BRACHIAL PLEXUS

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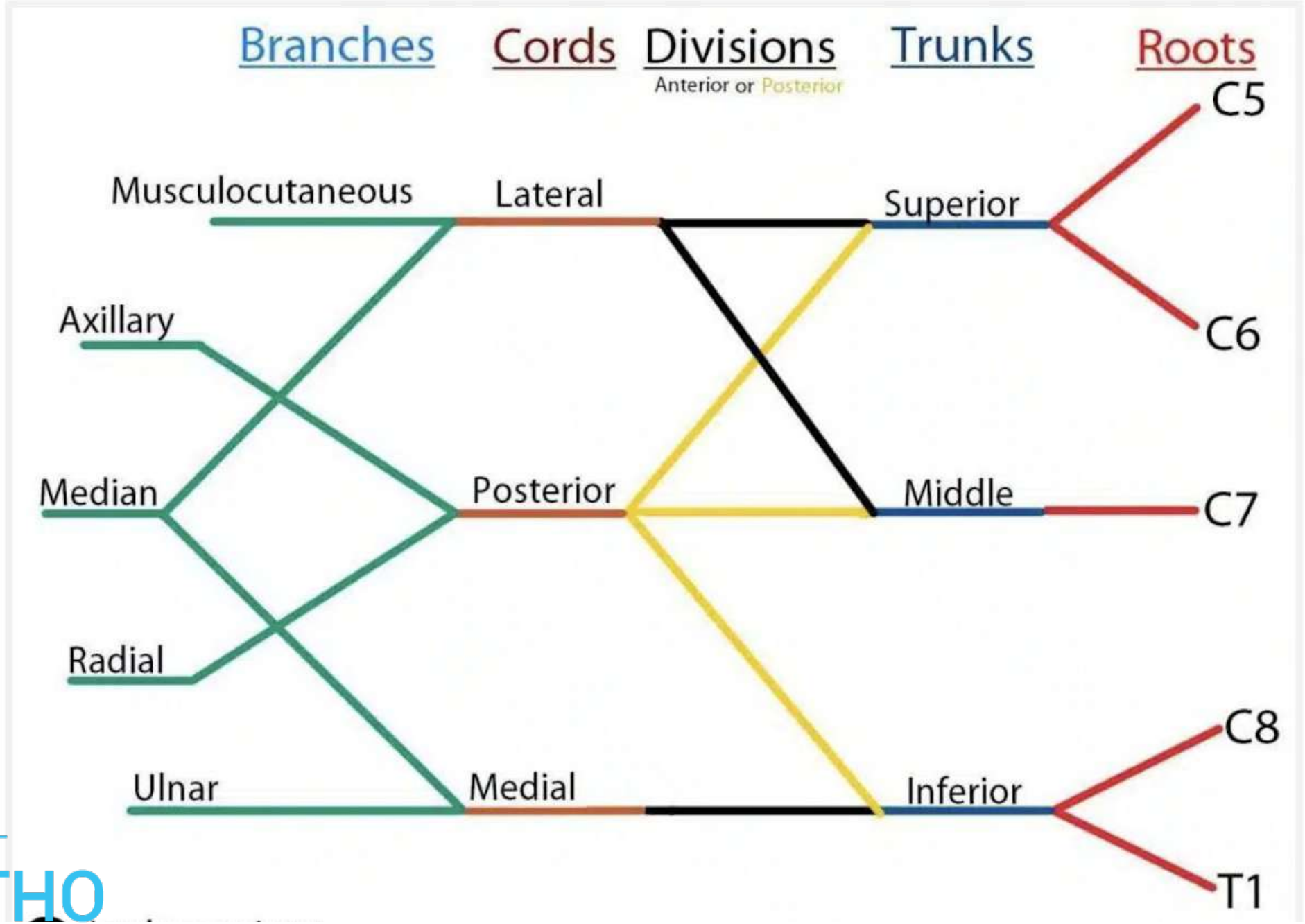
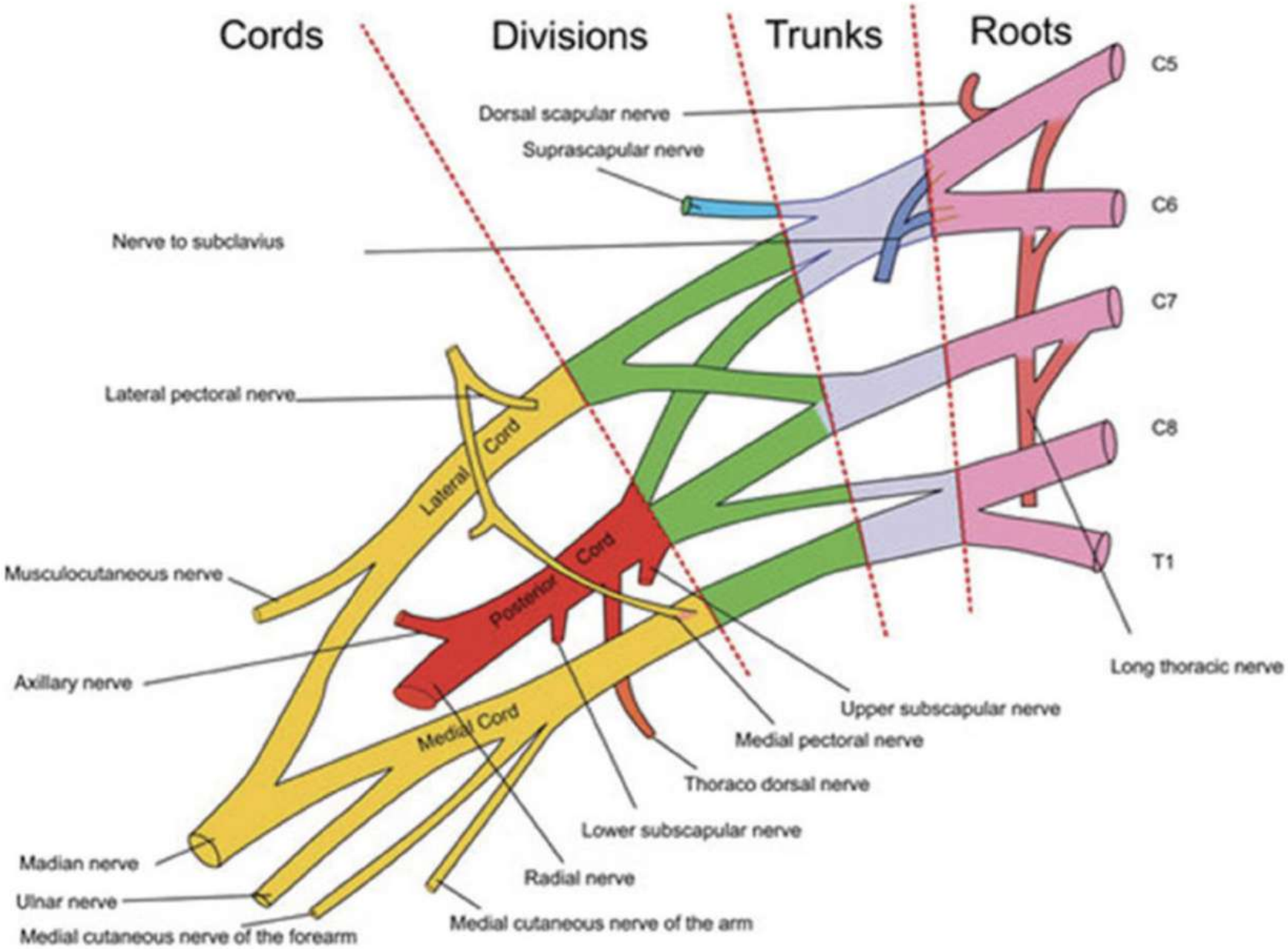




Brachial plexus anatomy video:

https://youtu.be/nYvmxWCfZVQ

Prefixed plexus: C4

Postfixed plexus: T2

Chuang's angle : Main branch of cephalic vein and clavicle

Most cases no fracturing of clavicle needed!

- Brachial plexus injuries: NBPP & TBPI

- NBPP – Neonatal brachial plexus palsy (OBPI) etiology –

- (1) Injury sustained in utero and during descent (e.g., with uterine anomalies such as bicornuate uterus)

- (2) Injury sustained at the time of expulsion

- Shoulder dystocia, humeral or clavicular fracture
- Maternal diabetes
- Forceps or vacuum-assisted delivery, breech delivery
- Episiotomy, fetal or birth asphyxia
- Macrosomia (>4.5 kg)
- Caesarean section and twin or multiple births were associated with decreased (but not zero) rates of NBPP*

WHEN to intervene?

- No recovery of biceps function at 3 months
- Failed cookie test at 9 months.

NARAKA CLASSIFICATION

Group	Name	Roots injured	Site of weakness or paralysis
I	Classic Erb's palsy	C5 or C6	Absent shoulder abduction, external rotation, elbow flexion, and forearm supination
II	Extended Erb's palsy	C5 to C7	As above, with absence of wrist and digital extension
III	Total palsy without Horner's syndrome or oculosympathetic paresis (defined as miosis, ptosis, and ipsilateral facial anhidrosis)	C5–T1	Complete flaccid paralysis (flail extremity) involving all plexus roots
IV	Total palsy with Horner's syndrome	C5–T1 and sympathetic chain involvement	Complete flaccid paralysis (flail extremity) with Horner's syndrome indicating sympathetic chain involvement and avulsion injury Sometimes, phrenic nerve palsy and an elevated ipsilateral hemi-diaphragm

TBPI :

- Burners and stingers (also known as "dead arm syndrome") refer to a transient brachial plexus injury in contact sports.
- Diagnosis is made clinically with a neurological examination most commonly consistent of unilateral tingling in the arm with transient weakness in C5, C6 muscles (deltoid, biceps).
- Treatment is typically observation and return to play if symptoms completely resolve. Players are not allowed to return to play in the setting of persistent or bilateral symptoms.

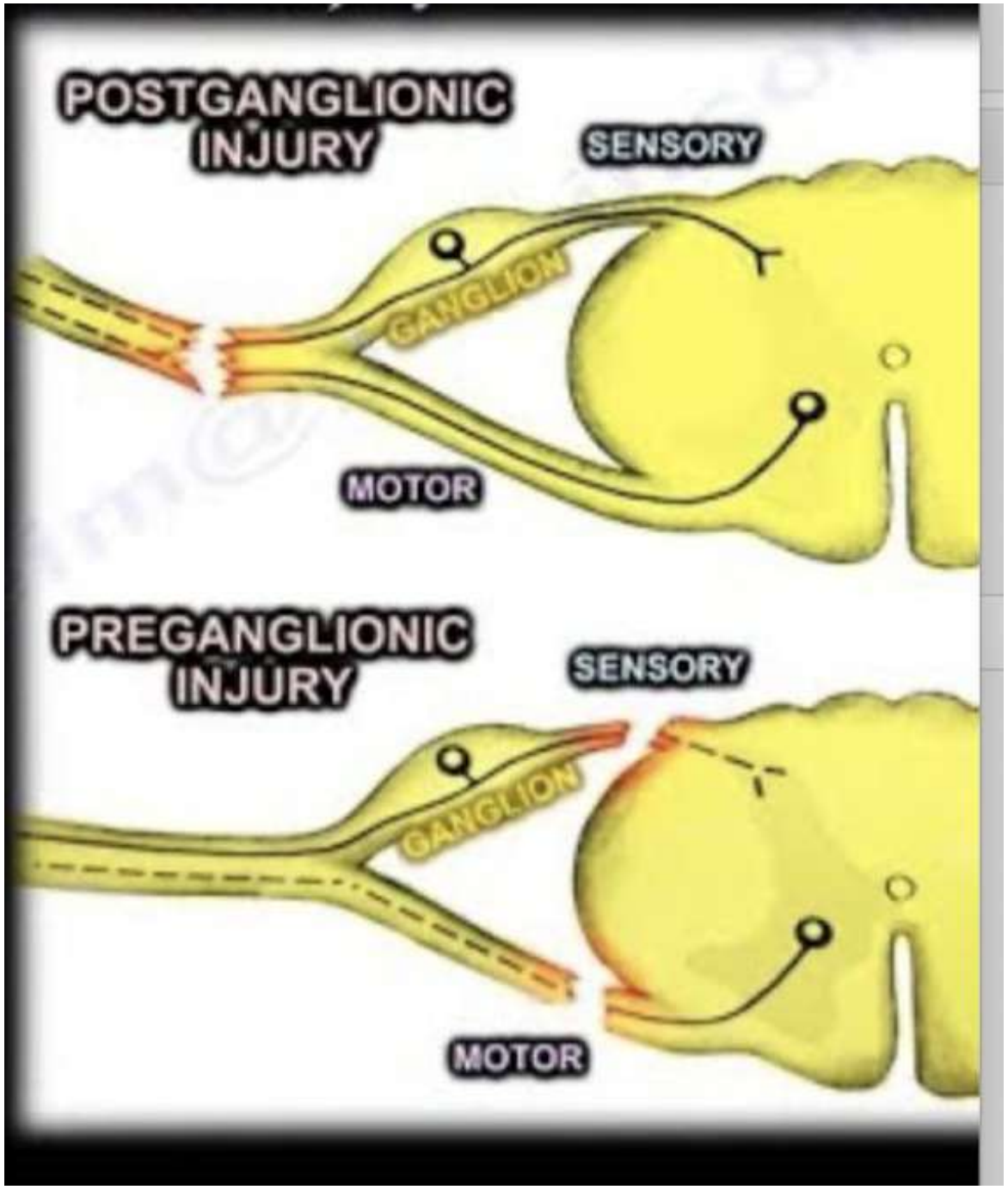
- Traction injury : occurs by downward displacement of arm and bending of neck away from side of injury

- Compression injury: occurs by lateral head turning toward affected side

- Direct blow: can cause injury with blow at Erb's point superior to the clavicle

- Brachial neuritis (Parsonage-Turner syndrome) is an uncommon disorder characterized by severe shoulder pain followed by patchy muscle paralysis and sensory loss involving the shoulder girdle and upper extremity.

- Long thoracic nerve – winging of scapula
- Autoimmune, viral, stress , drugs



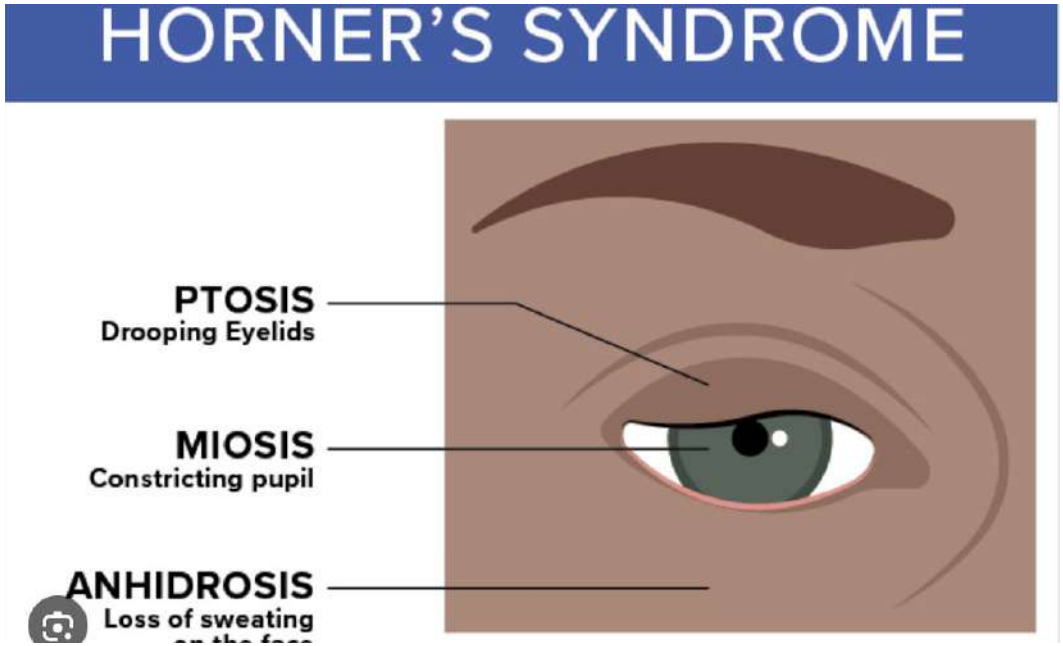
*DORSAL ROOT GANGLION

Preganglionic signs:

- High speed trauma/ forceful delivery
- Horners sign
- Winging of scapula : Thoracodorsal nerve - serratus anterior
  : Dorsal scapular – rhomboids
- Loss of sensation/ severe neuropathic pain
- Intact triple response – positive Lewis test
- Elevated hemi diaphragm (phrenic nerve C3,4,5)

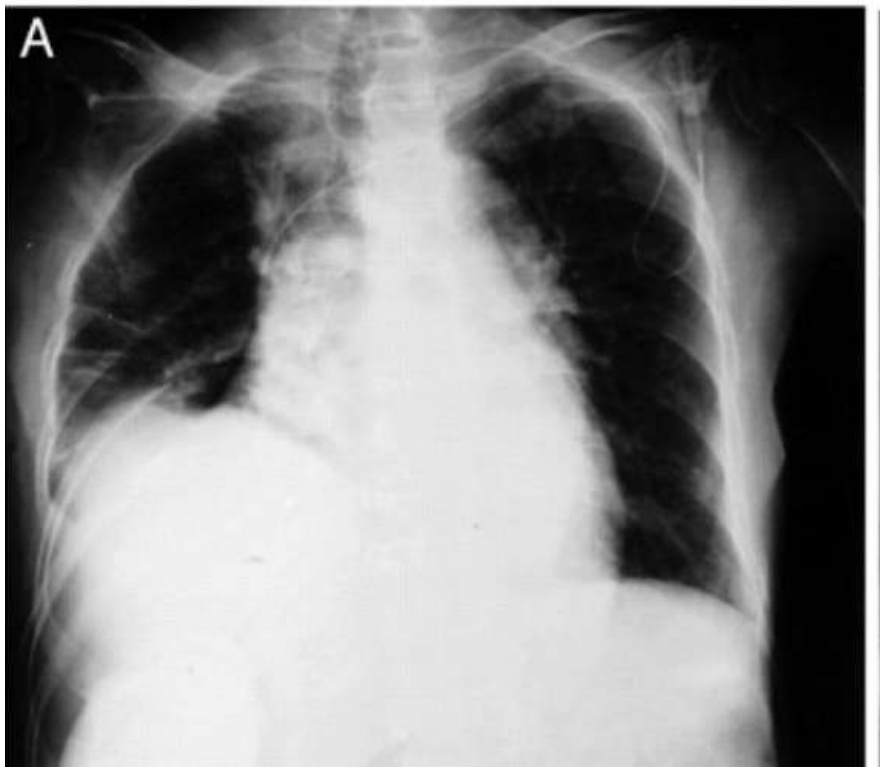
- Disruption of sympathetic chain

- C8, T1 lesions



- Phrenic nerve injury C3, C4 and C5

- Elevated hemi diaphragm on affected side



Winging of scapula :

Thoracodorsal nerve - serratus anterior – medial border

Dorsal scapular – rhomboids – lateral border

- Red spot due to vasodilation
- Wheal: swelling of red spot due to increased vascular permeability
- Flare due to axonally mediated reflex vasodilation

Triple Response of Lewis

- The normal Lewis triple inflammatory reaction includes a secondary neurogenic erythema that is mediated by an axonal reflex.
- Pre-ganglionic lesions preserve the integrity of the network of free nerve endings in the skin, because they are supplied by neurons located in the paravertebral sympathetic chain.
- On the other hand, in post-ganglionic lesions, there is distal degeneration of small autonomic nerve fibers, which leads to skin neurovegetative denervation. This results in absence of secondary neurogenic erythema during the histamine test.

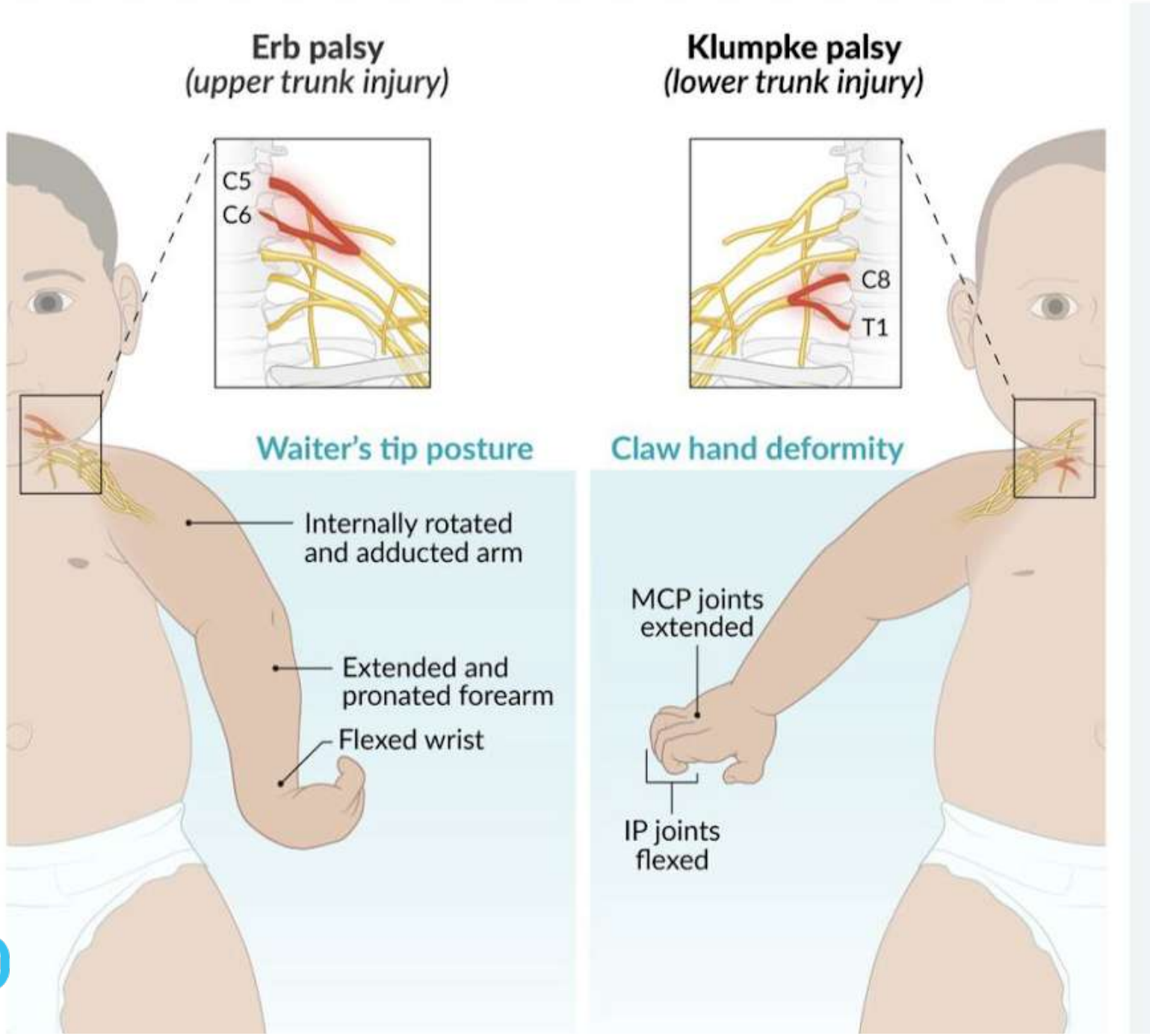
Erbs palsy: C5, C6

- Clinically, the arm will be adducted, internally rotated, at shoulder; pronated, extended at elbow ("waiter's tip")
- C5 deficiency
- -axillary nerve deficiency (weakness in deltoid, teres minor)
- -suprascapular nerve deficiency (weakness in supraspinatus, infraspinatus)
- -musculocutaneous nerve deficiency (weakness to biceps)
- C6 deficiency
- -radial nerve deficiency (weakness in brachioradialis, supinator)

Klumpkes paralysis: C8, T1

- Deficit of all of the small muscles of the hand (ulnar and median nerves)

- Clinically, presents as “claw hand”
- -wrist held in extreme extension because of the unopposed wrist extensors
- -hyperextension of MCP due to loss of hand intrinsics
- -flexion of IP joints due to loss of hand intrinsics



TRUMPET SIGN

Co-contraction:

Shoulder abductors
Elbow flexors

Diagnostics:

- CT myelography
- indications
- gold standard for defining level of nerve root injury
- avulsion of cervical root causes dural sheath to heal with meningocele
- scan should be done 3-4 weeks after injury
- allows blood clot in the injured area to dissipate and meningocele to form

- MRI
- suspect injury is distal to nerve roots
- can visualize much of the brachial plexus
- CT/myelogram demonstrates only nerve root injury

- Findings consistent with injury include:
- pseudomeningocele (T2 highlights water content present in a pseudomeningocele)
- empty nerve root sleeves (T1 images highlight fat content nerve roots and empty sleeves)
- cord shift away from midline (T1 highlights fat of cord)

EMG

- Electromyography tests muscles at rest and during activity
- fibrillation potentials (denervation changes)
- as early as 10-14 days following injury in proximal muscles
- as late as 3-6 weeks in distal muscles

- Can help distinguish preganglionic from postganglionic
- rhomboids
- serratus anterior
- cervical paraspinals

NCS/ Electrodiagnostics

- NCV Performed along with EMG
- measures sensory nerve action potentials (SNAPs)
- Compound muscle action potential (CMAP)
- distinguishes preganglionic from postganglionic
- SNAPs preserved in lesions proximal to dorsal root ganglia

- Sensory and Motor Evoked Potential (SMEP)
- more sensitive
- perform 4-6 weeks after injury to allow for Wallerian degeneration to occur
- stimulation done at Erb's point and recording done over cortex with scalp electrodes (transcranial)

Treatment

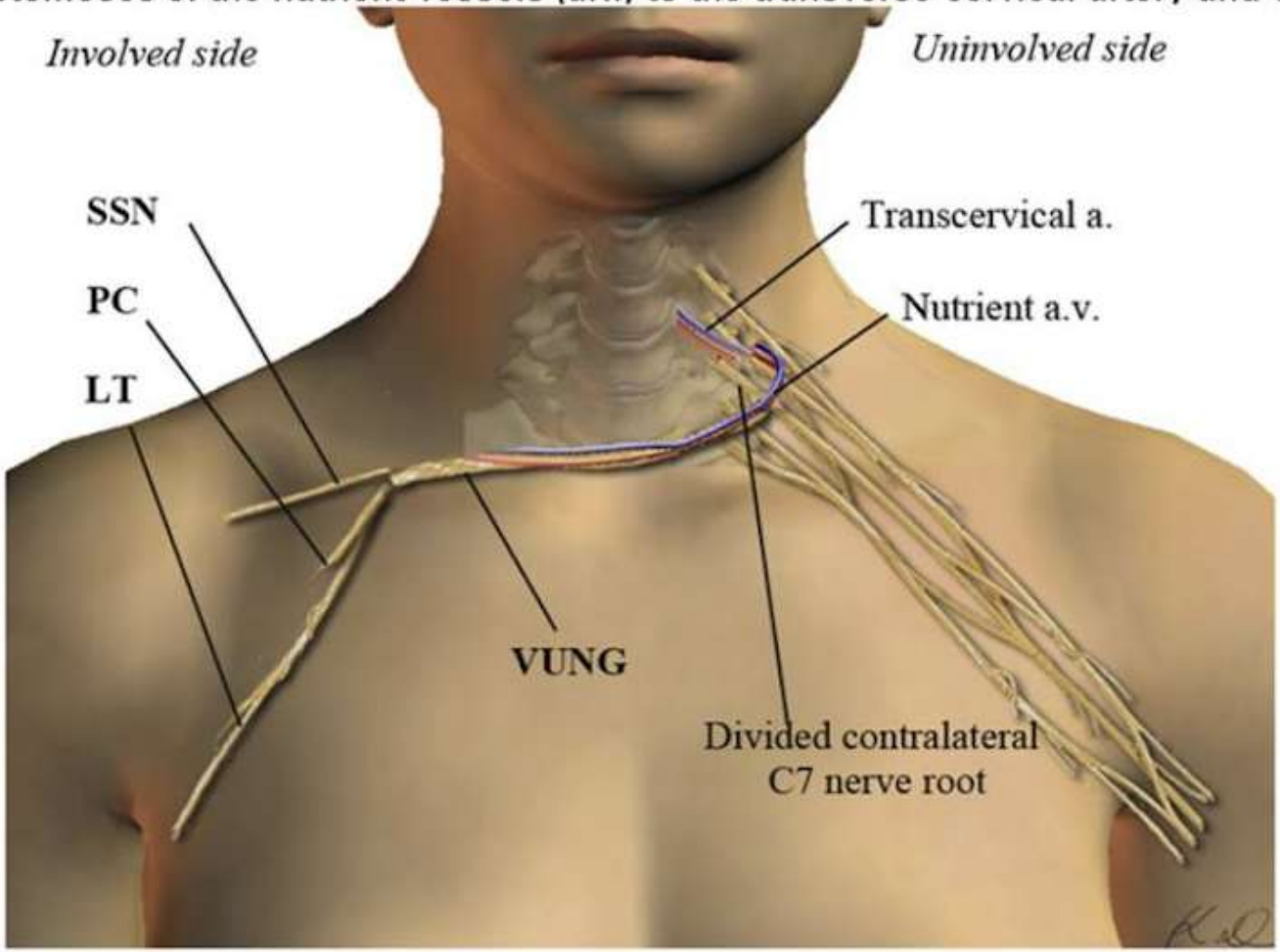
- Direct nerve repair: nerve regeneration occurs at speed of 1mm/day

- Nerve graft – Reversed cable nerve graft
  - Sural, medial ante / brachial

- VUNG – vascularized ulnar nerve graft : C8, T1 lesions.

- Advancing Tinel sign is best clinical sign of effective nerve regeneration

Vascularized ulnar nerve graft (VUNG) between the contralateral C7 nerve root and the suprascapular nerve (SSN), posterior cord (PC), and long thoracic nerve (LT) following anastomoses of the nutrient vessels (a.v.) to the transverse cervical artery and vein.



Nerve transfer/ Neurotisation

- Functional nerve to nonfunctional one

- Extraplexal
- spinal accessory nerve (CN XI)
- intercostal nerves
- contralateral C7
- hypoglossal nerve (CN XII)

- Intraplexal
- phrenic nerve
- pectoral nerve

OBERLIN transfer

- Coaptation of an ulnar nerve (UN) fascicle to the musculocutaneous nerve (MCN) innervating the biceps muscle.

- Mackinnon modification:

Double fascicular transfer, with the addition of a median nerve (MN) fascicle transfer to a branch of MCN supplying the brachialis muscle to improve elbow flexion.

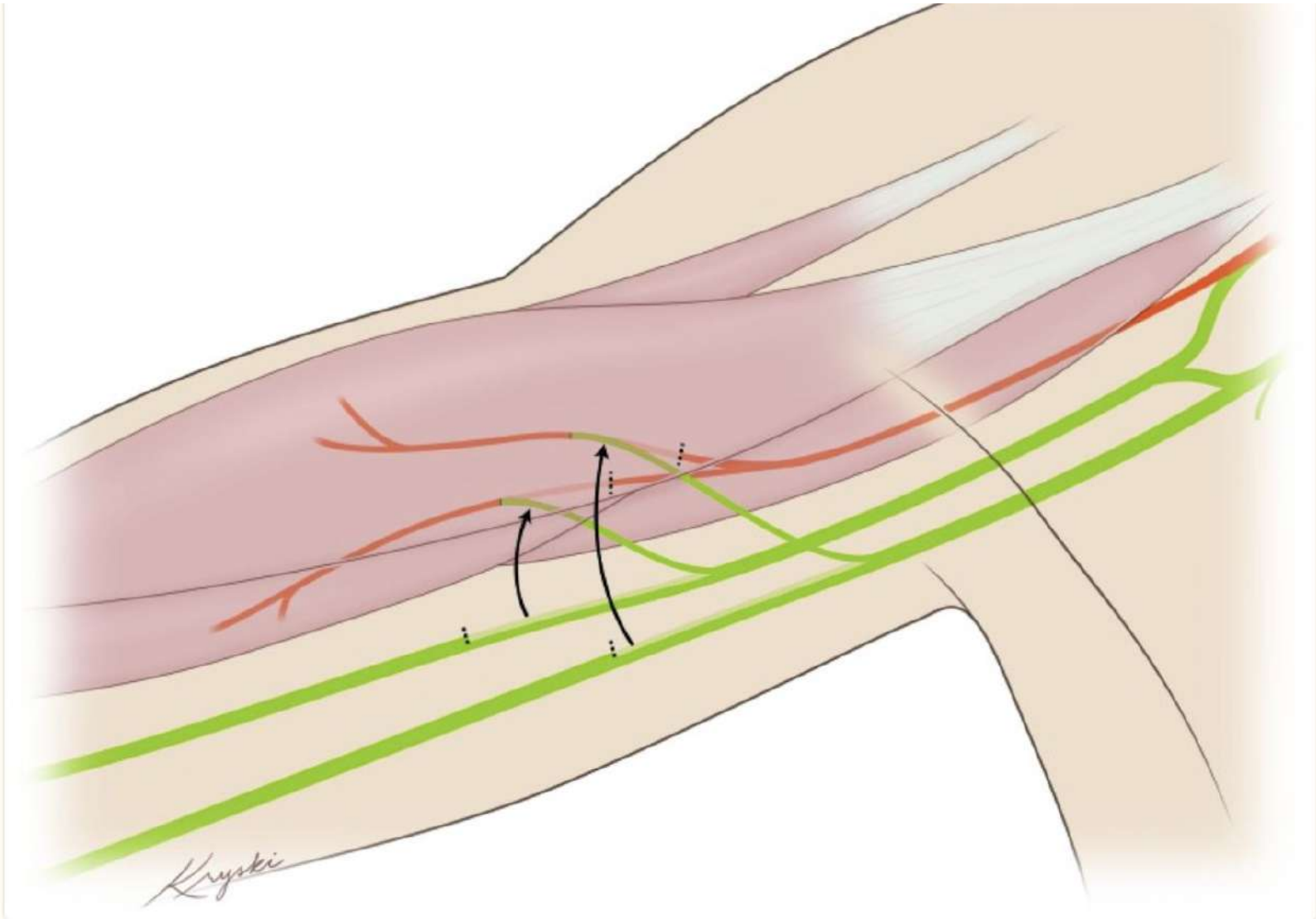


Figure 1

This illustration shows the ulnar and median fascicular transfers to the two branches of the musculocutaneous nerve.

- The Median nerve is located by its close anatomic relationship to the brachial artery.

- The Ulnar nerve lies medial and posterior to the MN and is identified either at the medial intermuscular septum or distally running on the anterior surface of the medial head of the triceps muscle.

- The fascicle with the least amount of intrinsic hand function is chosen for transfer.

- The MCN is identified in the interval between the biceps and brachialis muscles.

- Somsak transfer :Nerve to long head of triceps is neurotized to the anterior branch of the axillary nerve, via a posterior approach, to restore function to the deltoid muscle, thus enabling shoulder abduction and external rotation.

- Spinal accessory to suprascapular nerve for shoulder **

- Intercostal nerves 3,4,5 – musculocutaneous nerve

- **Immediate surgical exploration** (< 1 week)
- open injuries
- progressive neurologic deficits
- expanding hematoma or vascular injury

- **Early surgical intervention** (3-6 weeks)
- indicated for near total plexus involvement and with high mechanism of energy

- Delayed surgical intervention (3-6 months)???: Too late!

Muscle transfer

- Pedicled Lattisimus dorsi
  - Elbow flexion
  - Finger flexion

- Pedicled Pectoralis major

- FFMT Gracilis – elbow or finger flexion

- BOTOX for co-contractions and spasms.

Secondary procedures OBPI : Shoulder abduction

- External rotation osteotomy

- Triangular tilt surgery: Osteotomy of the clavicle at the junction of the middle and outer thirds, osteotomy of the acromion at its junction with the spine of the scapula, ostectomy of the superomedial angle of the scapula, anterior shoulder capsule, and soft tissue releases and splinting of the limb in adduction, 5° of external rotation, and full forearm supination

- In the mod Quad operation:
- Latissimus dorsi
- Teres major
- Subscapularis
- Pectoralis muscle contractures are released.

- Additionally, the axillary nerve is neurolysed.

Thank you

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