Introduction to the Upper Limb

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Overview

• Shoulder
• Arm
• Forearm
• Hand

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
• Joints

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
- Joints
- Areas of transition
Upper limb movements

Rotation

Retraction

Protraction

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Glenohumeral Joint

- Broad movement
- Reduced skeletal stability
- Enhanced muscular, ligamentous, and indirect skeletal stability
  - Biceps tendon *
  - Glenoid labrum *
  - Fibrous joint capsule * membrane
  - Acromion and coracoid
Glenohumeral Joint

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Drake – Gray’s Anatomy for Students
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Upper limb movements

- Flexion
- Extension
- Medial rotation
- Lateral rotation
- Abduction
- Adduction
- Circumduction
Elbow Joint

Anterior View

- Trochlea
- Capitulum
- Head (of radius)
- Trochlear notch (of ulna)
- Radial notch (of ulna)
Elbow Joint

A

Anterior

Trochlea

Capitulum

Head (of radius)

Radial notch (of ulna)

Trochlear notch (of ulna)

Lateral

Anterior

Flexion

Extension

Pronation

Supination
Upper limb movements

- Flexion
- Extension
- Pronation
- Supination

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Wrist

- **Carpal bones**
  - Scaphoid
  - Lunate
  - Triquetrum

- **Metacarpal bones**

- **Radius**

- **Ulna**

- **Wrist joint**

- **Oblique cord**

- **Angular ligament**

- **Ulna**

- **Interosseous membrane**

- **Aperture for anterior interosseous artery**

- **Distal radioulnar joint**

- **Articular disc**
Upper limb movements
Upper limb movements

Abduction

Abduction

Adduction

Adduction

Insertion into dorsal hood

Insertion into base of metacarpal

First dorsal interosseous

Radial artery

Insertion into dorsal expansion

First palmar interosseous

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Innervation of the Upper Limb

4- and 5- week human embryos

- Limbs develop on the ventral (anterior) side of an embryo
Epaxial vs. Hypaxial

Vertebral Column = Body Axis

Insert guts here
Epaxial vs. Hypaxial

Epi = above or over

Vertebral column = body axis

Hypo = below or under
Epaxial vs. Hypaxial

Epaxial = muscle above the axis

Vertebral column = body axis

Hypaxial = muscle below the axis
Epaxial vs. Hypaxial

Epaxial muscles
- innervated by dorsal (posterior) rami of spinal nerves

Hypaxial muscles
- innervated by ventral (anterior) rami of spinal nerves
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
- Exceptions are the trapezius and SCM that are not hypaxial muscles and are innervated by cranial nerve XI
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
Limb innervation

- Limbs are multi-segmental
- They are supplied by multiple nerve segments
Upper Limb: Major Branches

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

**Musculocutaneous n.**
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

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It can be helpful to organize the distal motor branches of the brachial plexus into posterior and anterior groups.
**Muscles of the Shoulder**

**Latissimus dorsi**

*Origin*: spinous processes of T6-L5 and sacrum, iliac crest, & ribs 10 to 12

*Insertion*: intertubercular sulcus of humerus

*Innervation*: Thoracodorsal nerve (C6-C8)

*Action*: Extends, adducts and medially rotates the humerus.
Muscles of the Shoulder

**Levator scapulae**

- **Origin**: Transverse process of C1 to C4
- **Insertion**: Upper medial border of scapula
- **Innervation**: C3, C4 & Dorsal scapular nerve (C4,C5)
- **Action**: Elevates scapula

**Rhomboid minor and major**

- **Origin**: Ligamentum nuchae and spinous processes of C7 to T5
- **Insertion**: Medial border of scapula
- **Innervation**: Dorsal scapular nerve (C4,C5)
- **Action**: Adducts, elevates and rotates scapula
Deltoid

**Origin:** spine of scapula, acromion and lateral third of the clavicle

**Insertion:** Deltoid tuberosity of the humerus

**Innervation:** Axillary nerve (C5, C6)

**Action:** Abducts humerus (15-90° abduction of arm)
Muscles of the Shoulder

Supraspinatus

Origin: Supraspinous fossa
Insertion: Greater tubercle of humerus
Innervation: Suprascapular n. (C5, C6)
Action: abducts arm (below 15°)
**Infraspinatus**

**Origin:** Infraspinous fossa  
**Insertion:** Greater tubercle of humerus  
**Innervation:** Suprascapular n. (C5, C6)  
**Action:** Lateral rotation of humerus
Muscles of the Shoulder

Rotator Cuff Muscles

Teres Minor

Origin: lateral part of Infraspinous fossa

Insertion: Greater tubercle of humerus

Innervation: Axillary n. (C5, C6)

Action: Lateral rotation of humerus
Subscapularis

Origin: subscapular fossa of the scapula

Insertion: Lesser tubercle of humerus

Innervation: Upper and lower subscapular nn. (C5 - C7)

Action: Medial rotation of arm
Muscles of the Shoulder

Teres major

Origin: posterior surface of inferior triangle of the scapula

Insertion: Medial side of lesser tubercle on anterior side of humerus

Innervation: Inferior subscapular n. (C5 - C7)

Action: Medial rotation and extension of humerus
**Muscles of the Shoulder**

**Pectoralis Major**

**Origin:** anterior, medial half of clavicle; anterior surface of sternum; costal cart. 1-7; rib 6; and aponeurosis of external oblique

**Insertion:** intertubercular sulcus of humerus (lateral lip)

**Innervation:** Medial and lateral pectoral nerves (C5-T1)

**Action:** Flexion, adduction and medial rotation of humerus. Extension of flexed arm (sternocostal part only)
**Pectoralis Minor**

**Origin:** anterior surfaces and superior borders of ribs 3 to 5  
**Insertion:** Corocoid process of scapula  
**Innervation:** Medial pectoral nerve (C6-C8)  
**Action:** Inferior rotation of scapula (= Rotates glenoid fossa inferiorly), protracts scapula
Serratus anterior m.
Long thoracic nerve
Lateral thoracic artery

**Serratus anterior**

**Origin:** surface of upper 8 or 9 ribs and facia of intercostal muscles

**Insertion:** Medial border of scapula

**Innervation:** Long thoracic nerve (C5-C7)

**Action:** Protracts scapula, holds scapula to body wall

Muscles: Trunk to Girdle
Compartments of Upper Limb

- Medial: Deep fascia
- Lateral: Skin
- Anterior (flexor compartment)
- Posterior (extensor compartment)

- Intermuscular septa
- Intermuscular septum
- Thenar eminence

- Humerus
- Radius
- Ulna
- Interosseous membrane

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Muscles of the anterior compartment of the arm are mostly innervated by the **musculocutaneous n.**
Muscles in the *posterior* compartments of arm AND forearm are innervated by **radial n.**

- Triceps (long head)
- Triceps (medial head)
- Triceps (lateral head) - CUT

*Posterior Compartment of Arm*

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Compartment 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

Anterior

Posterior

Radius

Ulna
Innervation of the Forearm

(A) Median nerve
- Median nerve
- PT
- FCR
- PL
- Anterior interosseous nerve
- FPL
- FDS
- PQ
- FDP (lateral half to digits 2, 3)

(B) Ulnar nerve
- Ulnar nerve
- FCU
- FDP (medial half to digits 3, 4)

(C) Radial nerve
- Radial nerve
- Br
- ECRL
- ECRB
- Posterior interosseous nerve
- ECU
- EDM
- ABP
- EPB
- EPL
- EI

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Anterior Compartment of the Arm – Mostly Median n.

Intrinsic Muscles of Hand – Mostly Ulnar n.

**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.
Sensory 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**

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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
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!)

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Testing Nerves of the Upper Limb

Myotomes
# Testing spinal level deficits

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<th>Nerve</th>
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<td>Extensor carpi radialis longus</td>
<td>C6</td>
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</tr>
<tr>
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<td>Abductor pollicis brevis</td>
<td>T1</td>
<td>Median</td>
</tr>
</tbody>
</table>
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)
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

Sensory
- loss of sensation on lateral shoulder
- superior lateral cutaneous n. of arm

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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.

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Testing Nerves of the Upper Limb

Musculocutaneous nerve

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

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Bicipital Reflex

Tests musculocutaneous n. and C5, C6 spinal nerves
Testing Nerves of the Upper Limb

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

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