ESSENTIAL SURFACE & RELATED ANATOMY FOR CLINICAL PRACTICE

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INSTRUCTIONS

• Consider the clinical relevance of each surface marking.
• Where possible find it on yourself or a colleague.
• Use this document for reference both now and later in your career.
• Regard the information as a means of communicating with both your patients and colleagues.
HEAD AND NECK

1. **Supra-orbital foramen** – exit site for supra-orbital nerve.
2. **Infra-orbital foramen** – exit site for infra-orbital nerve.
3. **Mental foramen** – exit site for mental nerve.
   (Note: 1, 2, 3 above are all on an imaginary vertical line).
4. **Marginal mandibular branch of facial nerve (VII)** – passes well below ramus of mandible before returning onto face to supply muscles of chin and lower lip - nerve damage possible whilst operating on submandibular gland.
5. **Facial nerve (VII)** - emerges from parotid gland onto face - nerve damage possible during parotid gland surgery. Complete unilateral paralysis of facial muscles suggests lower motor neurone lesion (Bell’s palsy) whilst paralysis of lower face only suggests upper motor neurone lesion (CVA).
6. **Mastoid process.** Muscle attachments – Sternocleidomastoid (SCM) on outer aspect and posterior belly of digastric on inner aspect.
7. **External jugular vein** - from angle of jaw to mid clavicle.
8. **Internal jugular vein** - from angle of jaw to sternoclavicular joint – used for measurement of jugular venous height as marker of right sided heart pressure and for insertion of central line or cardiac pacemaker. - patient is 15 degrees head down and head turned to 45 degrees to left. Needle is aimed caudally and ventrally toward the right nipple underneath the sternocleidomastoid at an angle that is 45º to the sagittal and horizontal planes and 15º forward in the frontal plane. Aspiration is performed until there is free return of venous blood (FIGURE 1).
9. **Superior vena cava** – forms at 1st right intercostal space parasternally.
10. **Spinal root of accessory nerve** - supplies SCM and trapezius – crosses posterior triangle of neck one third down posterior border of SCM to one third up anterior border of trapezius. Damage in the posterior triangle gives a loss of trapezius and inability to shrug or completely abduct the shoulder.

![Right Neck Veins Diagram](image1)
1. Pulses
   a. Limb pulses - (see upper and lower limb section).
   b. Carotid pulse - just medial to SCM in the mid-neck– vital for examining character of the pulse and timing of the cardiac cycle while auscultating.
   c. Apex beat – typically defined below in 2.d

2. Cardiac surface markings - there should be cardiac dullness on **percussion** within these limits. (FIGURE 2)
   a. Superior left border of heart - 2\(^{nd}\) left costal cartilage.
   b. Superior right border of heart - 3\(^{rd}\) right costal cartilage.
   c. Inferior right border of heart - 6\(^{th}\) costal cartilage parasternally.
   d. Inferior left border of heart - 5\(^{th}\) interspace in mid-clavicular line (corresponds to apex beat – is displaced laterally by cardiac enlargement).

3. Auscultation Sites (FIGURE 2)
   a. Pulmonary valve area (P) – 2\(^{nd}\) intercostal space parasternally on left side.
   b. Aortic valve area (A) – 2\(^{nd}\) intercostal space parasternally on right side.
   c. Mitral valve area (M) – (see 2.d above).
   d. Tricuspid valve area (T) – lower sternum or just to right of it. (note - 4\(^{th}\) intercostal space left sternal edge for listening to aortic murmurs).

4. Internal jugular vein - (See No 8 in head and neck section above).
RESPIRATORY SYSTEM (FIGURE 3)

5. **Pleural reflections** – Commence at apices of pleural cavities which are 3cm above the middle of the medial third of the clavicle. They extend above the anterior aspect of the first rib but not above its neck posteriorly. At **ribs 2** – angle of Louis - pleura meet in midline; **ribs 4** - pleura separate; **ribs 6** - left pleura swings to left to make room for the heart; **ribs 8** - pleura symmetrical in midclavicular line; **ribs 10** - pleura symmetrical in midaxillary line; **ribs 12** - pleura symmetrical just below neck of 12th rib. These reflections define the area of lungs to be **percussed** and **auscultated**.

6. **Oblique fissures (both lungs)** - spine of T3 posteriorly to rib 6 anteriorly, passing along the medial border of the abducted scapula.

7. **Horizontal fissure (right lung only)** – rib 4 parasternally to rib 5 in midaxillary line.

Knowledge of the fissures allow **percussion** and **auscultation** over individual lung lobes.

8. **Lungs within visceral pleura** – apices of lungs extend superiorly as described for pleural above. Trauma from knife wounds and insertion of central lines, etc. Note that lungs are two spaces short of the lower reaches of the pleural cavities from below the 6th rib in expiration, BUT note that the lungs fill the pleural cavity completely superiorly.
8. **Mechanics of chest expansion (FIGURE 4)**
   a. **Upper rib cage** expands in an anteroposterior plane.
   b. **Lower rib cage** expands in a side to side plane.
   (In combination, the rib cage expands typically by 3-5cm on full inspiration).

   ![RIB MOVEMENTS IN RESPIRATION](image)

   **Upper thorax (ribs 1–6)**
   There is pump handle movement on inspiration. Mostly anteroposterior expansion - minimal lateral expansion

   ![Gliding at costovertebral joints](image)

   **Lower thorax (ribs 7–10)**
   In quiet inspiration the costal margins separate producing lateral and slight upwards movement of the whole lower thorax.
   In forced inspiration there is an additional eversion of the last few ribs by the diaphragm pulling on them.
   This is likened to the lifting of a bucket handle (not illustrated)
THORACIC JOINTS AND VERTEBRAL LEVELS (FIGURE 5)

9. a. **Sternoclavicular** – atypical synovial - fibrocartilage on surface of the bones instead of hyaline.
   b. **Costochondral junctions** – primary cartilaginous joints.
   c. **Chondrosternal** joints – atypical synovial (see thorax 9a) – except first rib to manubrium which is a primary cartilaginous joint.
   d. **Angle of Louis (sternomanubrial junction)** – 2nd rib anteriorly, T4/5 vertebral disc posteriorly. Lying on plane are: under surface of arch of aorta, bifurcation of trachea, division of pulmonary trunk, ligamentum arteriosum, cardiac plexuses. Essential starting point for identification of ribs from rib 2 downwards. (FIGURE 5)

10. a. **Suprasternal notch** – T2/3 disc - useful for counting down spaces to define position of the apex beat and also to measure upwards for position of the jugular venous pressure.
   b. **9th costal cartilage** on costal margin has small notch (midclavicular line).
   c. **7th rib** is last rib to attach to the sternum.

QUESTIONS ON THORAX

1. Why are right sided murmurs loudest in inspiration and left sided murmurs louder in expiration?
2. What does positioning of the body do to the position of the heart (a) on sitting forward and (b) on lying on the left hand side?
ABDOMEN

AREA AND QUADRANTS (FIGURE 6)
1. Division of abdomen into 4 quadrants
   a. Left and right upper
   b. Left and right lower
2. Division of abdomen into 9 areas
   a. Epigastric, left and right hypochondrium
   b. Umbilical, left and right loin (or renal)
   c. Suprapubic, left and right iliac fossa

ABDOMINAL WALL (FIGURE 6)
3. Umbilicus – Variable position (approx. level with iliac crest) depending on degree of obesity – site of umbilical hernia and T10 dermatome.
4. Linea alba - Midline - midline laparotomy gives good exposure but may result in incisional hernia. Turns into linea negra in pregnancy.
5. Linea semilunaris - Lateral edge of the rectus sheath – possible site of Spigelian hernia.
6. Arcuate line – 5-6cm below umbilicus - no posterior rectus sheath below this point.
7. 3 tendinous intersections - Six-pack appearance in upper abdomen – anterior rectus sheath attaches to rectus abdominis muscle transversely in three areas on each side.

**FIGURE 6**

9CC = 9th costal cartilage
U = Umbilicus (at level of L3)
AL = Arcuate line
   (3-5cm below umbilicus)
LA = Linea alba (midline)
IL = Inguinal ligament
   (ant sup iliac spine to pubic tubercle)
LS = Linea semilunaris
   (lateral edge of rectus sheath)
MP = McBurney’s point
   (1/3 along a line from ASIS to umbilicus)
TPP = Transpyloric plane
   (1/2 way between suprasternal notch & symphysis pubis)
8. **McBurney’s point** – 1/3 along line from anterior superior iliac spine (ASIS) to umbilicus – site for incision for appendicectomy.

9. **Transpyloric plane** – (FIGURE 7).

10. **Aortic bifurcation** - L4 vertebral body – palpable in thin patients below umbilicus.

11. **Inferior vena cava** – forms at L5 vertebral body.

12. **Falciform ligament** - Remnant of ventral gastric mesentery joining anterior abdominal wall to liver and containing ligament teres (obliterated left umbilical vein). Distended veins are seen here in portal hypertension – caput medusae.

13. **Epigastric dermatomes** - T5-9 - Pain referral from foregut via greater splanchnic nerve.

14. **Peri-umbilical dermatomes** – T10, 11 - Pain referral from midgut via lesser splanchnic nerve.

15. **Suprapubic dermatomes** T12 - Pain referral from hindgut via least splanchnic nerve.

Note: Knowledge of dermatomes is needed for assessing spinal cord damage or compression.

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**TRANSPYLORIC PLANE**

*Horizontal line half way between suprasternal notch & pubic symphysis*

The following structures lie **approximately** on this line:

1. L1 vertebral body
2. Origin of superior mesenteric art.
3. End of spinal cord
4. Pylorus of the stomach
5. Neck of pancreas
6. Origin of portal vein
7. Second part of duodenum
8. Sphincter of Oddi
9. Hilum of each kidney
10. Duodenojejunal flexure
11. Fundus of gall bladder
12. Tips of ninth costal cartilages

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**FIGURE 7**
16. **Inguinal ligament** – Attached to pubic tubercle and anterior superior iliac spine.

17. **Mid-inguinal point** – Half way between ASIS and pubis - landmark for **femoral artery** in groin. (see lower limb pulses and cardiovascular examination).

18. **Midpoint of inguinal ligament** – Half way between ASIS and pubic tubercle - landmark for deep inguinal ring and **indirect inguinal hernia**. Medial to this for **direct inguinal hernia**.

19. **Inguinal canal**
   a. **Anterior wall** - two muscles contributing - external oblique all the way and internal oblique laterally only.
   b. **Posterior wall** - two muscles contributing - internal oblique and transversus as conjoint tendon.
   c. **Roof** – curved fibres of internal oblique and transversus.
   d. **Floor** – inguinal ligament.
20. **Two nerves IN the spermatic cord** - sympathetics and genital branch of the genitofemoral.

21. **One nerve ON the spermatic cord** – ilioinguinal.

22. **Femoral canal** – a space medial to femoral vein, lateral to lacunar ligament, posterior to inguinal ligament and anterior to pectineal line of pubis. Contained within femoral sheath and transmitting lymphatics from lower limb to iliac region of abdomen. Site of femoral hernia, identified clinically as below and lateral to inguinal ligament and pubic tubercle.

**INGUINAL CANAL**

A 4cm tunnel in the lower, anterior abdominal muscles that runs downwards and medially between the deep and superficial inguinal rings

**FIGURE 9**

Deep inguinal ring is a hole in the transversalis fascia lying 3cm superior to the mid point of the inguinal ligament

Superficial inguinal ring is a V-shaped defect in the lower, medial fibres of the external oblique, just superior and lateral to the pubic tubercle

**SITES FOR PALPATION OF ORGANS (FIGURE 10)**

23. **Liver** – must be percussed both superiorly and inferiorly as it may be either enlarged or merely pushed down by hyper-inflated lungs.

24. **Kidneys** – Move a little with respiration – ballotable – often palpable even if normal in children and thin people.

25. **Spleen** – Not normally palpable but when enlarged to twice its normal size, is felt beneath the left costal margin and enlarges towards the right iliac fossa.

26. **Bladder** – When full in children it may be palpable suprapubically but not normally so in adults.
COMMON ABDOMINAL SURGICAL INCISIONS
(All less common in era of laparoscopic surgery) (FIGURE 11 )

27. **Midline** – good for general exploration of abdomen and extensive surgery such as aortic aneurysm.

28. **Paramedian** – Similar to midline but heals better. Slightly less access.

29. **Subcostal** – Good for biliary surgery. More vascular and less nerve sparing.

30. **Suprapubic (Pfannensteil)** – Excellent access to pelvis although not necessarily better than midline. Heals well and good cosmetic result.

31. **Loin (posterior subcostal)** – ideal for renal and adrenal surgery. Chest can be opened to give greater access.
QUESTIONS ON ABDOMEN

1. How would you determine the location of the appendix?
2. Why is one kidney higher than the other? Where does one put ones hands to try to ballot it?
3. Why is it not possible to “get above “ the spleen? How is it distinguishable from a kidney?

LOWER LIMB

1. PULSES (FIGURE 13)
   a. Femoral – at mid inguinal point (see abdomen 17).
   b. Popliteal – deep in popliteal fossa with knee flexed by 30 degrees.
   c. Posterior tibial – 3cm postero-inferior to medial malleolus.
   d. Dorsalis pedis – between extensor hallucis longus and extensor digitorum on dorsum of foot.
   (All important in reference to peripheral vascular disease).

2. VEINS (FIGURE 13)
   a. Great saphenous vein – lies on anterior part of medial malleolus then passes a hands-breath medial to the patella on its way to saphenofemoral junction (see 2c below). Vein often harvested for coronary artery bypass.
   b. Short saphenous vein – lies posterior to lateral malleolus then passes up posterior lower leg to enter popliteal vein in the popliteal fossa.
c. **Saphenofemoral junction** – located 4cm inferior and lateral to pubic tubercle – site of great saphenous vein passing through fascia lata (saphenous opening) to reach the femoral vein. Also superficial inguinal lymphatics passing deeply to join deep inguinal lymphatics which then enter into abdomen via femoral canal.

3. **BONY AND OTHER LANDMARKS**
   a. **Lateral thigh** – site of iliotibial tract (thickened fascia lata), pulled upon by gluteus maximus and tensor fasciae latae to hold knee locked. Dermatome is L2 and 3 (lateral cutaneous nerve of thigh). Condition that is caused by irritation of this nerve is meralgia paraesthetica.
   b. **Adductor tubercle** – on lower medial femur just above knee. Muscle attachment for adductor magnus. Hiatus in this muscle is for passage of femoral to popliteal vessels.
c. **Patella** – liable to dislocate laterally because of Q angle but 3 factors helping to prevent this are fibres of medial vastus inserting into the patella, thicker medial retinacular fibres in the knee capsule and a more prominent lateral condyle of the femur.

d. **Femoral triangle** – medial border is MEDIAL border of adductor longus, lateral border is medial border of sartorius and superior border is inguinal ligament. *(FIGURE 14)*

![FEMORAL TRIANGLE](image)

**BOUNDARIES**
- **Superior:**
  - Inguinal ligament
- **Lateral:**
  - Medial border of sartorius
- **Medial:**
  - Medial border of adductor longus

**Roof:**
- Fascia lata

**Floor:**
- Muscles as shown with adductor brevis just showing. It has the anterior division of the obturator nerve on its surface

**Contains:**
- Femoral nerve
- Femoral artery
- Femoral vein
- Deep inguinal nodes

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![POSTERIOR ABDOMEN AND BACK](image)

**Buttock injection**
Intramuscular injections are given in the upper, outer (lateral) quadrant of the buttock to avoid the sciatic nerve which lies in the lower inner (medial) quadrant and passes inferiorly half way between the ischial tuberosity and the greater trochanter of the femur

**Supracristal plane**
A transverse line along the upper aspects of the iliac crests passing through the spinous process of the L4 vertebra. A useful aid in lumbar puncture for either the L3-4 or L4-5 spaces

*(FIGURE 15)*
e. **Popliteal fossa** – diamond shaped area behind the knee bordered below by two heads of gastrocnemius and above by biceps femoris laterally and semitendinosus medially.

f. **Saphenous nerve** – Root value L4, lying with the great saphenous vein on the anterior aspect of the medial malleolus – liable to damage when performing a “cut-down” cannulation.

g. **Gluteal Region** – Injections into upper outer quadrant to avoid sciatic nerve (FIGURE 15).

**QUESTIONS ON LOWER LIMB**
1. Which two nerves enter the subsartorial canal?
2. Does the saphenous nerve pass through the adductor hiatus?
3. Is the dorsalis pedis pulse palpable between tibialis anterior and extensor hallucis longus or between the extensor hallucis longus and extensor digitorum?

**UPPER LIMB**

1. **PULSES**
   a. **Brachial** – just medial to tendon of biceps in cubital fossa - used during blood pressure measurement.
   b. **Radial at wrist** – lateral to tendon of flexor carpi radialis. Ideal for measurement of heart rate and rhythm.

2. **VEINS (FIGURE 16)**
   a. **Cephalic** – on lateral border of wrist and in deltopectoral groove.
   b. **Basilic** – on medial forearm and piercing fascia on medial arm to join deep veins and become axillary vein.

![Diagram of veins and pulses in the upper limb]
3. **AUTONOMOUS AREAS (with no overlap) FOR PERIPHERAL NERVES (FIGURE 17)**
   a. Radial nerve – first dorsal web space.
   b. Ulnar nerve – pulp of little finger.
   c. Median nerve – pulp of index finger.
   d. Axillary nerve – upper lateral arm - referred to as “regimental patch”.

4. **BONY AND OTHER LANDMARKS**
   b. Coracoid process – just medial to head of humerus - attachment of pectoralis minor, coracobrachialis and short head of biceps.
   c. Acromion – tip of shoulder - attachment of deltoid.
   d. Clavicle – palpable throughout its length - supraclavicular nerves (C4) palpable over it. They supply shoulder tip – relevant to referred pain in gall bladder disease.
   e. Anatomical snuff box - most dorsal tendon - extensor pollicis longus, more ventral tendons – extensor pollicis brevis and abductor pollicis longus.
   (FIGURE 18)
   f. Lateral forearm - dermatome (C6), nerve is cutaneous branch of musculocutaneous nerve.
   g. Cubital fossa – anterior to elbow – bordered by pronator teres medially, medial border of brachioradialis laterally, and an imaginary line joining the epicondyles superiorly. Veins here usually used for venepuncture (blood tests).
h. **Flexor retinaculum**, carpal tunnel. (FIGURE 19)

i. **Medial epicondyle** of humerus “funny bone” – tingling down ulnar nerve.

**QUESTIONS**

1. Are the symptoms of a carpal tunnel syndrome worse by day or by night?
2. Is the median nerve medial or lateral to the brachial artery in the cubital fossa?