Peripheral Nerve Anatomy, Function, examination, Injury

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A 28 days infant, unable to extend her knee 3 days after Pavlik

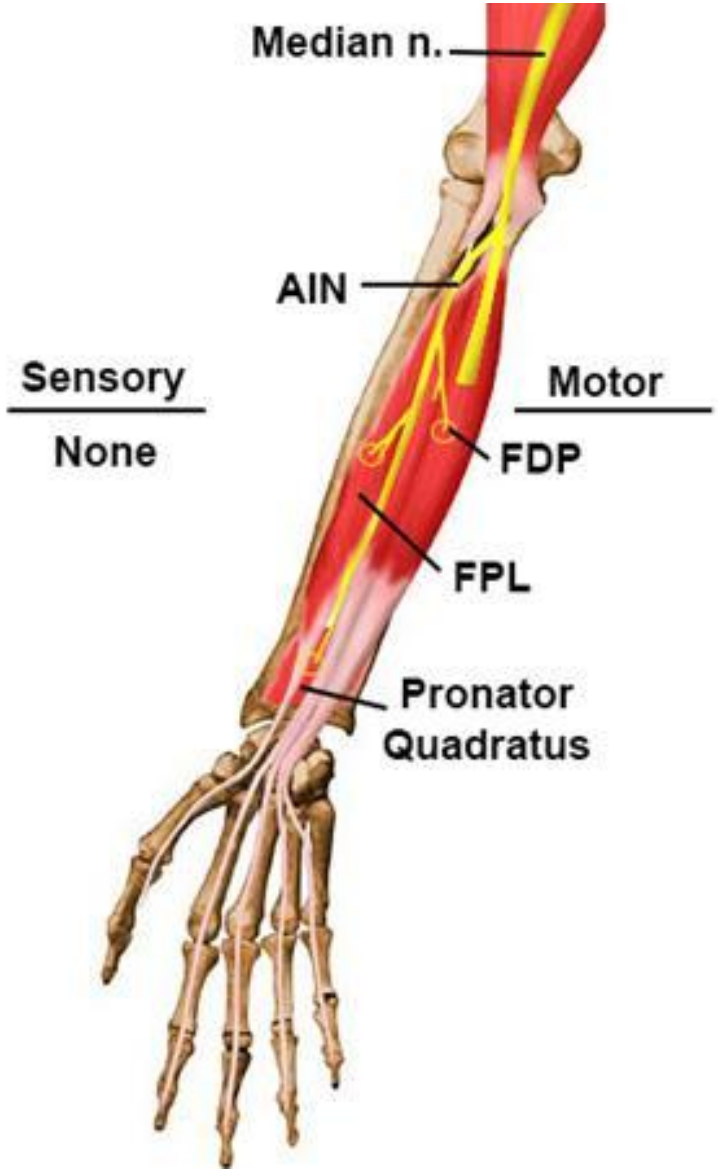
What is the cause?

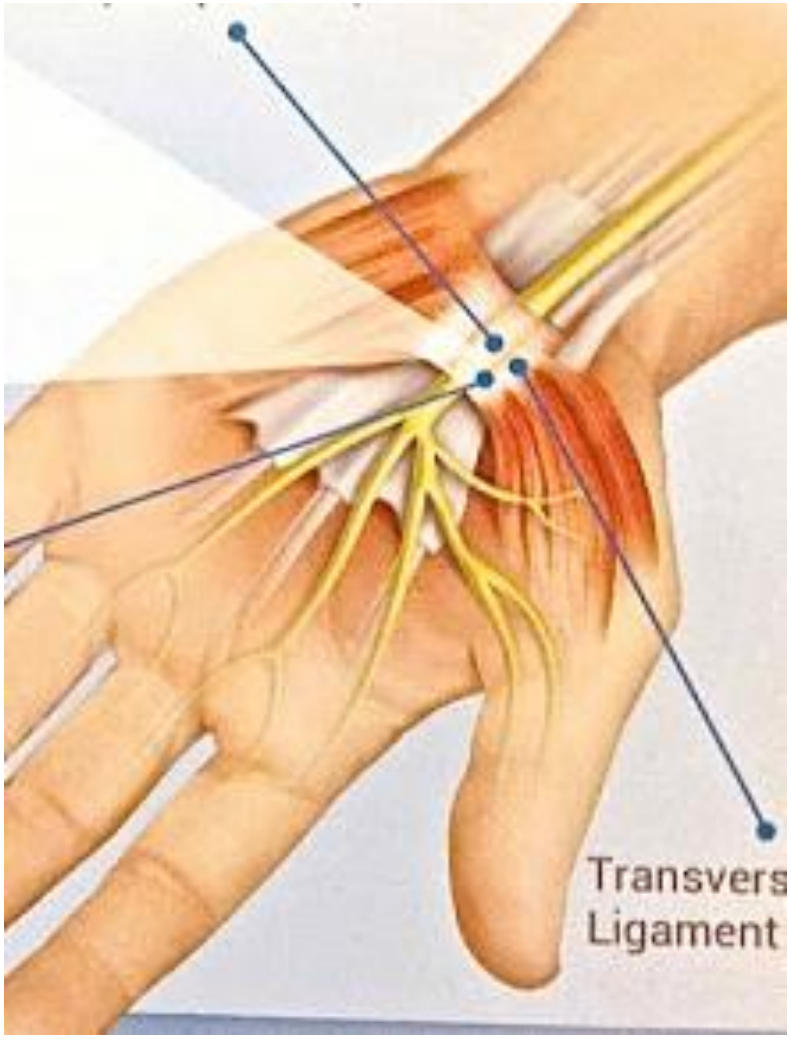
- 45 yrs old female
- Night time finger numbness
- Difficult phone holding
- What is the problem?

A 25 yrs old male, wrist stab wound

Normal finger flexion

Do you suture the wound?

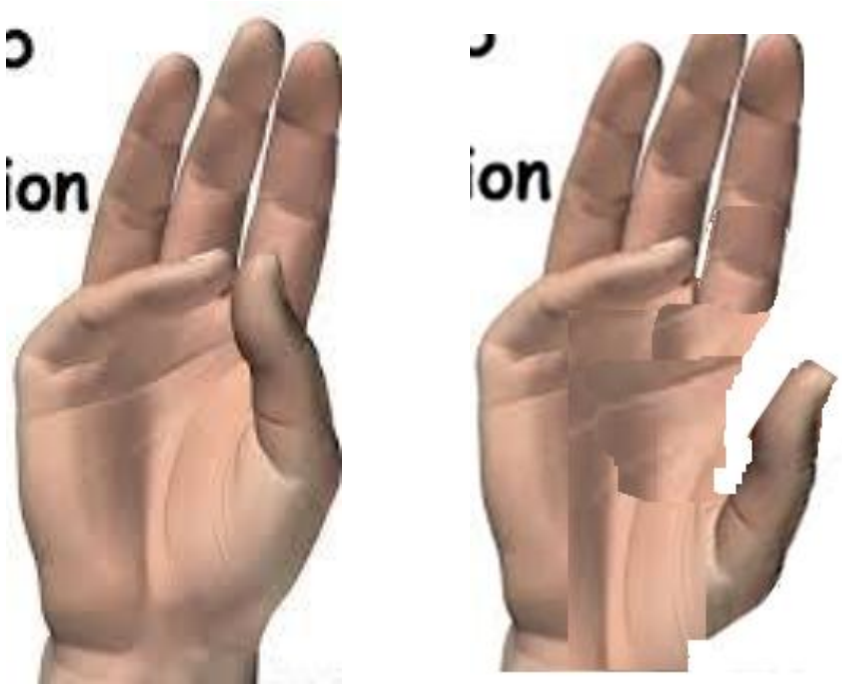

Median n.
AIN
Sensory
None
Motor
FDP
FPL
Pronator
Quadratus


Transvers
Ligament

A 25 yrs old male, wrist stab wound

Normal finger flexion

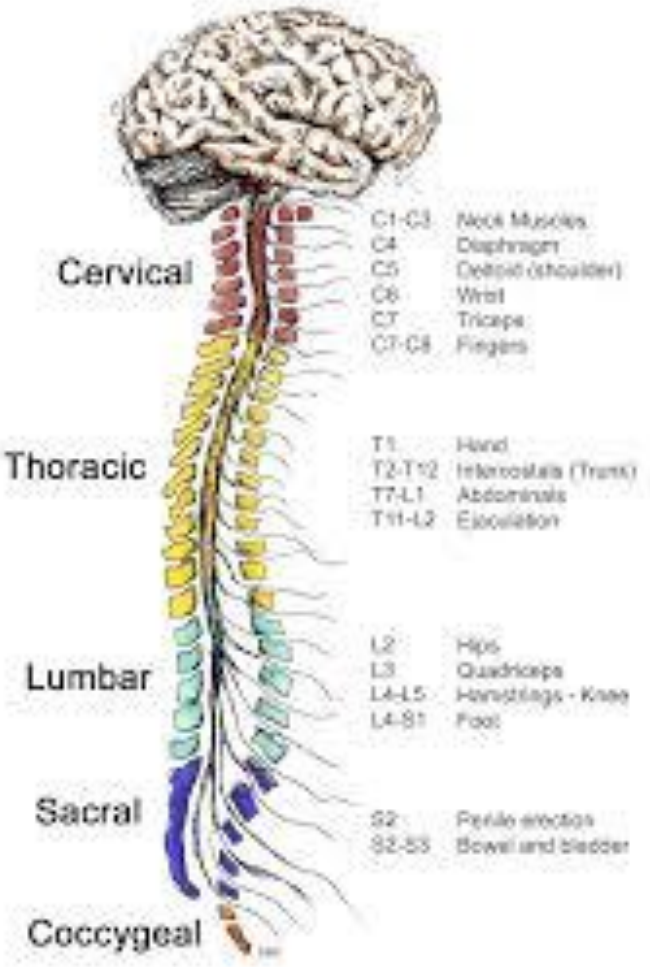
Do you suture the wound?



Wrist drop after crutch use?

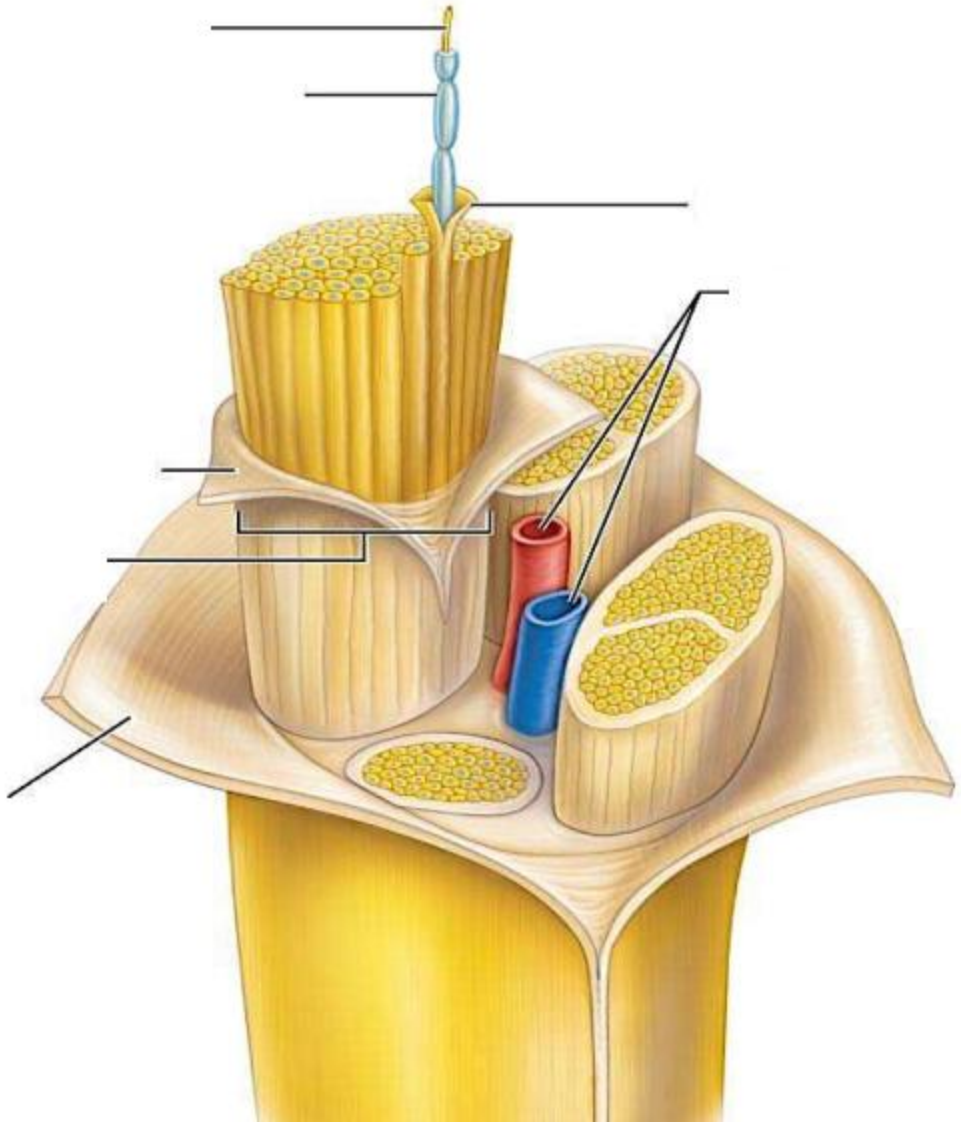
What is the reason?

Foot drop after cast, why?


Cervical
C1-C3 Neck Muscles
C4 Diaphragm
C5 Deltoid (shoulder)
C6 Wrist
C7 Triceps
C7-C8 Fingers
Thoracic
T1 Hand
T2-T12 Intercostals (Trunk)
T7-L1 Abdominals
T11-L2 Ejaculation
Lumbar
L2 Hips
L3 Quadriceps
L4-L5 Hamstrings - Knee
L4-S1 Foot
Sacral
S2 Penile erection
S2-S3 Bowel and bladder
Coccygeal

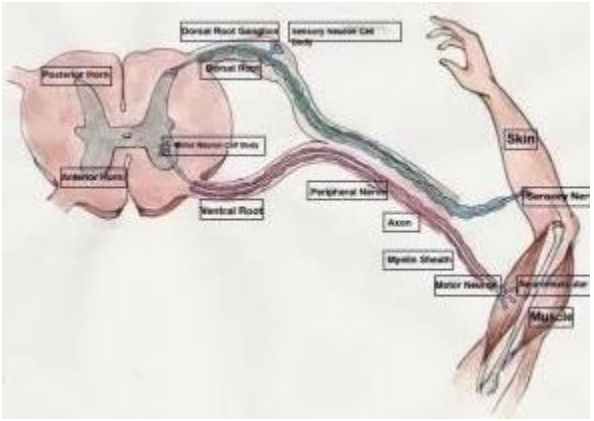

Axillary nerve
Humerus
Radial n
Musculo
Ulna
Radius
Ulnar ne
Median
Radial ne
Dorsal branch
Superficial bra
Digital branch
Muscular branch
Digital branch

- Sensory
- Motor
- Autonomic
- Combined



Nerve injury

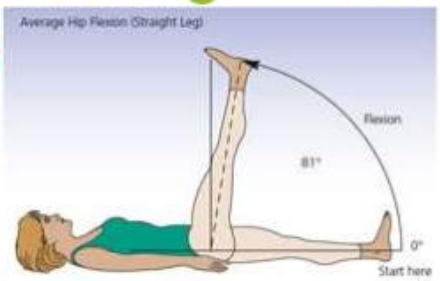
- Sharp object
- Compression
- Other


Skin
Axon
Muscle

Muscle, Nerve, Joint

Movements and Muscles of the Hip Joint/Thigh – Flexion

- Flexion

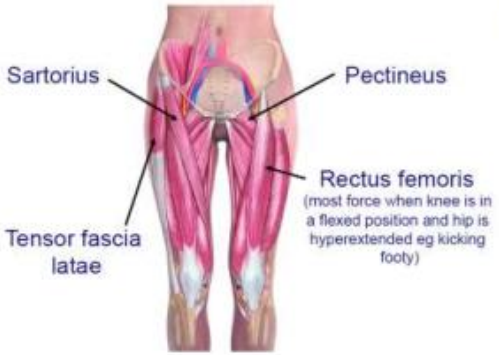


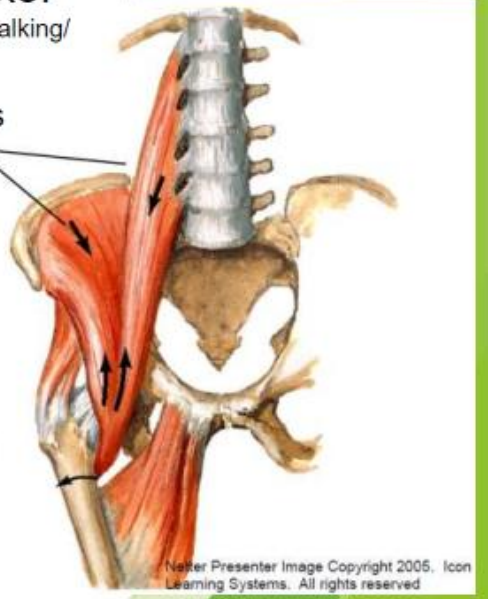
- Primary Hip Flexor is the iliopsoas (psoas major and iliacus).
- Iliopsoas also involved in anterior pelvic tilt and trunk flexion with reversed origin. What does this mean?
- Other weak hip flexors that assist the iliopsoas include the Sartorius, Pectineus, Tensor Fascia Latae and Rectus Femoris.

The Primary Hip Flexor

Role in swinging leg forward during walking/ running etc

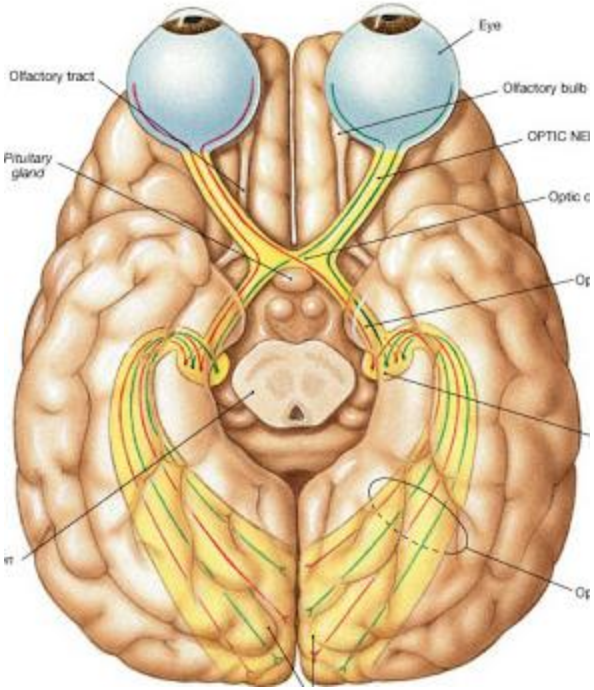
iliacus + psoas = iliopsoas

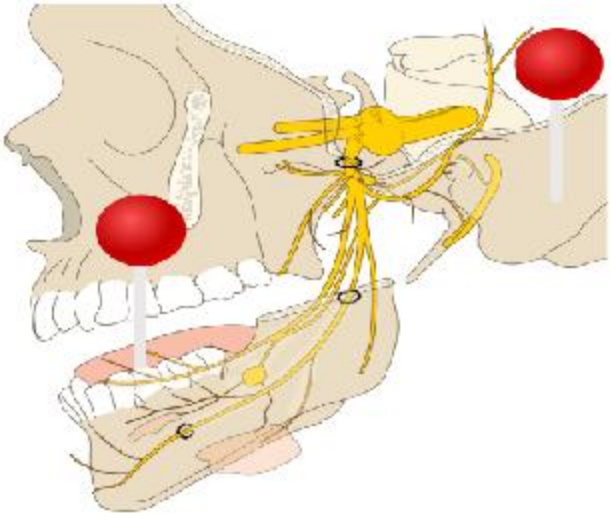


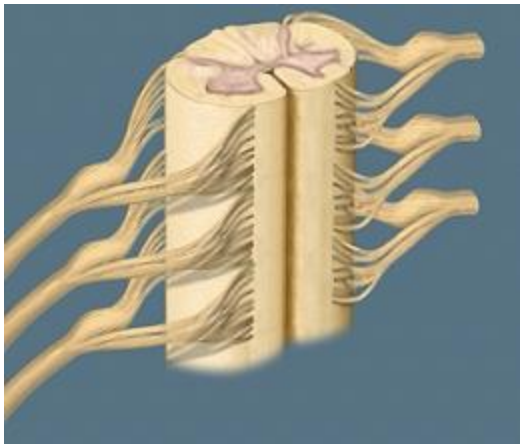


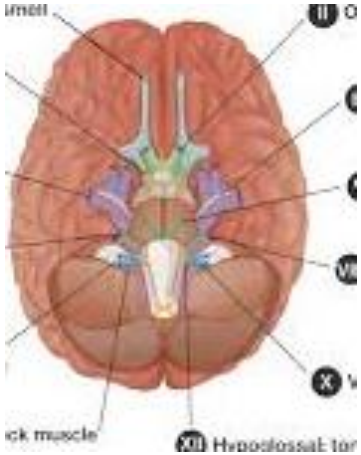
Movements and Muscles of the Hip Joint/Thigh – Abduction

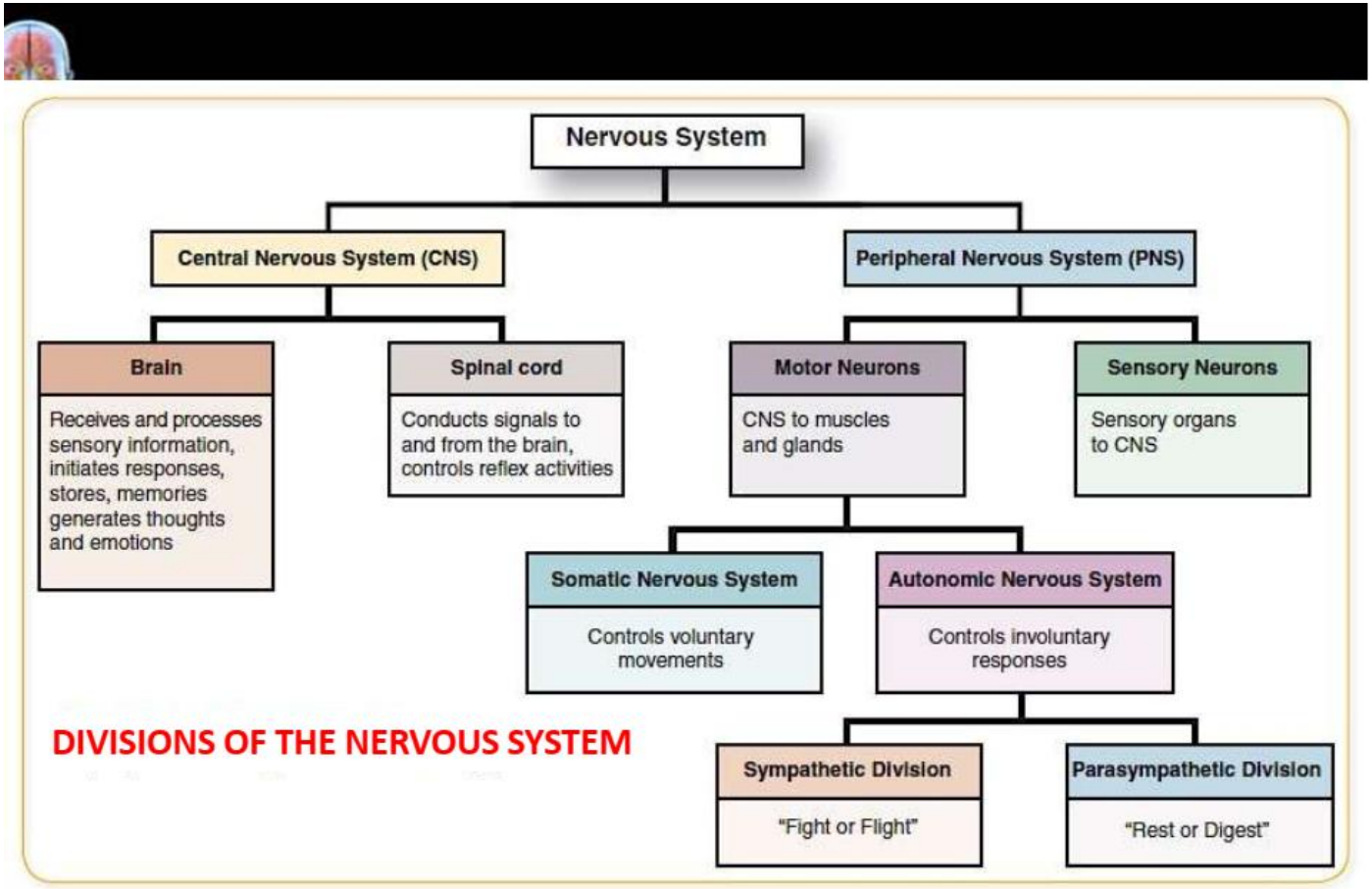
- Abduction- The thigh is pulled laterally away from the midline
- Main Hip Abductors: Gluteus Medius (larger of the two muscles) and Gluteus Minimus (smaller muscle). These muscles keep the hips levelled when walking, running, etc (when weight is placed on that leg).
- When these muscles are weakened, hips are no longer even.
- These two muscles are assisted by the piriformis muscle, quadriceps femoris (rectus femoris part) and tensor fascia latae.


Eye
Olfactory tract
Olfactory bulb
Pituitary gland







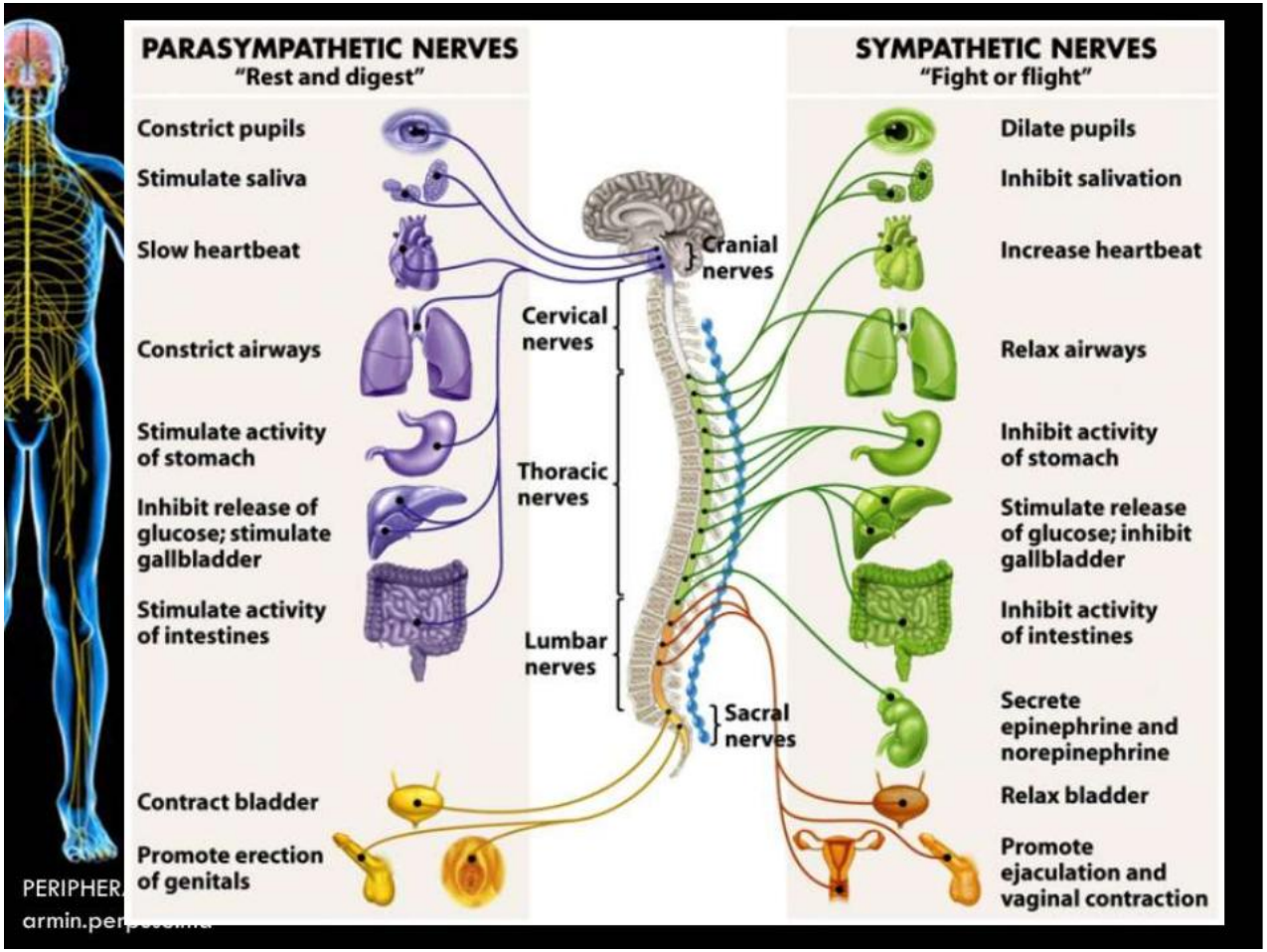


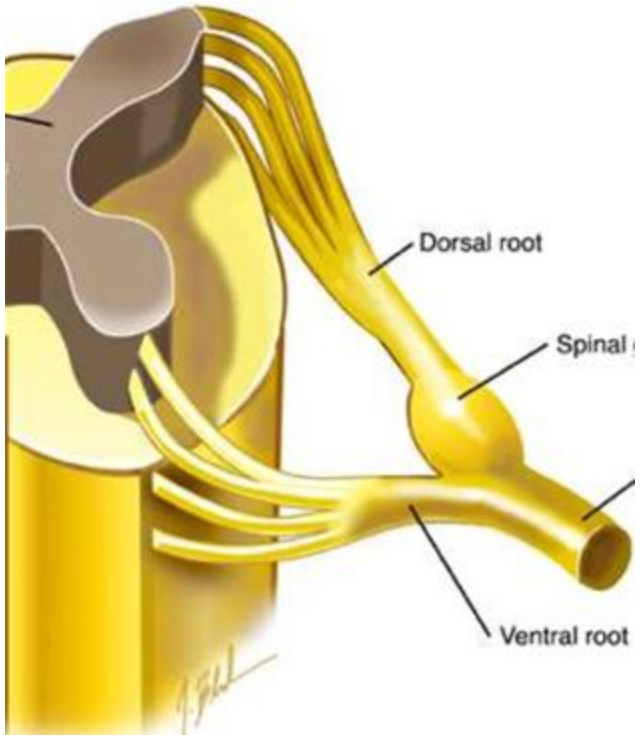
DIVISIONS OF THE NERVOUS SYSTEM

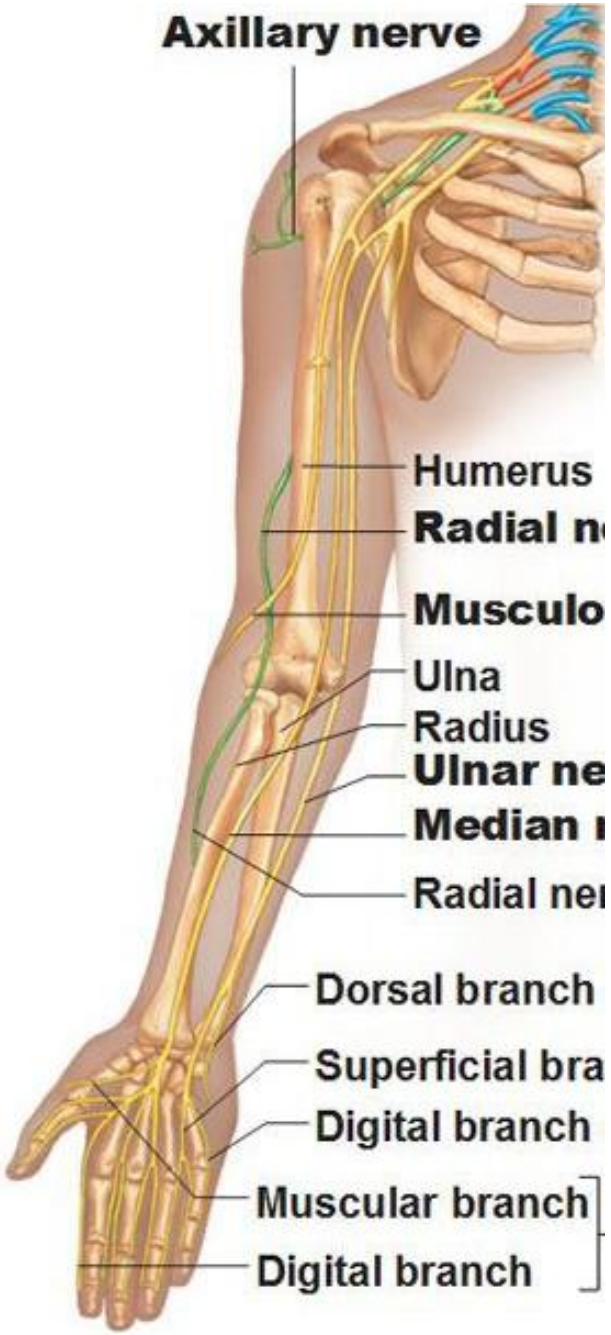
2 divisions of ANS

- **Sympathetic**
  - "Fight or flight"
  - "**E" division**
    - Exercise, excitement, emergency, and embarrassment

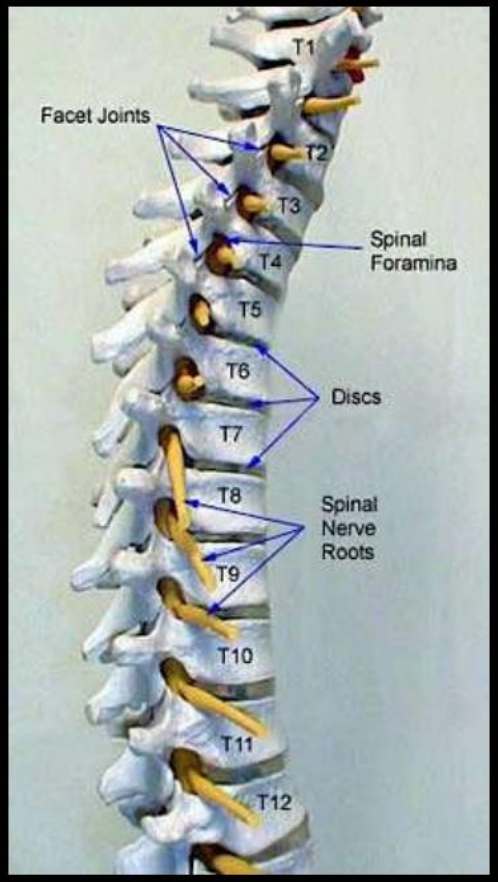
- **Parasympathetic**
  - "Rest and digest"
  - "**D" division**
    - Digestion, defecation, and diuresis


PARASYMPATHETIC NERVES
"Rest and digest"
Constrict pupils
Stimulate saliva
Slow heartbeat
Constrict airways
Stimulate activity of stomach
Inhibit release of glucose; stimulate gallbladder
Stimulate activity of intestines
Contract bladder
Promote erection of genitals
Cranial nerves
Cervical nerves
Thoracic nerves
Lumbar nerves
Sacral nerves
SYMPATHETIC NERVES
"Fight or flight"
Dilate pupils
Inhibit salivation
Increase heartbeat
Relax airways
Inhibit activity of stomach
Stimulate release of glucose; inhibit gallbladder
Inhibit activity of intestines
Secrete epinephrine and norepinephrine
Relax bladder
Promote ejaculation and vaginal contraction


Dorsal root
Spinal
Ventral root


Axillary nerve
Humerus
Radial n
Musculo
Ulna
Radius
Ulnar ne
Median
Radial ner
Dorsal branch
Superficial bra
Digital branch
Muscular branch
Digital branch

SPINAL NERVES



PERIPHERAL NERVOUS SYSTEM

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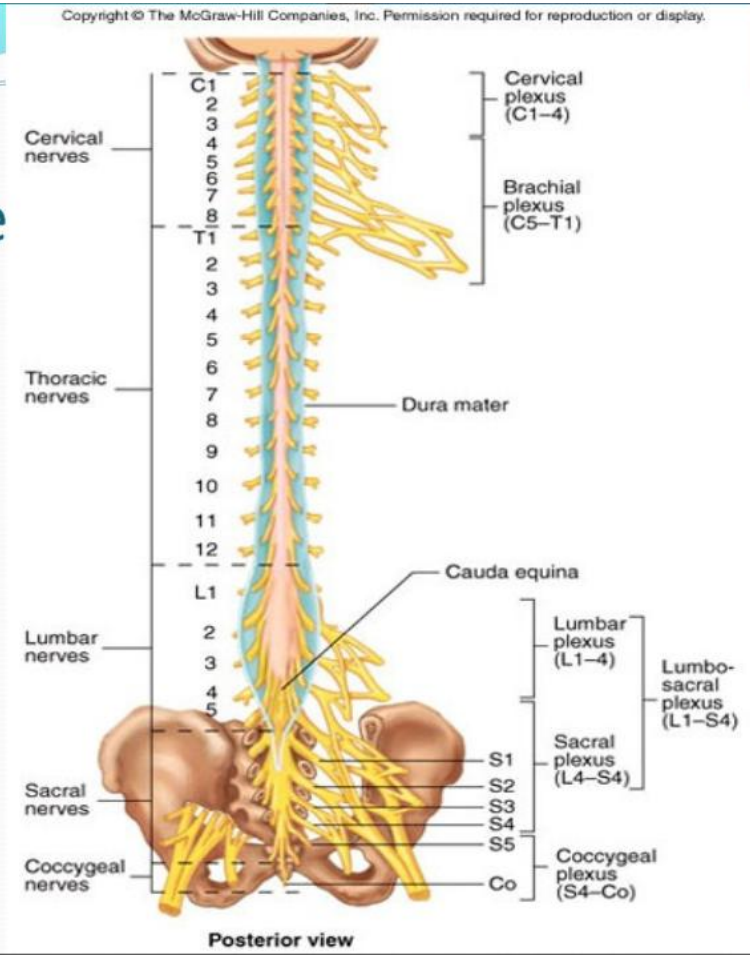
Figure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C1
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T1
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12
L1
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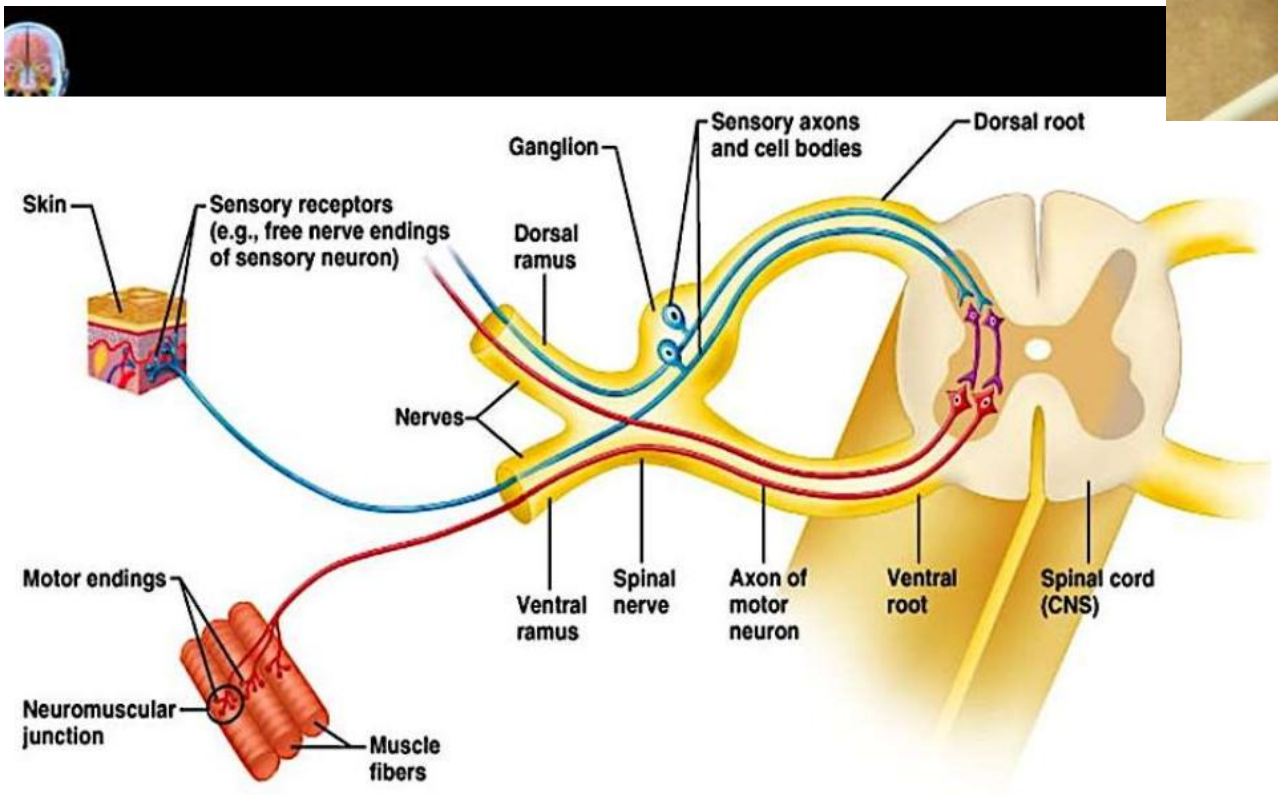
3
4
5
S1
S2
S3
S4
S5
Co
Cervical nerves
Thoracic nerves
Lumbar nerves
Sacral nerves
Coccygeal nerves
Cervical plexus (C1–4)
Brachial plexus (C5–T1)
Dura mater
Cauda equina
Lumbar plexus (L1–4)
Sacral plexus (L4–S4)
Lumbo-sacral plexus (L1–S4)
Coccygeal plexus (S4–Co)
Posterior view



PERIPHERAL NERVOUS SYSTEM

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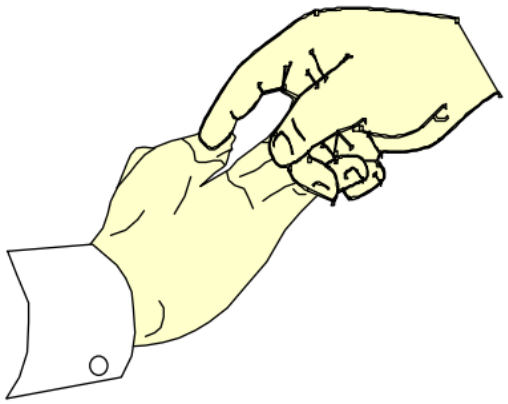
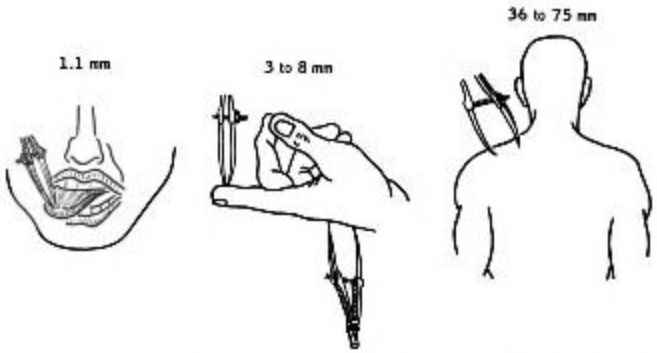
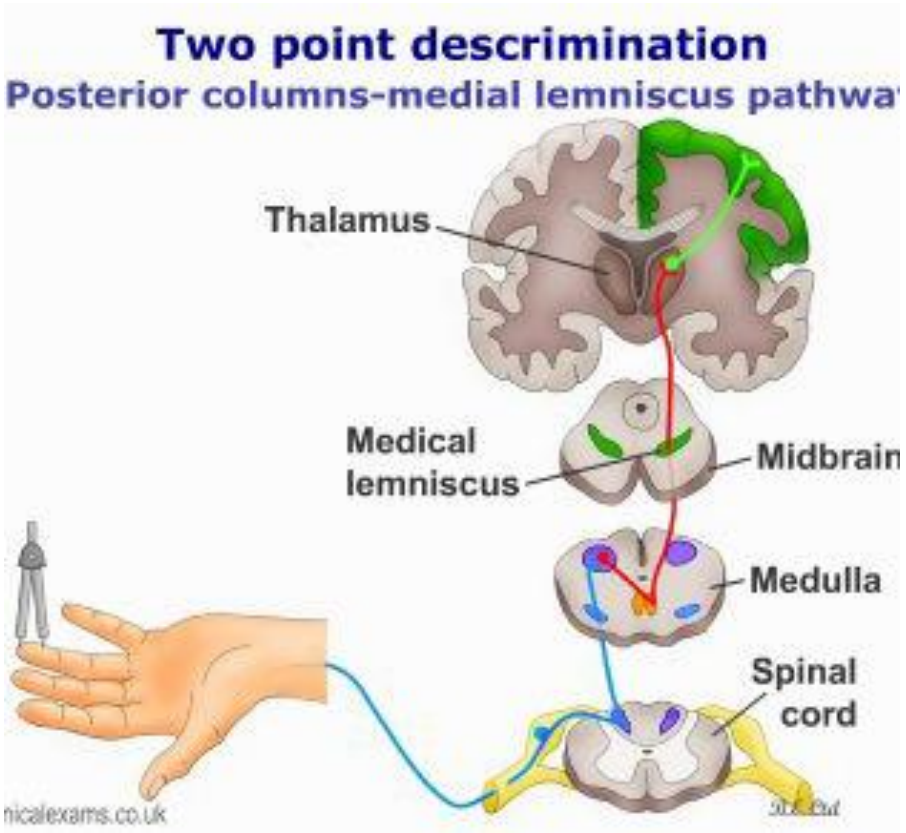
Testing light touch



- Use a wisp of Cotton wool or a fine paint brush
- Ask the patient to respond when stimulus is detected
- Dab the skin and then withdraw the stimulus - do not drag the cotton wool across the skin
- Compare one side with the other


1.1 mm
3 to 8 mm
36 to 75 mm


Two point descrimination
Posterior columns-medial lemniscus pathwa
Thalamus
Medical
lemniscus
Midbrain
Medulla
Spinal
cord
nicalexams.co.uk

Pain (superficial)

- Use a disposable neurotip, pin or unfolded paper clip
- Do NOT use a hypodermic needle
- Always dispose of “sharp” safely
- Explain and show the touching with “sharp” and “blunt” on an unaffected area
- Test by randomly using sharp and blunt (negative stimulus) noting patient’s response in each dermatome (always try to apply same pressure)
- Start distally and move proximally

Proprioception 2

- If patient cannot detect small amplitude movements, or makes errors, increase the amplitude of movement
- If patient cannot detect larger amplitude movements, test proprioception at a more proximal joint (see next slide)

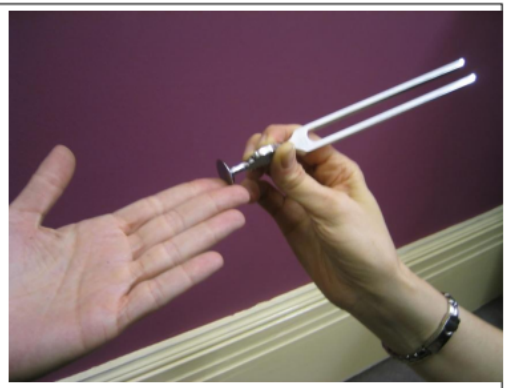
Testing vibration sense 1

- With a 128 Hz tuning fork create vibration by either taping it gently against your hand or by pushing the prongs towards one another
- To avoid reducing the vibration hold at the round thumb rest just under the fork, the flat rest at the base is held against the patient.

Demonstrate on a boney prominence away from the affected area (forehead or sternum for example)

Testing vibration sense 2

- Place base of 128 Hz tuning fork on tip of a finger or toe
- Ask patient ‘Can you feel that buzzing?’
- If they can not, move proximally, testing vibration sense at bony prominences (hallux, medial malleolus … clavicle) until the vibration is detected



Power testing

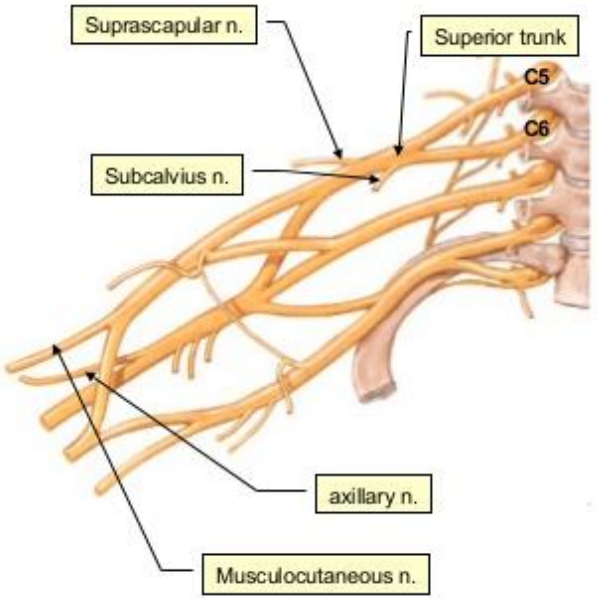
Elbow flexion (C5,6) and extension (C7)

Biceps (Musculocutaneous nerve; C5, C6)
The patient is flexing the supinated forearm against resistance.
Arrow: the muscle belly can be seen and felt.

Triceps (Radial nerve; C6, C7, C8)
The patient is extending the forearm at the elbow against resistance.
Arrows: the long and lateral heads of the muscle can be seen and felt.

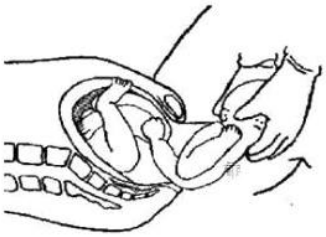
Upper brachial plexus injury

- **Erb-Duchenne palsy:**
- Affects C5 & C6 roots or the superior trunk
- Nerves affected:
  - Suprascapular nerve: supraspinatus, infraspinatus, teres major.
  - Nerve to subclavius: subclavius.
  - Musculocutaneous nerve: biceps, brachialis and coracobrachialis (BBC).
  - Axillary nerve: deltoid and teres minor.
- Movements affected: Abduction and lateral rotation at the shoulder and flexion at the elbow.

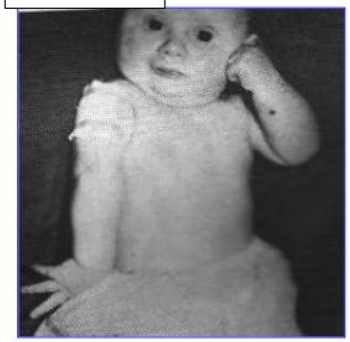


Upper brachial plexus injury

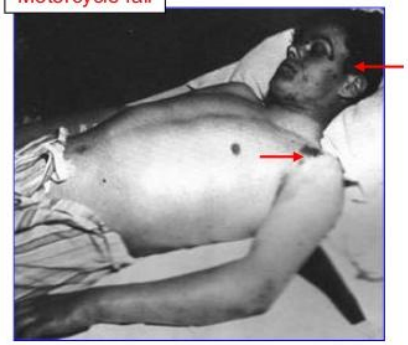
- **Erb-Duchenne palsy:**
- Results from excessive displacement of the head to the opposite side and depression of the shoulder on the same side.

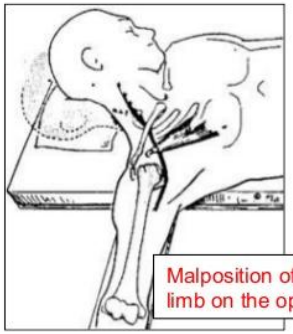


Difficult labour

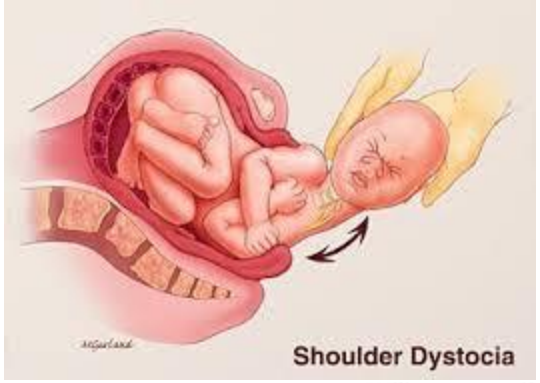


Motorcycle fall



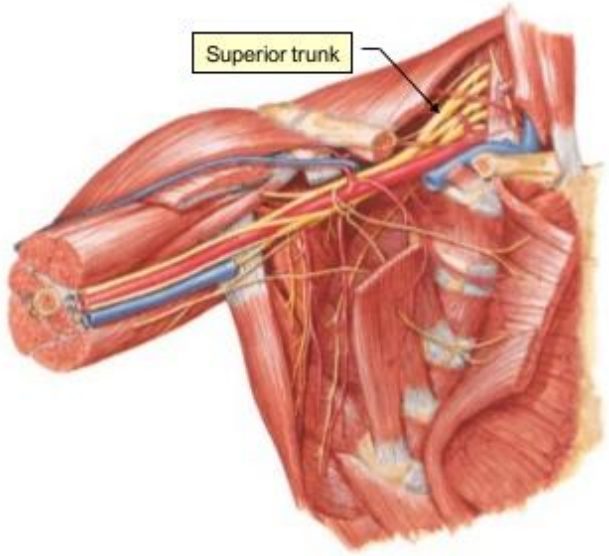


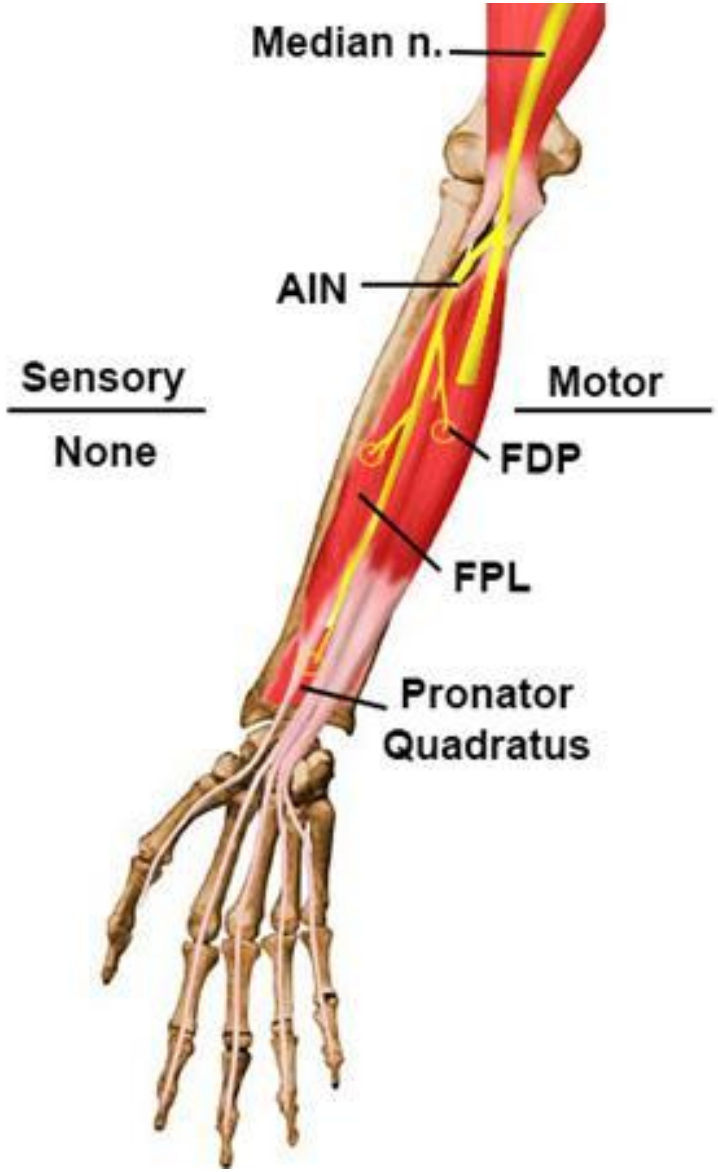
Malposition of the upper limb on the operation table



Upper brachial plexus injury

- **Erb-Duchenne palsy:**
- Also produced by a stab or bullet wound in the neck affecting the superior trunk of the brachial plexus




Median n.
AIN
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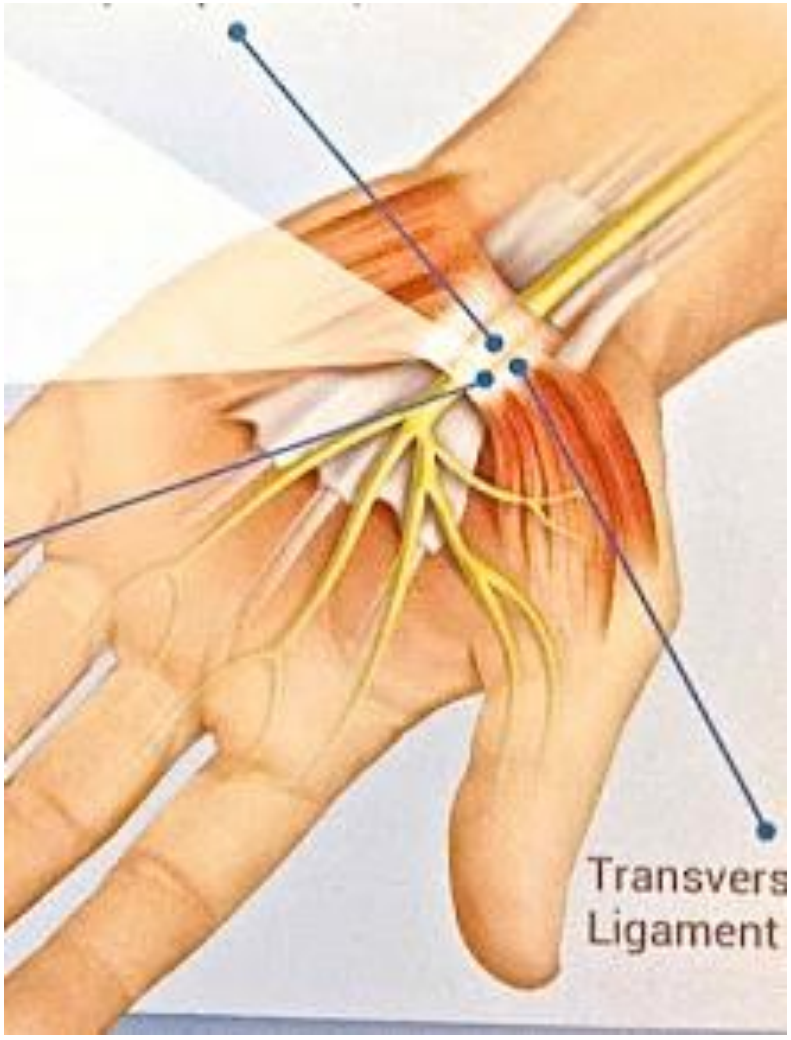
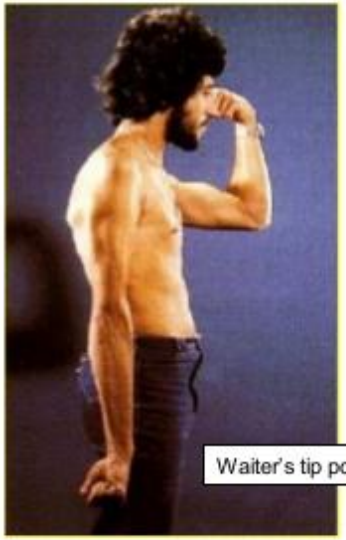

Transvers
Ligament

Upper brachial plexus injury

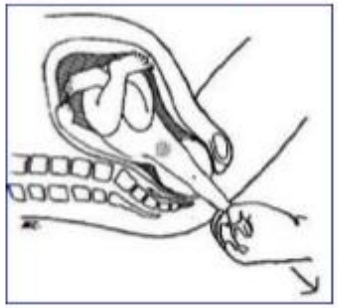
- **Erb-Duchenne palsy:**
- Waiter's tip position:
- The limb hangs by the side adducted and medially rotated by unopposed pectoralis major.
- The forearm extended and pronated because the action of biceps is lost.

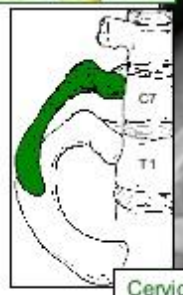


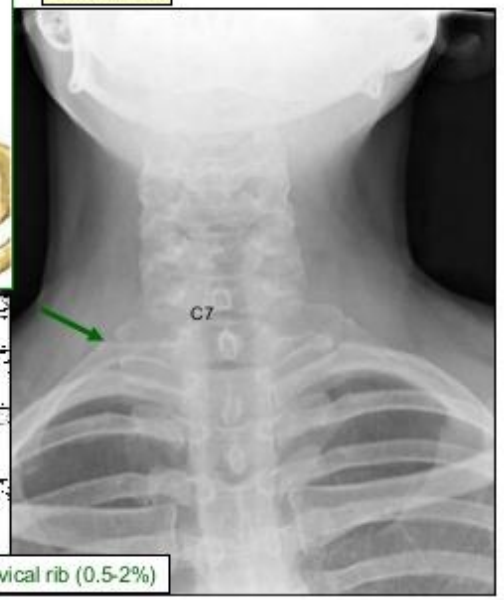
Waiter's tip position

Lower brachial plexus injury

- **Klumpke palsy:**
- Results from excessive abduction of the arm as in during labor or when a person falls from a height grasping something to save himself
- Cervical rib

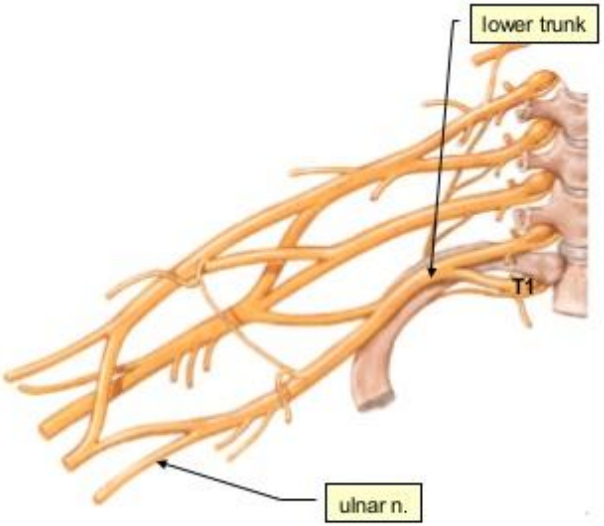




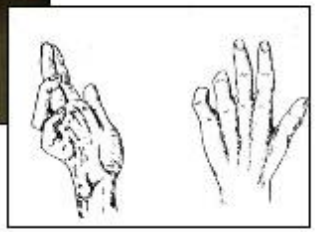


Lower brachial plexus injury

- **Klumpke palsy:**
- Affects T1 nerve root.
- Small muscles of the hand are affected →
  - Wasting.
  - Claw hand.

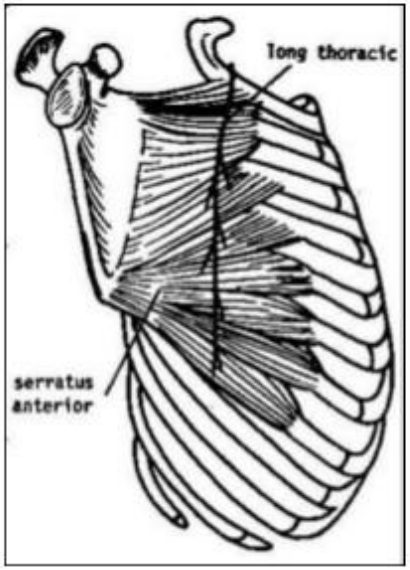


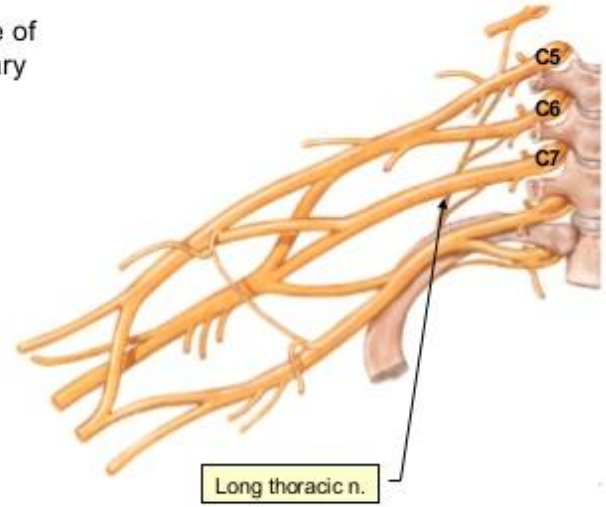
Wasting of dorsal interossei and claw hand



Long thoracic nerve

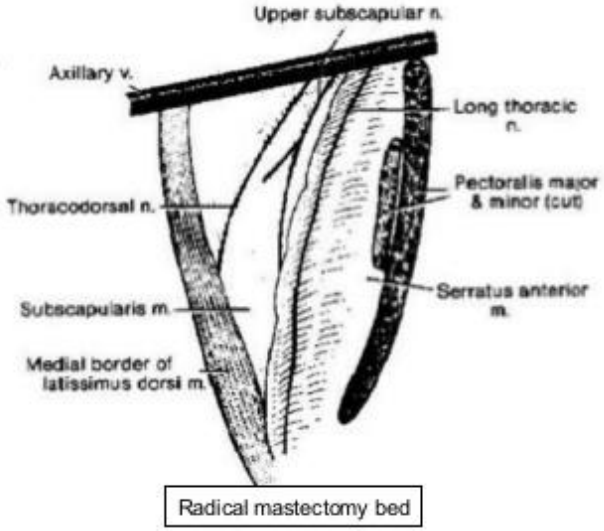
- A branch of brachial plexus C5,6, & 7.
- Seen in the pectoral region on the surface of serratus anterior just behind the mid axillary line, supplying the muscle.





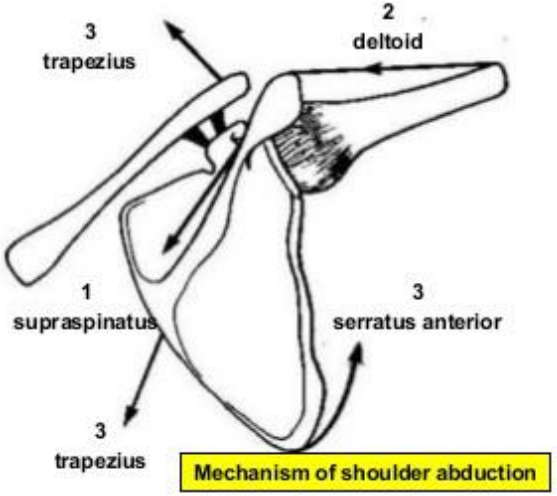
Long thoracic nerve injury

- During radical mastectomy
- Stab wound
- Thoracic surgery
- Chest tube insertion.
- Crushed between clavicle and the first rib while carrying a heavy object on the shoulder.



Long thoracic nerve injury

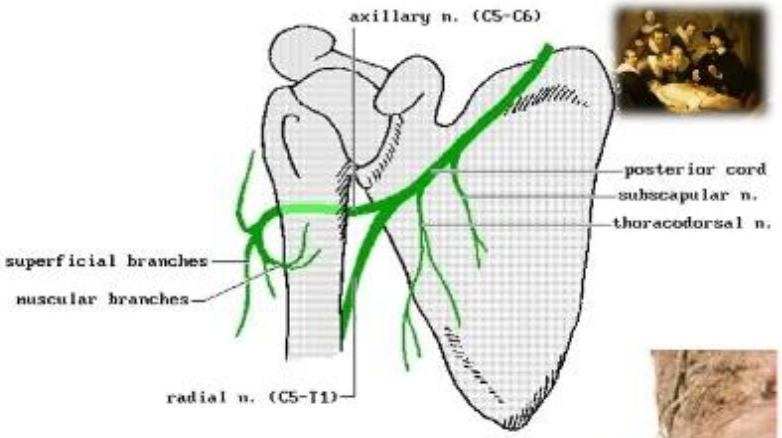
- Paralysis of serratus anterior.
- Winging of the scapula: medial border of the scapula projects backwards when the patient presses against a wall, giving the appearance of a wing
- Inability to raise the arm above the head: inability to rotate the scapula during abduction of the arm above a right angle.

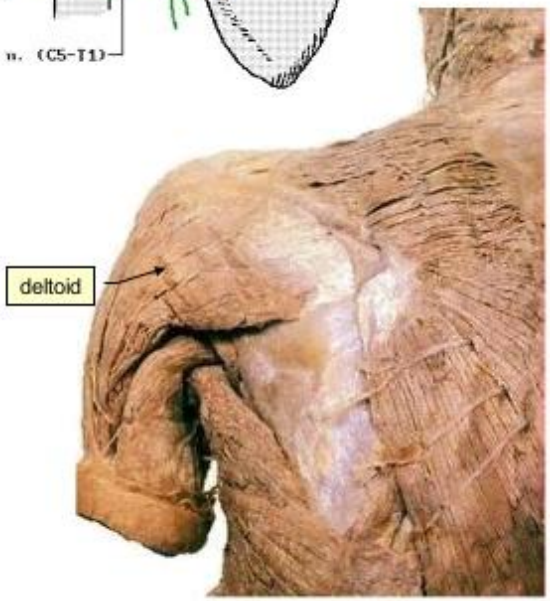


Mechanism of shoulder abduction

Axillary nerve

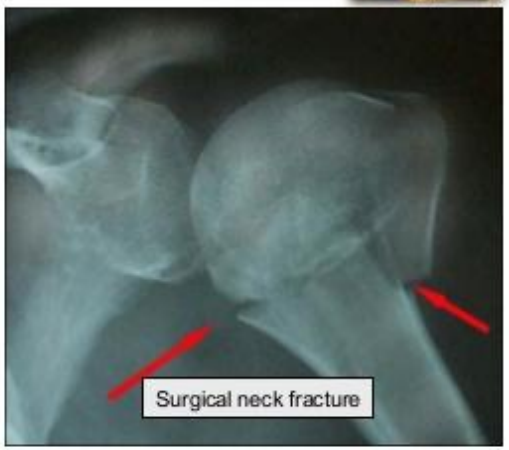
- **Origin and branches:**
  - Muscular: deltoid and teres minor.
  - Sensory: upper lateral cutaneous nerve of the arm.
- **Testing.**

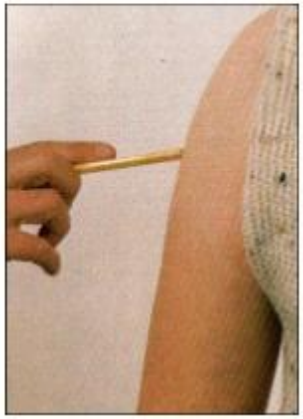


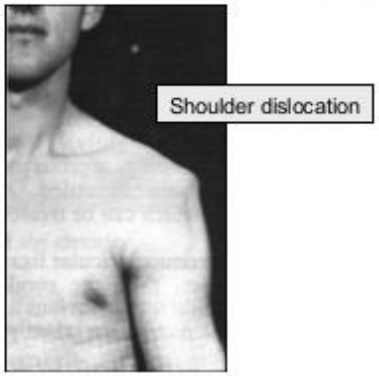


Axillary nerve injury

- Results from fracture of the surgical neck of the humerus and dislocation of the shoulder joint.
- Impossible to test the integrity of the axillary nerve by testing the ability of deltoid to abduct the arm because of severe pain
- The presence of a small area of lost or diminished sensation over the inferior half of deltoid enables the diagnosis of axillary nerve injury to be made.

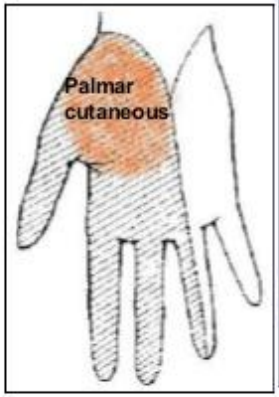


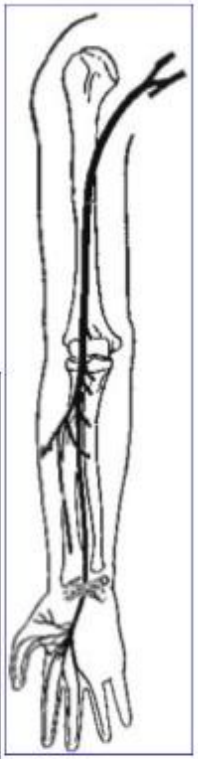




Median nerve

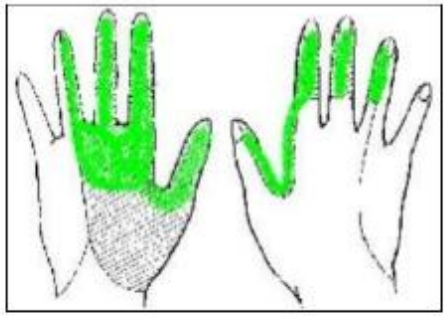
- **Origin**: medial and lateral cords of the brachial plexus
- **Branches**:
- No branches in the axilla.
- No branches in the arm.
- <u>Branches in the forearm:</u>
- Motor:
  - ALL the muscles of the flexor compartment.
  - EXCEPT 1 &1/2: Flexor carpi ulnaris & medial part of flexor digitorum profundus.
- Sensory:
  - Palmar cutaneous branch: skin over the thenar eminence.

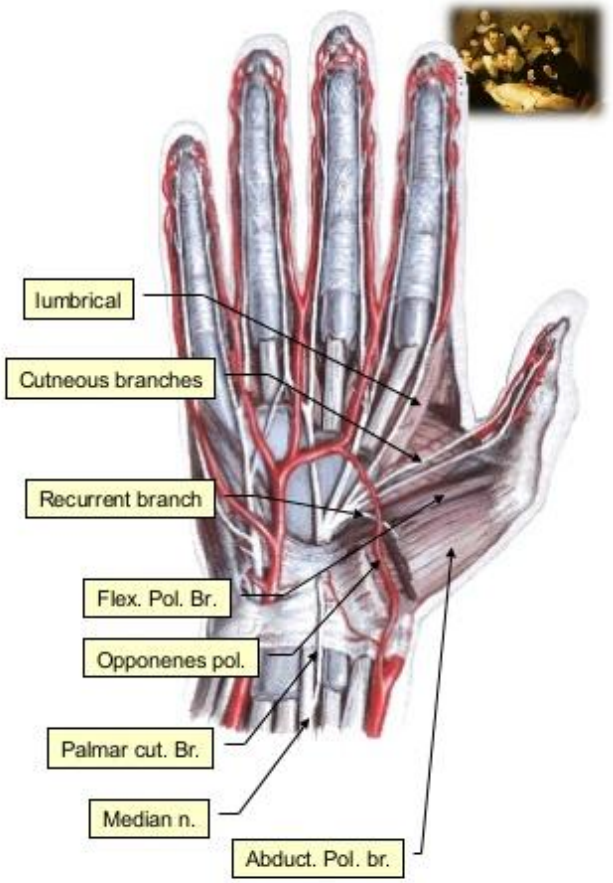




Median nerve

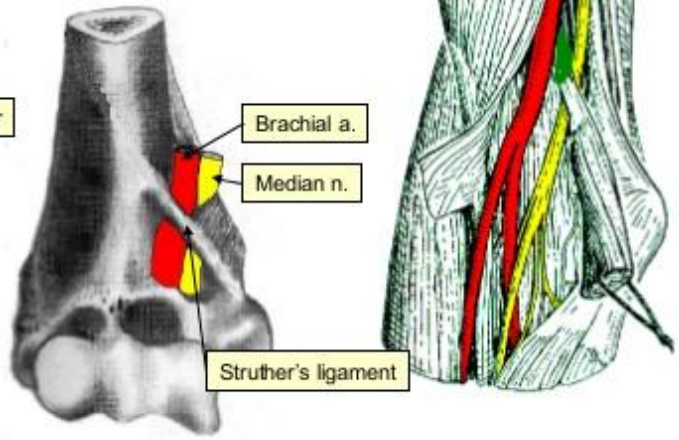
- Branches in the hand
- Motor: Recurrent branch
  - Muscles of the thenar eminence
    - Abductor pollicis brevis
    - Flexor pollicis brevis
    - Opponens pollicis
  - First 2 lumbricals
- Cutaneous branches





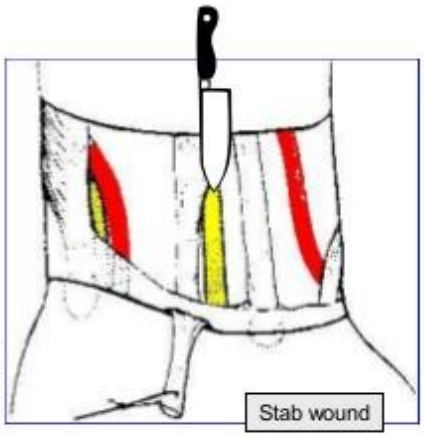
Median nerve injury

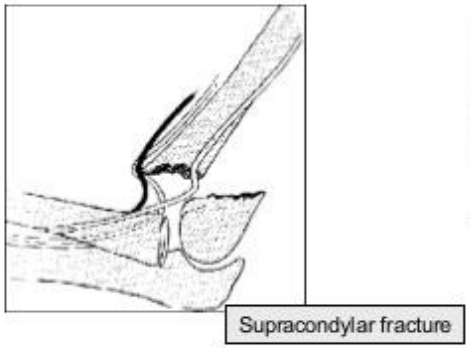
- **Common sites of injury**
- In the arm
  - Entrapment by Struther's ligament which extends between an occasional supracondylar spur and the medial epicondyle of the humerus. May also entrap the brachial artery.



Median nerve injury

- **Common sites of injury**
- At the elbow
  - Supracondylar fracture of the humerus
- At the wrist
  - Colle's fracture
  - Stab wound





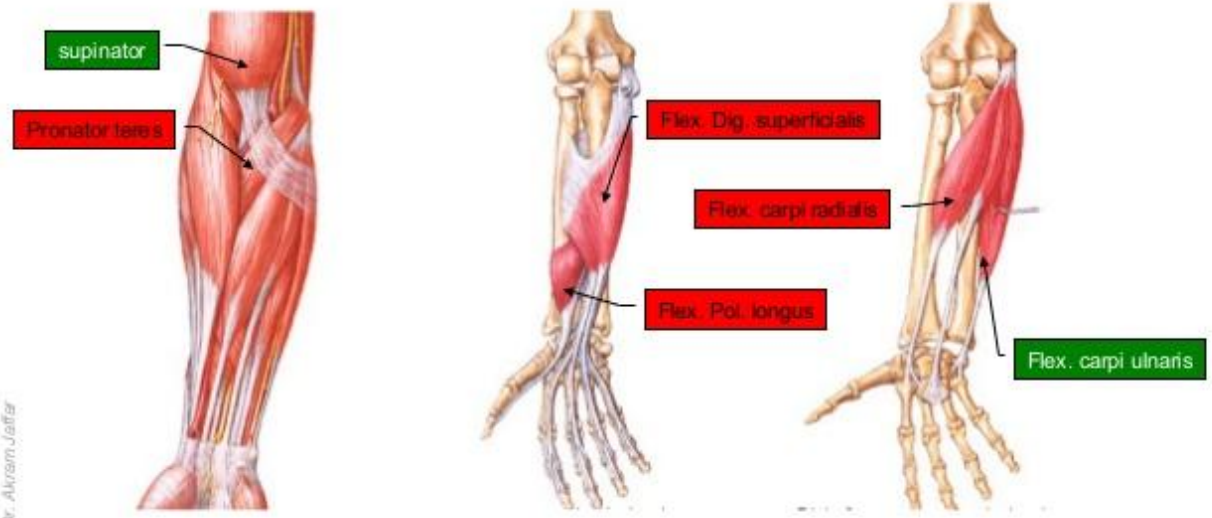
Median nerve injury at the elbow

Deformity

- Forearm in supinated position.
- Weak flexion at wrist.
- Wrist flexion accompanied by wrist adduction.

Cause

- Pronator muscles paralyzed.
- Long flexors paralyzed EXCEPT 1&1/2
- Flexor carpi ulnaris unopposed by flexor carpi radialis



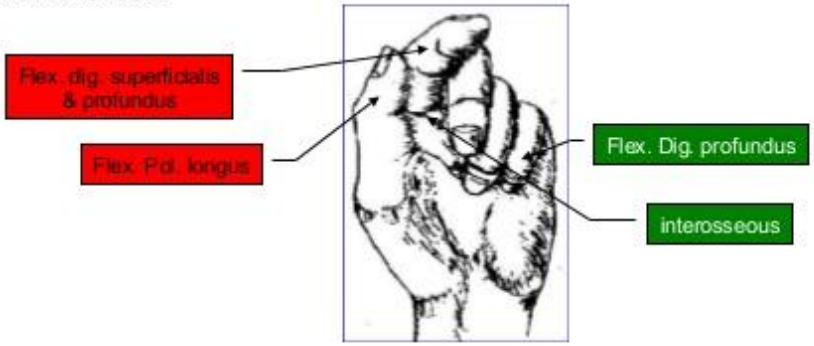
Median nerve injury at the elbow

Deformity

- Loss of flexion of index and middle fingers. When the patient tends to make a fist the index and middle fingers tend to remain straight while the ring and little fingers weakly flex
- Flexion of the metacarpophalangeal joints of index and middle fingers can still be attempted.
- Flexion of the distal phalanx of the thumb is lost.

Cause

- Flexor digitorum superficialis and lateral half of profundus.
- Interosseous muscles are not affected (supplied by the ulnar nerve).
- Paralysis of flexor pollicis longus.



Median nerve injury at the elbow or at the wrist

- **Deformity**
- Ape-like hand:
  - Flatenning of the thenar eminence.
  - The thumb is adducted
- Opposition and abduction of the thumb are not possible → loss of the pincer-like action of the hand (difficulty with fine manual tasks e.g. buttoning).

Cause

- Paralysis and wasting of the muscles of the thenar eminence (recurrent branch).
- Adductor pollicis is unopposed (supplied by the ulnar nerve).
- Opponens pollicis, abductor pollicis brevis, flexor pollicis brevis.

Loss of thumb opposition

Flatenning of thenar eminence

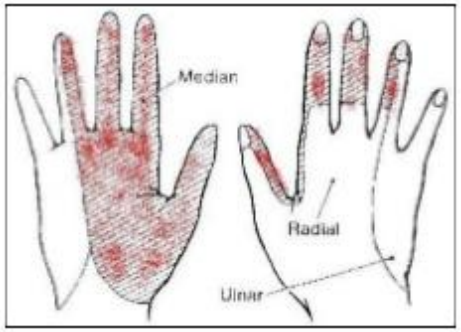
Median nerve injury
at the elbow or at the wrist

Sensory loss

- Skin areas involved are also warmer and dryer than normal.

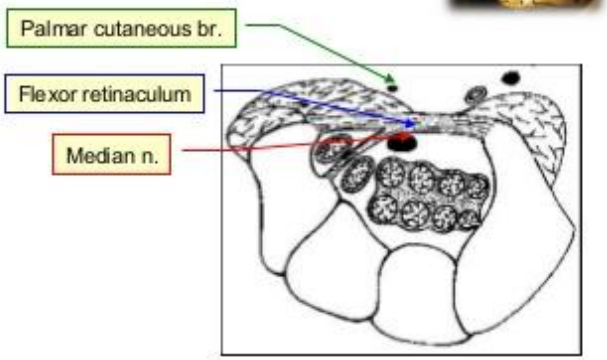
Cause

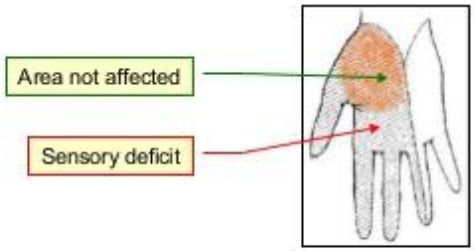
- arterial dilatation and absence of sweating resulting from loss of sympathetic control.

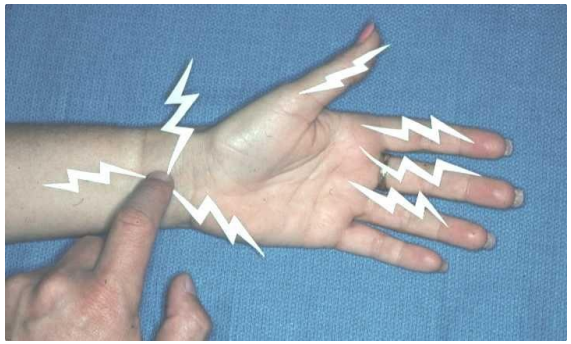


Median nerve injury
Carpal tunnel syndrome

- Compression of the median nerve in the carpal tunnel.
- The carpal tunnel is tightly packed by the flexor tendons with their surrounding synovial sheaths.
- Clinically, there will be pain and tingling along the sensory distribution of the median nerve in the hand excluding the skin of the thenar eminence which is supplied by the palmar cutaneous branch of the median nerve.
- The palmar cutaneous branch of the median nerve passes superficial to the flexor retinaculum is not caught by compression of the main nerve.

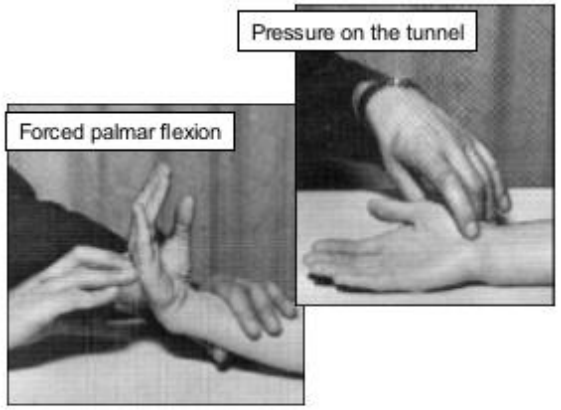






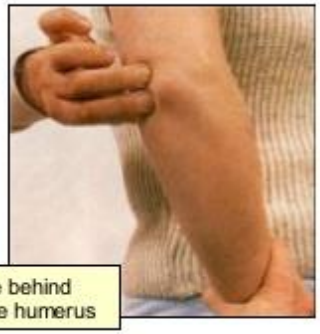
Median nerve injury
Carpal tunnel syndrome

- Forced palmar flexion or pressure on the tunnel may reproduce pain and tingling.
- The remaining signs and symptoms are similar to those produced by injury of the nerve at the wrist.
- The condition is corrected by decompressing the tunnel through an incision along the flexor retinaculum



Ulnar nerve

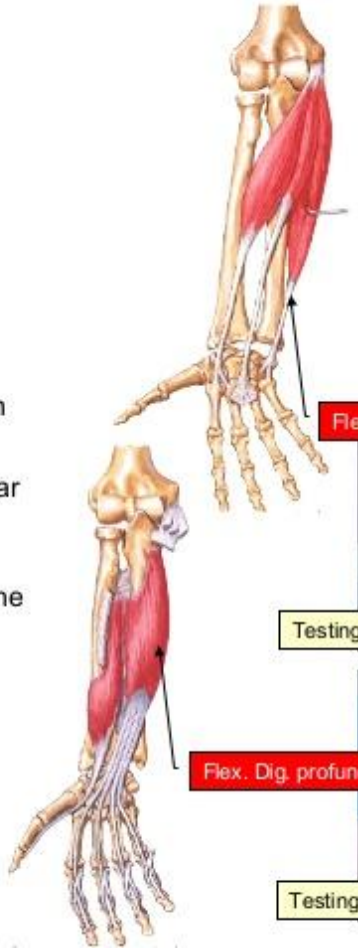
- Arises from the medial cord of the brachial plexus
- No branches in the axilla
- No branches in the arm.
- Passes behind the medial epicondyle to enter the forearm.



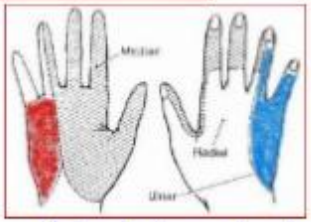
Palpation of the ulnar nerve behind the medial epicondyle of the humerus

Ulnar nerve

- **Branches in the forearm**
- Motor: 1 & ½ muscles
- Sensory
  - dorsal cutaneous branch
  - Palmar cutaneous branch
- **Testing**
- Flexion of the wrist on the ulnar side against resistance tests flexor carpi ulnaris
- Flexing the distal phalanx of the little finger against resistance tests ulnar side of flexor digitorum profundus



Palmar cutaneous branch



dorsal cutaneous branch

Flex. Carpi ulnaris

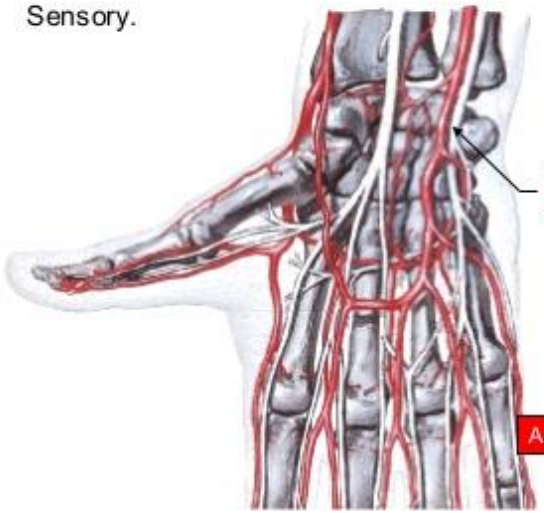
Testing flexor carpi ulnaris

Flex. Dig. profundus

Testing flexor digitorum profundus

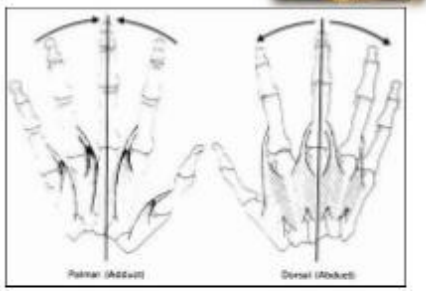
Ulnar nerve

- **Branches in the palm**
- Motor:
  - Hypothenar muscles.
  - Medial two lumbricals.
  - Adductor pollicis.
  - ALL interossei.
- Sensory.



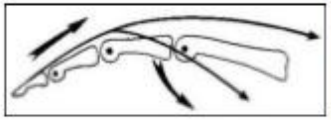
Ulnar nerve

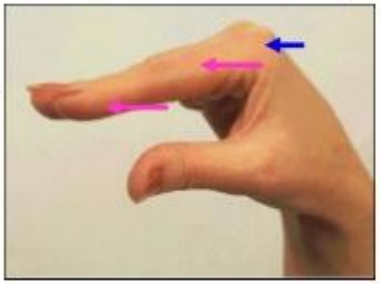
- **Action of interossei**
- Palmar ADduct – Dorsal Abduct (PAD & DAB)
- **Testing**:
  - Palmar interossei: adducting the fingers against a piece of paper
  - Dorsal interossei: Resisted abduction of fingers.
- **Action of interossei and lumbricals:**
  - Flexion of metacarpo-phalangeal joints and Extension of inter-phalangeal joints.
  - Act through the extensor expansion.



Testing palmar interossei

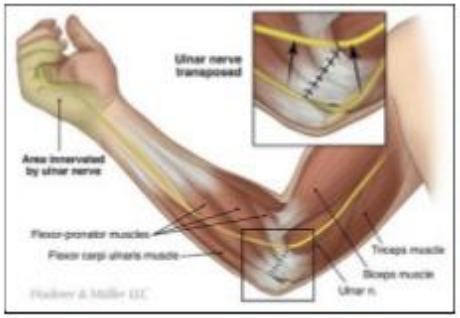
Testing dorsal interossei





Ulnar nerve injury

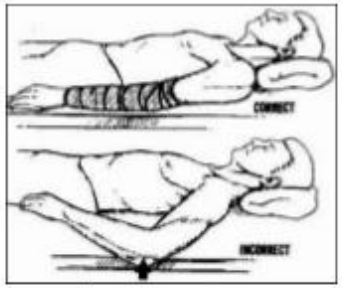
- **Common sites of injury**
- At the elbow
  - Cubital tunnel syndrome: repetitive minor trauma of the ulnar nerve behind the medial epicondyle.
  - Treatment: anterior transposition of the ulnar nerve.



Ulnar nerve injury

- **Common sites of injury**
- At the elbow
  - Fracture or dislocation
  - Improper positioning of the arm on the operating table
- At the wrist
  - Stab wound

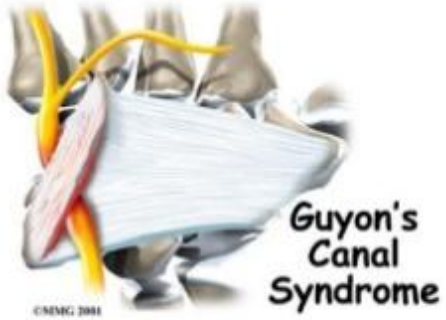
Medial epicondyle fracture

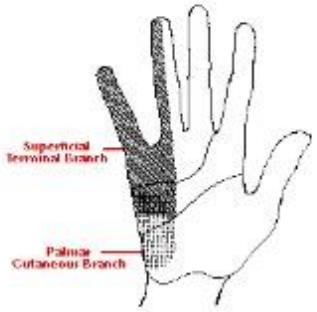


Dislocation of the elbow

Ulnar nerve injury

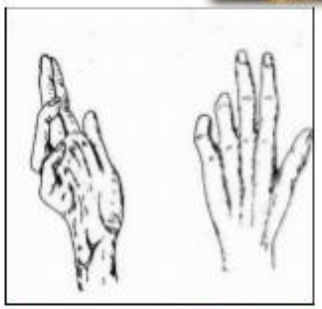
- **Common sites of injury**
- Guyon's canal syndrome
- Entrapment of the ulnar nerve as it passes through a tunnel in the wrist between the pisiform and hamate and the ligament that connects them (Guyon's canal).
- Similar to carpal tunnel syndrome but involves the ulnar nerve.
- Fracture of the hook of the hamate.





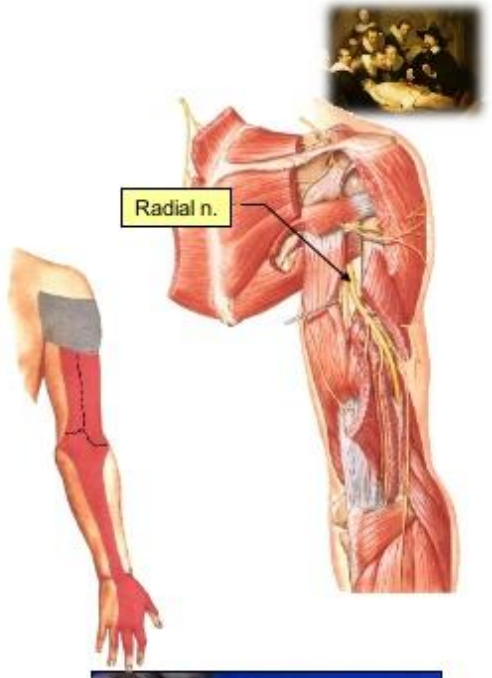
Ulnar nerve injury

- **Claw hand**
- Paralysis of the interosseous muscles → extension of the metacarpophalangeal joints and flexion of the interphalangeal joints which is most prominent in the fifth and fourth fingers whose lumbricals are also supplied by the ulnar nerve.
- Atrophy of the interossei.



Radial nerve

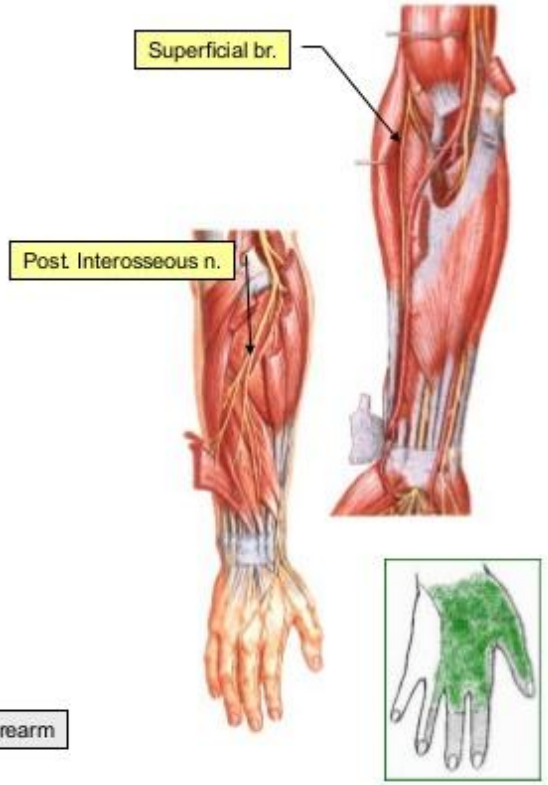
- Arises from the posterior cord of the brachial plexus
- Is the nerve of the extensor compartments of the upper limb
- Gives its branches some distance to the part to be innervated
- Branches in the axilla
  - Motor: triceps
  - Sensory: posterior cutaneous of arm
- Branches in the spiral groove
  - Motor: Triceps
  - Sensory: lower lateral cutaneous n. of arm and posterior cutaneous n. of forearm
- Testing: Resisted extension at the elbow at 90°.



Testing triceps: resisted extension at the elbow

Radial nerve

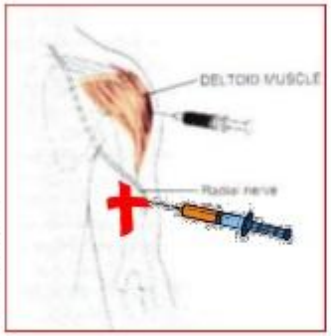
- Branches at the elbow:
- Motor: Supplies ALL the muscles in the extensor compartment of the forearm.
- Sensory : superficial branch to dorsum of the hand.
- Testing
- Extension of the wrist against resistance

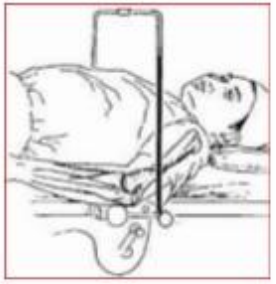


Testing extensors of forearm

Radial nerve injury

- **Common sites of injury**
- Axilla: pressure of the upper end of a badly fitting crutch (crutch palsy). Crutches should NOT be thrust high into the axilla
- Spiral groove:
- Fracture of the shaft of the humerus.
- Improper IM injection.
- Improper positioning of the arm on the operating table.
- Posterior interosseous nerve in fractures of the proximal end of the radius





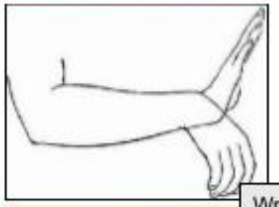
Dr. Akram Jaffar

Wrist drop after crutch use?

What is the reason?

Radial nerve injury

- **Wrist drop** results from paralysis of the extensors of the wrist
- Inability to extend the fingers at the metacarpophalangeal joints.
- Interphalangeal joints can still be extended by the intrinsic muscles.
- Muscle wasting.
- Loss of skin sensation over the back of the arm, forearm, and dorsum of the hand.



Wrist drop

Sensory loss

Inability to extend metacarpophalangeal joint but interphalangeal joints can be extended

Extensor muscle wasting

A

B

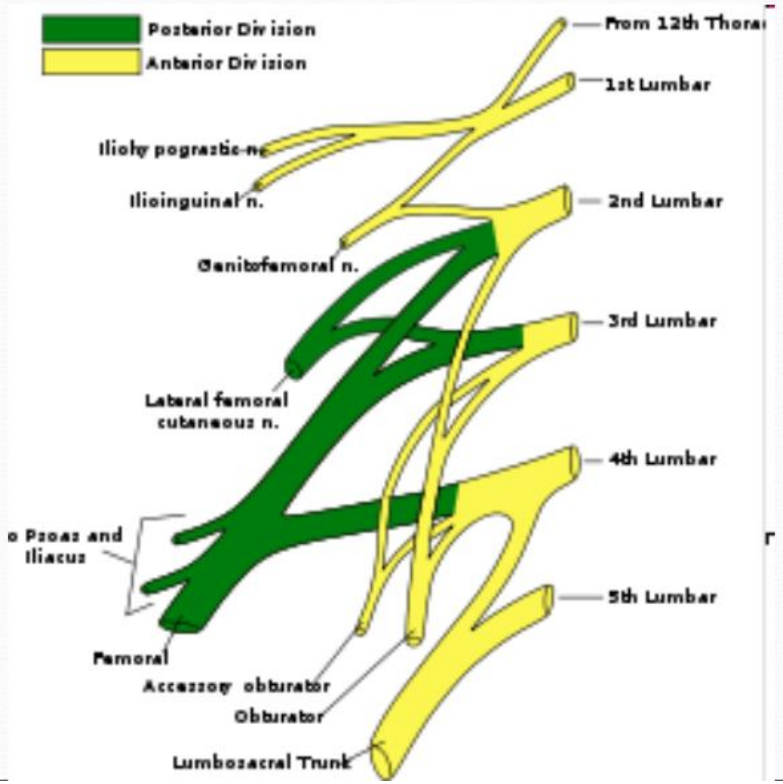
C

Opponens

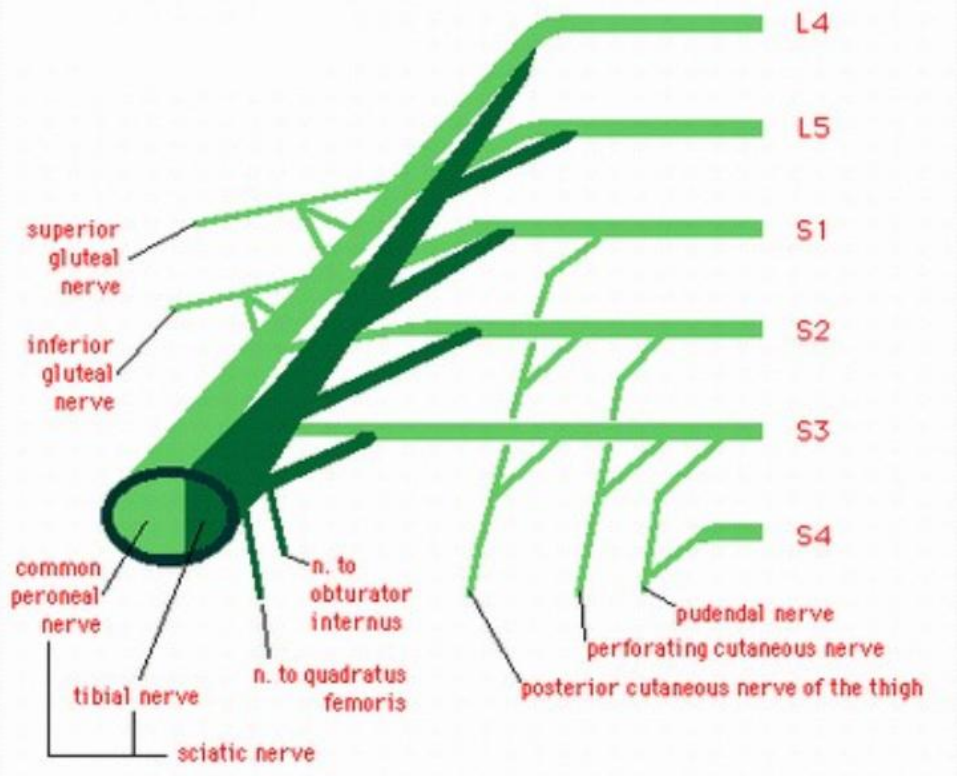
Failed index flexion, but positive opposition

Where is damage? Tendon? Nerve?

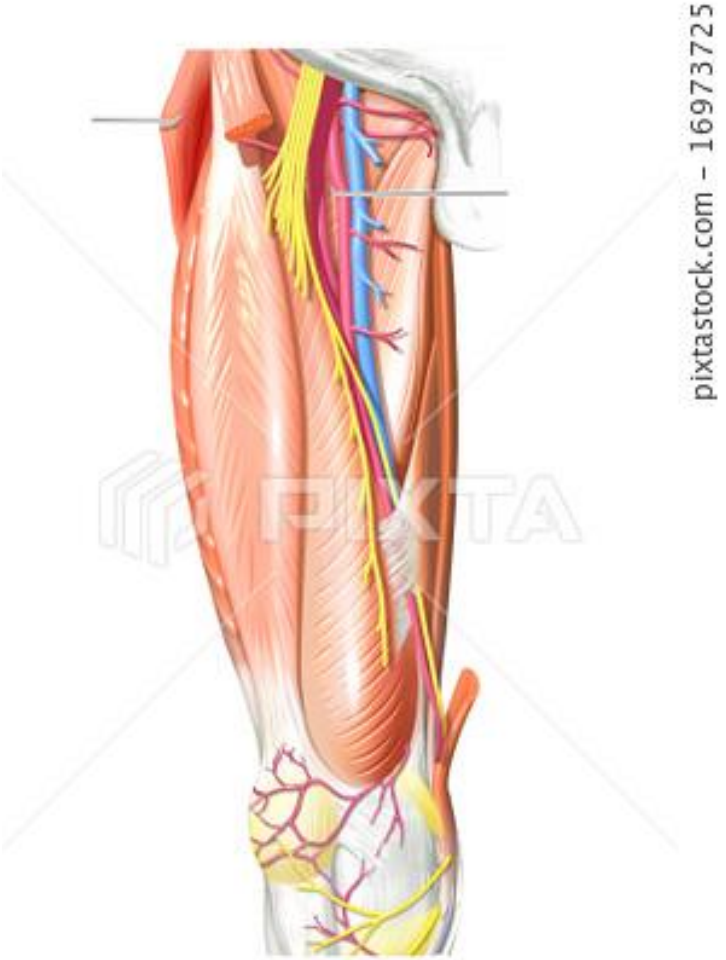
Lumbar Plexus



Lumbosacral Plexus



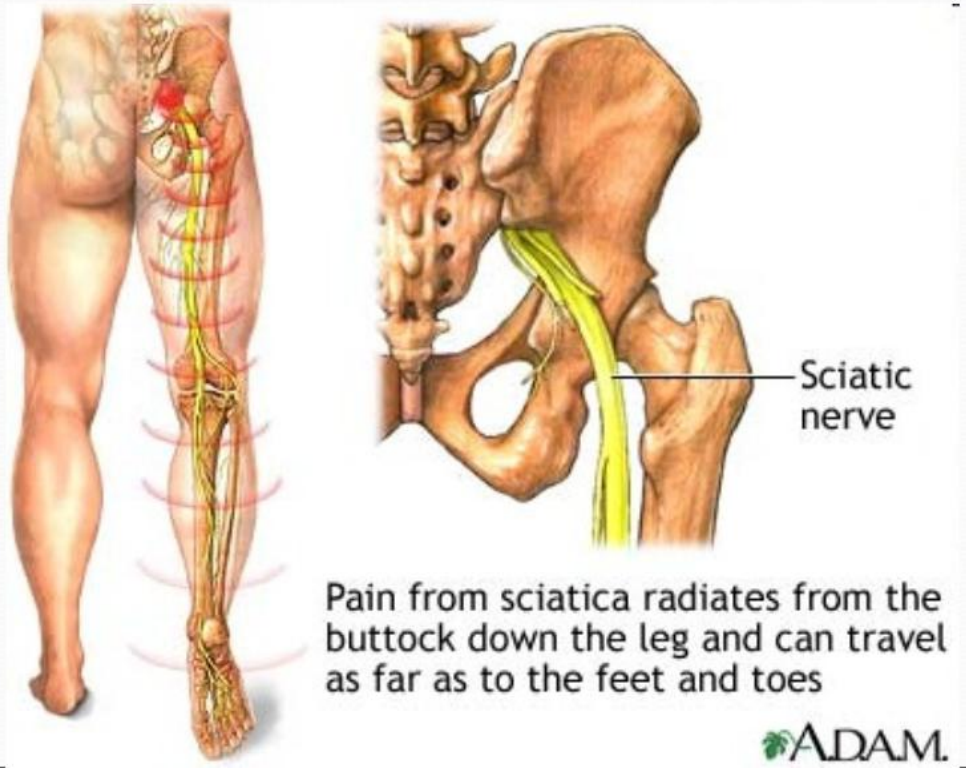
Femoral nerve



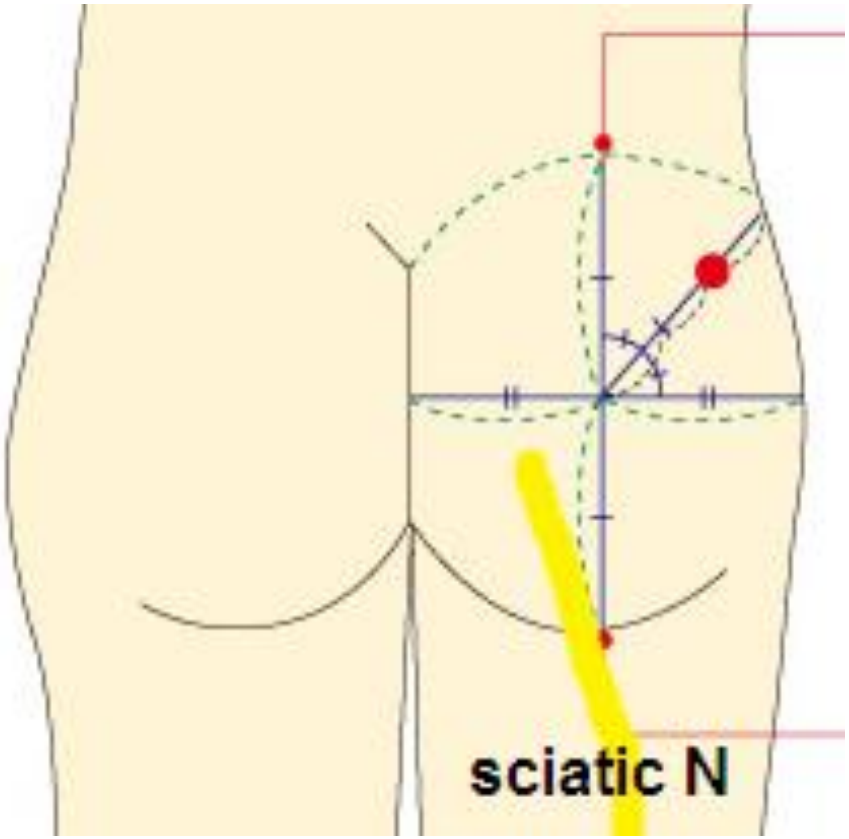
A 28 days infant, unable to extend her knee 3 days after Pavlik

What is the cause?

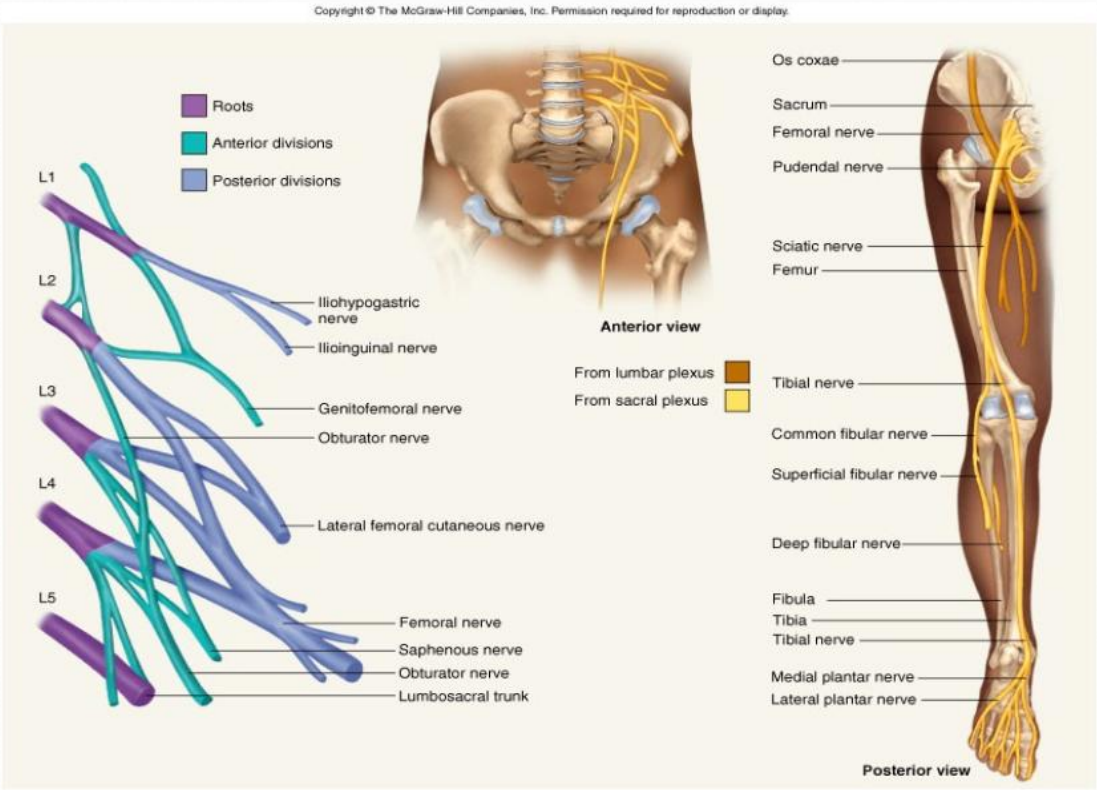
Sciatic Nerve

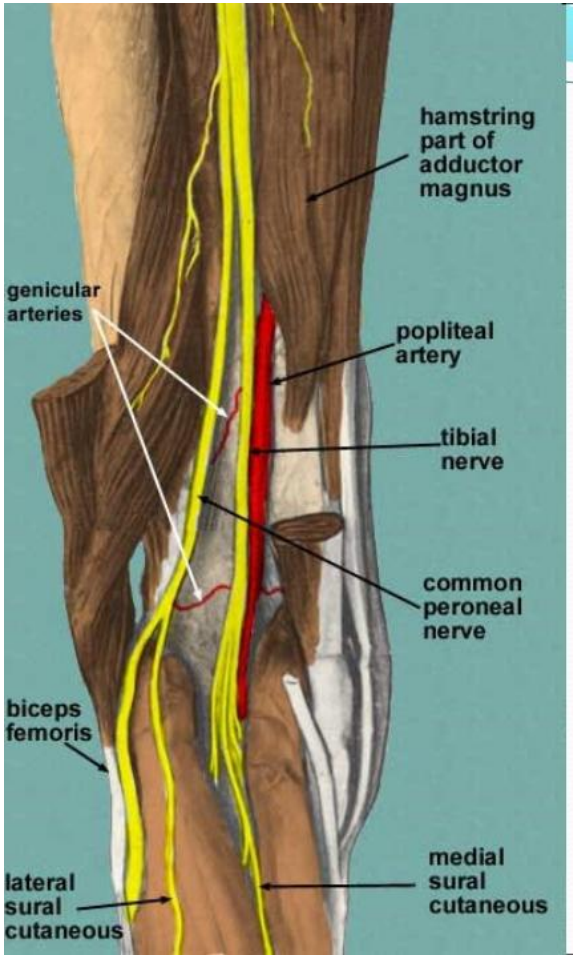


Gluteal injection technique



The Lumbar Plexus

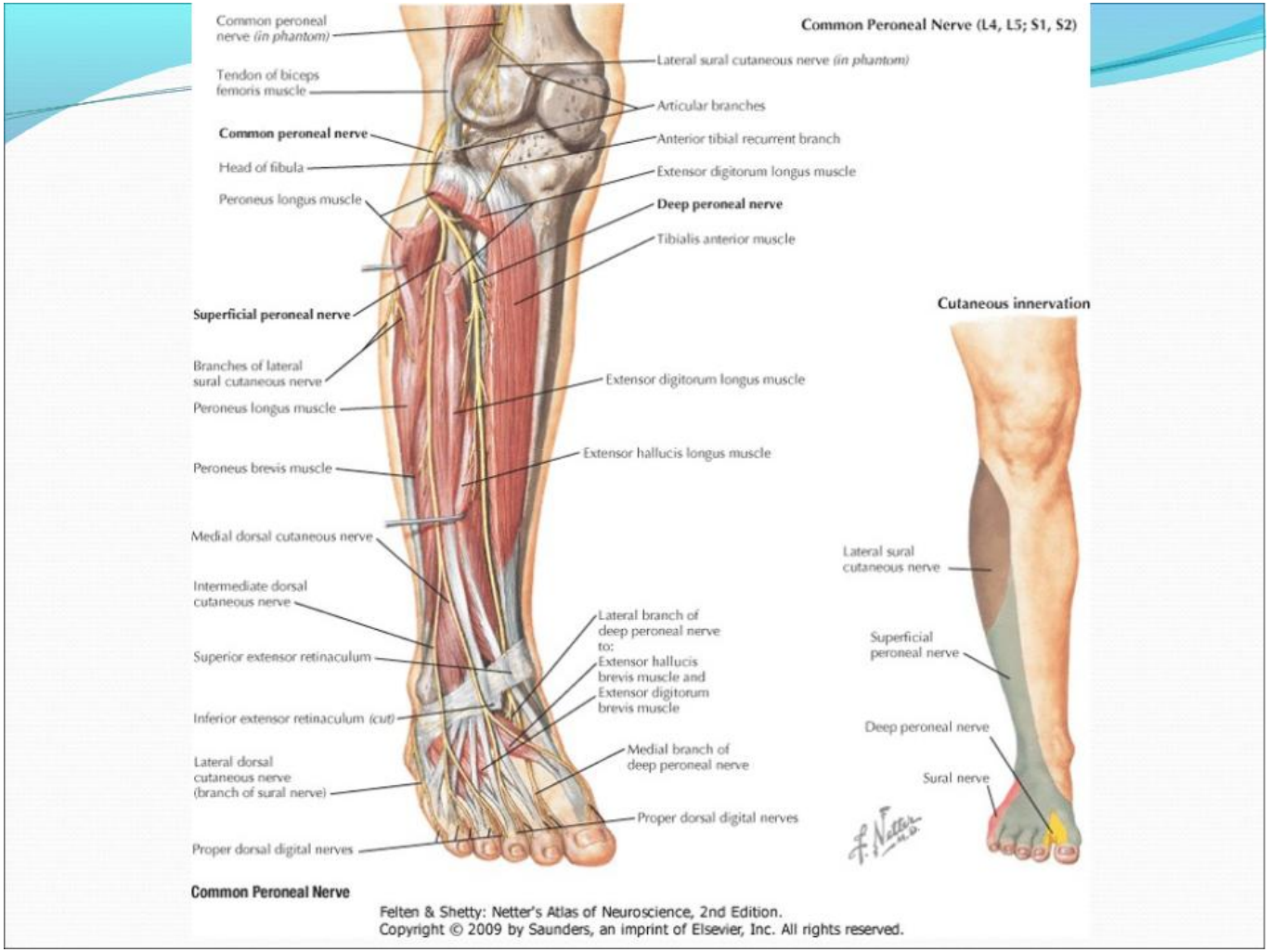




Sciatic Nerve

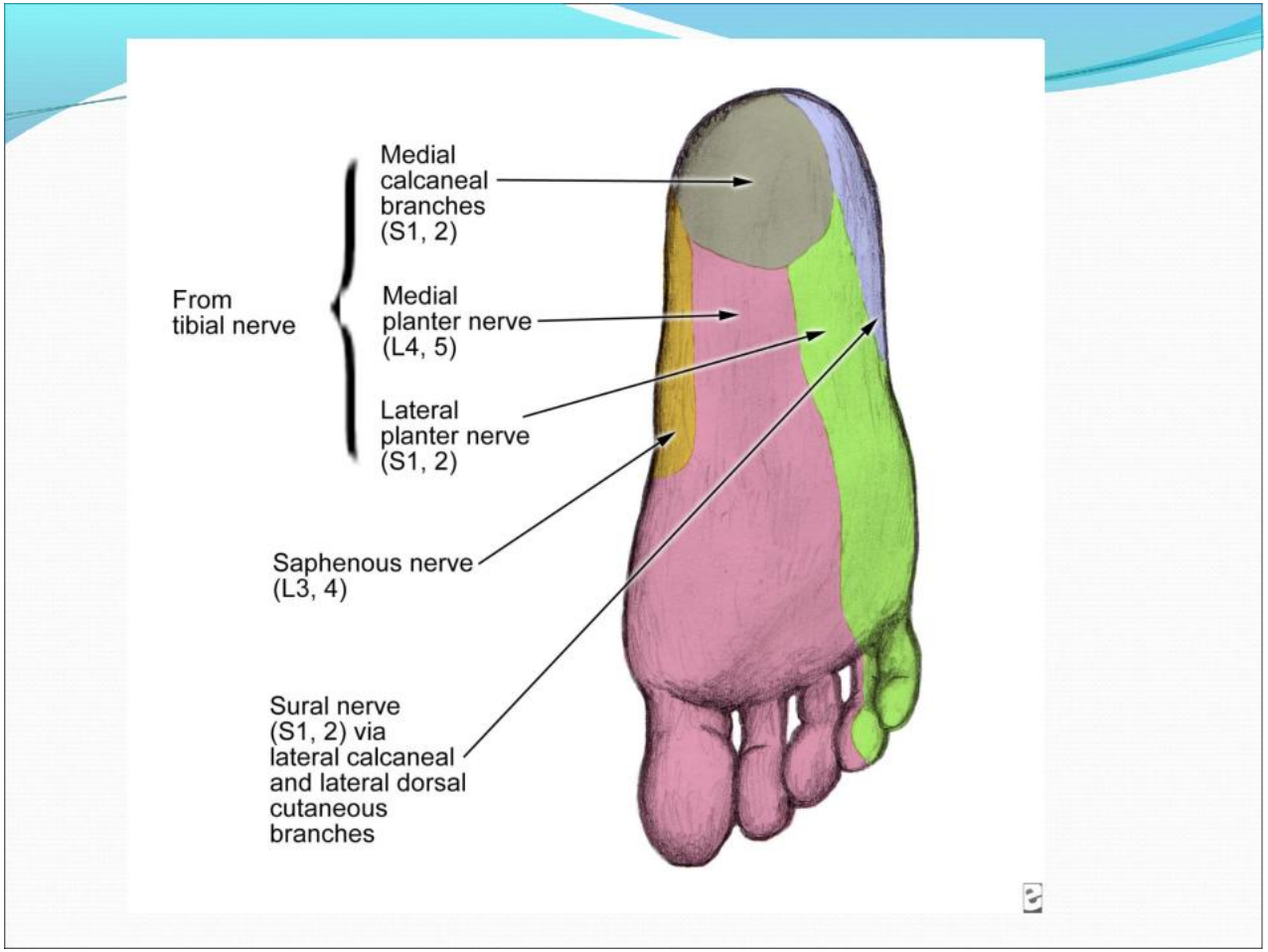
- Just posterior to knee joint, sciatic nerve will branch off to form medially tibial nerve and laterally common peroneal nerve.
- Tibial nerve will running posteriorly of the leg and enter the plantar of the foot.
- Common peroneal nerve descends anteriorly of the leg and enter the dorsum of the foot.

Peroneal nerve



Foot drop after cast, why?

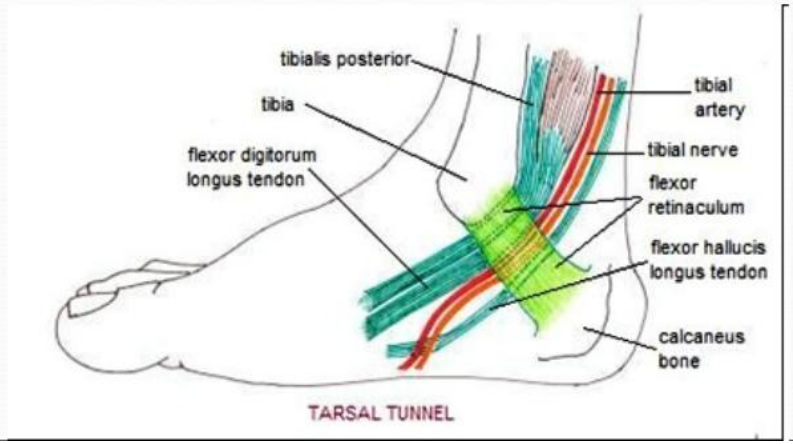
Tibial nerve



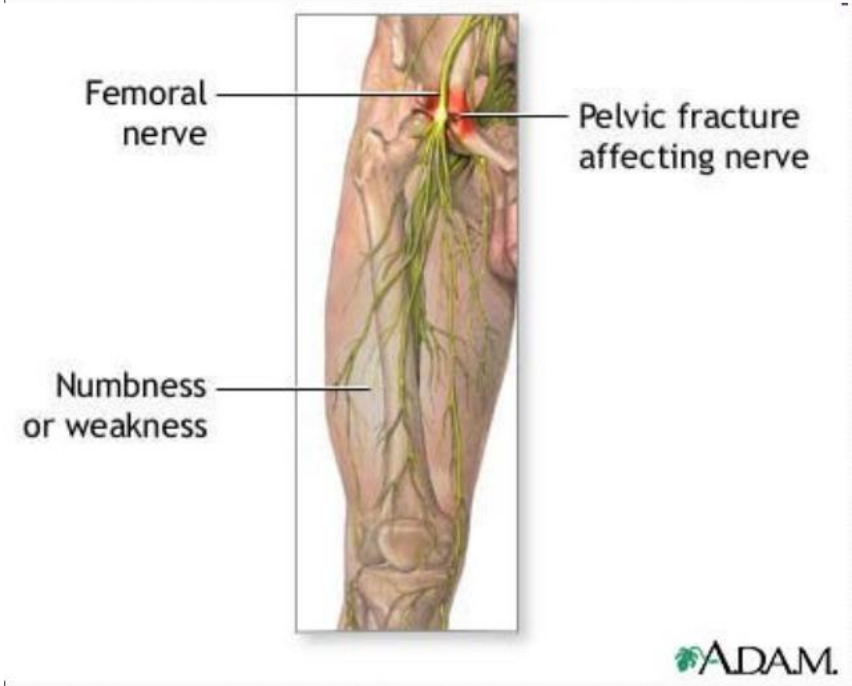
SUMMARY ON MOVEMENTS CONTINUED

Leg and foot (ankle) movement

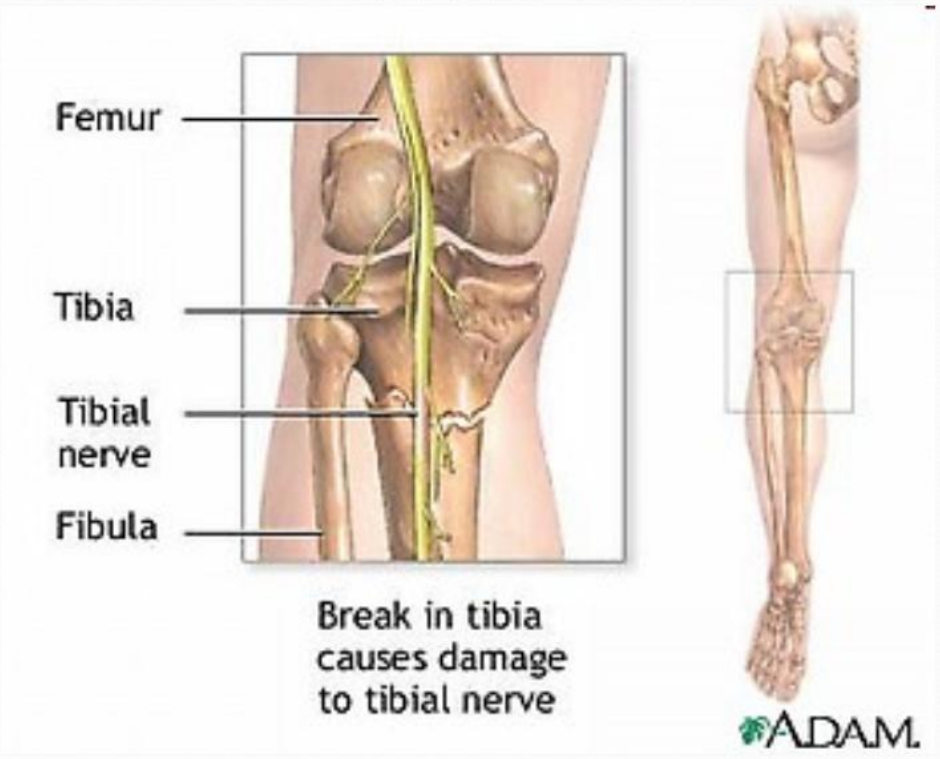
- For cutaneous branch, it will arise to the sural nerve and supply the skin lateral side of the leg.
- The nerve pass into the foot running posterior to the medial malleolus.
- Here it bound by the flexor retinaculum of the foot.
- In the foot the tibial (sural nerve) divide into lateral and medial plantar nerves.

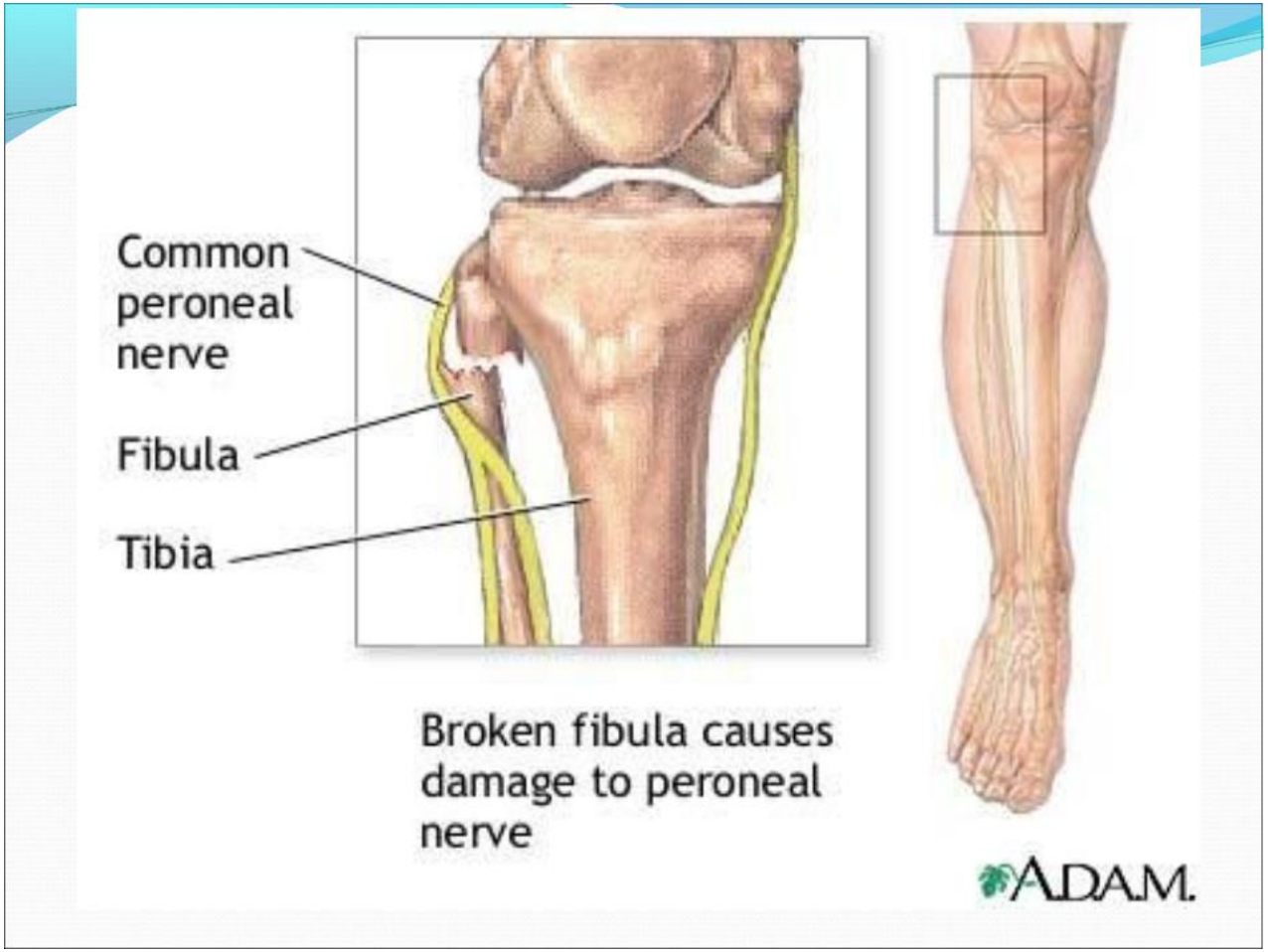


Clinical Condition



Injury to Tibial Nerve




Common peroneal nerve
Fibula
Tibia
Broken fibula causes damage to peroneal nerve
A.D.A.M.

Thanks