THE BRACHIAL PLEXUS
• The grouping of nerves connecting the C4 to Th1 junctions of the spinal cord to the left and right arms.
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• Brachial plexus grafts
• Anaesthesia of brachial plexus and area of sensory loss
Brachial Plexus Anatomy
(SPINAL ROOTS CONNECTED WITH BRACHIAL PLEXUS)
3D MRI, TRANSVERSE OBLIQUE SEQUENCE (C8-T1: Ulnar nerve)
MUSCULOCUTANEOUS NERVE (MU), ULNAR NERVE (UL), MEDIAL CORD (MC)
Relationship of the brachial plexus to the axillary artery

Ventral rami (roots)
Upper trunk
Middle trunk
Divisions
Lateral cord
Coracoid process
C5
C6
C7
C8
Lower trunk
Thoracic nerve
Posterior cord
Axillary artery
Medial cord
Pectoralis minor
Axillary nerve
Musculocutaneous nerve
Ulnar nerve
Median nerve
Radial nerve

Posterior divisions and their branches dark green
DERMATOMES (C5-T1)

Dermatome: The area of the skin supplied by a single, specific, spinal nerve root.
ROOTS

• Formed by primary rami of spinal nerves C5, C6, C7, C8 and T1.
• Types of plexus:
  1. Prefixed plexus: Contributions from C4 is large (Contribution from T1 is absent)
  2. Post fixed plexus: contributions from T1 is large, from C4 is absent and C5 is reduced in size.
ROOTS
TRUNKS

• Upper trunk: Roots C5 and C6 join to form upper trunk.
• Middle trunk: Root C7 forms middle trunk.
• Lower trunk: Roots C8 and T1 join to form lower trunk.

Each trunk divides into ventral and dorsal divisions.
Dissection of left suprascapular artery and suprascapular nerve, showing the, upper trunk (UT), middle trunk (MT) and lower trunk (LT) of brachial plexus.
CORDS

- Lateral cord: Formed by union of ventral divisions of upper and middle trunks.
- Medial cord: Formed by ventral division of lower trunk.
- Posterior cord: Formed by union of dorsal divisions of all 3 trunks.
CORDS

- dorsal scapular n.
- suprascapular n.
- lateral pectoral n.
- musculo-cutaneous n.
- axillary n.
- radial n.
- median n.
- ulnar n.
- to subscapularis
- teres major
- latissimus dorsi
- medial pectoral n.
- medial cutaneous nerves to the arm and forearm
- long thoracic n.
BRANCHES OF ROOTS

- Nerve to serratus anterior (long thoracic nerve)
- Nerve to rhomboideus (dorsal scapular nerve)
BRANCHES OF UPPER TRUNK

- Suprascapular nerve
- Nerve to subclavius
SUBSCAPULAR NERVE

- ScN: suprascapular nerve

Fig. 2. Postero-superior view of the left shoulder region is seen. Trapezius is reflected superiorly to expose the additional ligament into which the fibres of subclavius posticus are seen to insert. Also note the relation of the suprascapular nerve and artery to the additional ligament.
NERVE TO SUBCLAVIUS

- Nerve to subclavius supplying subclavius muscle

Fig. 1 This photograph shows the left infraclavicular region. The subclavius muscle along with the subclavius posticus is visualized. Note the course of the axillary artery (AA) and the cords of brachial plexus (BP) beneath the above mentioned muscle slip.
BRANCHES OF LATERAL CORD

- Lateral pectoral nerve
- Musculocutaneous nerve
- Lateral root of median nerve
LATERAL CORD (Branches)

FIGURE 3 - Anterior view of a right brachial plexus showing a communicating branch (black arrows) between the musculocutaneous nerve (MS) and the median nerve (M), after piercing the coracobrachialis muscle (CB). LC = lateral cord, PC = posterior cord, MC = medial cord, A = axillary nerve, R = radial nerve, U = ulnar nerve. Asterisks indicate the lateral root of the median nerve and black arrowheads indicate the medial root of the median nerve. SB = short head of the biceps brachii muscle. Note that the median nerve is formed distally in the arm.
Fig. 1. Drawing displaying a single sural graft placed between the C-6 root and the musculocutaneous nerve (highlighted in white).
BRANCHES OF MEDIAL CORD

- Medial pectoral nerve
- Medial cutaneous nerve of arm
- Medial cutaneous nerve of forearm.
- Ulnar nerve
- Medial root of median nerve.
MEDIAL CORD (Branches)

- MCN: Medial cutaneous nerve of arm
- Medial cutaneous nerve of forearm
- UN: Ulnar nerve.
- MR: Medial root of median nerve.
MEDIAL CORD (Branches)
BRANCHES OF POSTERIOR CORD

• Upper subscapular nerve.
• Nerve to latissimus dorsi (Thoraco dorsal nerve)
• Lower subscapular nerve
• Axillary nerve.
• Radial nerve.
POSTERIOR CORD (Branches)

- Upper and lower Subscapular nerve
- Thoracodorsal nerve
• Figure 3: Lower border of axillary vein exposed at left mastectomy. Large venous tributary clipped with metal clips (just prior to division), passing from the axillary contents (retracted inferiorly) to the axillary vein. Note the neurovascular bundle to latissimus dorsi (arrow) posterolateral to the tributary.
THORACODORSAL NERVE

Cephalic vein
Musculocutaneous nerve
Axillary artery and vein
Thoracoacromial artery
Pectoralis major muscle (cut)
Pectoralis minor muscle
Long thoracic nerve
Thoracodorsal nerve
Medial nerve
Rachial artery
Ulna nerve
Brachial vein
Teres major muscle
Latissimus dorsi muscle
Intercostobrachial nerves II and III
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POSTERIOR CORD (Branches)

- A : Axillary nerve.
- R : Radial nerve.
APPLIED ANATOMY

- Erb’s paralysis.
- Klumpke’s paralysis.
- Injury to nerve of serratus anterior.
- Injury to lateral cord.
- Injury to medial cord.
ERB’S PARALYSIS
( Site of injury )

• **Erb's point** is the site in the lateral root of brachial plexus. It is formed by the union of C5 & C6 roots, which later converges together. Nerves forming Erb’s point.

• Roots: C5, C6: Suprascapular nerve, nerve to subclavius, anterior and posterior divisions of upper trunk of brachial plexus.
SITE OF INJURY (Erb’s paralysis)
Shoulder Dystocia and Brachial Plexus Injury

- Scarring and contracture of the sternocleidomastoid muscle causing the head to be pulled down and to the right (torticollis)
- Damage to the 5th and 6th cervical nerve roots of the brachial plexus
- Erb’s palsy of the right arm
- Normal sternocleidomastoid muscle

Baby as seen at 2 months
CAUSE OF INJURY

• The injury usually happens when too much force is applied to the baby's head, while trying to pull out a baby stuck in the birth canal.

• Other causes:
  1. Fall on shoulder
  2. During anaesthesia
DEFORMITY IN ERB’S PARALYSIS

- Arm: Hands by the side which is abducted, medially rotated.
- Fore arm: extended and pronated.
  This deformity is called police man’s tip hand.
- Muscles paralysed: Biceps, deltoid, brachialis (Partly supraspinatus, infraspinatus, supinator)
DISABILITY IN ERB’S PARALYSIS

• Movements lost:
  1. Abduction and lateral rotation of arm.
  2. Flexion and supination of forearm.
  3. Biceps and supinator jerks are lost.
Sensation over a small area in the lower part of deltoid is lost.
TREATMENT OF ERB’S PARALYSIS (through exercises)

- With the baby, start range-of-motion exercises 2 times a day

  - Extend the child’s arm and turn the hand upwards.
  - Then raise the arm straight over the child’s head.
CONT’D

• When the child is old enough, have him do exercises himself, for range of motion and to increase strength.

Ask him to lift his arm as high as he can, turning the palm up as far as he can,

and then lift it with the other hand as high as he can, with the palm up.
OTHER USEFUL EXERCISES

- Swing arm in circle.
- Make circles with shoulder.
- Pull hard.
- Move back and forth.
SPLINTS

- The splint is now being used by infants, children, and adults. It has a variety of applications including cerebral palsy (C.P.), stroke, Erb's Palsy (Brachial Plexus Injury) orthopedic conditions, and cumulative trauma.

- Blue splint (for clear picture refer diagram 2)
KLUMPKE’S PARALYSIS

(Site of injury, lower trunk of brachial plexus)

1. Nerves involved: Mainly T1 and partly C8 roots.
2. Site of injury in Klumpke palsy. [A] Root of T1 and spinal nerve of C8. [B] Lower trunk. The green lines at T1 represent the most frequent origin of sympathetic fibers for the eyes. (PS): paraspinal muscles; (R): rhomboid muscle; DS: dorsoscapular nerve; LT: long thoracic nerve; (SA): serratus anterior muscle; (SS): supraspinal muscle; (IS): infraspinal muscle; SPS: suprascapular nerve; PL: pectoral lateralis nerve; (P): pectoralis muscle; PM: pectoralis medialis nerve; SF: sympathetic fibers to the eyes; (M of M): muscle of Müller; (DP): dilator pupillary muscle; (TM): teres major muscle; (SBS): subscapularis muscle; SBS: subscapularis nerves; TD: thoracodorsal nerve; (LD): latissimus dorsi muscle; MC: musculocutaneous nerve; (Bi): biceps muscle; (Br): brachialis muscle; M: median nerve; U: ulnar nerve; A: axillary nerve; (TMi): teres minor muscle; (D): deltoid muscle; R: radial nerve.
CAUSE AND SITE OF INJURY

• Cause of injury: undue abduction of arm (as in clutching something with the hands after a fall from a height)
DEFORMITY IN KLUMPKE’S PARALYSIS

• Deformity: Claw hand due to unopposed action of long flexes and extenses of fingers (claw hand: hyperextension at metacarpophalangeal and flexion at interphalangeal joints.

• Muscles paralysed: Intrinsic muscles of hand (T1), ulnar flexors of the wrist and fingers (C8).
DISABILITY IN KLUMPKE’S PARALYSIS.

- Claw hand.
- Cutaneous anesthesia and analgesia in narrow area along ulnar border of forearm and hand.
- Also associated with Horner’s syndrome.
INJURY TO NERVE TO SERRATUS ANTERIOR

• Deformity: Winging of scapula.
  (Excessive prominence of the medial border of Scapula).
Normally, pull of the Muscle keeps the medial border against the thoracic wall.
• Causes: 1. Sudden pressure on the shoulder from above.
2. Carrying heavy loads on shoulder.
WALL TEST FOR WINGING OF SCAPULA
DISABILITY IN INJURY TO NERVE OF BELL

- Disability:
  1. Loss of pushing and punching actions. During attempts at pushing, winging of scapula occurs.
  2. Arm cannot be raised beyond 90° i.e., overhead abduction are formed by serratus anterior is not possible.
INJURY TO LATERAL CORD

• Cause: dislocation of humerus
• Nerves involved:
  1. Musculocutaneous nerve.
  2. Lateral root of median nerve.
• Muscle paralysed:
  1. Biceps brachii and corachobrachialis.
  2. All muscles supplied by median nerve, except those of hand.
DEFORMITY IN INJURY TO LATERAL CORD

- Midprone forearm.
- Loss of flexion of forearm.
- Loss of flexion of wrist.
- Sensory loss on radial side of forearm.
INJURY TO MEDIAL CORD

• Cause: Subcoracoid process of humerus.
• Muscles paralysed:
  1. Muscles supplied by ulnar nerve.
  2. 5 muscles of hand supplied by median nerve.
MEDIAL CORD INJURY
(*Injury to ulnar nerve)

- Nerves involved:
  1. Ulnar nerve.
  2. Medial root of median nerve
DEFORMITY IN INJURY TO MEDIAL CORD

- Claw hand.
- Sensory loss on the ulnar side of forearm and hand.
Thoracic Outlet Syndrome with Resection of the First Rib and Scalene Muscles

Normal Anatomy

Post-Accident Condition
The swelling or scarring of the scalene muscles causes compression of the vessels and nerves against the clavicle.

Post-Operative Condition
The scalene muscles and the first rib are removed, decompressing the brachial nerves and vessels.
Prolonged Abduction of the Shoulder with Brachial Plexus Injury

NORMAL ANATOMY

INJURY TO THE BRACHIAL PLEXUS

- CLAVICLE
- CORACOID PROCESS
- HEAD OF HUMERUS
- BRACHIAL PLEXUS

ARM IS ABducted (AWAY) UP PAST 90 DEGREES

ANTERIOR VIEW OF LEFT SHOULDEr AND ARM
Von Recklinghausen's Syndrome

- Neurofibromatosis 1 (NF1) is a congenital disease which is also known as Von Recklinghausen’s Syndrome, named after a famous German pathologist. It is an autosomal dominant disease that is characterised by dysplasia of ectodermal tissues. These are tissues that have developed from the outer layer of the three germ layers of the early embryo, such as the nervous system, sense organs, teeth, epidermis and its associated structures, for example hair and nails.

The incidence of this disease is 30 in 10,000. It is inherited as an autosomal dominant trait but new mutations are responsible for about 50% of cases. The mutation has a very high penetrance but variable expressivity. The gene involved is situated on the long arm of chromosome 17; this gene’s normal function is as a tumour suppressor gene and the loss of both copies of this results in the growth of variety of neoplasms and non-neoplastic lesions.

One of its main clinical features is the presence of peripheral nerve tumours, called neurofibromas, such as the one found in our dissection. A neurofibroma develops as dysplasia of the fibrous covering of the nerve, producing a benign tumour. Tumours can then develop further becoming malignant by invading into the surrounding tissues; these are called neurosarcomas. Normally benign neurofibromas are symptomless, however if they grow beyond the nerve sheath they can cause a varying amount of pain. The neurofibroma that we found in our dissection was a benign tumour of the ulnar nerve, it may have cause this person no pain or symptoms other than a lump beneath the skin. The tumour is shown in this photograph:

(Picture in next slide)
Photograph showing the neurofibroma (ulnar nerve)
DIFFERENT APPROACHES FOR REGIONAL ANESTHESIA OF BRACHIAL PLEXUS
Sensory loss following anaesthesia

a. Sensory loss after division of median nerve

b. Sensory loss after division of the ulnar nerve at the wrist

c. Sensory loss after division of the radial nerve at the elbow

There is considerable overlap of adjacent nerves so that division of a nerve (or anaesthesia) results in a relatively small area of anaesthesia.
Harvesting of Nerve Grafts for Brachial Plexus Reconstruction

Sural Nerve Harvests

A. Multiple incisions are made along the course of the sural nerves in both legs.

B. The sural nerve is dissected in its entirety. Blunt dissection is required beneath the skin bridges.

Intercostal Nerve Harvests

A. The anterior abdominal wall is exposed through an elliptical incision extending from the armpit to the naval.

B. The intercostal nerves (T3-T11) are dissected free from the surrounding muscle and transferred subcutaneously to the arm.
THANK YOU