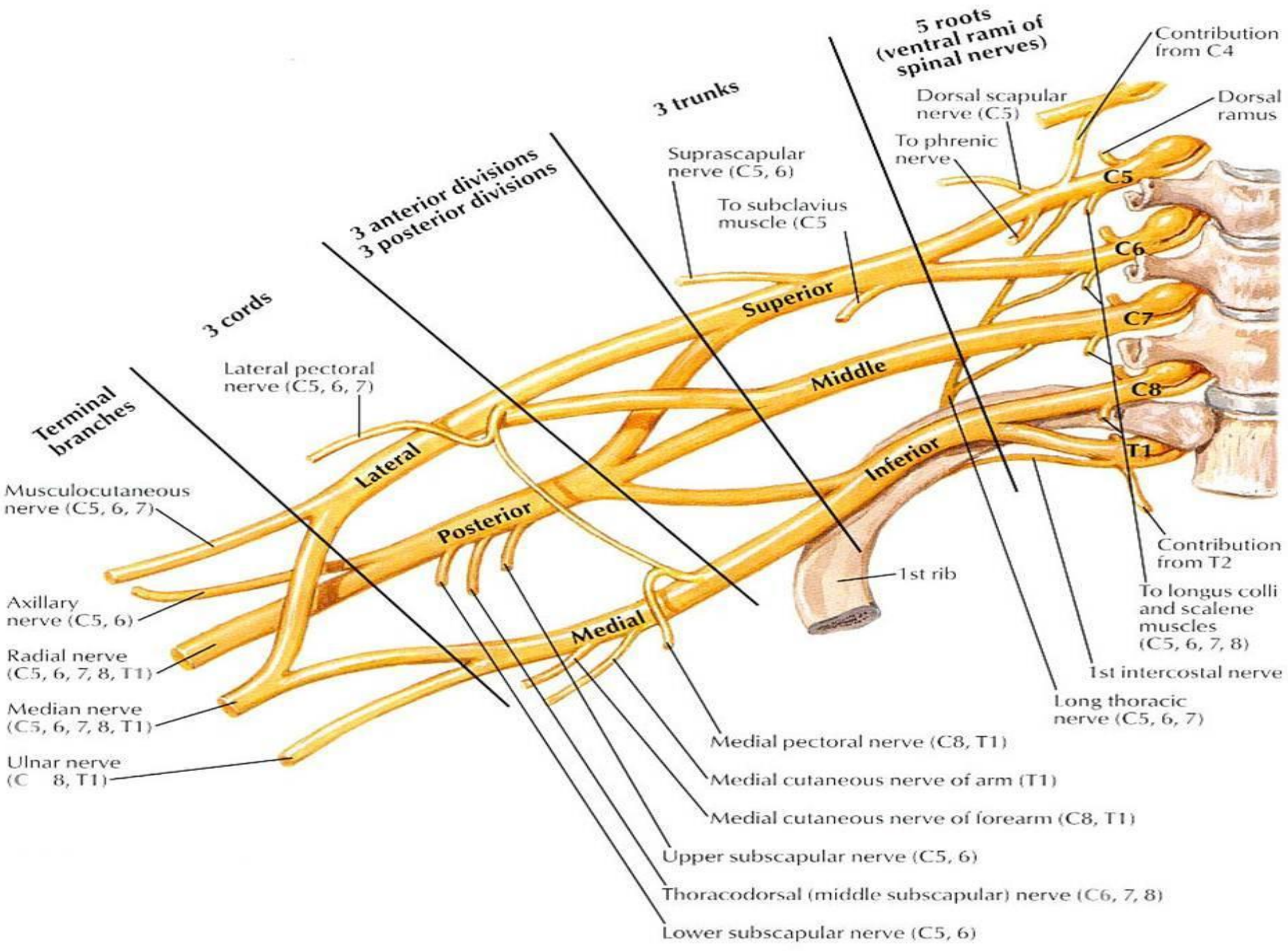
Surgical anatomy II

Brachial plexus injury

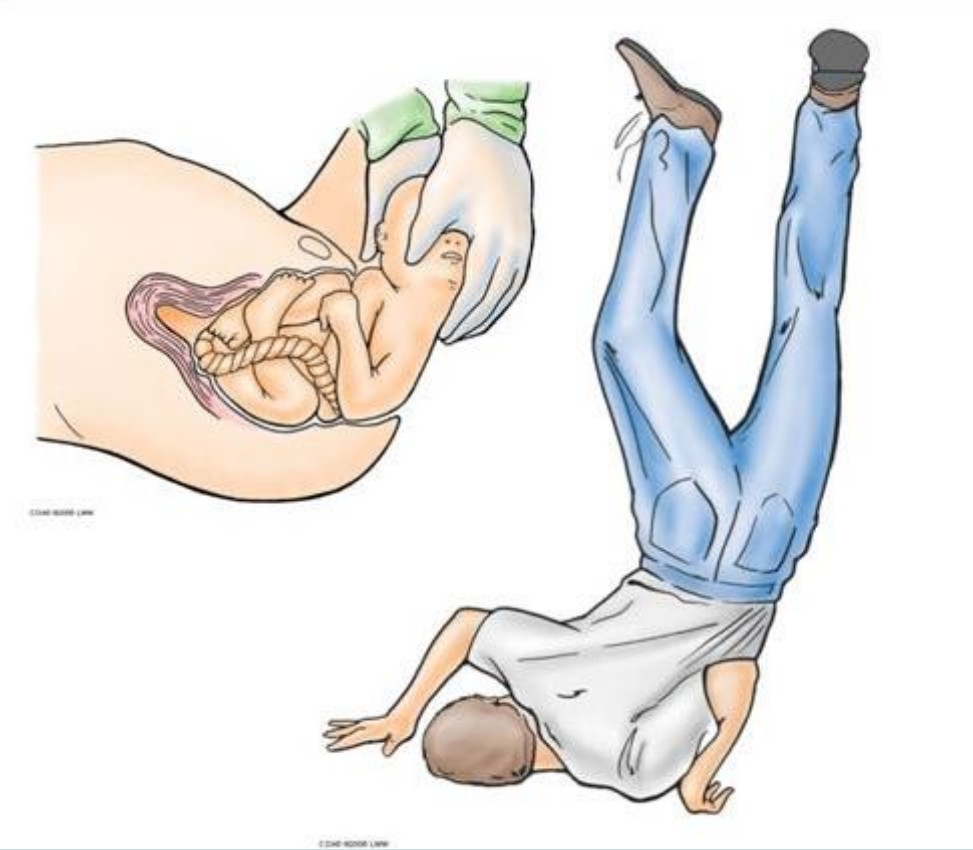

5 roots
(ventral rami of
spinal nerves)
3 trunks
3 anterior divisions
3 posterior divisions
3 cords
Terminal
branches
Contribution
from C4
Dorsal scapular
nerve (C5)
Dorsal
ramus
To phrenic
nerve
Suprascapular
nerve (C5, 6)
To subclavius
muscle (C5
C5
C6
C7
C8
T1
Superior
Middle
Inferior
Lateral pectoral
nerve (C5, 6, 7)
Lateral
Posterior
Medial
Musculocutaneous
nerve (C5, 6, 7)
Axillary
nerve (C5, 6)
Radial nerve
(C5, 6, 7, 8, T1)
Median nerve
(C5, 6, 7, 8, T1)
Ulnar nerve
(C 8, T1)
1st rib
Contribution
from T2
To longus colli
and scalene
muscles
(C5, 6, 7, 8)
1st intercostal nerve
Long thoracic
nerve (C5, 6, 7)
Medial pectoral nerve (C8, T1)
Medial cutaneous nerve of arm (T1)
Medial cutaneous nerve of forearm (C8, T1)
Upper subscapular nerve (C5, 6)
Thoracodorsal (middle subscapular) nerve (C6, 7, 8)
Lower subscapular nerve (C5, 6)

Level of injuries

- Often involving the mixture of nerve root, trunks and nerve
- Preganglionic versus postganglionic lesions?
- Lesions in continuity (1st to 4th degree), better prognosis than complete ruptures
- Mild lesions(neurapraxia) fairly common

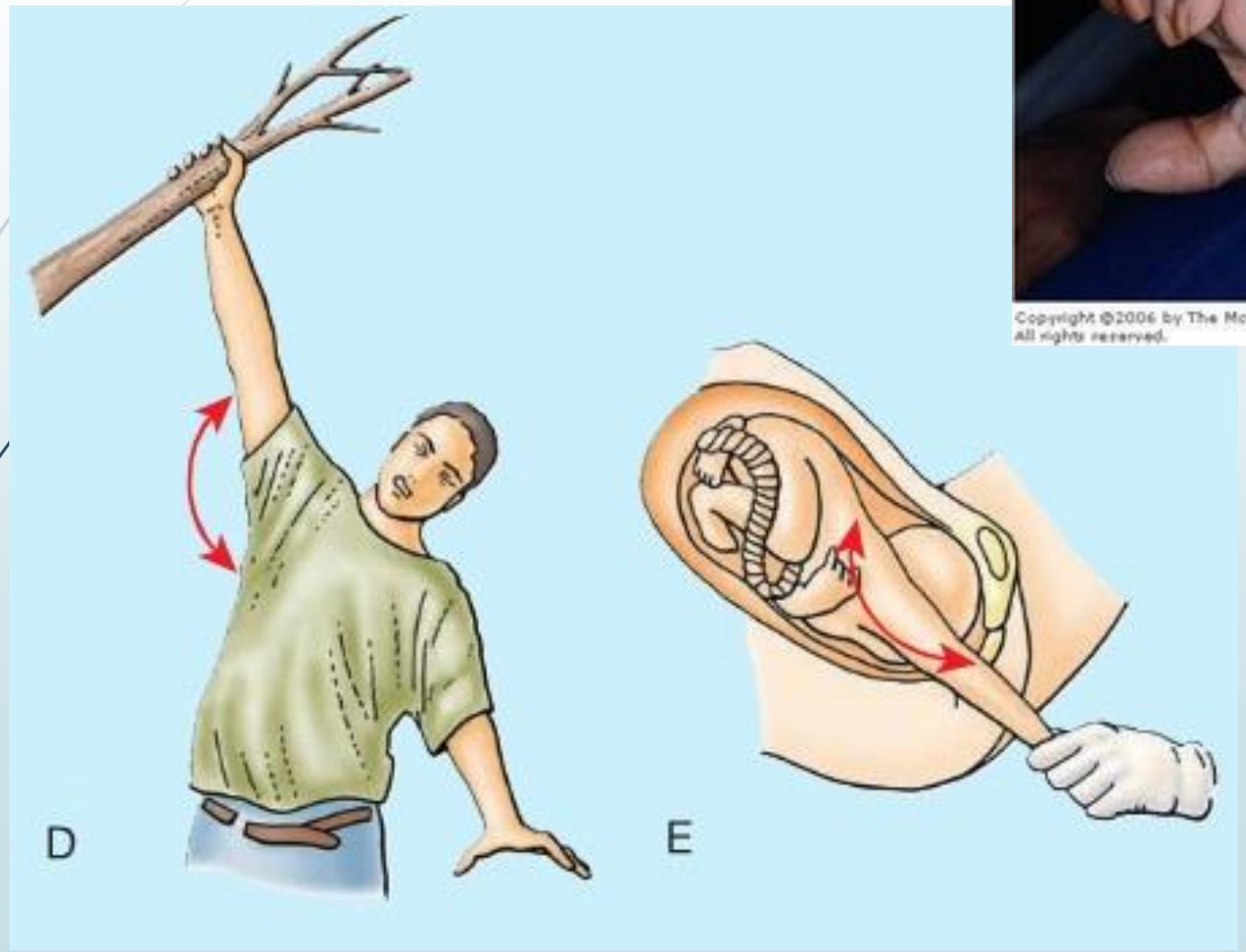
Clinical features

- Usually overshadowed by other injuries, that can be life threatening
- Neurological deficits based on:
  - Level of lesion
  - Pre/post ganglionic



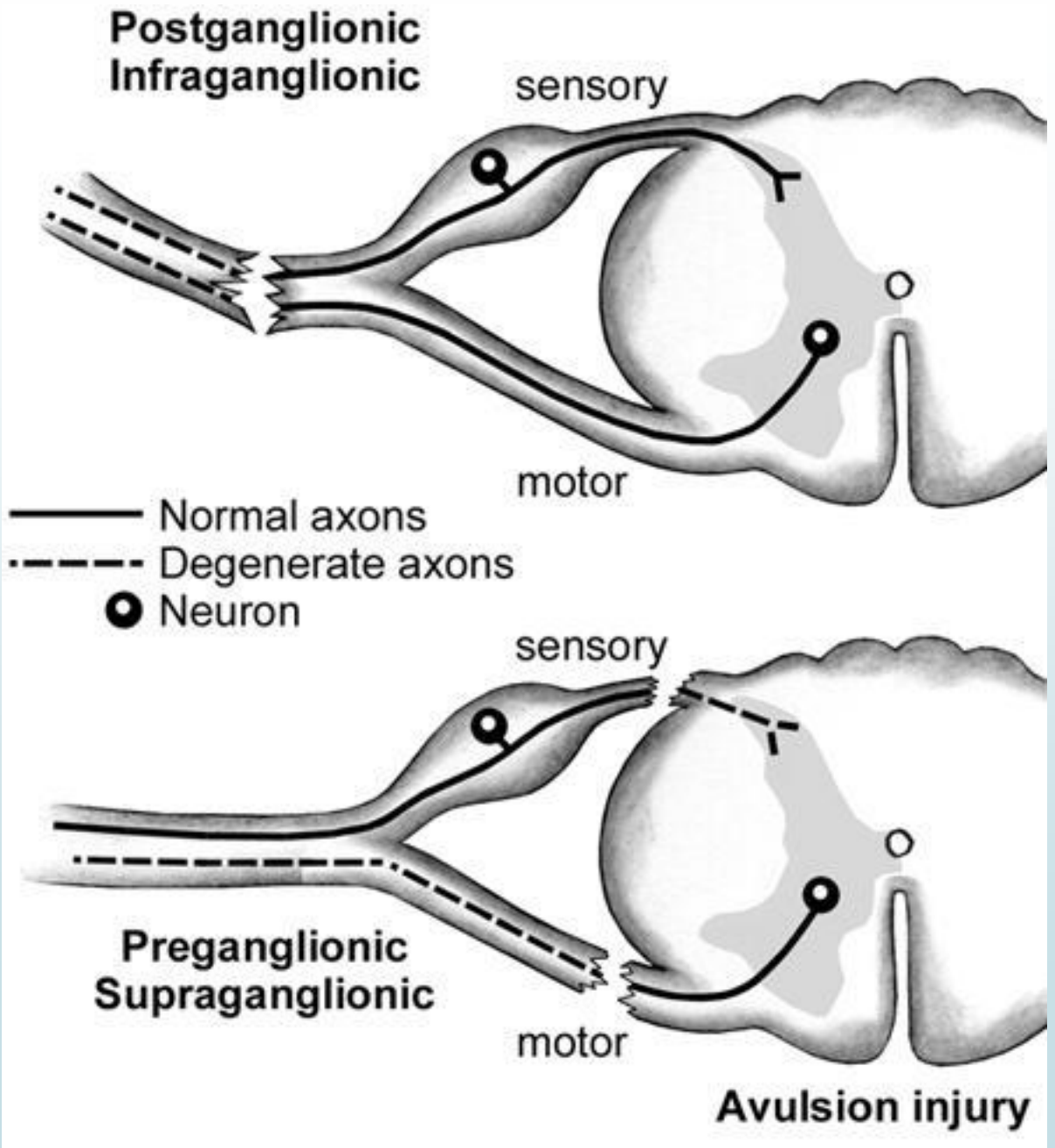
Upper trunk

- Shoulder abductors and external rotators and forearm supinators paralysed
- Sensory loss at outer space of arm and forearm



Lower trunk

- Wrist and finger flexors are weak and intrinsic hand muscles are paralysed
- Sensory loss in ulnar forearm and hand


Postganglionic
Infraganglionic
sensory
motor
Normal axons
Degenerate axons
Neuron
sensory
Preganglionic
Supraganglionic
motor
Avulsion injury

Pre ganglionic (root avulsions)

- Disruption proximal to dorsal root ganglion
- Irreparable
- Features:
  - Crushing or burning pain at the anesthetic hand
  - Paralysis of scapular muscle or diaphragm
  - Horner's syndrome- ptosis, miosis, enopthalmos and anhidrosis
  - Severe vascular injury
  - Assoc. fracture of cervical spine
  - Spinal cord dysfunction (eg; hyperreflexia in the lower limb)

Horner's syndrome

ptosis, miosis, enopthalmos and anhidrosis

Peripheral nerve injury

How do you clinically approach this problem?

- Identify presence of nerve injury
- Identify which nerve is affected
- Identify level of nerve injury

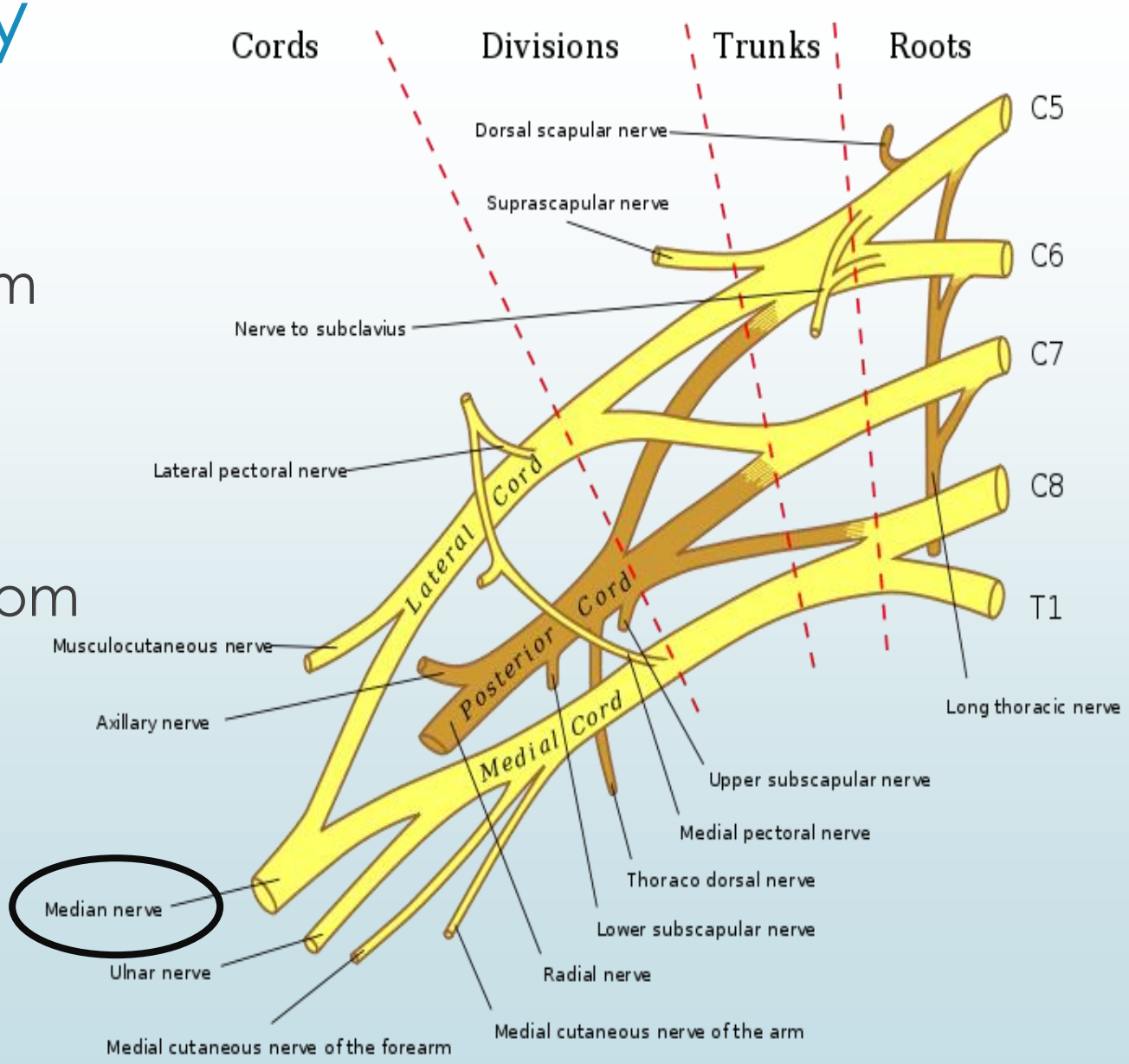
Median nerve

Anatomy

- Formed by:

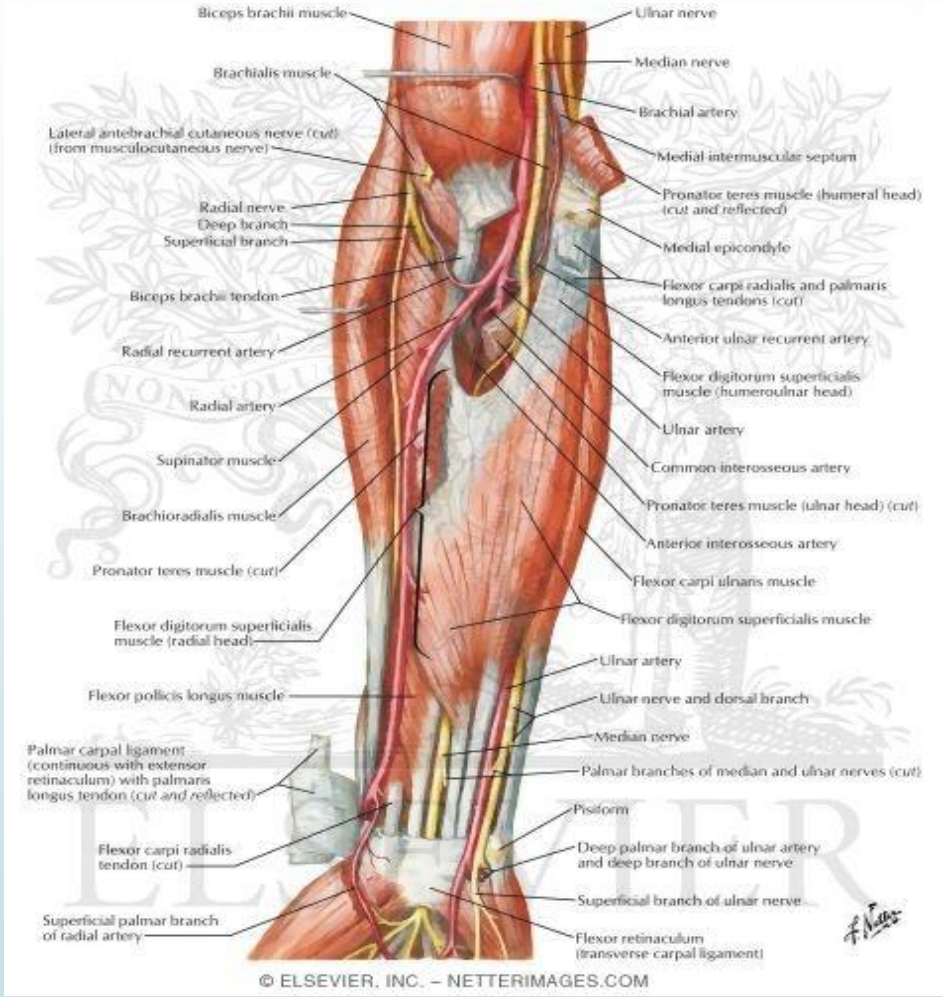
  - c5 to c7 roots from lateral cord of brachial plexus

  - c8 and T1 roots from medial cord of brachial plexus



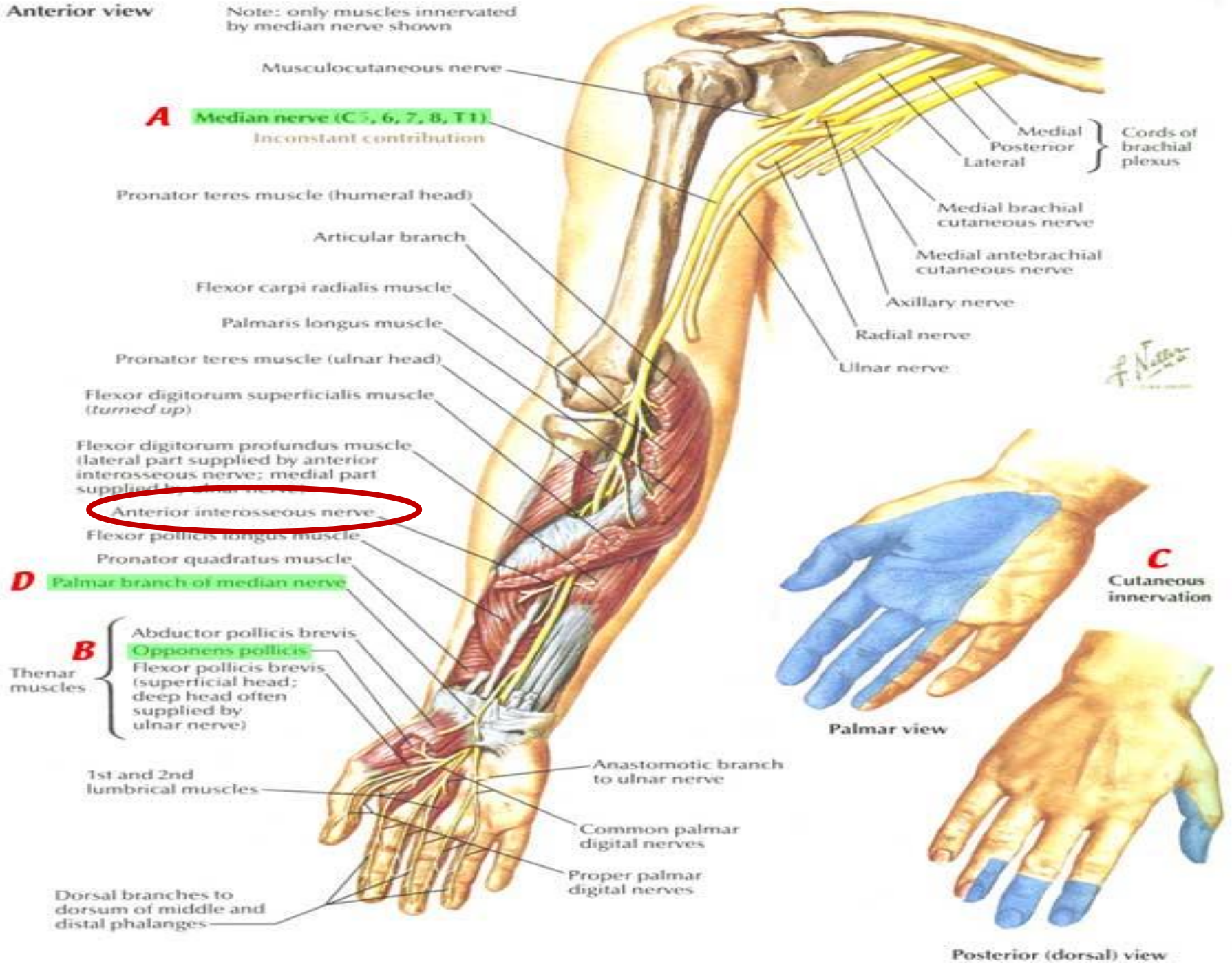
Course

- Leaves cubital fossa by passing between the two heads of **pronator teres**
- Continues downward behind flexor **digitorum superficialis** and rests posteriorly on the **flexor digitorum profundus**
- At the wrist, the median nerve emerges from the lateral border of the flexor digitorum superficialis muscle and lies behind the tendon of **palmaris longus.**
- Enters palm by passing behind the **flexor retinaculum**



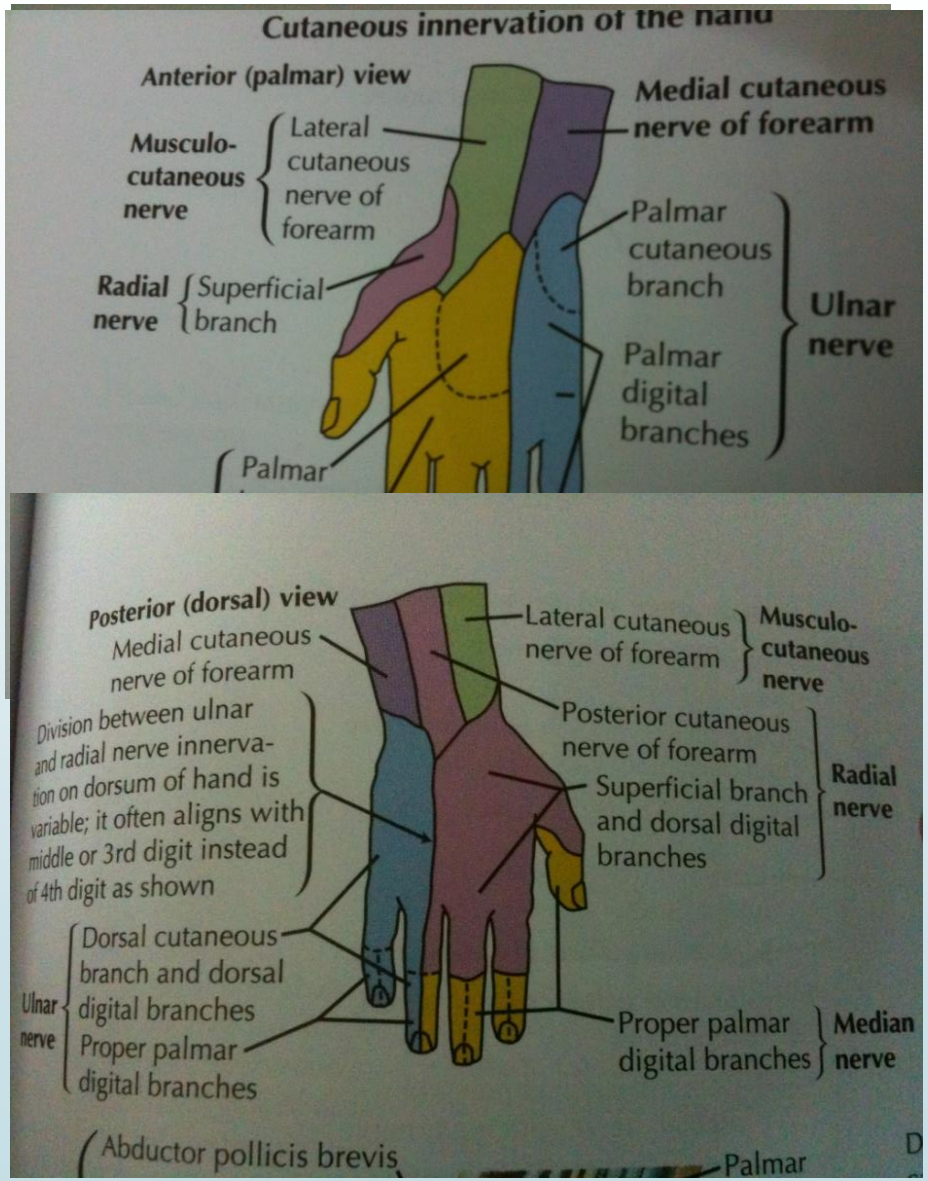
Branches

Forearm: muscular branches	Anterior interosseous (motor)	Palmar cutaneous	Terminal motor	Terminal sensory
•Pronator teres •Flexor carpi radialis •Palmaris longus •Flexor digitorum superficialis	•Flexor pollicis longus •Flexor digitorum profundus to 2nd & 3rd fingers •Pronator quadratus	•Sensory distribution: skin over thenar eminence •Branch arises proximal to carpal tunnel	•Abductor pollicis brevis •Opponens pollicis •Lumbricals: 1st & 2nd •+/- flexor pollicis brevis	•Sensory to palmar surface of thumb, 2nd, 3rd, and lateral half of 4th finger


Anterior view
Note: only muscles innervated by median nerve shown
Musculocutaneous nerve
A Median nerve (C5, 6, 7, 8, T1)
Inconstant contribution
Pronator teres muscle (humeral head)
Articular branch
Flexor carpi radialis muscle
Palmaris longus muscle
Pronator teres muscle (ulnar head)
Flexor digitorum superficialis muscle (turned up)
Flexor digitorum profundus muscle (lateral part supplied by anterior interosseous nerve; medial part supplied by ulnar nerve)
Anterior interosseous nerve
Flexor pollicis longus muscle
Pronator quadratus muscle
D Palmar branch of median nerve
B Thenar muscles
Abductor pollicis brevis
Opponens pollicis
Flexor pollicis brevis (superficial head; deep head often supplied by ulnar nerve)
1st and 2nd lumbrical muscles
Dorsal branches to dorsum of middle and distal phalanges
Anastomotic branch to ulnar nerve
Common palmar digital nerves
Proper palmar digital nerves
Medial
Posterior
Lateral
Cords of brachial plexus
Medial brachial cutaneous nerve
Medial antebrachial cutaneous nerve
Axillary nerve
Radial nerve
Ulnar nerve
C Cutaneous innervation
Palmar view
Posterior (dorsal) view

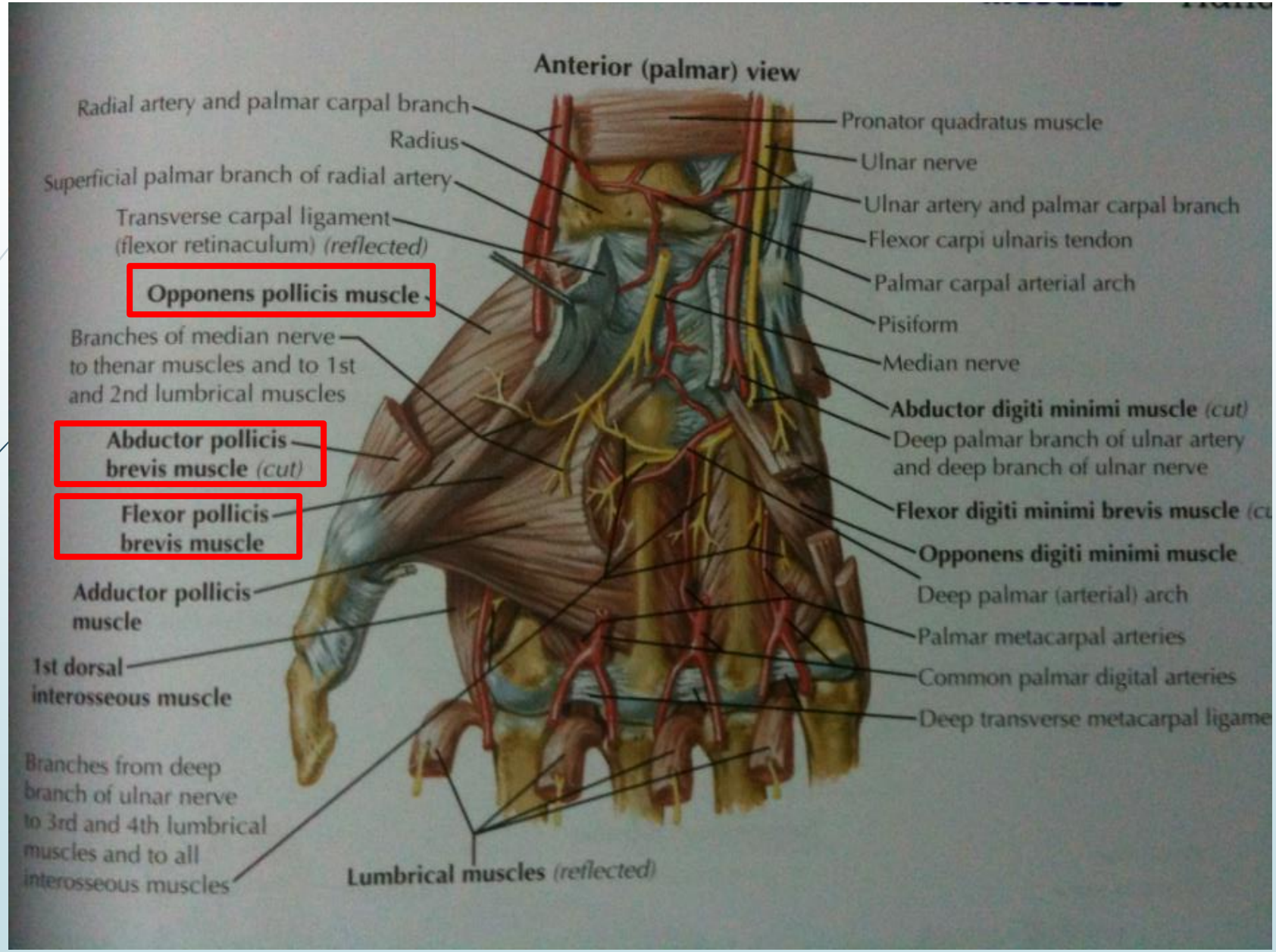
The ANATOMY

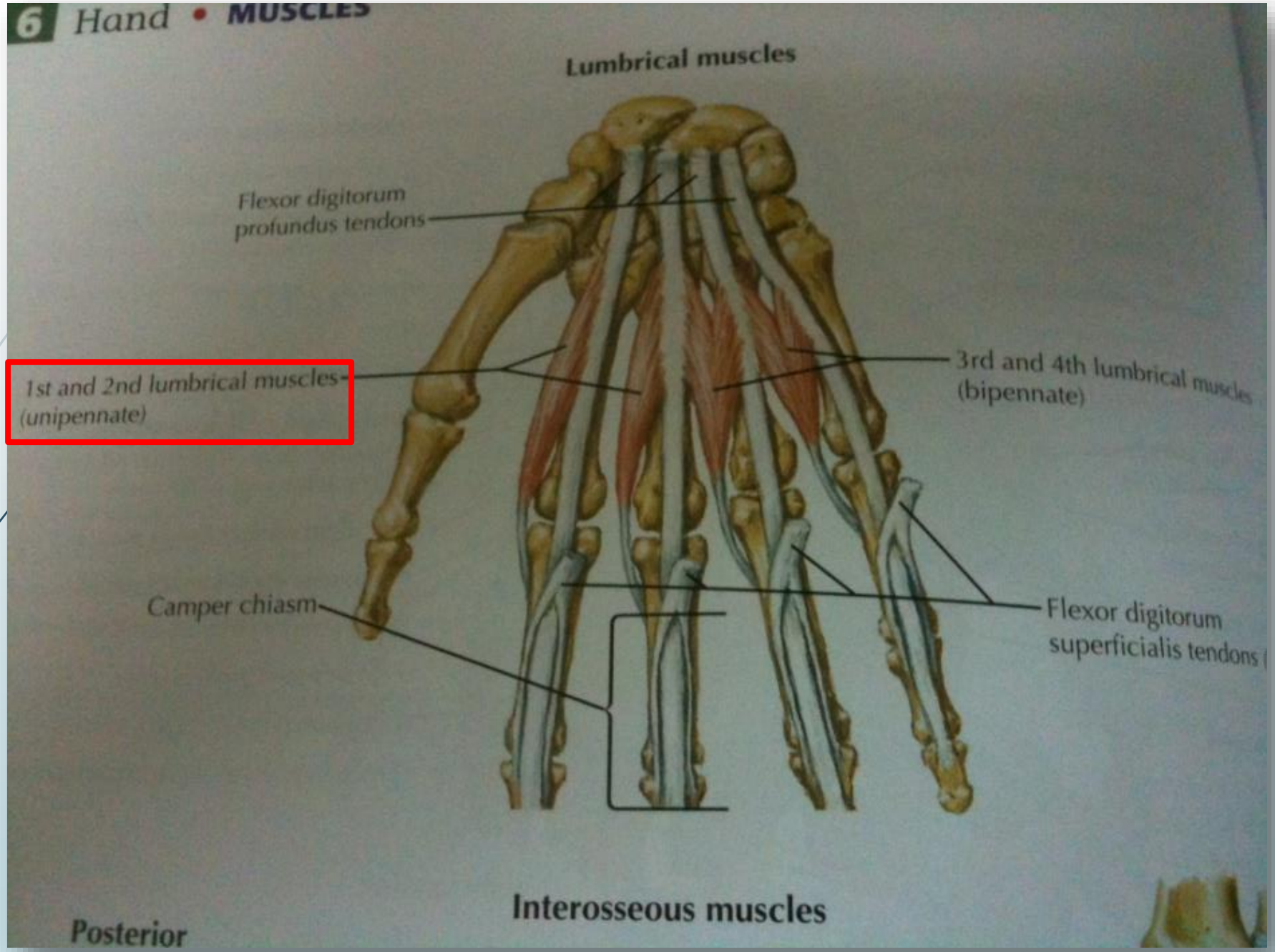
- Runs in forearm on FDP then enter wrist through FLEXOR RETINACULUM
- Palmar cutaneous branch branches proximal to carpal tunnel and supply sensory of thenar muscles
- Motor recurrent branch exit distal to flexor retinaculum and supplies the thenar muscles
- Digital branch supplies the sensory of palmar radial 3 ½ digits and the motor of radial two lumbricals



Nerve **SUPPLY**

Muscle	Nerve	Action
Thenar compartment		
Abductor pollicis brevis	Median	Palmar pronation
Flexor pollicis brevis 1) Superficial head 2) Deep head	Median Ulnar	Thumb MCP flexion
Opponens pollicis	Median	Oppose (flex/abduct) thumb
Intrinsic muscle of hand		
Lumbricals 1 & 2	Median	Extend PIP, flex MCP


Anterior (palmar) view
Radial artery and palmar carpal branch
Radius
Superficial palmar branch of radial artery
Transverse carpal ligament (flexor retinaculum) (reflected)
Opponens pollicis muscle
Branches of median nerve to thenar muscles and to 1st and 2nd lumbrical muscles
Abductor pollicis brevis muscle (cut)
Flexor pollicis brevis muscle
Adductor pollicis muscle
1st dorsal interosseous muscle
Branches from deep branch of ulnar nerve to 3rd and 4th lumbrical muscles and to all interosseous muscles
Lumbrical muscles (reflected)
Pronator quadratus muscle
Ulnar nerve
Ulnar artery and palmar carpal branch
Flexor carpi ulnaris tendon
Palmar carpal arterial arch
Pisiform
Median nerve
Abductor digiti minimi muscle (cut)
Deep palmar branch of ulnar artery and deep branch of ulnar nerve
Flexor digiti minimi brevis muscle
Opponens digiti minimi muscle
Deep palmar (arterial) arch
Palmar metacarpal arteries
Common palmar digital arteries
Deep transverse metacarpal ligame

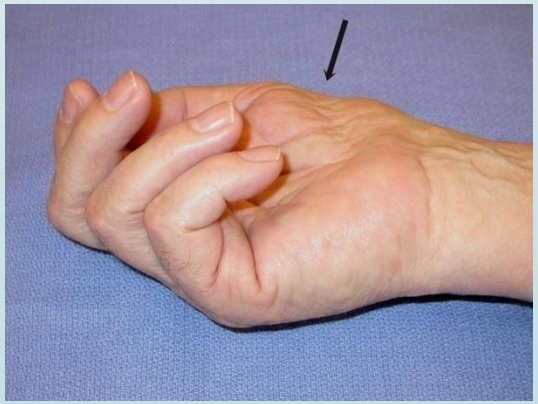

6 Hand • MUSCLES
Lumbrical muscles
Flexor digitorum profundus tendons
1st and 2nd lumbrical muscles (unipennate)
3rd and 4th lumbrical muscles (bipennate)
Camper chiasm
Flexor digitorum superficialis tendons
Interosseous muscles
Posterior

Injury to median nerve

- Low lesion
  - Unable to abduct thumb
  - Sensory loss over radial 3 ½ digits
  - Thenar eminence wasting-in chronic
- High lesion
  - Same as above
  - Pointing sign
  - Pinch defect
- Isolated anterior interosseous nerve lesion
  - Similar with high lesion but without sensory loss

Injuries at wrist (low lesion)

- Motor:
  - Thumb is laterally rotated and adducted. Muscle of thenar eminence paralyzed and wasted. Hand looks flattened.
- Sensory:
  - Identical to those in elbow lesions.



Common sites affected

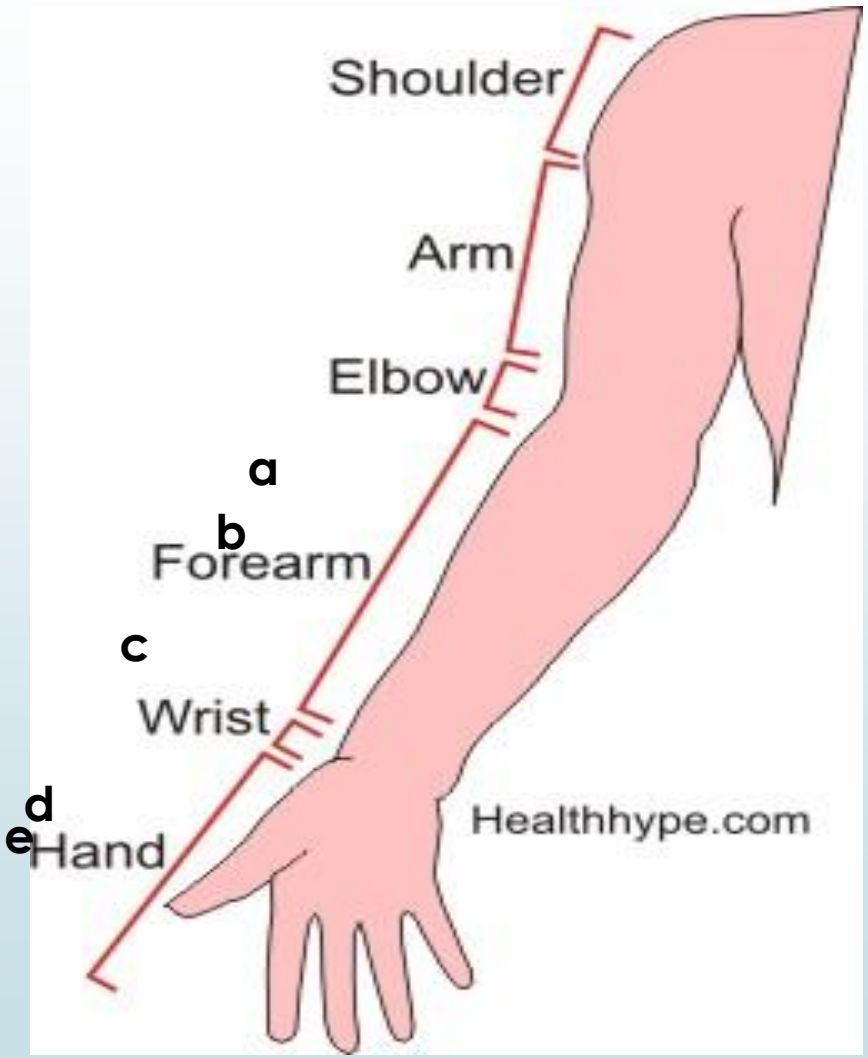
a. **At the elbow**
   - After elbow dislocation in children
   - Fracture of supracondylar/ medial epicondylar of humerus
   - Injection injury
   - *Pronator syndrome*

b. **Just distal to the elbow**
   - *Pronator syndrome*

c. **In the forearm**
   - Fracture of radius midshaft
   - *Anterior interosseous nerve (AIN) syndrome*

d. At the wrist

e. In the carpal tunnel



PRONATOR SYNDROME

- Compression of the median nerve by the muscles of the forearm
- sites of compression
  -ligament of struthers
  -pronator teres
  - FDS

Symptoms

- Slow onset of aching pain at proximal forearm or elbow at volar surface
- Numbness and tingling of the thumb, 2nd, 3rd, and lateral half of 4th finger
- Weakness with dexterity. E.g buttoning up clothes or picking up small objects

How to diagnose?

- Swelling at proximal, volar forearm
- Tenderness at point of compression
- Pressure applied at point of compression reproduces symptoms
- Tinel's sign
- Sensation diminished to thumb, 2nd, 3rd, and lateral half of 4th finger
- Muscle weakness (e.g FDS, PT)
- Benediction sign

Benediction
sign

tests

- Flexion of middle finger against resistance (compression by FDS)

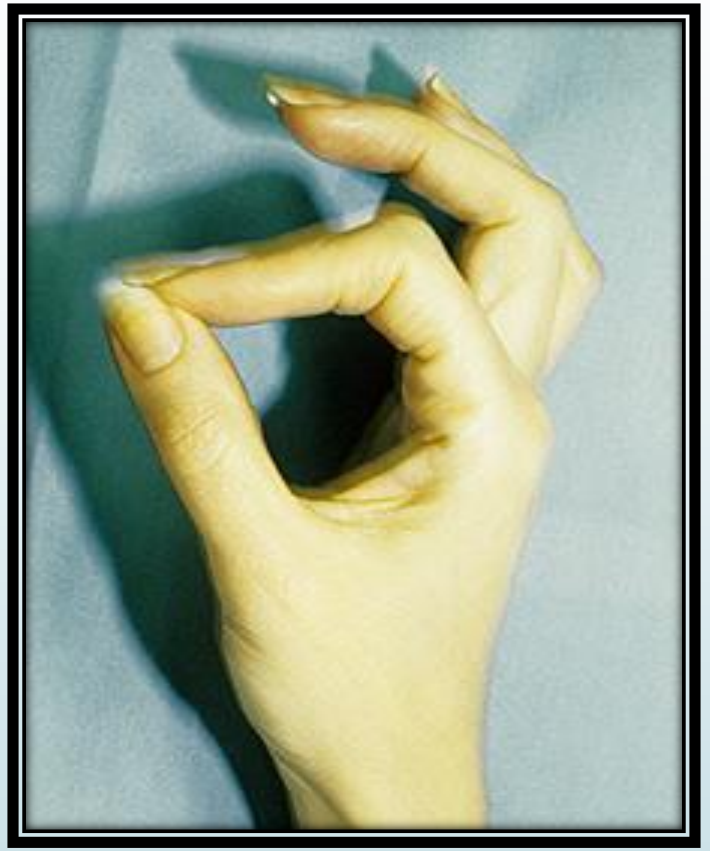
- Pronation against resistance (compression by pronator teres)

AIN SYNDROME

- Due to entrapment of AIN
- Rare nerve compression
- Causes:
  - fracture: radius midshaft
  - excessive exercise
  - idiopathic
  - direct trauma; stab wound, venopuncture
  - anatomic anomalies

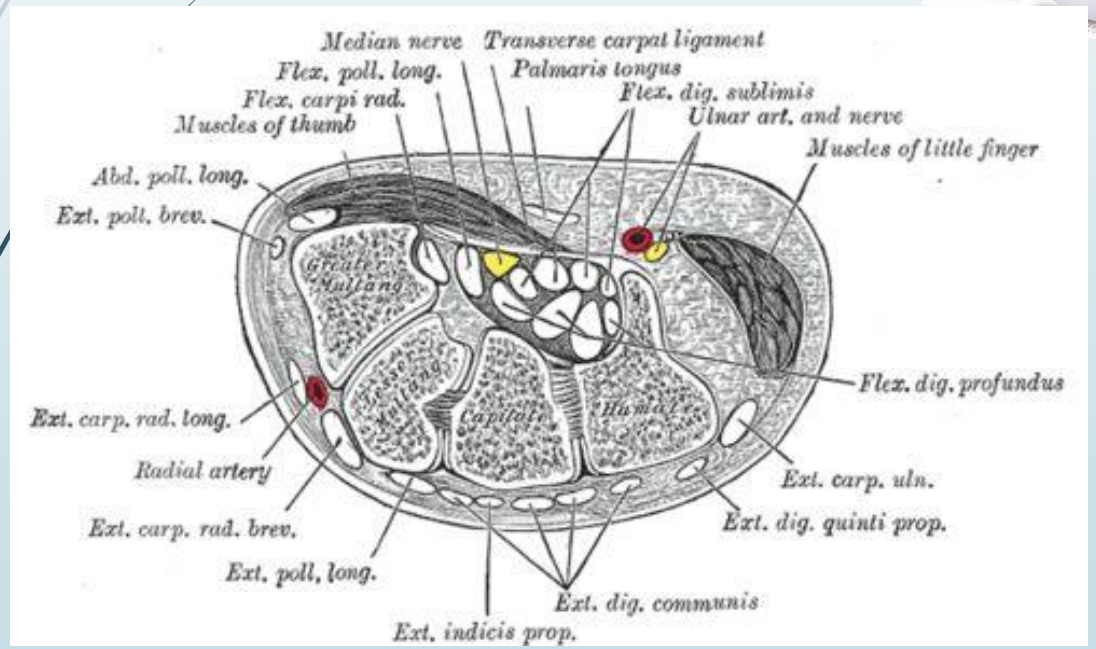
Symptoms & signs

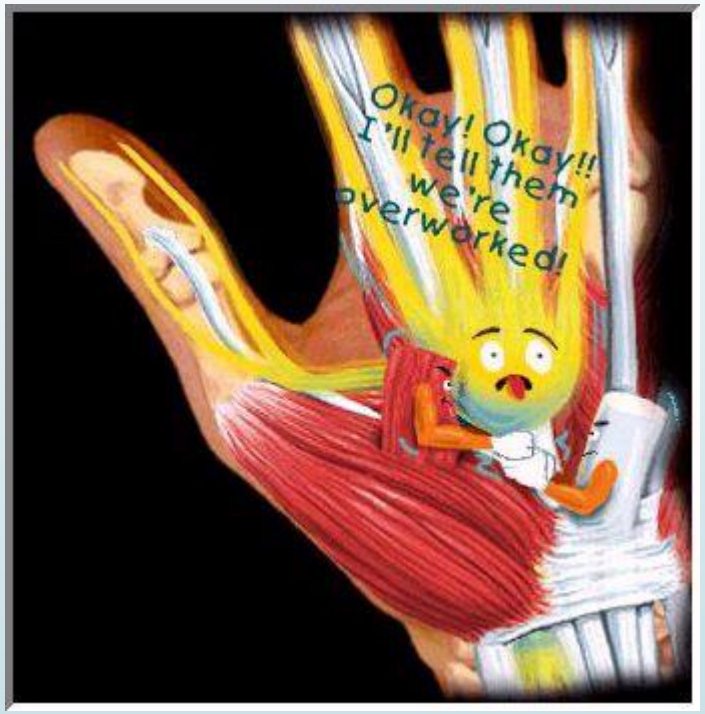
- Motor only
- Pain in the upper forearm, usually vague
- Inability to pinch thumb to index finger tip to tip (OK) sign. Due to paresis of FDP and FPL muscles
- Thumb weakness, or weakness of index finger
- Frequent dropping of objects or difficulty in writing
- Weakness when turning palm down against resistance



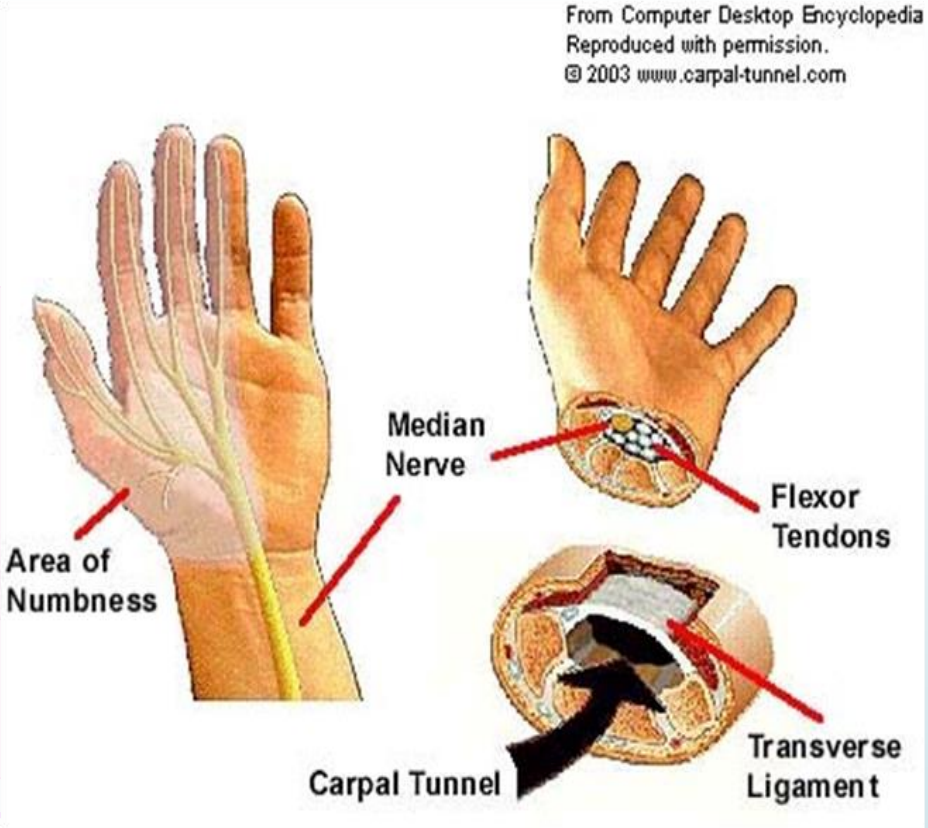
Carpal tunnel**

Formed by concave anterior surface of the carpal bones. Closed by flexor retinaculum. Pack with long flexor tendons of the fingers





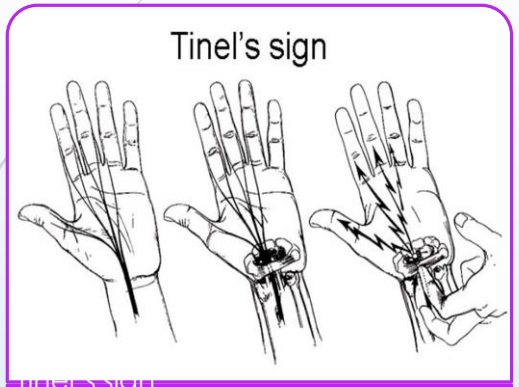
- More common in women, age around
  40-50 years old
- Common with metabolic diseases (thyroid, DM), menopause, RA, and pregnancy.



Cf:

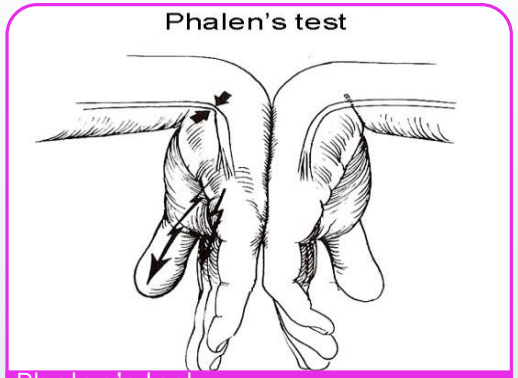
- Burning pain or 'pins and needles' along the median nerve distribution
- Weakness of thenar muscles

Special test



Tinel's sign

percussing along the course of the median nerve; the result is positive if paresthesia is reproduced in the median nerve distribution



Phalen's test

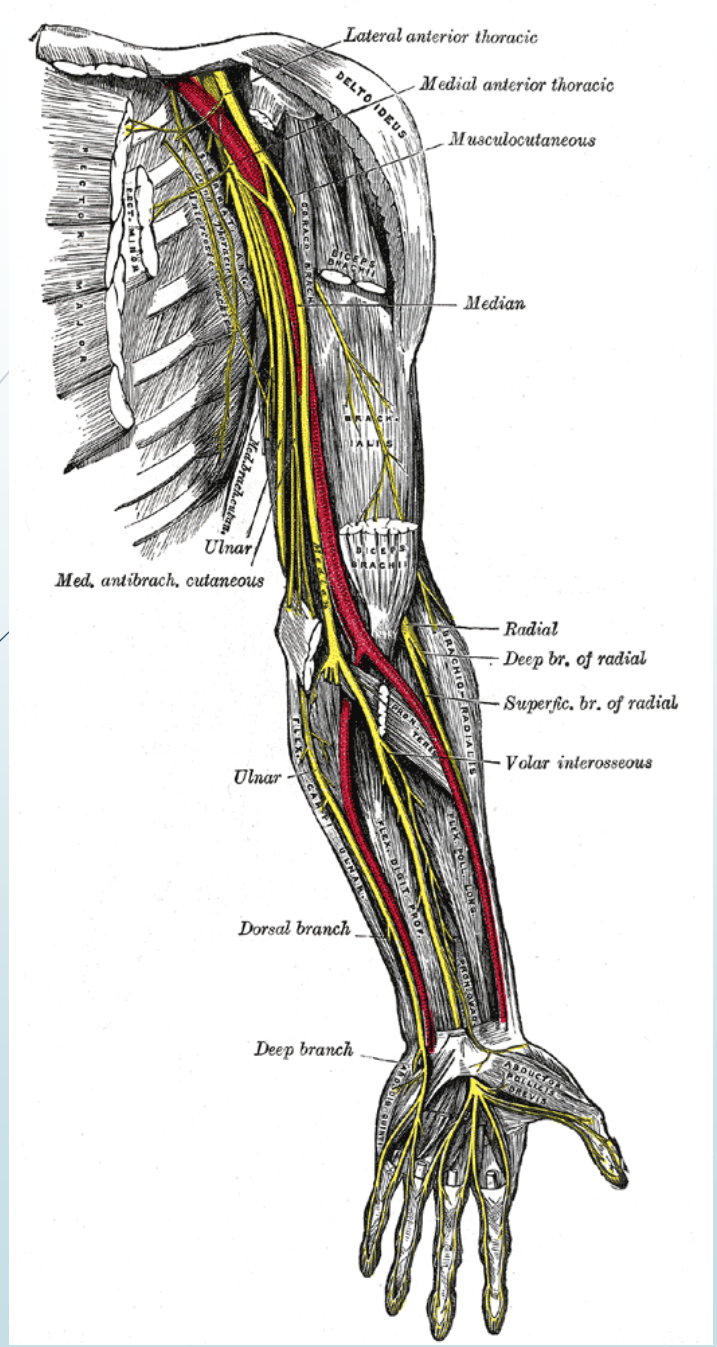
The result is positive if symptoms are reproduced after the wrist is held in a flexed position for 60 seconds or less.

Durkin's compression test

applying direct pressure on the median nerve at the carpal tunnel with his or her thumb (A). The result is positive if symptoms appear within 30 seconds and disappear when pressure is released.

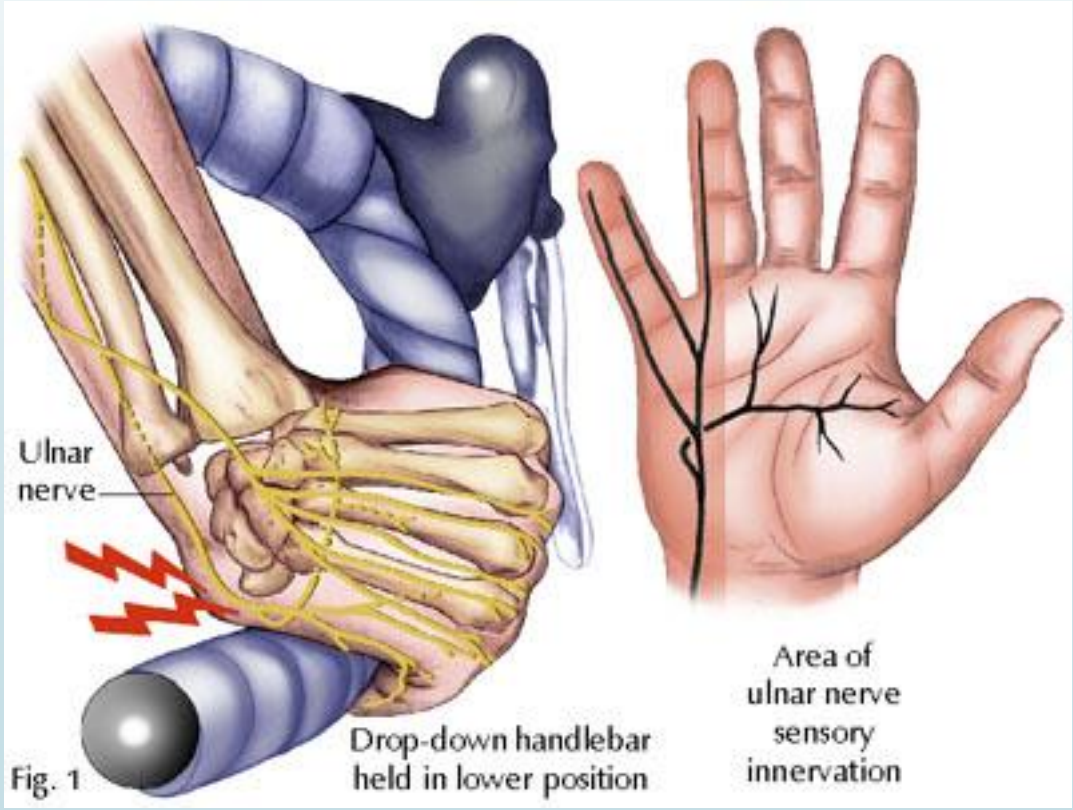
Others: check motor function of the muscle supplied by the nerve

Ulnar nerve injury


Lateral anterior thoracic
Medial anterior thoracic
Musculocutaneous
Median
Ulnar
Med. antibrach. cutaneous
Radial
Deep br. of radial
Superfic. br. of radial
Volar interosseous
Ulnar
Dorsal branch
Deep branch

Causes

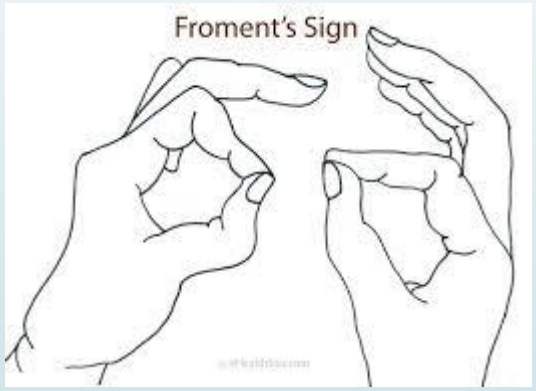
- Direct injury – MVA, cuts on glass
- Entrapment in Guyon's canal
  - Long distance cyclist – pisiform compresses unto handlebars
  - Deep carpal ganglion
  - Ulnar artery aneurysm

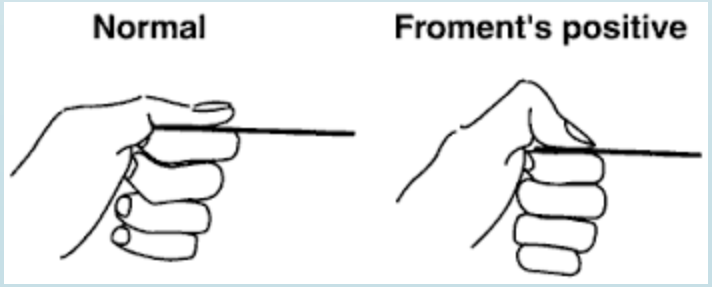


Clinical features

- Numbness of ulnar one and half fingers
- Typical posture in repose – ulnar claw hand
- Hypothenar and interosseous wasting
- Weak finger abduction with loss of thumb adduction

Froment's test



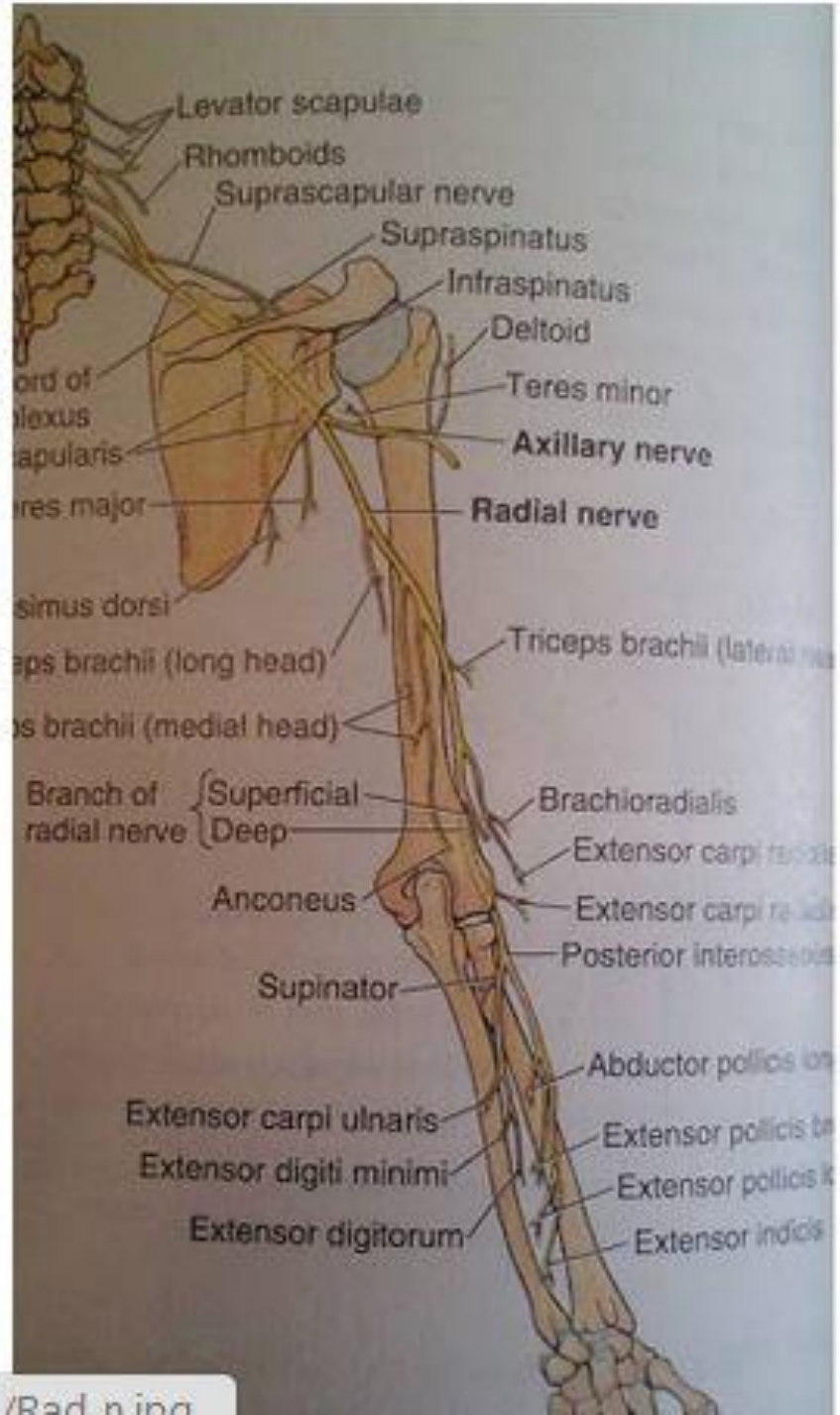


- A powerful flexion of the thumb interphalangeal joint signals weakness of adductor pollicis and first dorsal interosseous with overcompensation by the flexor pollicis longus

High lesions

- Elbow fracture or dislocation
- Hand not markedly deformed :
  - ulnar half of flexor digitorum profundus is paralysed
  - less ‘clawed’
  - ‘high **ulnar paradox**’
- Motor & sensory loss same as in low lesions

Radial nerve injury

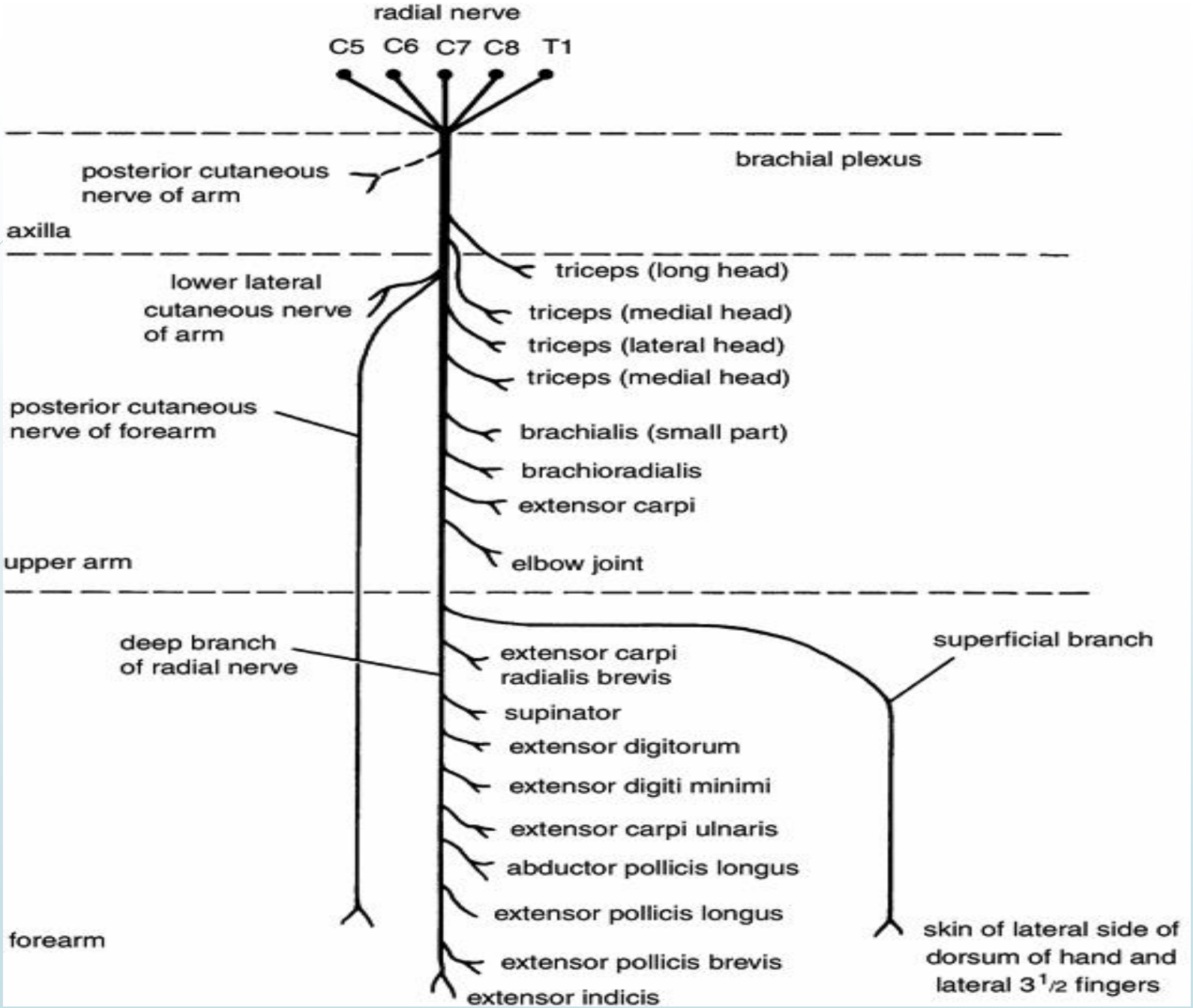


Radial Nerve Path

- Terminal branch of Posterior Cord
- traverses Triangular Interval w/ Deep Brachial Artery
- Thru Radial groove same DBA
- pierces lateral intermuscular septum into anterior compartment of arm
- Runs between Brachialis and Brachioradialis
- Runs anterior to lateral epicondyle
- splits into deep and superficial branches
- Deep: pierces Supinator and becomes Posterior Interosseus nerve
- Superficial: runs under Brachioradialis, emerges from under it at distal forearm, sensory to hand

Common Lesions

1) Mid-Humerus Fx, ivo radial groove*
2) Crutch Palsy
3) Saturday night Palsy
4) Handcuff Palsy


radial nerve
C5 C6 C7 C8 T1
brachial plexus
posterior cutaneous nerve of arm
axilla
triceps (long head)
lower lateral cutaneous nerve of arm
triceps (medial head)
triceps (lateral head)
triceps (medial head)
posterior cutaneous nerve of forearm
brachialis (small part)
brachioradialis
extensor carpi
elbow joint
upper arm
deep branch of radial nerve
superficial branch
extensor carpi radialis brevis
supinator
extensor digitorum
extensor digiti minimi
extensor carpi ulnaris
abductor pollicis longus
extensor pollicis longus
forearm
skin of lateral side of dorsum of hand and lateral 3 1/2 fingers
extensor pollicis brevis
extensor indicis

Levels of lesion

- The radial nerve may be injured at the
  - Elbow (low lesion)
  - Upper arm (high lesion)
  - Axilla (very high lesion)

Low lesions (elbow) - PIN

- Cause:
  - fractures or dislocations of elbow (especially around radial head/neck)
  - local wound
  - Operation of proximal radius
- Symptoms:
  - Inability to extend MCP joint – finger drop
  - Thumb: weak extension & retroposition
  - Wrist extension preserved (ECRL intact)

High lesion (upper arm)

- Cause:
  - Fracture of distal 3rd humerus
  - Prolonged tourniquet pressure
- Symptoms:
  - Inability to extend MCP joint
  - Thumb: weak extension & retroposition
  - Wrist drop
  - Sensory loss: anatomical snuffbox

Very high lesion (axilla)

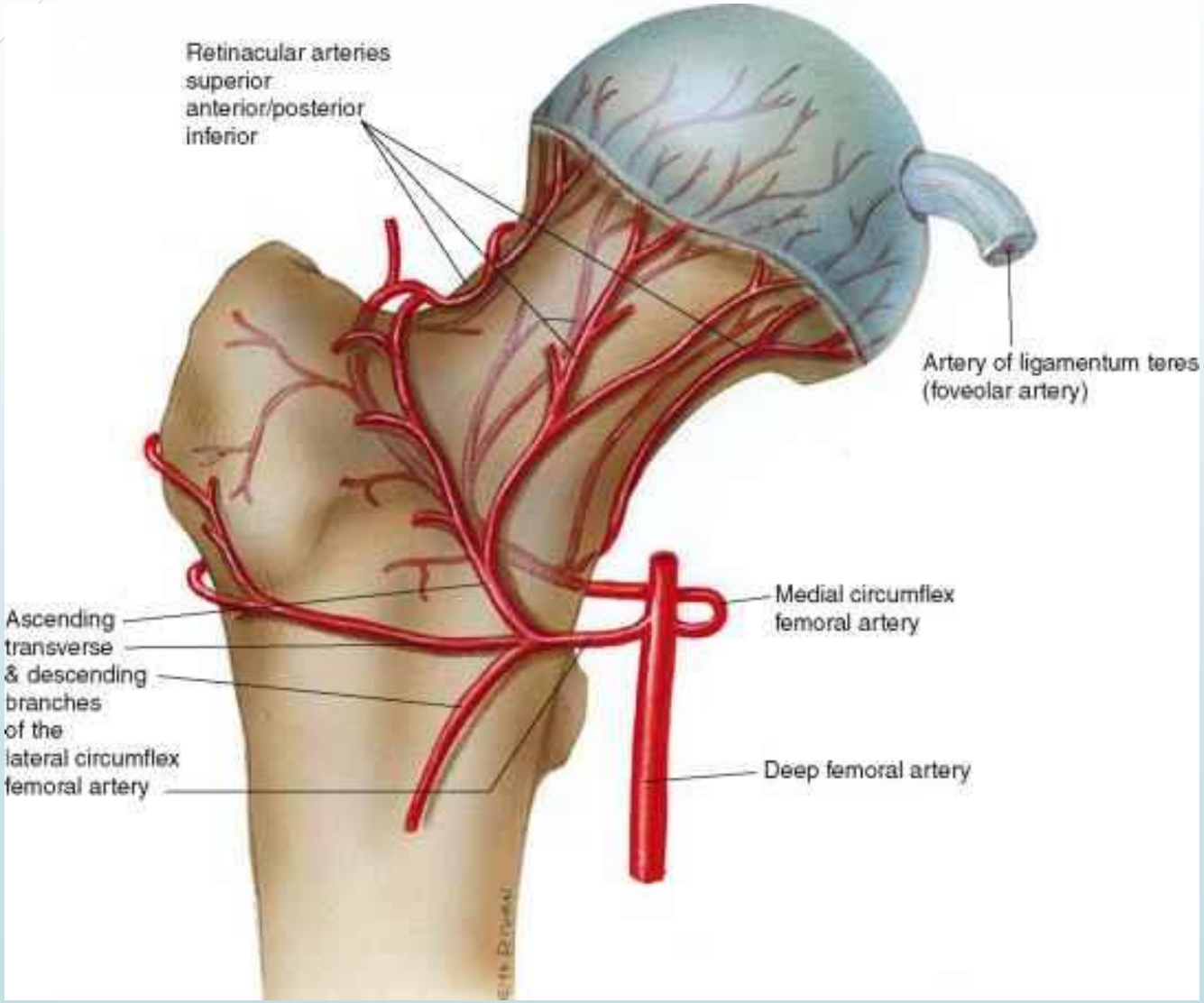
- Cause:
  - Trauma
  - Operation
  - Compression (Saturday night palsy; crutch palsy)
- Symptoms:
  - Weak hand extension
  - Weak wrist extension
  - Paralysed triceps (tricep reflex absent)

Injuries which disrupt bone vascularity

Which injuries?

- Neck of femur fractures
- Talus fracture
- Scaphoid fractures

Neck of femur

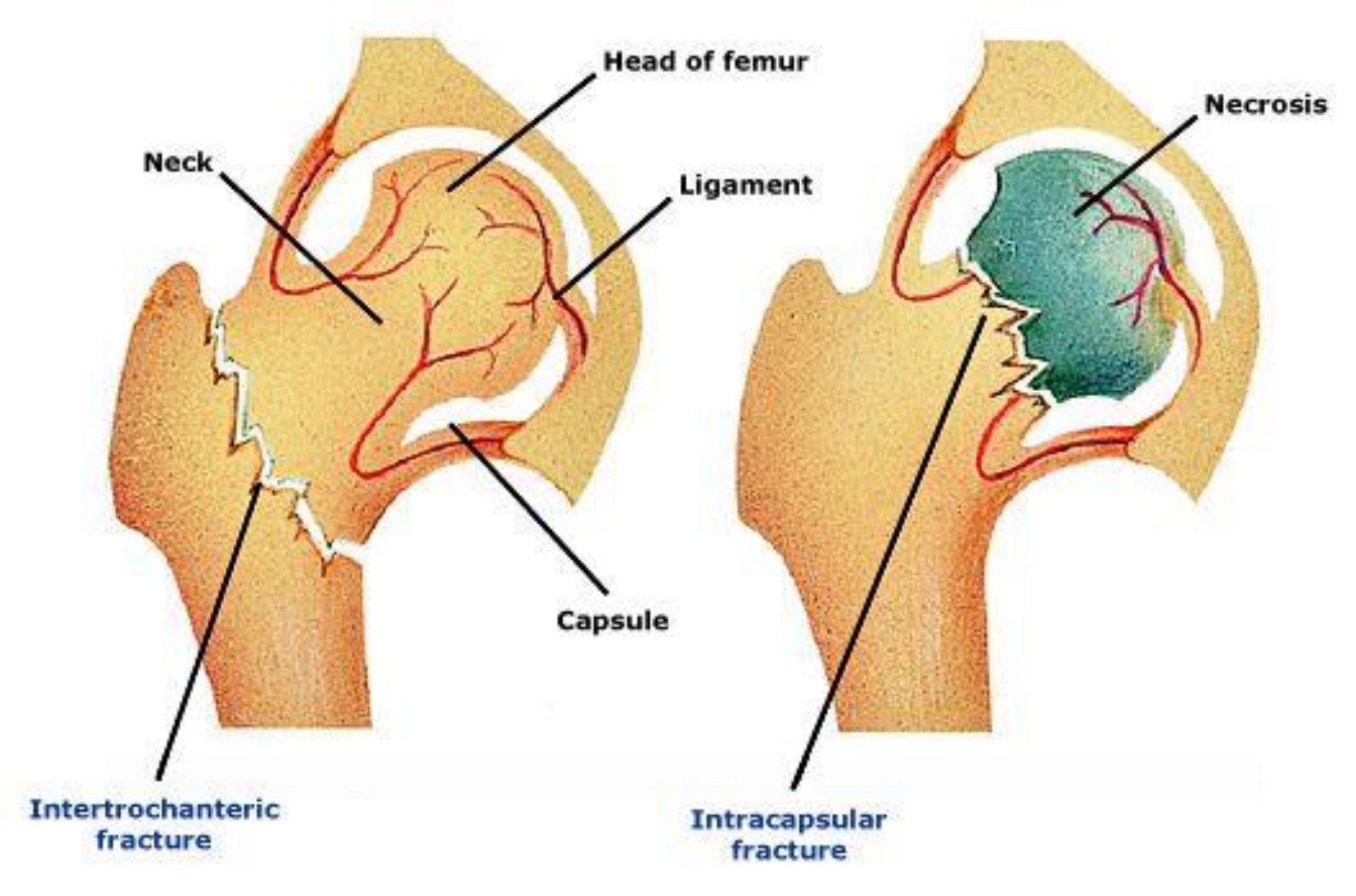


MAIN SUPPLY?

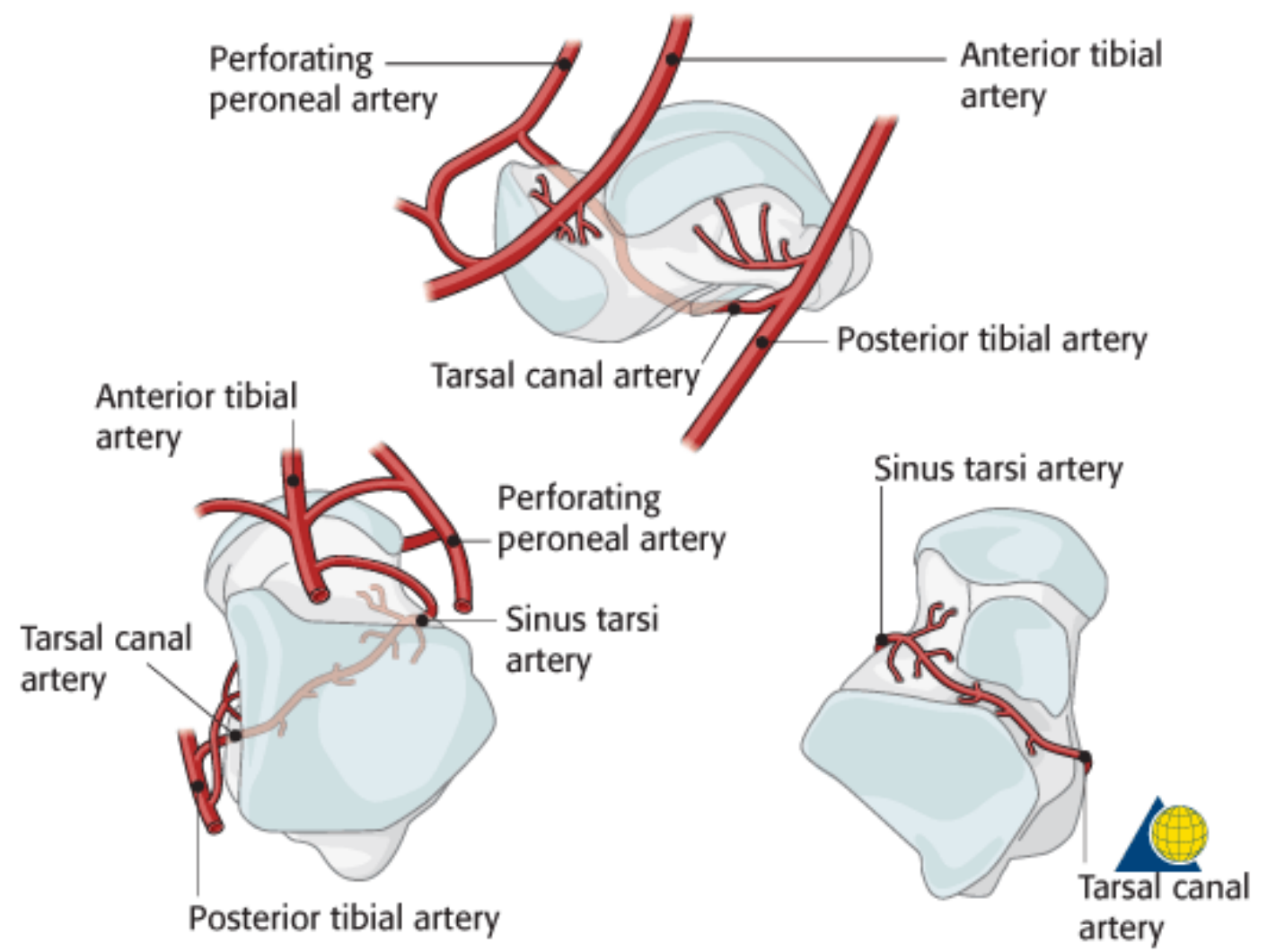
Neck of femur

- 2 anastomosis
  - Trochanteric – centered trochanteric fossa
  - Cruciate – centered lesser trochanter
- Extracapsular arterial ring
- Ascending cervical vessels – retinacular artery
- Subsynovial ring (of Chung)
- Artery of ligamentum teres
- Intramedullary supply – branch from superior nutrient artery

Neck of femur



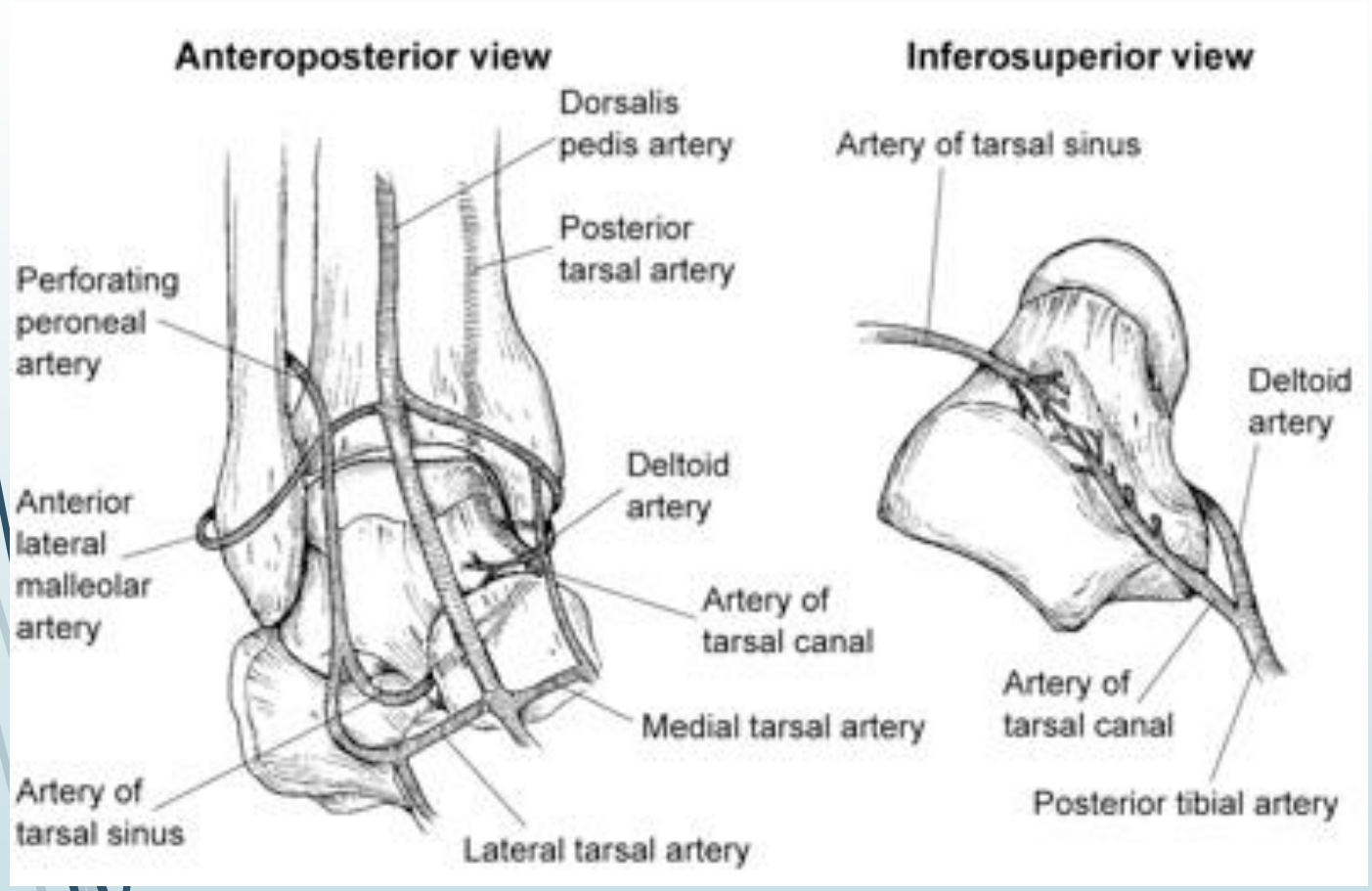
Talus fracture

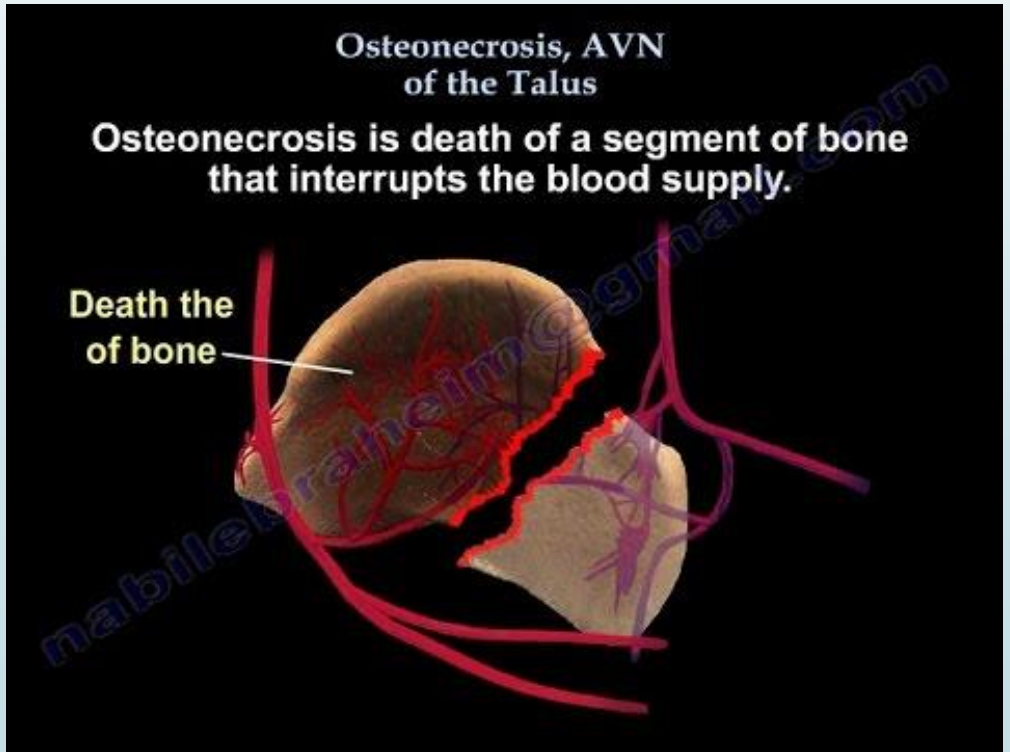


Talus fracture

- Posterior tibial artery
  - Deltoid branches – medial 1/3 of talar body
  - Artery of the tarsal canal
- Anterior tibial artery
  - Artery of tarsal sinus – anastomose with tarsal canal artery

Talus fracture

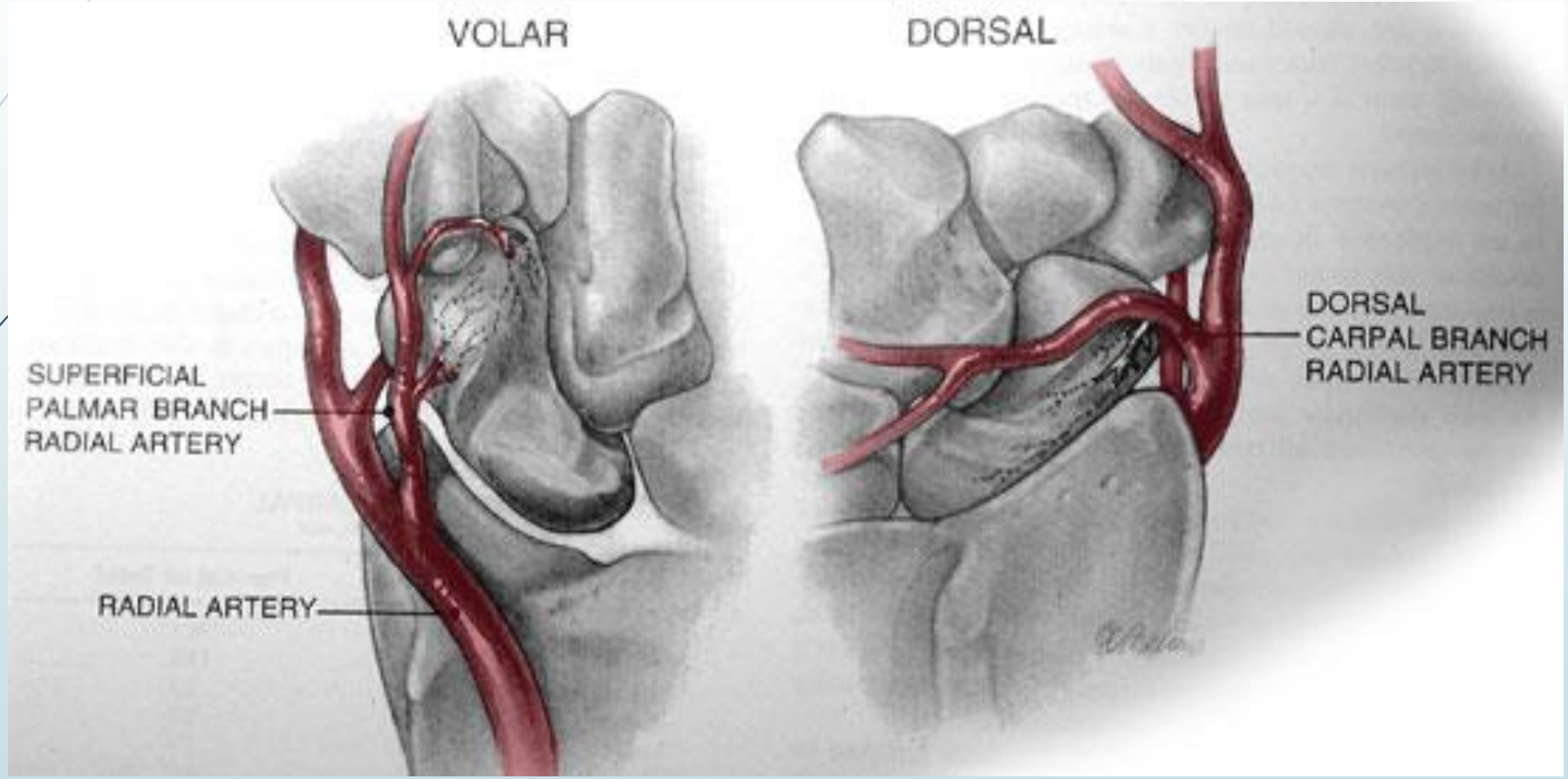




Talus fracture

- Head of talus
  - Medial – branches of DPA
  - Lateral – artery of tarsal sinus
- Body of talus
  - Lateral 1/3 – artery of tarsal sinus
  - Middle 1/3 – anastomosis of tarsal sinus and tarsal canal arteries
  - Medial 1/3 – deltoid artery

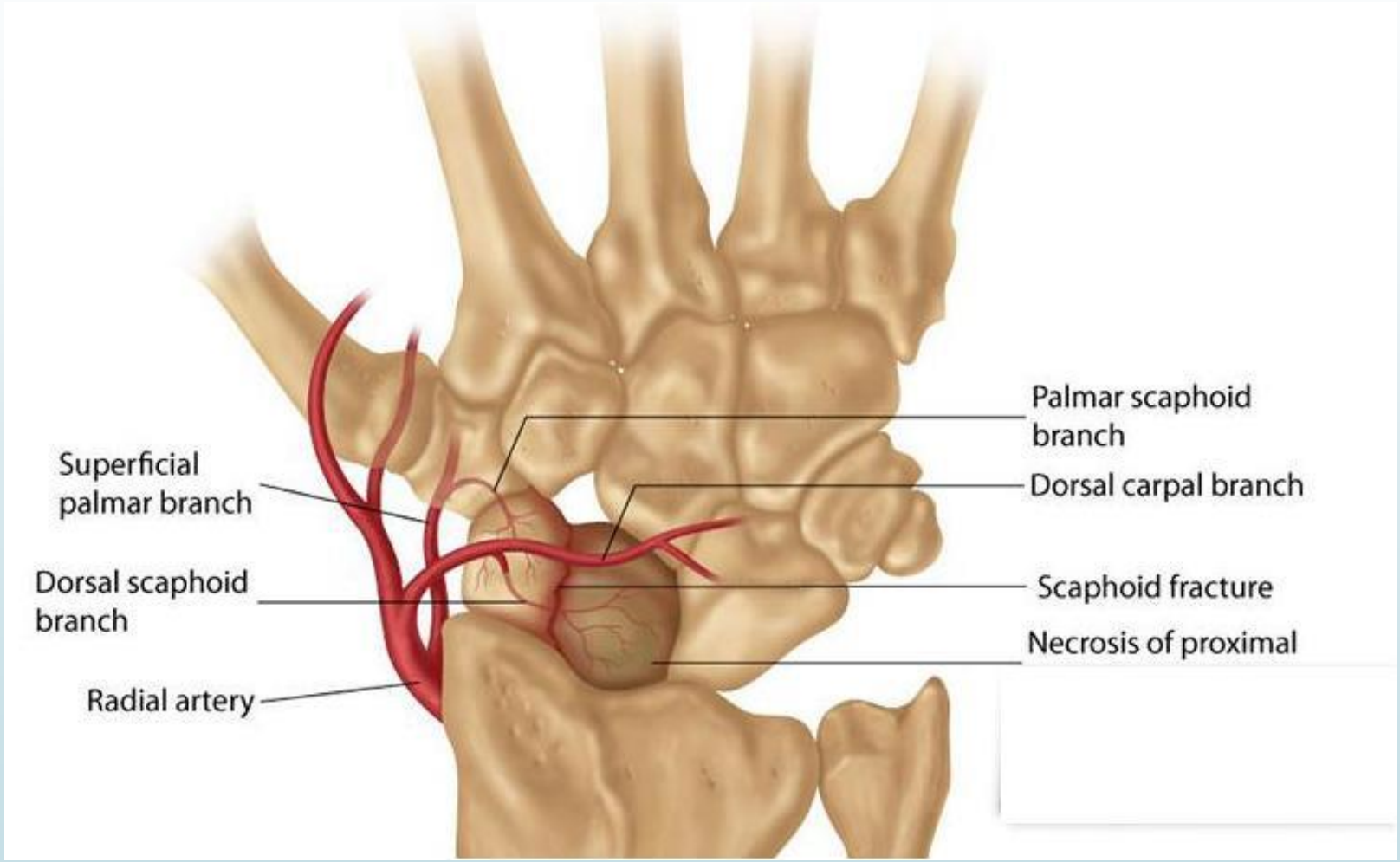
Scaphoid fracture



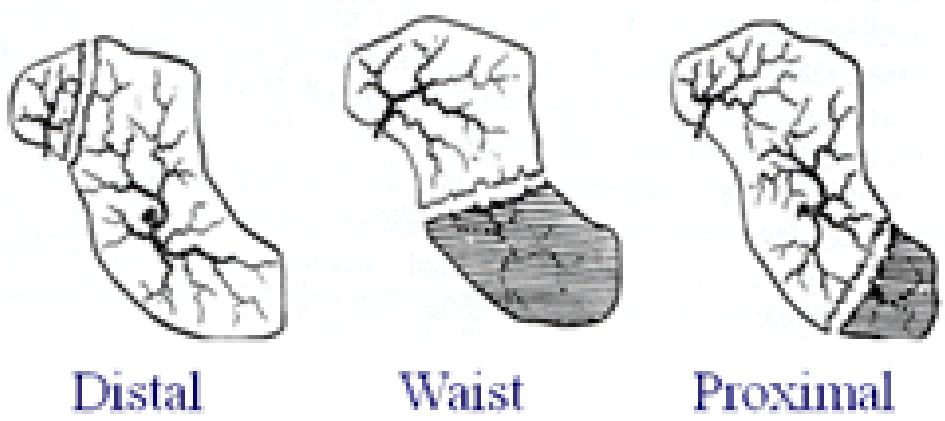
Scaphoid fracture

- Main supply from radial artery
- Dorsal scaphoid branch
  - Enters scaphoid at distal dorsal ridge - waist
  - 70-80% of scaphoid supply
- Volar scaphoid branch
  - enters scaphoid at distal volar
  - 20-30% of scaphoid supply
- NO supply at proximal – blood supply one way

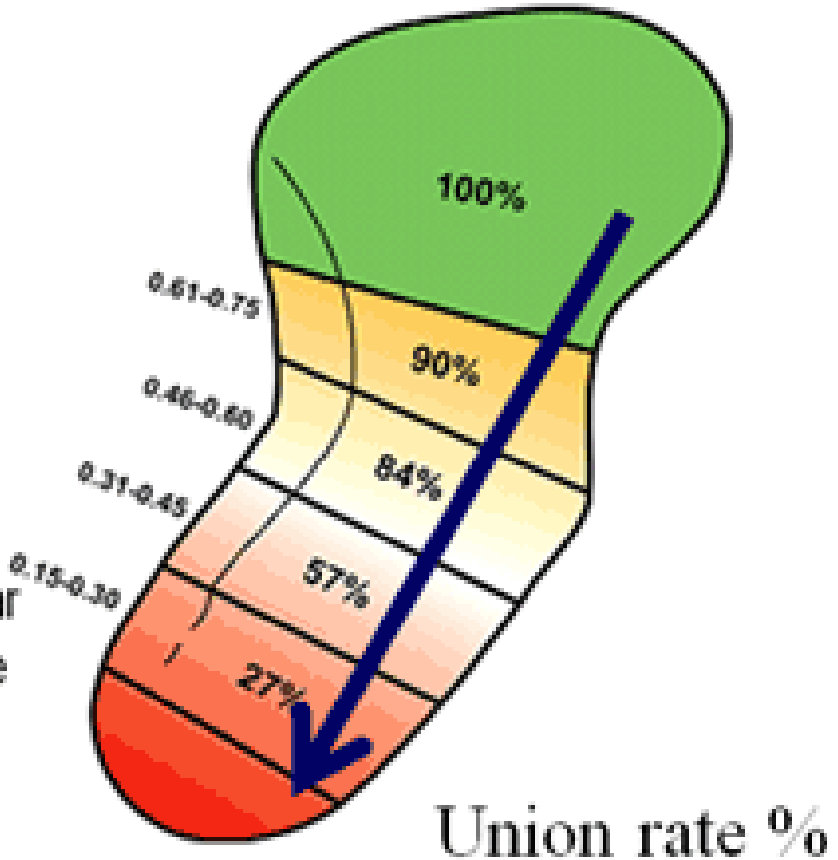
Scaphoid fracture



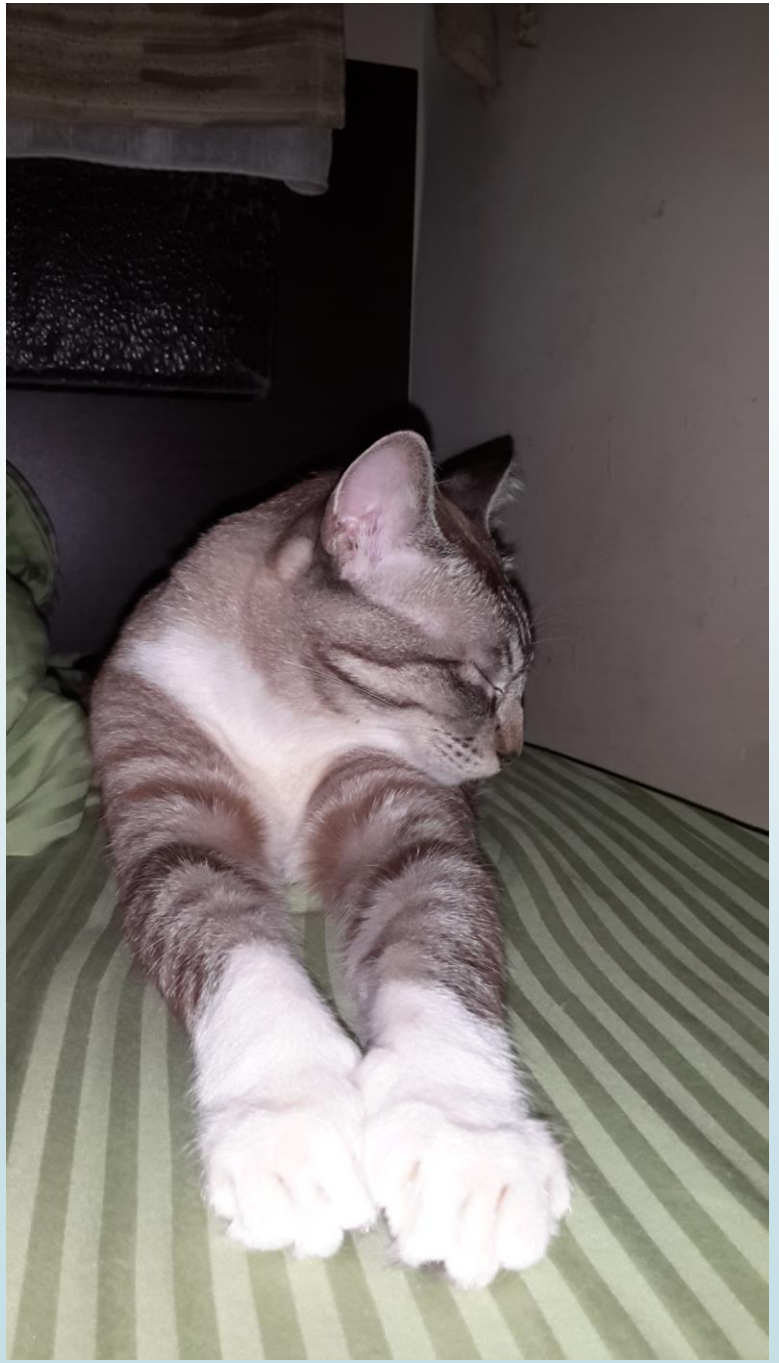
Scaphoid fracture



The scaphoid has a blood supply which only comes from one direction. This diagram shows how a fracture in the bone near to the wrist (proximal pole) will leave the small fragment at the bottom with no blood supply. Diagram showing decrease in union rate as you get closer to the proximal pole.



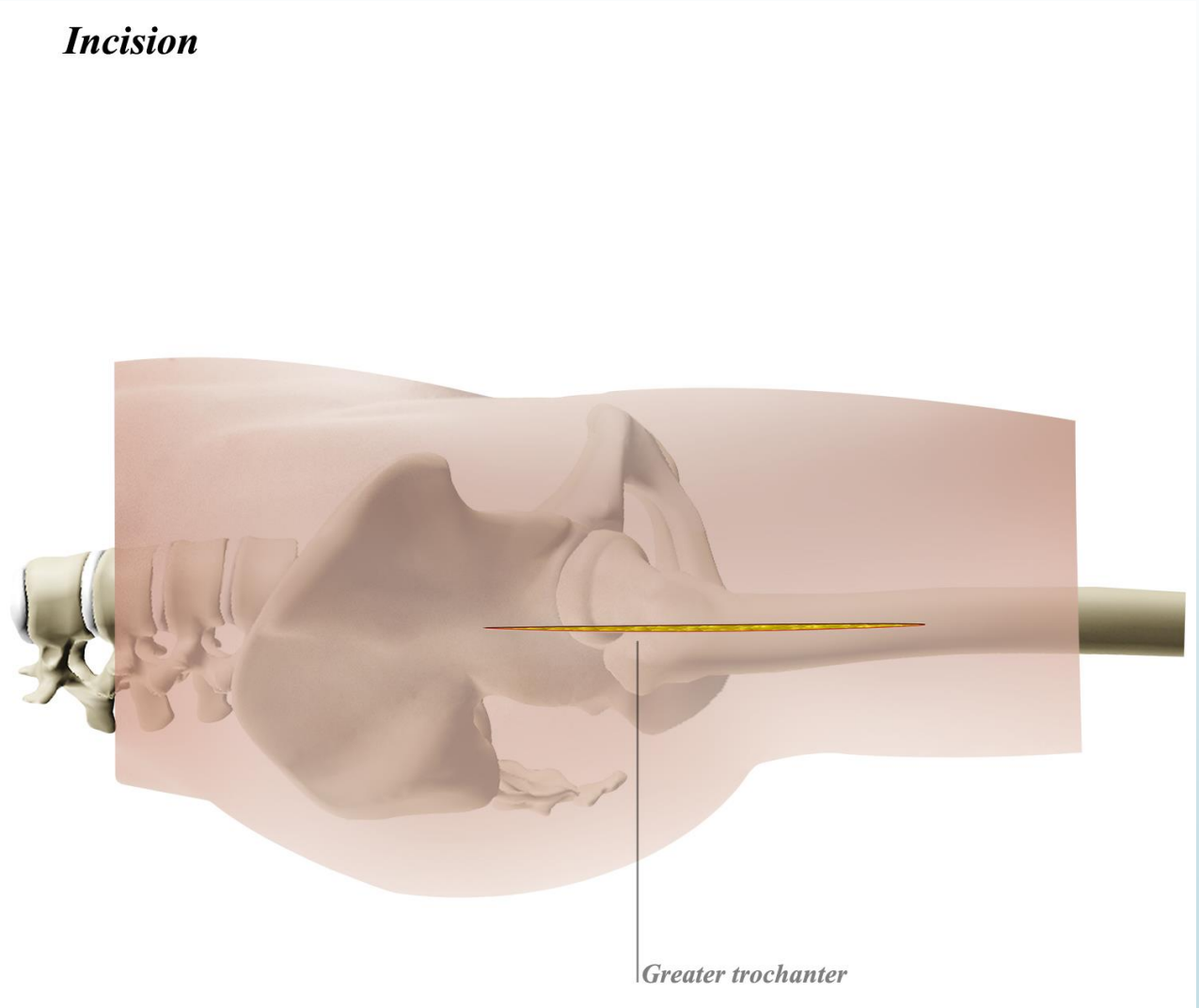
Rest for 15 minutes



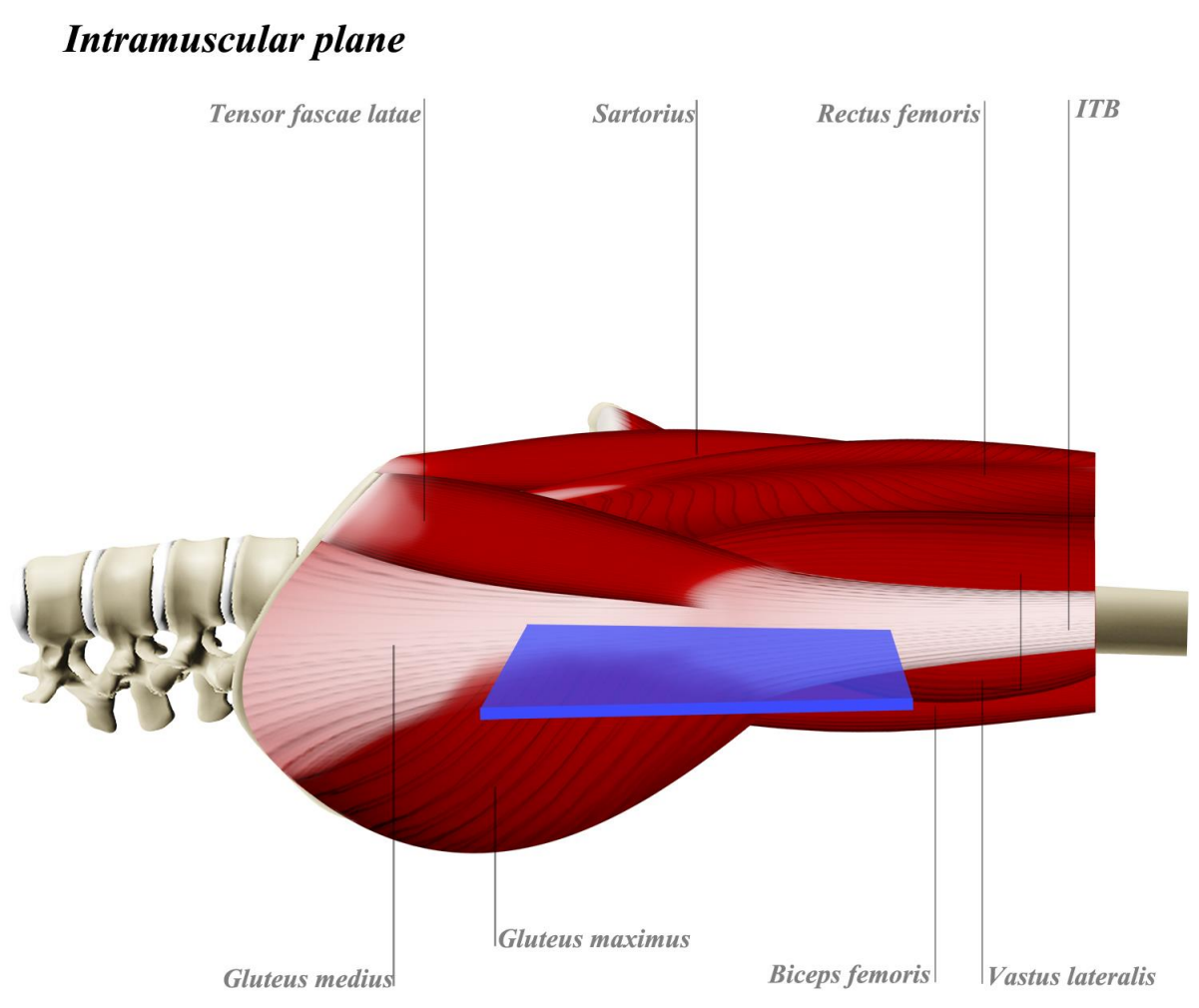
Surgical approaches

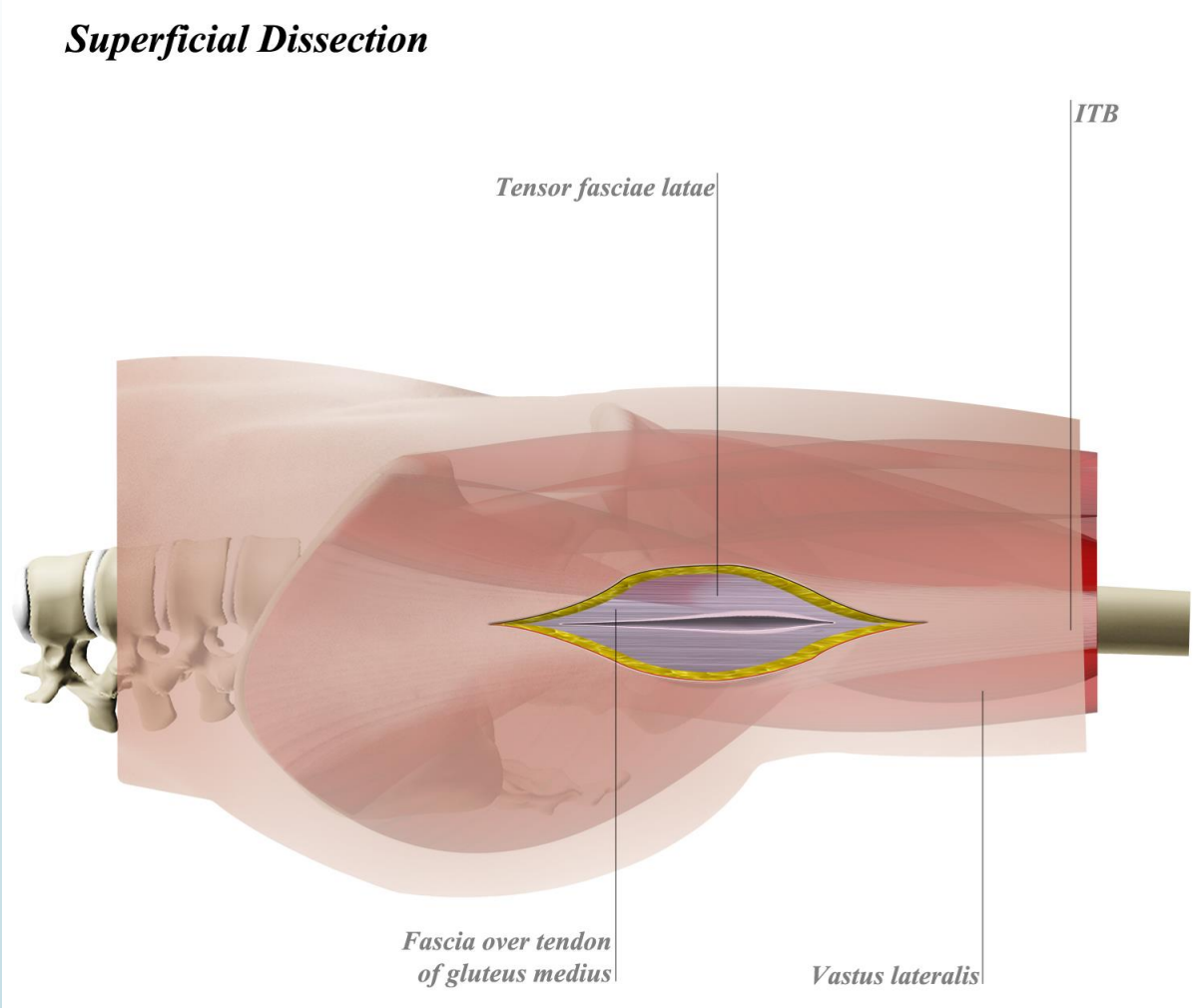
Hip and knee

Hip – lateral approach

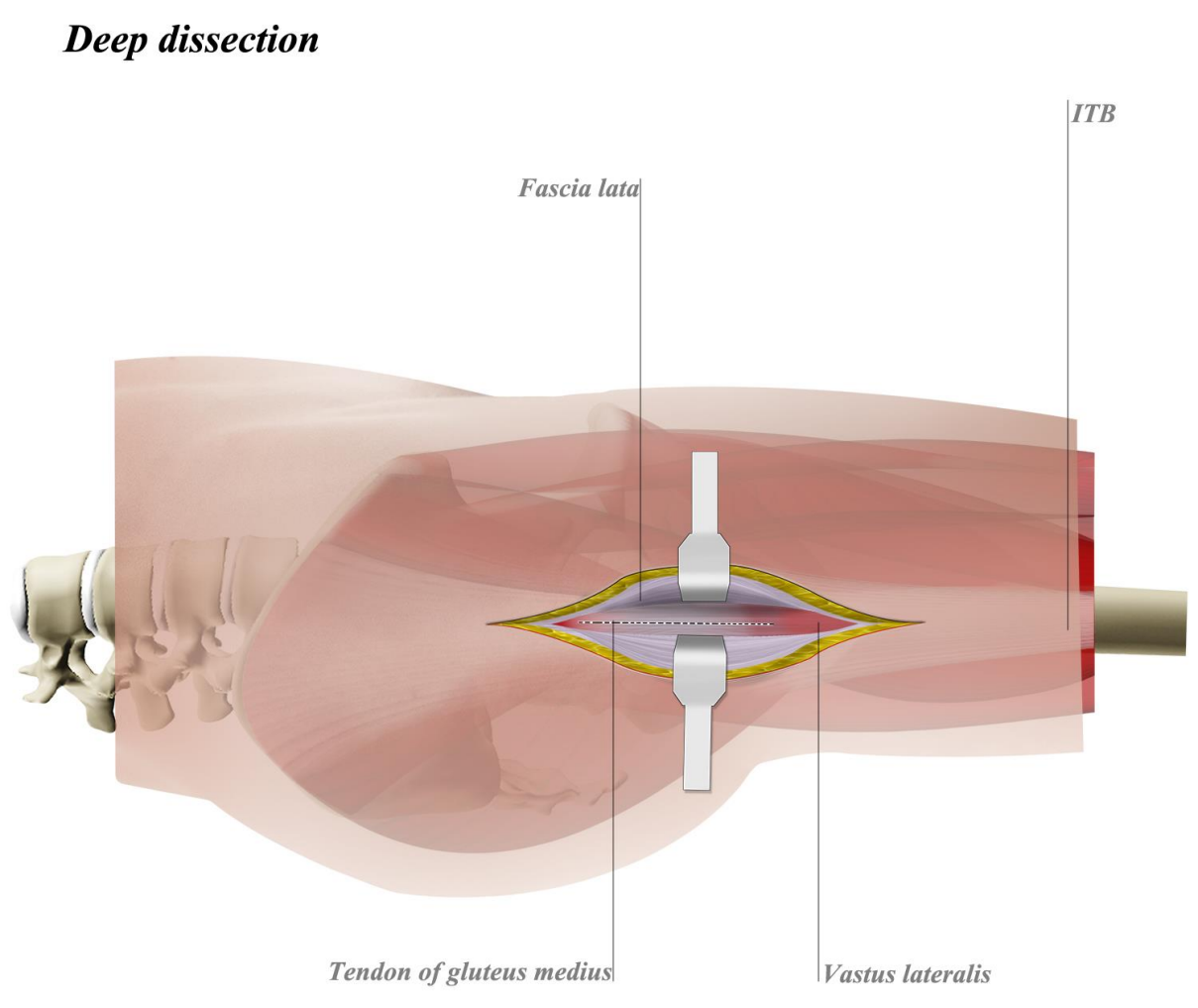


Hip – lateral approach





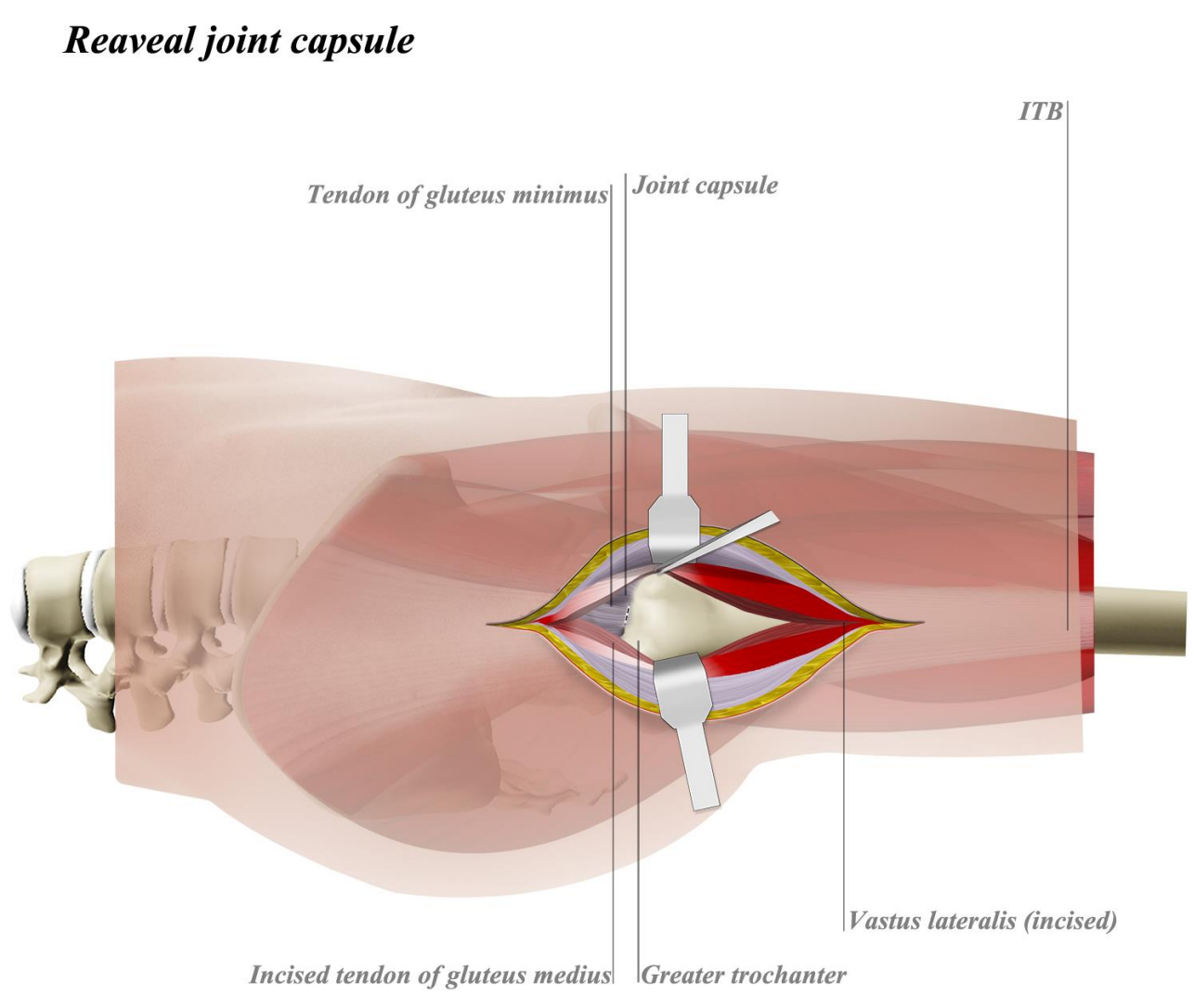
Hip – lateral approach



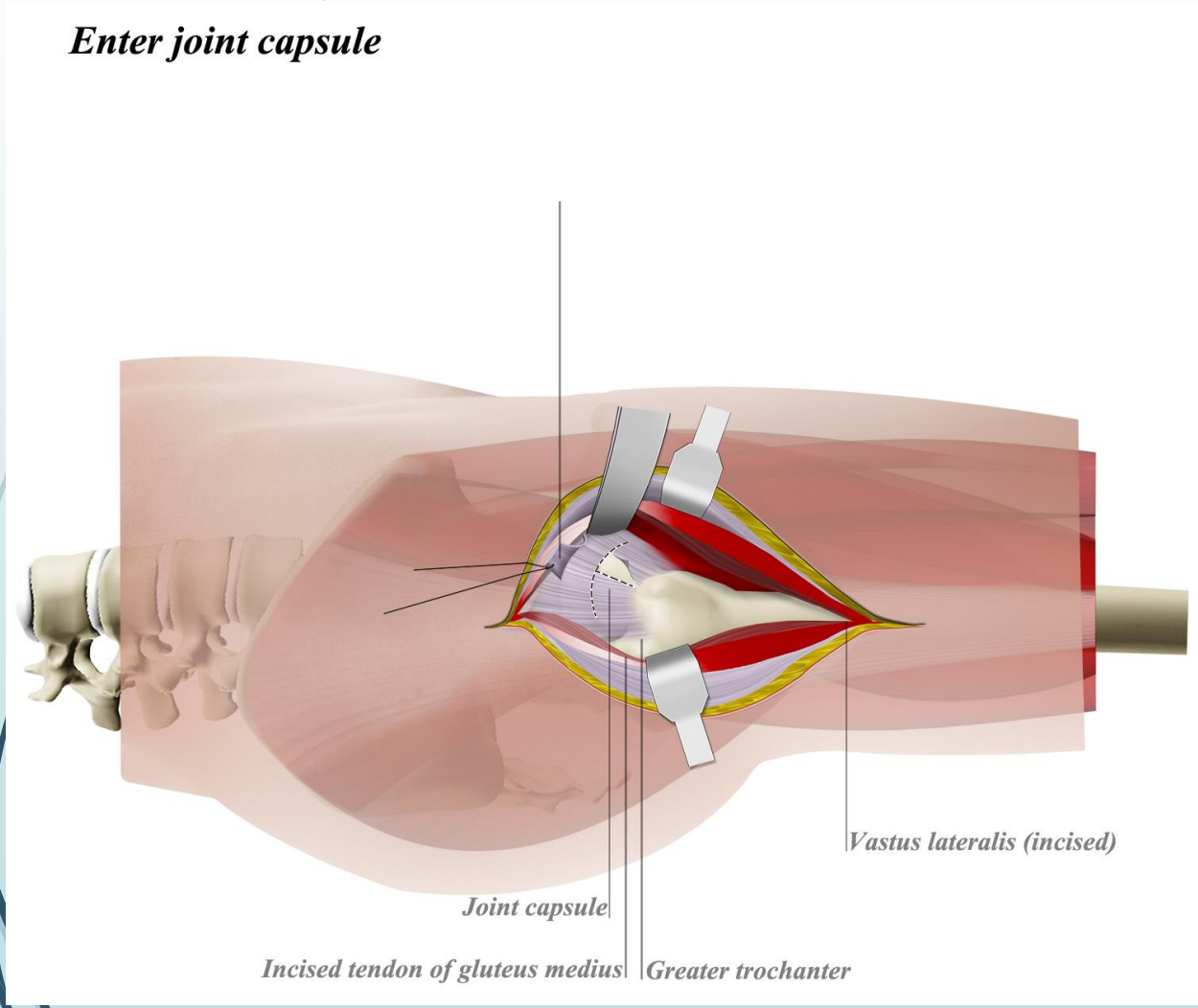
- What will be encountered before tendon?
- How far proximally can go? Why?
- Effect of incising glut medius tendon?

Hip – lateral approach

If difficult to obtain good exposure of capsule?

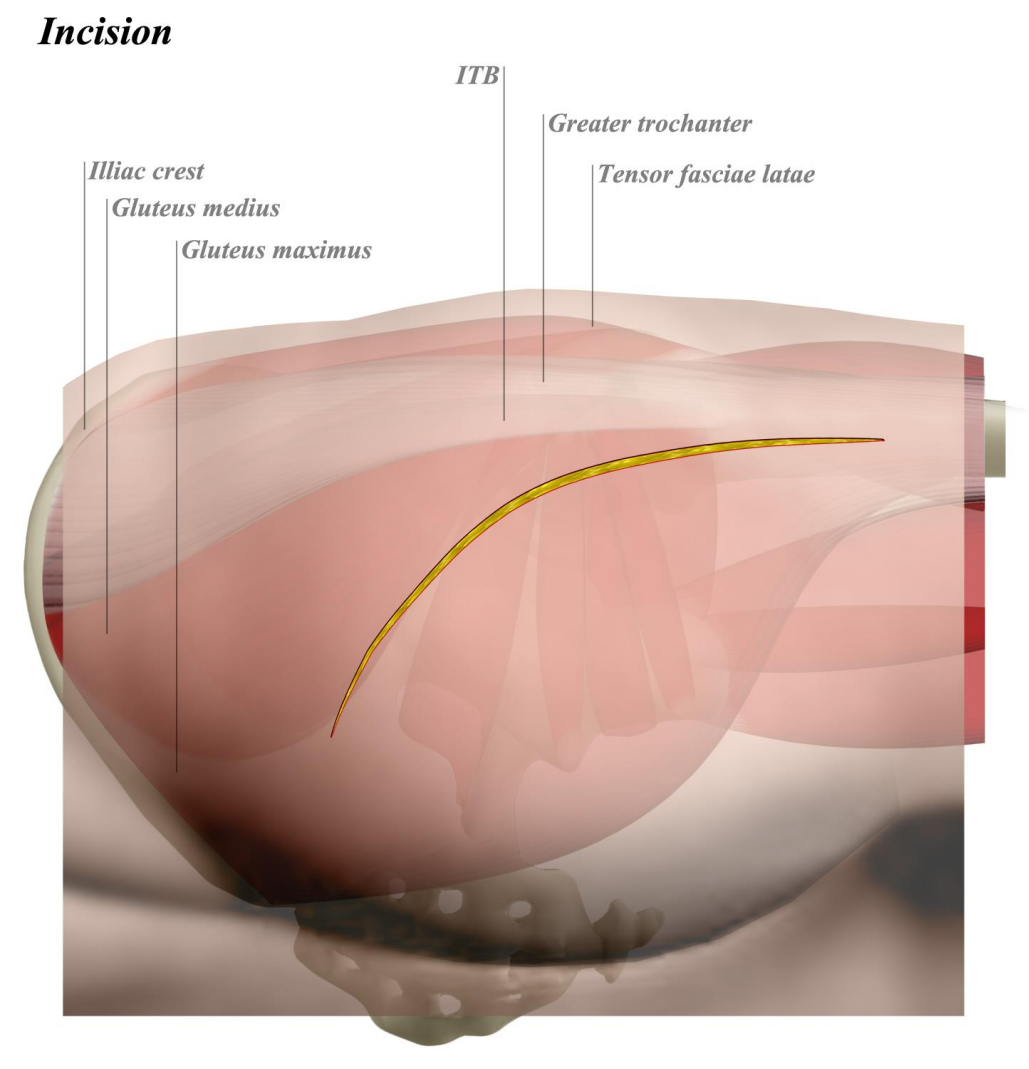


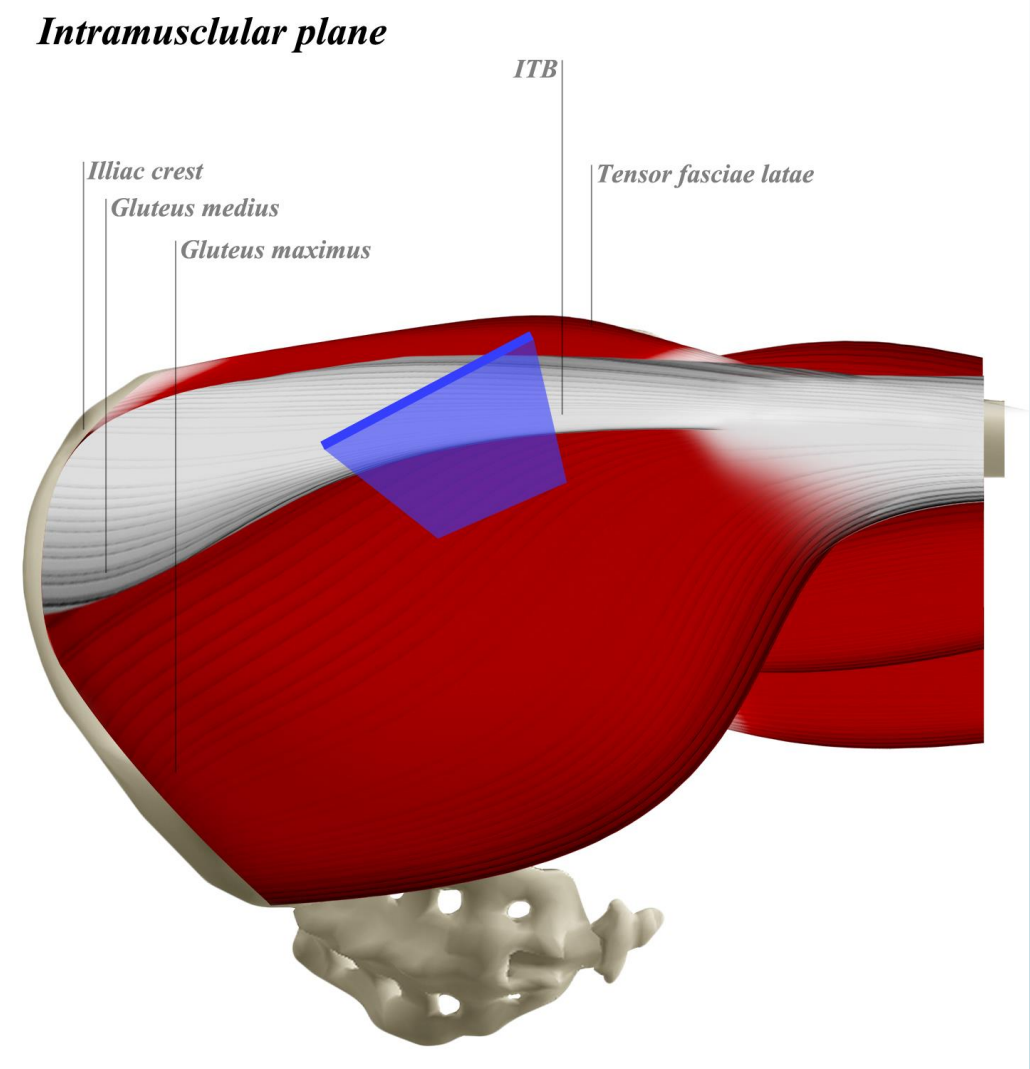
Hip – lateral approach



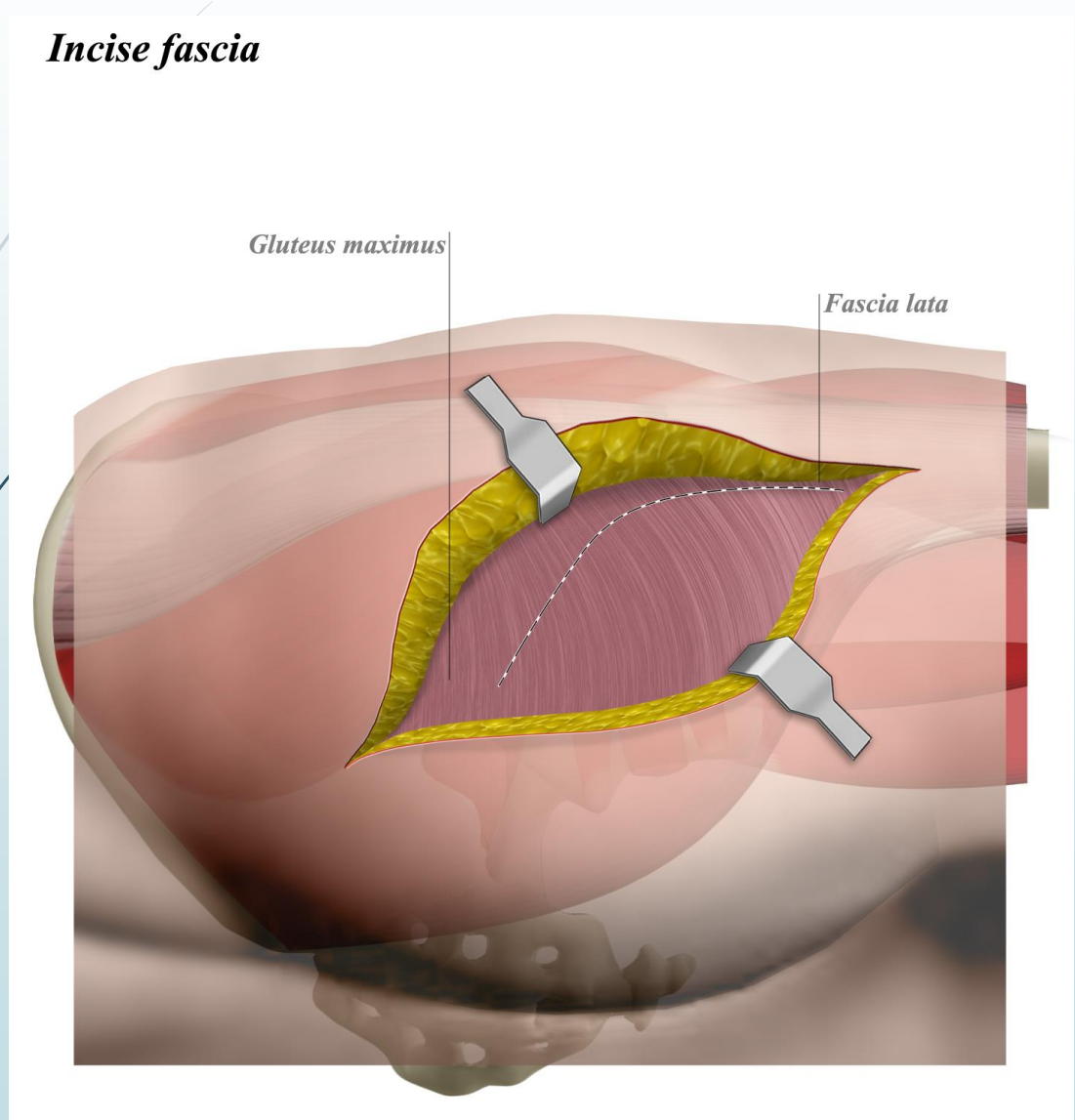
Which tendon to incise before reach joint capsule?

Hip – posterior approach



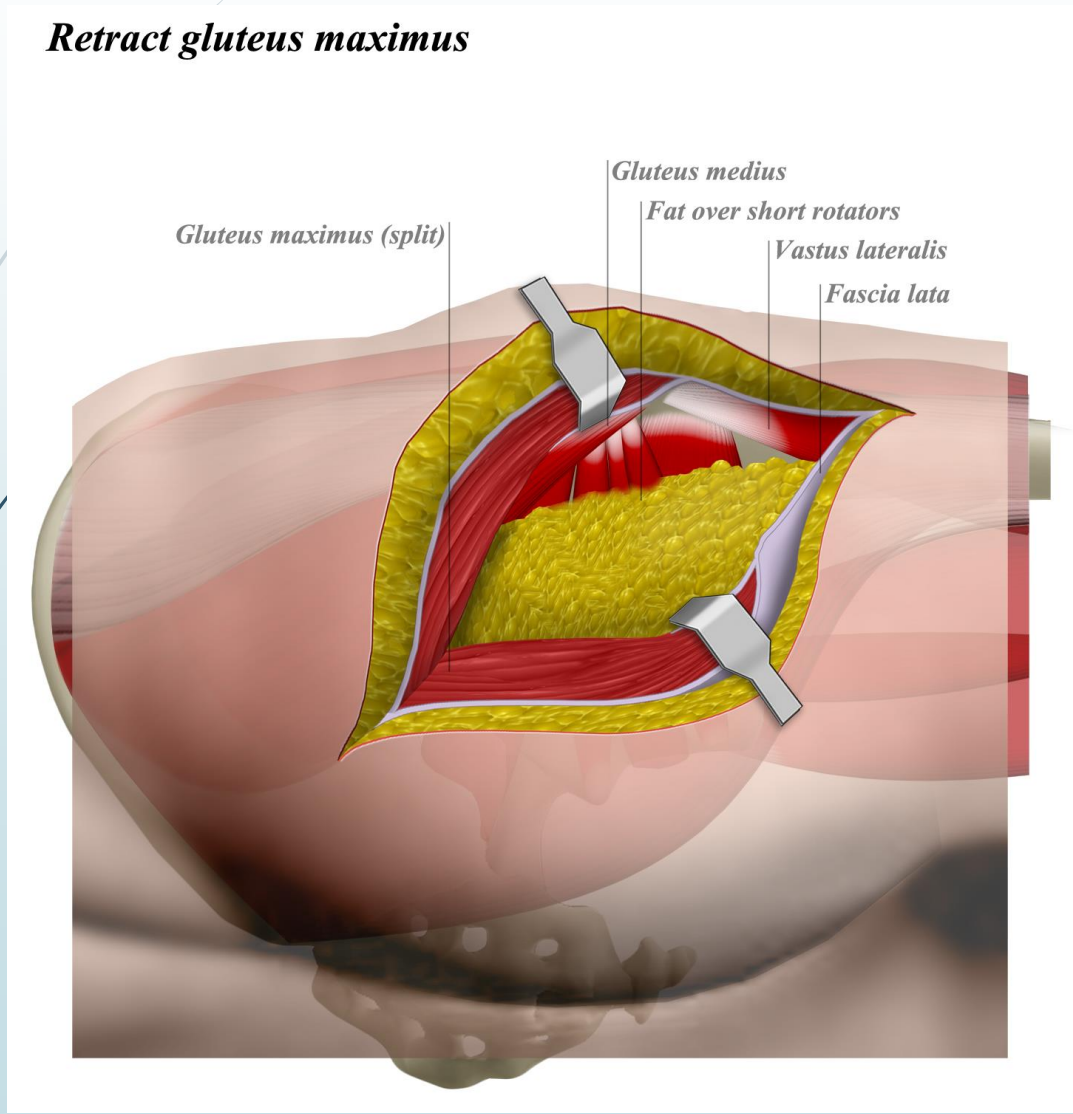


Hip – posterior approach



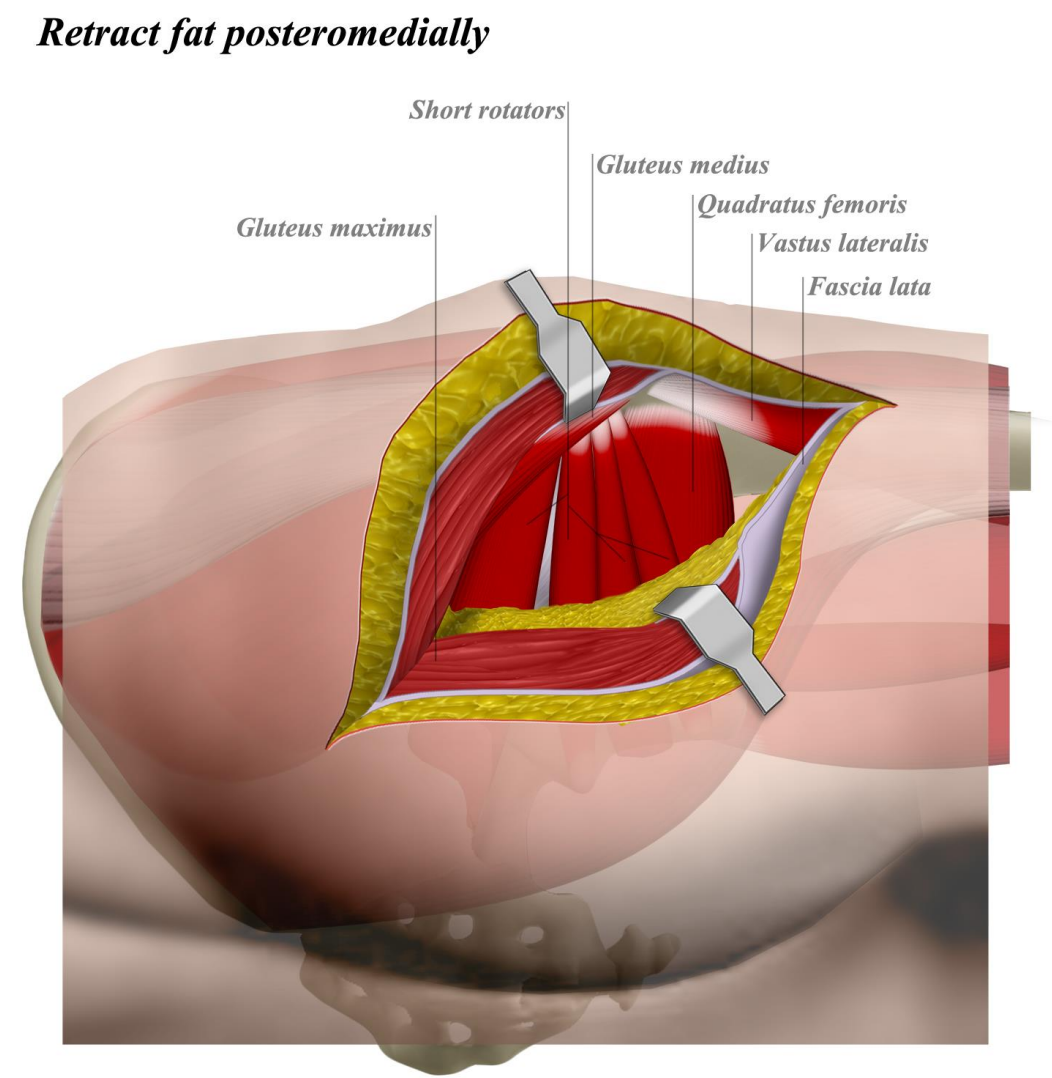
- Bluntly dissect the glut maximus
- What structure has to be identified?

Hip – posterior approach



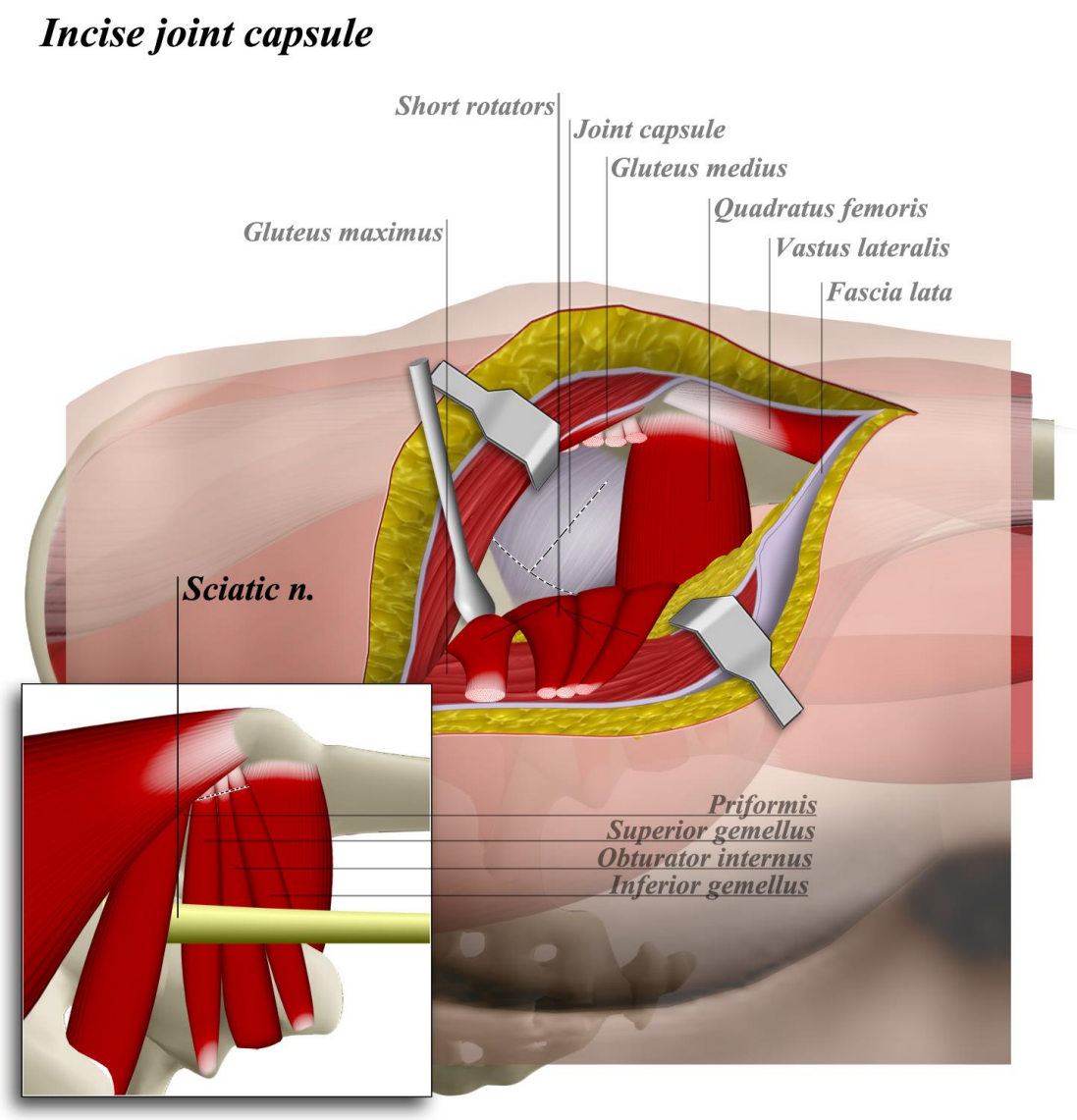
- Push the fat posteromedially
- What lies in the fatty tissue?

Hip – posterior approach



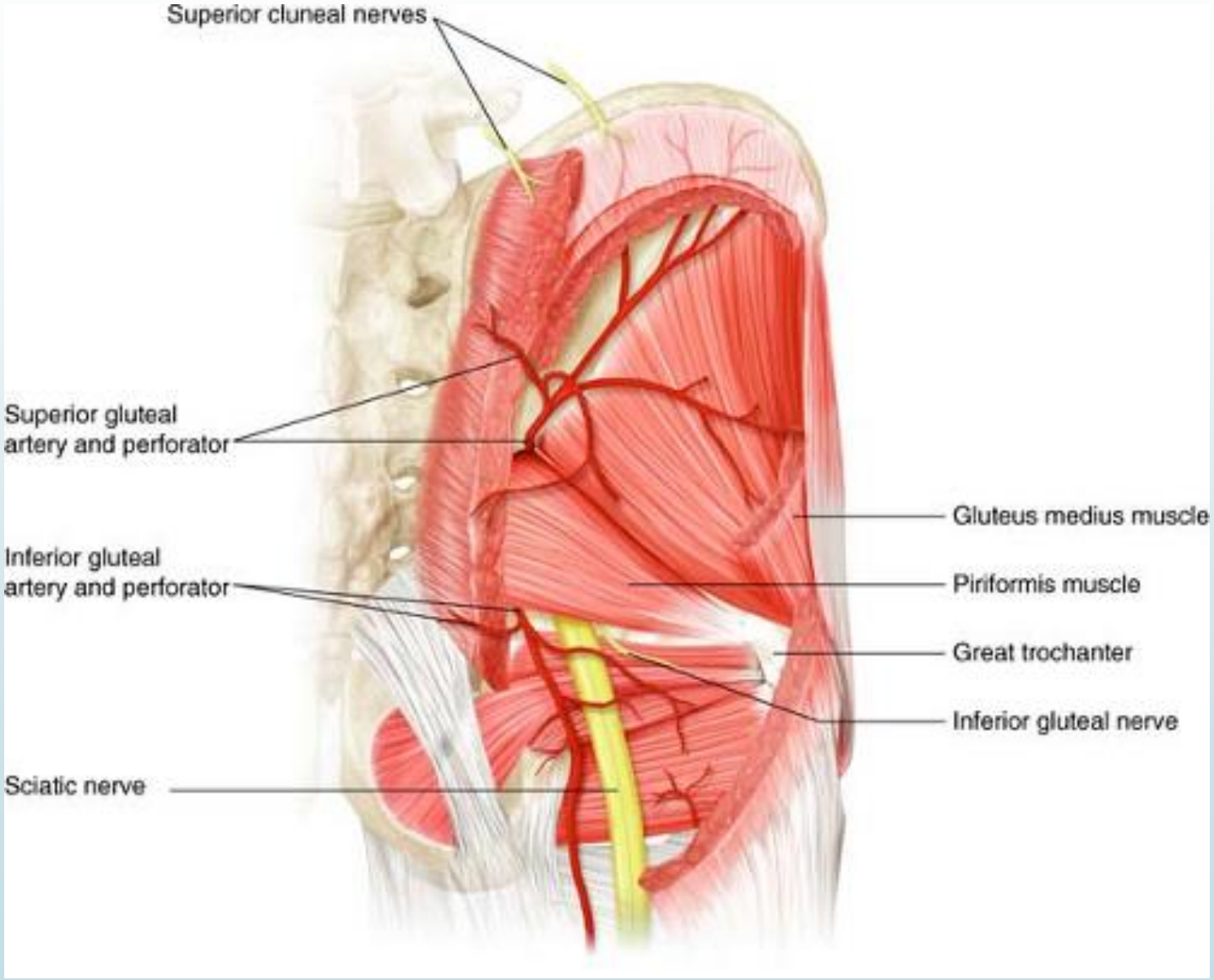
- Internal rotate the hip – why?
- Stay suture at insertion of short rotators
- How to retract? Why?

Hip – posterior approach



- Incise the short rotator at their insertion
- Can we incise the quadratus femoris?
- Structures in danger?

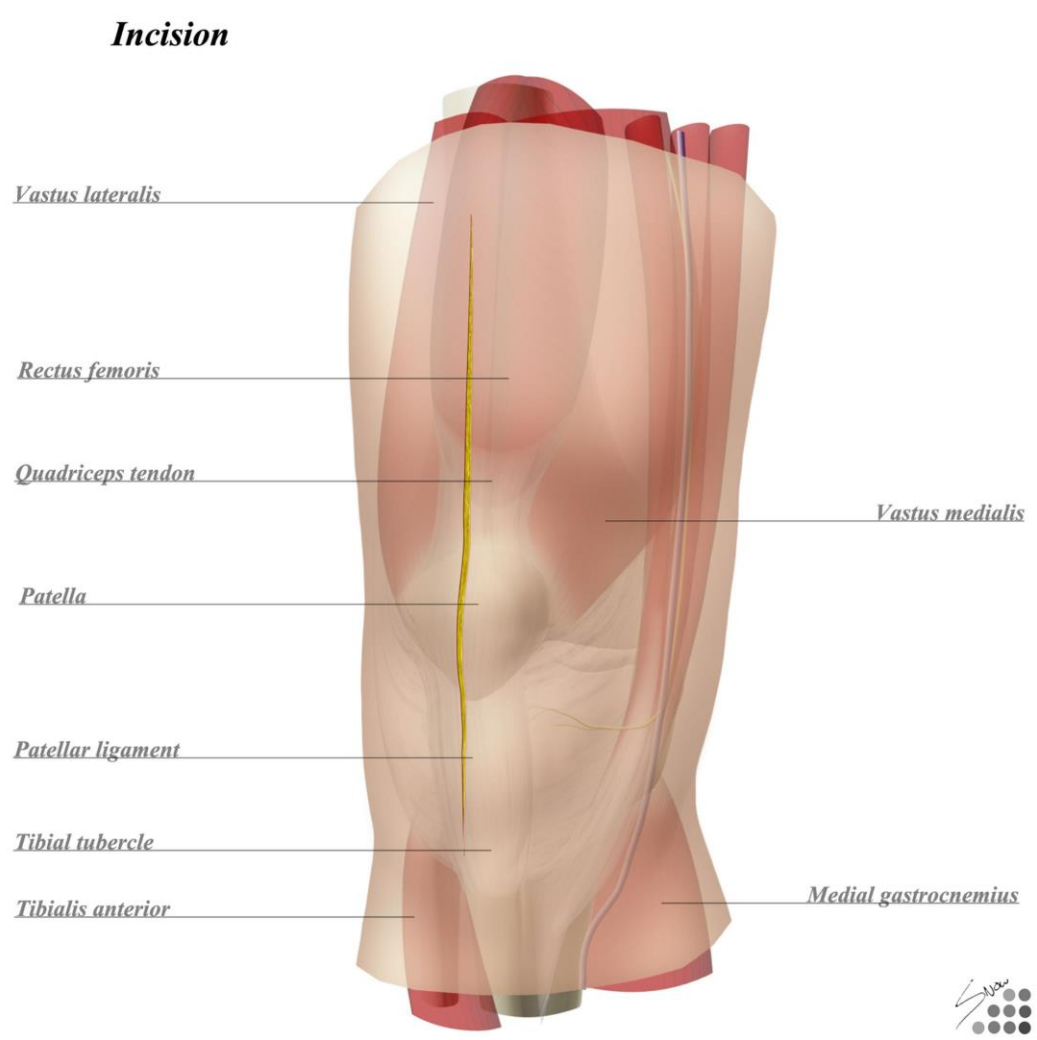
Hip – posterior approach

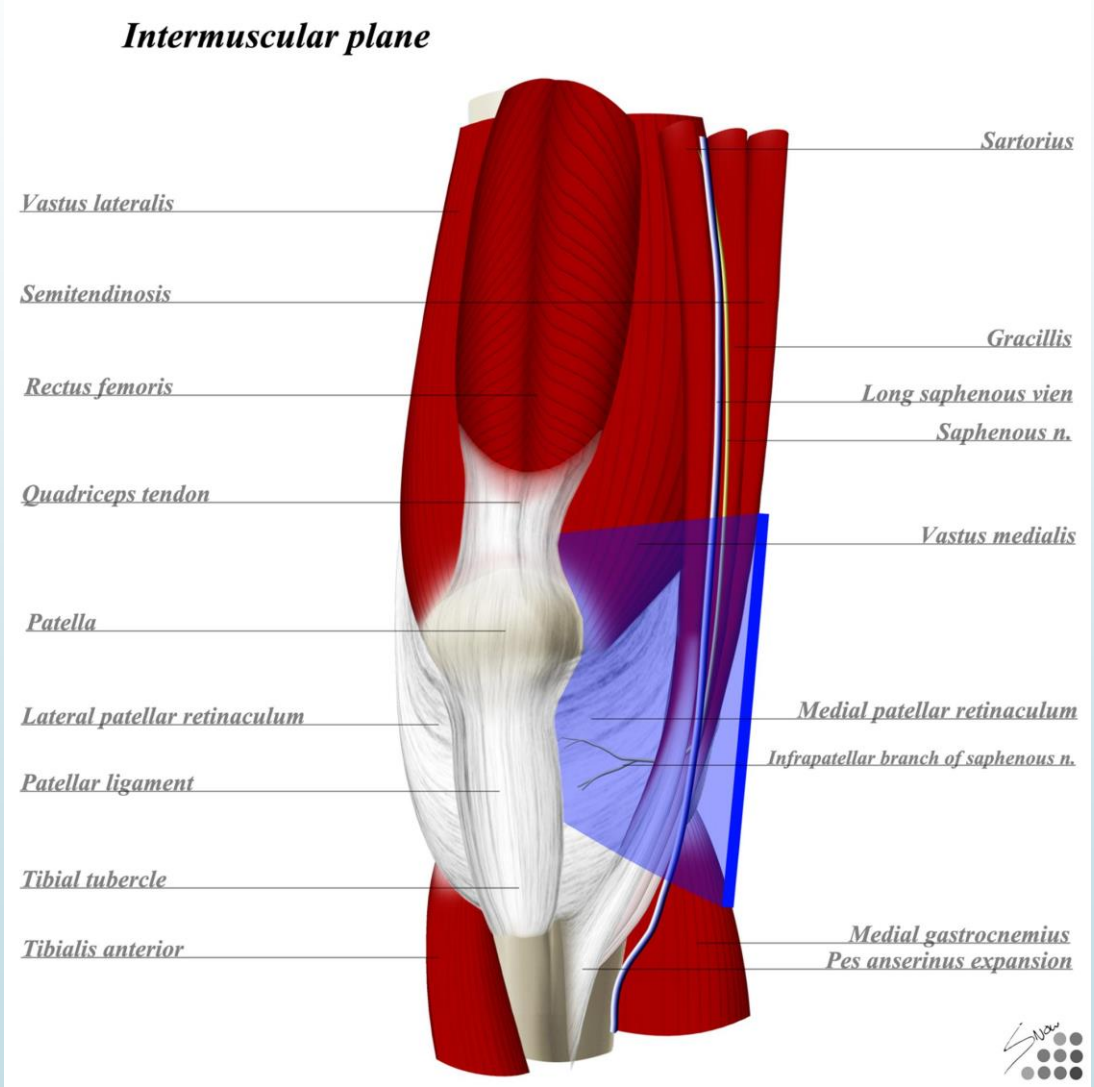


Hip approaches

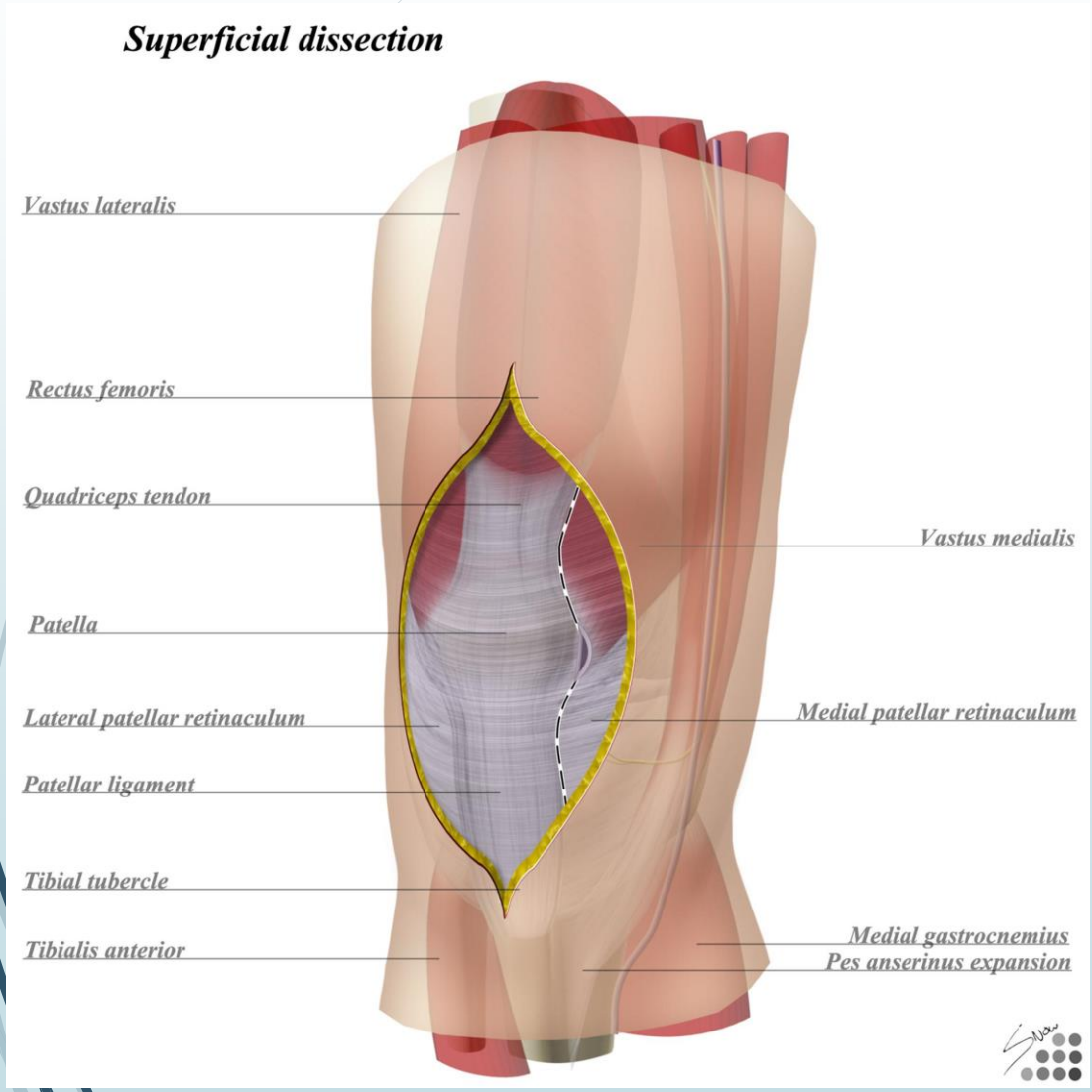
- Pros and cons of each?

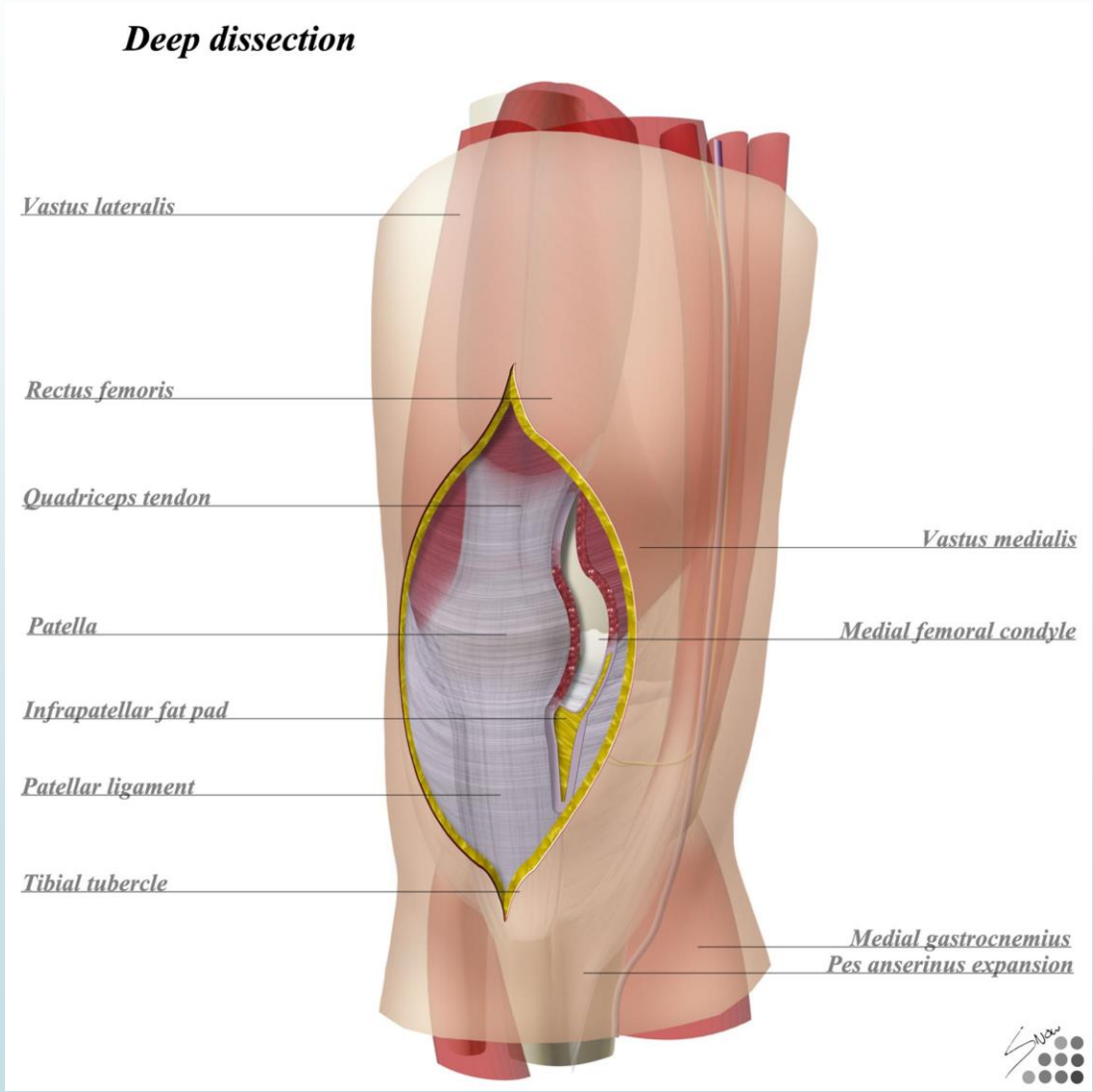
Knee – medial parapatellar approach



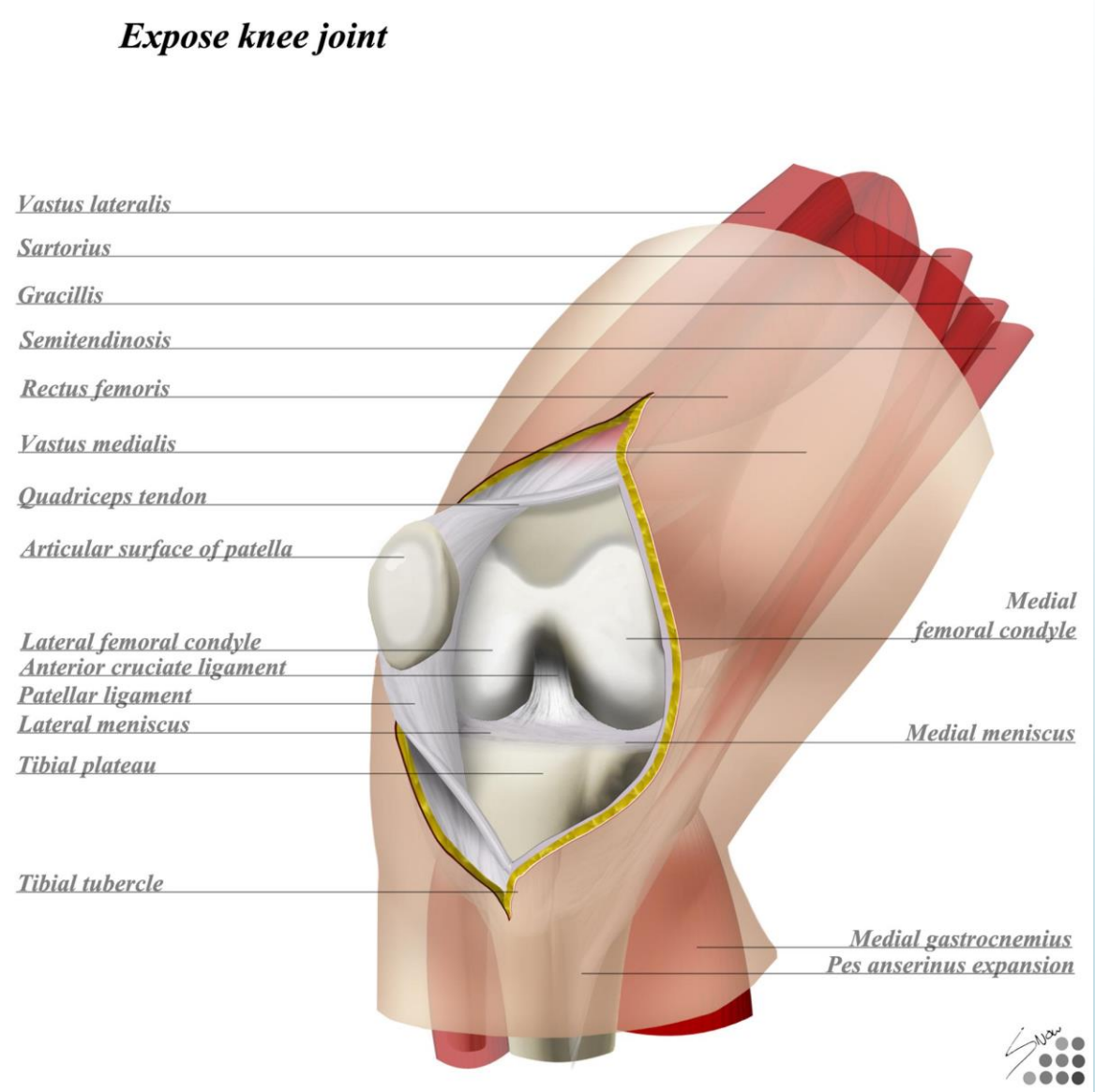


Knee – medial parapatellar approach





Knee – medial parapatellar approach



Anatomy of lower limb in relation to ext fix

Strat Traum Limb Recon (2007) 2:105–110
DOI 10.1007/s11751-007-0023-7

REVIEW

Safe corridors in external fixation: the lower leg (tibia, fibula, hindfoot and forefoot)

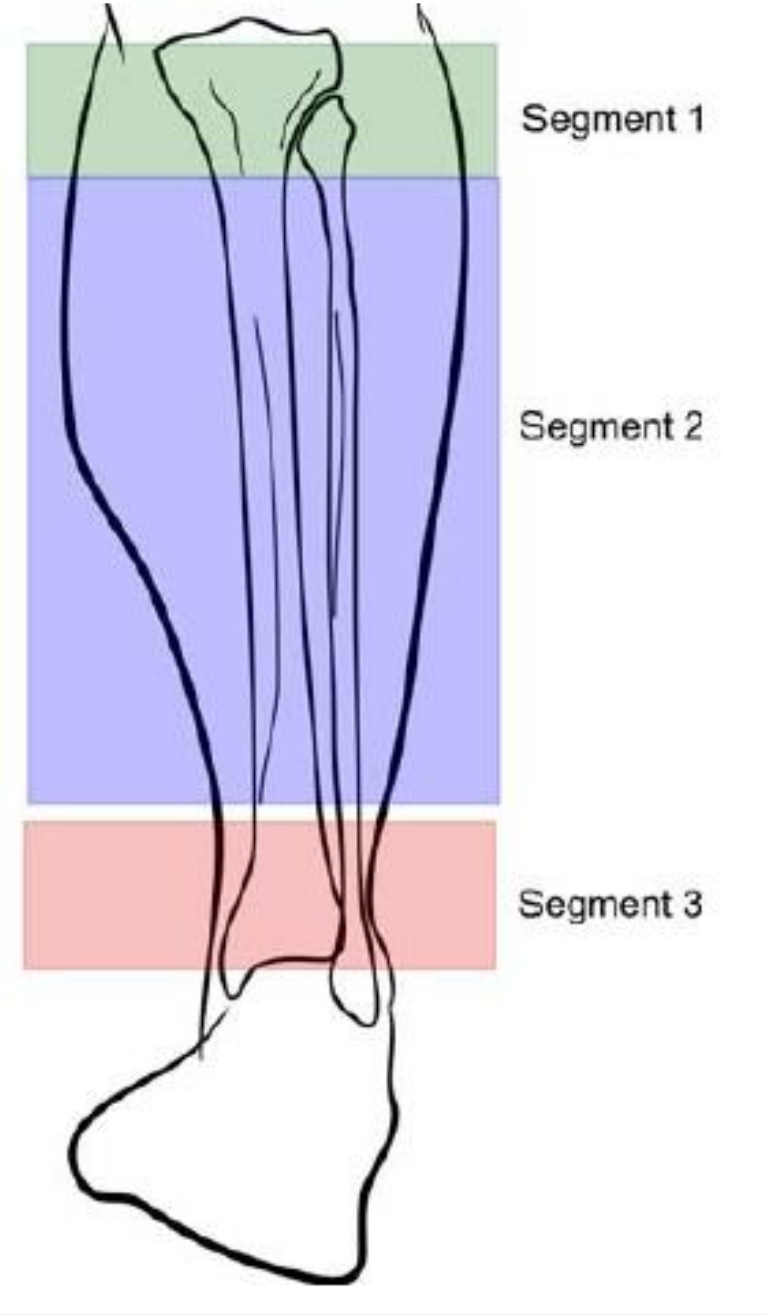
Selvadurai Nayagam

Cardinal rules

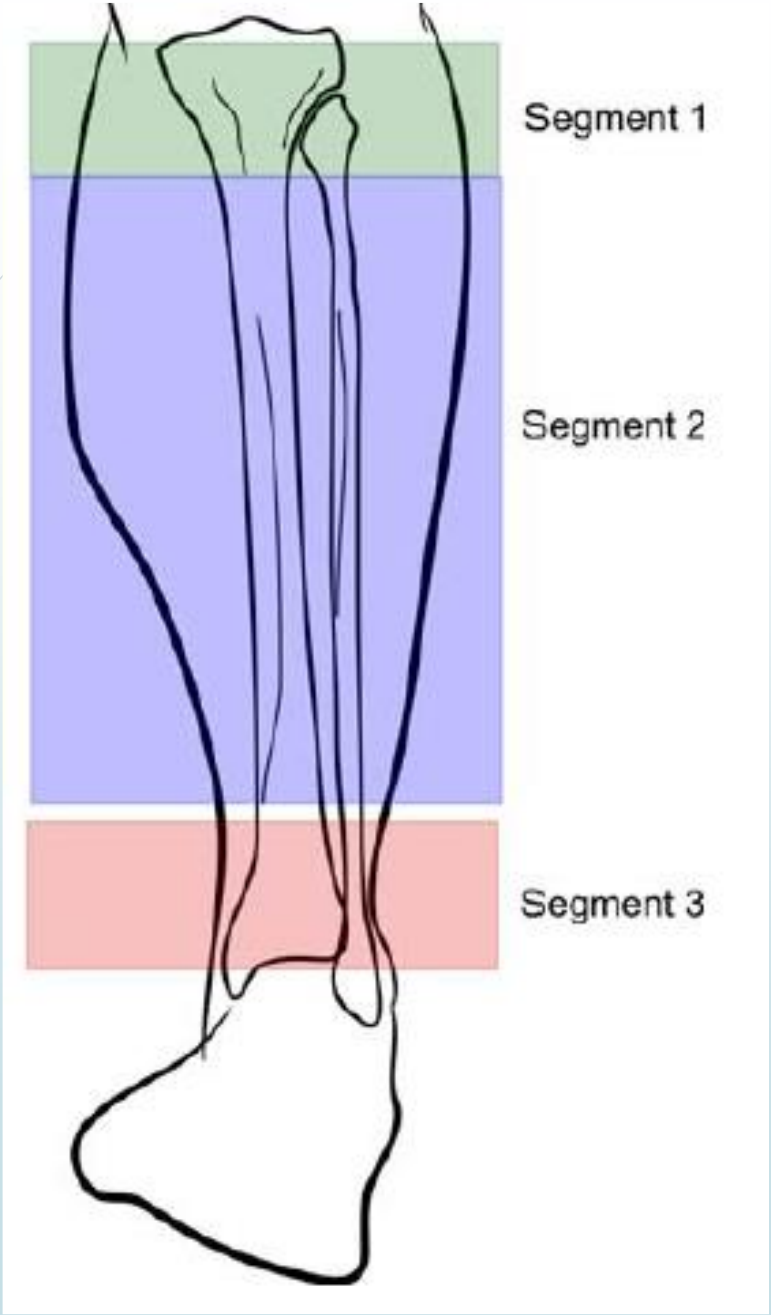
- Push wire unto bone before drilling
- Start from side that has more risk – better surgeon control on wire placement
- Start drill in short burst – observe for any sensitive structures caught by pin
- Tap wire through soft tissue on opposite side, especially if has risky structures
- If need to go through muscle/tendon, ensure is fully stretched – easier to get good function post-op
- Patient should not be paralysed (muscle flaccid) intraop – so can obtain feedback on inaccurate wire placement

Common structures at risk

- Common peroneal nerve – around fibula neck
- Deep peroneal nerve – within anterior compartment along with anterior tibial vessels
- Posterior tibial neurovascular bundle – posteromedial border of tibia at distal 3rd



Segmental division of tibia



Segment 1:

- Knee joint to fibula neck
- Anatomical considerations:
  - Knee capsule and synovium extends 15mm distal to the actual joint line
  - Neck of fibula - surface marker for common peroneal nerve

Segment 1 – most proximal

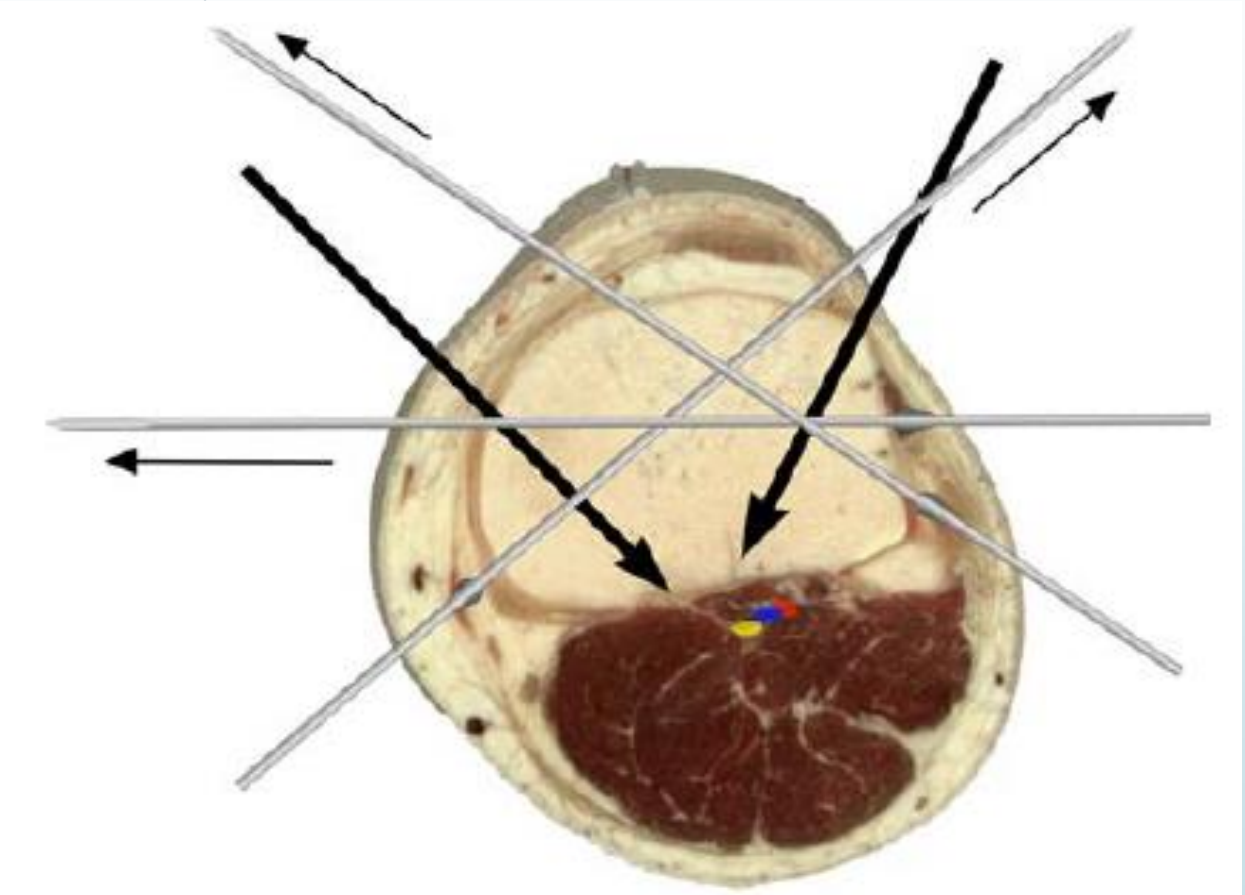


Fig. 2 Segment 1: two fingers' breadth distal to the joint line of the knee

Common wires almost throughout whole tibia:

- Coronal plane wire
- Medial face wire (parallel to anteromedial tibia surface)

Segment 1 – fibula head

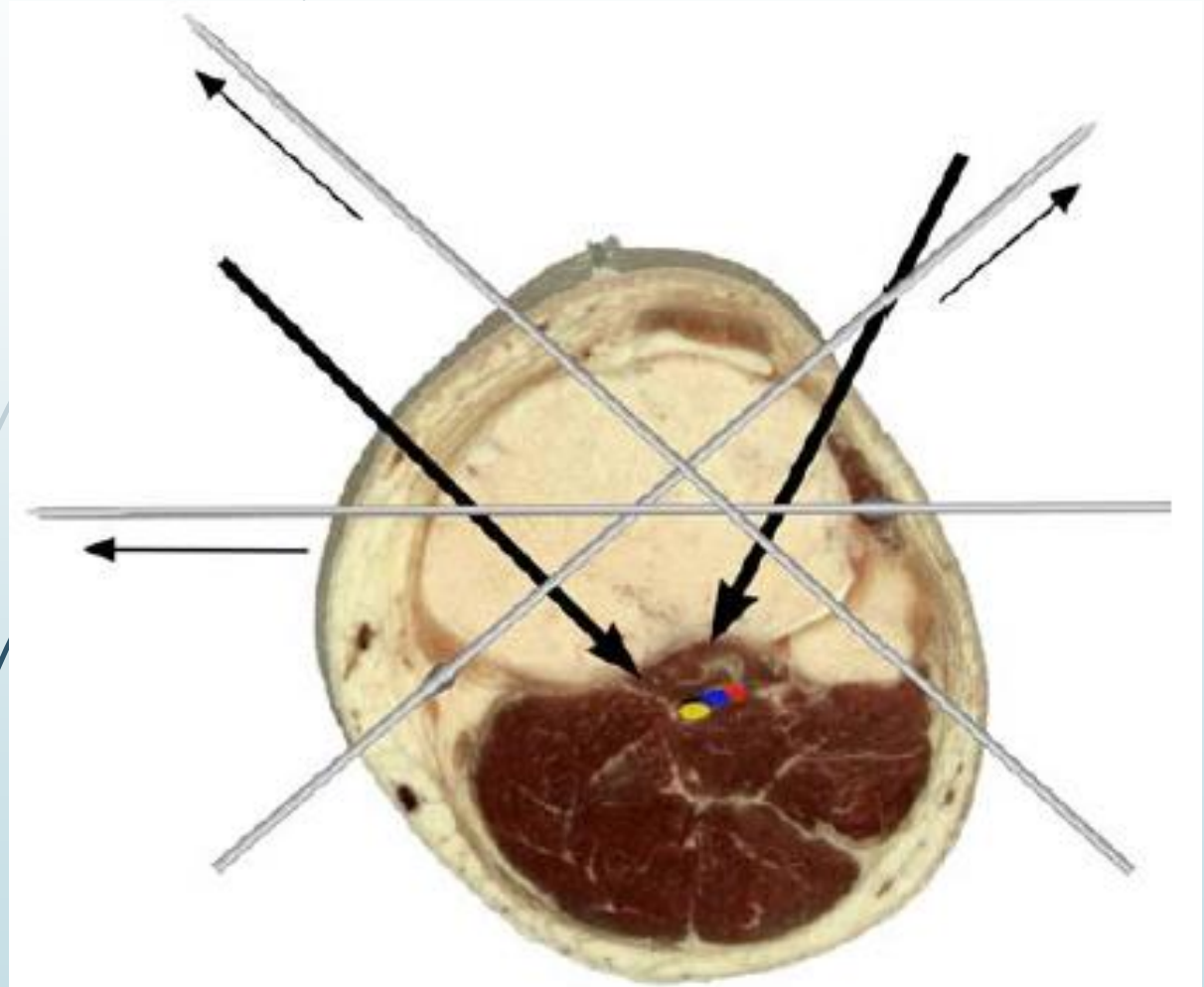


Fig. 3 Segment 1: at the level of the fibula head

Can transfix the fibula head to tibia

Segment 1 – fibula neck

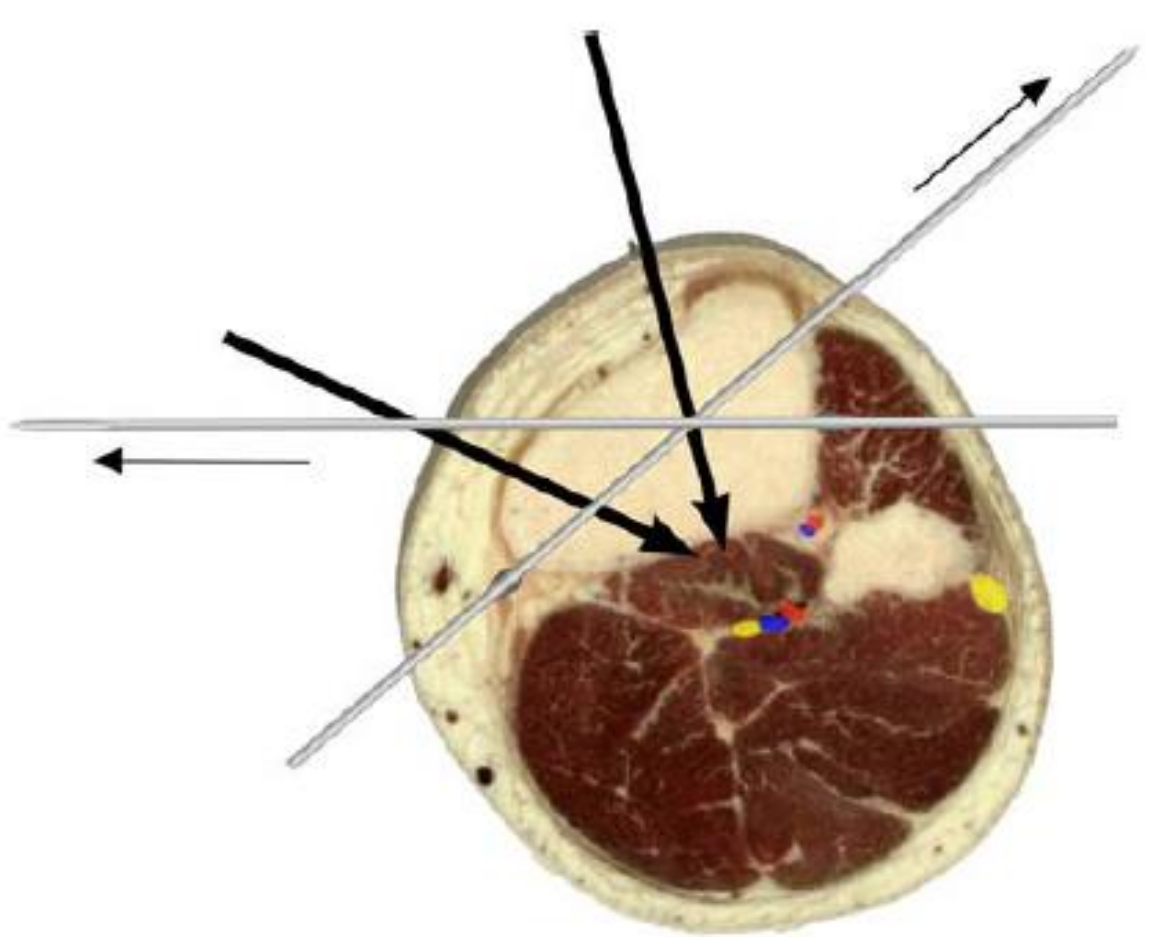
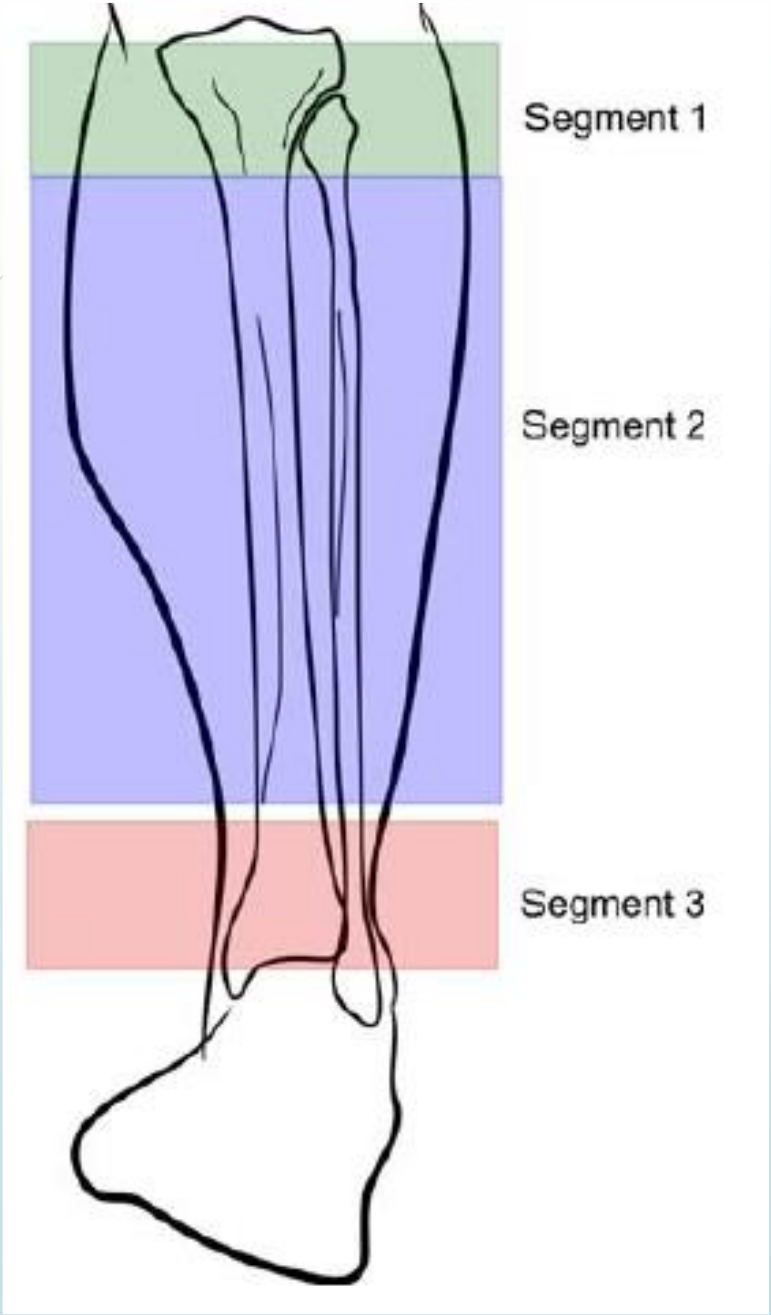


Fig. 4 Segment 1: at the level of the fibula neck

ABSOLUTELY no wires thru fibula neck



Segment 2:

- Distal to tibial tuberosity to beginning of metaphyseal flare proximal to ankle

Segment 2 – tibial shaft

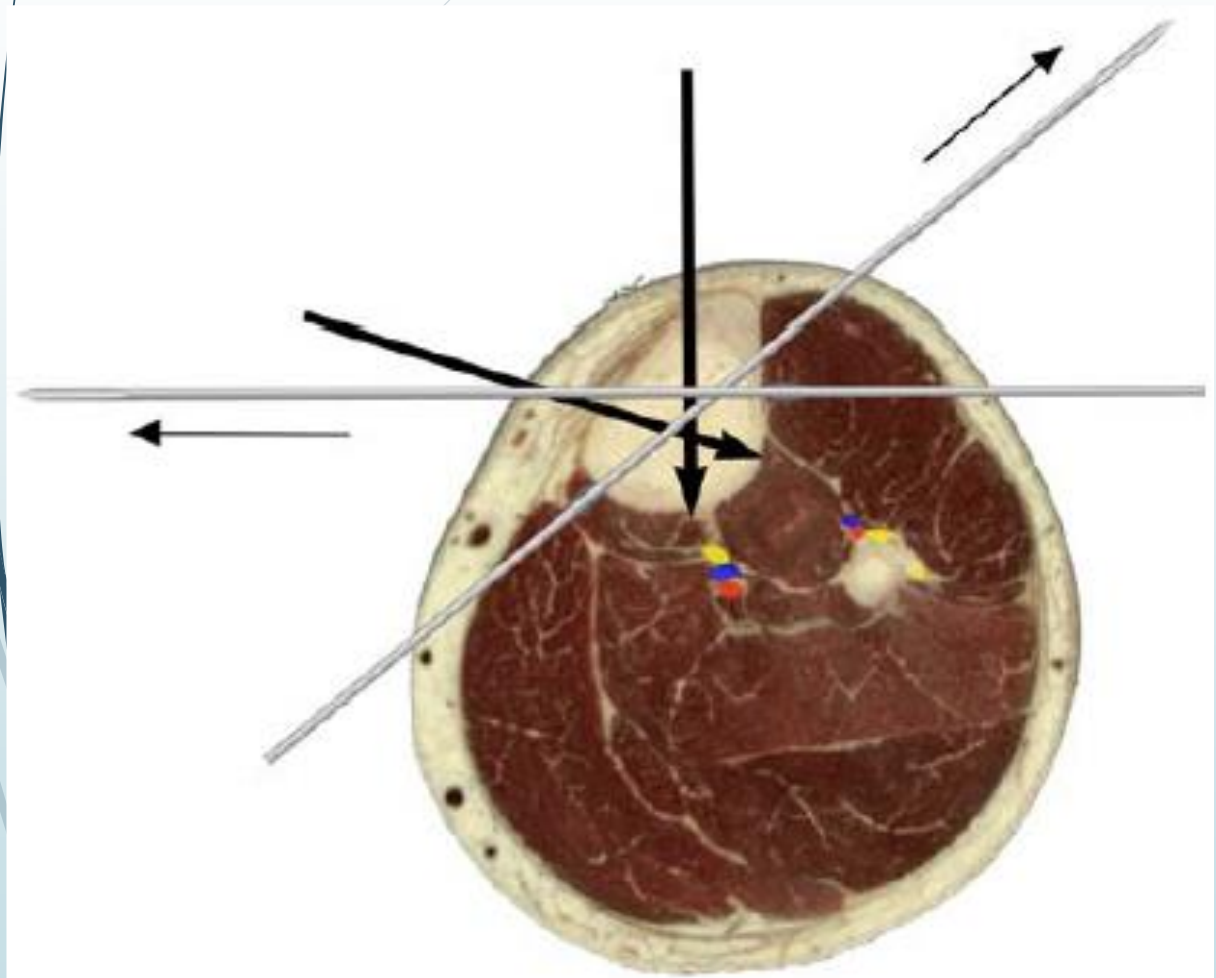


Fig. 5 Segment 2: just distal to the tibial tuberosity

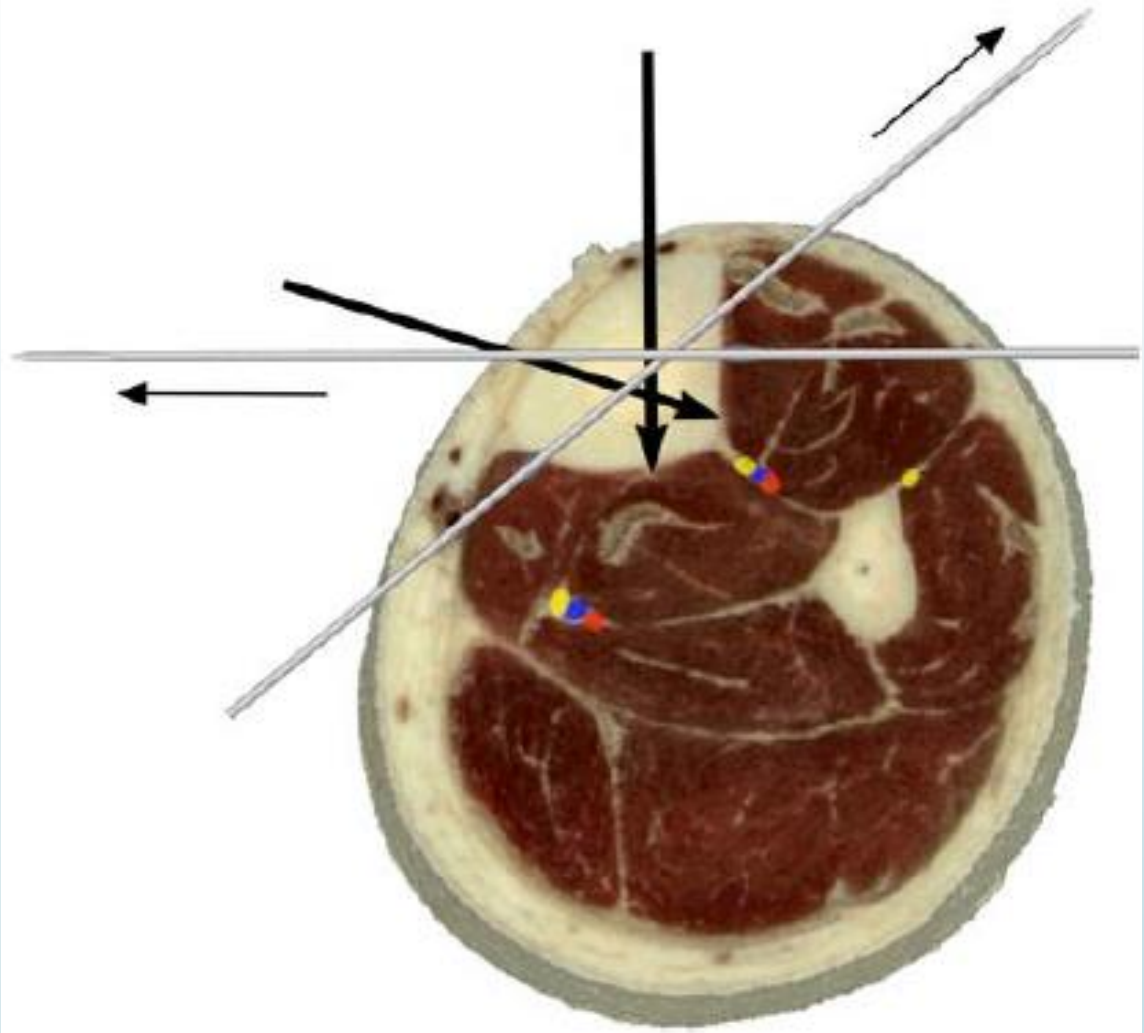


Fig. 6 Segment 2: mid-shaft of the tibia

Segment 2 – start of distal flare

Post tibial – goes posteromedially
Ant tibial – more anteriorly

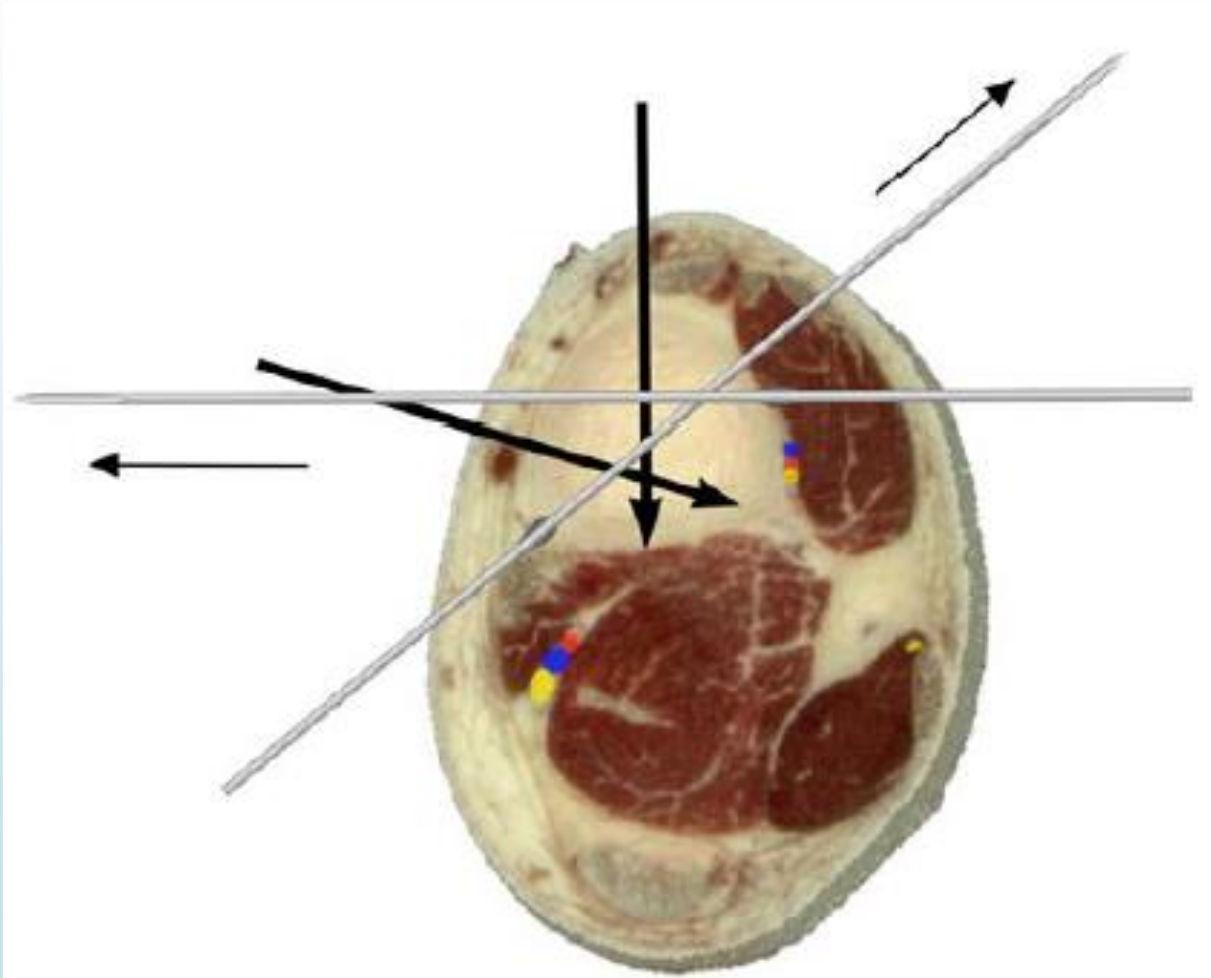
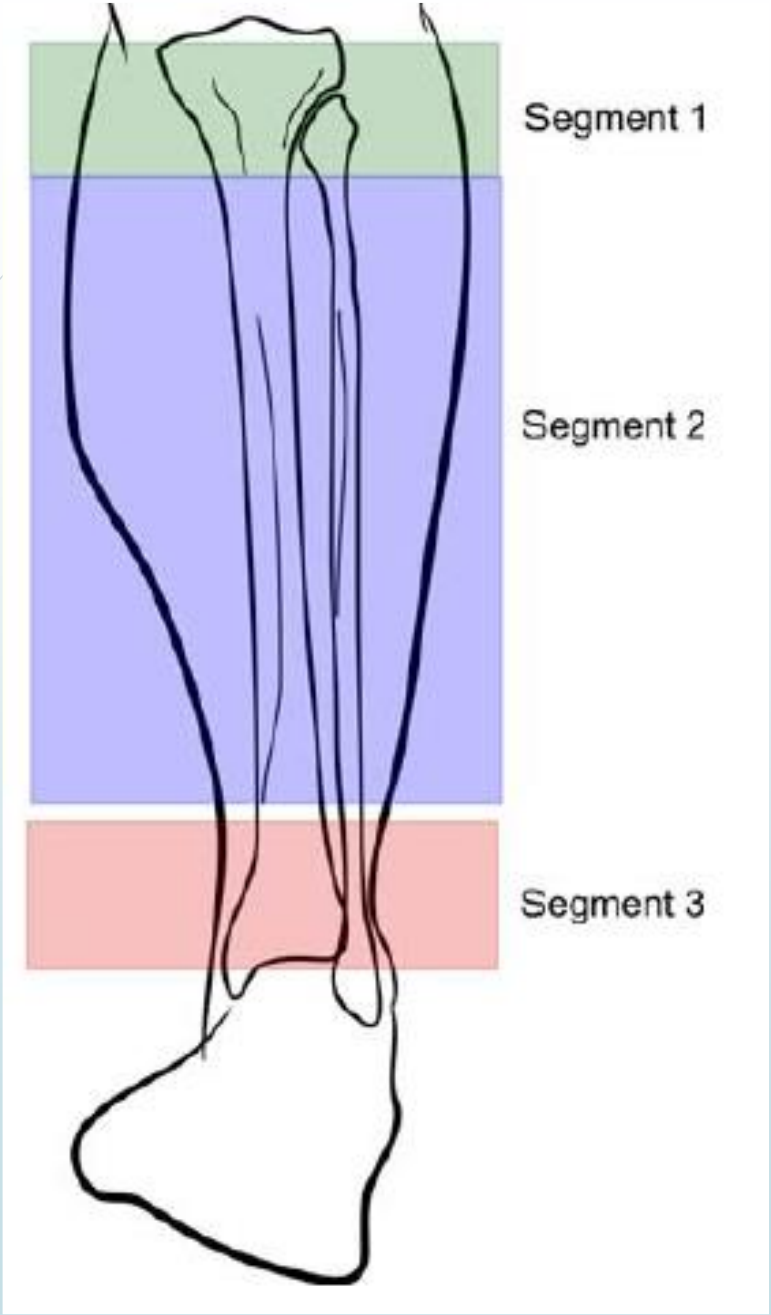


Fig. 7 Segment 2: start of the distal metaphyseal flare



Segment 3:

- Distal metaphyseal flare to ankle joint line

Segment 3 – distal tibia

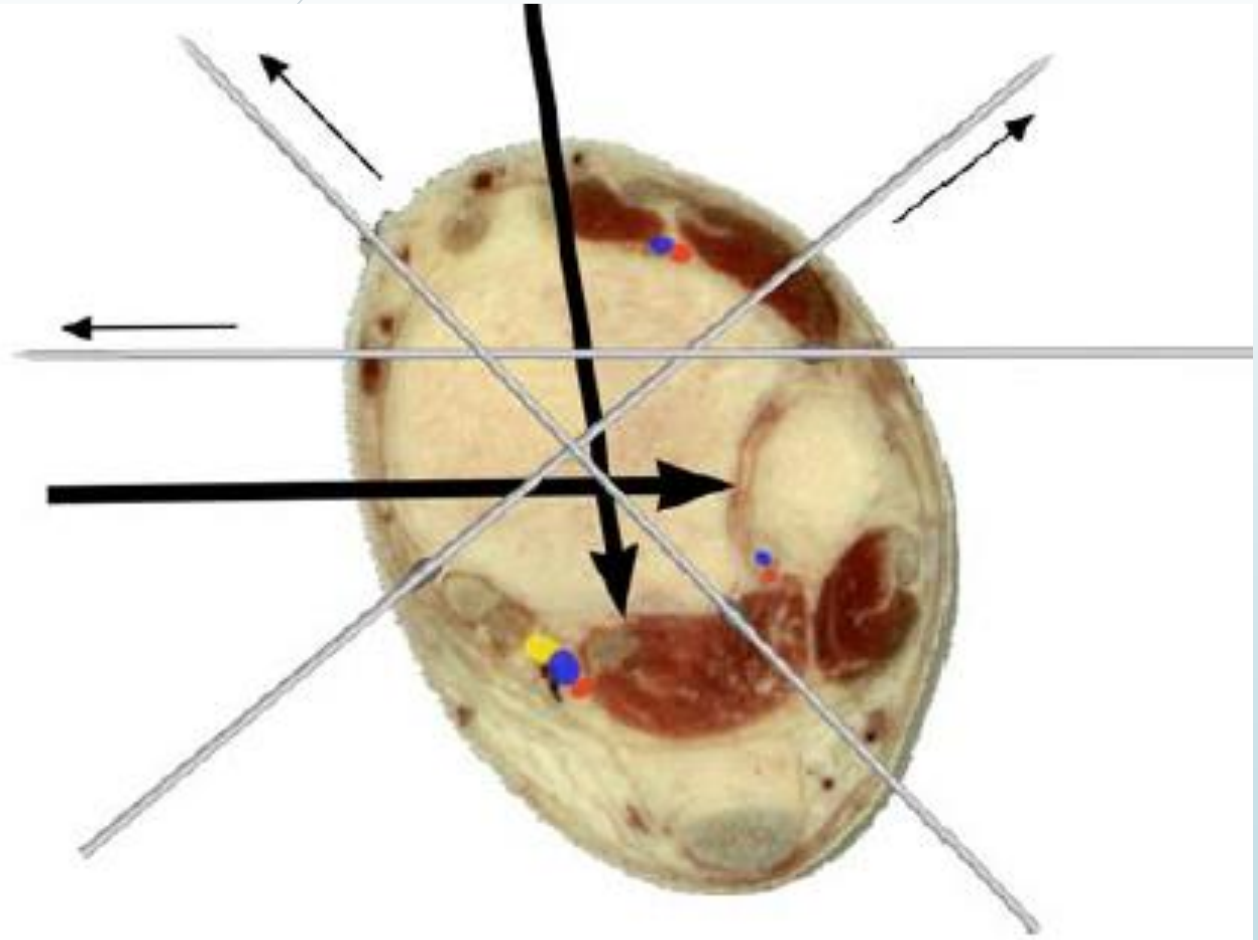


Fig. 8 Segment 3: proximal to the ankle joint

2 additional wires

- Transfibular wire – must dorsiflex ankle
- Wire bet peroneals and tendoAchilles – will transfix FHL belly – must extend great toe

KAHOOT questions

Question 1

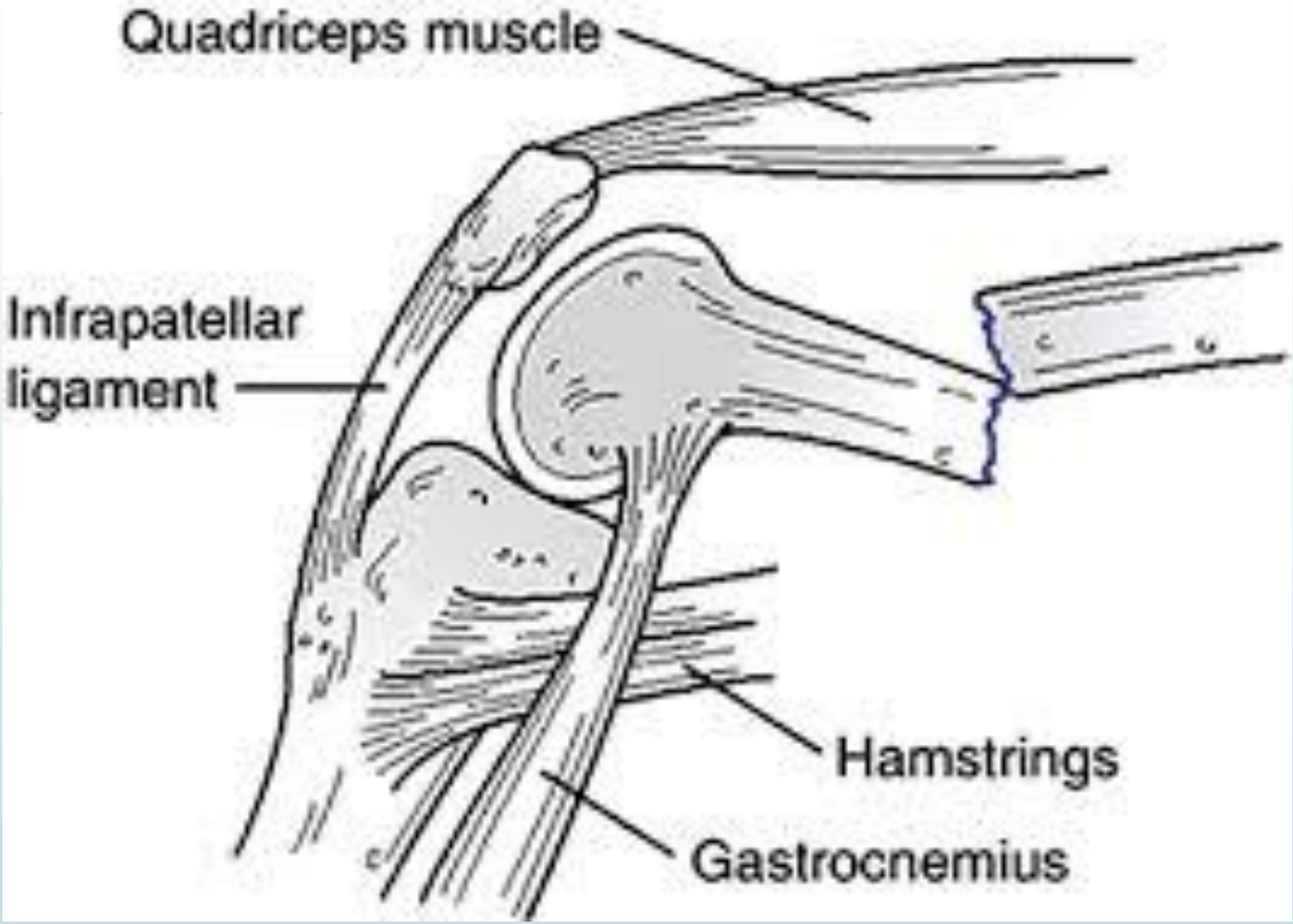
Best technique to reduce a displaced supracondylar femur fracture is:

A. Traction

B. Flexing the knee

C. Shantz pin thru distal segment

D. Femoral distractor


Quadriceps muscle
Infrapatellar ligament
Hamstrings
Gastrocnemius

Question 2

In open book pelvis injury, profuse bleeding originates from:

A. The fracture surface
B. Presacral venus plexus
C. Corona mortis artery
D. Internal iliac artery

Why it bleeds so much?

Pre-sacral venous plexus overlies the SI joint

↓

Fracture disrupts SI joint

↓

Tears the veins

↓

BLEEDS!


thank you
danke
謝謝
ngiyabonga
рахмат
teşekkür ederim
спасибо
gracias
tapadh leat
dank je
bedankt
dziękuję
obrigado
go raibh maith agat
sukriya
kop khun krap
merci
arigatô
dakujem
mochchakkeram
terima kasih
grazie
takk
mauruuru
hvala
sagolun
Баярлалаа
faafetai lava
kiitos
dankie
dhanyavad
nanni
nandri
vinaka
спасибі
blagodaram
mersi
barka
welalin
tack
spas
misaotra
matondo
paldies
grazzi
mahalo
хвала
asante
manana
obrigada
tenki
murakoze
chokrane
djiere dieuf
tau
дякую
mamnun
enkosi
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ευχαριστώ