Core Surgical Sciences course for the Severn Deanery

Surgical Anatomy: Upper Limb - detailed learning objectives/stations

The session will be taught in small groups, with examination of prosections, and three rotating stations: axilla and breast; shoulder, arm and elbow; forearm, wrist and hand.

1. Axilla and breast

You should be able to:

Describe the boundaries of the axilla:
- Space between upper arm & side of thorax
- Bounded anteriorly & posteriorly by axillary folds
- Communicates with posterior triangle of neck above
- Floored by axillary fascia

Describe and identify the contents of the axilla:
- Axillary artery & vein
- Brachial plexus
- Lymph nodes
- Fat

Identify and describe the axillary artery
- Main artery of upper limb
- Derives from subclavian artery at lateral border of 1st rib; becomes brachial artery at lower border of teres major
- Lies in groove between long head of triceps & coracobrachialis; can be palpated in lateral wall of axilla – may be compressed here to prevent excessive bleeding
- Branches: superior thoracic artery (from first part); thoracoacromial and lateral thoracic arteries (from second part, deep to pectoralis minor); anterior and posterior circumflex humeral, subscapular arteries (from third part).

Scapular anastomoses
Many anastomoses around shoulder joint, branches of:
- Dorsal scapular artery - from transverse thoracic from thyrocervical trunk of subclavian artery
- Suprascapular artery – also from thyrocervical trunk
- Circumflex scapular artery – from subscapular artery from third part of axillary artery
- Create collateral circulation – important in ligation or vascular stenosis

Identify and describe the axillary vein
- Commences at lower border of teres major as continuation of basilic vein
- Joined by venae comitantes of brachial artery
- Cephalic vein pierces clavipectoral fascia above pectoralis minor, to drain into axillary vein
- Often damaged in axillary wounds – dangerous as bleeds profusely, and air emboli may be created

Describe the axillary lymph nodes

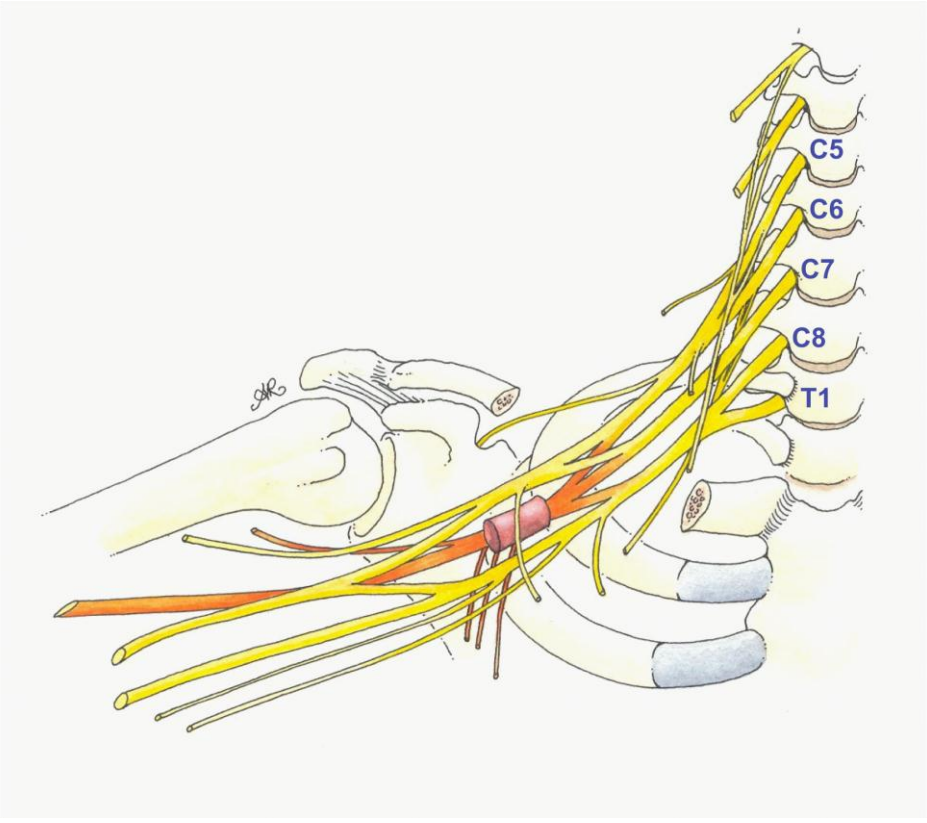
- Become enlarged and tender in infections of upper limb, pectoral region, breast and upper abdominal wall
- Enlargement of apical group may obstruct cephalic vein
- Long thoracic and thoracodorsal nerves are at risk in axillary lymph node dissection

Dsecribe the anatomy of the breast

- Base extends from sternum to midaxillary line, from 2nd to 6th ribs; tail extends into axilla
- Posterior capsule firmly attached to overlying dermis by suspensory ligaments
- Breasts grow at puberty (fat and glandular development)
- Alveoli bud in pregnancy
- 15-20 lobules each drained by lactiferous duct
- Male breast rudimentary – nipple at level of 4th i/c space
- Neurovascular supply: mainly supplied by internal and lateral thoracic arteries; drains mostly to internal thoracic and axillary veins; 75% lymph drains to axillary (mostly anterior) nodes; supplied by 4th to 6th intercostal nerves (sensory & sympathetic)

Brachial plexus

- 5 roots emerge through interscalene groove (between scalenus anterior and medius)
- 3 trunks run across posterior triangle
- 6 divisions under the clavicle
- 3 cords form at lateral border of first rib
- Numerous branches (5 main nerves entering arm)



Variations in the brachial plexus

- Roots may vary: C4-C8 may contribute – prefixed brachial plexus; C6-T2 may contribute – postfixed brachial plexus
- Trunks, divisions, cords, branches and relations may also vary

Brachial plexus injuries - may be produced by disease, stretching or wounds in neck & axilla

Injury to superior parts of plexus

- C5 & C6 roots - Erb-Duchenne palsy - when neck and shoulder are forcibly separated, eg: childbirth, falls; 'waiter's tip position'
- Superior trunk may be compressed in 'backpacker's palsy'

Injury to inferior parts of plexus

- Less common
- When upper limb forcibly pulled superiorly, eg: breech birth, breaking a fall; lower trunk (C8 & T1) pulled; 'clawhand'

Brachial plexus neuropathy

- Sudden onset of pain, muscular weakness
- May be followed by neurologic amyotrophy

Brachial neuritis

- May follow URTI, vaccination or trauma

Compression injuries

- Trunks may be compressed by axillary artery aneurysm causing pain and paraesthesia
- Cords (and axillary vessels) may be compressed in prolonged hyperabduction of arm

2. Shoulder, arm and elbow

You should be able to:

Describe the pectoral girdle:

- Pectoral girdle = scapula & clavicle
- Highly mobile; scapula is attached to thorax by muscles, and via acromioclavicular, sternoclavicular joints

Describe, identify (and side) the clavicle

- Longer & more curved in male
- Medial 2/3 round & convex anteriorly; lateral 1/3 flat & convex posteriorly
- Upper surface smoother – clavicular head of scm attaches to medial 1/3 superior surface; trapezius to lateral 1/3 posterior surface; deltoid to lateral 1/3 of lateral surface; rough area for costoclavicular ligament medially on inferior surface; groove for subclavius muscle in middle 1/3 inferior surface (nutrient foramen in groove); coracoclavicular ligament attaches to conoid tubercle & trapezoid ridge
- Lies horizontally; subcutaneous
- 1st bone to ossify in fetus; secondary centre appears in late teens & fuses rapidly
- Clavicle fractures – common; usually by direct blow; common mountain biking injury; usually at junction between middle and lateral thirds; acromial end sags

Describe, identify (and side) the scapula

- Concave costal surface marked by ridges for fibrous septa of subscapularis
- Serratus anterior attaches from medial margin, anteriorly
- Scapular notch – transverse scapular ligament gives attachment to inferior belly of omohyoid
- Levator scapulae, rhomboid major & minor attach to medial border
- Infraglenoid tubercle – long head triceps; supraglenoid tubercle – long head biceps
- Dorsal surface – supraspinous & infraspinous fossae
- Teres major attaches to inferior angle; teres minor from dorsal edge of lateral border – origin often bisected by groove for circumflex scapular vessels
- Spine & acromion are subcutaneous & palpable; trapezius attaches to medial edge acromion & spine; deltoid to inferior margin
- Glenoid faces slightly anteriorly
- Coracoclavicular ligament, pectoralis minor, short head of biceps & coracobrachialis attach to coracoid process
- Ossifies in cartilage from several centres; secondary centres fuse about 20years.

Identify and describe the clavicular joints:

- Acromioclavicular & sternoclavicular joints are atypical synovial joints (articular cartilage is fibrocartilage)
- Disc divides sternoclavicular joint; incomplete disc in acromioclavicular joint
- Thickenings of joint capsules form sternoclavicular (anterior & posterior) & acromioclavicular ligaments

Identify and describe muscles of the pectoral girdle (attachments, action, nerve supply)

Attaching pectoral girdle to trunk directly:
- Pectoralis minor
- Subclavius
- Trapezius
- Rhomboids
- Levator scapulae
- Serratus anterior

Indirectly (via humerus):
- Pectoralis major
- Latissimus dorsi

Describe, identify (and side) the humerus
- Proximal epiphysis and metaphysis: head, neck, greater and lesser tubercles, bicipital groove
- Shaft: radial groove
- Distal epiphysis: trochlea, capitulum, medial and lateral epicondyles, olecranon fossa and coronoid fossa

Identify and describe the shoulder joint
- Ball & socket synovial joint
- Fibrous capsule forms glenohumeral ligament
- Coracoacromial ligament prevents upward displacement of humerus
- Subacromial bursa interposed between acromion and supraspinatus tendon
- Short scapular (rotator cuff) muscles
- Rotator cuff injuries: rotator cuff tears are common sports injuries; may also follow shoulder dislocation; degenerative tendinitis of supraspinatus common in elderly – tendon may rupture; subacromial bursitis causes painful arc syndrome

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Identify and describe the muscles of the arm (attachments, action, nerve supply):

Flexor compartment:
- Biceps brachii
    - Biceps injuries
        - Biceps tendinitis – throwing and racquet sports
        - Dislocation of tendon of long head of biceps
        - Rupture of the tendon of long head of biceps – ‘popeye deformity’
- Brachialis
- Coracobrachialis

Extensor compartment:
- Triceps brachii

Identify and describe nerves in the arm, including root value, areas of supply, and causes and consequences of damage:

Axillary nerve (C5,6)
- Passes under shoulder joint & through quadrangular space with posterior circumflex humeral vessels
- Gives branches to shoulder joint, deltoid & teres minor muscles
- May be damaged by fractured surgical neck of humerus (and in intramuscular injections) – deltoid atrophies, loss of sensation laterally over shoulder
- Continues as lateral cutaneous nerve of arm

Musculocutaneous nerve (C5,6,7)
- Pierces coracobrachialis, supplying it
- Lies between biceps and brachialis, supplying them
- Emerges lateral to biceps as lateral cutaneous nerve of forearm
- May be damaged by wound in axilla

Radial nerve (C5-T1)
- Largest branch of brachial plexus
- Passes through triangular space to lie in radial groove, gives branches to triceps, and posterior cutaneous nerve of arm
- May be damaged by midshaft fracture of humerus – wrist-drop
- Radial nerve pierces lateral intermuscular septum above elbow
- Divides into terminal branches at lateral epicondyle: superficial branch and posterior interosseous nerve

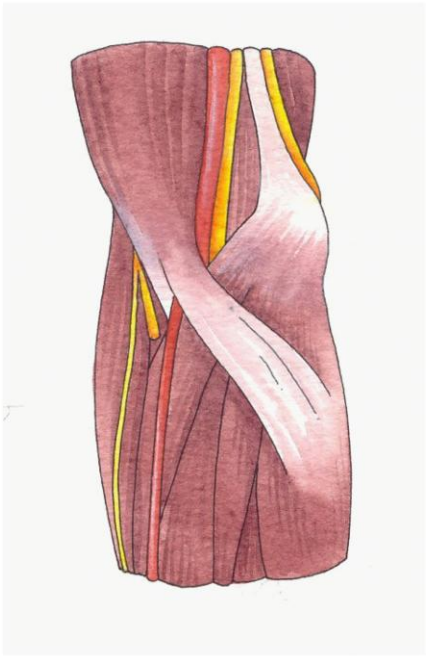
Median nerve (C5-T1)
- Median nerve crosses from lateral side of brachial artery in axilla, to medial side at elbow
- May be damaged in supracondylar fractures

Ulnar nerve (C8, T1)
- No branches in arm
- Pierces medial intermuscular septum, passes behind medial epicondyle – may be damaged by fracture or compressed here

Identify and describe the elbow joint:
- Synovial hinge joint: capitulum articulates with the head of the radius radius; trochlea with the trochlear notch of the ulna
- The trochlea projects more distally than the capitulum, creating the 'carrying angle' at the elbow joint
- Stabilized by ulnar and radial collateral ligaments; radial collateral ligament does not attach to the radius, but to the annular ligament, allowing pronation/supination
- Muscles acting on the elbow joint (identify; describe their actions and nerve supply): triceps, biceps, brachialis

Elbow injuries

- Supracondylar fractures may result from a fall on an outstretched hand, and may affect the brachial artery and median nerve; the ulnar nerve is at risk in olecranon fractures
- Olecranon fracture - often from fall on elbow with powerful contraction of triceps - olecranon avulsed; usually requires pinning due to triceps exerting traction on olecranon; healing slow
- Radial head subluxation (Nursemaid's elbow) is common in young children under 6 years of age; it is normally caused by a sudden pull on the upper limb: the radial head pulls out of the annular ligament
- Lateral epicondylitis (Tennis Elbow) is usually caused by overuse of the wrist extensors; medial epicondylitis (Golfer's Elbow) is usually caused by overuse of wrist flexors.



3. Forearm, wrist and hand

You should be able to:

Describe, identify (and side) the bones of the forearm and hand:

- Radius: identify head, neck, ulnar notch, tuberosity, radial styloid process, dorsal tubercle (of Lister), and interosseous border
- Ulna: identify olecranon, coronoid process, tuberosity, interosseous border, radial notch and ulnar styloid process
- Carpal bones: scaphoid, lunate, triquetral, pisiform, hamate, capitate, trapezoid, trapezium
- Metacarpals and phalanges

Fracture of distal radius

- Most common fracture in adults >50 years
- Colles' fracture: transverse fracture of distal radius with distal fragment displaced dorsally – 'dinner fork deformity'; often from fall on outstretched hand; bony union usually good

Fracture of the scaphoid

- Most commonly fractured carpal bone, often from fall on outstretched hand
- Pain elicited on dorsiflexion and abduction of hand
- Fracture may not be apparent on initial radiograph; appears on radiograph 2-3 weeks later – bone resorption
- Avascular necrosis of proximal part may occur

Metacarpal fractures

- Isolated fractures tend to be stable; fractures heal rapidly – good blood supply
- Boxer's fracture - fractured necks of 1st and 2nd metacarpal
- Multiple metacarpal fractures in crushing injuries - unstable

Phalanx fractures

- Common in crushing injuries; very painful
- Distal phalanx # often comminuted with painful haematoma
- Bone fragments must be carefully realigned to restore function of flexor tendons

Identify and describe the radioulnar joints:

- The proximal radioulnar joint is a synovial pivot joint between the radial head and the radial notch of the ulna and annular ligament
- The distal radioulnar joint is a synovial pivot joint between the ulnar head and the ulnar notch of the radius
- Pronation (pronator quadratus and pronator teres) and supination (biceps and supinator) occur here
- NB. radius and ulna are also joined by the interosseous membrane

Identify and describe the wrist joint:

- A condyloid synovial joint (permits abduction, adduction, flexion, extension) between the radius and the lunate and scaphoid (triquetral articulates with the capsule)
- Joint capsule is thickened as palmar, collateral and dorsal ligaments
- Rheumatoid arthritis is common at the wrist joint

Identify joints of the carpus and digits:

- Midcarpal joint: a continuous synovial joint between the 2 rows of carpal bones, increasing the range of flexion and extension at the wrist
- Carpometacarpal joints of fingers - relatively immobile compared with saddle-shaped CMC joint of thumb
- Metacarpophalangeal (MCP) joints of the fingers are more mobile than that of the thumb; they are stabilzed by the deep transverse metacarpal ligament and collateral ligaments
- Interphalangeal joints: synovial hinge joints, stabilized by collateral ligaments

Conditions affecting the fingers

- Dupuytren's contracture: myofibroblasts in the palmar fascia cause contraction - fixed flexion deformity in the fingers (usually digits IV and V)
- Osteoarthritis in the hand – usually DIP joints; RA tends to affect MCP and PIP joints, may cause rupture of flexor and extensor tendons, and swan neck, boutonniere deformities

Identify and describe the muscles of the forearm (attachments, action, nerve supply):

Flexor compartment:

- Superficial group (originating from medial epicondyle): pronator teres, flexor carpi radialis, flexor digitorum superficialis, palmaris longus, flexor carpi ulnaris
- Deep group: flexor digitorum profundus, flexor pollicis longus, pronator quadratus

Extensor compartment:

- Superficial group (originating from lateral supracondylar ridge and epicondyle): brachioradialis, extensor carpi radialis longus et brevis, extensor digitorum, extensor digiti minimi, extensor carpi ulnaris, anconeus
- Deep group: supinator, abductor pollicis longus, extensor pollicis brevis et longus, extensor indicis

Identify and describe the intrinsic muscles of the hand (attachments, action, nerve supply):

- Muscles of the thumb: abductor pollicis brevis, flexor pollicis brevis and opponens pollicis brevis (together forming thenar eminence); adductor pollicis
- Muscles of the hypothenar eminence: abductor digiti minimi, flexor digiti minimi, opponens digiti minimi
- Muscles acting on the fingers: lumbricals and interossei

Identify and describe nerves in the forearm and hand, including root value, areas of supply, and causes and consequences of damage:

Radial nerve branches in the forearm and hand

- Posterior interosseus nerve passes between heads of supinator, to lie on interosseous membrane in posterior compartment, supplying extensor muscles & wrist - may be damaged in penetrating injuries to forearm
- Superficial radial nerve runs under brachioradialis, passing under its tendon at the wrist, into the anatomical snuffbox to supply dorsum of hand.

Median nerve branches in the forearm and hand

- Median nerve leaves cubital fossa through heads of pronator teres (may be compressed here in pronator syndrome), and under the fibrous arch of flexor digitorum superficialis
- Gives branches to superficial forearm flexors near elbow; gives anterior interosseous nerve to deep flexors
- Palmar branches supply skin over thenar eminence
- Median nerve runs under flexor retinaculum – may be compressed in carpal tunnel syndrome (median nerve passes through carpal tunnel with deep and superficial digital flexor tendons, FPL, FCR; compression produces sensory loss in the lateral 3 ½ digits and weakness of the thenar muscles)
- Recurrent branches supply thenar muscles; medial & lateral branches in hand to fingers

Ulnar nerve branches in the forearm and hand

- Ulnar nerve passes between heads of flexor carpi ulnaris into flexor compartment of forearm – may be compressed here in cubital tunnel syndrome
- Ulnar nerve injury results in 'clawhand'
- Lies between flexor carpi ulnaris and flexor digitorum profundus, supplying them
- Emerges lateral to flexor carpi ulnaris tendon at wrist, over flexor retinaculum
- Ulnar nerve may be compressed in the osseofibrous tunnel under the pisohamate ligament – Guyon's canal syndrome; may be damaged in hamate fracture – decreased grip strength
- Gives palmar cutaneous branches to hypothenar skin; gives superficial branches to palmaris brevis and fingers (digital nerves)
- Gives deep branches to remaining muscles of hand

Identify and describe the vasculature of the forearm and hand:

- Brachial artery divides at neck of radius into radial and ulnar arteries
- The radial artery courses down forearm, medial to brachioradialis; lies between tendons of brachioradialis and FCR at wrist; superficial palmar branch runs over flexor retinaculum to anatomose with ulnar artery in superficial palmar arch; radial artery continues through anatomical snuffbox, between the heads of adductor pollicis; provides arteria priceps pollicis and arteria radialis indicis before anastomosing with the deep branch of the ulnar artery, to form the deep palmar arch
- The ulnar artery passes deep to the ulnar head of pronator teres, provides common interosseous artery (branches into anterior and posterior interosseous arteries); lies on flexor digitorum profundus, lateral to ulnar nerve; crosses flexor retinaculum into hand; deep palmar branch links with radial artery; ends in superficial palmar arch, giving off common digital arteries
- Deep veins accompany arteries; dorsal venous arch of the hand drains into the cephalic and basilic veins; superficial palmar plexus drains into median vein of forearm – may drain into median cubital or basilic veins
- Lymph from deep tissues drain via lymphatics running with main blood vessels, to lateral axillary nodes; lymph from superficial tissues drains via lymphatics running with superficial veins; some medial lymphatics drain to supratrochlear nodes; lateral lymphatics drain mainly to lateral axillary nodes; a few drain to infraclavicular nodes.