://www.centenoschultz.com/wp-content/images/ishiofemoral-liagment.jpg

Ligamentum capitis femoris

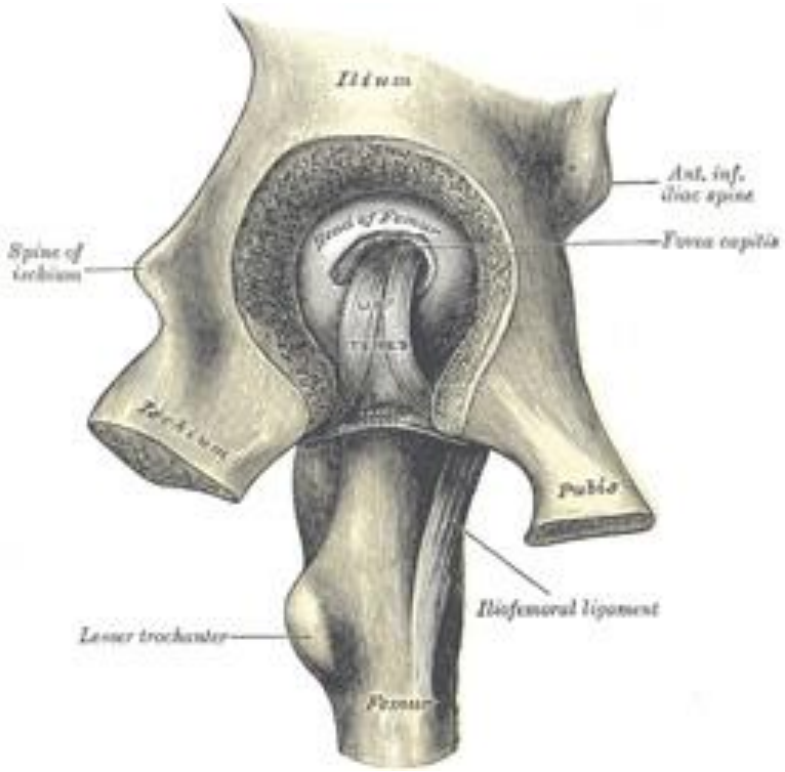


Obr. 307. FRONTÁLNÍ ŘEZ KYČELNÍM KLOUBEM; pravá šíraná; pohled zpředu
1 kloubní chrupavka na facies lunala acetabuli
2 pulvinar aeetabuli
3 ligamentum capitis femoris
4 ligamentum transversum acetabuli
5 labrum acetabulare
6 zóna orbicularis

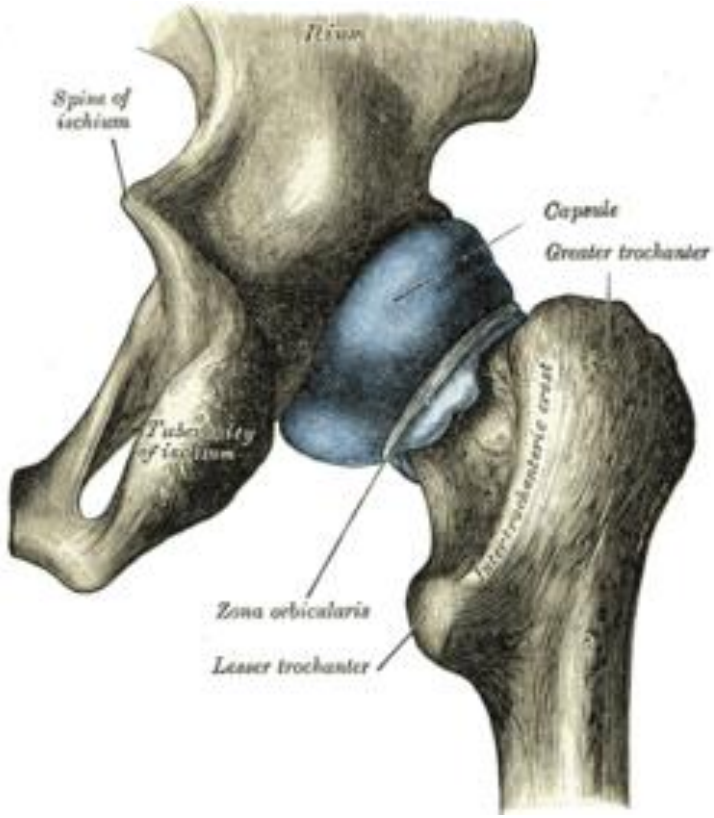


Ligaments of hip joint

- lig. capitis femoris
- lig. transversum acetabuli
- zona orbicularis
  - lig. ischiofemorale
  - lig. pubofemorale

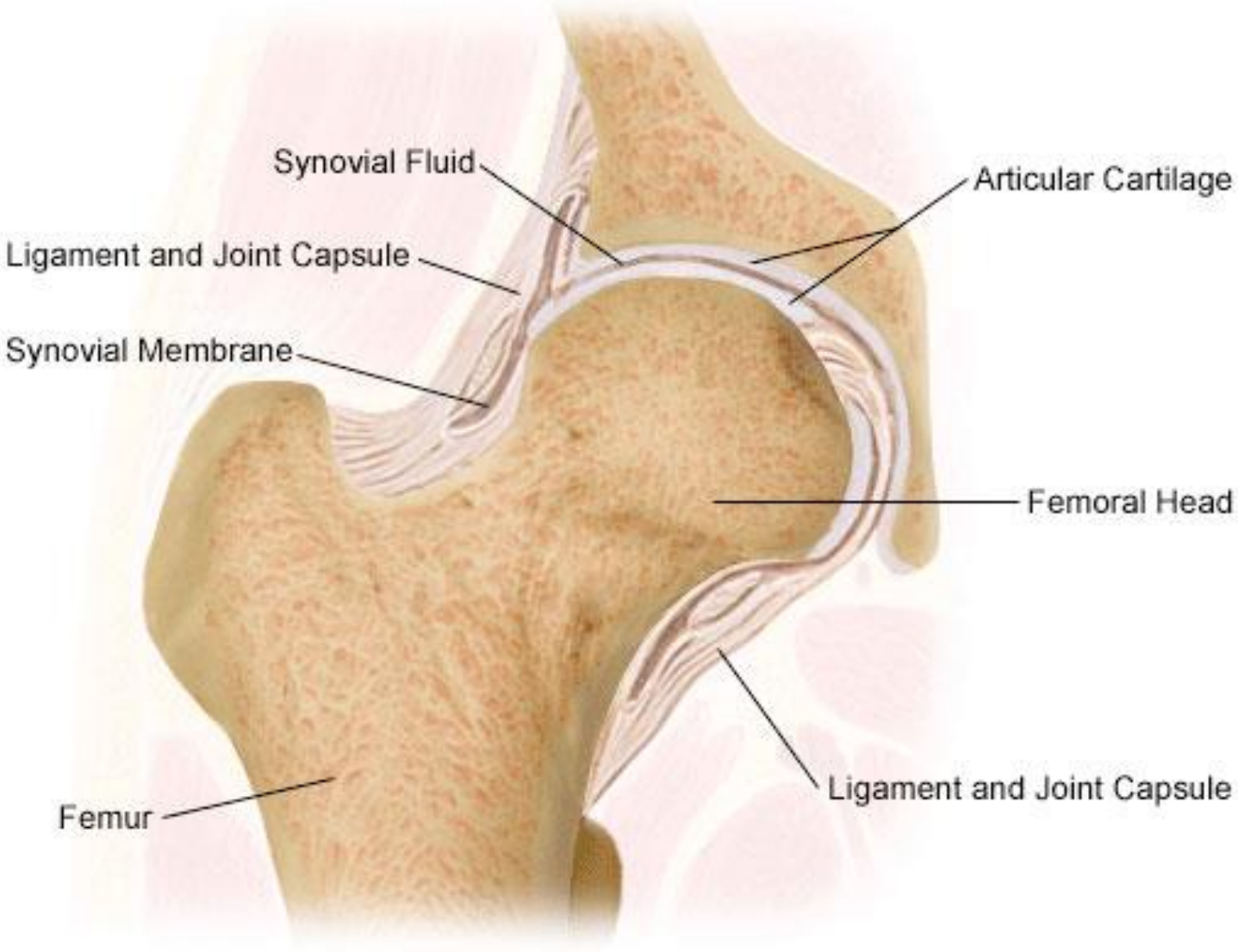


http://www.bartleby.com/107/Images/small/image341.jpg

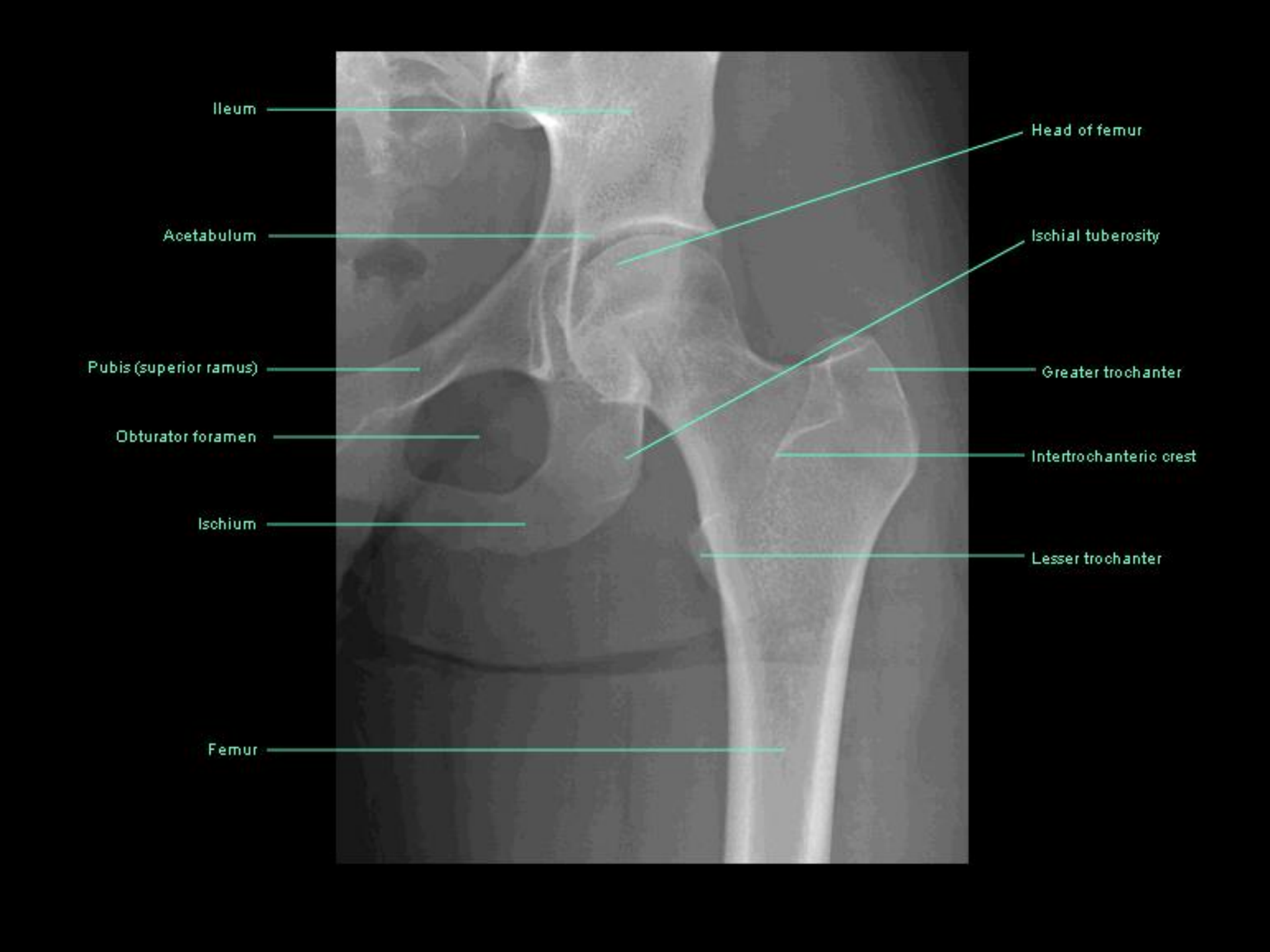


http://upload.wikimedia.org/wikipedia/commons/thumb/6/65/Gray343.png/250px-Gray343.png

Hip Joint



http://childrenshospital.org/clinicalservices/Site1163/Images/Hip.jpg


Ileum
Acetabulum
Pubis (superior ramus)
Obturator foramen
Ischium
Femur
Head of femur
Ischial tuberosity
Greater trochanter
Intertrochanteric crest
Lesser trochanter

Movements in hip joint

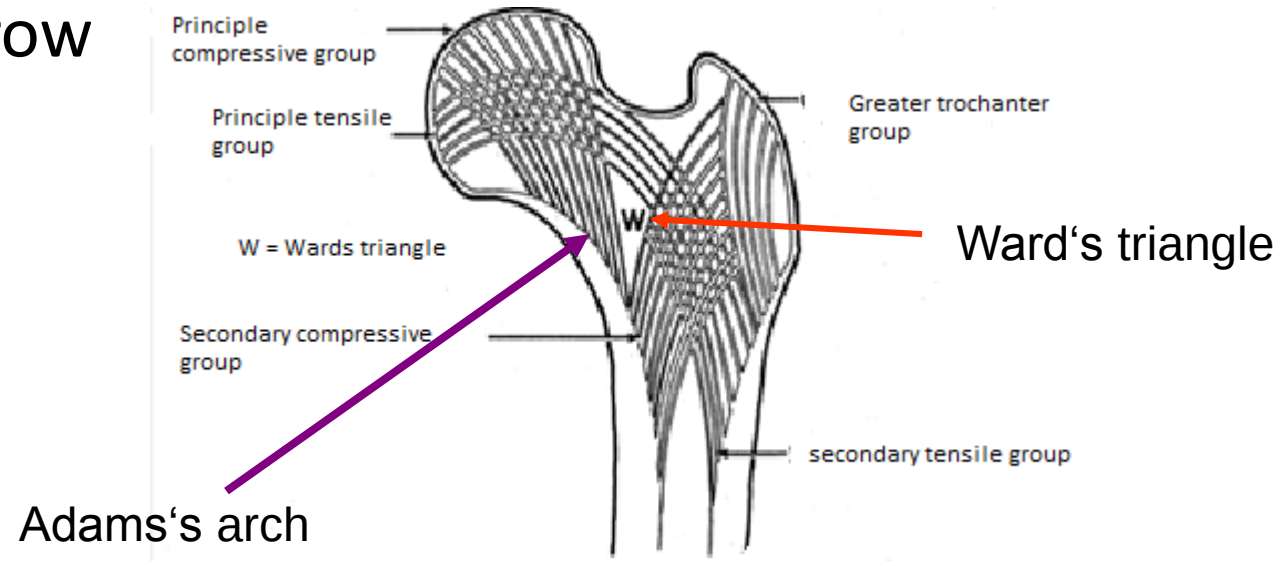
- flexion up to 120°
- extension up to 13°
- abduction up to 40°
- adduction up to 10°
- rotation
  - external up to 15°
  - internal up to 35°

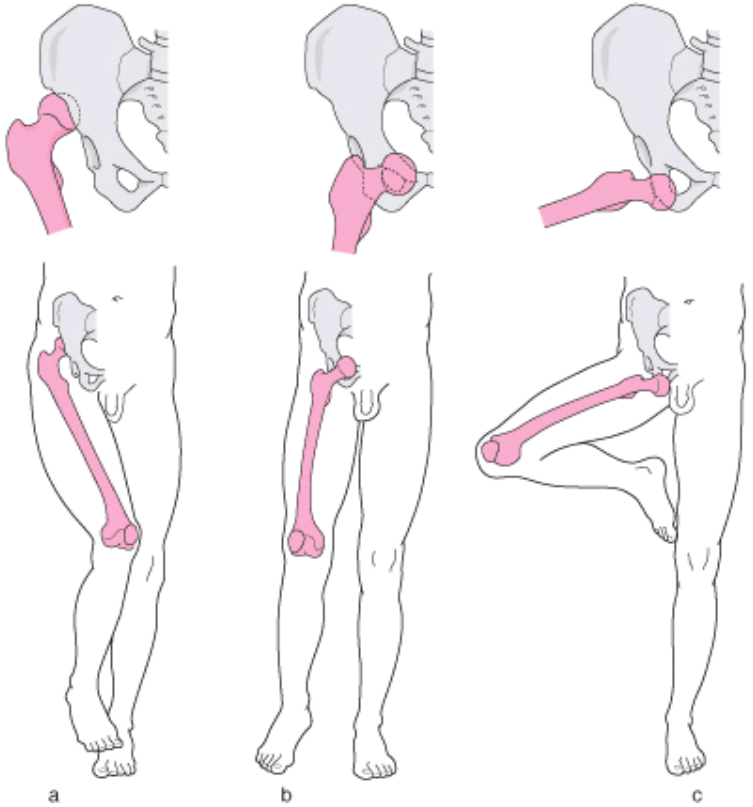
Clinical notes

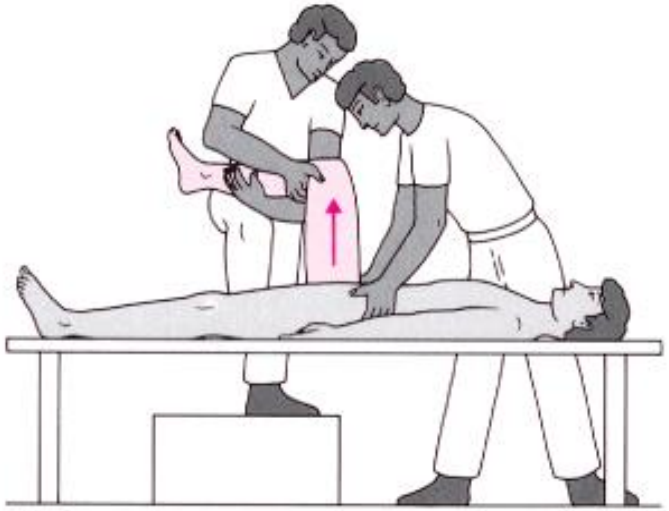
- transfer of great forces is done by architecture of acetabulum, *os ilium* and proximal femur (acetabular pillar, *Ward‘s triangle, Adams‘ arch*)
- hip joint luxation occurs mostly in high-energy injuries – typical is hit of the car dash board („dash-board“ injury)
- in 90% cases it is the posterior luxation (into weak spots between ligaments)
- 10% anterior luxation
  - rare obturator luxation

Structures inside femur

- Adams‘ arch
  - onn medial side; collum femoris continues into the diaphysis by thick cortical bone
- Ward‘s triangle
  - space inside the collum femoris between band of crossing trabecules is a cavity filled with yellow bone marrow







Hip joint replacement

- TEP – total endoprosthesis
- CEP – cervicocapital endoprosthesis
- one of the most common operations in orthopaedics
- arthrotic changes in joint, fractures of collum, fractures of acetabulum

knöcherne Pfanne

Gelenkknorpel der Pfanne

aufsetzbarer bipolarer Kopf

Femurkopf

Femur

Schaft

Achsengerechte Stellung und Funktion mit bipolarer Pro-

▼ Thompson-Prothese

▼ Charnley-Prothese

Pfannenteil (ultrahochmolekulares Polyethylen)

Schaftteil (Metall)

▼ Harris-Galante-Prothese (zementfrei)

▲ Der Pfannenteil besteht aus einer äußeren Schale aus Metall und einer reibungsarmen inneren Gelenkfläche aus Polyethylen

▲ Spritzgusskappe mit hochgezogener Hinterwand. Der Rand kann entsprechend den vorliegenden Größenverhältnissen zurechtgeschnitten werden

poröse Oberfläche des Pfannenteils

poröse Seitenfläche des Schaftteils (ermöglicht Knochenneubildung an der Prothesen-Knochen-Grenze und damit knöcherne Verankerung der Prothese im Markraum des Femurs)

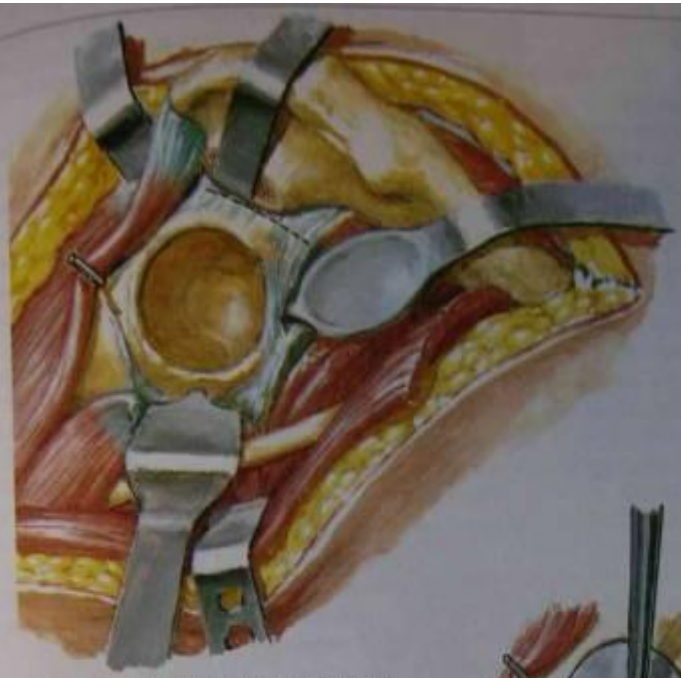
▲ Histologischer Befund. In die Zwischenräume

▲ Rasterelektronenmikroskopischer Befund.

▲ Der freiliegende Femurkopf wird mit von oben und unten eingeschobenen Knochenhebeln (z. B. nach Hohmann) gehalten

▲ Zur Bestimmung der Höhe der Schenkelhalsosteotomie wird eine Probeprothese an das Femur angelegt, und zwar so, dass sich ihr Drehmittelpunkt mit dem des Hüftkopfs deckt. Dort, wo der distale Rand des Prothesenkragens zu liegen kommt, wird mit dem Knochenmesser eine Markierung gesetzt

▲ Der Schenkelhals wird in der markierten Höhe mit einer oszillierenden Motorsäge abgesetzt



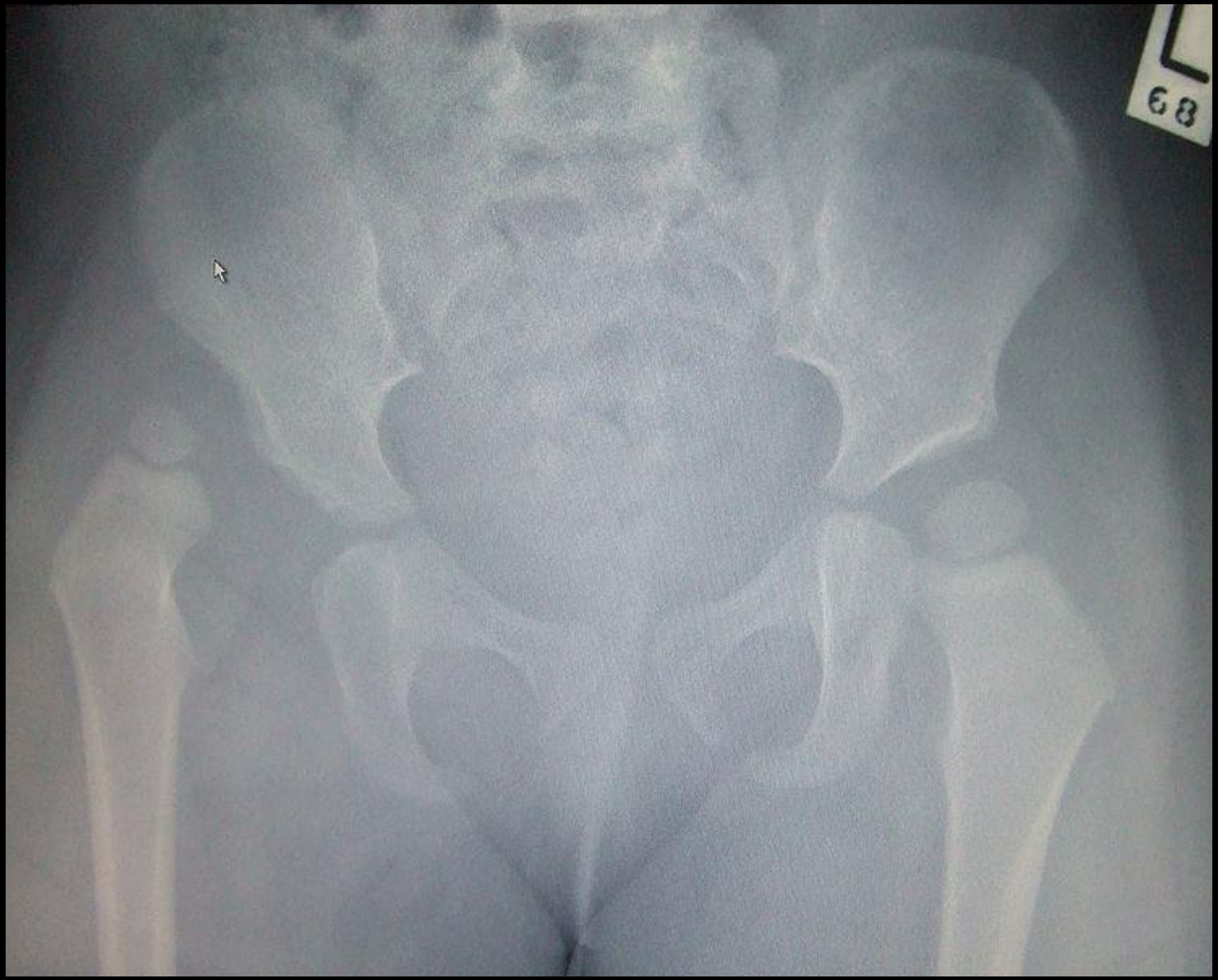
▲ Zur Darstellung der Pfanne wird das Femur nach Absetzen des Schenkelhalses nach ventral gebracht. Der besseren Übersicht halber kann auch die vordere Kapsel inzidiert werden

▲ Mit Probepfannen wird der Sitz geprüft

▲ Die Schale wird fest eingedrückt und so lange [illegible] bis der Zement ausgehärtet ist

Hip joint in children

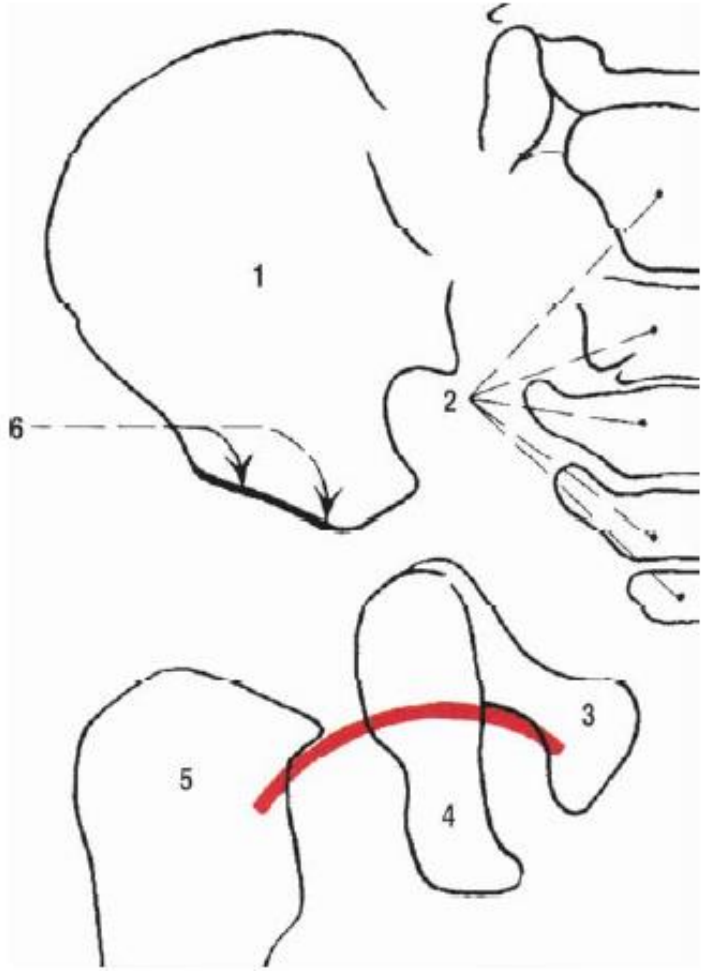
- **Developmental dysplasia of hip (DDH)** – 3 % of children
- girls more often (higher sensitivity to relaxine)
- all newborns are obligatorily examined by ultrasound (delivery room, 6th and 12th week)
- possible joint degeneration, luxation, function failure
- genetics, mechanical factors
- faster growth of femur, perinatal instability, failure of acetabular ossification, further worsening of situation
- pathological-anatomical picture
  - dysplasia of acetabulum
  - increased laxity of articular capsule
  - subluxation or luxation of caput femoris
  - 3 grades according to Dunn: positional instability – subluxation – luxation
- on X-ray: two most important markers of appropriate growth of hip joint = „roof“ and „Shenton‘s line“
- conservative treatment – for example Frejka‘s pillow, Pavlik‘s catch clamp
  - effort for abduction and flexion in hip joint (also wide diaper packing between children‘s thighs, not into binder!)
- surgical therapy – correction and completion of roof, correction of CCD angle



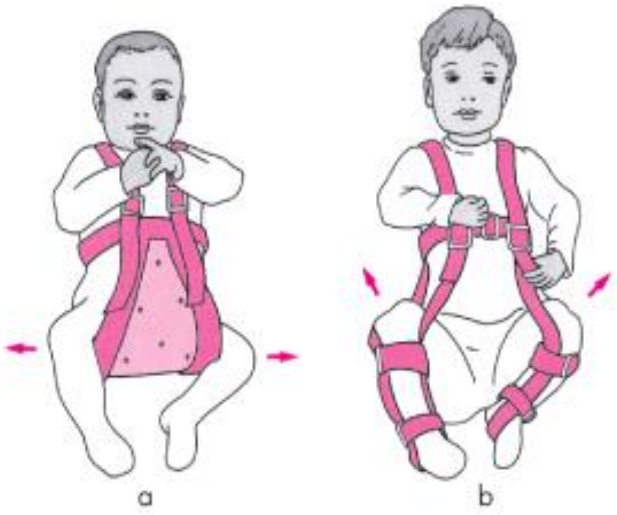
http://www.wikiskripta.eu/index.php/Soubor:Dislocated_hip.jpg

Roof

B



Pavlik‘s catch clamp



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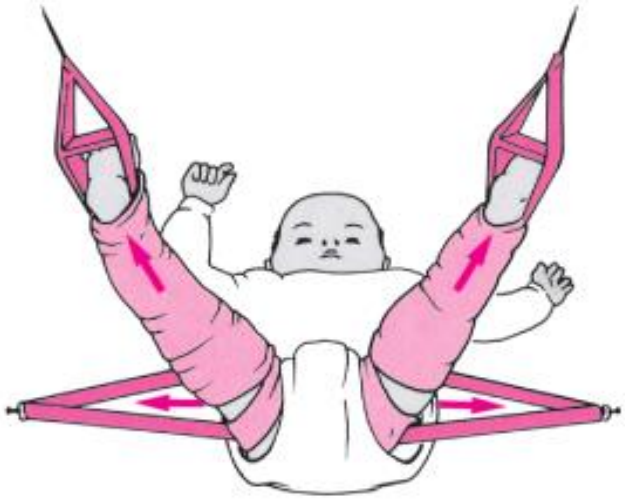

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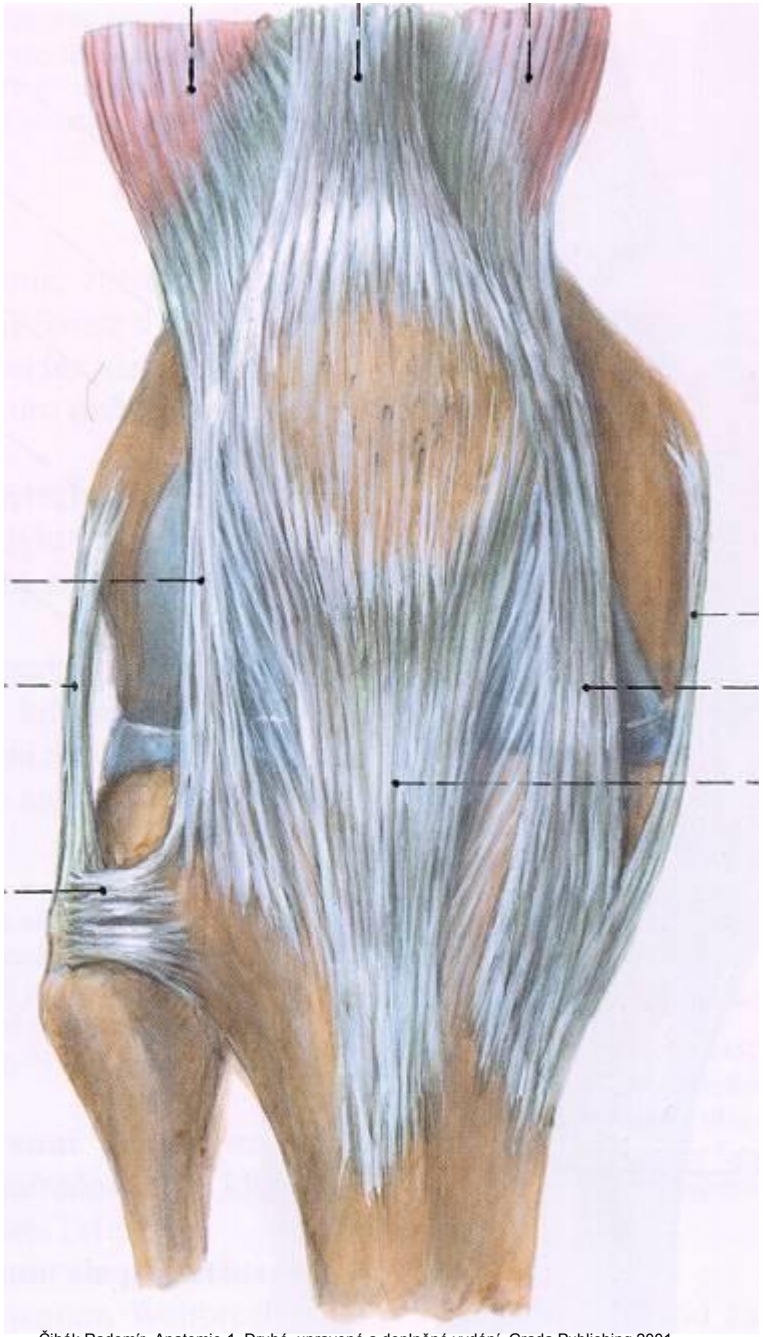
Knee joint (*Articulatio genus*)

Type	compound, 2-axial, bicondylar, mobile a) articulatio femorotibialis b) articulatio femoropatellaris
Head	a) condyli femoris b) facies patellaris femoris
Fossa	a) facies articularis superior tibiae b) facies articularis patellae
Articular capsule and its ligaments	**Articular capsule:** along margins of articular surfaces, skips epicondyli femoris recessus suprapatellaris (proximally) – usually connected with bursa suprapatellaris (knee puncture) recessus subpopliteus (laterally) meniscus medialis (shape of letter C) – fused with lig. collateralle tibiale → less mobile (moved by m. semimembranosus) meniscus lateralis (semicircular) – fused with m. popliteus; both menisci connected to capsule by external surfaces **Ligaments (12):** *extra-articular:* lig. patellae, retinaculum patellae mediale et laterale, lig. collaterale fibulare et tibiale, lig. popliteum obliquum,lig. popliteum arcuatum *intra-articular:* lig. cruciatum anterius et posterius *intrasynovial:* lig. transversum genus, lig. meniscofemorale anterius (*Humphryi*) et posterius (*Weitbrechti*) – may be absent
Special structures	meniscus medialis et lateralis, intra-articular ligaments, plica synovialis patellaris, plicae alares (palpable along margins of lig. patellae), corpus adiposum infrapatellare (Hoffae), bursae synoviales: bursa suprapatellaris, bursa gastrocnemiosemimembranosa (medially) – pathologically enlarged as Baker‘s cyst
Movements	flexion-extension (3 phases: initial rotation, rolling movement, sliding movement), internal-external rotation only in case of „unlocked“ knee !
Neutral position	flexion 20-30°
Notes	most complex joint in body physiological abduction angle between femur and calf = 170-175° unhappy triad: lesion of lig. collaterale tibiale, meniscus medialis, lig. cruciatum anterius

Ligaments



Rohen Johannes W, Yokochi Chihiro: Anatómia človeka, Osveta Martin 1991 / Schattauer Stuttgart NY 1988

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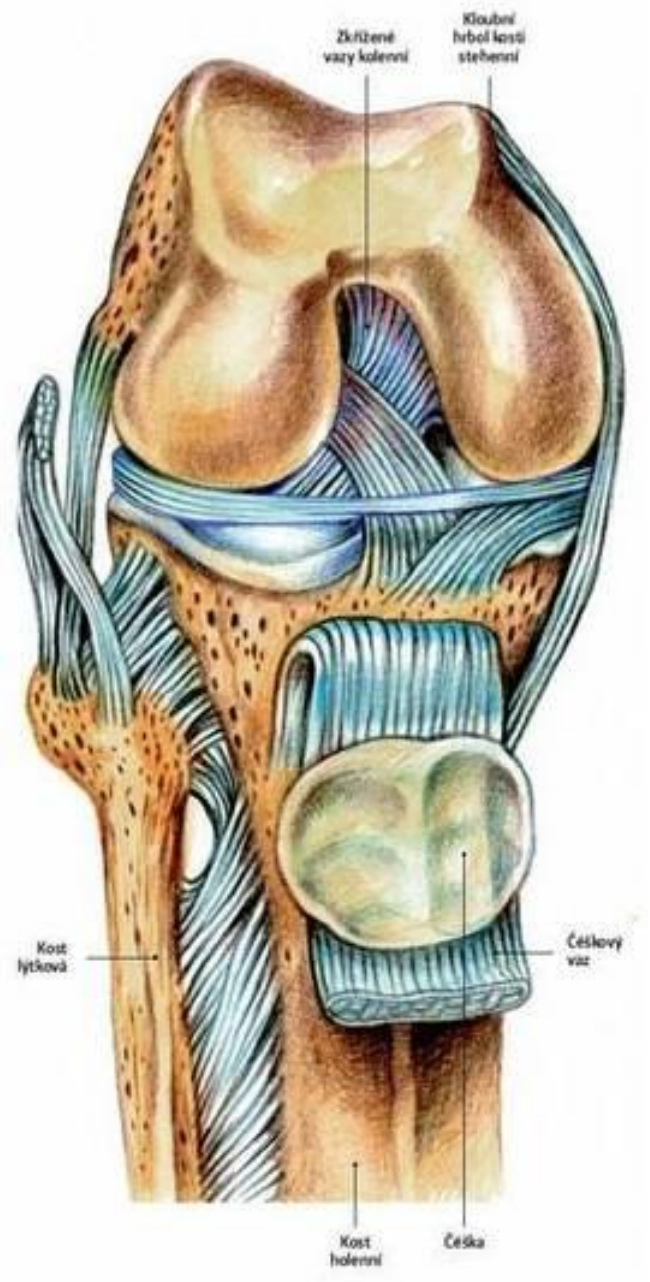

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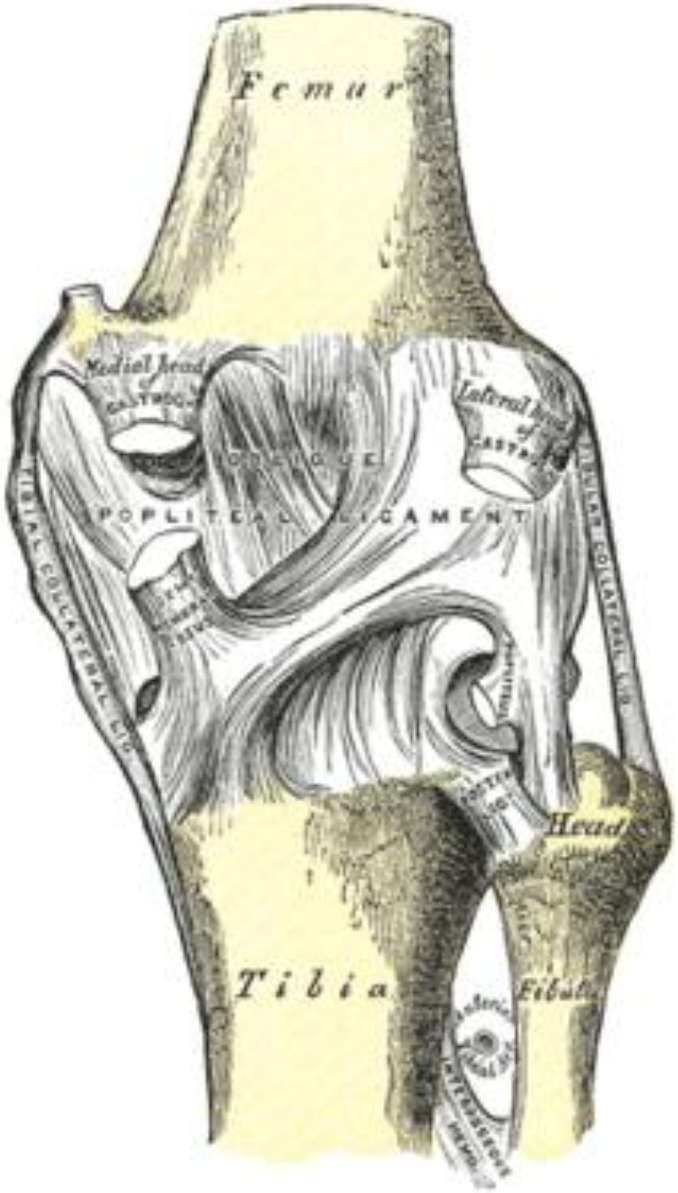

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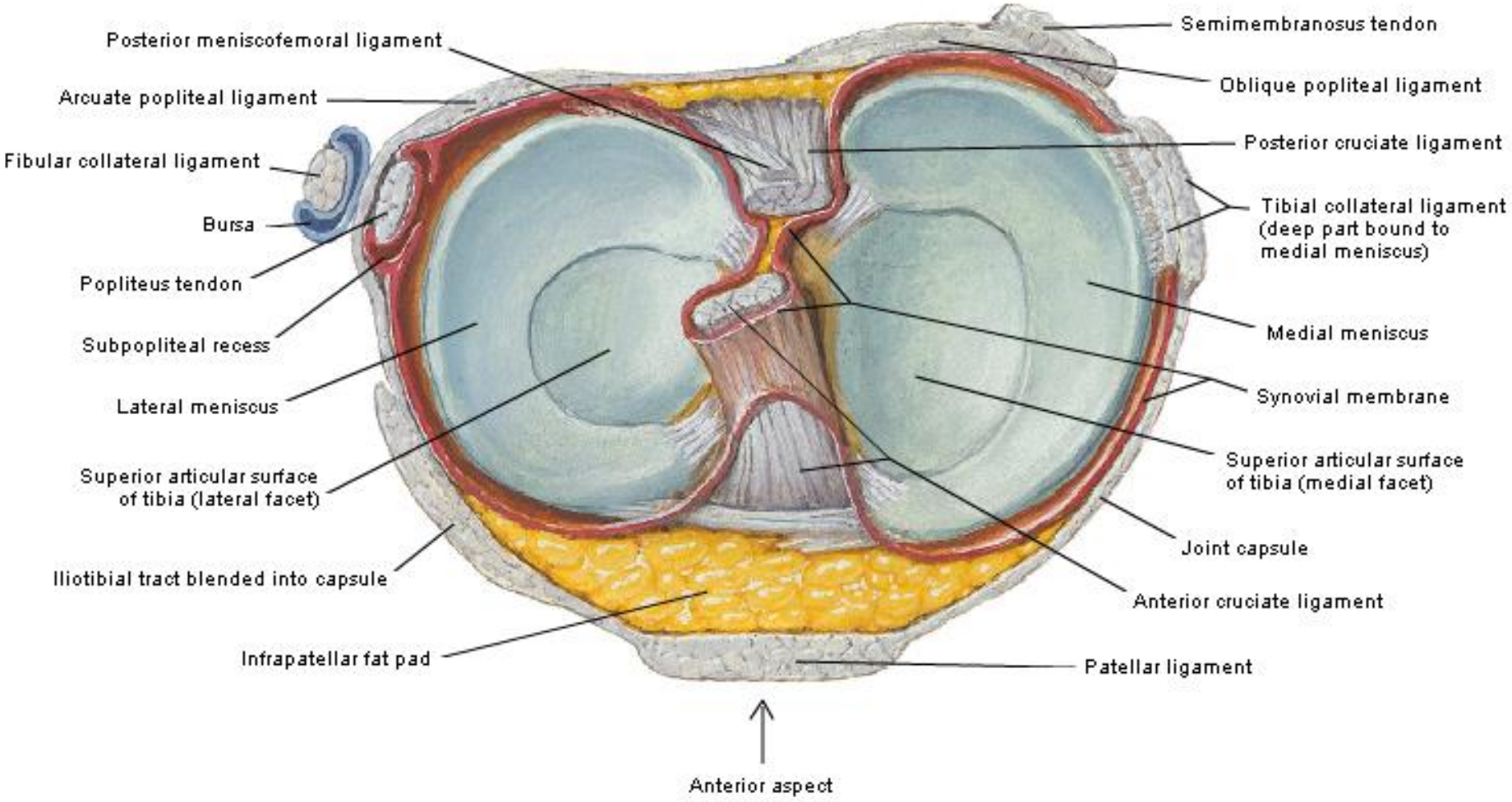
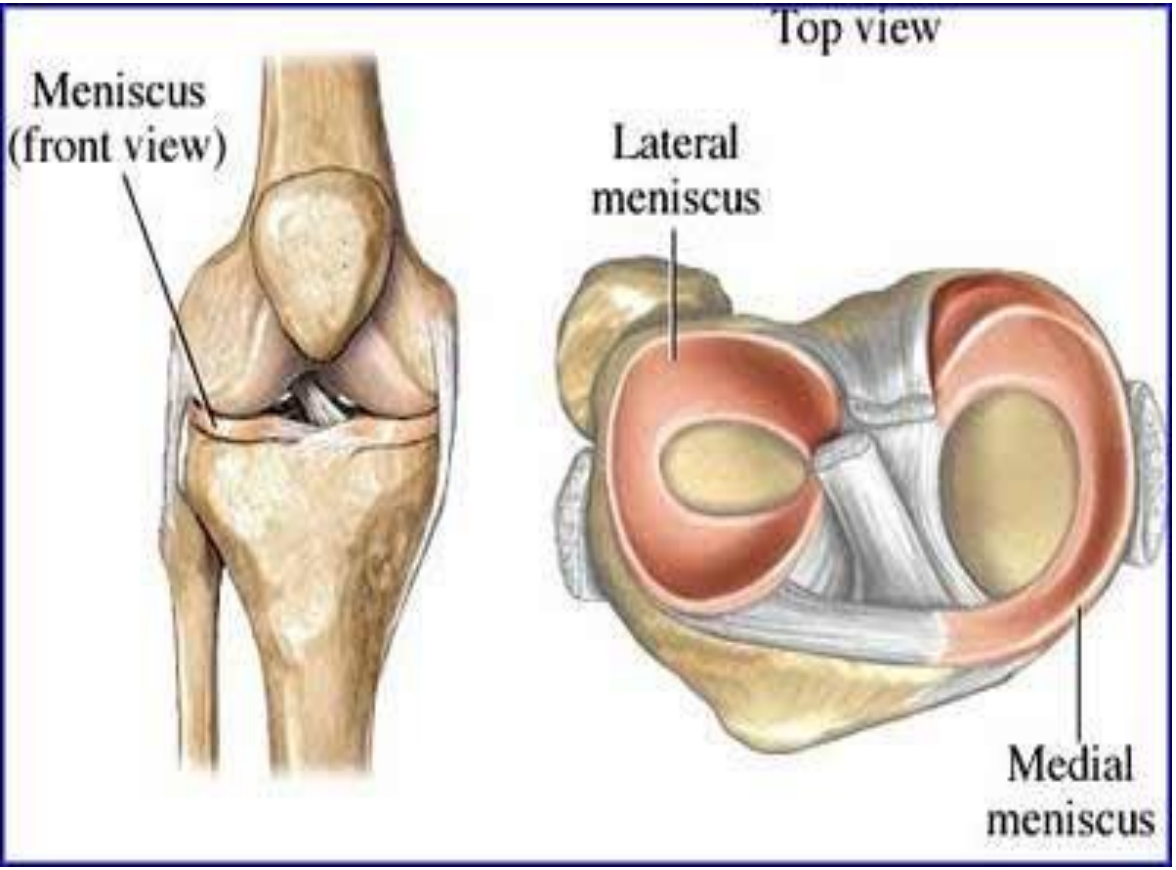
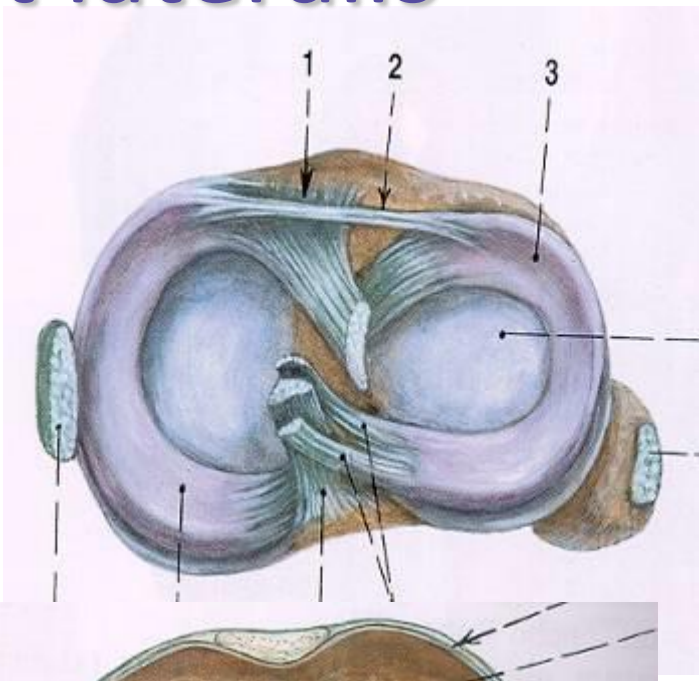

Posterior meniscofemoral ligament
Arcuate popliteal ligament
Fibular collateral ligament
Bursa
Popliteus tendon
Subpopliteal recess
Lateral meniscus
Superior articular surface of tibia (lateral facet)
Iliotibial tract blended into capsule
Infrapatellar fat pad
Semimembranosus tendon
Oblique popliteal ligament
Posterior cruciate ligament
Tibial collateral ligament (deep part bound to medial meniscus)
Medial meniscus
Synovial membrane
Superior articular surface of tibia (medial facet)
Joint capsule
Anterior cruciate ligament
Patellar ligament
Anterior aspect

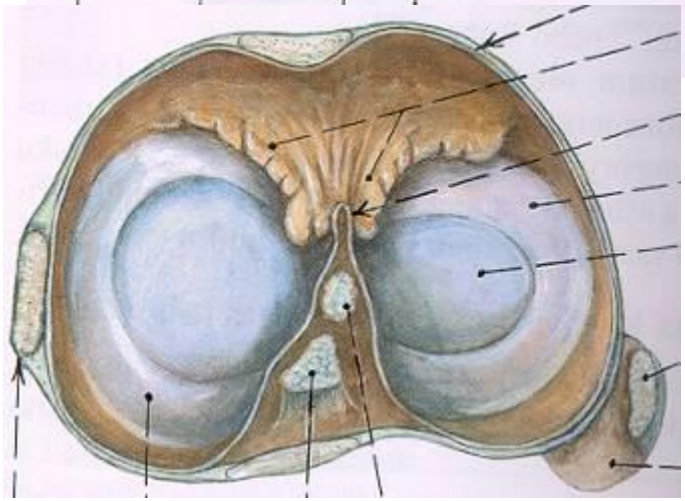
Intra-articular ligaments

- only true intrasynovial ligament is *lig. transversum genus*
- cruciate ligaments are covered ventrally (and positioned behind) synovial membrane = extrasynovial position
- *ligamentum cruciatum anterius*
  - from internal surface of *condylus lateralis femoris* into *area intercondylaris anterior*
  - LCA – stabilization of ventral movement of tibia, internal rotation of calf and hyperextension
- *ligamentum cruciatum posterius*
  - from external surface of *condylus medialis femoris* into *area intercondylaris posterior* (is shorter and thicker)
  - LCP – stabilization of dorsal movement of tibia
  - LCP crosses LCA dorsally
- together they are streched during flexion of the knee joint
- in case of internal rotation they wrap around each other = locked knee
- *ligamentum meniscofemorale posterius* (Weitbrechti) *et anterius* (Humphryi) – weak ligaments around LCP, can be absent

Meniscus medialis et lateralis







http://zdravi.volejbal-metodika.cz/img/fotos/9a78546b43f0676e5a4c4c8d1141848e.jpg

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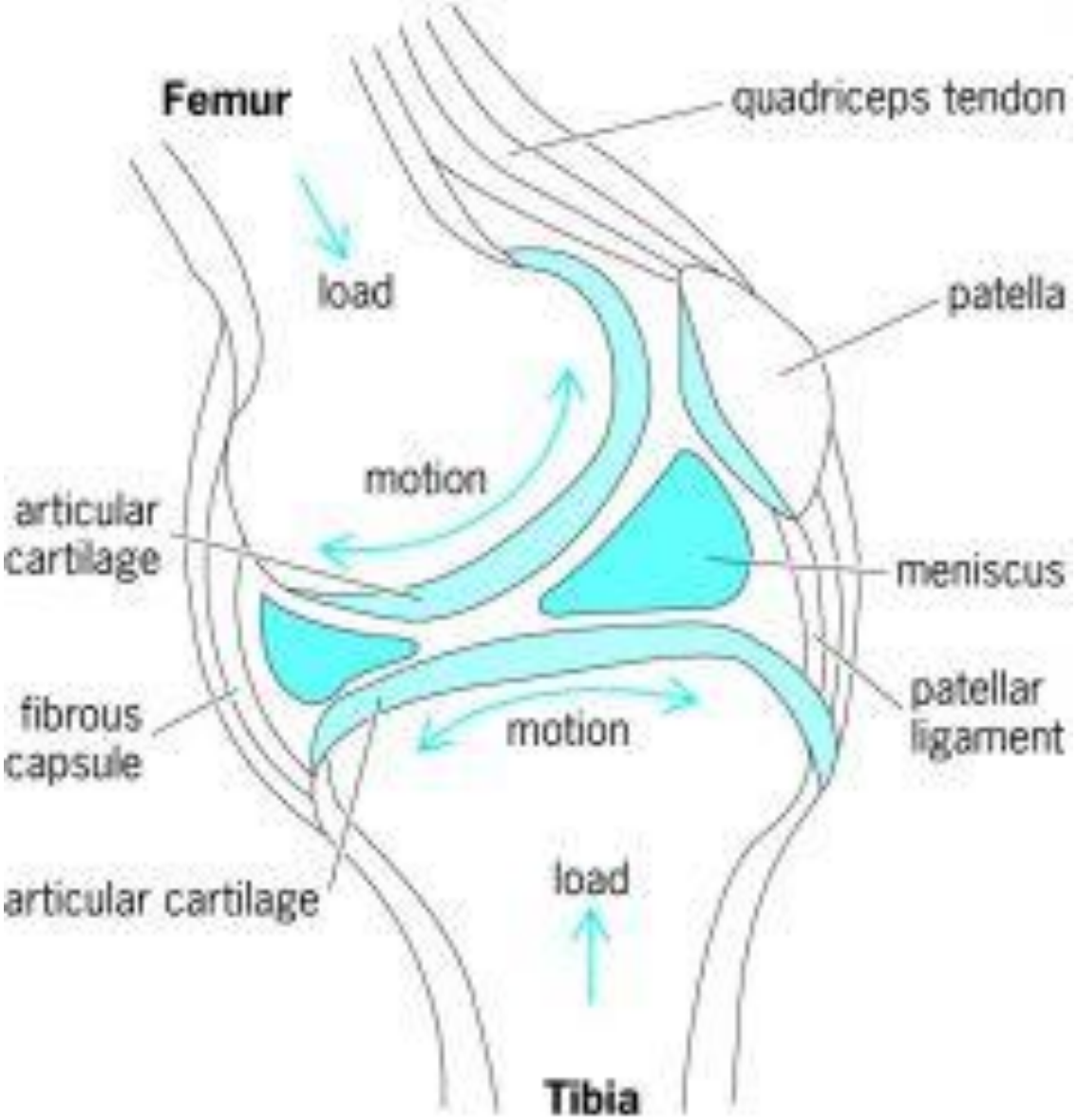
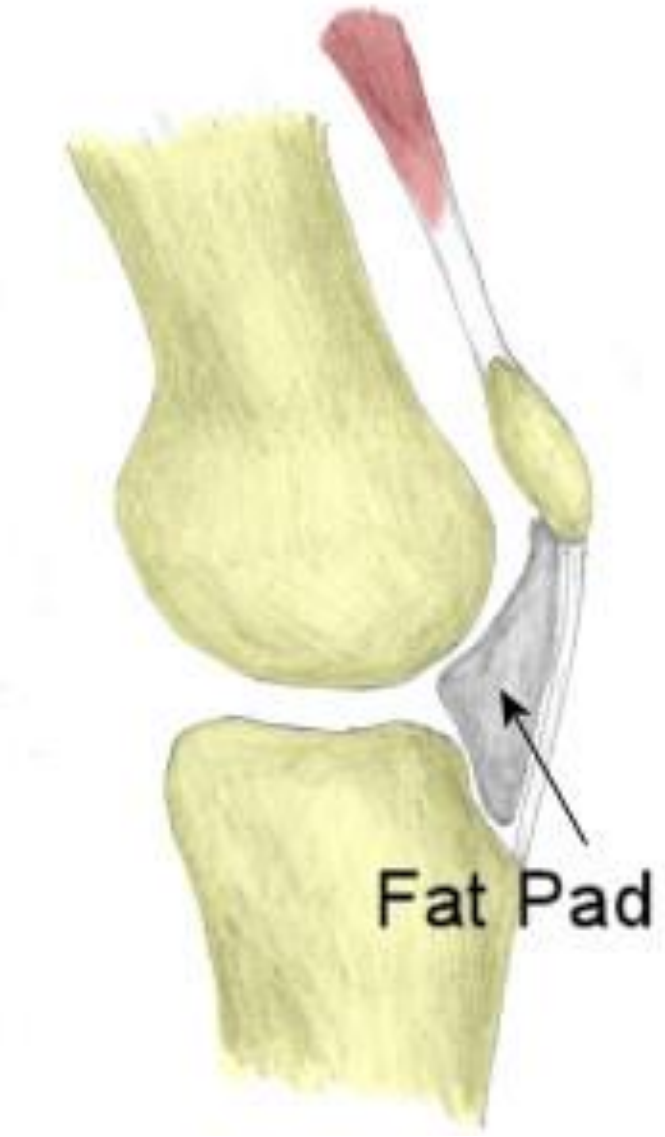
Meniscus medialis et lateralis

- structures having semilunar shape inserted between articular surfaces
- equalize incongruences of articular surfaces, participates in joint movement, function as hit absorbers
- ends are fixed in *area intercondylaris anterior et posterior*
- external margins are connected to articular capsule
- *meniscus lateralis* is fixed to *m. popliteus* and it is more mobile, its anterior and posterior ends are almost in touch (shape O)
- *meniscus meidalis* is connected (partially) to *lig. collaterale tibiale* (shape C)
- in crossection they have a cuneiform shape
- blood vessels supply only ¼ to 1/3 of external perimeter

<u>ENFORCING APPARATUS</u>

- dynamic stabilizers = circumarticular muscles
- static stabilizers = ligaments of articular capsule and intra-articular ligaments, *tractus iliotibialis*
- LCM – stabilizer of leg abduction and external rotation
- LCL – stabilizer of leg adduction



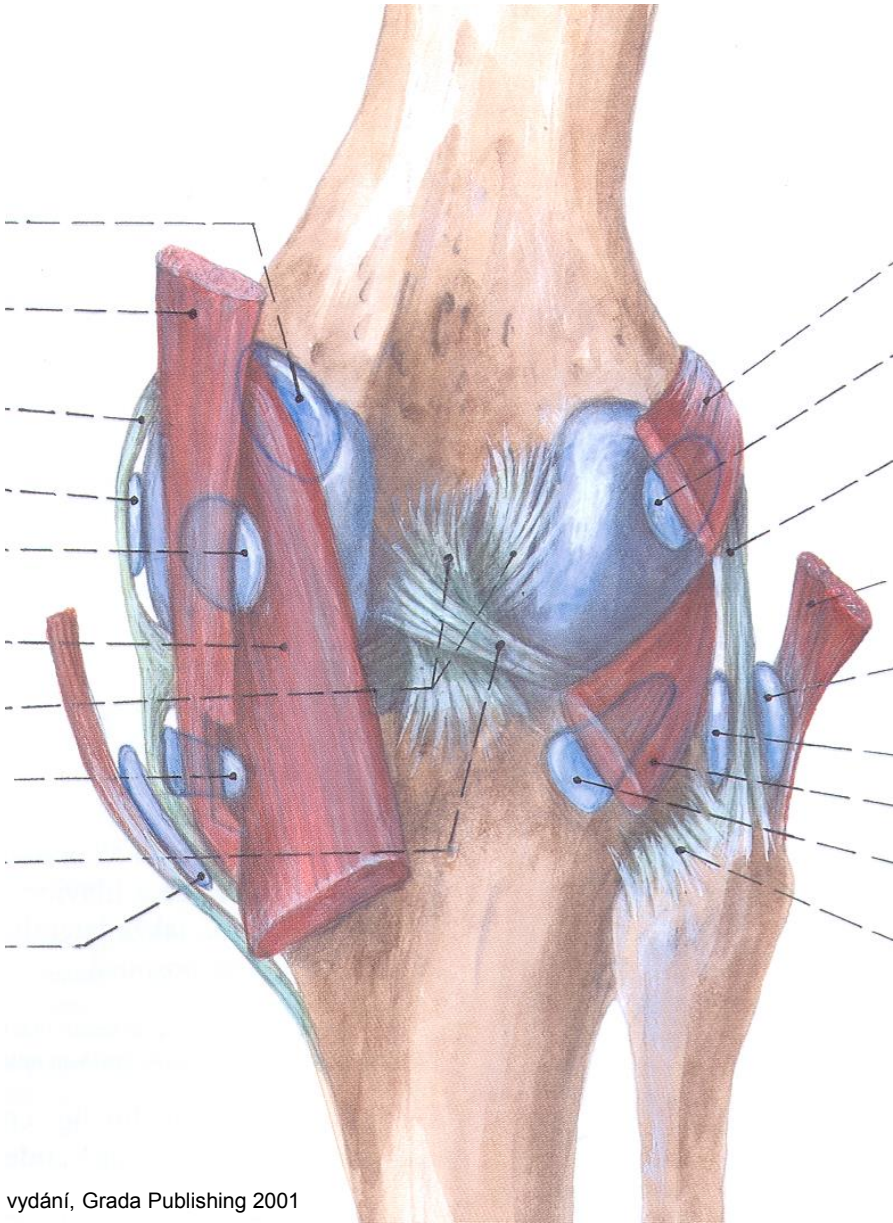


http://img.tfd.com/mgh/ceb/thumb/Cross-section-of-the-human-knee-showing-its-major-components.jpg

http://hcchang.files.wordpress.com/2011/03/knee-fat-pad.jpg

Synovial bursae (*bursae synoviales*)

- **b. suprapatellaris**
- b. subcutanea + subfascialis + subtendinea prepatellaris
- b. subcutenae infrapatellaris + infrapatellaris profunda
- b. subcutanea tuberositatis tibiae
- bb. subtendineae musculi sartorii
- b. subtendinea musculi bicipitis femoris inferior
- b. subtendinea musculi gastrocnemii lateralis
- b. subtendinea musculi gastrocnemii medialis
- b. musculi semimembranosi
- b. anserina
- **b. gastrocnemiosemimembranosa – pathologically as Baker‘s cyst**



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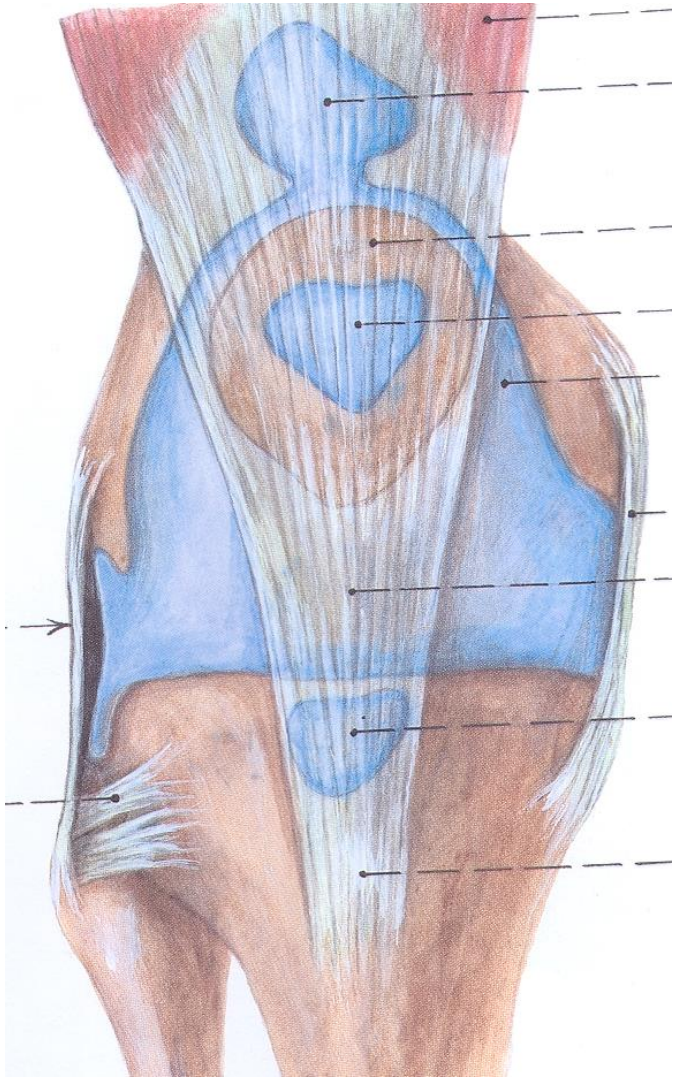
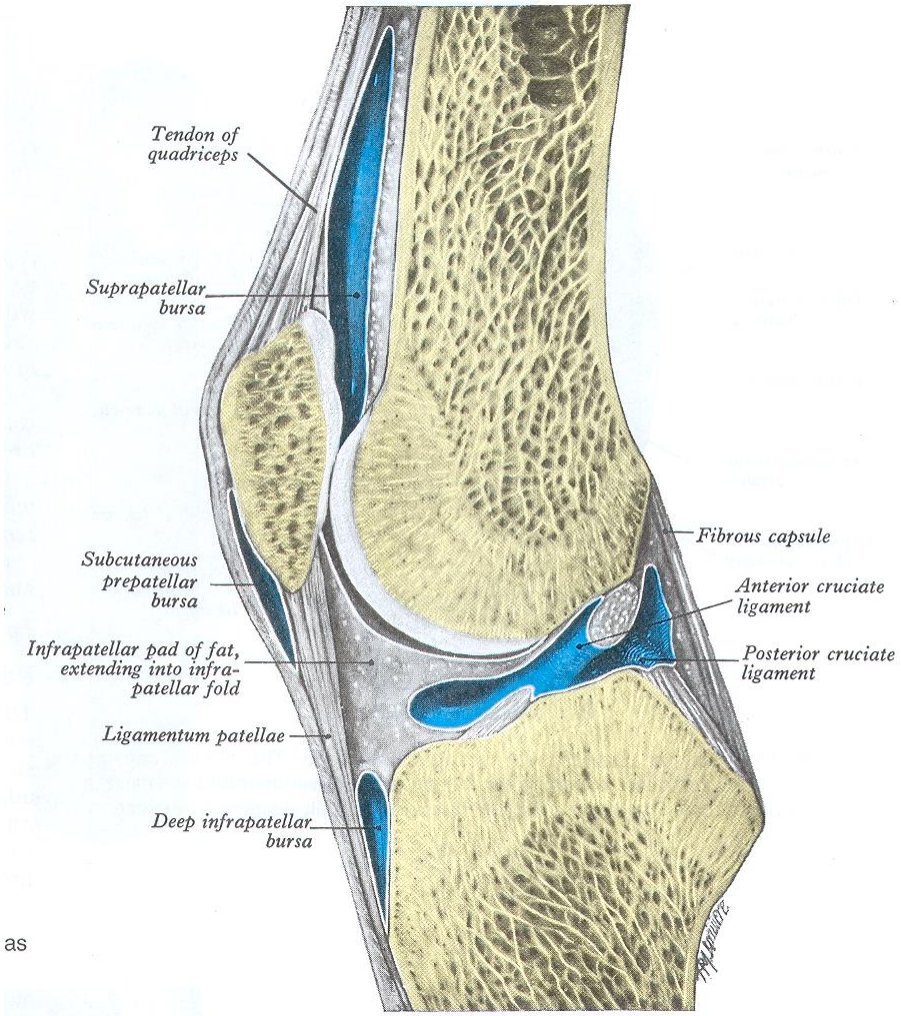
Synovial bursae (*bursae synoviales*)





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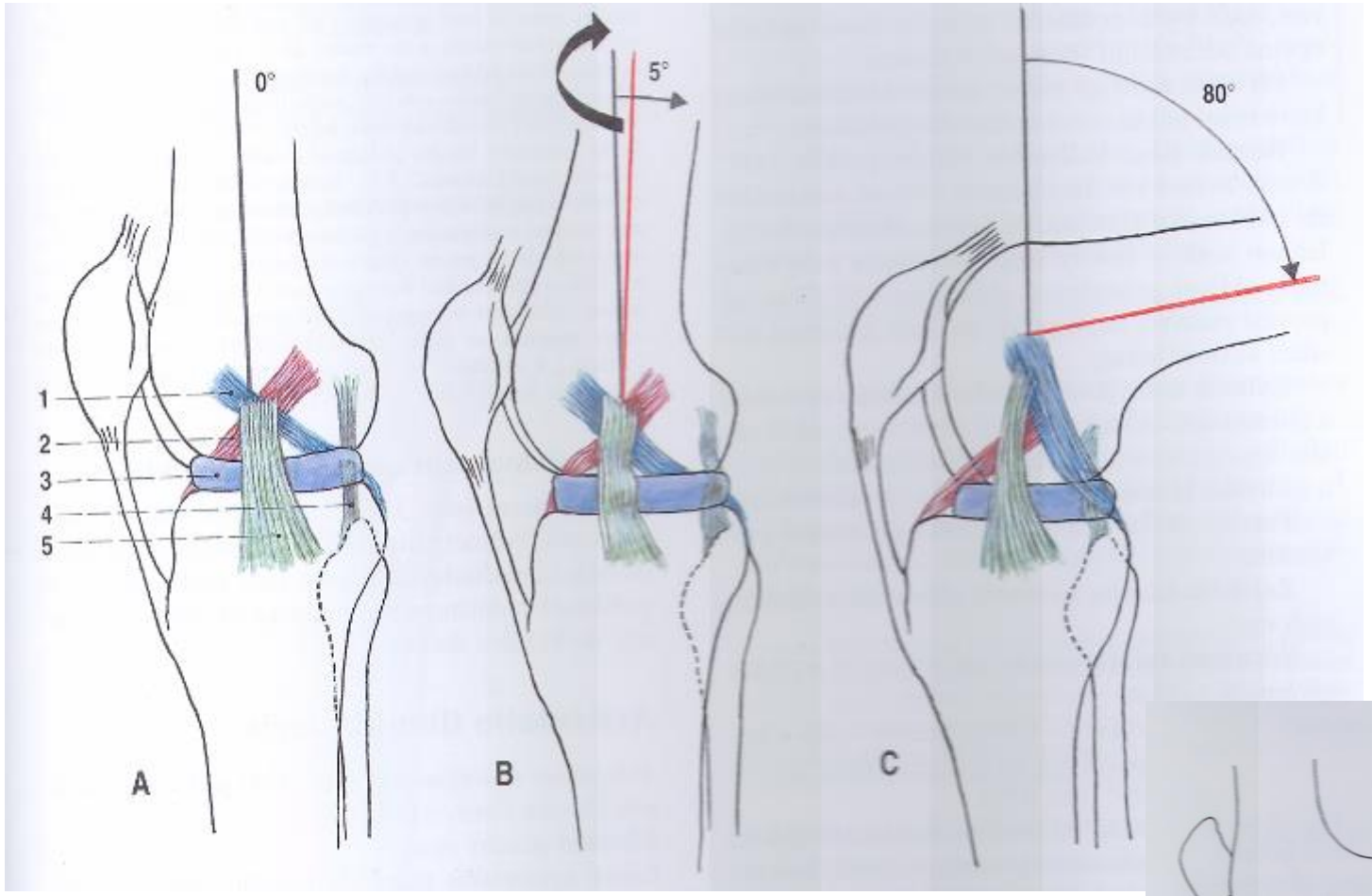
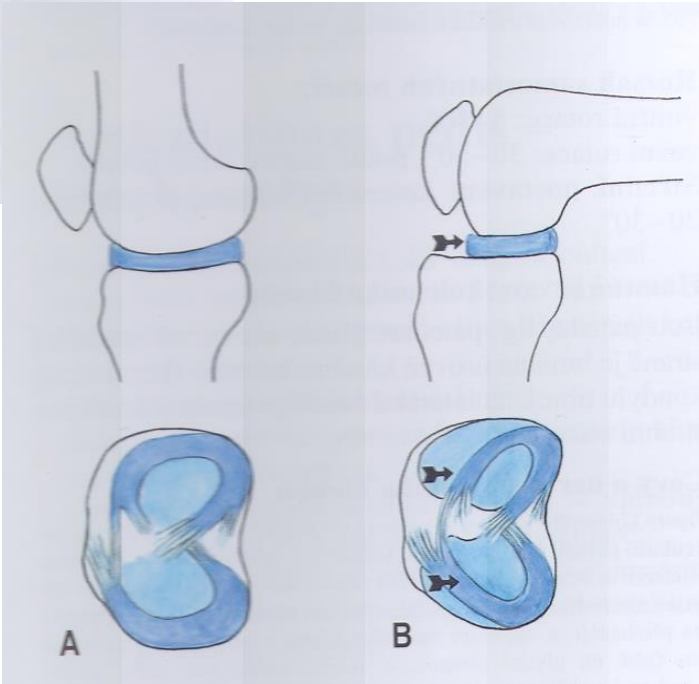
Movements in knee joint

- locked knee

1. unlocking of knee – initial rotation in first 5° of flexion
2. rolling movement
3. sliding movement

- at the end of flexion menisci change their shape





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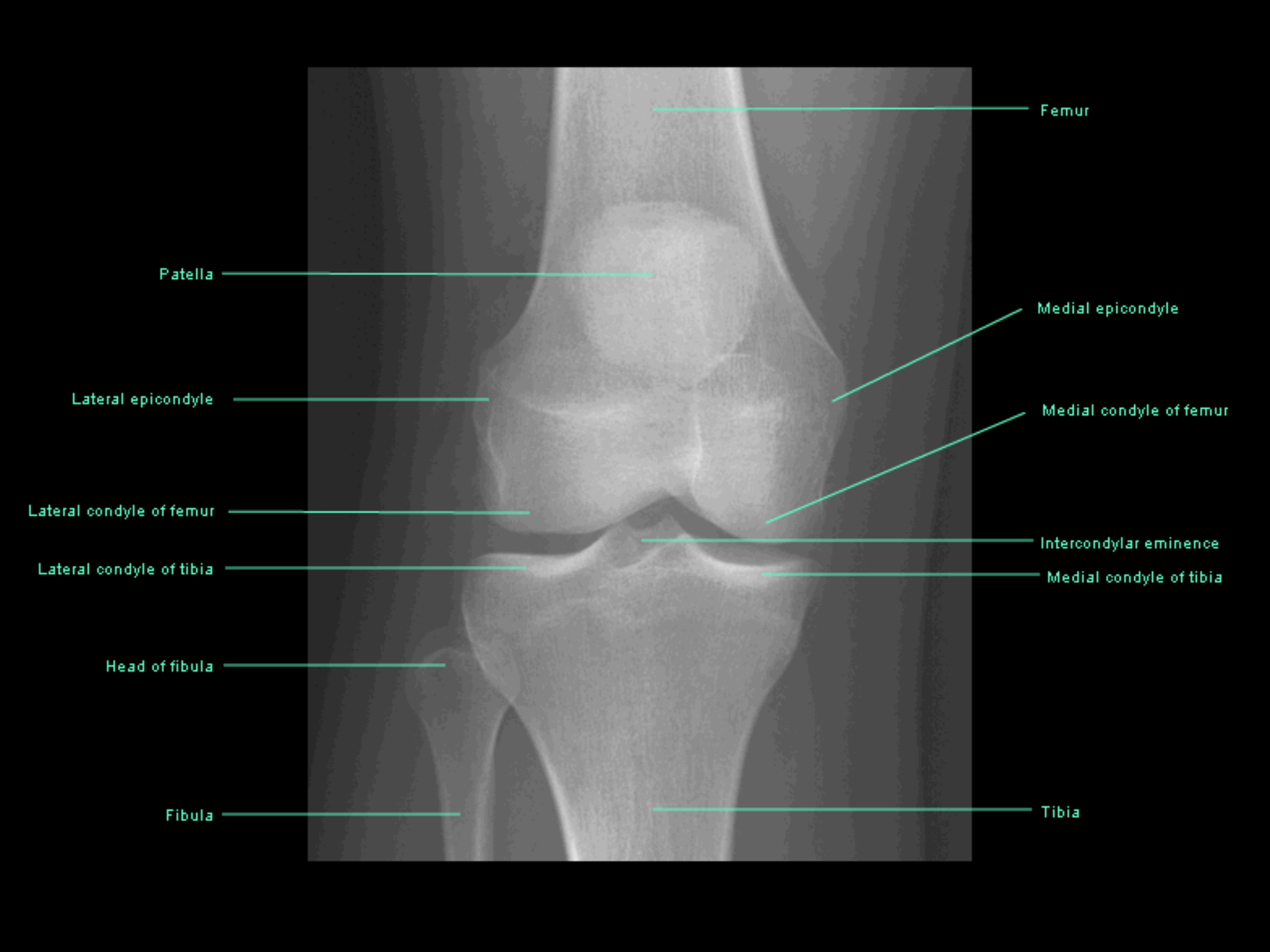
Anteroposterior and lateral X-ray of the knee joint


Femur
Patella
Medial epicondyle
Lateral epicondyle
Medial condyle of femur
Lateral condyle of femur
Intercondylar eminence
Lateral condyle of tibia
Medial condyle of tibia
Head of fibula
Fibula
Tibia

Clinical notes

- **Articular capsule**
  - *recessus suprapatellaris* – proximal extension of articular capsule, often communicates with *bursa suprapatellaris* – spot of knee joint puncture
  - presence of fluid in articular cavity
    - clear fluid – inflammation, overload
    - blood (= haemarthros) – e.g. ligament rupture, capsule rupture
    - blood with fatty eyes – intra-articular fracture
- **Synovial bursae**
  - around joint up to 20 bursae synoviales, clinically important are:
  - *bursa prepatellaris (subcutanea), b. ligamenti collateralis medialis, b. musculi gastrocnemii medialis, b. m. semimembranosi lateralis* – last two named are almost always merged into *b. gastrocnemiosemimembranosa*
  - Baker‘s cyst – in case of intra-articular pressure increase (in case of arthrosis) a communication between articular cavity and *bursa gastrocnemiosemimembranosa* can fill the latter with synovial fluid – and a cyst appears (palpable in popliteal fossa)

Injuries of soft knee*

- 70% of injuries happen during sport
- LCA is 10x more often injured compared to LCP
- rupture of LCA – violent abduction and external rotation of leg (kiing, soccer)
- LCP – dash-board injury, stepping with heel into a pit
- haemarthros – filling of articular cavity with blood
- LCM is 15x more often injured compared to LCL
- injury of LCM – direct violence on extended knee from external side (fight sports)
- medial meniscus is 8x more often injured compared to the lateral (top sportsmen)
- „unhappy triad“ – combined injury of medial meniscus, LCA and LCM – after jump on extended lower limbs
- dislocation of knee is a rare and difficult injury
- genu valgum/varum

Examination of knee joint*

- mobility of joint
- lateral stability – collateral ligaments
  - abduction and adduction test
- anteroposterior stability – cruciate ligaments
  - anterior and posterior drawer test, Lachman‘s test and pivot shift test
- menisci
  - Steinman‘s test I and II, Payer‘s test and Apley‘s test
- puncture
- arthroscopy

Examination of knee joint*

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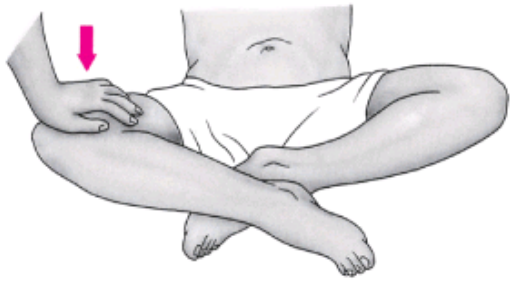
- anterior drawer test ↑
- Payer‘s test →
- Lachman‘s test →



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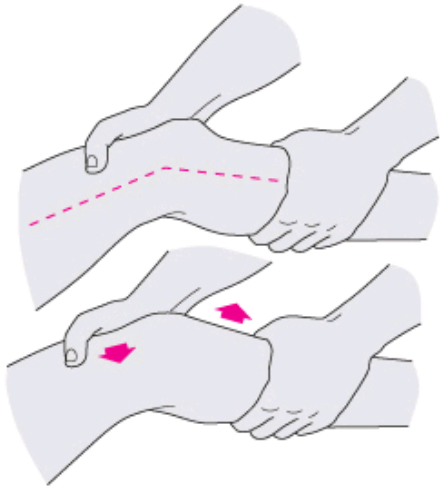

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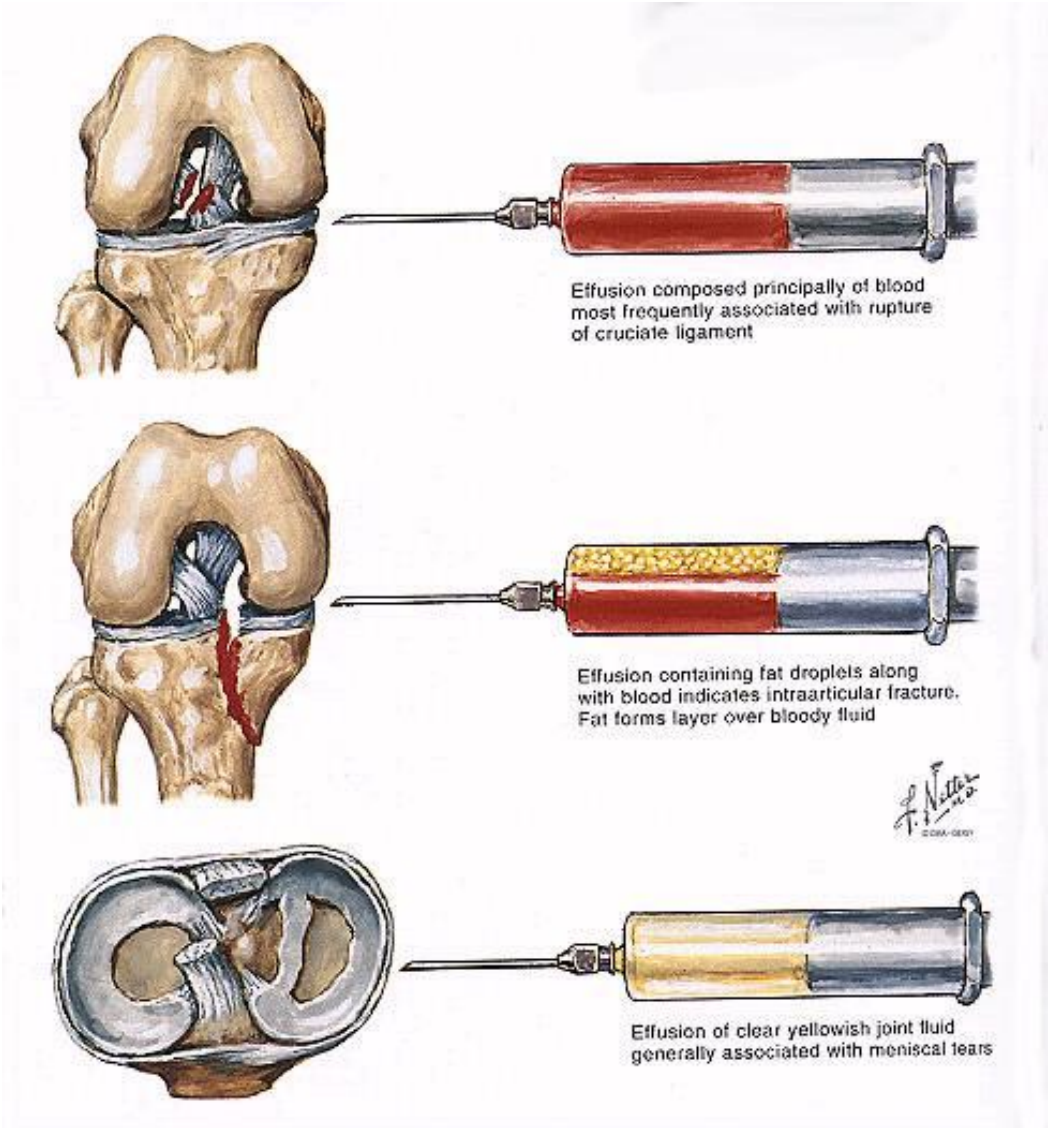
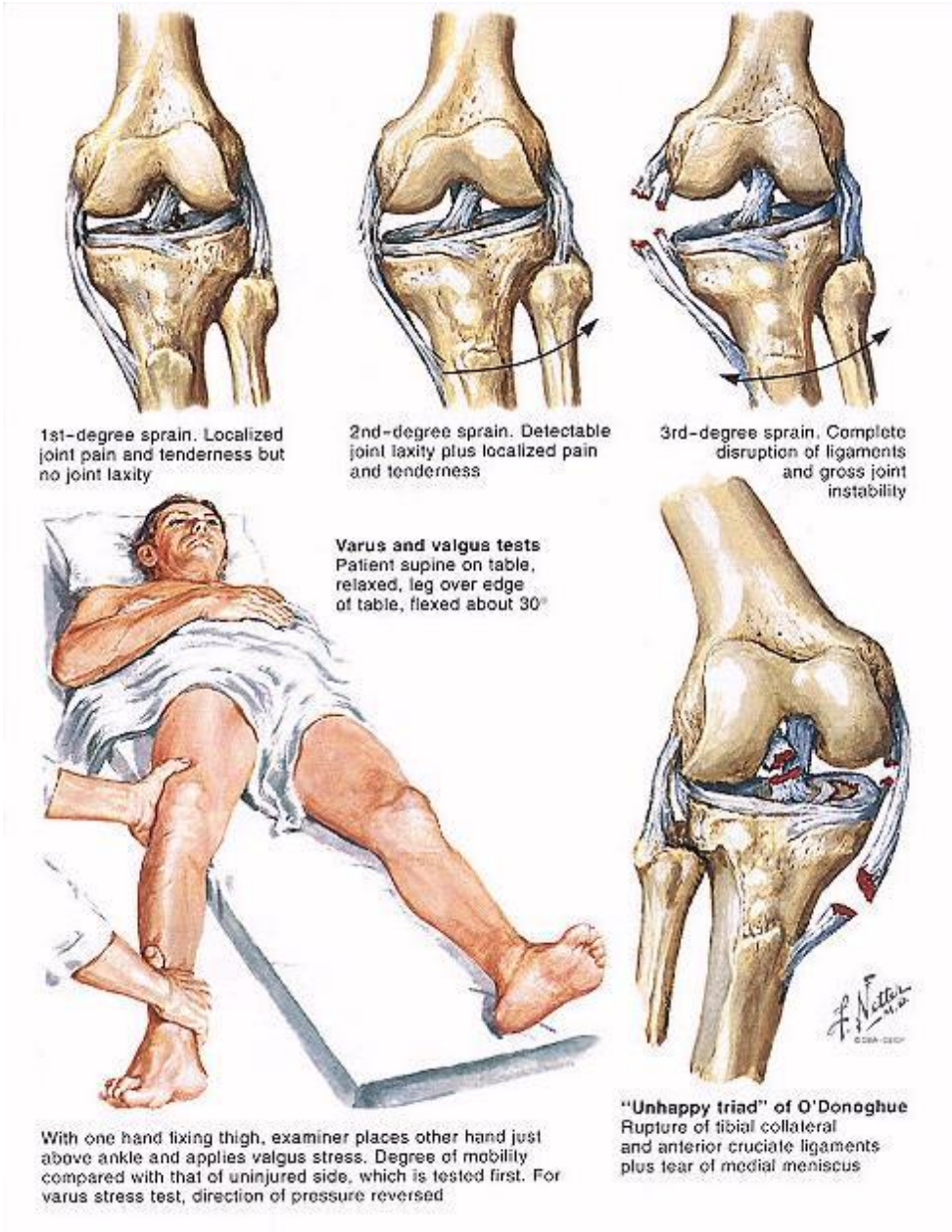
Puncture of knee joint



Netter, Atlas of Clinical Anatomy

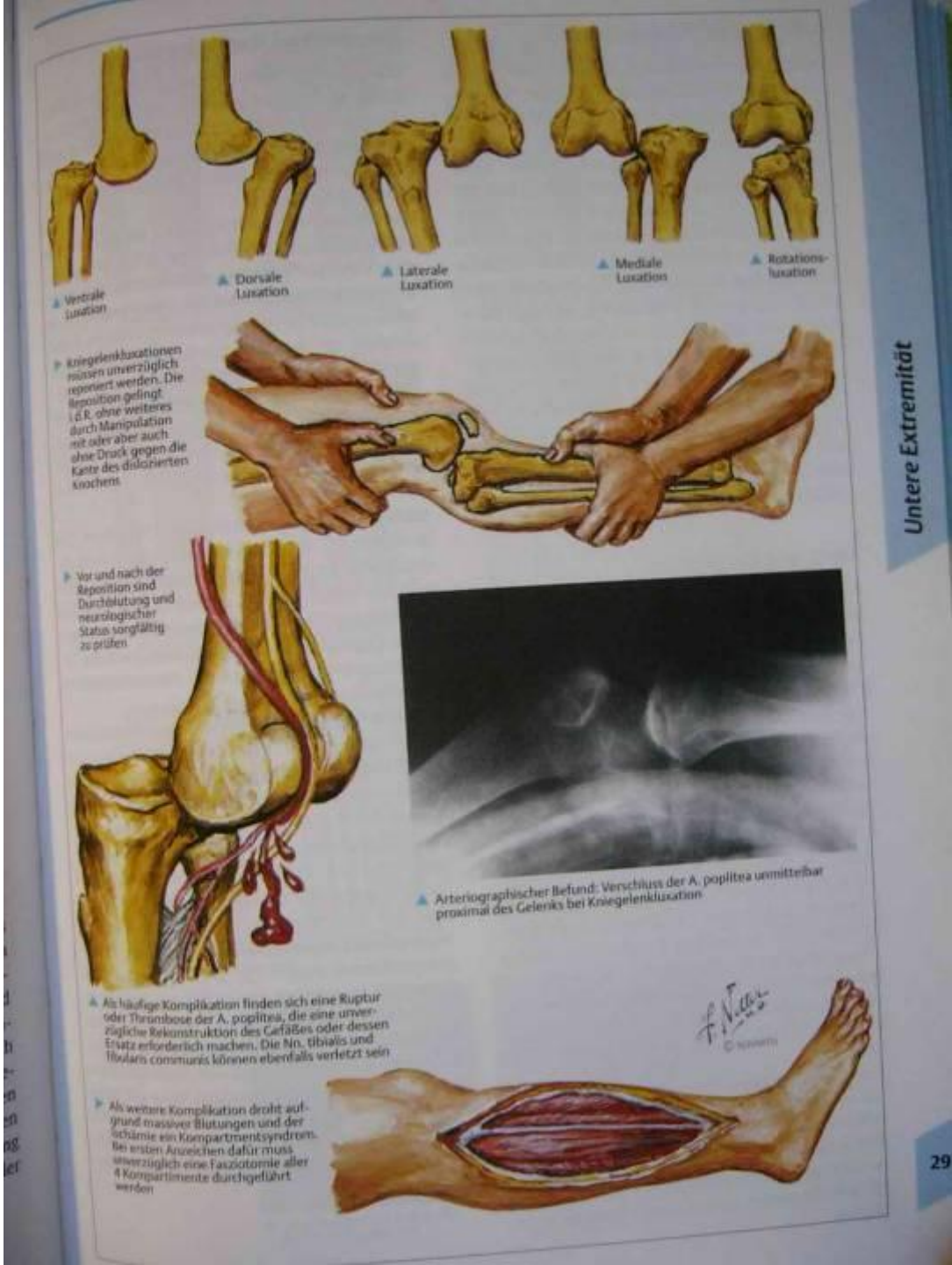
Injury of ligamentum collaterale tibiale

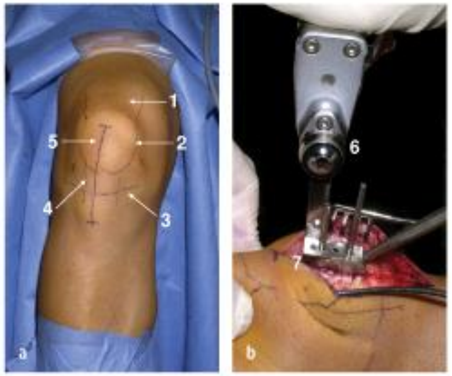
(clinically „lig- collaterale mediale = LCM“)

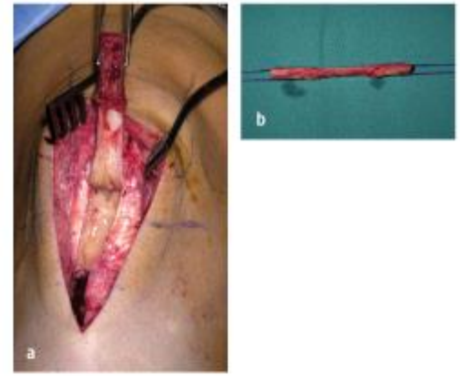


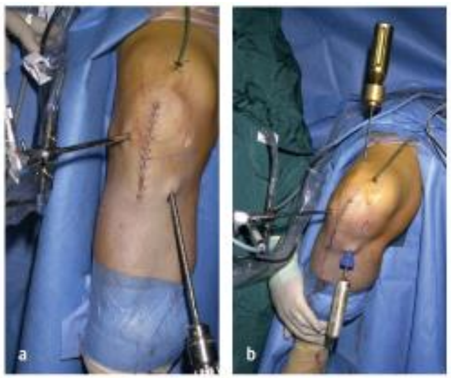
Netter, Atlas of Clinical Anatomy

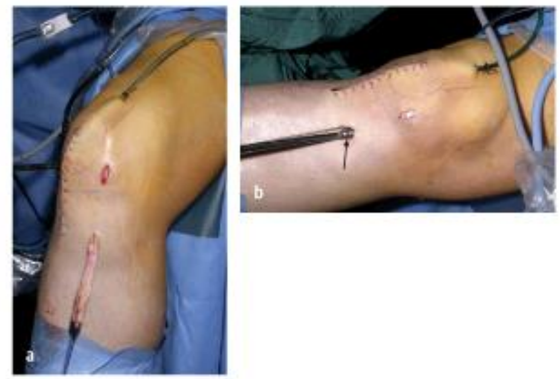
Luxation of knee

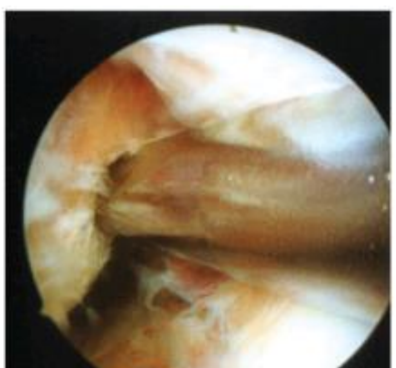








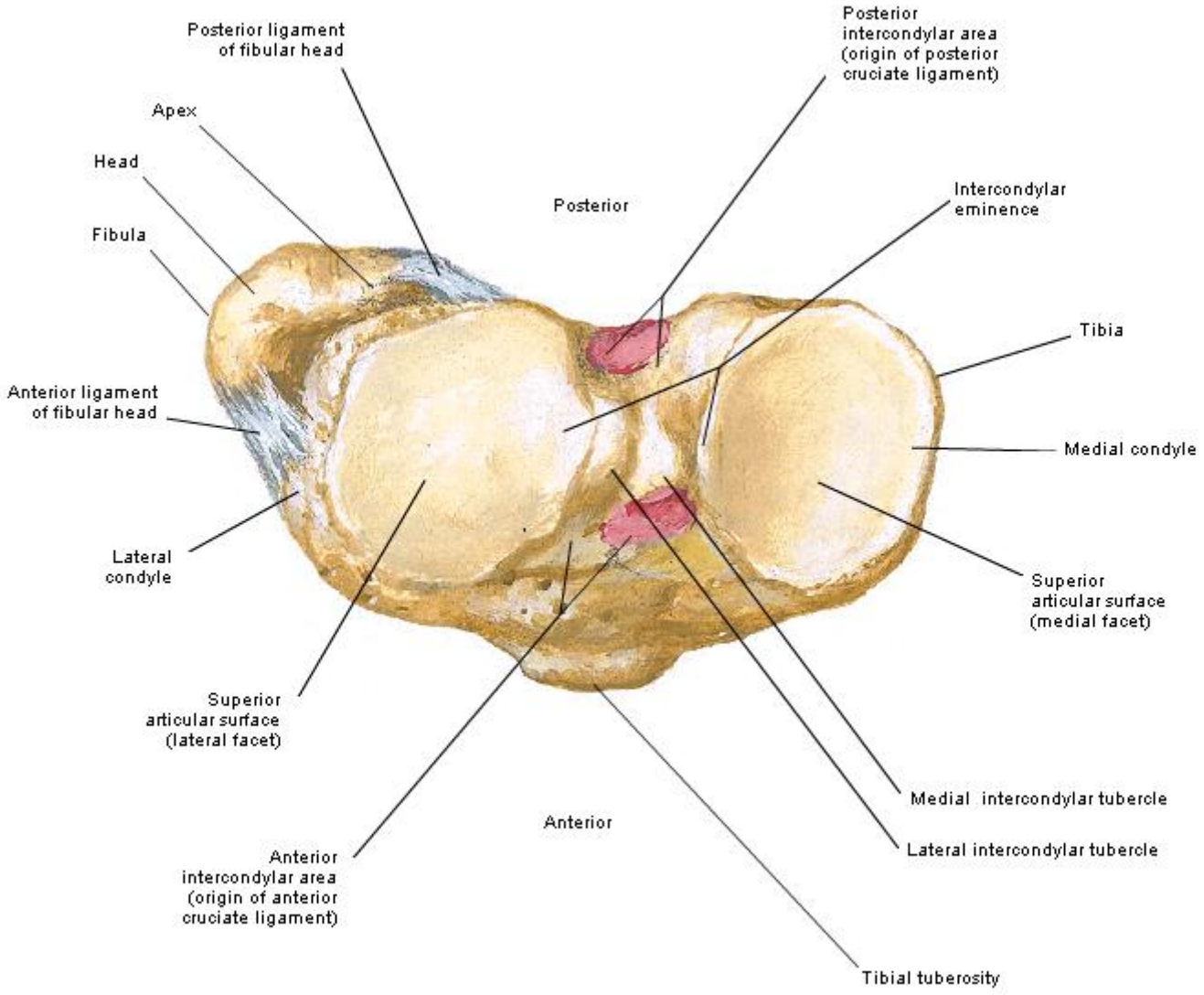




Tibiofibular joint (*Articulatio tibiofibularis*)

Type	simple, 3-axial, plane, stiff(amphiarthrosis)
Fossa	facies articularis capitis fibulae
Cavity	facies articularis fibularis tibiae
Articular capsule and its ligaments	lig. capitis fibulae anterius et posterius
Movements	small sliding movements in all directions
Neutral position	= basic position
Note	-

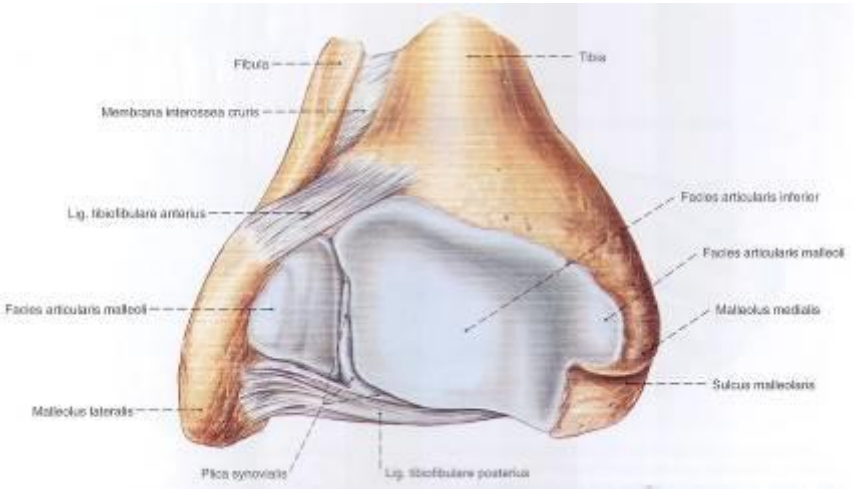
Tibiofibular joint (*Articulatio tibiofibularis*)

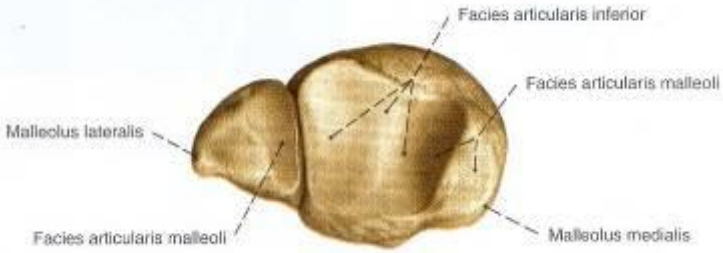


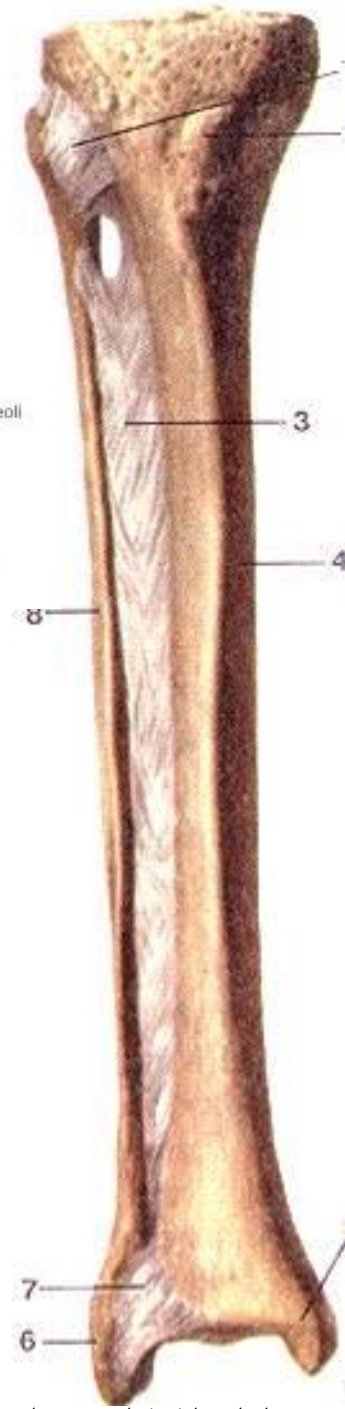
Syndesmosis tibiofibularis

- **membrana interossea cruris**
  - coursing from tibia laterodistally to fibula
  - margo interosseus tibiae et fibulae
  - proximally hiatus for vasa tibialia anteriora
  - distally hiatus for *ramus perforans arteriae fibularis*
- in **distal** part **enforced by ligaments**
  - lig. tibiofibulare anterius et posterius
  - fibula fits by an innominate tuberosity into incisura fibularis tibiae
  - distal part is clinically termed „syndesmosis“
- in case of injury it is more likely to happen the fracture of malleolus compared to syndesmosis rupture

Syndesmosis tibiofibularis

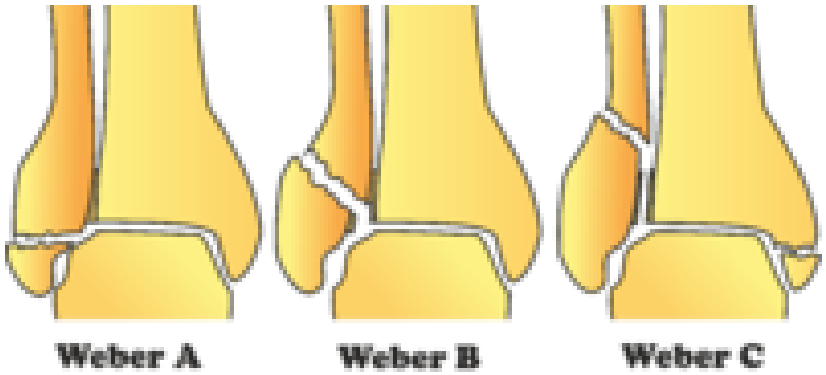






Classification of ankle fractures according to Weber (according to syndesmosis position)

below – W A, at the level W B, above W C



http://www.wikiskripta.eu/images/thumb/f/f5/WeberABC.png/200px-WeberABC.png

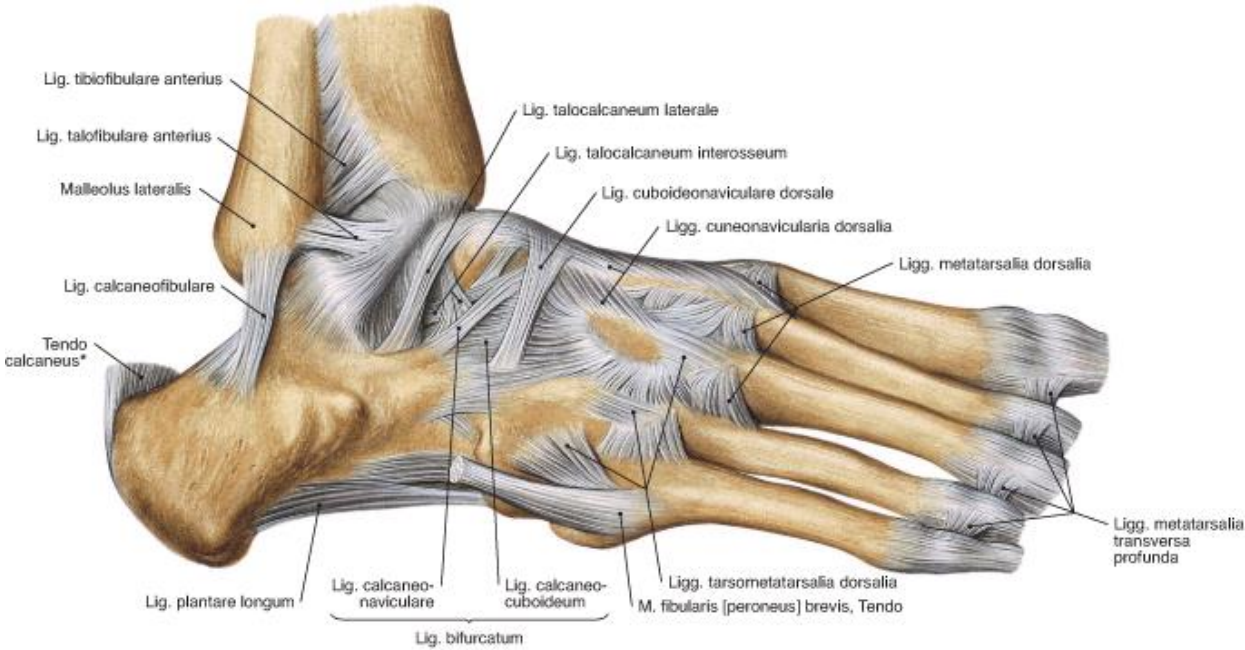
http://medgeo.net/wp-content/uploads/2009/11/94.jpg

Weber C

Ankle joint (*Articulatio talocruralis*)

Type	compound, trochlear,1-axial, mobile
Head	trochlea tali: facies superior, facies malleolaris medialis et lateralis
Fossa	facies articularis inferior tibiae, facies articularis malleoli medialis tibiae et lateralis fibulae
Articular capsule and its ligaments	articular capsule: proximally recessus tibiofibularis lig. collaterale mediale (lig. deltoideum): 4 parts (pars tibiotalaris anterior, tibionavicularis, tibiocalcanearis, tibiotalaris posterior) lig. collaterale laterale: 3 separate ligaments (lig. talofibulare ant., calcaneofibulare, talofibulare post.)
Movements	plantar-dorsal flexion (30°-50°) traction of lig. talofibulare anterius → narrowing of tibiofibular cleft traction of lig. tibiofibulare posterius + ventrally wider talus → widening of tibiofibular traction
Neutral position	= basic position
Note	in dorsal flexion wider ventral part of trochlea tali slightly opens the fork of leg bones

Ligaments



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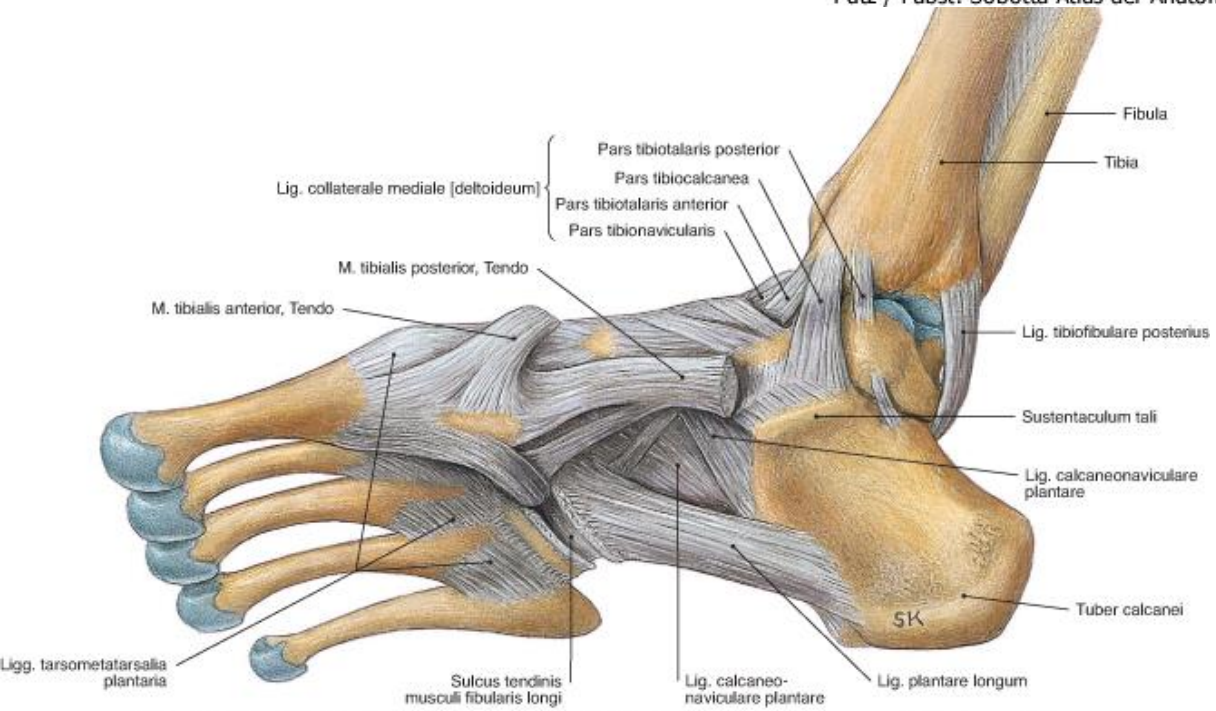

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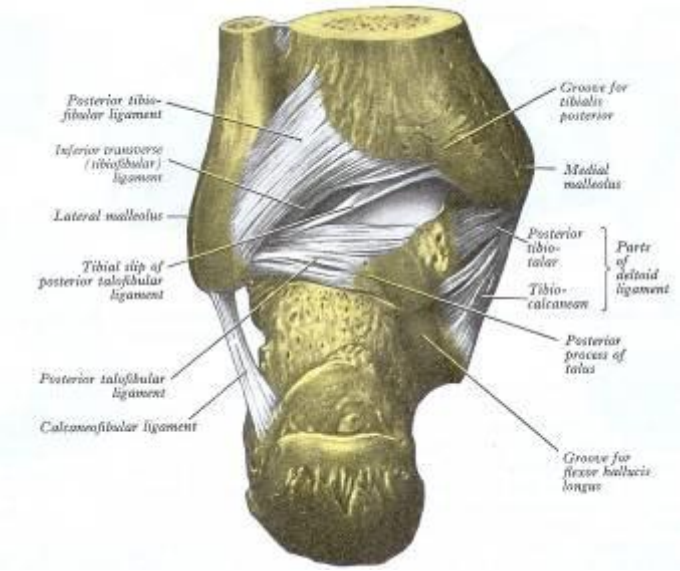
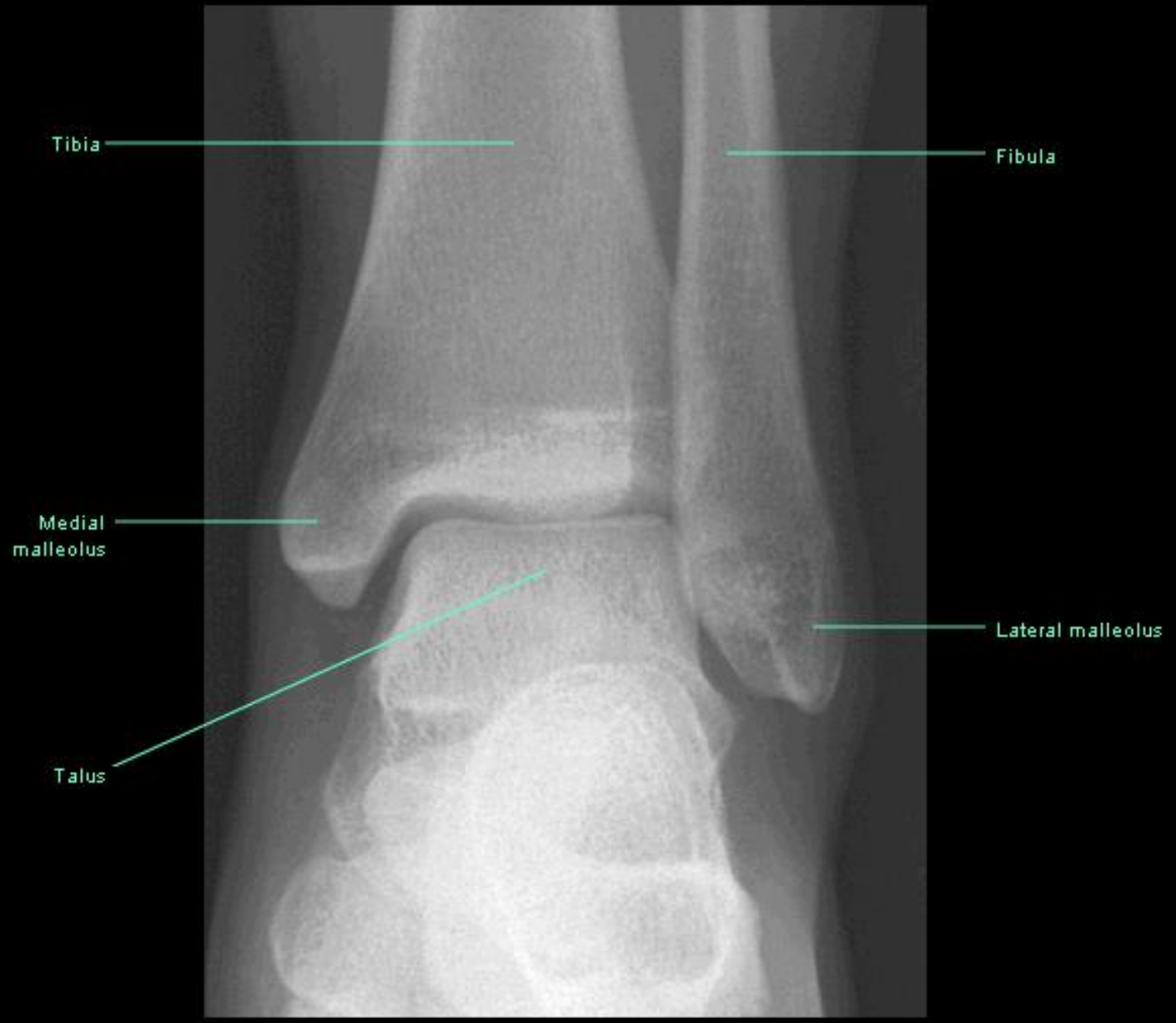


Gray´s anatomy, 37th edition, Churchill Livingstone 1989

Anteroposterior and lateral X-ray of ankle joint



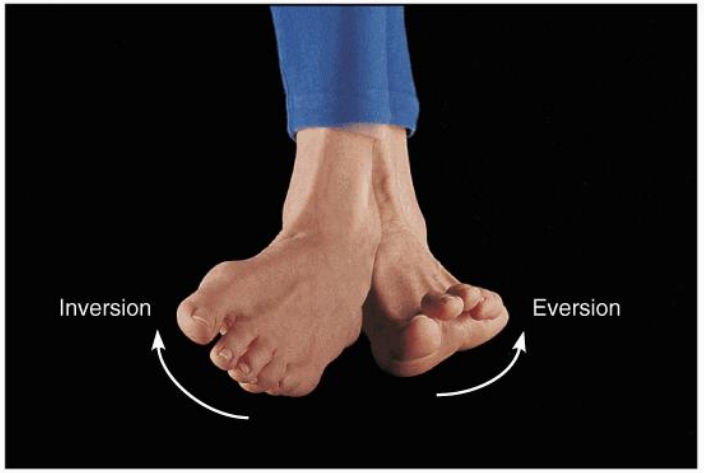
Clinical notes

- compound joint, very complex biomechanics of movement
- every movement in ankle joint is followed by rotation of fibula
- plantar flexion – extended *lig. talofibulare anterius* pushes fibula forward and into internal rotation – narrowing of tibiofibular fork
- dorsal flexion – traction of *lig. tibiofibulare posterius* moves fibula proximally and into external rotation – into widened fork fits the anterior widened part of trochlea tali
- injury of ligaments is most common in sport injury (tennis, volley-ball, soccer)
- *lig. collaterale mediale* is stronger
- supination injury is more common (distension of *lig. collaterale laterale*)

Movements of the foot as a whole

Individual movements:

- plantar – dorsal flexion (= extension)
- abduction – adduction
- pronation – supination



(b) Inversion and eversion

Combined movements:

- **inversion:** plantar flexion + adduction + supination
- **eversion:** dorsal flexion + abduction + pronation

Subtalar (talocalcaneal) joint (*Articulatio subtalaris* seu *talocalcanea*)

Type	simple, 1-axial, cylindric (hinge), mobile
Head	facies articularis talaris posterior calcanei
Fossa	facies articularis calcanea posterior tali
Articular capsule and its ligaments	lig. talocalcaneum posterius, mediale, laterale et interosseum (the last one located inside sinus tarsi)
Movements	inversion-eversion (combined movements)
Neutral position	= basic position
Note	movements common for the whole foot


Ligg. tarsometatarsalia dorsalia
Ossa metatarsi IV; V
Ossa metatarsi I; II
Tuberositas ossis metatarsalis quinti [V]
Ligg. intercuneiformia dorsalia
Lig. cuneocuboideum dorsale
Ligg. cuneonavicularia dorsalia
Os cuboideum
Lig. calcaneonaviculare
Lig. calcaneocuboideum
Lig. bifurcatum
Os naviculare
M. fibularis [peroneus] brevis, Tendo
Lig. calcaneonaviculare plantare
Facies articularis talaris anterior
Facies articularis talaris media
Lig. talocalcaneum interosseum
Facies articularis talaris posterior
Calcaneus
Tuber calcanei

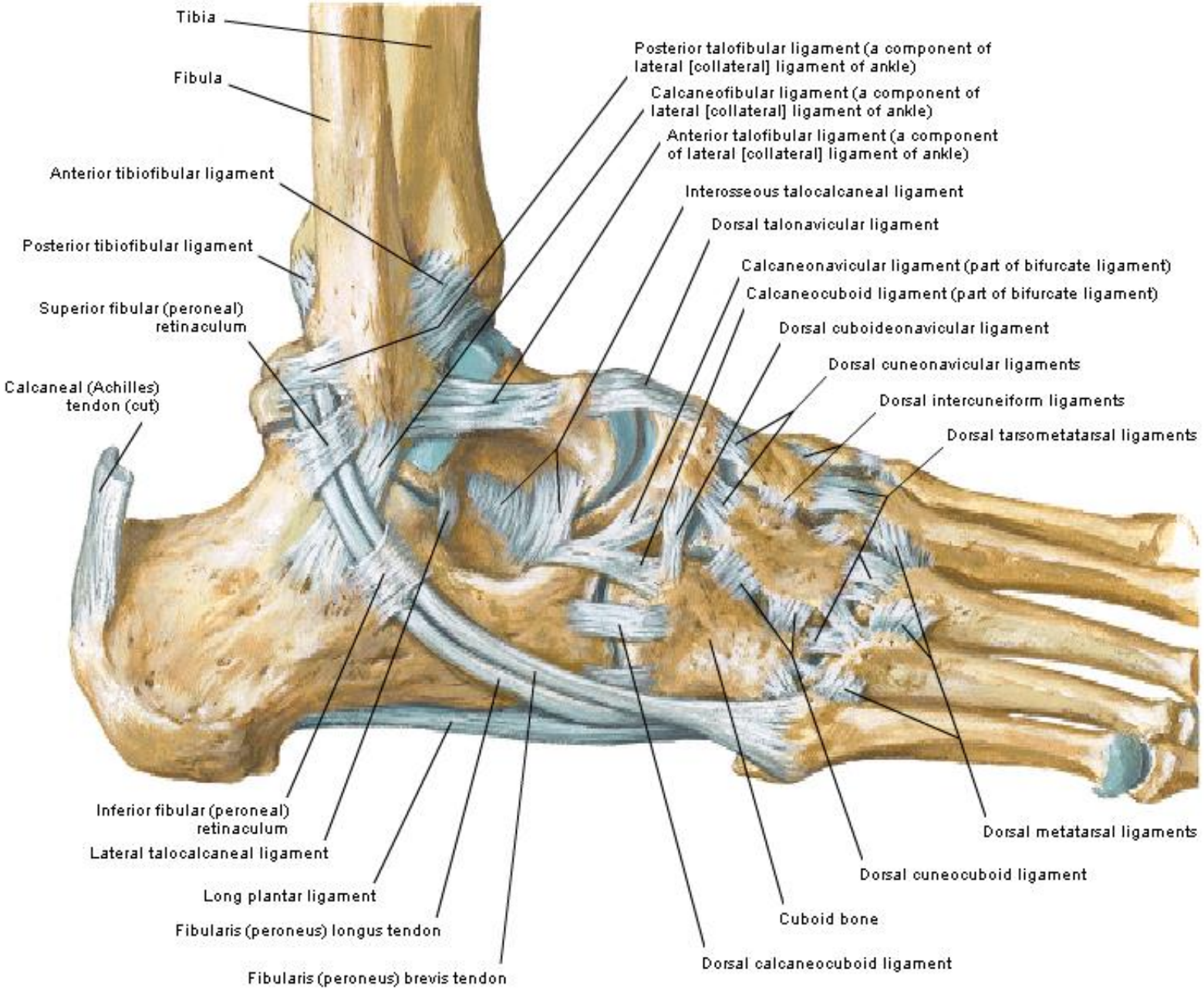
Articulatio talocalcaneonavicularis

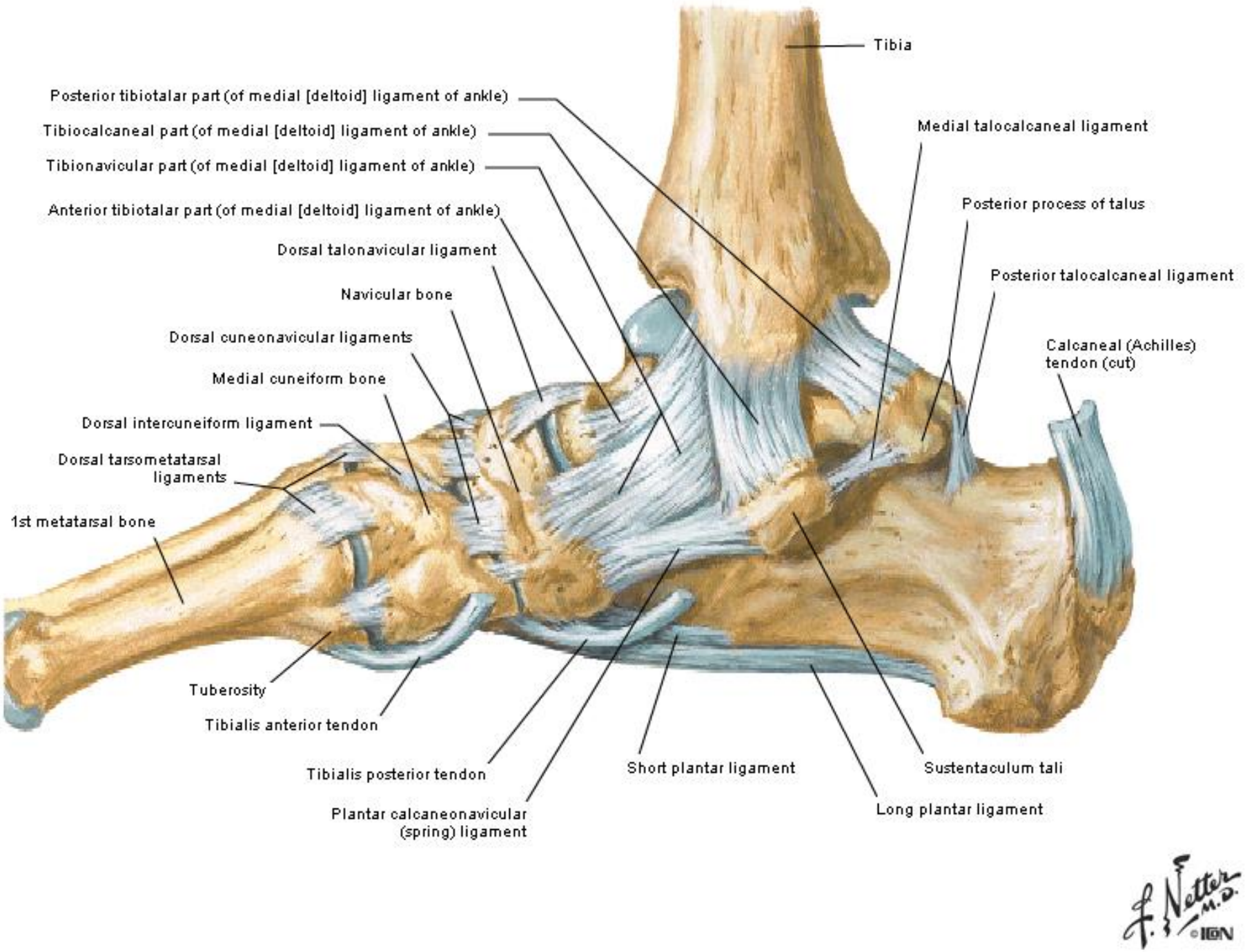
(part of *articulatio tarsi transversa*)

Type	compound, 3-axial, ball-and-socket, mobile
Head	a) caput tali b) facies articularis calcanea media et posterior tali
Fossa	a) facies articularis ossis navicularis b) facies articularis talaris media et posterior calcanei
Articular capsule and its ligaments	lig. talonaviculare, lig. calcaneonaviculare plantare, part of lig. bifurcatum (lig. calcaneonaviculare dorsale)
Special structures	fibrocartilago navicularis (enlarges the articular fossa)
Movements	inversion-eversion (combined movements)
Neutral position	= basic position
Note	movements common for the whole foot

Calcaneocuboid joint *(Articulatio calcaneocuboidea)*

Type	simple, 3-axial, plane (saddle.shaped articular surface), stiff (amphiarthrosis)
Head	facies articularis cuboidea calcanei
Fossa	facies articularis calcanea ossis cuboidei
Articular capsule and its ligaments	lig. calcaneocuboideum plantare, part of lig. bifurcatum (lig. calcaneocuboideum dorsale)
Movements	limited; inversion-eversion (combined movements)
Neutral position	= basic position
Note	movements common for the whole foot

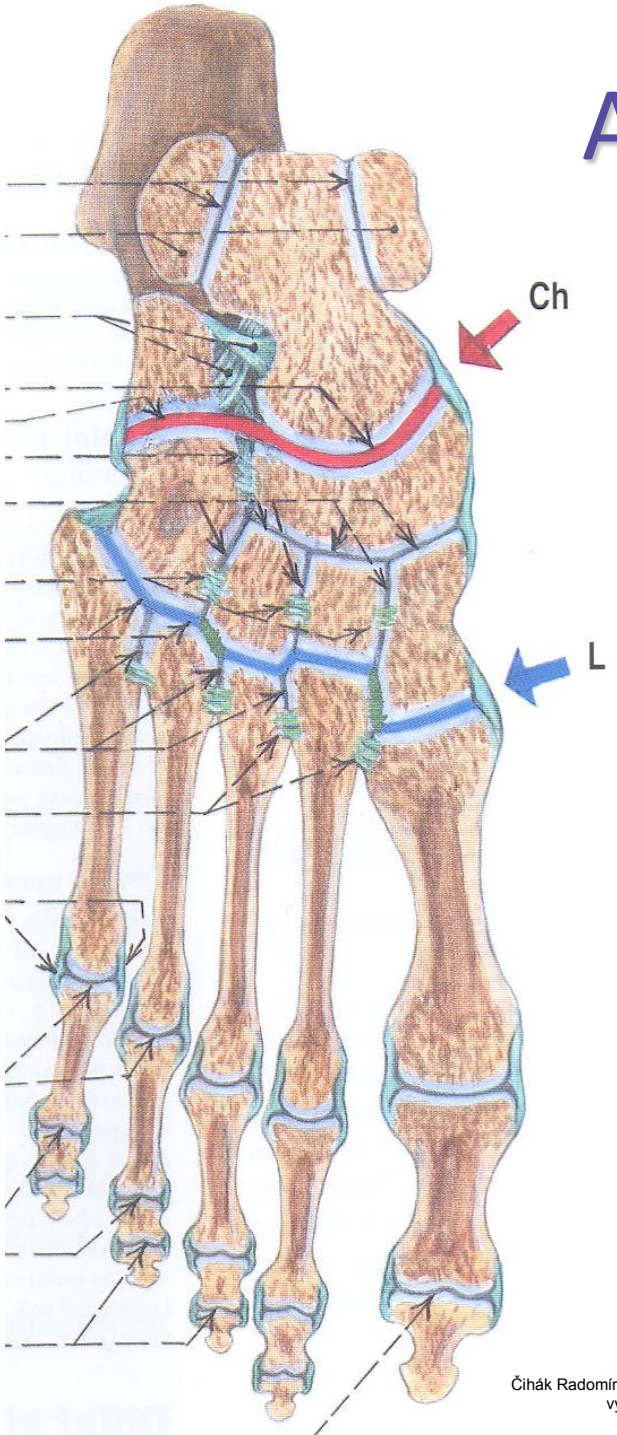

Tibia
Fibula
Anterior tibiofibular ligament
Posterior tibiofibular ligament
Superior fibular (peroneal) retinaculum
Calcaneal (Achilles) tendon (cut)
Inferior fibular (peroneal) retinaculum
Lateral talocalcaneal ligament
Long plantar ligament
Fibularis (peroneus) longus tendon
Fibularis (peroneus) brevis tendon
Posterior talofibular ligament (a component of lateral [collateral] ligament of ankle)
Calcaneofibular ligament (a component of lateral [collateral] ligament of ankle)
Anterior talofibular ligament (a component of lateral [collateral] ligament of ankle)
Interosseous talocalcaneal ligament
Dorsal talonavicular ligament
Calcaneonavicular ligament (part of bifurcate ligament)
Calcaneocuboid ligament (part of bifurcate ligament)
Dorsal cuboideonavicular ligament
Dorsal cuneonavicular ligaments
Dorsal intercuneiform ligaments
Dorsal tarsometatarsal ligaments
Dorsal metatarsal ligaments
Dorsal cuneocuboid ligament
Cuboid bone
Dorsal calcaneocuboid ligament


Tibia
Posterior tibiotalar part (of medial [deltoid] ligament of ankle)
Tibiocalcaneal part (of medial [deltoid] ligament of ankle)
Tibionavicular part (of medial [deltoid] ligament of ankle)
Anterior tibiotalar part (of medial [deltoid] ligament of ankle)
Dorsal talonavicular ligament
Navicular bone
Dorsal cuneonavicular ligaments
Medial cuneiform bone
Dorsal intercuneiform ligament
Dorsal tarsometatarsal ligaments
1st metatarsal bone
Tuberosity
Tibialis anterior tendon
Tibialis posterior tendon
Plantar calcaneonavicular (spring) ligament
Short plantar ligament
Long plantar ligament
Sustentaculum tali
Medial talocalcaneal ligament
Posterior process of talus
Posterior talocalcaneal ligament
Calcaneal (Achilles) tendon (cut)

Articulatio tarsi transversa (*Choparti*)

- **articulatio calcaneocuboidea** + **articulatio talonavicularis** (part of art. talocalcaneonavicularis)
- lig. bifurcatum (lig. calcaneonaviculare, lig. calcaneocuboidea) = „clavis“ (key of joint)
- functional joint across the tarsus
- small movements for foot elasticity
- clinically important:
  - contusion
  - for exarticulation in amputation (in past times)

Articulatio tarsi transversa (*Choparti*)



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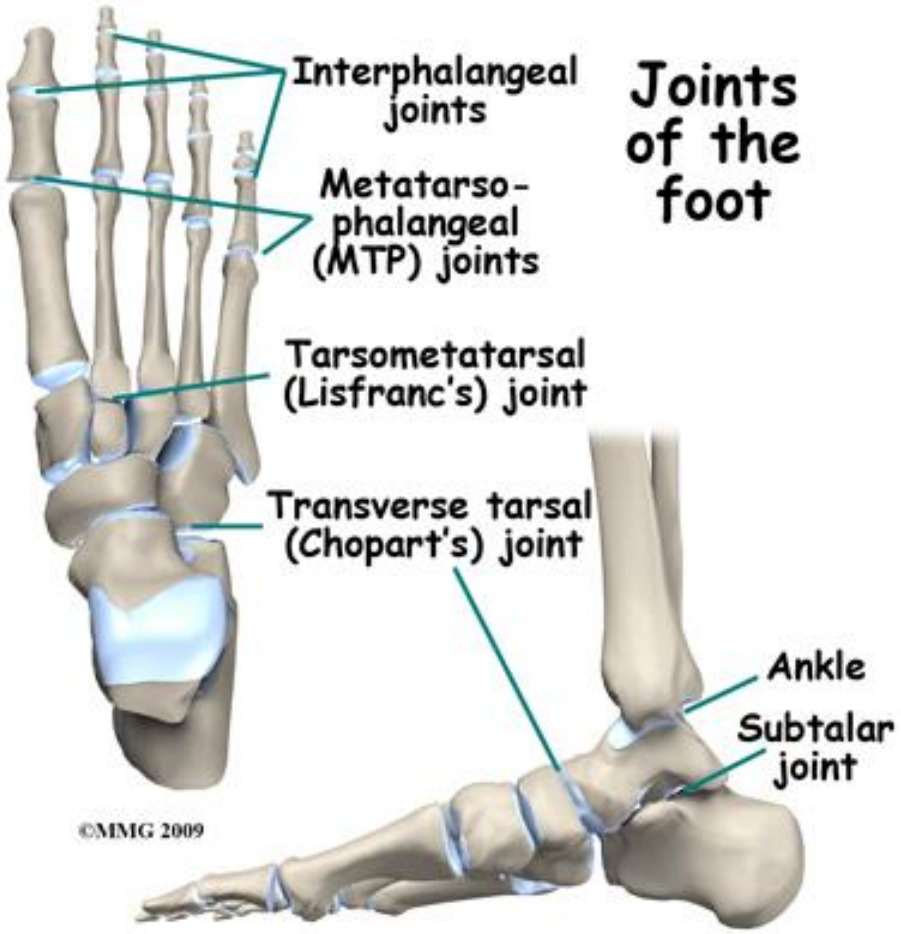
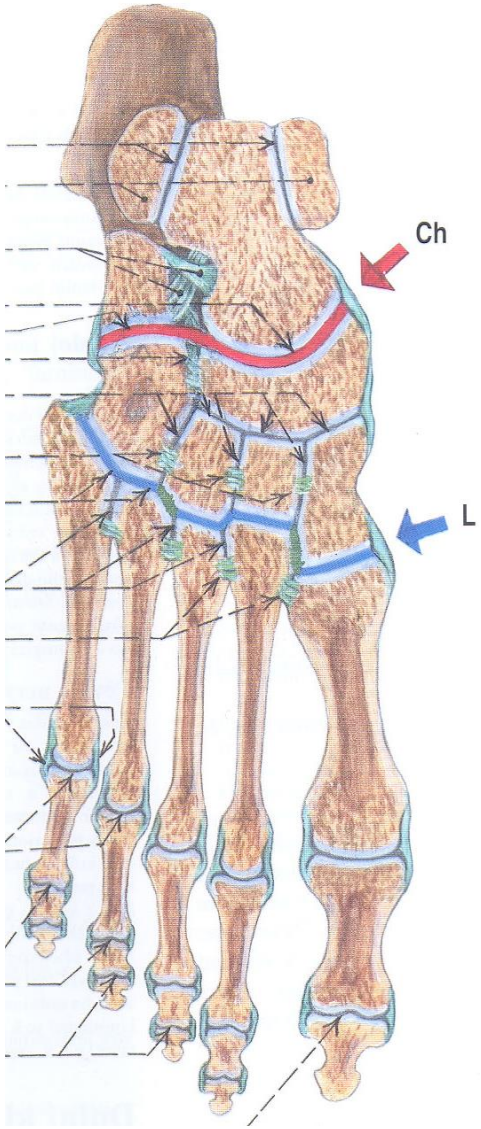


http://www.eorthopod.com/sites/default/files/images/adult_foot_fx_anatomy01b.jpg

Distal tarsal joints

- **articulatio cuneonavicularis**
  - ossa cuneiformia + os naviculare
  - stiff joint (amphiarthrosis)
- **articulationes intercuneiformes**
  - 2 joints
  - between ossa cuneiformia
  - stiff joint (amphiarthrosis)
- **arcticulatio cuneocuboidea**
  - os cuneiforme laterale + os cuboideum
  - stiff joint (amphiarthrosis)



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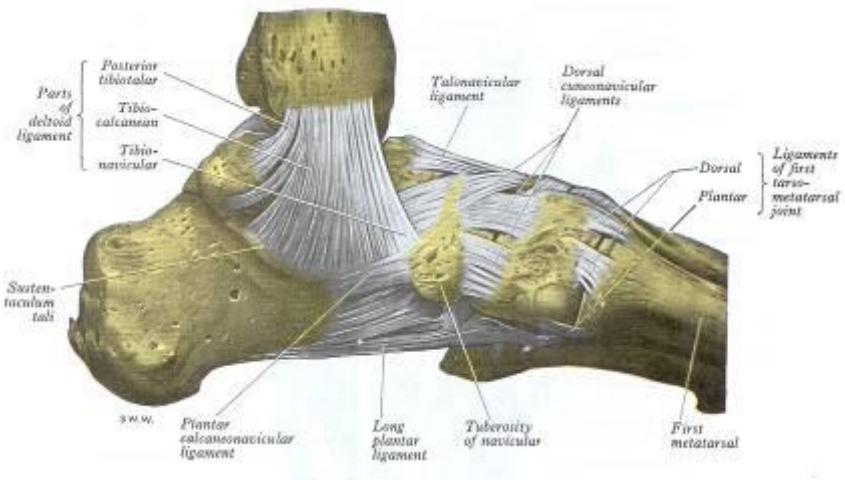
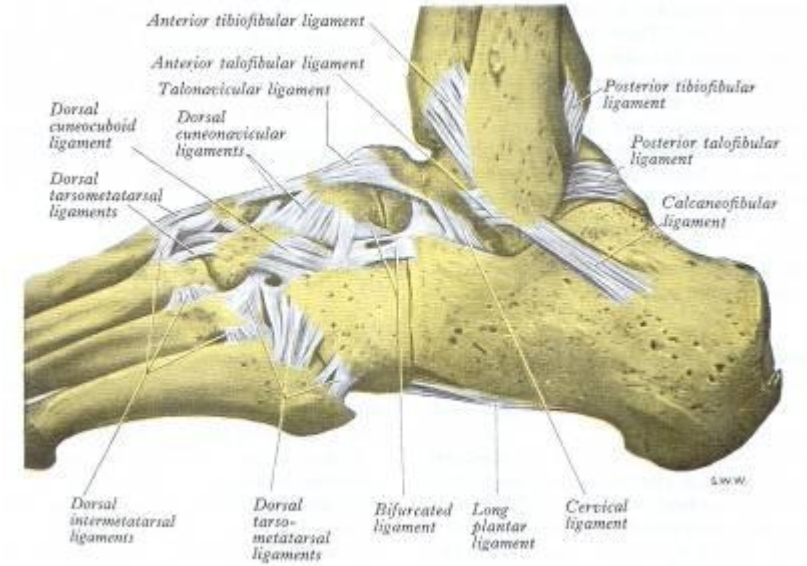
Tarsal ligaments

- **lig. plantare longum**
  - from calcaneus to metatarsal bases
- ligg. tarsi **interossea**
  - talocalcaneum, cuneocuboideum, intercuneiformia
- ligg. tarsi **dorsalia**
  - talonaviculare, intercuneiformia, cuneocuboideum, cuboideonaviculare
- ligg. tarsi **plantaria**
  - calcaneocuboideum, calcaneonaviculare, cuneonavicularia, cuboideonaviculare, intercuneformia, cuneocuboideum

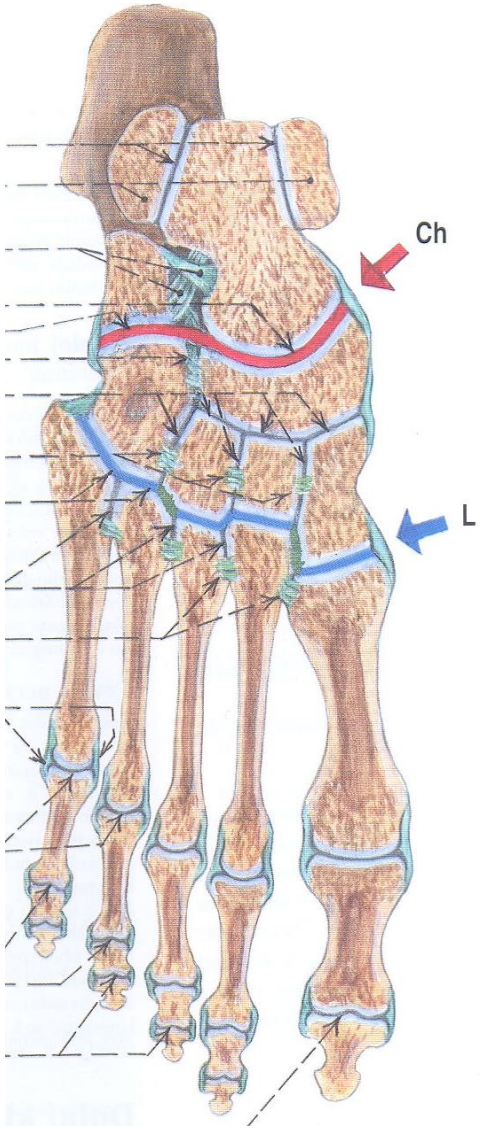




Gray´s anatomy, 37th edition, Churchill Livingstone 1989

Tarsal joints

- **articulationes tarsometatarsales**
  - plane and stiff joints (amphiarthroses)
  - ligg. tarsometatarsalia dorsalia et plantaria, ligg. cuneometatarsalia interossea
- **articulationes metatarsophalangeae**
  - compound, plane
  - fibrocartilago plantaris (5)
  - ligg. collateralia et plantare, lig. metatarsale transversum profundum
- **articulationes interphalangeae proximalis et distalis**
  - compound, trochlear
  - fibrocartilago plantaris (9)
  - ligg. collateralia et plantare



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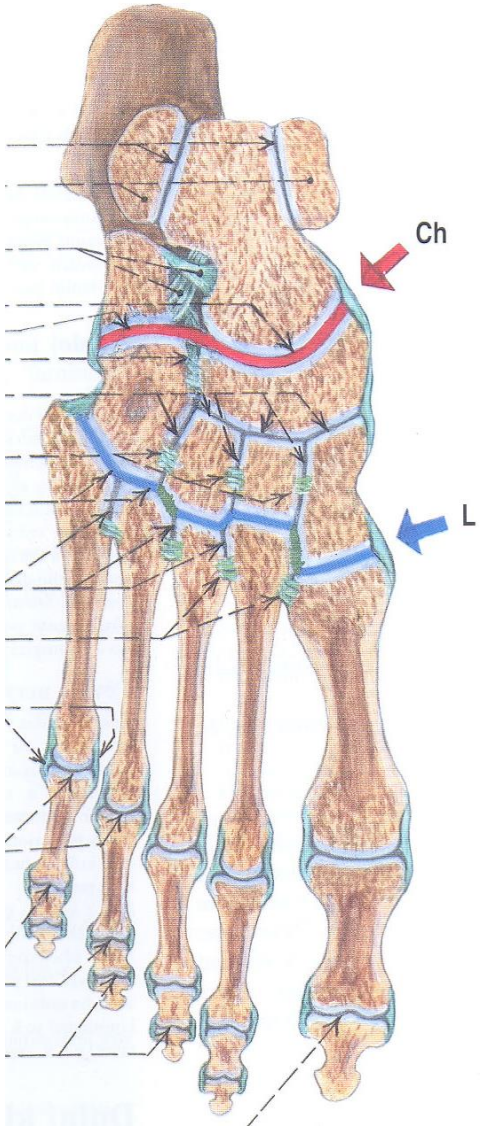
Lisfranck‘s joint

- ***articulationes tarsometatarsales + articulationes intermetatarsales***
- *os metatarsi secundum* as hinge against ossa cuneiformia
  - reduces abduction and adduction movements
- spring movements, accomodation to weight
- clinically important for exarticulation in amputation (rather in the past)



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Lateral X-ray of foot

Foot arch

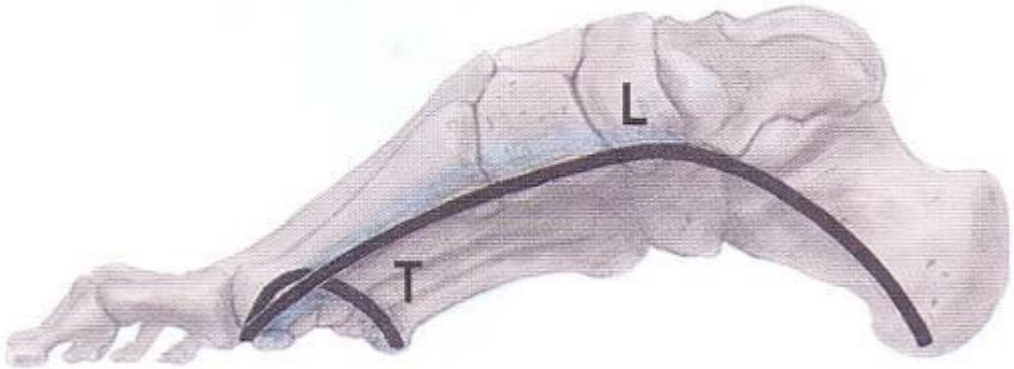
longitudinal

- higher on tibial side
- short ligaments of the foot
- lig. plantare longum
- long muscles of the foot
- short muscles of the foot
- aponeurosis plantaris
- **tendinous stirrup of m. tibialis anterior**

transverse

- position of bones in two rows (proximodistal lines)
- foot ligaments running transversely
- **tendinous stirrup of m. tibialis anterior + m. fibularis longus**

Foot arch



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Foot arch – clinical notes

- body weight is carried by:
  - posteriorly: *tuber calcanei* – 60 %
  - anteriorly: *cpaut ossis metatarsi I* (from 2nd metatarsal bone laterally weight decreases) – 40 %
- great toe is important for bounce of foot from the floor in walking

- *pes transversoplanus* = transversely flat foot – collapse of transverse arch
- *pes planus* = arch collapse
- *pes cavus* = high arch

Foot – clinical notes

- **calcar avis (Haglundi)** – calcar of Achilles‘ tendon
  - bony spur on posterior side of calcaneus at the insertion of calcaneal (Achilles‘) tendon
- **calcar calcanei (heel spur)**
  - exostosis of plantar part of calcaneus at the insertion of short muscles of foot and plantar aponeurosis
  - result of oveload or wearing inappropriate shoes