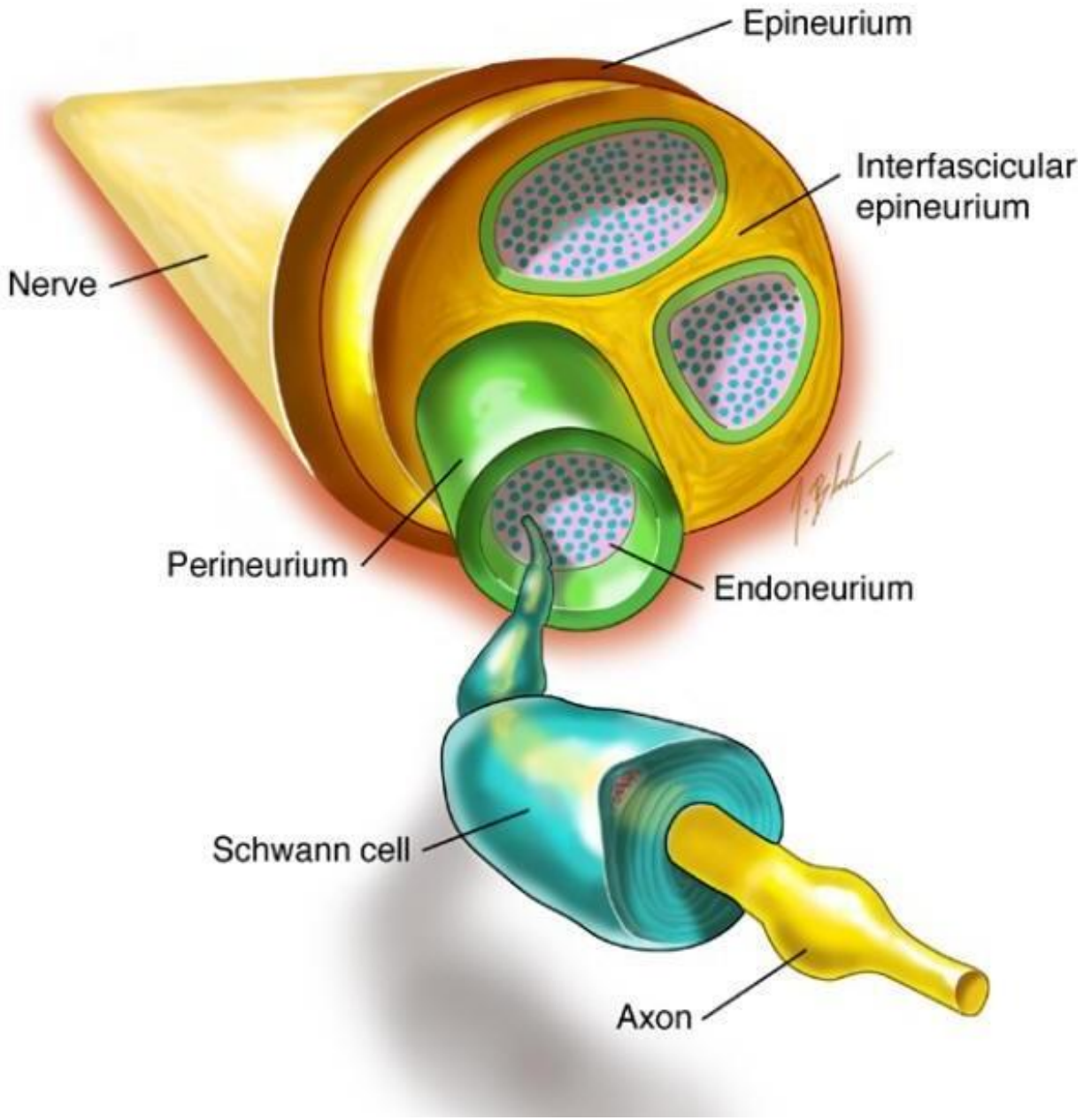
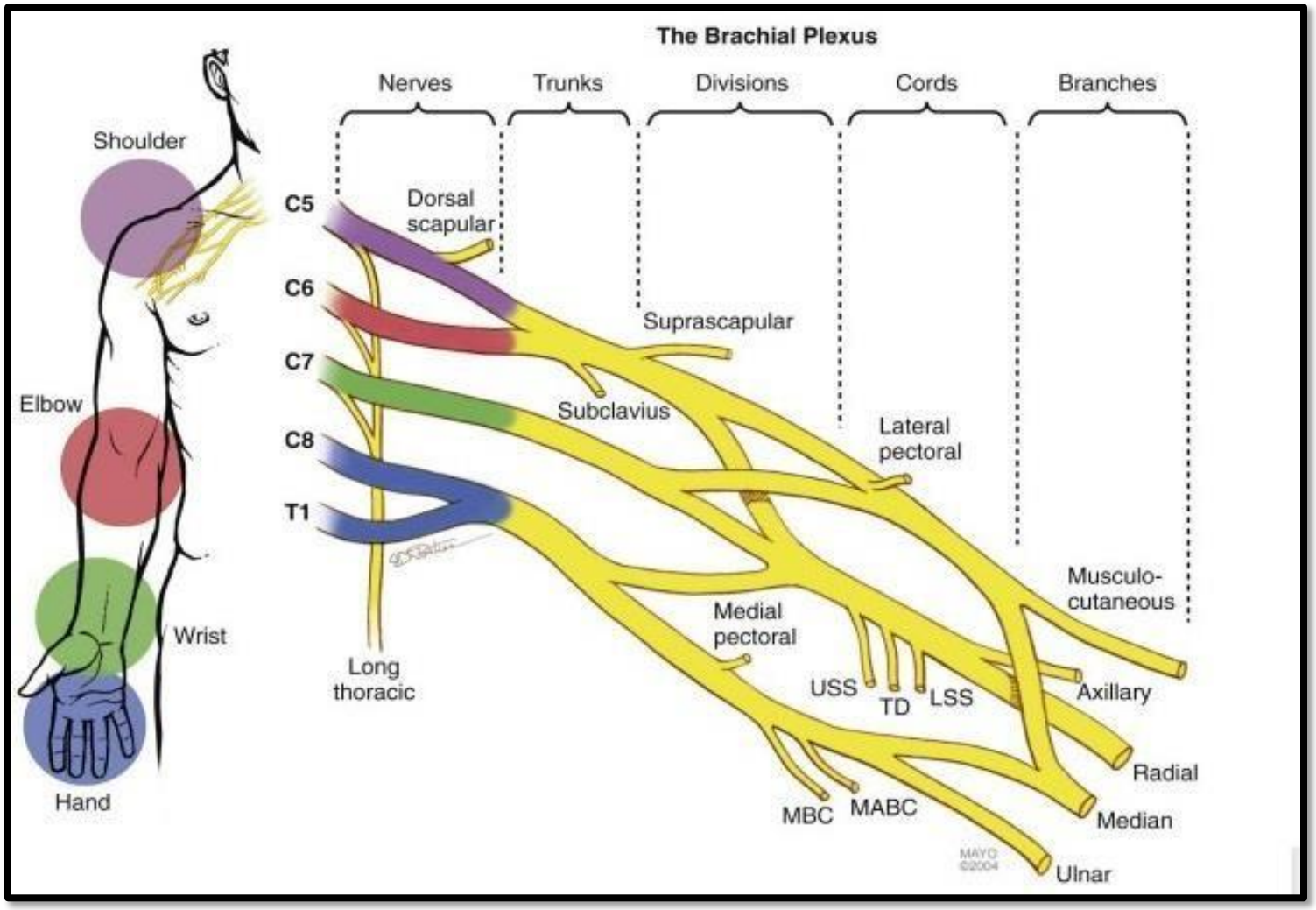
وَقُلْ رَبِّ أَدْخِلْنِي مُدْخَلَ صِدْقٍ وَأَخْرِجْنِي مُخْرَجَ صِدْقٍ وَاجْعَلْ
لِي مِنْ لَدُنْكَ سُلْطَانًا نَصِيرًا

Nerve and Tendon injury

NERVE STRUCTURE



ANATOMY OF BRACHIAL PLEXUS



TYPES OF NERVE INJURIES

SEDDON classifications

- **Neuropraxia:** physiological block to nerve function –selective demyelination of large fibers without distal axon degeneration – spontaneous recovery within few days to several weeks
- **Axonotmesis:** disruption of axons & its myelin sheath with intact fibrous sheath - Wallerian degeneration-slow recovery depend on regeneration
- **Neurotmesis:** complete discontinuity

N.B nerve regenerate at a rate of 1 ml/day (variable)

BRACHIAL PLEXUS INJURIES

- **According to Etiology**
  - Obstetric (Traction injuries)
  - Traumatic (MCA, Motor cycle, FAI, Penetrating wounds and Iatrogenic)
- **According to Nerves affected**

1. Upper trunk (C5, 6) injury.
2. Upper and Middle trunks (C5, 6,7) injury.
3. Lower trunk (C8, T1) injury.
4. Total Brachial plexus palsy (C5,6,7,8, T1) injury. with or without Horner's syndrome.

Upper roots are less susceptible to avulsion than lower roots

- **Longer**
- **More downward inclination**
- **Attached to the c-spine by transversoradicular ligament**

Horner ‘s syndrome :

- Ptosis
- Miosis
- Anhydrosis
- Enophthalmos

Due to injury to sympathetic trunk

OBSTETRIC BRACHIAL PLEXUS INJURY

CLINICAL PRESENTATION

- **Symptoms: parents complain of lack of active hand / arm motion**
- **Erb ‘s palsy 65-90% : adducted internally rotated shoulder**

  pronated extended elbow

  waiter ‘s tip position

  Best prognosis

  C5 : deltoid , teres minor (axillary n.)

  Supra- infra spinatus (SSN)

  biceps ,brachialis (mcn)

  C6 : brachioradialis ,supinator (radial n.)
- **Extended Erb’s : + loss of wrist and finger extension**

- **Klumpke’s paralysis : v. rarely isolated**

  loss of wrist &finger flexion and intrinsic function
- **Total OPBI: flail upper limb**
- **Look for signs of preganglionic injury**

Differntial diagnosis (paralysed U.L in neoborn):

- **Fractures : commonly clavicle and humerus**
- **Intracranial haemorrage**

DIGNOSIS OF PERIPHERAL NERVE LESION

Clinical diagnosis

- Motor effect
- Sensory effect
- Autonomic effect
- Loss of reflexes if the nerve is part of reflex arc

Motor effect

- **Paralysis**
- **Atonia**
- **Atrophy**

Ms power is measured n a scale from 0 to 5

Sensory effects :

Loss of 4 primary sensation toutch –pressure – pain – temp

Loss of reflexes

Autonomic effect :

- **Vasomotor :v.d followed by v.c**
- **Sudomotor : partial lesion →hyperhydrosis**
- **complete lesion→ anhydrosis**
- **Atrophy of skin & skin appendeges , loss of s.c fat**

Electrodiagnosis

Nerve conduction velocity

electromyography

Investigations

Plain radiography

MRI

treatment

Non operative **: observation & physical therapy**

Indication : first line of treatment in almost all cases as spontenous recovery frequently occur

- **:** **Full Spont. Recovery (%)**
  - **C5-6 80**
  - **C5-7 60**
  - **Total 30**
  - **Total + Horner's 0**

Goal : maintain full passive motion & wait for recovery

PRINCIPLES OF TREATMENT

Non-operative treatment

In cases treated conservatively and before – after surgery

1. **Passive & active movements to avoid stiffness**
2. **Electrical stimulation (Physiotherapy)of paralyzed muscles.**

Operative treatment

Indications:

1. **Open injuries**
2. **Delay in expected time of recovery**
3. **Neuroma is formed (tender- palpable)**

This may be primary or secondry

Options

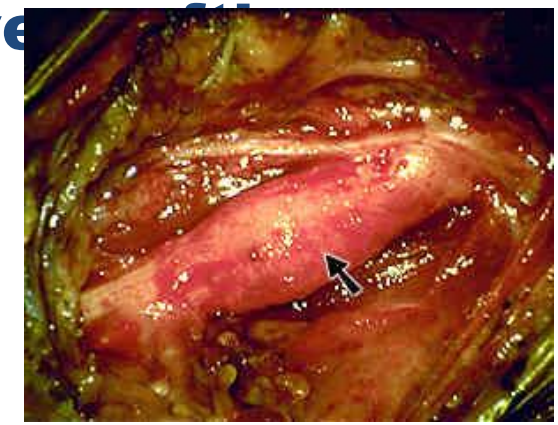
1. **Direct repair (neuroraphy)**
2. **to close gaps**

Use of nerve graft or bone shortening or nerve transposition or neurolysis

3.Irrepairable lesions : tendon transfer s / arthrodesis e.g foot drop

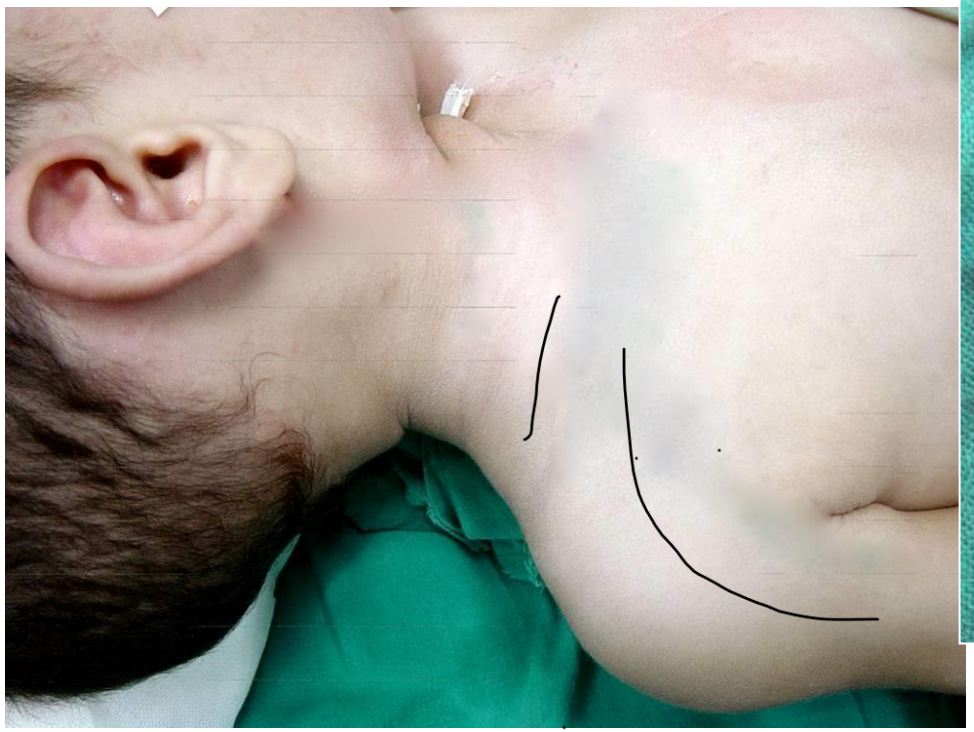
Operative

Indications : total with horner's syndrome
no antigravity biceps function by 3-6 months
Goals : HAND FUNCTION
elbow flexion & shoulder stability
Types of surgery
A Exploration & Microsurgical reconstruction : neurolys ir \ nerve

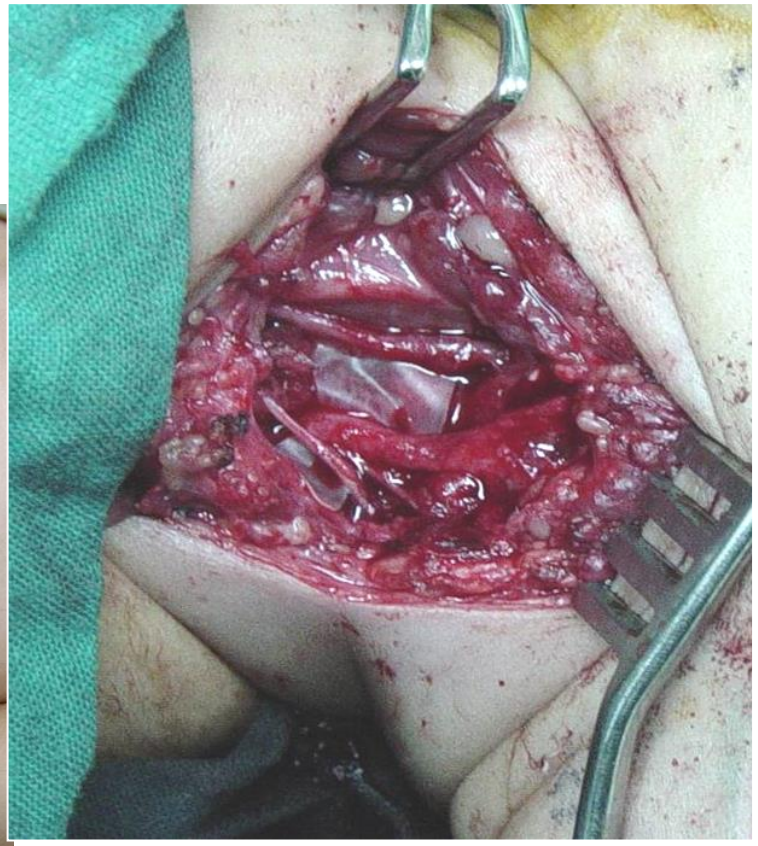


operative

Technique

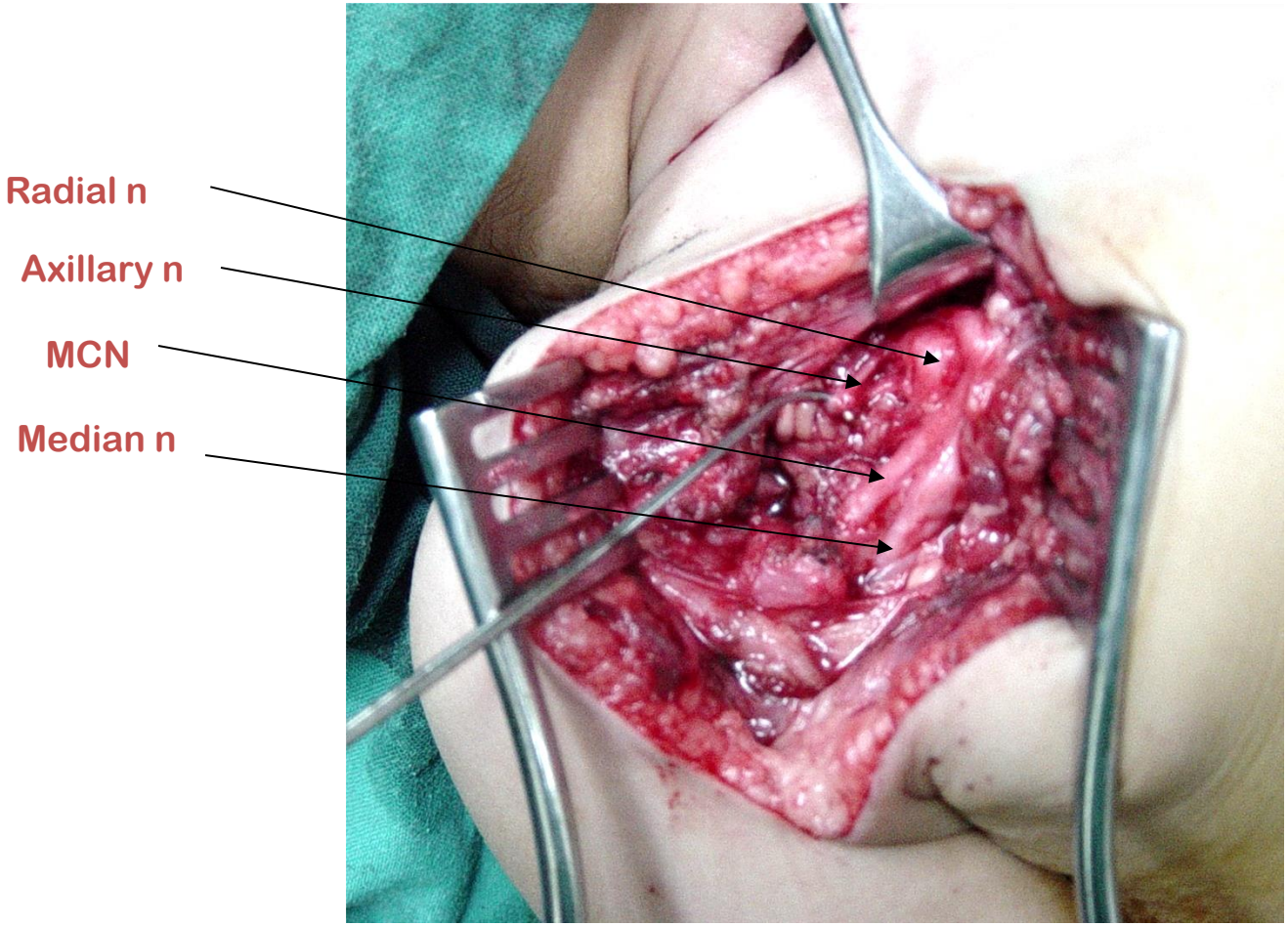


Incisions



Supraclavicular exploration

TECHNIQUE



Infraclavicular exploration

B- Neurtization : nerve transfer

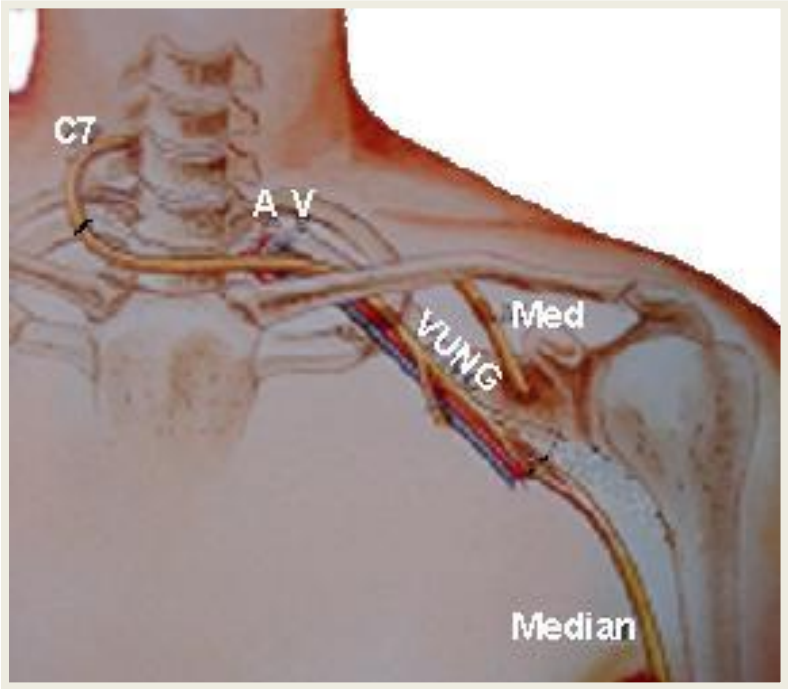
Indications : root avulsions (no available roots)

Donors : motor \ sensory \ mixed

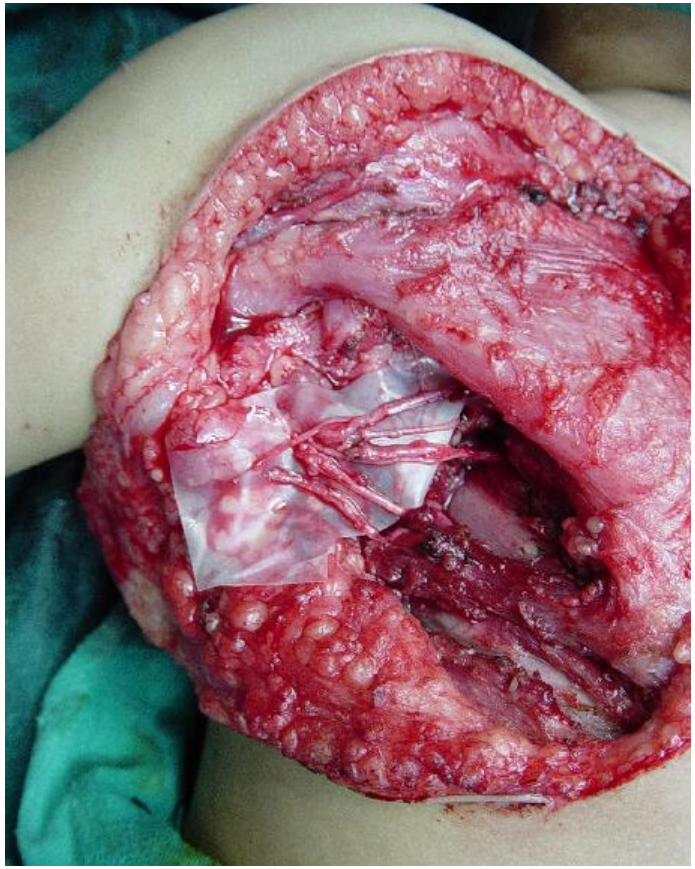
Sources of extraplexal donors

Motor	Sensory	Mixed
•spinal accessory (SAN) •phrenic •motor brs. of deep cervical plexus •hypoglossal •long thoracic •contralateral medial pectoral	Supra-clavicular	•Intercostals T3- T6 •contralateral C7

NEUROTIZATION

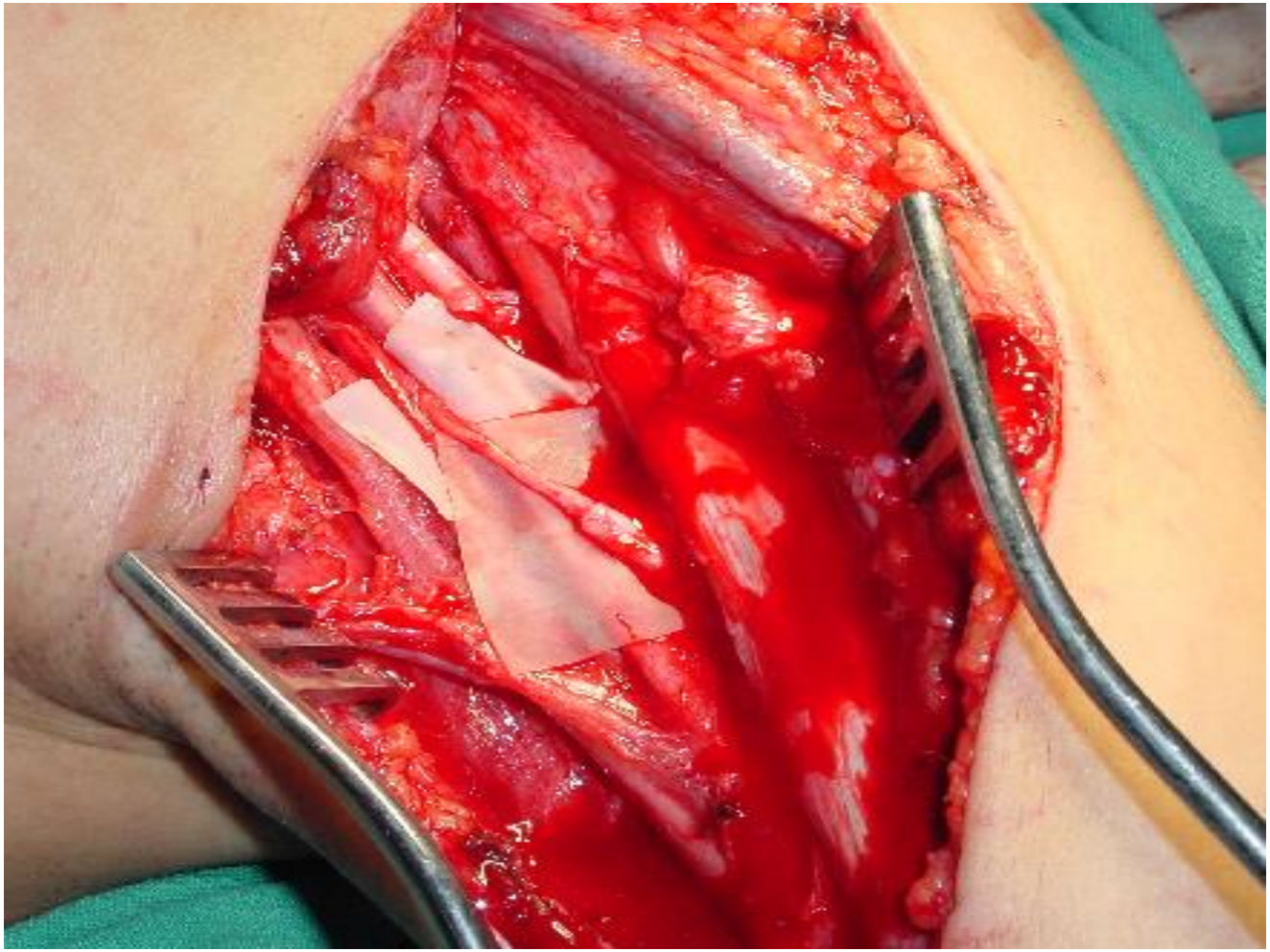


Contralateral C7



Intercostal nerves

Oberlin procedure **ulnar n. to MCN**



Examples

- **Three roots available**

One root to each cord

- **Two roots available**

one root to medial cord and the other to PC +
ICNs to MCN and LRMN

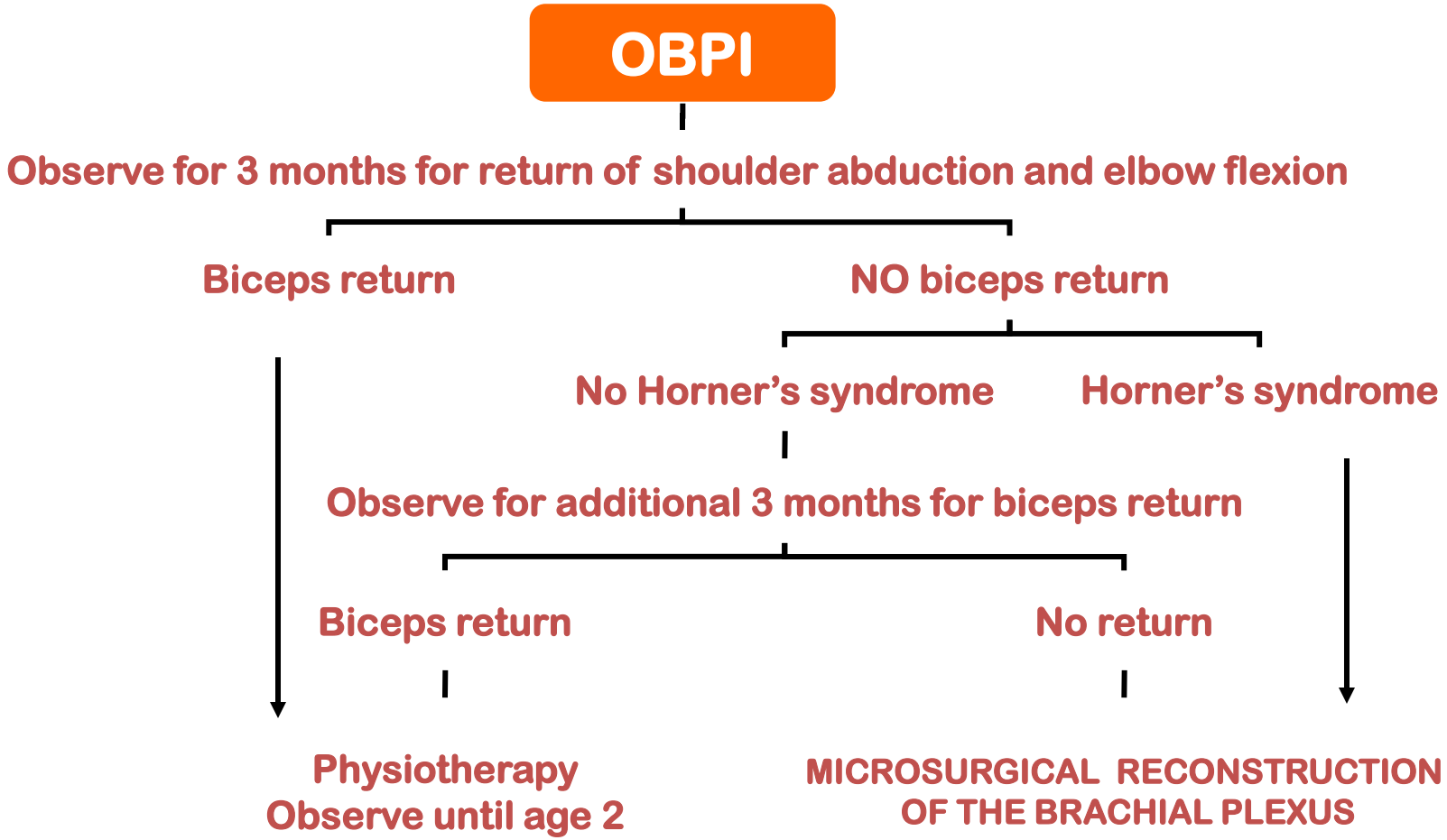
- **One root available**

available root to medial cord
ICNs to MCN and LRMN
CN-C7 to PC via a graft

- **Five roots avulsed**

as above + two additional ICN to Median

POLICY



Late cases, flail anesthetic hand, or biceps less than grade 3 MRC.

late surgeries

To address secondry problems

- **Shoulder Internal rotation deformities and lack of external rotation**

Young children : anterior shoulder release + tendon transfer e.g teres majoir to infraspinatus

Older children with glenoid hypoplasia : humeral derotational osteotomy

- **Shoulder abduction** : trapezius to deltoid
- **Elbow flexion restoration** : e.g

Latissmus transfer
Pectroalis major transfer
Steindler flexoplasty

Traumatic brachial plexus injuries

Traumatic injuries can involve any degree of injury at any level of the plexus

More severe injuries as root avulsions are associated with high energy trauma

Mechanism:

High speed motor vehicle accidents (mostly motorcycles)

Caudally forced shoulder affect upper plexus

Forced arm abduction predomonently affects lower roots e.g grabbing into something during faling

Anatomy
&
function
As in OPBI

Classification

- **Preganglionic vs postganglionic:**
- **Location:**

Total palsy :C5-T1 : commonest 75-80%

worst prognosis

Upper lesion (?erb's palsy) C5-C6 20-25%

Lower lesion (klumpke palsy) C8-T1 : 0.6-3%

Preganglionic vs post ganglionic

Preganglionic : proximal to dorsal root ganglion – not repairable – poor prognosis

Lesions suggesting preganglionic:

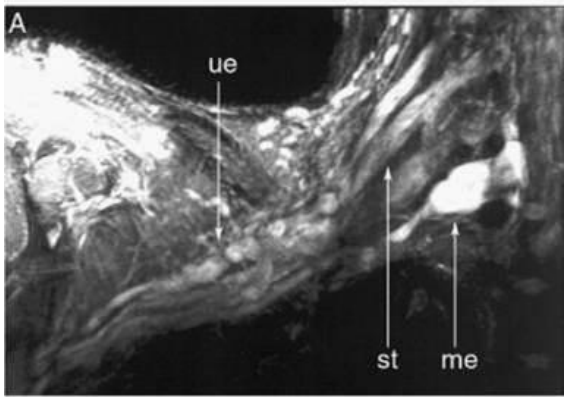
- **Proximally innervated muscles paralysis:**
  - ✓ **Rhomboids (dorsal scapular n.)**
  - ✓ **Hemidiaphragm (CXR)**
  - ✓ **Serratus anterior (long thoracic n.)**
  - ✓ **Cervical paraspinal muscles by EMG**
- **Absence of tinel sign on neck**
- **Pain in an anathetic limb**
- **Horner syndrome**

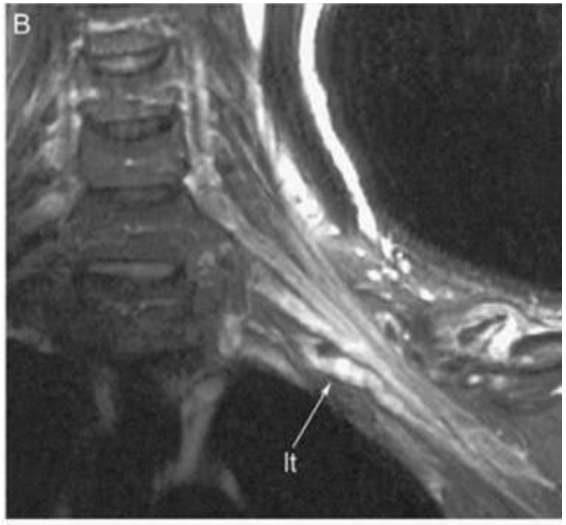
Presentation

History : usually high energy trauma
ATLS protocol
Cervical spine clearance
Physial examination : complete motor & sensory upper limb examination
Important muscles to test : rhomboids – s.a
Pulses : arterial injury is common with complete TBPI
Horner ‘s syndrome

investigations

Radiographs:
Cervical x-reys: fractures – transverse process frac
Chest x rey: fracture ribs – elevated hemidiphra
Shoulder series: clavicle - scapulothoracic di
CT ,CT mylography
MRI: cervical spine and brachial ple
(meningocele)





Electrodiagnosis

- Nerve conduction velocity : differentiate pre from post ganglionic by SNAP
- Electromyography : fibrillation potential

Done after 3-6 weeks

Differntiate pre from postganglionic

- Nerve action potentials : intraoperative across neuromas

prognosis

Recovery can take up to 3 ys after reconstruction
Upper lesion are better than lower
Root avulsions have worst prognosis

traetme
nt

Nonoperative : observation waiting for spontenous recovery
Indications : most injuries initially , specially gunshot wounds
Advancing tinel sign is best clinical sign

Operative

Immediate exploration : sharp penetrating injury
iatrogenic injury
associated vascular injury

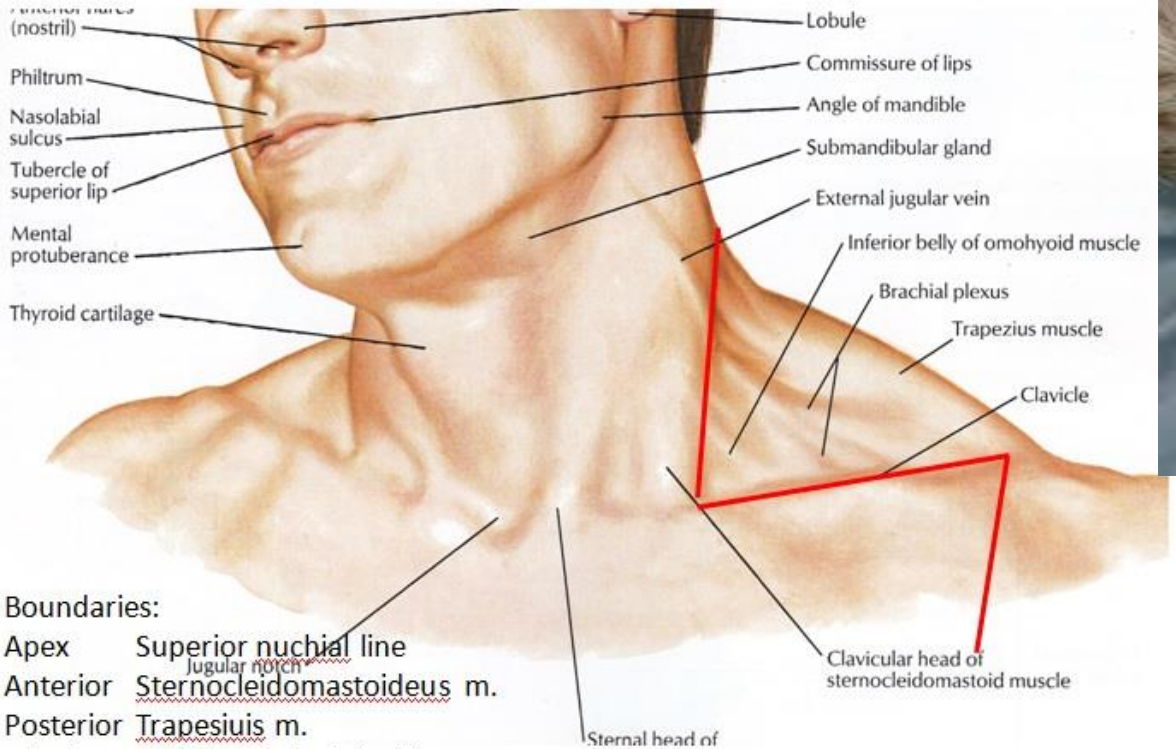
Early exploration (3-6 weeks) : total TBPI with high energy

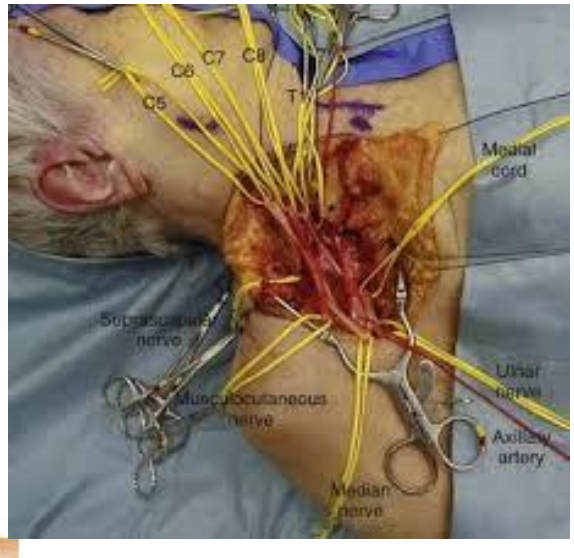
Delayed explration (3-6m) : plateau recovery
upper plexus with low energy

Techniques :

- **nerve repair – neurolysis – grafting**
- **neurtization as in OBPI**
- **free functional muscle transfer : in C8-T1 in adults low likelihood of recovery due to long distance**
- **Secondry reconstructive surgeries : e.g tendon transfer , arthrodesis**

TRUNKS IN
POSTERIOR TRIANGLE & SUPRACLAVICAL APPROACH





Boundaries:

Apex	Superior nuchial line
Anterior	Sternocleidomastoideus m.
Posterior	Trapesiuis m.
Inferior	Middle third of clavicle

goals

Priorities of repair \ reconstruction

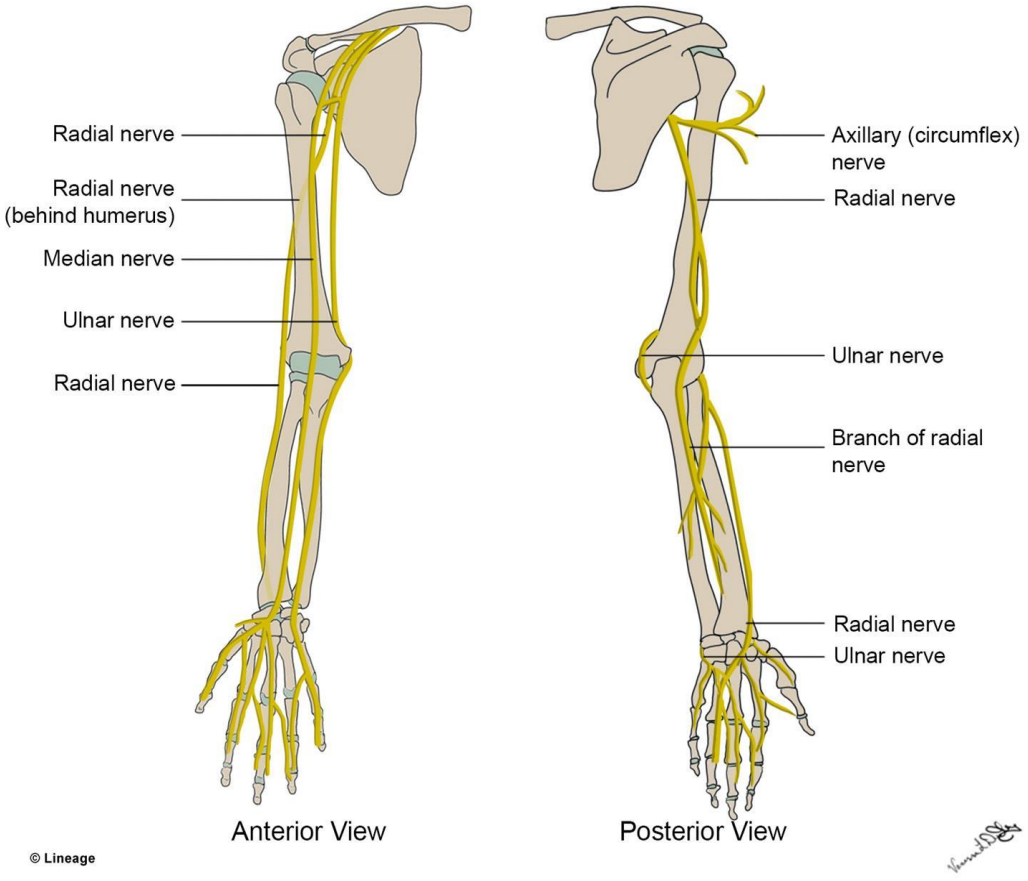
- **Elbow flexion**
- **Shoulder stability**
- **Sensation (LRMN)**
- **Wrist extension**
- **Finger flexion**
- **Wrist flexion\finger extension**
- **Intrinsic function**

Nerve injuries

Peripheral nerve injuries in Upper limb

1. Axillary N. Injury
2. Median N. Injury
3. Radial N. injury
4. Ulnar N. Injury

Nerves of the Upper Extremities

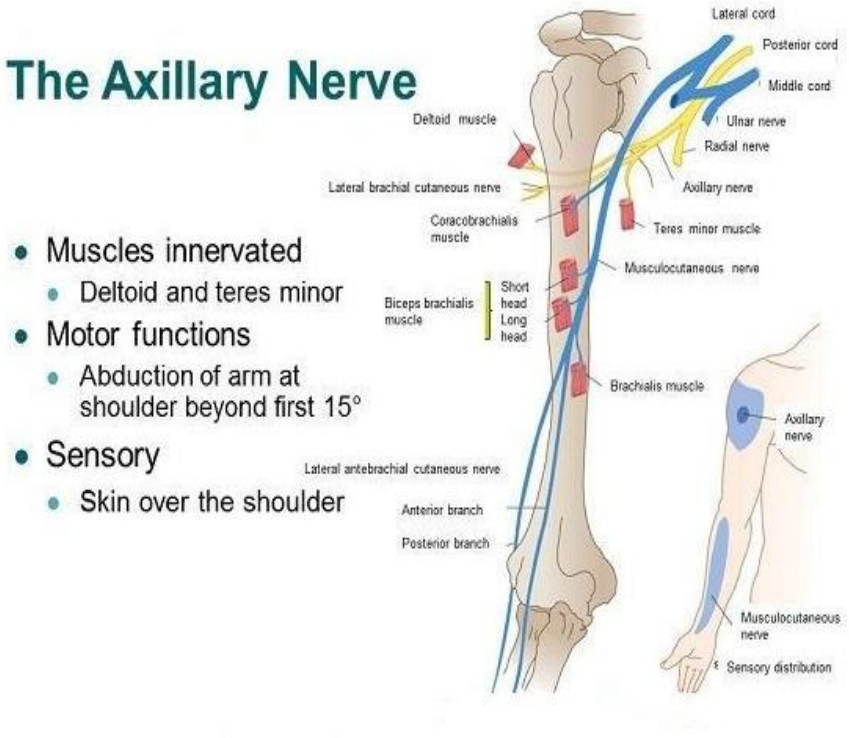


Axillary Nerve injury

- Sensory Function :
- sensation of an oval shaped area over the lateral shoulder.

- Motor : Deltoid muscle → shoulder Abduction .
- Teres minor → ext. Rotation .

Axillary Nerve Injury



Common causes of injury

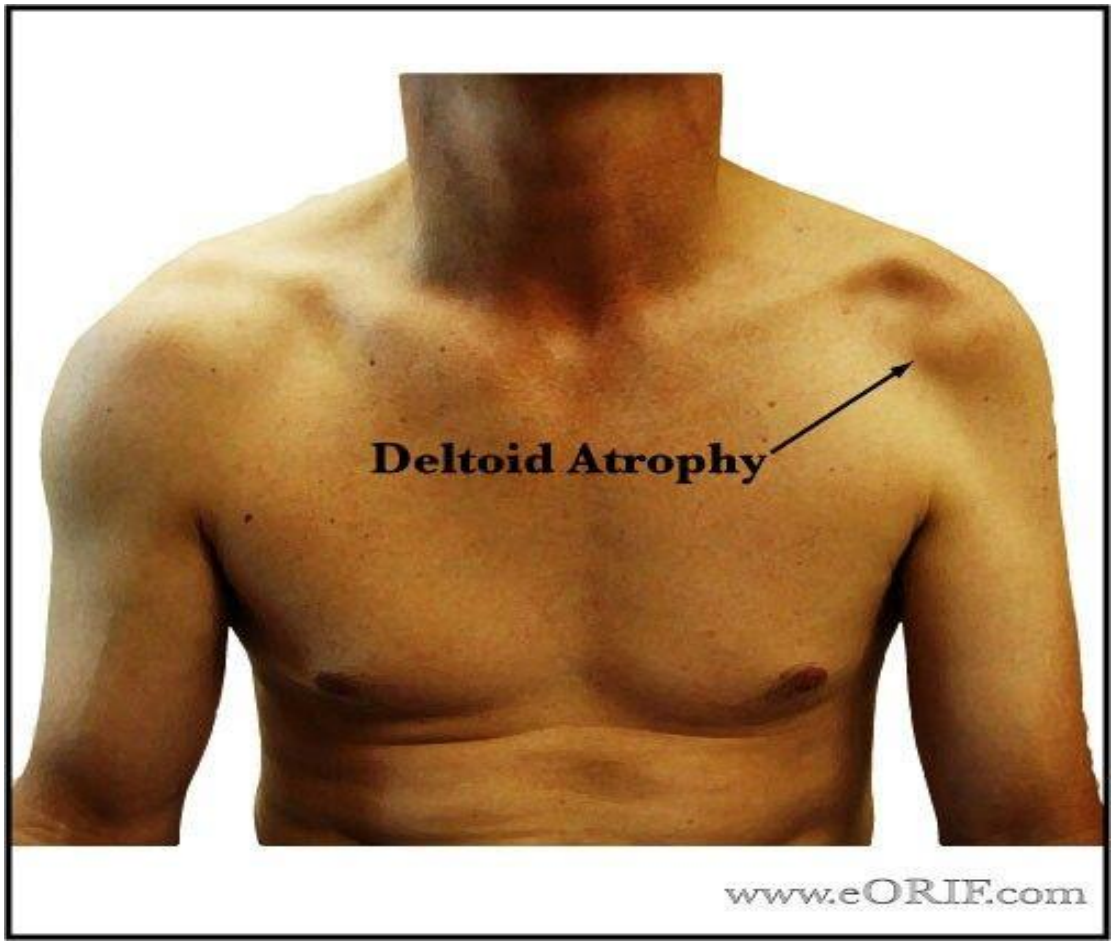
- Trauma
- Shoulder dislocation
- proximal humeral fractures

Manifestations

- Sensory loss : over the shoulder

Motor loss : Abduction intiated but not maintained

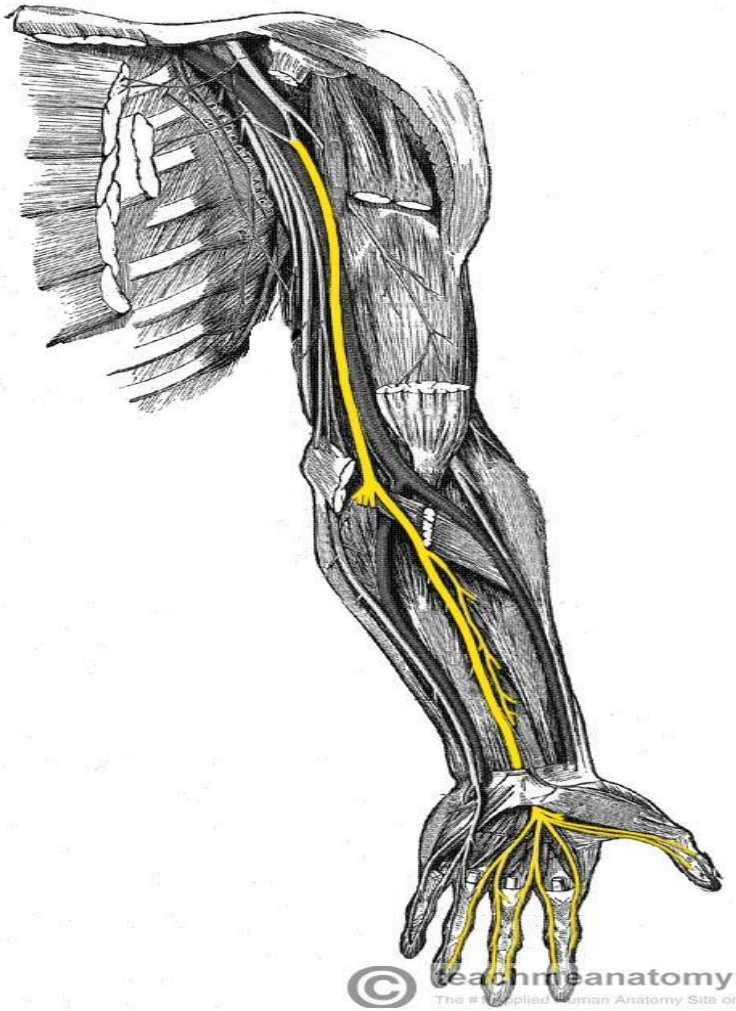
Deformity : wasting of deltoid


Deltoid Atrophy
www.eORIF.com

Median Nerve Injury

- Sensory : skin over thenar eminence
- lateral 3&1/2 fingers (palmar aspect) .
- lateral 2/3 palm of the hand

- Motor : All muscles of Anterior compartement of the forearm
- except (ulnar half of FDP & FCU) .



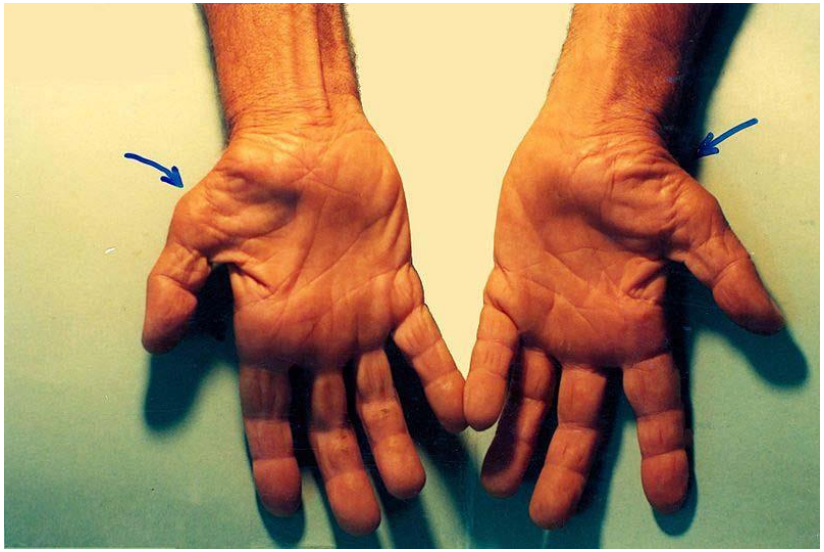
Common causes of injury

- Trauma :
- elbow → S.C # humerus .
- wrist → CTS .

- Penetrating injuries .

Ape hand deformity

CTS

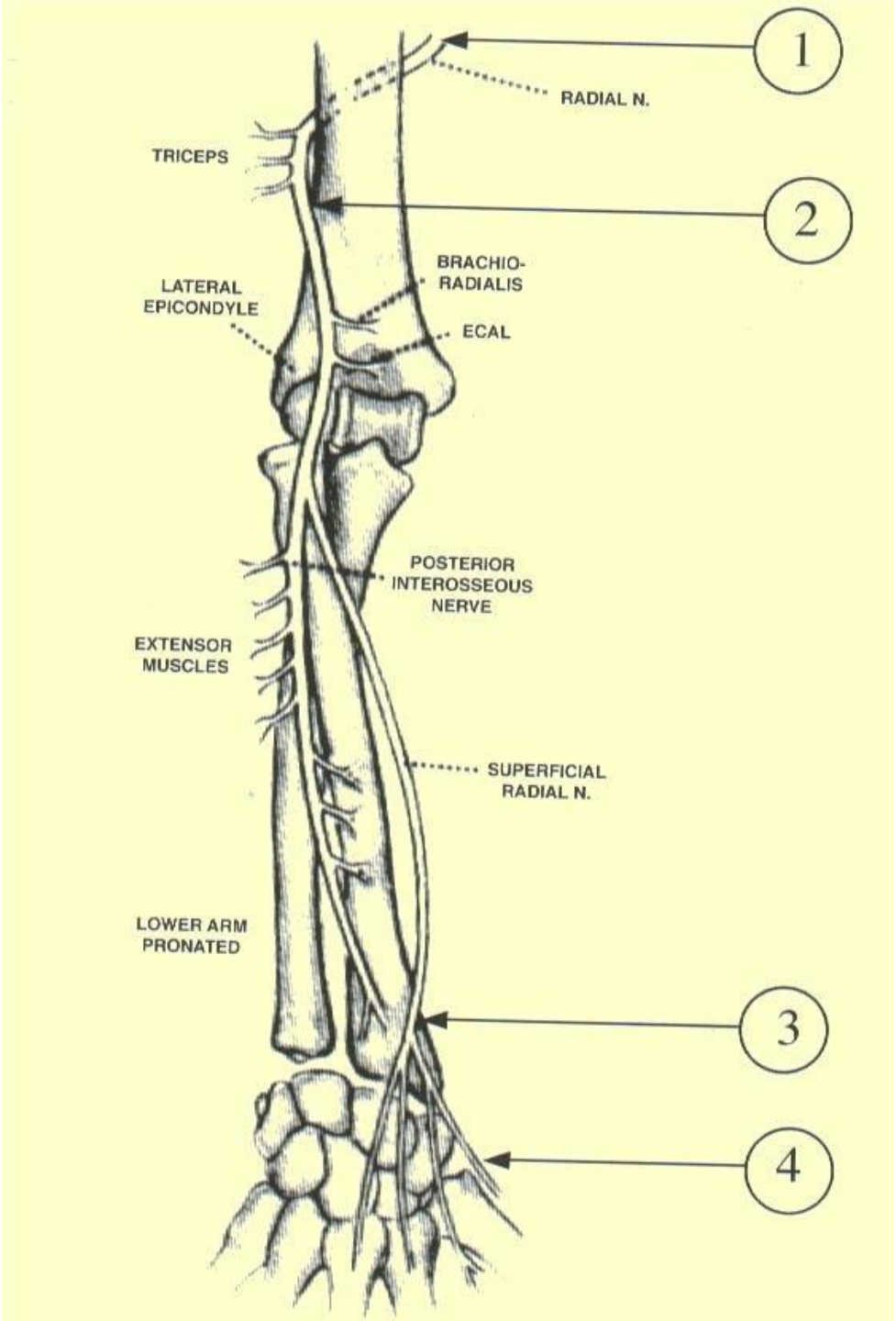


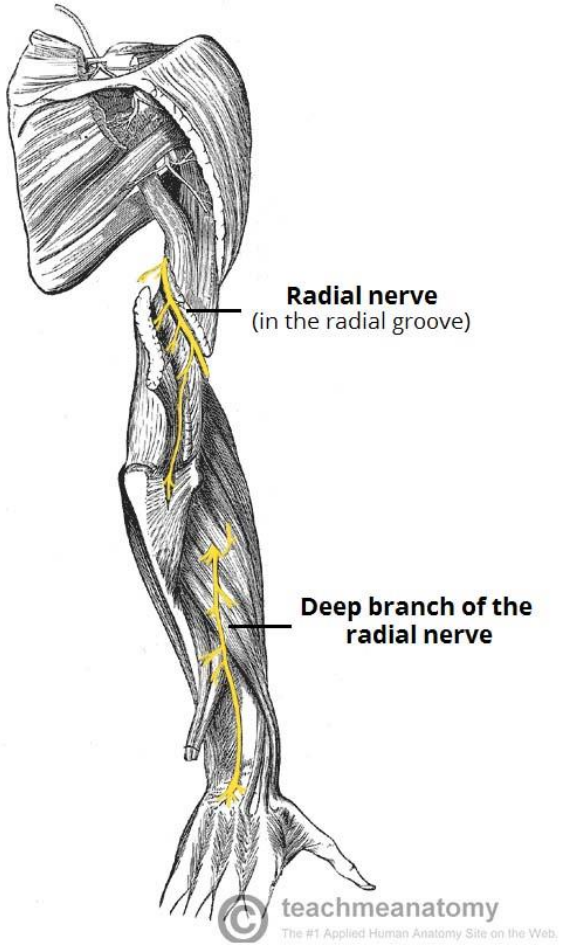
- Thenar atophy

Radial Nerve Injury

- Sensory : Innervates most of the skin of the posterior forearm, the lateral aspect of the dorsum of the hand, and the dorsal surface of the lateral three and a half digits.

- Motor : Innervates the triceps brachii and the extensor muscles in the forearm.


1
RADIAL N.
TRICEPS
2
BRACHIO-
RADIALIS
LATERAL
EPICONDYLE
ECAL
POSTERIOR
INTEROSSEOUS
NERVE
EXTENSOR
MUSCLES
SUPERFICIAL
RADIAL N.
LOWER ARM
PRONATED
3
4


Radial nerve
(in the radial groove)
Deep branch of the
radial nerve
teachmeanatomy
The #1 Applied Human Anatomy Site on the Web.

Common causes of injury

- Trauma → proximal and shaft humerus #
- → radius #
- →

Penterating injuries (cupital fossa & wrist)

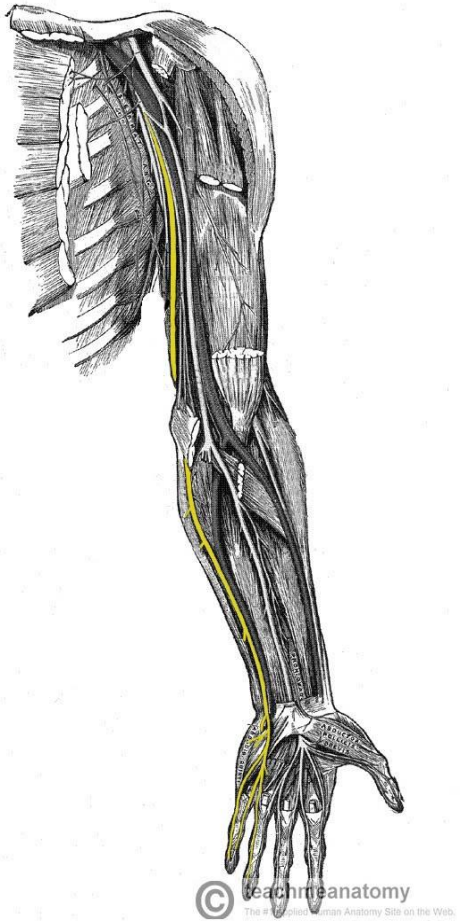
Deformity

- Wrist Drop

Ulnar nerve injury

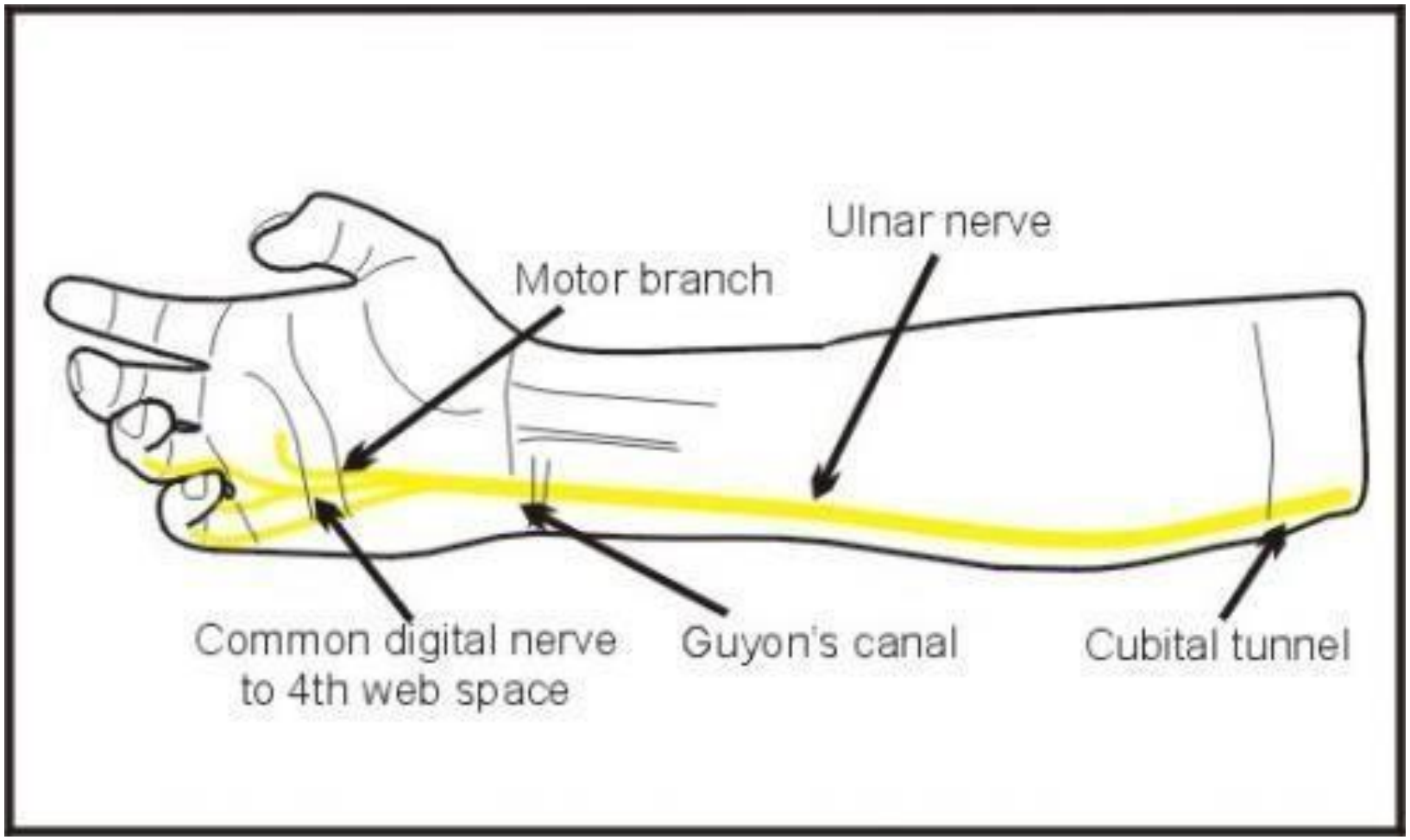
- Sensory **:** Medial one and half fingers and the associated palm area.

- Motor : Two muscles of the anterior forearm – flexor carpi ulnaris and medial half of flexor digitorum profundus
- Intrinsic muscles of the hand (apart from the thenar muscles and two lateral lumbricals



Common causes of injury

- Cubital tunnel syndrome
- Trauma supracondylar # humerus
- Penetrating injury .

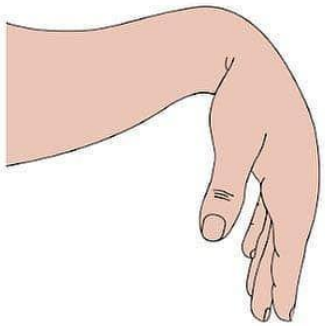
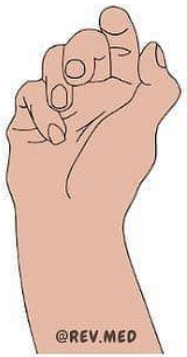

Ulnar nerve
Motor branch
Common digital nerve
to 4th web space
Guyon's canal
Cubital tunnel

Deformity

Claw hand

Wasting of hypothenar muscles

Nerve Injuries

APE HAND	WRIST DROP	CLAW HAND
		
Median Nerve Injury	Radial Nerve Injury	Ulnar Nerve Injury

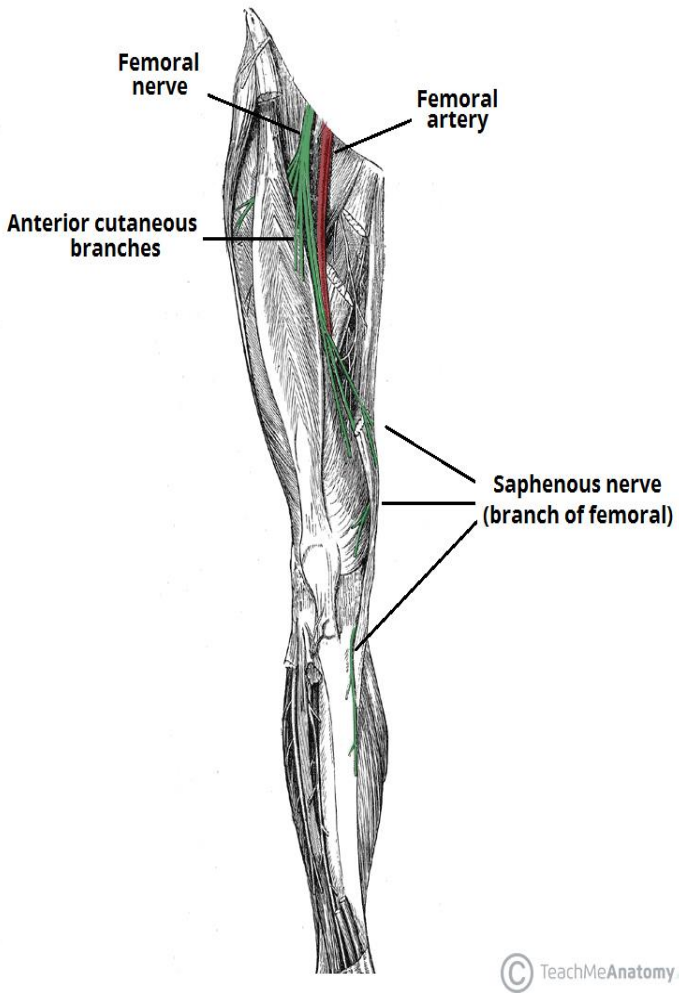
Peripheral nerve injuries in lower limb

1. Femoral N. Injury .
2. Sciatic N.Injury .
3. Peroneal N . Injury .

Femoral nerve injury

- Sensory : Supplies cutaneous branches to the anteromedial thigh (anterior cutaneous branches of the femoral nerve) and the medial side of the leg and foot (saphenous nerve).

- Motor : Innervates the anterior thigh muscles that flex the hip joint (pectineus, iliacus, sartorius) and extend the knee (quadriceps femoris: rectus femoris, vastus lateralis, vastus medialis and vastus intermedius).


Femoral nerve
Femoral artery
Anterior cutaneous branches
Saphenous nerve (branch of femoral)
© TeachMeAnatomy

Common causes of injury

- Pelvic and hip fractures
- FAI and gunshot injuries
- Iatrgenic (operation traction)

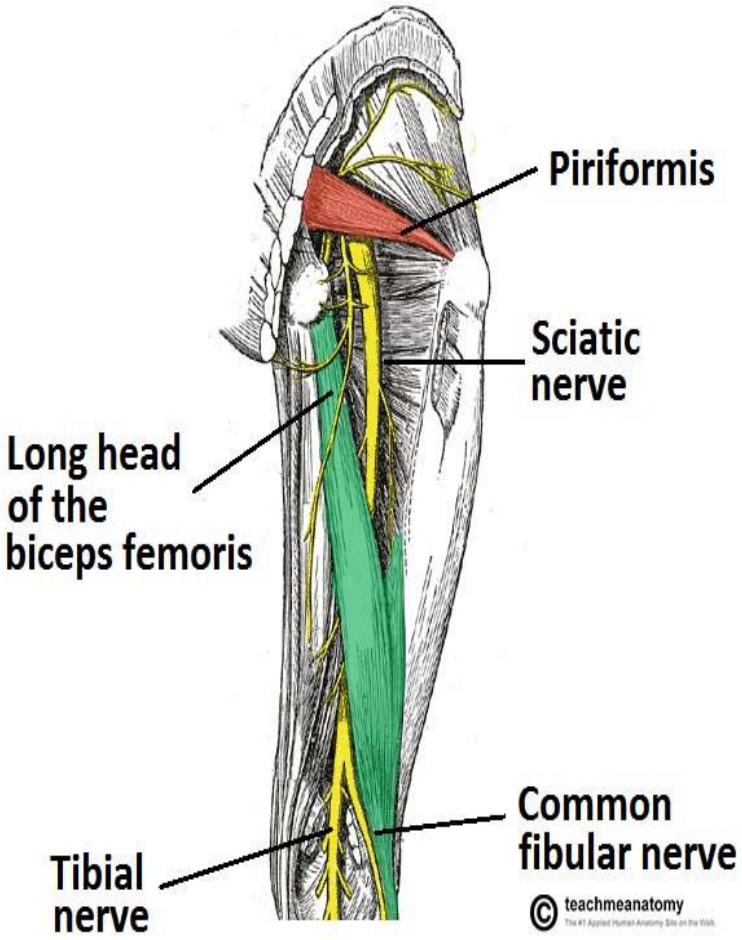
Deformity

- Weak quadriceps → weak knee extention
- Numbness over ant. Thigh and medial leg
- Sever neurogenic pain is common .

Sciatic nerve injury

- Motor :Innervates the muscles of the posterior thigh (biceps femoris, semimembranosus and semitendinosus) and the hamstring portion of the adductor magnus (remaining portion of which is supplied by the obturator nerve).
- Indirectly innervates (via its terminal branches) all the muscles of the leg and foot

- Sensory : No direct sensory functions. Indirectly innervates (via its terminal branches) the skin of the lateral leg, heel, and both the dorsal and plantar surfaces of the foot.


Piriformis
Sciatic nerve
Long head of the biceps femoris
Common fibular nerve
Tibial nerve
© teachmeanatomy

Common causes of injury

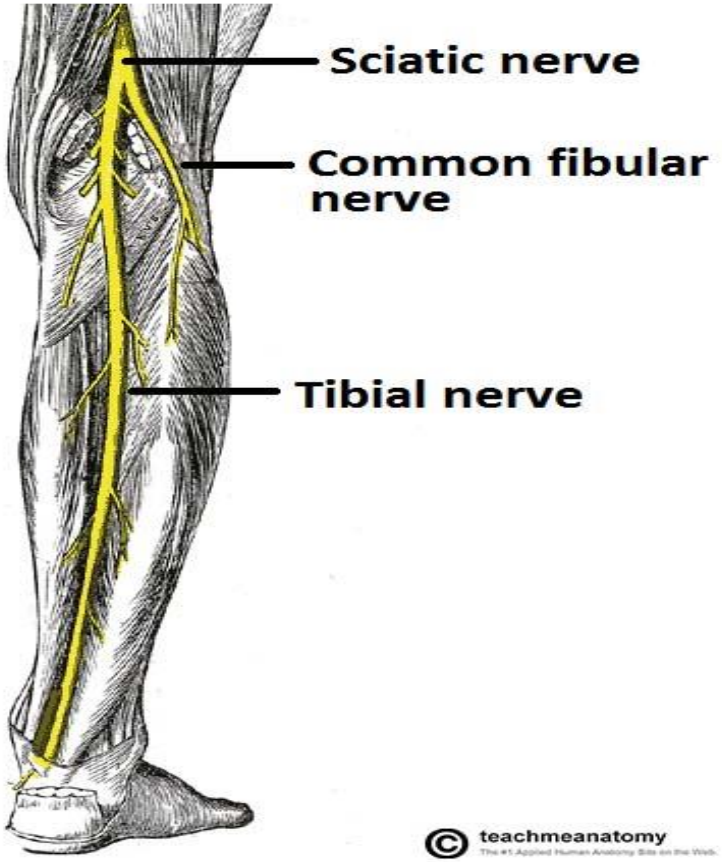
- Pelvic and hip fractures and dislocatios
- FAI
- Stap wounds
- Iatragenic

Deformity

- Paralysis to hamstring and all muscles below knee
- Absent ankle jerk
- Lost sensation below the knee .
- Drop foot and high stepping gait.

Peroneal nerve injury

- Continuation of sciatic nerve
- Tibial and common peroneal nerves
- Superficial and deep peroneal


Sciatic nerve
Common fibular nerve
Tibial nerve
© teachmeanatomy
The #1 Applied Human Anatomy Site on the Web.

- Sensory and motor function of the leg
- Tibial n. Post. Compartment + foot muscles
- Superficial peroneal lateral compartment
- Deep peroneal ant. Compartment + foot muscles

Common causes of injury

- Fracture head fibula
- FAI
- Compartment syndrome

Deformity

- Same as sciatic nerve injury .
- According injury level
- Pain is significant .

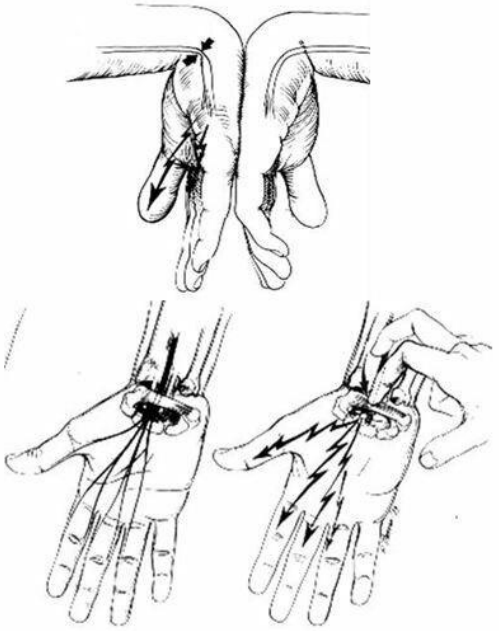
Carpal tunnel syndrome

- Carpal Tunnel Syndrome is a compressive neuropathy of the median nerve at the level of the wrist.
- Diagnosis is made by clinical signs and symptoms (night pain, hand weakness/clumsiness, numbness in median nerve distribution) and positive provocative tests .

- Treatment is generally conservative with night splints and injections with carpal tunnel release reserved for refractory cases.

Special Tests
Phalen's & Tinel's Tests

- Phalen's
  - Wrist flexion to maximum for 60 sec
- Tinel's
  - Tapping over transverse carpal ligament
- Symptoms
  - Pain
  - Anesthesia
  - Paresthesia



- Treatment :
- Nonoperative
- **NSAIDS, night splints, activity modifications**
- Indications :
- first line of treatment
- Modalities :
- night splints (good for patients with nocturnal symptoms only)
- activity modification (avoid aggravating activity)

- **steroid injections** _
- Indications:
- adjunctive nonoperative treatment
- diagnostic utility in clinically and electromyographically equivocal cases
- outcomes
- 80% have transient improvement of symptoms (of these 20% remain symptom-free at one year)
- failure to improve after injection is poor prognostic factor
- surgery is less effective in these patients
-

- Operative
- **carpal tunnel release**
- Indications:
- failure of nonoperative treatment (including steroid injections)
- temporary improvement with steroid injections is a good prognostic factor that the patient will have a good result with surgery)
- acute CTS following ORIF of a distal radius fx
- Outcomes :
- pinch strength returns in 6 week
- grip strength is expected to return to 100% preoperative levels by 12 weeks postop
- rate of continued symptoms at 1+ year is 2% in moderate and 20% in severe CTS
- improved patient reported-outcomes with surgery at 6 and 12 months as compared to splinting, NSAIDs/therapy, and a single steroid injection

CUBITAL TUNNEL SYNDROME

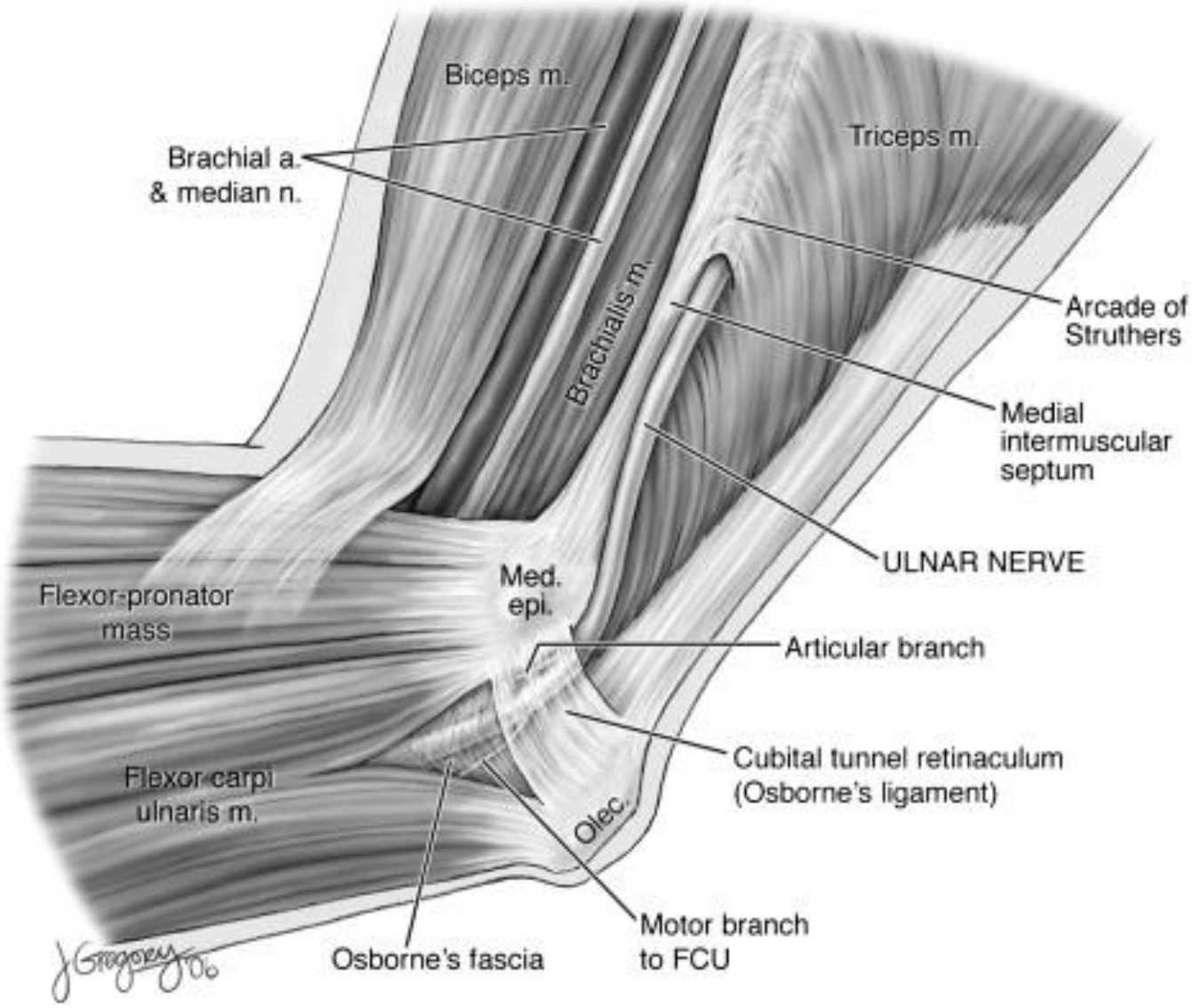
DEFINTION

COMPRESSIVE NEUROPATHY OF THE ULNAR NERVE AT THE ELBOW

2ND COMMONEST COMPRESSIVE NEUROPATHY OF THE UPPER LIMB

RELEVANT ANATOMY (COMMONEST SITES OF COMPRESSION)

- **FCU HEADS**
- **OSBORNE FASCIA**
- **ARCADE OF STRUTHERS**


Biceps m.
Brachial a.
& median n.
Triceps m.
Brachialis m.
Arcade of
Struthers
Medial
intermuscular
septum
ULNAR NERVE
Med.
epi.
Flexor-pronator
mass
Articular branch
Cubital tunnel retinaculum
(Osborne's ligament)
Flexor carpi
ulnaris m.
Olec.
Motor branch
to FCU
Osborne's fascia

COMMON ASSOCIATIONS

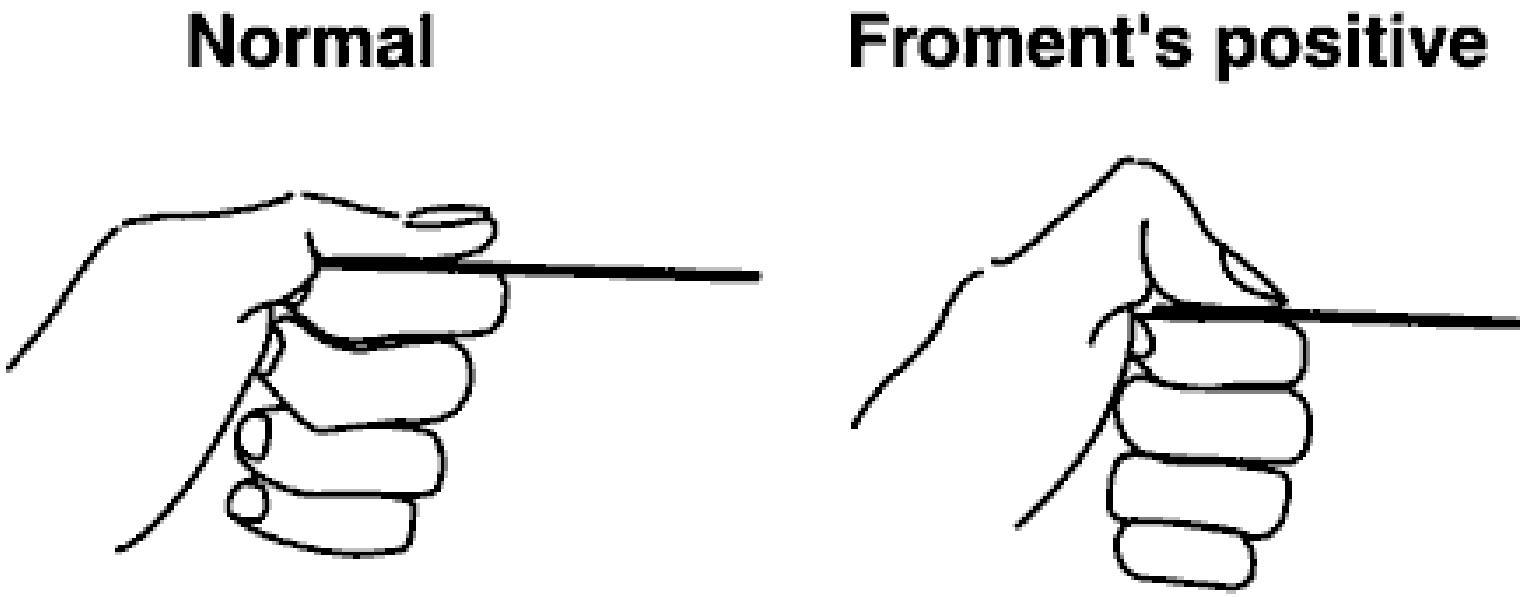
- ELBOW DEFORMITIES (TARDY ULNAR NEUROPATHY)
- ELBOW CONTRACTURE RELESE
- ELBOW ARTHRITIS
- HETEROTOPIC OSSIFICATION
- ORIF
- MEDIAL EPICONDYLE FRACTURES – NON UNIONS AND EPICONDYLITISTIS

C\P

- **PARATHESIA IN ULNAR DISTRIBUTION**
- **EXACERBATING ACTIVITIES :**
  - Cell phone use
  - Occupational \atheletic activities with flexion and vulgus stress
- **NIGHT SYMPTOMS**
- **INTEROSSEUS AND 1ST WEB ATROPHY**
- **WEAK GRASP – PINCH**
- **FROMENT SIGN**
- **TINEL SIGN OVER CUBITAL TUNNEL**
- **EVIDENCE OF A CAUSE**

INTRINSIC ATROPHY

WEAK THUMB ADDUCTION (FROMENT TEST)



IMAGING

ACCORDINGLY

ELECTRODIAGNOSTIC STUDIES

SLOWED CONDUCTION ACROSS ELBOW LOW AMPLITUDE OF SNAP & CMAP

TREATMENT

CONSERVATIVE : EFFECTIVE IN 50% OF CASES

- NSAIDS
- ACTIVITY MODIFICATIONS
- such as NIGHT ELBOW EXTESION SPLINTING

surgical decompression

depending on the severity and duration of symptoms, and success of nonoperative treatment.