Introduction to the Upper Limb

James C. O’Reilly PhD
oreillyj@ohio.edu
Anatomical Planes
- Sagittal
- Coronal
- Axial
  (= Transverse or Horizontal)

Anterior - Posterior
Medial - Lateral
Superior - Inferior
Proximal - Distal
Cranial - Caudal
Rostral
Superficial - Deep
Ipsilateral - Contralateral

Note
Proximal - Distal used differently in limbs vs. nerves, blood vessels, airways, urinary tract and reproductive organs
Overview

- Shoulder
- Arm
- Forearm
- Hand

(C) Lateral view

FIGURE 6.1. Segments and bones of upper limb. The upper limb is divided into four main segments: shoulder, arm, forearm, and hand.
Overview

- Bones

**FIGURE 6.1.** Segments and bones of upper limb. The upper limb is divided into four main segments: shoulder, arm, forearm, and hand.
Overview

• Bones

• Areas of transition
Upper limb movements

**Figure 6.53. Scapular movements.** Scapula moves on the thoracic wall at the conceptual “scapulothoracic joint.” Dotted lines, the starting position of each movement.
Upper limb movements

- Flexion
- Extension
- Medial rotation
- Lateral rotation
- Abduction
- Adduction
- Circumduction
Upper limb movements

- **Flexion**
- **Extension**
- **Pronation**
- **Supination**

Legend:
- **Radius**
- **Ulna**
Upper limb movements
Upper limb movements
Innervation of the Upper Limb

4- and 5- week human embryos
Limbs Develop on the Hypaxial = Ventral = Anterior Side of the Trunk

- Most of the muscles that attach to the girdle and limb are hypaxial muscles.
- Thus, they are innervated by branches of anterior rami of spinal nerves.
- The only exceptions are the trapezius and SCM that are not hypaxial muscles and are innervated by cranial nerve XI.
The Trapezius and Sternocleidomastoid

Only muscles acting directly on the upper limb that are not innervated by branches of anterior primary rami of spinal nn.

Innervated by spinal accessory n. (CN XI)
Limbs have posterior and anterior “halves” *relative to their internal axis*

- Limb girdle with posterior and anterior elements
- Limb skeleton in plane of separation
- Nerves with dorsal and ventral divisions
- Muscles in posterior (extensor) and anterior (flexor) groups
Overview

- Medial
- Deep fascia
- Humerus
- Skin
- Intermuscular septa
- Lateral
- Anterior (flexor compartment)
- Posterior (extensor compartment)
- Intermuscular septum
- Anterior (flexor compartment)
- Ulna
- Radius
- Deep fascia
- Interosseous membrane
- Thenar eminence
Anterior Compartment of Arm

Biceps (short head)

Biceps (long head)
### Triceps brachii = “three-headed arm muscle”

- **Origin** –
  - infraglenoid tubercle of the scapula (long head)
  - posterior surface of humerus, superior (lateral head)
  - inferior to the radial groove (medial head)

- **Insertion** – olecranon of ulna

- **Innervation** – axillary (LH) and radial nerve

- **Action** – extension of arm and forearm

---

Muscles in the *posterior* compartments of arm AND forearm are innervated by radial n.
Compartments of the forelimb

Idealized Left Arm

As you look down at your left elbow in anatomical position

Actual Left Arm

As you look down at your left elbow in anatomical position: a clockwise rotation
Compartments of the forelimb

Anterior right limb

Posterior left limb

Radius
Ulna

Anterior

Posterior
Anterior Compartment of the Arm – Mostly Median

Intrinsic Muscles of Hand – Mostly Ulnar

**Figure 6.49.** Muscles and nerves of hand and deep palmar arch. A. Distribution of median and ulnar nerves. B. Deep dissection showing muscles, nerves, and deep palmar arch.
Limb innervation

- Limbs are multi-segmental
- They are supplied by multiple nerve segments
The Brachial Plexus

**FIGURE 6.23.** Schematic illustrations of brachial plexus.

### Key
1. Dorsal scapular nerve
2. Suprascapular nerve
3. Subclavian nerve
4. Long thoracic nerve
5. Lateral pectoral nerve
6. Medial pectoral nerve
7. Medial cutaneous nerve of arm
8. Medial cutaneous nerve of forearm
9. Upper subscapular nerve
10. Thoracodorsal nerve
11. Lower subscapular nerve

AD: Anterior division
PD: Posterior division

1–4: Supraclavicular branches
5–11: Infraclavicular branches

---

Randy Travis Drinks Cold (Root) Beer
Musculocutaneous n.
Muscles of anterior compartment of arm

Musculocutaneous n.
Muscles of anterior compartment of arm

Radial n.
All Muscles of posterior compartment of arm (except LHT) and forearm. There are no posterior muscles in hand.

Median n.
Most Muscles of anterior compartment of forearm; thenar muscles in hand

Ulnar n.
Most Muscles of anterior hand; fl.carp.ul. and medial ½ fl.dig.prof in anterior forearm

Axillary n.
Deltoid, Teres minor and Long head of triceps

Upper Limb: Major motor nerves
The Brachial Plexus

It can be helpful to organize the smaller motor branches of the brachial plexus into posterior and anterior groups.
The Brachial Plexus

Copyright © The McGraw-Hill Companies, Inc. All rights reserved.
Limb innervation

- Dermatomes make sense from a developmental perspective
- Arranged superior to inferior in sequence in an arc following the central axis of the limb
It is important to understand that peripheral nerves contain fibers from multiple spinal cord levels and **nerve maps are not the same as dermatomes**.
Testing Nerves of the Upper Limb

Avulsion - spinal nerve torn from spinal cord

Rupture - spinal nerve torn beyond CNS

Neuroma - spinal nerve torn and partially healed

Neuropraxia - spinal nerve stretched and damaged
   (most common)
Testing Nerve Function

Symptoms

Anesthesia - Loss of Sensation
Paresthesia – Abnormal sensations e.g., “Pins and Needles”
Paralysis - Loss of Motor Control & Abnormal Limb Postures

If damage is at level of spinal nerve
- both anesthesia and paralysis
- effects entire dermatome and myotome

If damage is more peripheral
- effects more localized region
- may only include anesthesia or paralysis
- can include parts of dermatomes and myotomes of multiple spinal nerves
Testing Nerves of the Upper Limb

Testing myotomes
## Testing spinal level deficits

<table>
<thead>
<tr>
<th>Arm movement</th>
<th>Muscle</th>
<th>Root</th>
<th>Nerve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder abduction</td>
<td>Deltoid</td>
<td>C5</td>
<td>Axillary</td>
</tr>
<tr>
<td>Elbow flexion</td>
<td>Biceps</td>
<td>C5/6</td>
<td>Musculocutaneous</td>
</tr>
<tr>
<td></td>
<td>Brachioradialis</td>
<td>C6</td>
<td>Radial</td>
</tr>
<tr>
<td>Elbow extension</td>
<td>Triceps</td>
<td>C7</td>
<td>Radial</td>
</tr>
<tr>
<td>Radial wrist extensor</td>
<td>Extensor carpi radialis longus</td>
<td>C6</td>
<td>Radial</td>
</tr>
<tr>
<td>Finger extensors</td>
<td>Extensor digitorum</td>
<td>C7</td>
<td>Posterior interosseous</td>
</tr>
<tr>
<td>Finger flexors</td>
<td>Flexor pollicis longus &amp; flexor digitorum</td>
<td>C8</td>
<td>Anterior interosseous</td>
</tr>
<tr>
<td></td>
<td>profundus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flexor digitorum profundus</td>
<td></td>
<td>Ulnar</td>
</tr>
<tr>
<td></td>
<td>Ring &amp; little</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finger abduction</td>
<td>First dorsal interosseous</td>
<td>T1</td>
<td>Ulnar</td>
</tr>
<tr>
<td></td>
<td>Abductor pollicis brevis</td>
<td>T1</td>
<td>Median</td>
</tr>
</tbody>
</table>
Dermatomes – Spinal nerves

- Dermatomes overlap
- Minimal areas of overlap (used for testing):
  - C5 – upper lateral arm
  - C6 – Pad of thumb (I)
  - C7 – Pad of middle finger (III)
  - C8 – Pad of little finger (V)
  - T1 – Medial elbow

Evaluation of derma- and myotomes may provide important information about potential breathing problems that may develop (C3-5 is phrenic nerve!)
Testing Nerves of the Upper Limb

Brachial plexus injuries

- Upper brachial plexus injuries (Erb-Duchenne palsy)
  - Damage to root of C5 and C6
  - Traumatic lateral neck bending
    - during childbirth
    - from fall on shoulder
  - Paralysis or weakness of shoulder and arm
    - Deltoid, biceps, brachialis and brachioradialis
    - “Waiter’s tip” position
      - adducted and medially rotated arm
      - extended elbow
Testing Nerves of the Upper Limb

Brachial plexus injuries

Upper brachial plexus injuries (Erb-Duchenne palsy)

Waiter’s Tip Position
Testing Nerves of the Upper Limb

Brachial plexus injuries

- Lower brachial plexus injuries (Klumpke Palsy)
  - Damage to roots of C8 and T1
  - From traumatic hyper-abduction of arm
    - childbirth
    - Spiderman (?)
  - Paralysis or weakness of most intrinsic muscles of hand
    - results in “Claw hand”
Testing Nerves of the Upper Limb

Accessory n.

Test trapezius function
- elevate scapula (shrug) against resistance while palpating superior border of muscle
Testing Nerves of the Upper Limb

Axillary Nerve

Common Causes
- Fracture of surgical neck of humerus
- Dislocation of glenohumeral joint
- Improper use of crutches
- Intramuscular injections
Axillary Nerve

Motor
- paralysis of deltoid
- atrophy of deltoid

Figure 6.20. Testing deltoid muscle. The examiner resists the patient’s abduction of the limb by the deltoid. If the deltoid is acting normally, contraction of the middle part of the muscle can be palpated.
Axillary Nerve

Sensory
- loss of sensation on lateral shoulder
- superior lateral cutaneous n. of arm
Testing Nerves of the Upper Limb

Thoracodorsal n.

Test function of Latissimus dorsi
- arm abducted 90°
- adducted against resistance while anterior border of muscle is palpated

Susceptible to injury during surgery in inferior part of axilla
Injury to the Long Thoracic Nerve (C5, 6, 7) results in a ‘winged scapula’
Musculocutaneous nerve

**Testing Nerves of the Upper Limb**

Motor
- biceps, coracobrachialis and brachialis
- weak elbow flexion and forearm supination

Sensory
- Loss of sensation on lateral surface of forearm
- Lateral cutaneous n. of forearm
Testing Nerves of the Upper Limb

Bicipital Reflex

Tests musculocutaneous n. and C5,C6 spinal nerves
Radial nerve

Motor
- Triceps, brachioradialis, supinator and extensors of wrist and fingers
- “Wrist drop” - patient unable to extend wrist
- If lesion is beyond humerus, triceps not effected

Sensory
- Loss of sensation on lateral elbow, posterior forearm and dorsum of hand
- Inferior lateral cut. n. of arm, post. cut. n. of forearm, and superficial branch of radial nerve

Figure B6.17. Wrist-drop.
Testing Nerves of the Upper Limb

Median nerve

Motor
- Finger and wrist flexors (most), thenar muscles and 1st and 2nd lumbricals
- Can’t flex proximal IP joints of digits 1-3
- Can’t flex distal IP joints on digits 2 and 3
- “Benediction hand” when attempting to make fist
Testing Nerves of the Upper Limb

Median nerve

Sensory
- loss of sensation in lateral palm and tips of digits 1-3
Testing Nerves of the Upper Limb

Ulnar nerve

Motor
- Flexor carpi ulnaris, medial part of FDP, most intrinsic hand muscles
- Wrist adduction impaired
- Lateral deviation of wrist flexion
- MP joints become hyperextended
- Cannot flex digits 4 and 5 when making a fist

Sensory
- loss of sensation in medial palm and tip of digit 5