ESSENTIAL
SURFACE & RELATED ANATOMY
FOR CLINICAL PRACTICE

Compiled by

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(See also pages 205–242 in Instant Anatomy.
Blackwell Publishing. 4th Edition by Whitaker & Borley)

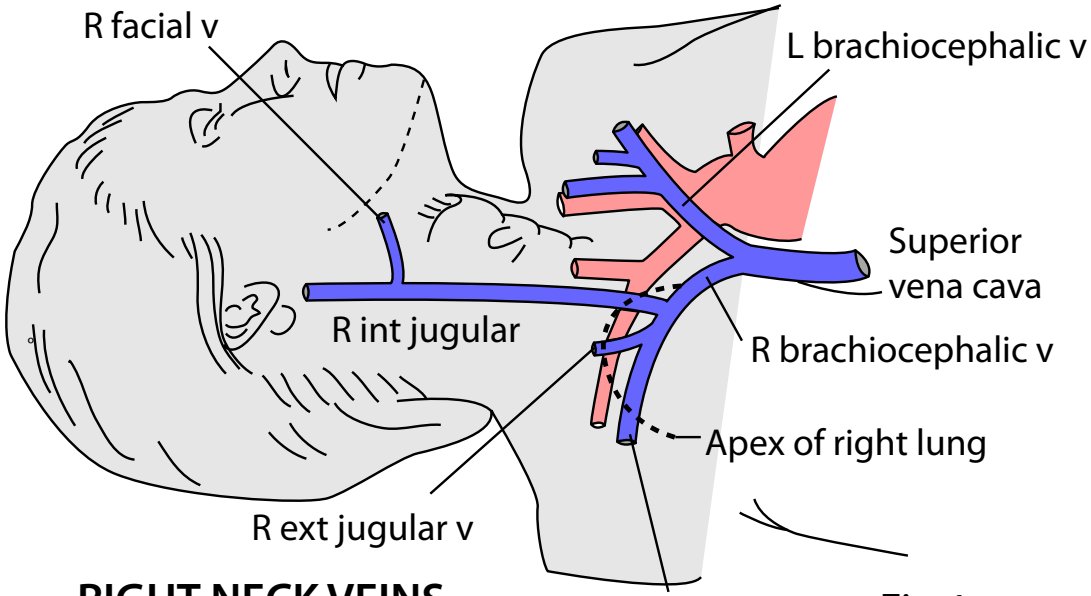
INSTRUCTIONS

- 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.

Last revised 22.07.2104

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 & 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 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 & 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 (marker of right sided heart pressure) & for insertion of central line or cardiac pacemaker (patient is 15° head down & head turned to 45 degrees to left). Underneath the sternocleidomastoid the needle is aimed caudally & ventrally toward the right nipple at an angle that is 45° to the sagittal & horizontal planes & 15° 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 & 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 & inability to shrug or completely abduct the shoulder.



RIGHT NECK VEINS Fig 1

THORAX

CARDIOVASCULAR SYSTEM

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 & 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 - 2nd left costal cartilage.
   b. Superior right border of heart - 3rd right costal cartilage.
   c. Inferior right border of heart - 6th costal cartilage parasternally.
   d. Inferior left border of heart - 5th 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) – 2nd intercostal space parasternally on left side.
   b. Aortic valve area (A) – 2nd 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 - 4th intercostal space left sternal edge for listening to aortic murmurs).
4. **Internal jugular vein** - (See No 8 in head & neck section above).

HEART

BORDERS:

2cc - 3cc - 6cc - 5 1/2

VALVES:

P - A - M - T

AUSCULTATION:

P - 2L (parasternal space)
A - 2R (parasternal space)
M - 5L (mid clavicular line)
T - Lower left sternal border

As the valves open and close they produce sounds that appear to be transmitted in the direction of the flow of blood. Thus, by picturing the heart and the positions of the four valves it is easy to work out the likely points for maximal audiability of the sounds.

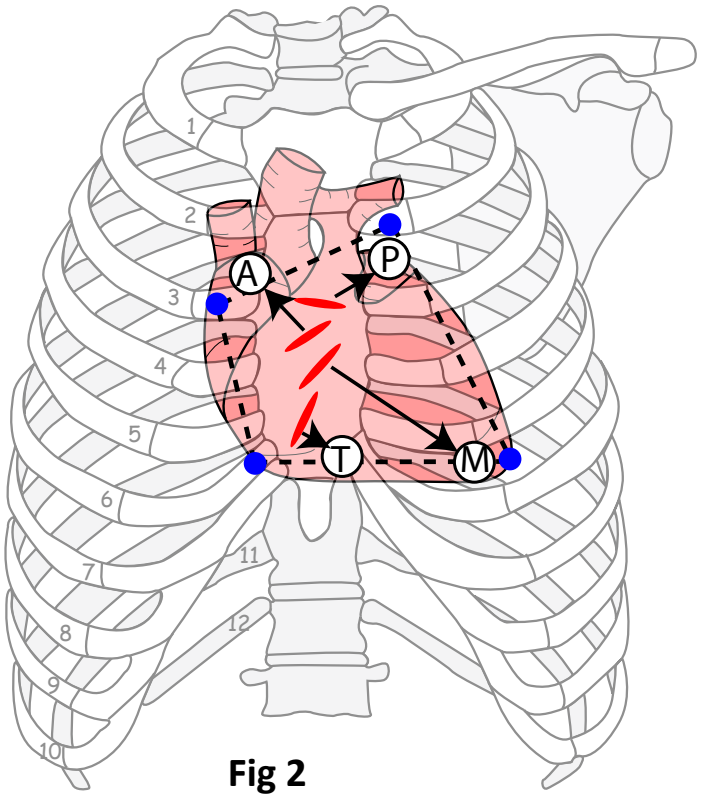


Fig 2

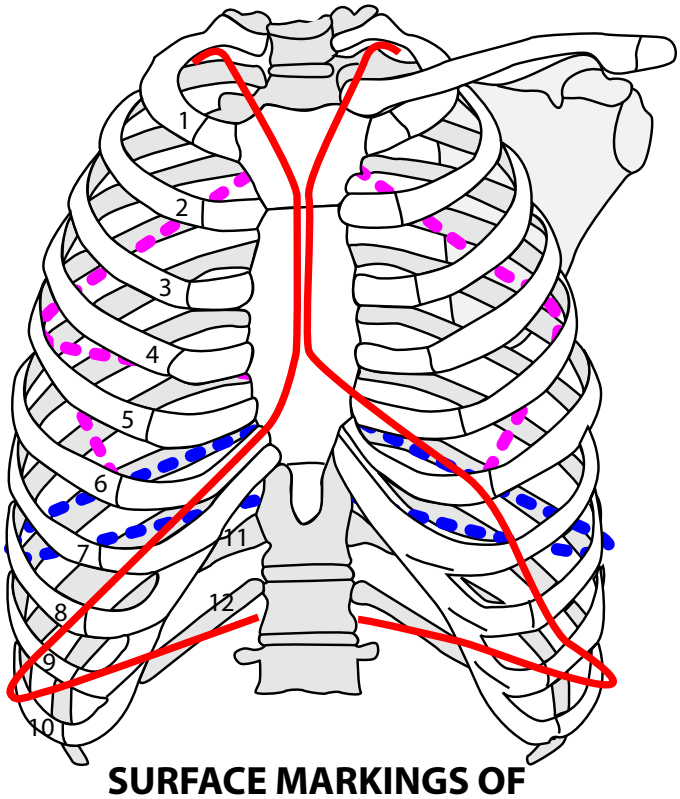
RESPIRATORY SYSTEM (FIGURE 3)

5 **Pleural reflections** – Commence at apices of pleural cavities which are 3cm above middle of medial third of clavicle. They extend above anterior aspect of 1st 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 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 medial border of abducted scapula.

7. **Horizontal fissure (right lung only)** – rib 4 parasternally to rib 5 in mid-axillary line. Knowledge of fissures allow percussion & auscultation over individual lung lobes.

8. **Lungs within visceral pleura** – apices of lungs extend superiorly as described for pleural above. Trauma from knife wounds & insertion of central lines, etc. Note that lungs are two spaces short of lower reaches of pleural cavities from below 6th rib in expiration, BUT note that lungs fill pleural cavity completely superiorly.



SURFACE MARKINGS OF PLEURA AND LUNGS

Fig 3

Pleura 2-4-6-8-10-12
Continuous Red line, starting 1" (2.5cm) above mid point of medial 1/3 of clavicle. Meet in midline at rib 2, left side then diverges at rib 4 to make room for the heart, whilst right continues parasternally to rib 6. Both cross rib 8 in the mid-clavicular line, then rib 10 in the mid-axillary line. Both reach posterior chest just below rib 12.

Lungs 2 less than pleura
Blue dotted lines indicate lower extension of lungs in expiration. Below ribs 6, the lungs extend to 2 rib spaces less than the pleura.

Fissures 3-6-4-5
(purple dotted lines)
Oblique: spine of T3 vertebra to rib 6 anteriorly along medial border scapula
Horizontal (on R only): rib/costal cartilage 4 to rib 5 in mid-axillary line.

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).

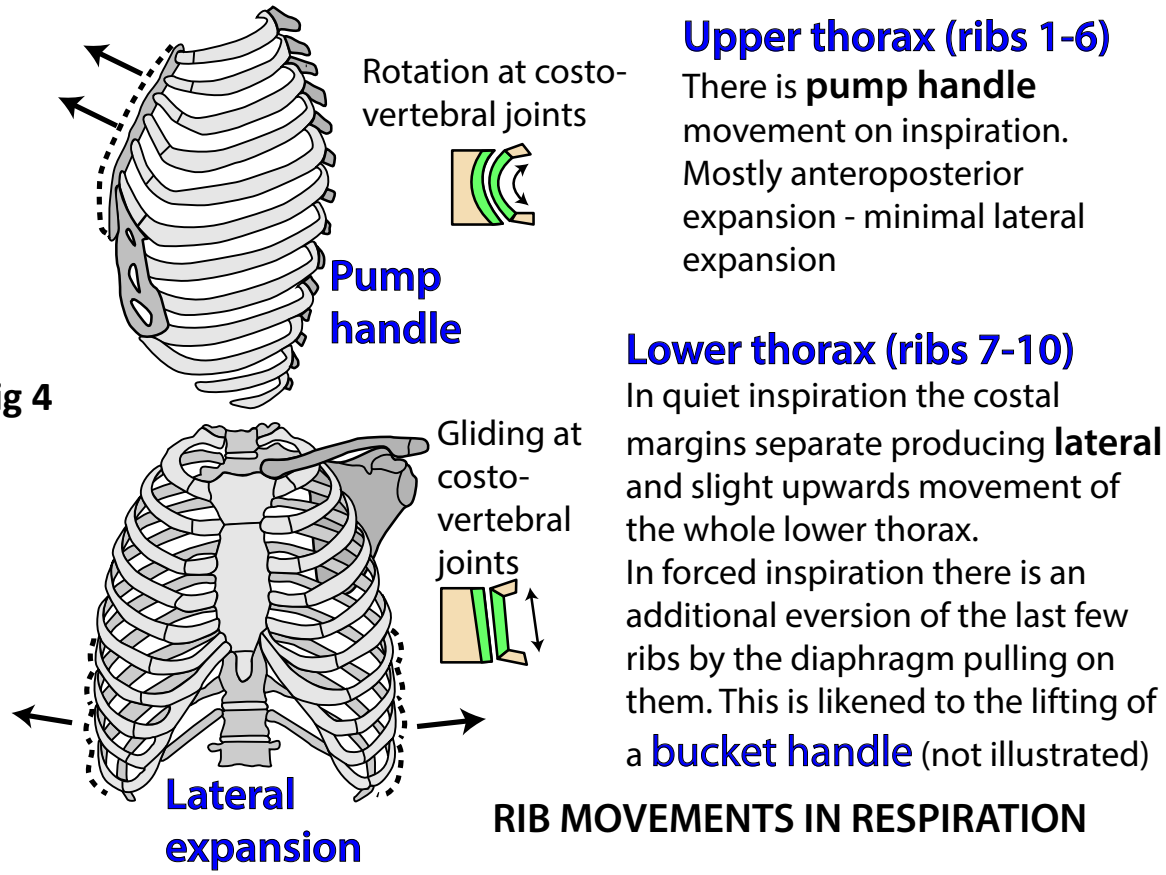
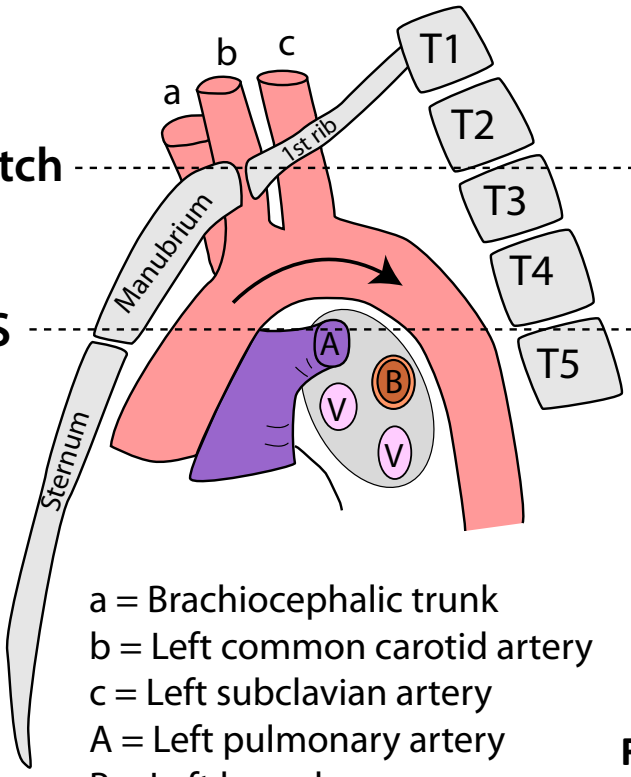


Fig 4

THORACIC JOINTS & VERTEBRAL LEVELS (FIGURE 5)

9. a. Sternoclavicular – atypical synovial - fibrocartilage on surface of 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 & also to measure upwards for position of jugular venous pressure.
    b. 9th costal cartilage on costal margin has small notch (midclavicular line).
    c. 7th rib is last rib to attach to sternum.

KEY LEVELS IN UPPER THORAX



Suprasternal notch ---------- **T2/3**

ANGLE OF LOUIS
(manubriosternal junction) ---------- **T4/5**

The direction of the arch is mostly posterior but also to the left

Vertebral bodies of T3 and T4 lie behind the manubrium

a = Brachiocephalic trunk
b = Left common carotid artery
c = Left subclavian artery
A = Left pulmonary artery
B = Left bronchus
V = Left pulmonary veins

Fig 5

ABDOMEN

AREA & 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 & right hypochondrium
   b. Umbilical, left & right loin (or renal)
   c. Suprapubic, left 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 & T10 dermatome.
4. **Linea alba** - Midline - midline laparotomy gives good exposure but may result in incisional hernia. Turns into linea nigra in pregnancy.
5. **Linea semilunaris** - Lateral edge of 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 3 areas on each side.

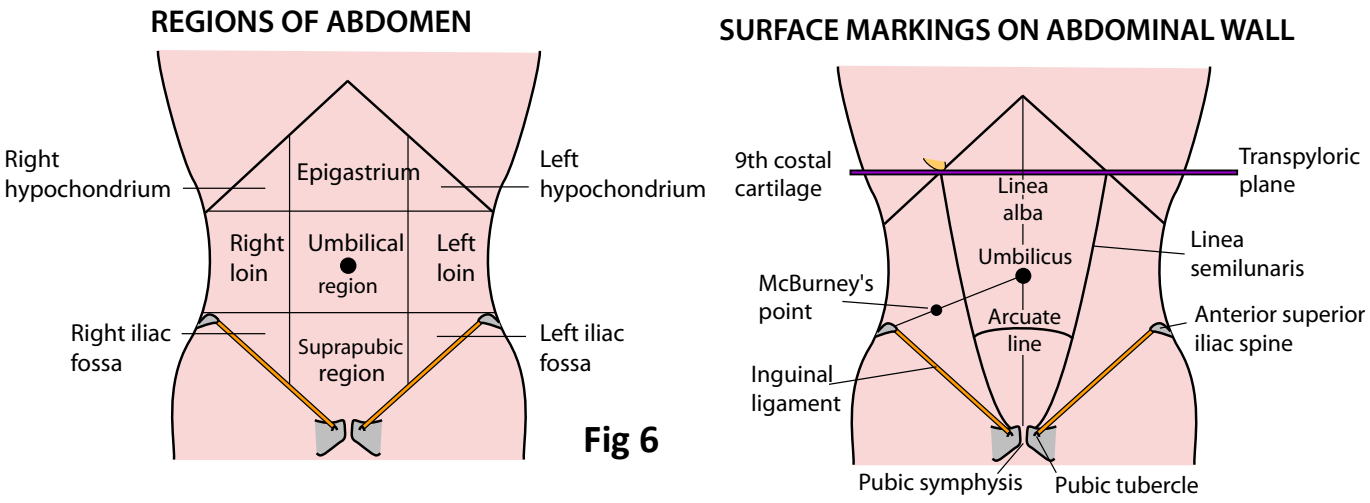


Fig 6

Transpyloric plane: half way between suprasternal notch & symphysis pubis
Inguinal ligament: anterior superior iliac spine to pubic tubercle
Arcuate line: 3-5cm inferior to umbilicus
Linea semilunaris: lateral edge of rectus sheath
McBurney's point: one third along a line from ASIS to umbilicus

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 & 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 ns.
14. **Peri-umbilical dermatomes** – T10, 11 - Pain referral from midgut via lesser splanchnic nerves.
15. **Suprapubic dermatomes T12** - Pain referral from hindgut via least splanchnic ns. Note: Knowledge of dermatomes is needed for assessing spinal cord damage or compression.

TRANSPYLORIC PLANE

(Horizontal line half way between suprasternal notch & pubic symphysis)

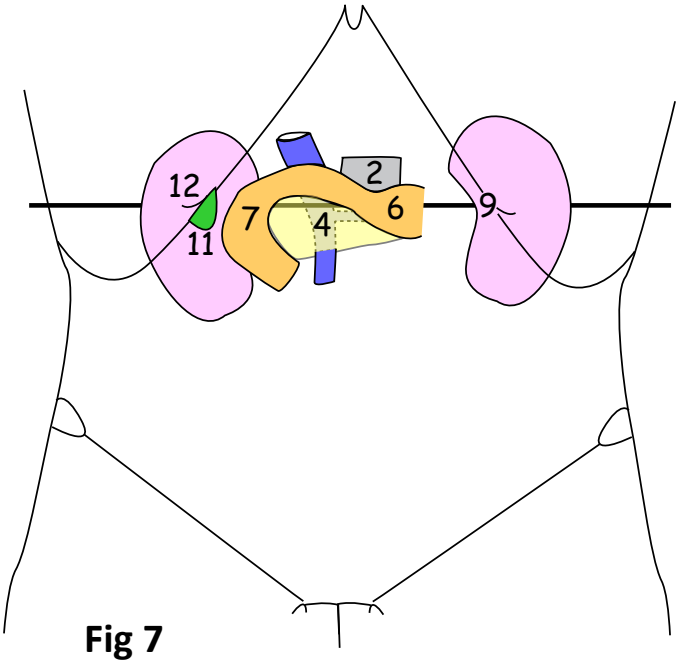


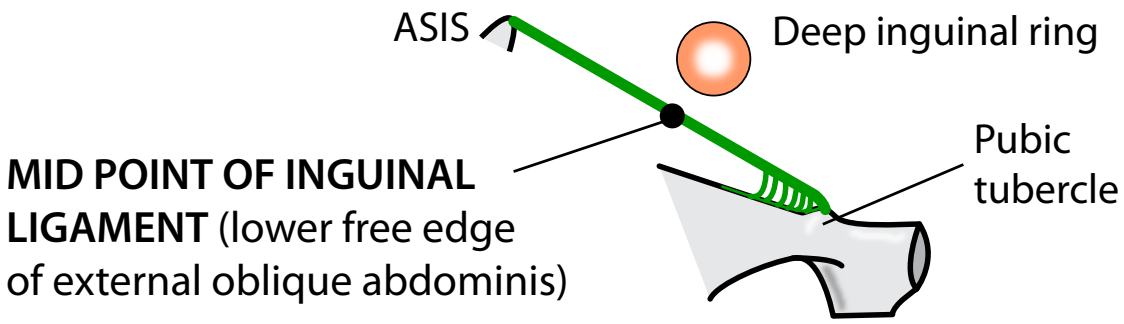
Fig 7

Structures approximately on this line:

1 End of spinal cord
2 L1 vertebral body
3 Origin of superior mesenteric art
4 Origin of portal vein
5 Neck of pancreas
6 Pylorus of the stomach
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

INGUINAL REGION (FIGURES 8 & 9)

16. **Inguinal ligament** – Attached to pubic tubercle & anterior superior iliac spine.
17. **Mid-inguinal point** – half way between ASIS & pubis - landmark for femoral artery in groin. (see lower limb pulses & 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** - external oblique all the way & internal oblique laterally only.
    b. **Posterior wall - two muscles** - internal oblique & transversus as conjoint tendon.
    c. **Roof** – curved fibres of internal oblique & transversus.
    d. **Floor** – inguinal ligament.



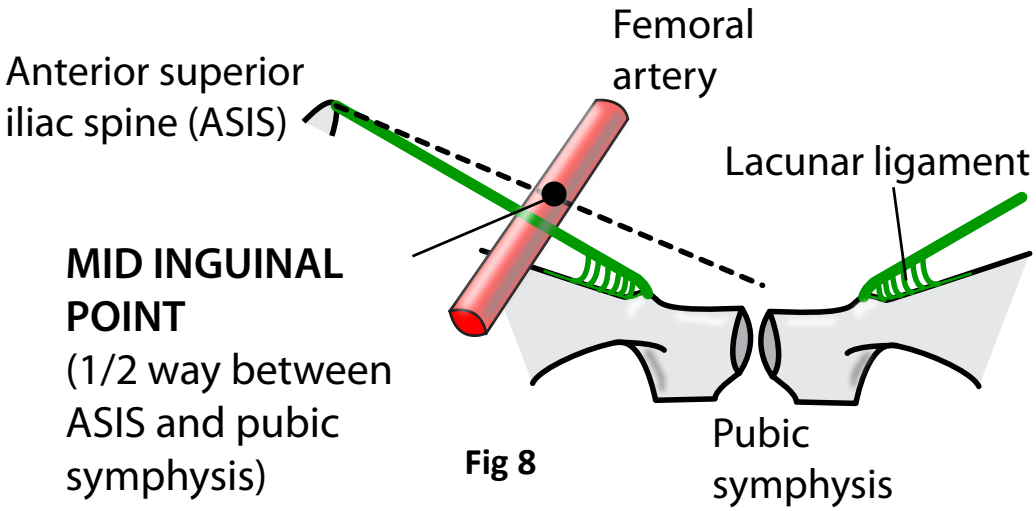
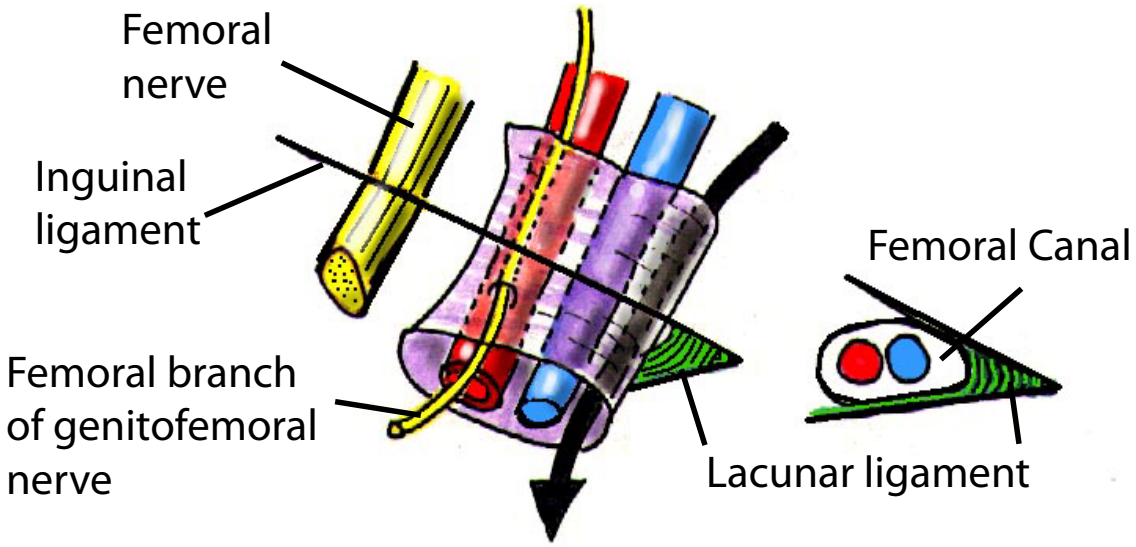


Fig 8

20. **Two nerves IN spermatic cord** - sympathetics & genital branch of the genitofemoral.
21. **One nerve ON spermatic cord** – ilioinguinal.
22. **Femoral canal** – a space medial to femoral vein, lateral to lacunar ligament, posterior to inguinal ligament & anterior to pectineal line of pubis. Contained within femoral sheath & transmitting lymphatics from lower limb to iliac region of abdomen. Site of femoral hernia, identified clinically as below & lateral to inguinal ligament & pubic tubercle.

FEMORAL SHEATH & CANAL



INGUINAL CANAL

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

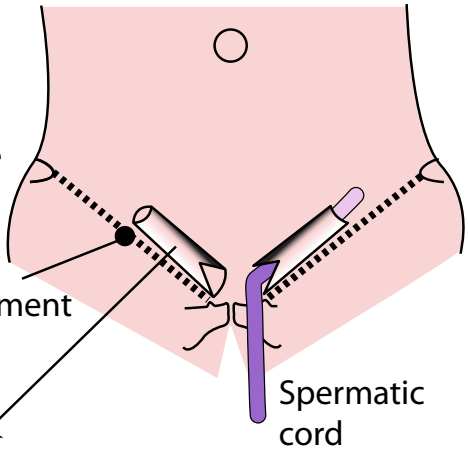
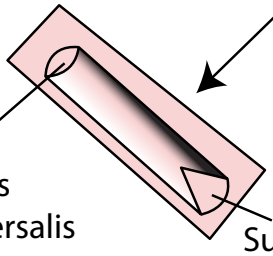


Fig 9



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

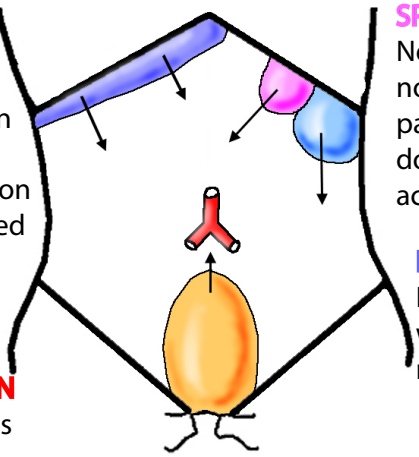
SITES FOR PALPATION OF ORGANS (FIGURE 10)

23. **Liver** – must be percussed both superiorly & 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 & thin people.
25. **Spleen** – Not normally palpable but when enlarged to twice its normal size, is felt beneath left costal margin & enlarges towards right iliac fossa.
26. **Bladder** – When full in children it may be palpable suprapubically but not normally so in adults.

PALPABLE ORGANS AND AORTIC BIFURCATION

LIVER
Often just palpable in infancy. In adults it is palpable on inspiration if moderately enlarged

SPLEEN
Needs to be twice normal size to be palpable. Advances down abdomen and across to right



KIDNEY
Bimanually palpable when low lying or moderately enlarged

Fig 10

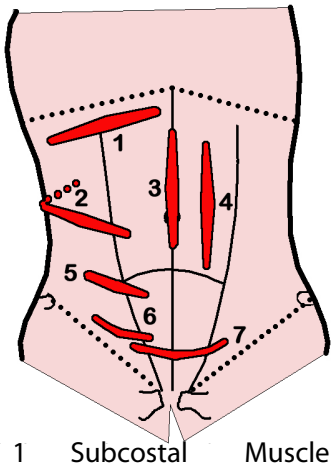
AORTIC BIFURCATION
Lies at L4. Pulsation is palpable in thin patients. Bruits are listened to at the umbilicus

BLADDER
Lies in abdomen in small children and is fairly easily palpable when full. In adults it sinks into pelvis and is only palpable when very full or chronically distended

COMMON ABDOMINAL SURGICAL INCISIONS

(All less common in era of laparoscopic surgery) (FIGURE 11)

27. **Midline** – good for general exploration of abdomen & 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 & less nerve sparing.
30. **Suprapubic** (Pfannensteil) – Excellent access to pelvis although not necessarily better than midline. Heals well & good cosmetic result.
31. **Loin** (posterior subcostal) – ideal for renal & adrenal surgery. Chest can be opened to give greater access.



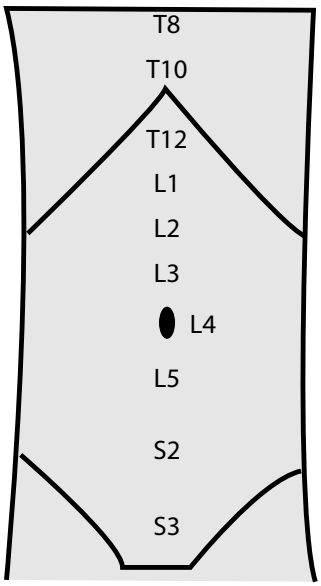
ABDOMINAL INCISIONS

Surgical Access
The more anterior the incision the poorer the blood supply and the worse the healing, but the less nerve and muscle damage. Vice versa for more posterior incisions

Fig 11

1	Subcostal	Muscle cutting	Gall bladder
2	Loin	Muscle cutting	Kidney/ureter
3	Midline	Between rectus sheaths	Upper/lower abdomen
4	Paramedian	Rectus sheath cutting	General
5	Grid iron	Muscle splitting	Appendix
6	Inguinal	Rectus sheath splitting	Hernia
7	Suprapubic	Sheath/muscle cutting	Pelvic organs

ABDOMINAL VERTEBRAL LEVELS (FIGURE 12)



VERTEBRAL LEVELS

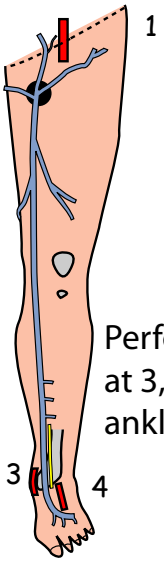
T8 **Caval** opening (diaphragm) & right phrenic n
T10 Oesophageal opening (diaphragm) + brs of left gastric vessels to lower oesophagus; vagus ns)
T12 Aortic opening (diaphragm) + aorta, **azygos veins, thoracic duct** & coeliac axis/trunk
L1 Transpyloric plane, sup mesenteric art
L1/2 Spinal cord ends, renal arts
L2 Subcostal plane, gonadal arts
L3 Inf mesenteric art
L3/4 Umbilicus
L4 Bifurcation of aorta, supracristal plane
L5 Formation of **vena cava**
S2 Sacral dimple, mid point of sacroiliac jnt, end of dural sac, lower attachment of small bowel mesentery
S3 Start of rectum

Fig 12

LOWER LIMB

1. **PULSES (FIGURE 13)**
   a. **Femoral** – at mid inguinal point (see fig 8).
   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 & 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 with saphenous nerve lying alongside, then passes a hands-breath medial to patella on its way to saphenofemoral junction. Vein often harvested for coronary artery bypass.
   b. **Short saphenous vein** – commences at lateral side of dorsal venous arch & passes just behind lateral malleolus. Then up posterior calf, with sural nerve, to perforate popliteal fascia & then join popliteal vein at a variable site.
   c. **Saphenofemoral junction** – located 4cm inferior & lateral to pubic tubercle – site of great saphenous vein passing through cribriform fascia (saphenous opening) to reach femoral vein. Also superficial inguinal lymphatics passing deeply to join deep inguinal lymphatics which then enter into abdomen via femoral canal.

VEINS AND PULSES IN THE LOWER LIMB

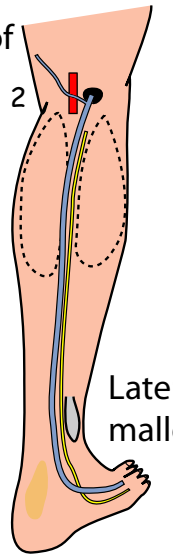


Anterior view of left lower limb to show:
GREAT (LONG) SAPHENOUS VEIN

Perforating veins at 3,6,9cm above ankle

Fig 13

Posterolateral view of right lower limb to show:
SMALL (SHORT) SAPHENOUS VEIN



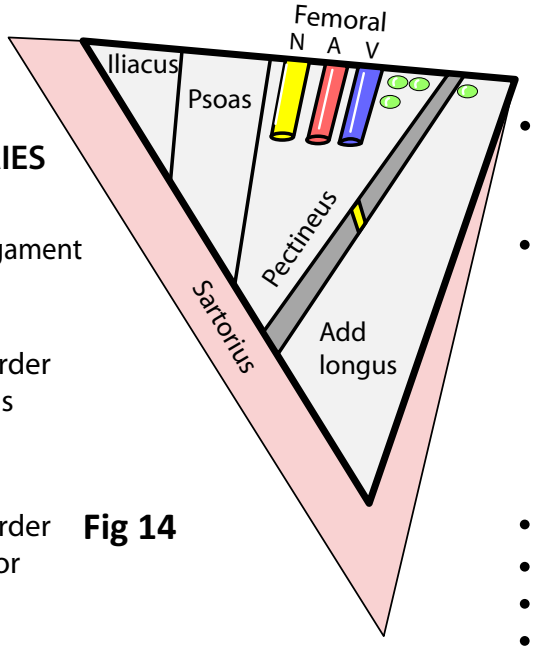
Lateral malleolus

Pulses
1. Femoral in groin
2. Popliteal in popliteal fossa
3. Posterior tibial behind medial malleolus
4. Dorsalis pedis on dorsum of foot between extensor hallucis longus & extensor digitorum

3. **BONY AND OTHER LANDMARKS**
   a. **Lateral thigh** – site of iliotibial tract (thickened fascia lata), pulled upon by gluteus maximus & 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 knee capsule & a more anteriorly prominent lateral condyle of femur.
d. **Femoral triangle** – medial border is MEDIAL border of adductor longus, lateral border is medial border of sartorius & superior border is inguinal ligament. (FIGURE 14)

FEMORAL TRIANGLE



BOUNDARIES

Superior:
- Inguinal ligament

Lateral:
- Medial border of sartorius

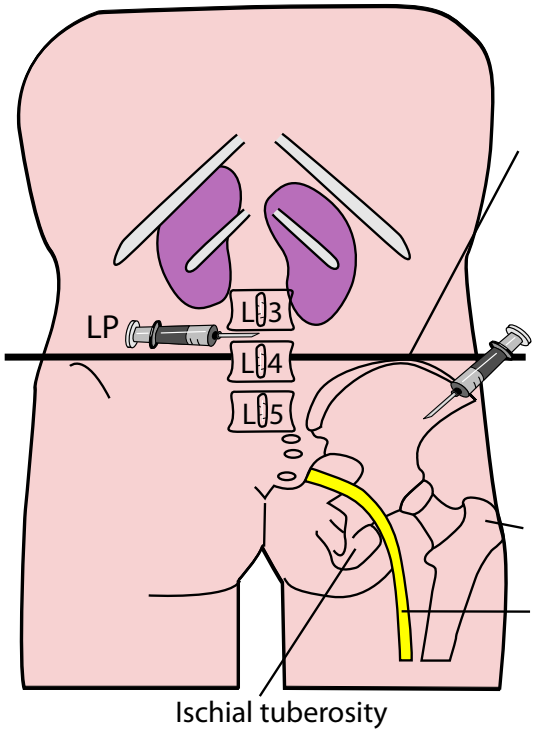
Medial:
- Medial border of adductor longus

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

Fig 14



Supracristal plane
A transverse line along the upper aspects of the iliac crests passing through the spinous process of the L4 vertebra.

Buttock injection
Intramuscular injections are given in the upper, outer (lateral) quadrant

Greater trochanter

Sciatic nerve

Fig 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).

UPPER LIMB

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

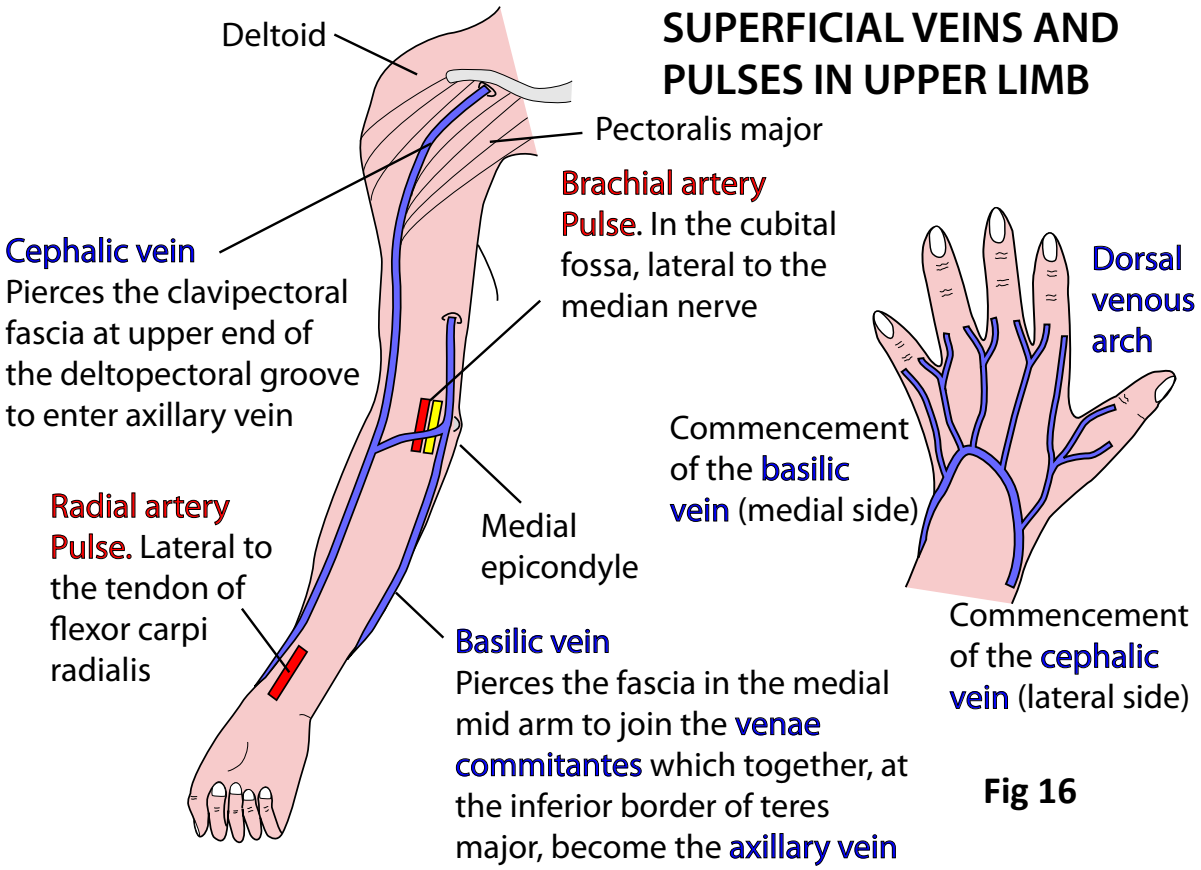
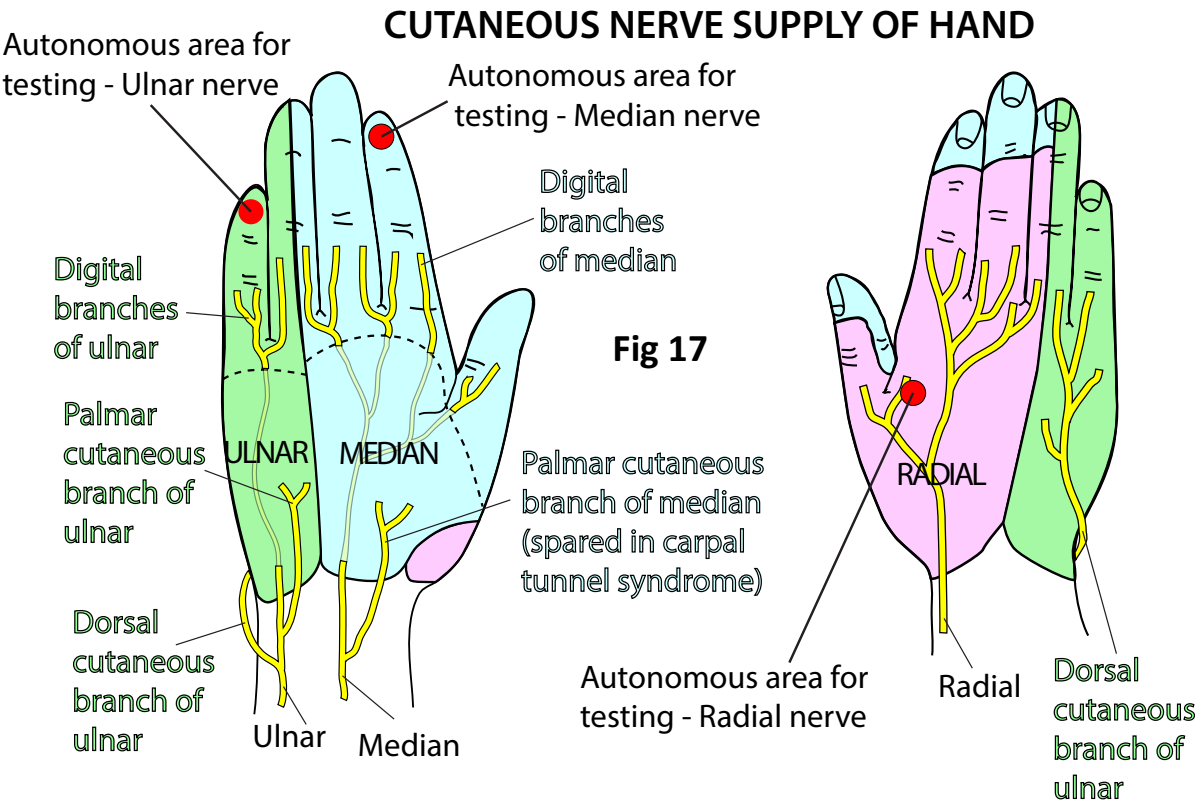


Fig 16

3. **AUTONOMOUS AREAS (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
   a. **Head of radius** – palpated 3 fingers' widths down from lateral epicondyle. Common site of fracture.
   b. **Coracoid process** – just medial to head of humerus - attachment of pectoralis minor, coracobrachialis & 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.
   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. **Medial epicondyle** of humerus "funny bone"– tingling down ulnar nerve.
e. **Anatomical snuff box** - most dorsal tendon - extensor pollicis longus, more ventral tendons – extensor pollicis brevis and abductor pollicis longus. (FIGURE 18)
f. **Flexor retinaculum**. carpal tunnel. (FIGURE 19)

ANATOMICAL SNUFF BOX

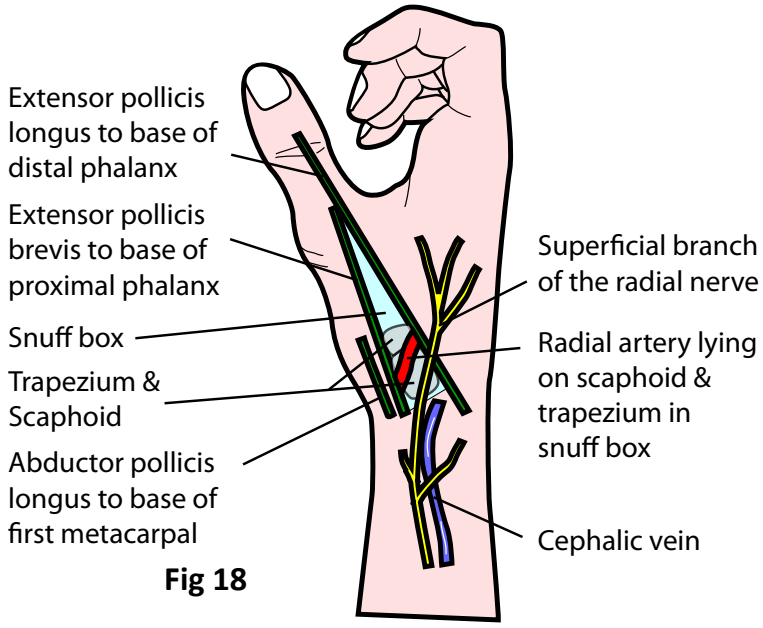


Fig 18

FLEXOR RETINACULUM & CARPAL TUNNEL

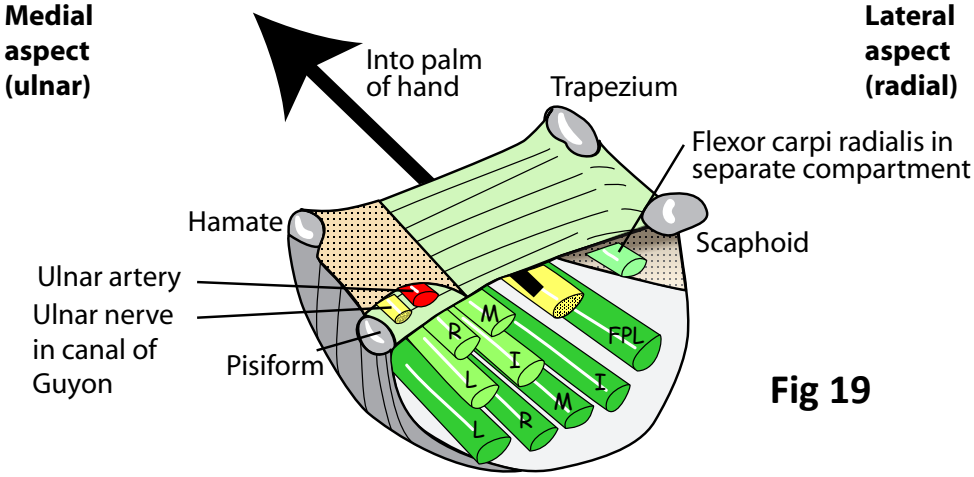


Fig 19

Beneath (deep to) the flexor retinaculum
1. Median nerve
2. 4 tendons of flexor digitorum profundus
3. 4 tendons of flexor digitorum superficialis
4. Tendon of flexor pollicis longus
5. Flexor carpi radialis (in its own compartment)

Superficial to the flexor retinaculum
1. Ulnar nerve and ulnar artery (in their own tunnel **(Canal of Guyon)**
2. Palmar cutaneous branchof median nerve