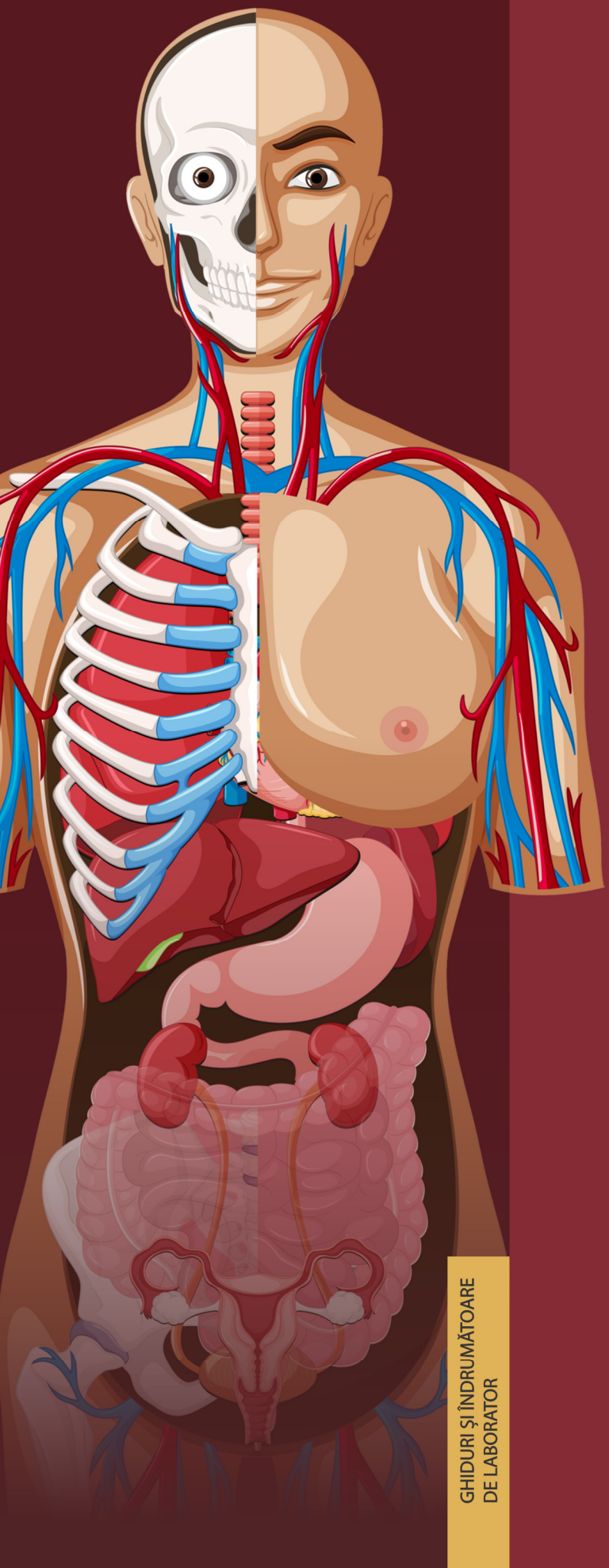

GHIDURI ȘI ÎNDRUMĂTOARE DE LABORATOR

80 ani

UNIVERSITATEA DE MEDICINĂ ȘI FARMACIE „VICTOR BABEȘ” DIN TIMIȘOARA

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HUMAN ANATOMY

STUDY GUIDE WITH CLINICAL CORRELATIONS

Editura „Victor Babeș”
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Contents:

CHAPTER I. HEAD AND NECK

LAURA ANDREEA GHENCIU

I.1. Introduction

Welcome to Human Gross Anatomy!

Skills to develop

1. Knowledge of terminologia anatomica
2. The acquisition by students of an appropriate medical language.
3. The acquisition by the student of theoretical and practical notions of individual anatomical components and composite structures.
4. Learning correct exploratory maneuvers and dissection techniques of normal anatomical structures.
5. Recognition of descriptive and topographic anatomy (by regions)
6. Linking knowledge of descriptive anatomy with morphological exploration of the concepts of radio-anatomy.
7. Linking elements of topographical anatomy with some notions of medical semiology
8. Effective use of information sources and communication resources and assisted training
9. Recognition of a normal anatomical element and evaluation of its participation in the achievement of pathological conditions, anatomic support of any non-invasive exploratory act (CT, MRI) or invasive (surgical instrument).

Learning objectives:

1. Knowing the elements of descriptive and topographic anatomy
2. Knowledge of regions, cavities /fosae in the topographic anatomy
3. Morphological exploration of prepared body pieces (cadavers) of the anatomical sections.

4. Acquiring international anatomical terminology (*Nomina Anatomica)*
5. Knowledge and understanding of anatomical features.
6. Recognition of all anatomical elements.
7. Knowing the relationship between the different anatomical structures.
8. Study of topographical regions and sectional anatomy

The discipline of anatomy is usually studied in a dual approach:

- Regional approach - description of structures regionally and their relationships to each other (back, thorax, abdomen, pelvis, perineum, neck, head, upper limb, lower limb)
- Systemic approach - description of the major systems of the body – musculoskeletal, nervous cardiovascular, lymphatic, digestive, respiratory, endocrine, urinary and reproductive

Start the dissection by palpating and identify the superficial landmarks of the head and neck region:

►frontal bone
►supra- and infraorbital margins
►zygomatic bone
►external ear with its features: helix, antehelix, tragus, antitragus
►mandible: angle, inferior border, mental protuberance
►philtrum
►commissure of lips
►clavicle
►sternocleidomastoid muscle
► trapezius muscle
►the scalp
►external occipital protuberance

Vertical and sagittal dissection lines through the skin will start at the e external occipital protuberance and further through the area of the sagittal suture, glabella, dorsum of the nose, philtrum, mental region, mandibular symphysis and then the anterior middle line of the neck. Additional dissection lines will be made to separate the areas of dissection as seen in the figure I.1A below. Be careful when dissecting the superficial pedicles of the scalp.

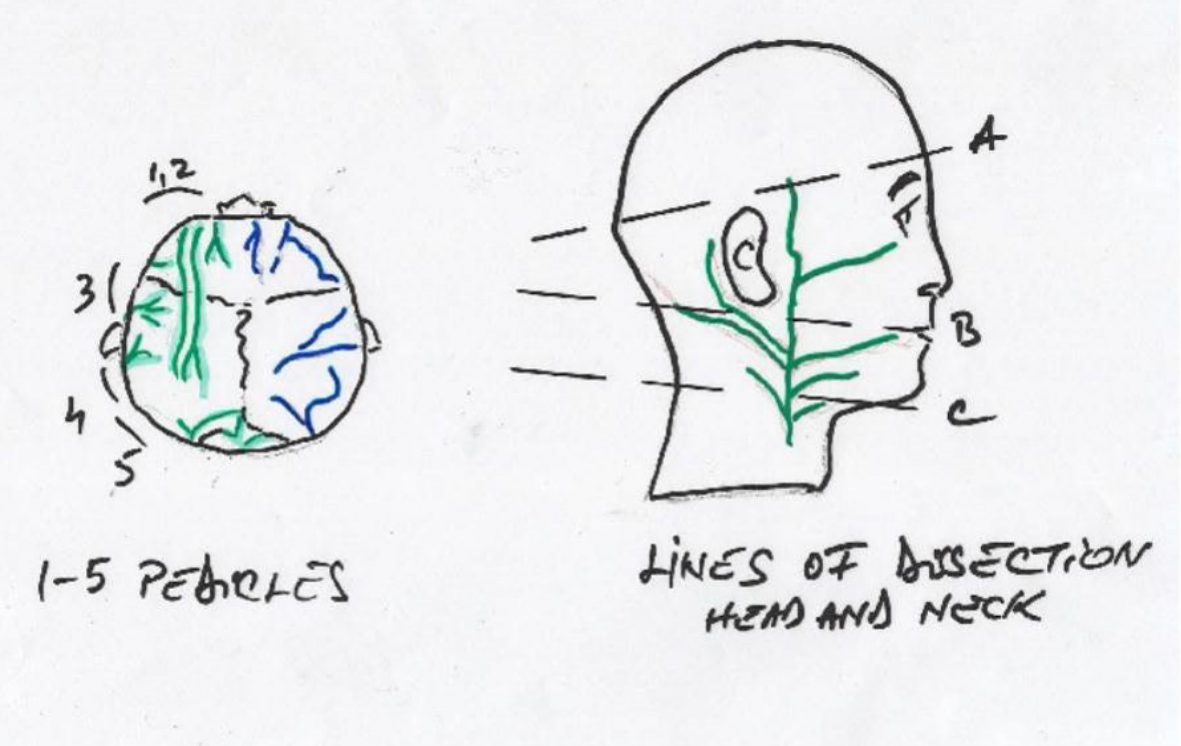


Fig. I.1A. Dissection lines and scalp pedicles to identify

I.2. Study of cranial fossae (walls, contents, communications); anatomical and clinical applications

How to prepare for the lab:

- to be able to identify the individual bones of the cranium
- to be able to identify and name the skulls sutures
- to read the courses/lectures from the first year that had the central nervous system as a subject
- to use the recommended references

e.g

-Netter Atlas of Human Anatomy: Classic Regional Approach, Elsevier, 2022, Ed.8

-Carmine D. Clemente - *Anatomy: A Regional Atlas of the Human Body* - Published by Lippincott Williams & Wilkins, 2010.

-Richard L.Drake, A. Wayne Vogl, Adam W.M.Mitchell, *Gray`s Anatomy for students*, Elsevier, 4th Ed. 2019.

In labs are useful:

-Dally AF, Agur MRA, Moore's Clinically Oriented Anatomy, 9th Edition, 2023

-*www.bartleby.com/sv/pr060700.html* –for Gray anatomy (with key words)

-*https://anatomiaartistica.files.wordpress.com/.../color-atlas-of-anatomy-a-photog-study-o.* –with key words on google color anatomy atlas

- Saladin K. Human Anatomy. The McGraw-Hill Education 2019

- Rohen JW, Yokoki C, Lutjen –Drecoll E-8th ed. Anatomy a photoghraphic atlas, Wolters Kluwer, 2023 (dissection images)

-Second sources for images from Google with key words (e.g of key words: skull anatomy, cranial fossae, cranial bones)

Let`s remember:

A. General knowdlege- the average adult number (1,2) : 206 bones in the human skeleton with:

Axial Skeleton

- *Skull* -***Total 22***

Cranial bones - *Total 8*

- Frontal bone -1
- Parietal bones -2
- Occipital bone -1
- Temporal bones -2
- Sphenoid bone -1
- Ethmoid bone -1

Facial bones - *Total 14*

- Maxillae -2
- Palatine bones -2
- Zygomatic bones -2
- Lacrimal bones -2
- Nasal bones -2
- Vomer -1
- Inferior nasal conchae -2
- Mandible -1

●*Auditory Ossicles* - ***Total 6***

- Malleus -2

- Incus -2
- Stapes -2
    - *Hyoid Bone -1 -* ***Total 1***
    - ***Vertebral Column - Total 26***
- Cervical vertebrae -7
- Thoracic vertebrae -12
- Lumbar vertebrae -5
- Sacrum -1
- Coccyx -1
    - ***Thoracic Cage - Total 25***
- Ribs -24
- Sternum -1

Appendicular Skeleton

- *Pectoral Girdle -* ***Total 4***
- Scapulae -2
- Clavicles -2
    - *Upper Limbs -* ***Total 60***
- Humerus -2
- Radius -2
- Ulna -2
- Carpals -16
- Metacarpals -10
- Phalanges -28

Pelvic Girdle - ***Total 2***

- Ossa coxae -2
    - *Lower Limbs -* ***Total 60***
- Femur -2
- Patella -2
- Tibia -2
- Fibula -2
- Tarsals -14
- Metatarsals -10
- Phalanges -28

B. The facial muscles (3) -mimics muscles versus muscles of mastication-use Fig. I.2.1

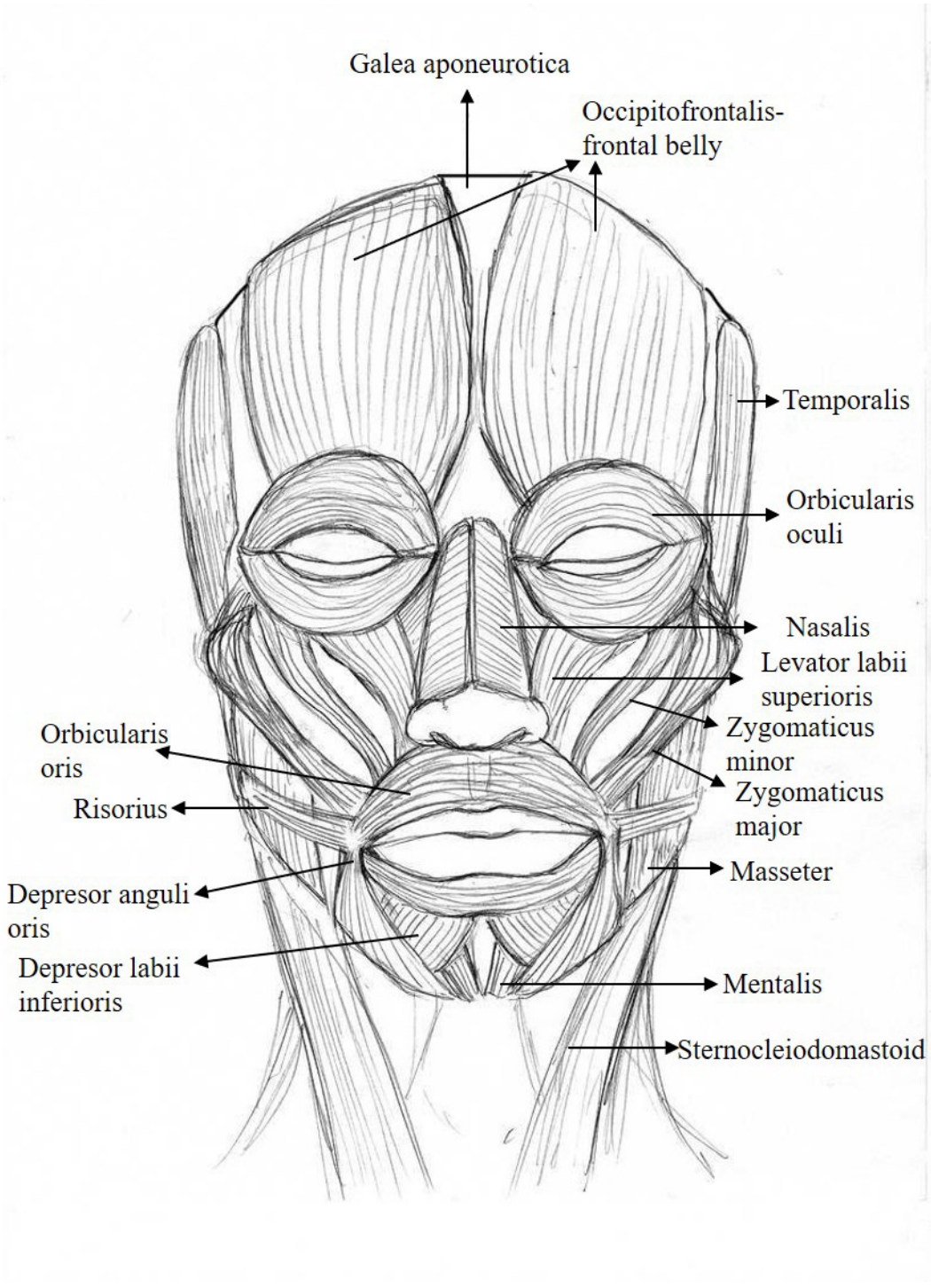


Fig. I 2.1. Mimic muscles (3)

C. The scalp layers-MNEMONIC **SCALP** -each letter in the word *scalp* serves as a memory key for each of its five layers (1,2):

- -**S**kin
- -**C**onnective tissue
- **-A**poneurosis
- -**L**oose areolar tissue
- -**P**ericranium

Descriptive terms (1,2):

- **Articulations**
  - *Condyle* – A rounded knob (occipital condyles of the skull)
  - *Facet* – A smooth, flat, slightly concave or convex articular surface (articular facets of the vertebrae)
  - *Head* – The prominent expanded end of a bone, sometimes rounded (head of the femur)

- **Depressions and openings**
  - Fissure – narrow slit through a bone (e.g.orbital fissures behind the eye)
  - Foramen – hole for nerves, blood vessels mainly a hole through a bone, round/oval in shape (e.g. foramen magnumof the skull)
  - Fossa – cuplike depression(e.g.iliac fossa, cranial fossae)
  - Sulcus – furrow on a bone surface, contains a nerve, tendon or blood vessel (e.g.intertubercular sulcus of the humerus)
  - Meatus – tubelike opening into a canal (acoustic meatus of the ear)
  - Canal – A tubular passage or tunnel in a bone (condylar canal of the skull)

- **Processes** – projection or outgrowth on bone for attachment
  - Condyle – smoothened process at end of bone, forms a joint
  - Facet – smooth flat surface, forms a joint
  - Head – rounded condyle on a neck, forms a joint
  - Crest – prominent ridge or projection, for attachment of connective tissues (iliac crest of the pelvis)
  - Epicondyle – projection above a condyle, for attachment of connective tissues (medial epicondyle of the femur)

- Line – long, narrow ridge (less prominent than a crest), for attachment of connective tissues (nuchal lines of the skull)
- Spinous process – sharp, slender projection, for attachment of connective tissues/muscle and also process: any bony prominence (mastoid process of the skull)
- *Protuberance* – A bony outgrowth or protruding part (mental protuberance of the chin)
- *Spine* – A sharp, slender, or narrow process (spine of the scapula)
- Trochanter – two massive processes unique to the femur, for attachment of connective tissues
- Tubercle – small, rounded process (greater tubercle of the humerus), for attachment of connective tissues
- Tuberosity – roughening on a bone surface, for attachment of connective tissues

The neurocranium: calvarium and cranial base (Fig. I.2.2)

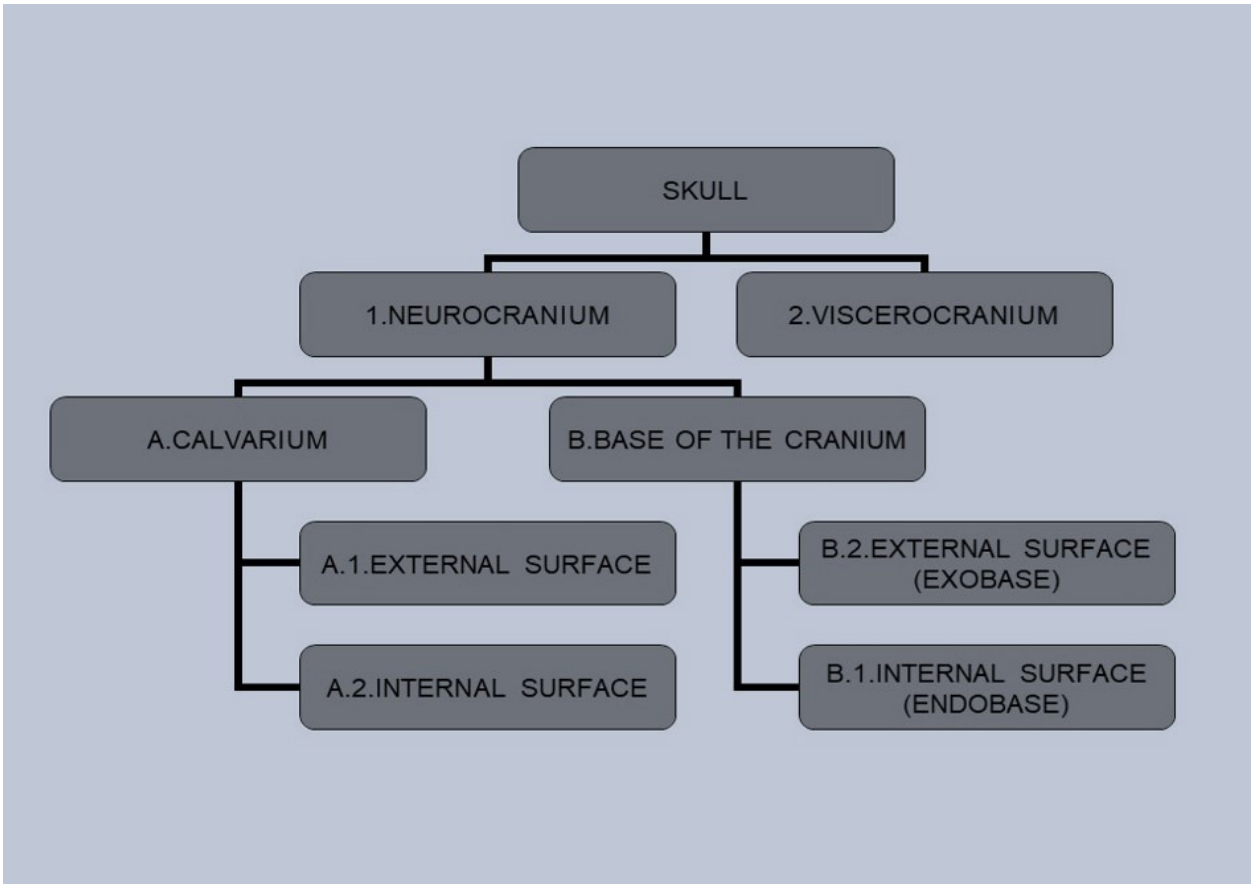


Fig. I.2.2 Subdivisions of the neurocranium: calvarium and cranial base

►The cranial fossae – identification, content (with emphasis on cranial nerves) and communications (I.1,2)

ORIFICES OF THE ANTERIOR CRANIAL FOSSA

Table I.2.1 Orifices, trajectory and content of anterior cranial fossa

Orifice	Trajectory	Content
foramen cecum	nasal cavity -to superior sagittal sinus	small emissary vein
foramina of the cribriform plate	olfactory grooves- to nasal cavities roof	olfactory nerves
ethmoidal fanta	olfactory grooves- to nasal cavities roof	extension of the dura mater
ethmoidal foramens	olfactory grooves -to nasal cavities roof	anterior and posterior ethmoidal arteries ,veins and nerves

ORIFICES OF THE MIDDLE CRANIAL FOSSA

Table I.2.2 Orifices, trajectory and content of middle cranial fossa

Orifice	Trajectory	Content
optic canal	endocranium -to orbital	optic nerve (CN II) ophtalmic artery
superior orbital fissure	endocranium-to the orbital cavity	oculomotor nerve (CN III) trochlear nerve (CN IV) abducens verve (CNVI) ophthalmic nerve (ophthalmic division of the CN V1)with its branches lacrimal, frontal and nassociliary superior ophthalmic vein branches of the middle meningeal artery sympathetic branches from the ophthalmic ganglia
foramen rotundum	endocranium- to the pterigopalatin fossa	maxillary nerve (CN V2) small emissary veins (Nuhn)
foramen ovale	endocranium- to the infratemporal fossa	mandibular nerve (CNV3) accessory branch from the middle meningeal artery venous plexus of the foramen ovale
foramen spinosum	endocranium- to the infratemporal fossa	middle meningeal artery middle meningeal vein meningeal branch of the mandibular nerve
foramen lacerum	endocranium-to the exocranium	greater petrosal nerve+deep petrosal nerve=nerve to the pterygoid canal (Vidian nerve) meningeal branches from the ascending pharingeal artery small emissary veins
internal orifice of the carotid canal	endocranium- to the exocranium	internal carotid artery internal venous carotid plexus internal nervous carotid plexus

ORIFICES OF THE POSTERIOR CRANIAL FOSSA

Table I.2.3. Orifice, trajectory and content of posterior cranial fossa

Orifice	Trajectory	Content
internal auditory meatus	endocranium- to the internal ear and to the exocranium	facial nerve (CN VII) intermediate of Wrisberg nerve vestibulocochlear nerve (CN VIII) internal auditory artery and veins
apertura canaliculi vestibuli	endocranium- to the vestibule of the internal ear	sac and the endolymphatic sac small arteries and veins
mastoid foramen	endocranium- to the exocranium	small branch of the occipital artery mastoid emissary vein
jugular foramen	endocranium- to the exocranium	glossopharyngeal nerve (CN IX) vagus nerve (CN X) accessory nerve (CN XI) internal jugular vein posterior meningeal artery inferior petrosal sinus
hypoglossal canal	endocranium- to the exocranium	hypoglossal nerve (CN XII) meningeal branch from the ascending pharyngeal artery venous plexus
condylar canal	endocranium- to the exocranium	emissary vein
foramen magnum	endocranium- to the exocranium	medulla oblongata the meninges vertebral arteries spinal arteries internal vertebral venous plexuses basilar plexus spinal roots of the accessory nerves

TEMPORAL FOSSA LIMITS (1,2):

- **superior** and posterior - the temporal lines;
- **anterior** - the frontal and zygomatic bones, and opening on the back of the latter (the zygomaticotemporal foramen).
- **lateral** - the zygomatic arch (formed by the zygomatic and temporal bones)
- **inferior***,* it is separated from the infratemporal fossa by the infratemporal crest on the great wing of the sphenoid, and by a ridge, continuous with this crest, which is carried backward across the temporal squama to the anterior root of the zygomatic process.

►Communications:

- In front and below, the fossa communicates with the orbital cavity through the inferior orbital fissure

►Floor:

-The floor of the fossa is concave in front and convex behind, and is formed by the zygomatic, frontal, parietal, sphenoid, and temporal bones.

►Content:

-The temporal fossa content: the Temporalis muscle and its vessels and nerves, together with the zygomaticotemporal nerve.

THE INFRATEMPORAL FOSSA(1,2)

- irregularly shaped cavity, situated below and medial to the zygomatic arch.

Limits:

- **anterior**-the infratemporal surface of the maxilla and the ridge which descends from its zygomatic process;
- **posterior**-the articular tubercle of the temporal and the spinal angularis of the sphenoid;
- **superior**- the great wing of the sphenoid below the infratemporal crest, and by the under surface of the temporal squama;
- **inferior**-the alveolar border of the maxilla;
- **medial**-the lateral pterygoid plate.
- **lateral-**the zygomatic arch, temporal surface of the zygomatic bone and the medial surface of the ramus of the mandible

Communications:

►neurocranium by the foramen ovale and foramen spinosum;

►the orbit by the inferior orbital fissure and zygomatic canal;

►temporal fossa by lateral part of the superior wall;

►facial regions by zygomatic canal;

►pterygopalatinal fossa by the anterosuperior part of the medial wall;

►the alveolae of superior teeth by the openings of the alveolar canals;

►alveolae of the inferior teeth by the opening of the dental canal (inferior alveolar canal);

►neighboring regions by the missing posterior and inferior walls, respectively with parotidian, mastoidian and inframandibular regions.

THE PTYERYGOPALATINE FOSSA(1,2)

-small, triangular space at the angle of junction of the inferior orbital and pterygomaxillary fissures, and placed beneath the apex of the orbit.

Limits:

●**superior** -inferior surface of the body of the sphenoid and by the orbital process of the palatine bone;

●**anterior**-infratemporal surface of the maxilla;

●**posterior**-base of the pterygoid process and lower part of the anterior surface of the great wing of the sphenoid;

● **medial**-vertical part of the palatine bone with its orbital and sphenoidal processes.

Communications:

►the orbit by the inferior orbital fissure

Content:

-inferior ophthalmic vein, ganglionic branches from pterygopalatine ganglion to maxillary division of trigeminal nerve, infraorbital nerve from trigeminal nerve, infraorbital artery and vein, zygomatic nerve

►the nasal cavity by the sphenopalatine foramen

Content:

-sphenopalatine artery and vein, posterior/superior nasal nerve and nasopalatine nerve)

►infratemporal fossa by the pterygomaxillary fissure.

CRANIOMETRIC POINTS (4)

►**Asterion** is located at the confluence point of the lambdoid, parietomastoid and the occipitomastoid suture.

►**Basion** corresponds to the anterior margin of the Foramen Magnum at midline

►**Bregma** is the craniometric point located at the junction of the coronal and the sagittal sutures.

►**Dacryon** is located at the anterior and the superior angle of the lacrimal bone, at the junction of the frontal bone.

►**Eurion** is located at the central point of the parietal eminence

►**Glabella** is located in the flat area between the superciliary arches.

►**Gonion** is located at the apex of the jaw angle. It can be used for the localization of the MMN (Marginal Mandibular Nerve), that runs along the inferior margin of the jaw: the gonion is ± 0.75 mm above the MMN.

►**Inion** is the craniometric point which corresponds to the external occipital protuberance.

►**Lambda** is located at the junction of the saggital the lambdoid sutures.

►M**enton** corresponds to the lower point of the mental tuberosity.

►N**asion** is located at the midpoint of the nasofrontal suture

►**Obelion** is located on the sagittal suture at the level of parietal foramens.

►**Opisthocranion** corresponds to the most posterior point of the occipital bone.

►**Pogonion** corresponds to the most forward point of the mental tuberosity.

!!!Task – name the craniometric points 1-6 from the below picture

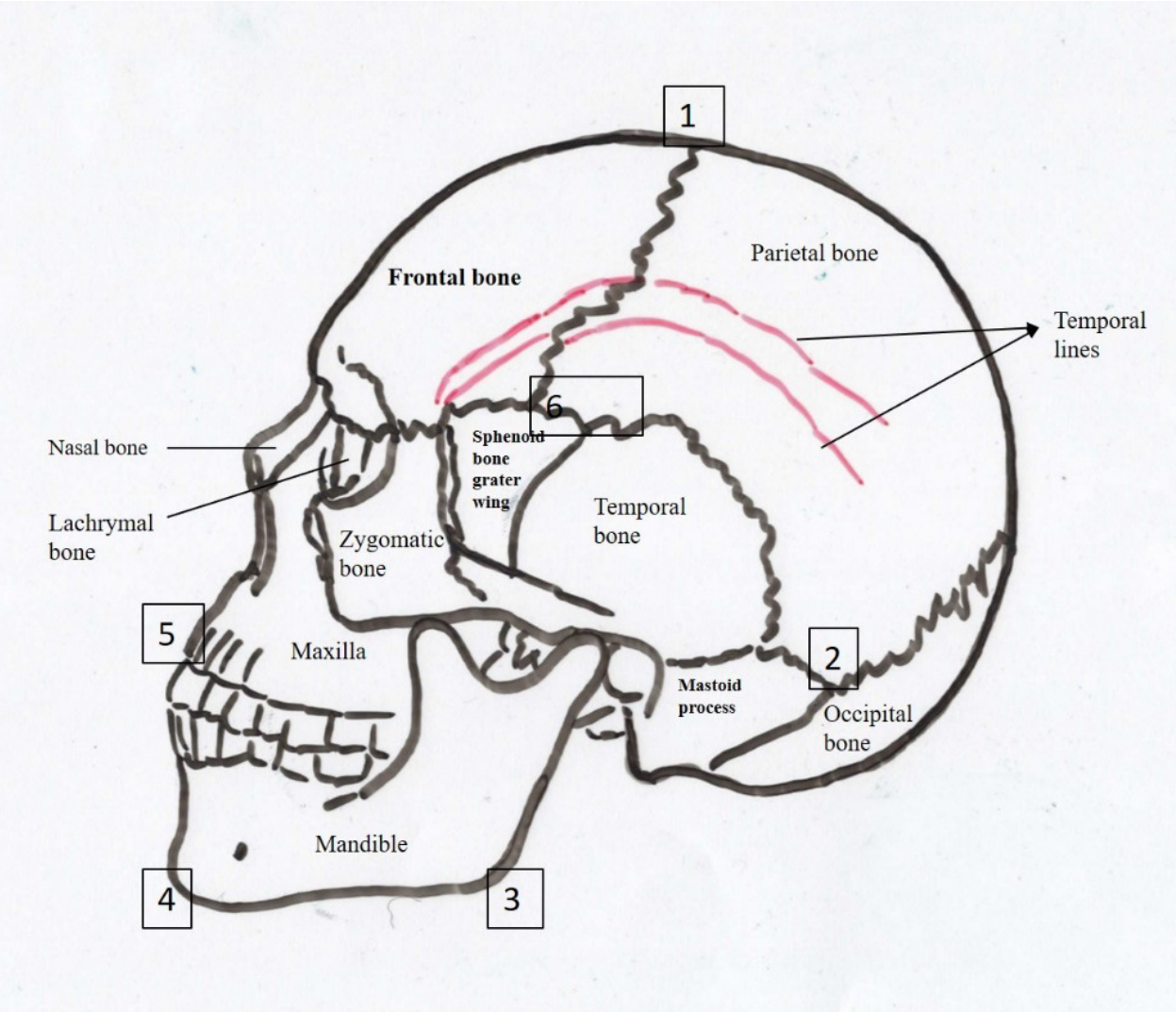


Fig. I.2.3.Craniometric points 1-6

Within the bones that make up the skull, accessory bones called wormian bones *(Ossa incae)* have been described (5-7)

Fig. I.2.4.Wormian/sutural bones

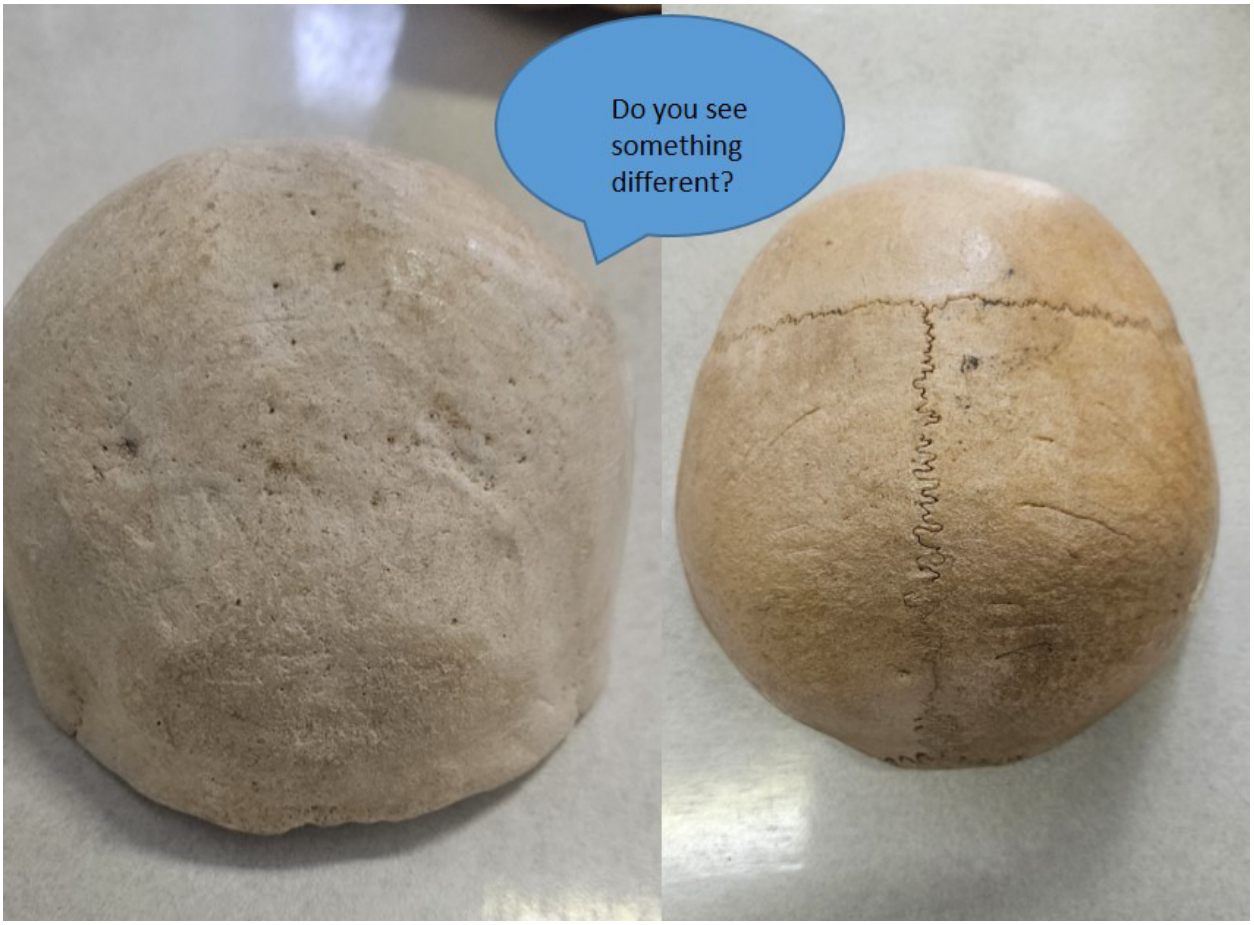


Fig. I.2.5. Compare the images above

Craniosynostosis-premature closure of the cranial sutures results in several cranial malformations, but usually does not affect brain development.(8)

Table I. I.2.4. Terms from terminologia anatomica used in this practical

Terminologia anatomica terms (9)	General English terms
eminentia	eminence
tuberculum	tubercle
tuberositas	tuberosity
processus	process
condylus	condyle
crista	crest,ridge
linea	line
fossa	fossa
incisura	notch
Facies articularis	Articular surface
Cavitas cranii	Cranial cavity
Calvaria	Calvaria
Basis cranii	Cranial base
Fossa cranii anterior	Anterior cranial fossa
Fossa cranii media	Middle cranial fossa
Fossa cranii posterior	Posterior cranial fossa
Fossa temporalis	Temporal fossa
Fossa infratemporalis	Infratemporal fossa
Fossa pterygopalatina	Pterygopalatine fossa

I.3. Dissection of the regions of the cranial vault (calvaria) and the upper facial region, (limits, anatomical landmarks and the highlighting of the musculo-aponeurotic planes, vessels and nerves of the regions); anatomical and clinical applications

Anatomically, the neurocranium can be subdivided into (1,4,9-11):

1. a roof (known as the calvaria)
2. a base:

Calvaria: consists of the frontal, occipital and two parietal bones (4 bones-2 unpaired).

Cranial base (Basis cranii): consists of six bones – the frontal, sphenoid, ethmoid, occipital, parietal and temporal bones.

Calvaria features:

►Frontal bone

-external table: frontal eminences, supercilliary arches, supraorbital foramina, glabella

-internal table: groove for superior sagittal sinus, frontal crest, frontal fossae, foramen ceaecum, coronal suture

►Temporal bone:

-external table- temporal lines, squama

-internal table: grooves for meningeal vessels

►Parietal bones:

-external table- temporal lines

-internal table: grooves for meningeal vessels, sagittal suture, granular pits for arachnoid granulations

►Craniometric points:

Bregma: at the junction of coronal suture with the sagittal suture

Lambda: at the junction of the sagittal suture with the lambdoid suture

Vertex: the highest of the craniometrics points in the anatomical position of the skull (inferior margin of the orbit is in alignment with the superior margin of the external auditory meatus)

Inion: the craniometrics point corresponding with the external occipital protuberance

The regions of the calvaria and the upper facial region

1. **Fronto-parieto-occipital region (1,4,9-10):**

Limits:

►Anteriorly: supraorbital border of frontal bone and glabella

►Posteriorly: superior nuchal line and external occipital protuberance

►Laterally: superior temporal lines

Can be analyzed as formed from 3 parts-frontal, parietal and occipital region

The frontal region presents the features:

-eyebrows

-superciliary arches

-glabella the craniometrics point located between the supercilliary arches - flat in children and adult females, and forms a rounded prominence in adult males

-has as limits supraorbital border of frontal bone and glabella anteriorly and the hair line posteriorly

The parietal region :

Limits:

-anteriorly by the hair line

-posteriorly by a coronal plane behind the parietal eminences

-and on either side by the temporal line.

Parietal eminence: a protuberance located 2 inches above the auricle on the interauricular line.

The occipital region:

Limits:

-anteriorly the interauricular line betwwen the two parietal eminence

- posteriorly: the external occipital protuberance and superior nuchal lines

The soft tissue covering frontal, parietal, and occipital regions forms the scalp.

Stratigraphy:

1. Skin
2. Subcutaneous tissue
3. Musculo-aponeurotic layer

!!Tasks: Identify and describe each those layers and their corresponding region

The region contains 10 vasculo-nervous pedicles, 5 on each side (2,10-13):

1. Medial frontal pedicle: formed by **supratrochlear** vessels and **medial** branch of **frontal nerve**.
    a. Supratrochlear artery arises from *ophthalmic artery*-branch of internal carotid artery.
    b. Medial branch of frontal nerve arises from frontal nerve-branch of *ophthalmic nerve.*
2. Lateral frontal pedicle: formed by **supraorbital vessels** and **lateral** branch of **frontal nerve**.
    a. Supraorbital artery -arises from *ophthalmic artery*.
    b. Lateral branch of frontal nerve -branch of frontal nerve, branch of *ophthalmic nerve*
3. Pre-auricular pedicle: formed by **superficial temporal vessels** and **auriculo-temporal nerve.**
    a. Superficial temporal artery = terminal branch of external carotid artery.
    b. Auriculo-temporal nerve - branch of *mandibular nerve.*
4. Retro-auricular pedicle: formed by **posterior auricular vessels** and **auricular and mastoid** branches of **superficial cervical plexus**. Posterior auricular artery is a collateral branch of external carotid artery.
5. Occipital pedicle: formed by **occipital vessels** and **posterior branches of the first 3 cervical spinal nerves** which can anastomose and form the posterior cervical plexus. Occipital artery is a branch of external carotid artery.

2. Temporal region (1,4,9-10):

- is a paired topographic region of the head, on the lateral sides of the scalp.

Limits:

►Superiorly: superior temporal line

►Inferiorly: zygomatic arch

►Antero-inferiorly: zygomatic process of frontal bone and frontal process of zygomatic bone

►Posteriorly: the line that prolongates inferiorly- the superior temporal line of parietal bone

Stratigraphy: skin, subcutaneous tissue (superficial blood vessels and nerves), aponeurotic layer, muscular layer, deep blood vessels and nerves, bony layer, and dura mater.

!!Tasks: Identify and describe those layers

3. Zygomatic region (1,4,9-10):

-is a prominent region of the face, situated superiorly to the buccal region and it overlies the zygomatic arch and zygomatic bone.

Limits:

►Superiorly-regions: orbital and frontal

►Inferiorly: parotideomasseteric region

►Laterally-regions infratemporal and temporal

►Medially: infraorbital region

Stratigraphy: skin, bone

!!Tasks: Identify and describe those layers

4. Infraorbital region (1,4,9-10)

-is a paired lateral region of the face, situated inferiorly to the orbital region and infrapalpebral sulcus.

Limits:

- **Superiorly**: infraorbital border of maxilla
- **Inferiorly**: a conventional line which connects labial commissure with the tragus or the inferior border of the zygomatic arch with the posterior extremity of nasal wing
- **Anteriorly** and **medially**: nasolabial sulcus
- **Posteriorly** and **laterally**: a vertical line through the zygomatic process of frontal bone and anterior border of masseter muscle/ zygomaticomaxillary suture

Stratigraphy (1,4,9-11):

1. **Skin** is thin and elastic and covered by hair follicles in males, containing numerous sebaceous and sudoriparous glands.
2. **Subcutaneous tissue** is poorly developed at this level.
3. **Muscular layer:** M. levator labii superioris alaeque nasi, M. levator labii superioris, M. levator anguli oris, Orbital part of M. orbicularis oculi
4. **Bony layer**
5. **Blood vessels and nerves-name and identify them**

!!Tasks: Identify and describe those layers

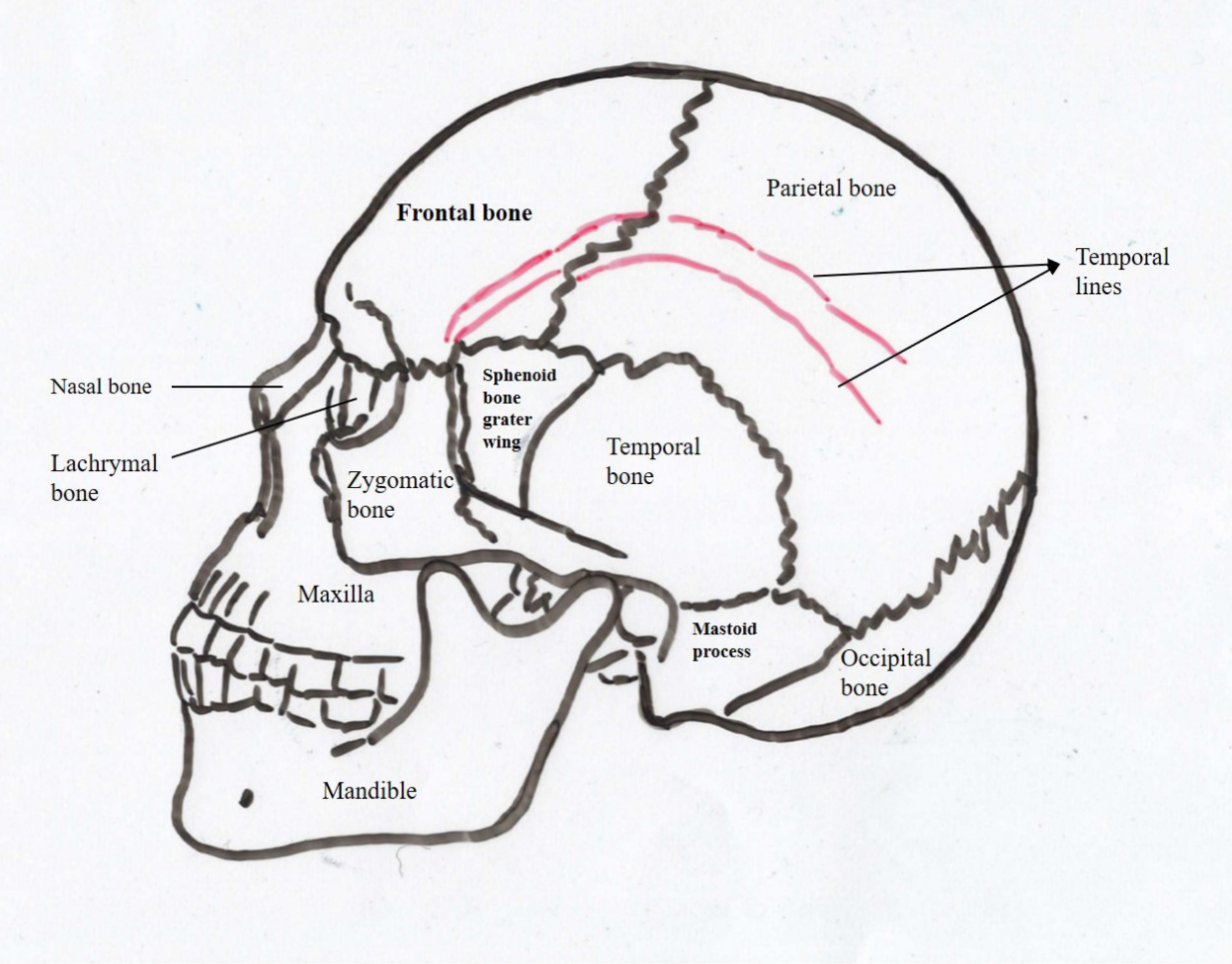


Fig. I.3.1 Landmarks that can be used for the identification of limits and features of the regions

!!Task: Use the above figure to write the limits of the regions that you have to study

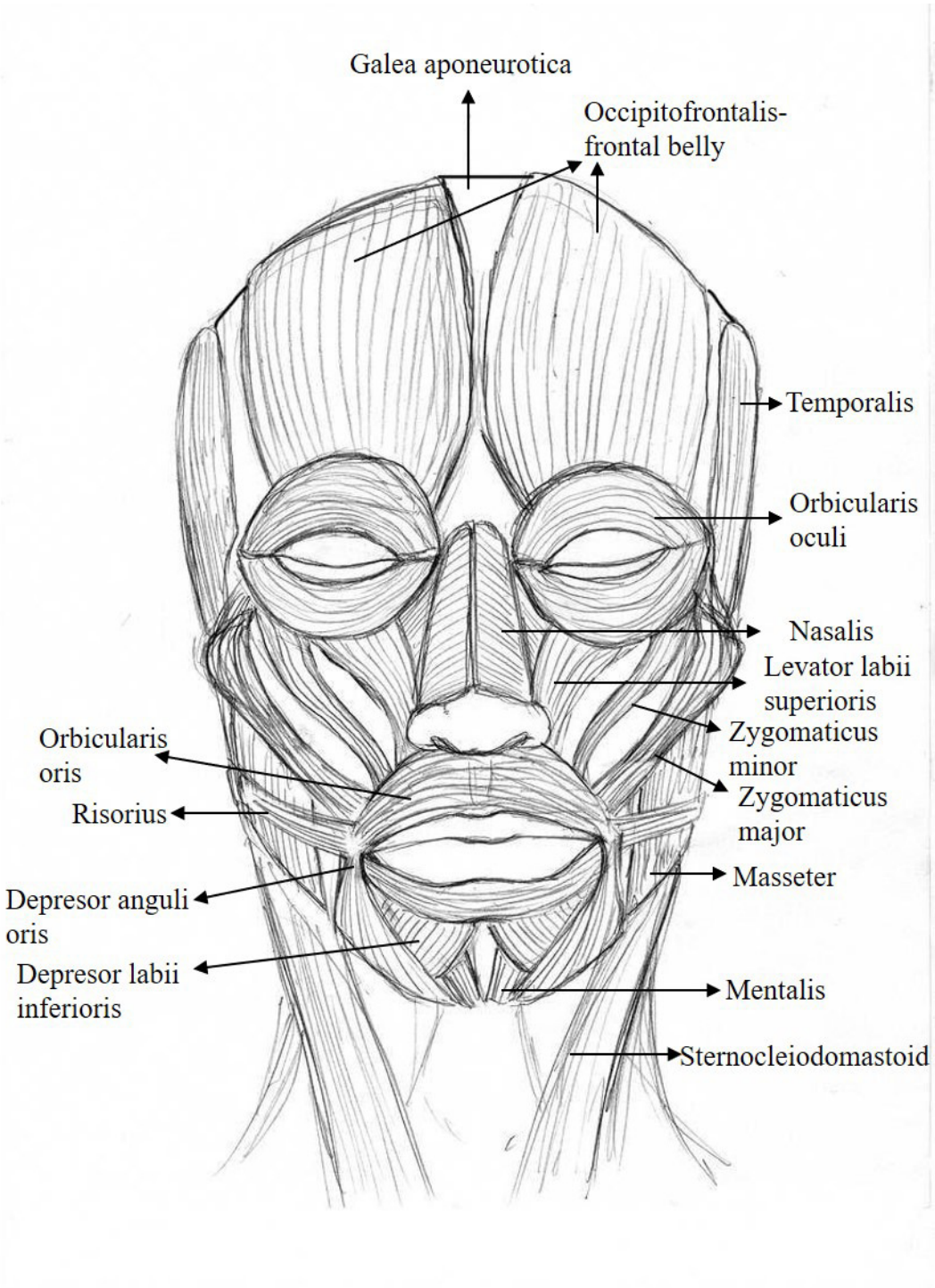


Fig. I.3.2 The musculo-aponeurotic planes to dissect

!!Task: Identify on the cadaver all the above muscles. Justify each answer –set identification landmarks and write them on the above image

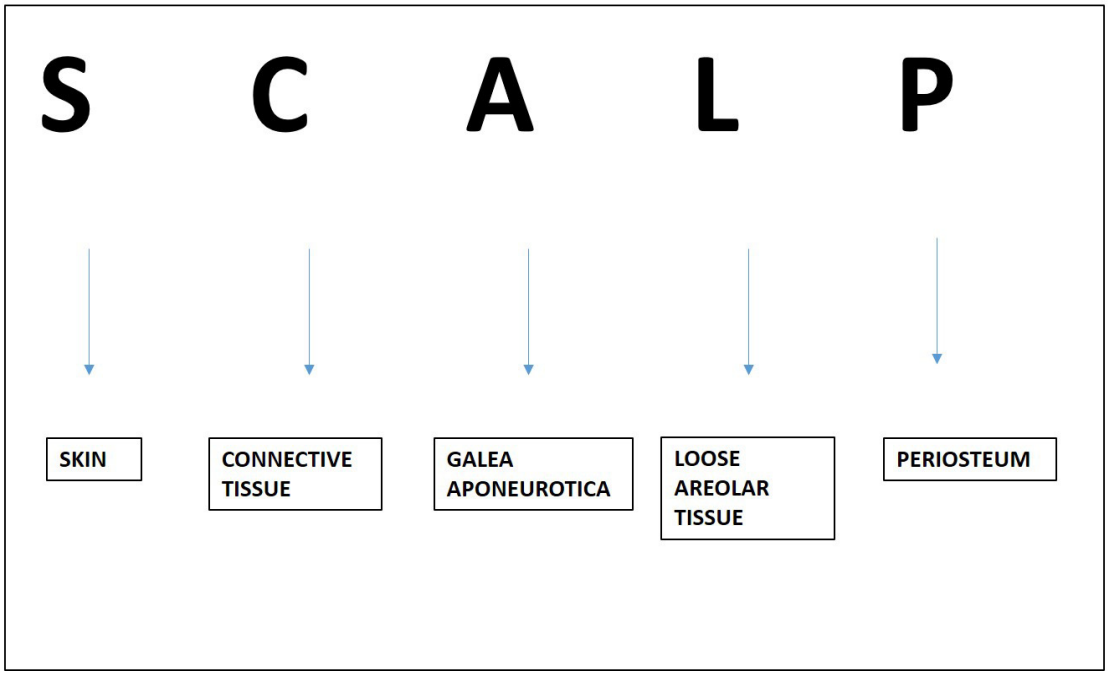
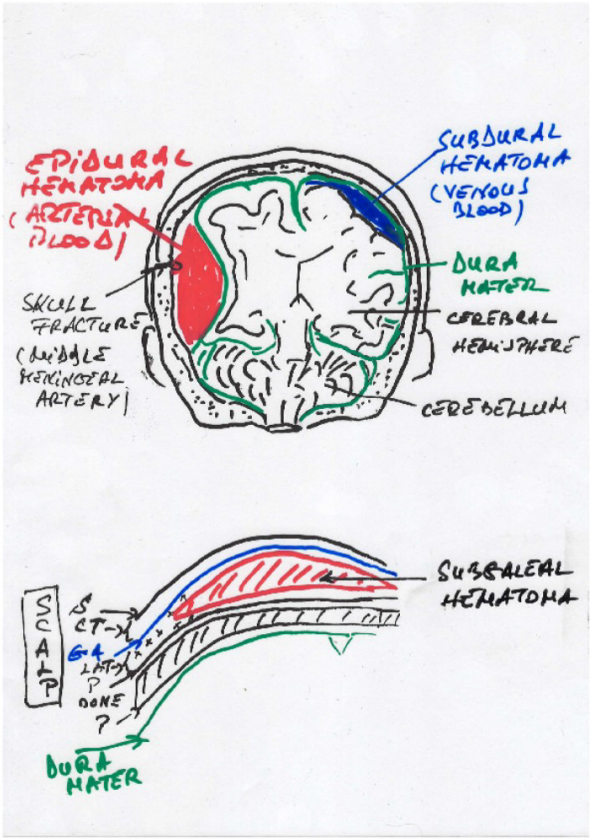


Fig. I.3.3 Scalp layers



<u>Epidural hematoma</u>= accumulation of blood in the space between skull bones and dura mater-periosteal layer of dura (more frequently arterial blood from middle meningeal artery)
On noncontrast CT=hiperdense **()** biconvex - shaped mass (13)

<u>Subdural hematoma</u>= accumulation of blood in the space between dura mater-meningeal layer and arachnoid mater
On noncontrast CT=hiperdense **((** crescent - shaped mass (13)

<u>Subgaleal hematoma</u>= accumulation of blood in the potential space between periosteum and galea aponeurotica (14)

Fig. I.3.5.4 Hematomas

I.4. Dissection of the lower facial regions and the parotid region (study of the muscles, vessels and nerves of the regions); anatomical and clinical applications.

1. Mastoid region (1-2,10,13)

The mastoid region -is located at the lateral part of the head

-includes the mastoid part of the temporalis bone and the soft tissue layers that cover it

Limits:

- superior: supramastoid crest
- inferior: mastoid process
- anterior: vertical line of the posterior border of the external acoustic meatus
- posterior: margo occipitalis (the occipital border of the temporal bone)

I. Task: Identify the landmarks and layers (skin, subcutaneous tissue and muscles)

2. Parotid region is the posterolateral part of the facial region, **bounded** by the:

• Superiorly: Zygomatic arch

• Posteriorly: External ear and anterior border of the sternocleidomastoid

• Medially: Ramus of the mandible medially.

• Anteriorly: Anterior border of the masseter muscle anteriorly.

• Inferiorly: Angle and inferior border of the mandible inferiorly.(2)

II. Task: Identify the features of the parotid region: parotid duct, facial nerve, retromandibular vein, extgernal carotid artery, maseter muscle

!!!Three main structures either in part or in whole traverse the gland and branch within it: search from superficial to deep:

1. Facial nerve.
2. Retromandibular vein.
3. External carotid artery.

III. Task: Name the vascular and nervous supply of the parotid gland

IV. Task:Identify the terminal branches of the facial nerve on the formalin-fixed specimen

Facial nerve-terminal branches (2,10):

(a) *Temporal branch*—run upwards and cross the zygomatic arch.

(b) *Zygomatic branches*—run below and parallel to the zygomatic arch.

(c) *Buccal branches*—are two in number. The upper buccal nerve runs above the parotid duct and the lower buccal nerve runs below the duct.

(d) *Marginal mandibular (also called mandibular) branch*—runs forwards below the angle of the mandible, deep to the platysma. It then crosses the body of the mandible to supply the muscles of the lower lip and chin.

(e) *Cervical branch*—runs downwards and forwards to reach the front of the neck, to supply the platysma.

3. The buccal region (1-2,10,13)

- The buccal region of face is a broad area of the face between the nose, mouth, and parotid region. It overlies the **buccinator muscle**. It is made of soft tissues of the cheek.
- The **pulsations of facial artery** can be felt about 1.25 cm lateral to the angle of the mouth.(10)
- **Limits:**
  - Superiorly: a conventional line which connects labial commissure with the tragus
  - Inferiorly: inferior border of mandibular
  - Anteriorly: a vertical line drawn at 1 cm laterally to the labial commissure, which connects the posterior extremity of alaeque nasi to the inferior border of the mandible`s body
  - Posteriorly: anterior border of masseter muscle

V. Task: Name and identify the layers of this region

4. Labial (oral) region (1-2,10,13)

Limits

Superior: nasolabial groove (nasolabial sulcus), posterior border of the nose wing

Inferior: the horizontal line passing through mento-labial fold (mento-labial sulcus)

Lateral: the vertical line passing one centimeter lateral to the angle of the mouth (angulus oris)

VI. Task: Name and identify the layers of this region

The **oral cavity** (**mouth**) consists of two parts: the *oral vestibule* and the *oral cavity proper* .

VII. Task: set the boundries for these two parts

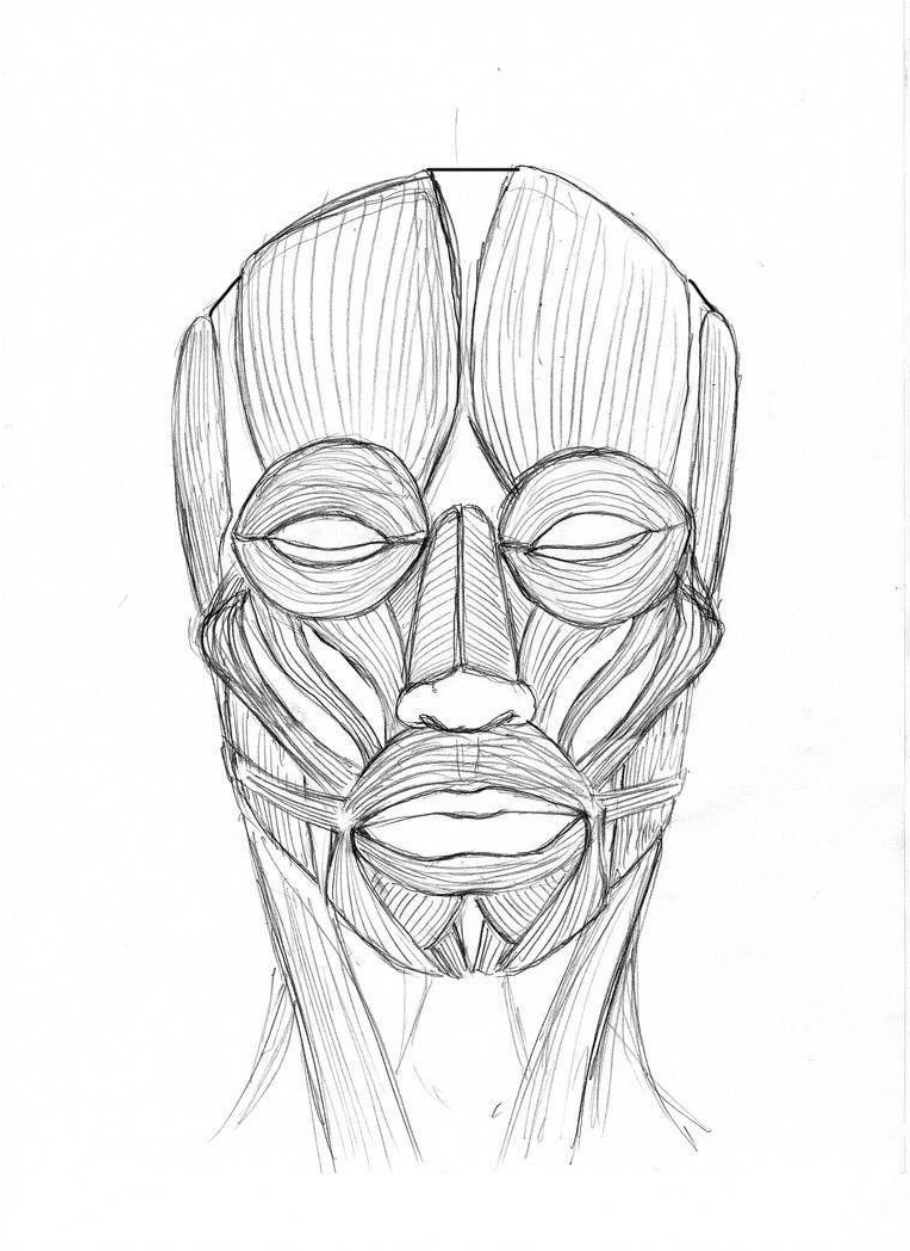


Fig. I.4.1 Image to be used for the tasks of this laboratory-Use the image to set the layer and boundries for the the lower facial regions and the parotid region

The tongue (1-2,10,13)

The tongue has: a root, a tip and a body.

VIII. Task: describe the feature on the dorsal and ventral part pf the tongue

Muscles of the tongue:

- **Intrinsic muscles**

1. Superior longitudinal.
2. Inferior longitudinal.
3. Transverse.
4. Vertical.

- **Extrinsic muscles**

1. Genioglossus.
2. Hyoglossus.
3. Styloglossus.
4. Palatoglossus.

5. Mental region (10)

Limits:

- Inferiorly: inferior border of the mandible`s body

- Superiorly: the mento-labial groove prolonged

-Laterally: a vertical line drawn at 1 cm laterally to the angle of the mouth to the inferior border of the mandible .(10)

IX. Task: describe the components of the stratigraphy of this region

X. Task: on the image below write the names of the regions and name their boundries

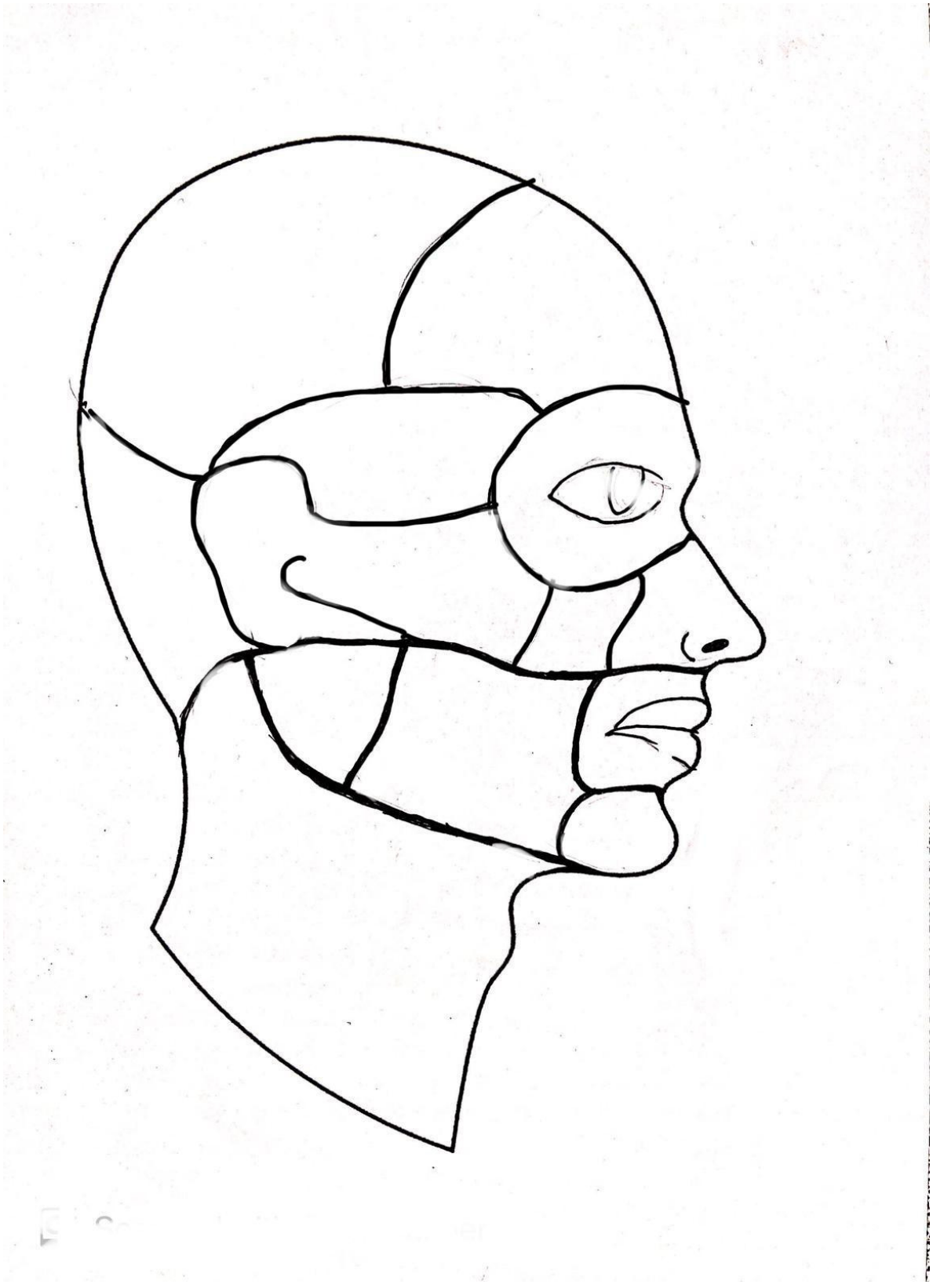


Fig. I.4.2. Image to be used to set the regions and their limits

Medical terms (1-2,10,13):

►**Adenoiditis=** Inflammatory process involving the pharyngeal tonsils

►**Tonsillitis=**Inflammatory process involving the palatine tonsils

-Surgical removal of the palatine tonsils=palatine tonsillectomy.

●Possible complications of palatine tonsillectomy: injurie of the glossopharyngeal nerve (loss of general sensation and taste sensation of the posterior 1/3 of the tongue) and hemorrhage (from brances of facial, ascending pharyngeal, maxillary and lingual arteries or paratonsilar veins)

-complication of tonsillitis-abscess (painful pus-filled inflammation).

●Clinical aspects of these abscesses: age (adolescents and young adults), soft palate and uvula edematous and displaced toward the unaffected side, sore throat, fever, impairment of speech and trismus (motor disturbances of the territory of trigeminal nerve with spasm of masseter muscle) (15)

►**Lymphadenopathy/adenopathy=**Disease of the lymph nodes; in which the lymph nodes are absnormal in terms of size, shape and consistency

►**Epistaxis=** nosebleed

Vessels involved:

a. Anterior and posterior ethmoidal vessels (superior part of the nasal septum)
b. Greater palatine artery (antero-inferior part of the nasal septum)
c. Superior labial artery(antero-inferior part of the nasal septum)
d. Sphenopalatine artery(postero-inferior part of the nasal septum)

In the anterior part of the nasal septum these arteries are forming a plexus (Kiesselbach) Epistaxis has as causes: trauma/injury, extreme heat/cold, deviated septum, hypertension, vascular malformatios, medication, allergies, tumors

A 35-years old woman complains about nose bleeding that is persistent. The physician is preparing to cauterize the source of this bleeding which appears to be a vessel on the superior part of the nasal septum. Which artery is most likely to be the source:

A. Posterior ethmoidal artery
B. Greater palatine artery
C. Superior labial artery
D. Sphenopalatine artery
E. None of the above

►**Ecchymosis** is a dark/purple area caused by the extravasation (hemorrhage) of blood from the vessels into the into the superficial layers of the skin (from e.g bruising)

Hematoma Localized collection of blood outside the vessels caused by trauma, could be clotted

►**Temporomandibular Joint (TMJ) Syndrome (1-2,10,13)**

Symptoms: acute /persistent pain in the region of TMJ, crepitations (clicking), difficulty in mastication, headache/tinnitus

TMJ syndrome has as causes: muscular pain due to hyperfunction (bruxism, eating habits like chewing gum, dentition dysfunction like hypodontia (missing teeth), deformity in the bones/ligaments forming of the TMJ), dysfunction in the TMJ caused by displacement of the articular disc, tension of the ligaments, arthritis, dislocation, tumors, lesions of the mandible or connetictive tissue damage

Bruxism=teeth grinding (caused mostly by stress)

Arthritis= Inflammatory process involving the joints

Tinnitus= noises in the ear that only the patient can hear

►**Temporal Arteritis(1-2,10,13)**

- Inflammatory process affecting the temporal arteries

-Symptoms: unilateral pain/headache in the area of the pathway of the temporal arteries (due to the blood passing into an inflamed artery)-usually in older patients

►**Dangerous area of the face(1-2,10,13)**=area on the facial vein pathway. Here, the devoid of valves facial vein rests on mimics muscles. The movements of these muscles may facilitate the spread of infections through deep facial vein, pterygoid venous plexus and emissary veins into cavernous sinus. Therefore, from the areas drained by these veins like the nose, upper lip and part of the cheek infections can spread and cause inflammatory processes of the meninges or thrombosis of the cavernous sinus (with septic emboli).

►The **parotid gland** more frequently diagnosed **pathological processes** are: viral parotidits, calculi (stones) formed in the parotid gland and duct and tumors (usually benign).

Mumps (viral parotitis)=viral acute inflammatory process with symptoms represented by diffuse enlargement of the parotid gland, swollen of the opening of the parotid duct, pain and fever. The pain sensation is due to the stretching of the glands capsule which stimulates

branches of great auricular nerve. The pain the pain increases during chewing movements and decreases after meals due to the evacuation of the gland's secretion product (the saliva). The inflammatory process can associate complications in adult life epididimo-orchitis, pancreatitis and oophoritis.(10)

Pleomorphic adenomas (PA) and Warthin`s tumors are benign tumors of the salivary glands with PA being the most common type. In rare cases, these tumors can become malignant (17-18). PA is usually located in the superficial lobe of the parotid gland (17). Parotid gland is divided into superficial and deep lobes by the facial nerve (10). Warthin`s tumor development was associated with smoking (18).

The pathway of the parotid duct and its patency can be assessed using a parotid sialogram. This is the technique of injecting a radio-opaque dye through a needle or canula in the parotid duct at the level of its opening in the vestibule of the oral cavity.(1)

Bell`s palsy is a condition characterized by paralysis of facial muscles as a result of compression of the facial nerve in the facial canal of the petrous part of the temporal bone(10). The symptoms are illustrated in the figure below:

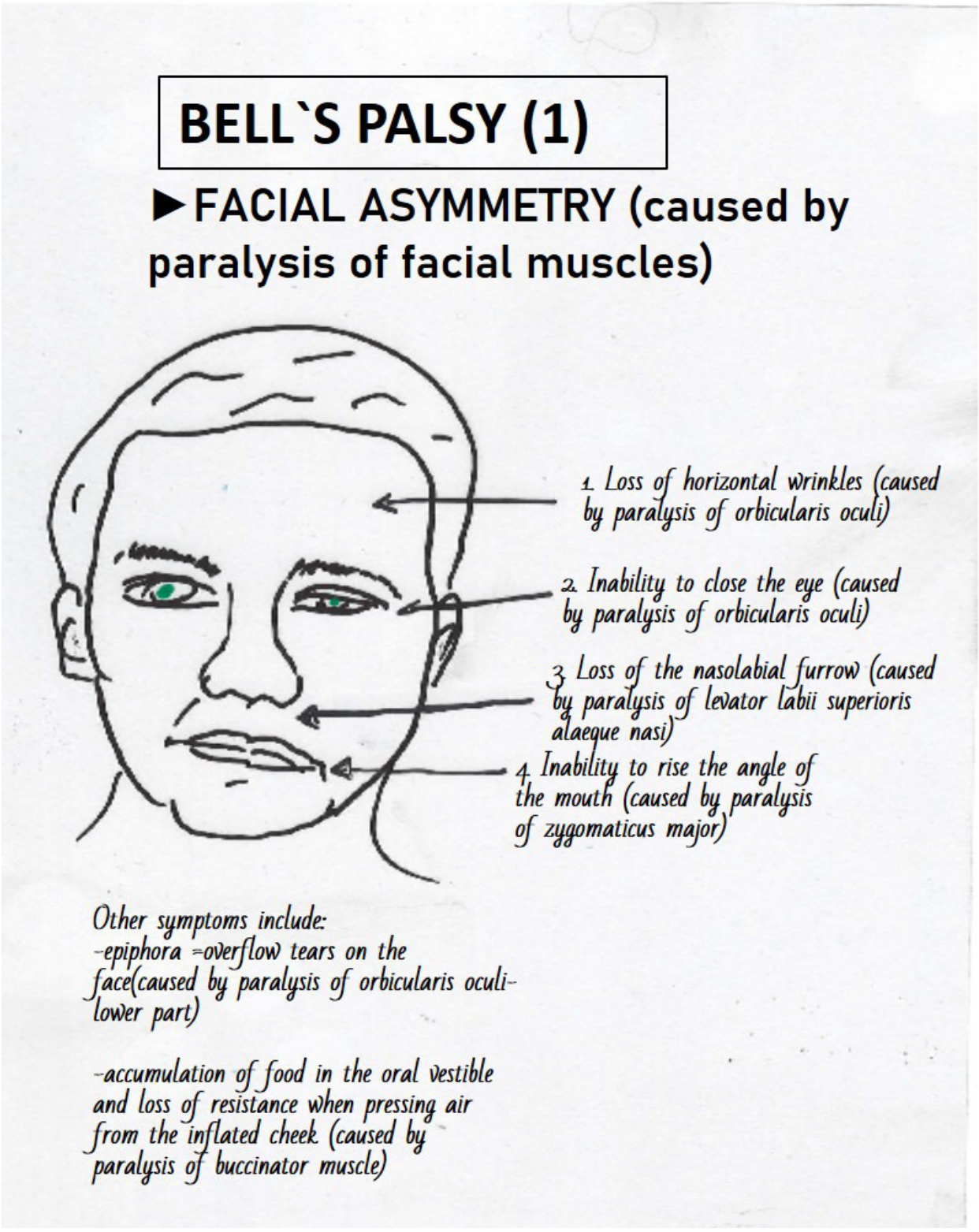


Fig. I.4.3 Bell`s palsy symptoms

I.5. Dissection of the soft parts of the neck. Highlighting the neck triangles (boundaries, content) with clinical and anatomical correlations. Study of the pharynx, larynx, esophagus, thyroid and parathyroid glands; anatomical and clinical applications

1. Anterior triangle of the neck (10)

Limits:

-Anterior: a line-median line of the neck.

-Posterior: a muscle- the sternocleidomastoid muscle (anterior border).

-Base: a bone and a line -mandible (lower border its body) and a line extending from the angle of mandible to the mastoid process.

*-Apex: a notch (*suprasternal notch –in the meeting point between anterior border of sternocleidomastoid and anterior median line.

*The **roof** is represented by:* Investing layer of deep cervical fascia.

This triangle is further divided into the submental triangle, muscular triangle, carotid triangle and digastric/submandibular triangle.

2. Submental triangle(10,19): the unpaired triagle

Limits:

- *Sides:* anterior belly of digastric muscle.
- *Base:* hyoid bone (body).
- *Apex:* symphysis menti

Floor: Mylohyoid muscle

Roof: Deep cervical fascia

Content:- Anterior jugular vein-formed by the drainage of small veins anastomose

-Submental lymph nodes receiving the lymphatic drainage from: tongue (its apex), lower lip, incisor teeth and mental region

Clinical correlation: Inflammatory processes of the incisors can spread into the submental space forming an abscess which can be drained without major complications because this triangle include no arteries

3. Muscular triangle (10,19)

Limits:

- *Anterior:* median line of the neck- from hyoid bone to the suprasternal notch.
- *Supero-laterally/posterosuperior:* omohyoid muscle (superior belly).
- *Infero-laterally/inferoposterior:* sternocleidomastoid (anterior border).

Floor: It is formed by: sternothyroid, sternohyoid, and thyrohyoid muscles.

Roof: Deep cervical fascia

The triangle includes: the superior thyroid artery, the anterior jugular and inferior thyroid veins, the ansa cervicalis and lymph nodes (anterior cervical, infrahyoid, prelaryngeal, thyroid, pretracheal, paratracheal groups). In the medial part of this triangle are esophagus, trachea, thyroid gland and the larynx (its inferior part).

Clinical correlation: common surgical procedures performed in this triangle are tracheostomy and thyroidectomy. A possible complication is hemorrhage from injury of the superior thyroid artery.

4. Carotid triangle (10,19)

Limits:

- *Superiorly:* Posterior belly of digastric supplemented by stylohyoid.
- *Anteroinferiorly:* Superior belly of omohyoid.
- *Posteriorly:* Anterior border of sternocleidomastoid.

Roof: deep cervical fascia

Floor-the following muscles: tyrohyoid, hyoglossus, middle and inferior constrictor

Content:

1. Carotid arteries

(a) Common carotid artery

And its bifurcation into

- Internal carotid artery

-External carotid artery and its first five branches: superior thyroid, lingual, facial, occipital and ascending pharyngeal arteries.

2. Carotid sinus and carotid body.

3. Internal jugular vein- draining the superior thyroid, lingual, facial, ascending pharyngeal and occipital veins.

4. Last three cranial nerves

(a) Vagus nerve-the external and internal branches of the superior laryngeal nerve arising from it (inferior to the hyoid bone and medially to external carotid artery)

(b) Spinal accessory nerve

(c) Hypoglossal nerve (crossing the externa land internal acrotid arteries).

5. Carotid sheath

6. Ansa cervicalis.

7. Cervical part of the sympathetic chain.

8. Deep cervical lymph nodes.

Clinical correlation (10,20): The inferior border of this triangle is in cross section/transverse plane at the same level as the anterior tubercle of the transverse process of C6 vertebra (known as the carotid tubercle/Chassaignac tubercle). These anterior tubercles, being the longest of the tubercles of cervical vertebra, can be used to feel the pulsation of the carotid artery by squeezing the artery against the body of the sixth vertebra.

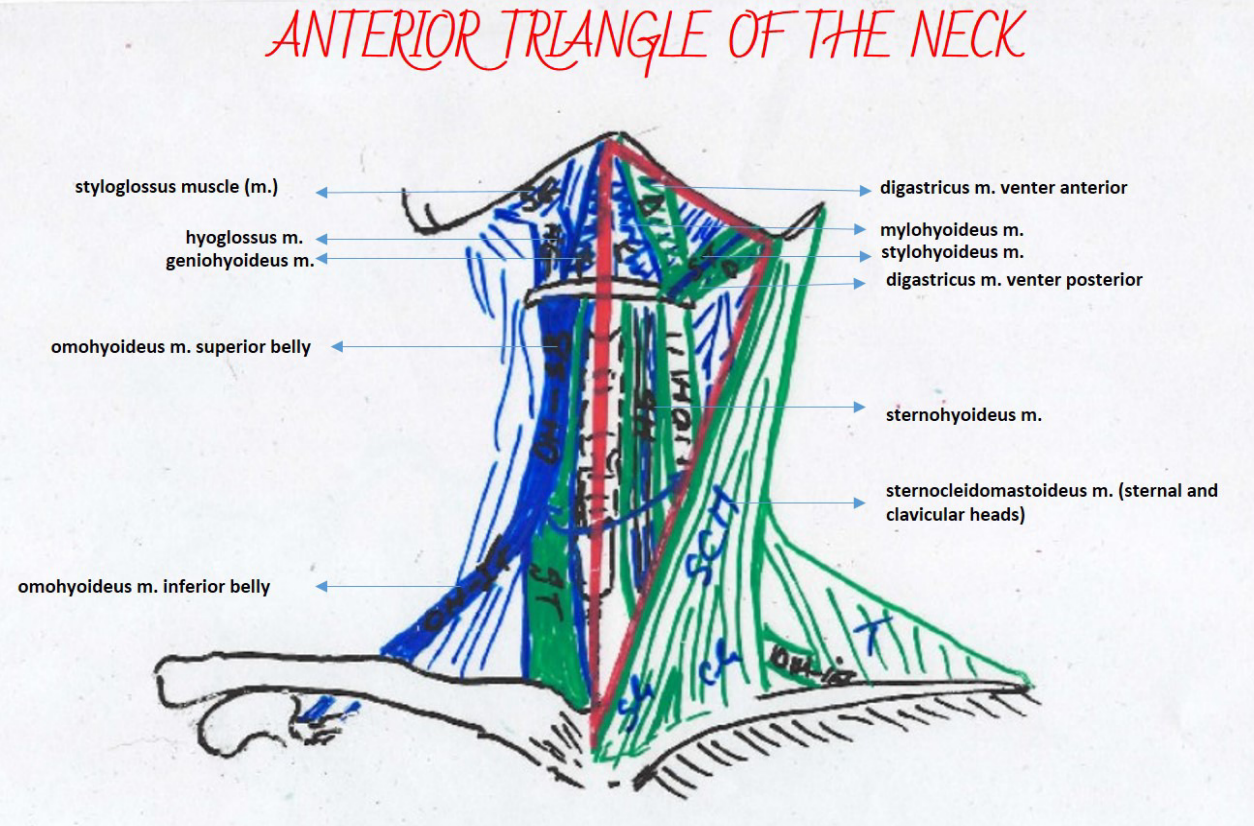


Fig. I.5.1.Muscles of the anterior triangle of the neck used as topographical landmarks

5. Submandibular triangle/digastric (10,19)

Limits

-Anteroinferiorly: Anterior belly of digastric muscle.

-Posteroinferiorly: Posterior belly of digastric muscle-supplemented by stylohyoid muscle.

-Base: Base of the mandible and imaginary –from the angle of the mandible to the mastoid process.

-Apex: formed by the intermediate tendon of the digastric muscle (on the hyoid bone, formed by a fascial sling derived from investing layer of deep cervical fascia).

Floor: It is formed by mylohyoid (anteriorly), hyoglossus, and small part of the middle constrictor

Clinical correlation: The mylohyoid muscle forms an angle between attachment points. Its attachment point on the mandible is inferiorly in the anterior part and superior in the posterior region creating a potential space. So, inflammatory processes of the teeth can spread into this potential submandibular space.

Roof: deep cervical fascia

Content:

-is subdivided into anterior and posterior parts by the stylomandibular ligament.

►The posterior part of the triangle is continuous above with the parotid region.

-usually contains the marginal mandibular branch of the facial nerve

Clinical correlation: Any submandibular incision should avoid this branch of the facial nerve (the incision should be made about 2 cm below the inferior border of the mandible)

►The anterior part of the triangle contains:

1. Submandibular salivary gland.
2. Submandibular lymph nodes.
3. Hypoglossal nerve.
4. Facial vein (lies superficial to the gland).
5. Facial artery (lies deep to the gland).
6. Submental artery.
7. Mylohyoid nerve and vessels.

In the posterior part of the triangle has relation/part of content:

1. External carotid artery.
2. Carotid sheath and its contents.
3. Structures passing between the external and internal carotid arteries (styloglossus muscle, stylopharingeus muscle, glossopharyngeal nerve,vagus nerve-pharyngeal branch)(10).

In the literature 3 small triangles are included inside this digastric triangle and all are named with eponyms: Lesser`s, Pirogov`s and Béclard`s triangles.(19)

►Lesser`s traingle is the triagular space between the hypoglossal nerve and the two bellies of the digastric muscle.

Clinical correlation: In the floor of this triangle is the hyoglossus muscle. The Lesser`s traingle is used to acces the lingual artery which can be found beneath the hyoglossus muscle

► Pirogov`s triangle (Pinaud`s triangle/hypoglossohyoid triangle) mainly represents the posterior part of Lesser`s traingle and has as boundries:

Superiorly: hypoglossal nerve

Inferoposteriorly: the intermediate tendon of the digastric muscle

Anteriorly: posterior border of the mylohyoid muscle

Clinical correlation (19): In this triangle, deep to the hyoglossus muscle the lingual artery is found. This is considered an appropriate location to perform a vascular anastomosis.

► Béclard`s triangle limits are: the posterior belly of the digastric muscle, the posterior border of the hyoglossus muscle and the greater cornu of the hyoid bone.

Clinical correlation(19): This triangle is used for identification of the lingual artery and hypoglossal nerve.

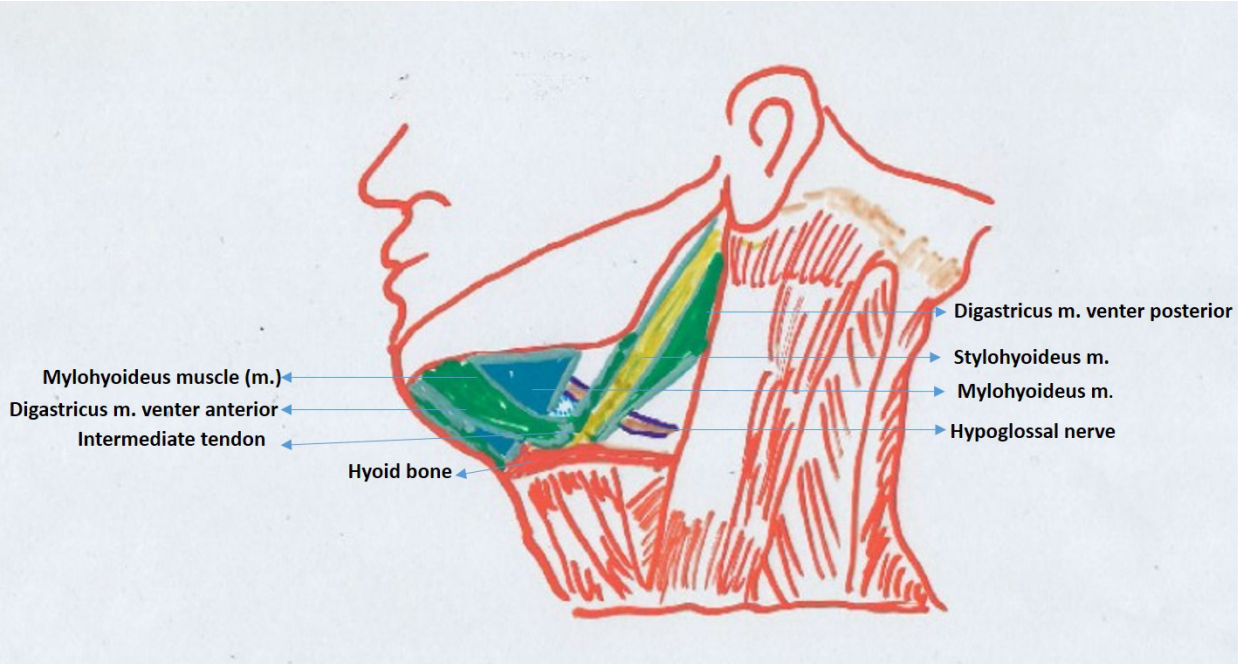


Fig.I.5.2.Structures of the submandibular triangle of the neck used as topographical landmarks

6. Posterior triangle*(10,19):*

- is divided by the inferior belly of the omohyoid muscle into the supraclavicular triangle inferiorly and the occipital triangle superiorly.

Limits:

-Anterior: Posterior border of sternocleidomastoid muscle.

-Posterior: Anterior border of trapezius muscle.

-Inferior (base): Superior aspect of middle third of the clavicle.

-Superior (apex): Meeting point of sternocleidomastoid and trapezius muscles at the superior nuchal line of the occipital bone. (19)

Floor:

The floor of posterior triangle is muscular and is formed from above downwards by the following muscles:

1. Semispinalis capitis.
2. Splenius capitis.
3. Levator scapulae.
4. Scalenus medius.
5. First digitation of serratus anterior (sometimes).

Roof: deep cervical fascia

Content:

-lymph nodes: accessory, inferior deep, transverse cervical groups

-arteries: suprascapular, subclavian

-vein:external jugular

-nerves: accessory, great auricular, transverse cervical, supraclavicular, nerve to the inferior belly of the omohyoid, branches of the thyrocervical trunk, including nerves to levator scapulae, serratus anterior and rhomboid muscles

Clinical correlation: When performing vagus nerve stimulation for the treatment of epilepsy with exposing the cervical part of this nerve the following anatomical structures have to be avoided: common facial vein, internal jugular vein, superior amd middle thyroid veins, accessory nerve, transverse cervical nerve, hypoglossal nerve, C1 and C2 spinal nerves roots and ansa cervicalis

This triangle is divided by the inferior belly of the omohyoid muscle into occipital triangle and supraclavicular (subclavian/omoclavicular) triangle (*19*).

The nerves in the occipital triangle content are:

-accessory nerve

-cutaneous and muscular branches of the cervical plexus

-supraclavicular nerves

-part of the brachial plexus

In the occipital triangle, the transverse cervical artery and lymph nodes (accessory and inferior deep lymph nodes) are located.

The supraclavicular triangle content is represented by subclavian artery and vein and the brachial plexus. In addition, the external jugular vein drains into the subclavian vein. In this triangle, the phrenic nerve located on the surface of the anterior scalene muscle can present an anatomical variation-the accessory phrenic nerve.

Clinical correlation(19): The inferior deep cervical lymph nodes of the supraclavicular triangle drain the larynx (its inferior part), thyroid gland, traches and the scalp (its posterior aspect). In the left supraclavicular group of lymph nodes located around the area of drainage of the thoracic duct, pathological processes of regions such as: the scalp, neck, pectoral, brachial, mediastinal, diaphragm, parotid gland, breast, lung, stomach, esophagus, pancreas, ovaries, can cause aspects of adenopathy of these lymph nodes. The enlargement of the left supraclavicular lymph nodes in known as the Virchow-Troisier sign (fig.4.3).

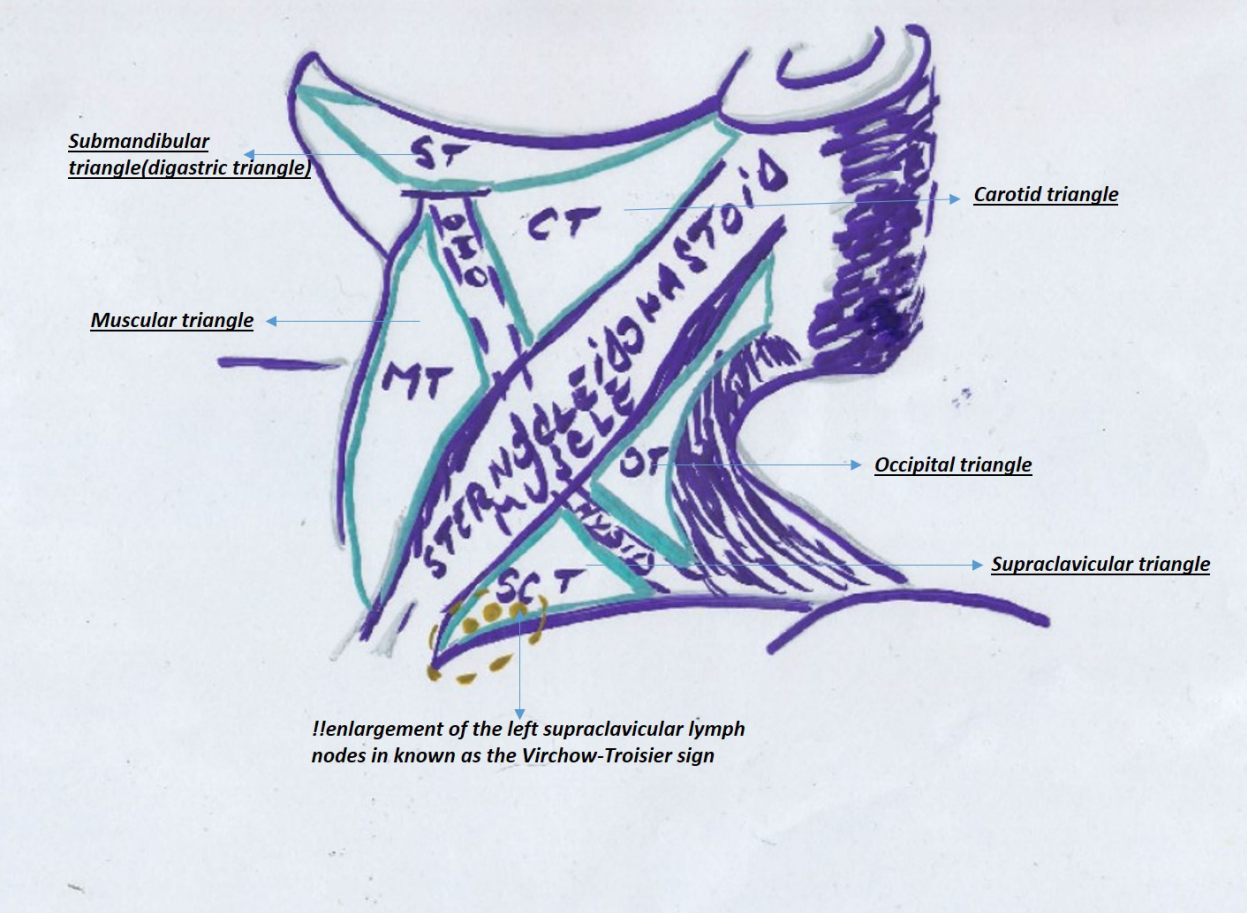


Fig. I.5.3. Head and neck triangles and clinical correlation of the posterior triangle

THE PHARYNX (10)

Task: use the images below to identify and write on each image the boundaries of nasopharynx, laryngopharynx and oropharynx

- **Nasopharynx**

Boundaries

Roof: It is formed by:

- (a) Body of sphenoid.
- (b) Basilar part of the occipital bone

Floor: It is formed by:

- (a) Soft palate (sloping upper surface).
- (b) Pharyngeal isthmus= an opening in the floor (between the free edges of soft palate and posterior pharyngeal wall)

Anterior wall: It is formed by posterior nasal apertures

- separated by the posterior edge of nasal septum.

Posterior wall: It forms continuous sloping surface with roof.

- It is supported by anterior arch of C1 vertebra.

Lateral wall: Medial pterygoid plate of sphenoid.

Fig. I.5.4 Nasopharynx boundaries

OROPHARYNX

- lies behind the oral cavity and extends from the lower surface of the soft palate above to the upper border of epiglottis below.

- **Boundaries**

Roof: It is formed by:

- (a) Soft palate (under surface).
- (b) Pharyngeal isthmus through which it communicated with the nasopharynx.

Floor: It is formed by:

- (a) Posterior 1/3rd of the tongue.
- (b) Interval between the tongue and epiglottis.

Anterior wall: It is incomplete and formed by:

- (a) Oropharyngeal isthmus (through which it opens into the oral cavity).
- (b) Pharyngeal part of the tongue.

Posterior wall: It is formed by body of C2 vertebra and upper part of the body of C3 vertebra.

Lateral wall: On each side, it is supported by - pterygomandibular raphe, mandible, tongue, and hyoid bone.

Fig. I.5.5 Oropharynx boundaries

LARYNGOPHARYNX

- **Boundaries**

Anterior wall: It is formed by:

- (a) Laryngeal inlet.
- (b) Posterior surface of the larynx.

Posterior wall: It is supported by the bodies of C3, C4, C5, and C6 vertebrae.

Lateral wall: It is supported by thyroid cartilage and thyrohyoid membrane.

Fig.I.5.6 Laryngopharynx boundaries

MUSCLES OF THE PHARYNX (10)

1.CONSTRICTOR MUSCLES

Table.I.5.1. Constrictor muscles of the pharynx

Muscle	Origin	Insertion	Nerve supply	Action
Superior constrictor /Quadrilateral in Shape	(a) Pterygoid hamulus (b)Pterygomandibular raphe (c) Medial surface of the mandible at the upper end of mylohyoid line (d) Side of the posterior part of the tongue	(a) Pharyngeal tubercle on the base of skull (b) Median fibrous raphe	Pharyngeal branch of the vagus nerve carrying fibres of cranial root of the accessory nerve	Helps in deglutition
Middle constrictor (Fan shaped)	(a) Lower part of the stylohyoid ligament (b) Lesser cornu of hyoid (c) Upper border of greater cornu of hyoid	Median fibrous raphe	Pharyngeal branch of The vagus nerve carrying fibres of cranial root of the accessory nerve	Helps in deglutition
Inferior constrictor (a)Thyropharyngeus	Oblique line on lamina Of the thyroid cartilage (b) Tendinous band between the thyroid (inferior) tubercle and cricoid cartilage	Median fibrous raphe	(a) Pharyngeal plexus and (b) External laryngeal nerve	Helps in deglutition
(b) Cricopharyngeus	Cricoid cartilage	Median fibrous raphe	Recurrent laryngeal nerve	

2. LONGITUDINAL MUSCLES

Table.I.5.2. Longitudinal muscles of the pharynx

Muscle	Origin	Insertion	Nerve supply
Stylopharyngeus	Medial surface of the base of styloid process	Posterior border of the lamina of thyroid cartilage	Glossopharyngeal (IX) nerve
Palatopharyngeus	By two fasciculi (anterior and posterior) from the upper surface of the palatine aponeurosis	Posterior border of the lamina of thyroid cartilage	Cranial root of 11th cranial nerve by pharyngeal plexus
Salpingopharyngeus	Lower part of the cartilage of the auditory tube	Posterior border of the lamina of thyroid cartilage	Cranial root of 11th cranial nerve by pharyngeal plexus

THE LARYNX (10)

Skeletal framework:

1. **cartilages**

-unpaired: thyroid, cricoid, epiglottis

-paired: arytenoids, corniculate, cuneiform

2. **ligaments:**

- thyroepiglottic, vestibular ligaments, vocal ligaments (can be found posterior to the surface of the thyroid cartilage:)

-tyrohyoid membrane (contains in its substance cartilage-triticea and it is pierced by internal laryngeal nerve and superior laryngeal vessels)

- cricotracheal ligament (between cricoid cartilage with the first tracheal ring)

- thyroepiglottic ligament (from the lower narrow end of epiglottis to the posterior surface of thyroid angle)

-hyoepiglottic ligament (from the posterior aspect of hyoid to the anterior surface of the superior end of epiglottis)

-cricothyroid ligament (from the inferiorr border of the thyroid cartilage to the cricoid cartilage in the midline)

3. **fibrous membranes**

- cricovocal membrane -it is slightly thickened to form the vocal ligament and it is covered by a mucous membrane forming the vocal fold.

-vocal ligament consists of elastic tissue

- quadrangular membrane – identified from sides of epiglottis to the arytenoids and it is thickened to form the vestibular ligament.

The vestibular ligament is fibrous tissue extending from posterior surface of the thyroid cartilage to the lateral surface of the arytenoid cartilage.

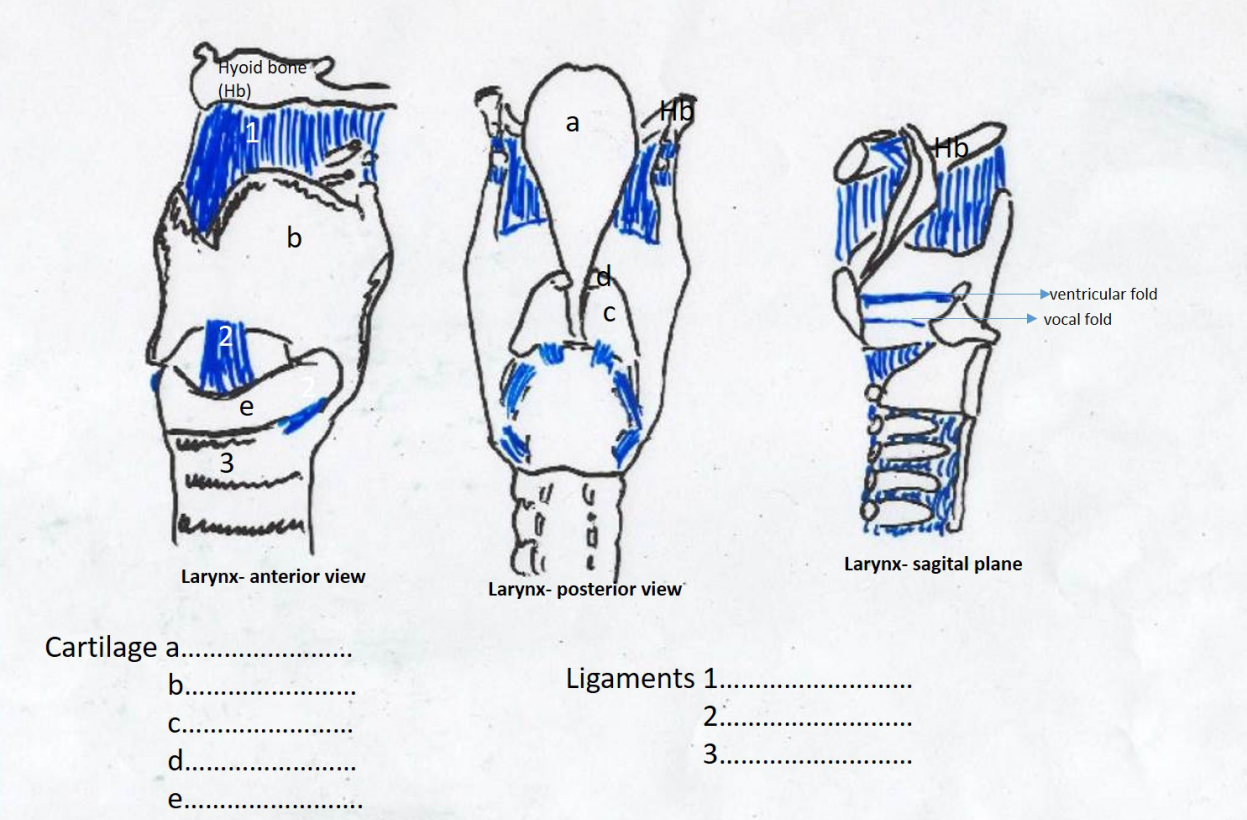


Fig. I.5.7. Identify the cartilages and ligaments of the larynx

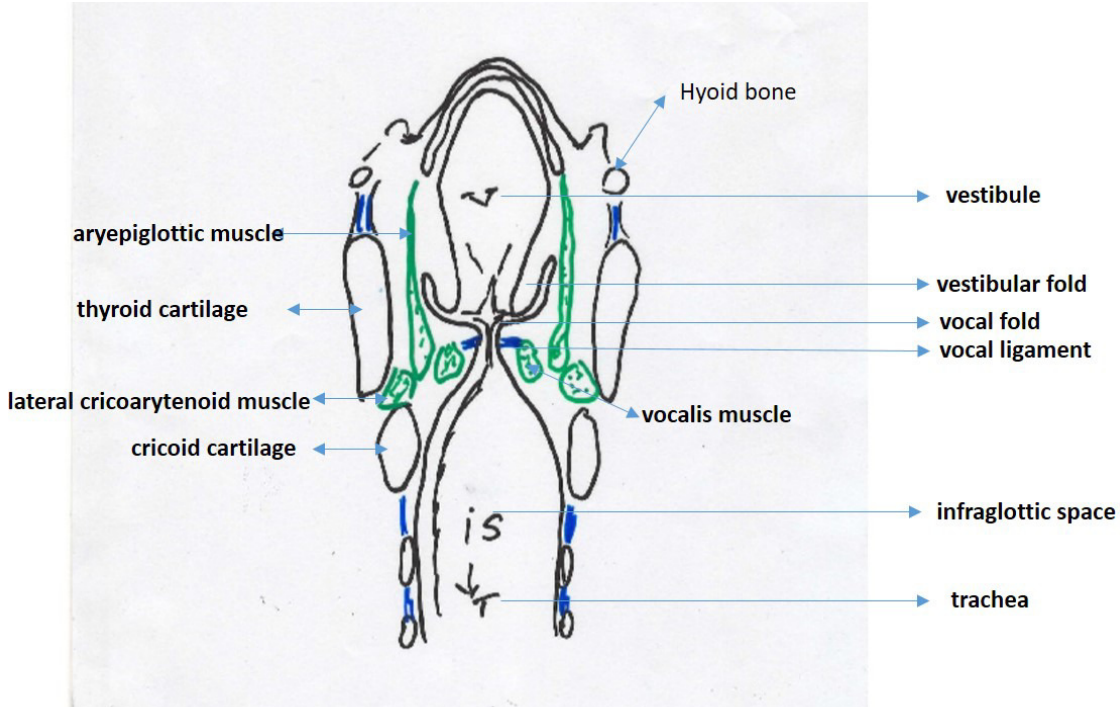


Fig. I.5.8. Larynx-cross section

Table I.5.3. Extrinsic suprahyoid muscles of the larynx (action: move the larynx up and down)

Suprahyoid muscles (21)	Origin	Insertion	Innervation
Geniohyoid	Inner(medial) surface mandible	Hyoid bone	C1 (through hypoglossal nerve)
Mylohyoid	Mandible	Hyoid bone	Trigeminal nerve (mandibular division-inferior alveolar nerve
Digastric-anterior belly	Inner surface mandible (inferior border)	Hyoid bone	Trigeminal nerve (mandibular division-inferior alveolar nerve)
Digastric-posterior belly	Mastoid process of temporal bone	Hyoid bone	Facial nerve
Stylohyoid	Styloid process	Hyoid bone	Facial nerve

Table I.5.4 Extrinsic infrahyoid muscles of the larynx (action: move the larynx up and down)

Infrahyoid muscles (10,21)	Origin	Insertion	Innervation
Sternothyroid	Sternum (manubrium)	Thyroid cartilage (oblique line)	Ansa cervicalis (C1-C3)
Thyrohyoid	Thyroid cartilage (oblique line)	Hyoid bone	C1 (C1 (through hypoglossal nerve)
Omohyoid	Scapula	Hyoid bone	Ansa cervicalis (C1-C3)
Sternohyoid	Sternum (manubrium) and sternoclavicular joint	Hyoid bone	Ansa cervicalis (C1-C3)

Table I.5.5. Intrinsic muscles of the larynx (action: on the vocal ligament/vocal folds/arytenoid cartilages)

Muscles (10,21)	Origin	Insertion	Innervation
Cricothyroid	Cricoid cartilage	Inferior horn and inferior margin of the thyroid carilage	External laryngeal nerve (branch of superior laryngeal nerve)
Thyroarytenoid	Angle of the thyroid cartillage	Arytenoid cartilage	Inferior laryngeal nerve (branch of recurent laryngeal)
Posterior cricoarytenoid	Cricoid cartilage	Arytenoid cartilage (its muscular process)	Inferior laryngeal nerve (branch of recurent laryngeal)
Lateral cricoarytenoid	Cricoid cartilage	Arytenoid cartilage (its muscular process	Inferior laryngeal nerve (branch of recurent laryngeal)
Transverse and Oblique arytenoids	Arytenoid cartilage	Opposite arytenoid cartilage	Inferior laryngeal nerve (branch of recurent laryngeal)

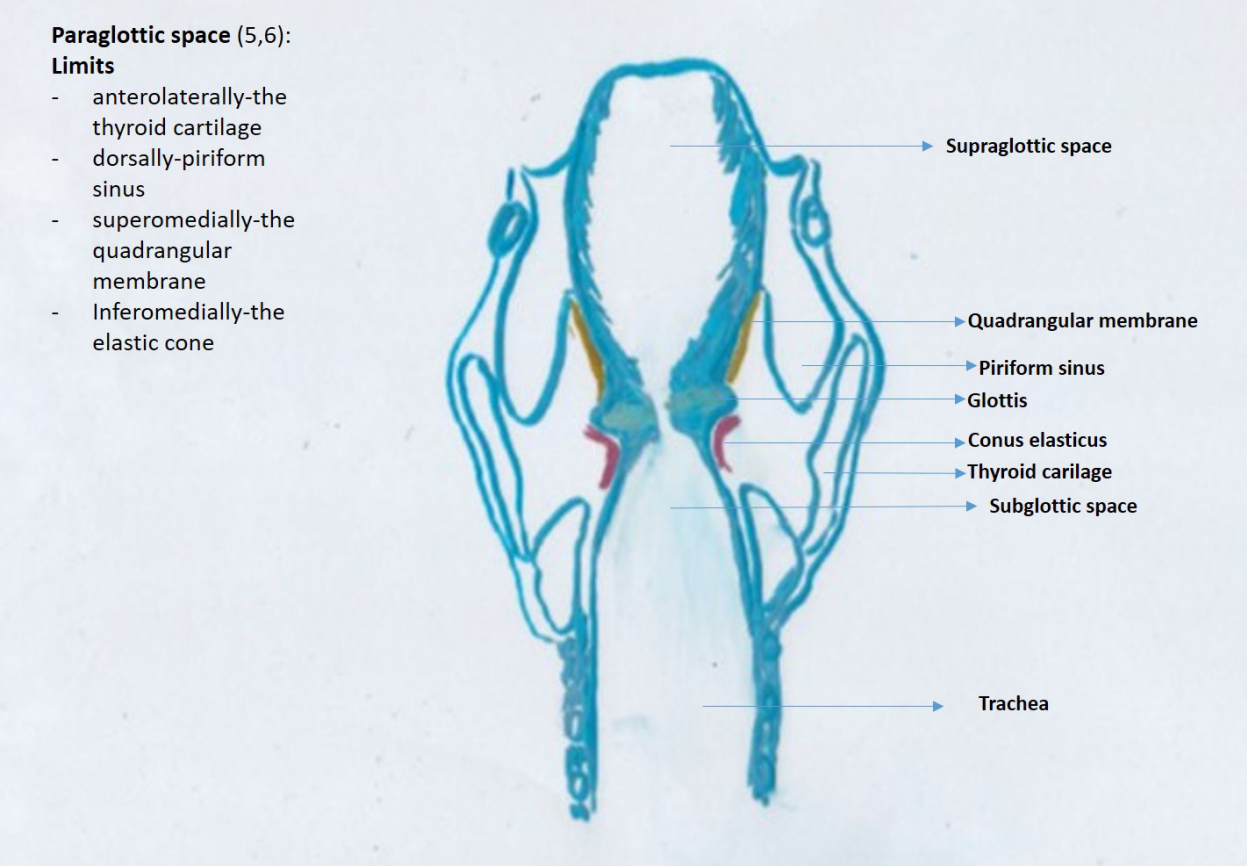


Fig. I.5.9 Paraglottic space boundaries-important structure for assessment the stages of invasion for laryngeal cancer

The paraglottic space :

-content is represented by loose connective tissue, adipose tissue, vessels (superior laryngeal vessels) and nerves (internal branch of the superior laryngeal nerve)

-communications-anterosuperiorly with preepiglottic space, anteroinferiorly with prelaryngeal tissues and posterosuperiorly with deep neck spaces (22,23)

THE THYROID GLAND (10,24)

-is a ductless endocrine gland that secrete the products (hormones) in the blood. The hormones secreted by the thyroid gland include **triiodothyronine (T3)**, **tetraiodothyronine** (**T4**; commonly called *thyroxine*), and **calcitonin**, which the following functions:

1. Regulation of the basal metabolic rate.
2. Stimulation the psychosomatic growth of the body
3. Has an important role in calcium metabolism.

Clinical correlation: 1. It is the only endocrine gland, which is located superficially in the body (accessible for physical examination).2. It is the only endocrine gland that depends on external factors-the iodine, to synthesize its hormones.

3. It is the only endocrine gland that stores its hormones and then releases them in blood for use as and when needed (so it does not pour its products into blood immediately after formation)

4. The thyroid gland is located in the anterior lower part of the neck opposite to the C5, C6, C7, and T1 vertebrae, embracing the upper part of the trachea

The thyroid gland:

- It is H-shaped
- Consists of vertical right and left lateral lobes and a horizontal isthmus connecting them across the midline.
    - Sometimes in the midline a small **pyramidal lobe can be found. This lobe** projects upwards from the isthmus (usually to the left of the midline). The pyramidal lobe can be connected to the body of the hyoid bone by a fibrous or fibromuscular structure : the **levator glandulae thyroideae.**
- Extensions:Superiorly, each lateral lobe of the gland extends upwards to the oblique line of the thyroid cartilage and inferiorly up to the 5th or 6th tracheal ring.The isthmus extends in front of the 2nd, 3rd, and 4th tracheal rings
- Weight: about 25 g.
- Dimensions: each lobe of the thyroid gland is approximately 5/3/2 cm with the isthmus measuring about 1.25 cm (vertical and transverse diameters, both).
- Has two capsules:
    1. Inner-a true capsule represented by the peripheral condensation of the fibrous stroma of the gland. A dense venous plexus lies deep to this capsule

Clinical correlation: To avoid hemorrhage during thyroidectomy, the thyroid gland has to be excised along with the true capsule.

2. Outer-false capsule: formed from the splitting of the pretracheal fascia.

Clinical correlation (10,24.):

(a) The false capsule is thin along the posterior border and thick on the medial surface of the lateral lobe.

(b) On the area of the medial surface of thyroid lobe the false capsule thickens to form the ligamentum suspensorium glandulae thyreoideae (suspensory ligament of Berry), which connects the lobe to the cricoid cartilage.

(c)inferior and middle thyroid veins and superior thyroid vessels are enclosed by the false capsule forming a structure similar with the mesentery by atacching to the gland. This structure can be used as a landmark to avoid injury to the recurrent laryngeal nerve, inferior thyroid artery and parathyroiid glands which all are located inferior to it.

PARATHYROID GLANDS (10):

- Are small yellowish-brown **paired** endocrine glands located along the posterior borders of the thyroid lobes
- These glands secrete the *parathormone* -a hormone with the function of maintaining the blood calcium level by mobilizing the calcium from the bones (an action opposite to that of *calcitonin)*
- *Location*

-the **superior parathyroid** lies at the middle of the posterior border of the thyroid lobe superior to the level at which inferior thyroid artery crosses the recurrent laryngeal nerve.

-the **inferior parathyroid** lies on the posterior border of the thyroid lobe near its lower pole, below the inferior thyroid artery. The position of the inferior parathyroid glands may vary and can be found:(1) within the thyroid capsule, below the curve made by the inferior thyroid artery, (2) outside the capsule, above the curve made by the thyroid artery, or (3) within the parenchima of the thyroid gland.

I.6. Practical skills in anatomy laboratory

A. Multiple choice questions (MCQs)

1. A patient is complaining of headaches and problems when eating. in the examination room, the clinician notices that the patient's tongue deviates to the left when the protusion is made. A MRI scan reveals a tumor affecting a cranial nerve. Which nerve is affected?
   a. Oculomotor nerve
   b. Hypoglossal nerve
   c. Vagus nerve
   d. Maxillary nerve
   e. None of the above

   Justify your answer……..

2. A patient has difficulty in closing the eye. Which cranial nerve is affected?
   a. Oculomotor nerve
   b. Optic nerve
   c. Vagus nerve
   d. Maxillary nerve
   e. Facial nerve
   Justify your answer……..

3. A 22-year old patient presenting after a head injury with a visible scalp area with signs of a trauma, without any external bleeding but with elevated blood pressure, pupil dilatation, slow pulse and irregular breathing. What tests will you make at the initial presentation of this patient:
   a. urine testing
   b. MRI
   c. CT
   d. Angiography
   e. Bone biopsy
   and what is your initial diagnosis?

Justify your answer……..

4. A 2-year old child presents with widening of knees, craniotabes (soft skull), delayed dentition, frontal bossing, persistent fontanelle, apathetic, irritable, lower body weight. At the examination the sternum is looking outward (pigeon chest) and with swellings of the ends of ribs (like rosary beads under the skin). Your initial diagnosis is:

a. Osteomalacia
b. Osteoporosis
c. Ricketts
d. Respiratory infection
e. None of the above

Justify your answer **after reading the following definitions** (2, 12-15)**:**

Osteomalacia-a disease that usually occurs in adults as a defect in mineralization of the bone matrix and weakens the bones, causing them to break easely. The patients have symptoms like: pain in the hips, bone fractures and muscle weakness

Rickets-a inherited or acquired condition with deficit of main factors that influence bone maturation and mineralization. Rickets and osteomalacia occur together in children. In rickets a defect in mineralization and widening of the epiphyseal plate is described.

Osteoporosis- a disease occurring mostly in adults after the age of 50 years old with weak and brittle bones occurring when the synthesis of new bone does not keep up with the loss of the old bone. Osteoporosis has as complication pathologic fractures of the hip, wrist or vertebral column. Some patients develop a thoracic deformity called kyphosis

►Useful tests: vitamin D levels, calcium and phosphate levels, X-rays, a bone mineral density scan

5. A 27-year old patient was brought in the emergency room after a car accident with a lesion in the temporal region. On the noncontrast CT a hiperdense biconvex-shaped mass was described consistent with aspects of blood accumulation. Your initial diagnosis is:

a. epidural hematoma
b. subdural hematoma
c. subgaleal hematoma
d. most likely arterial bleeding
e. most likely venous bleeding

B.Skull bones- Analyze the images and make a diagnosis

Fig. I.6.1a

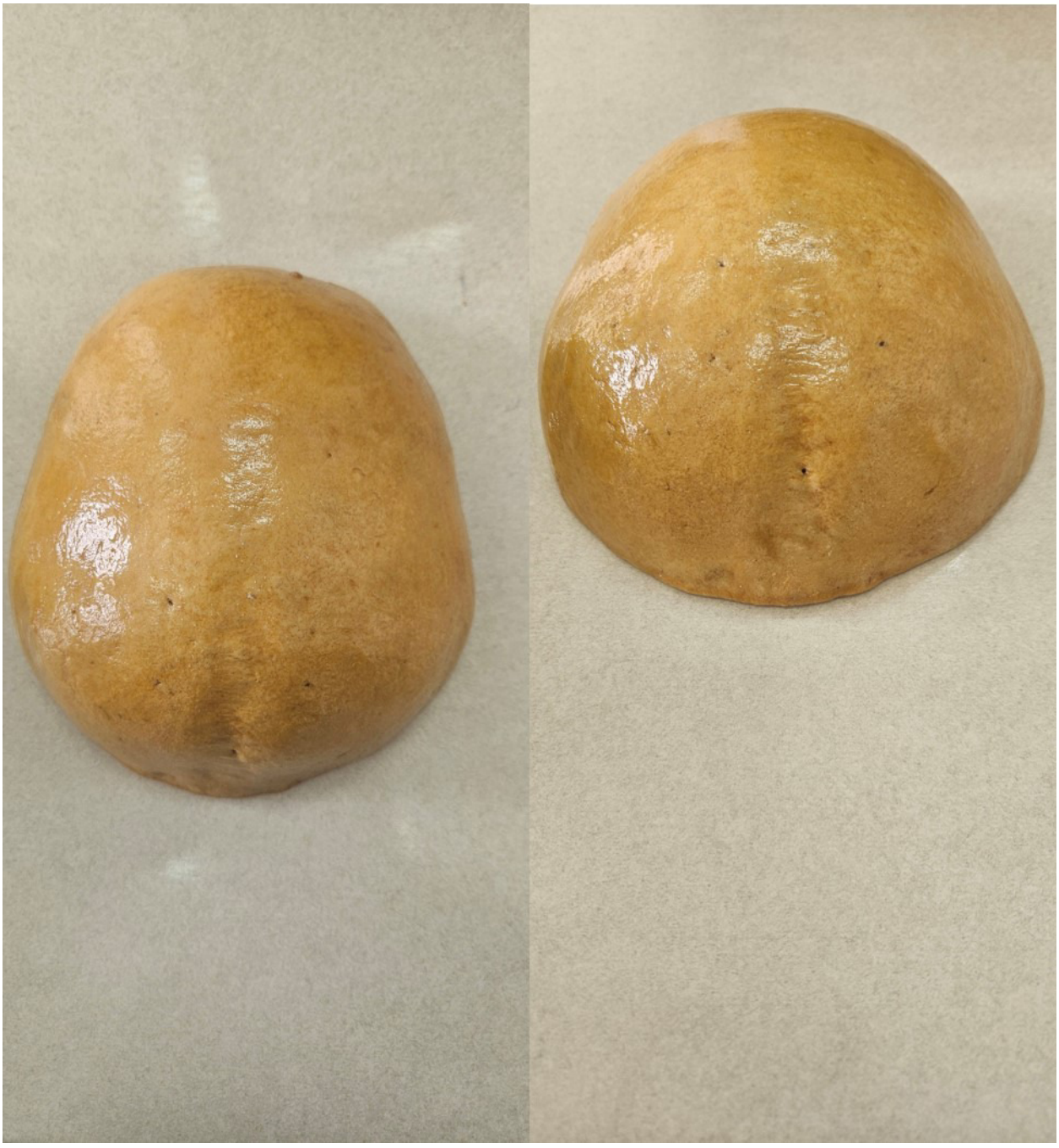


Fig. I.6.1b

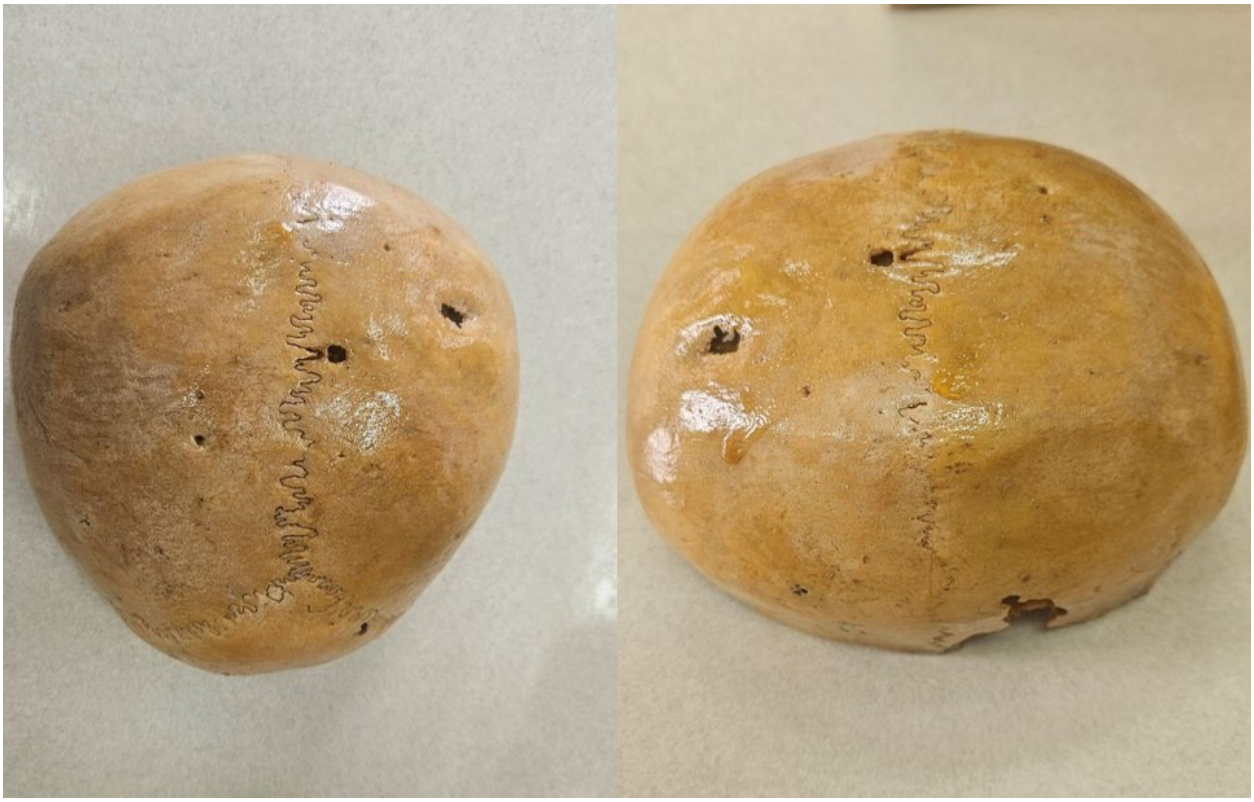


Fig. I.6.2

C. Dissection- Identify the marked structures

Fig. I.6.3

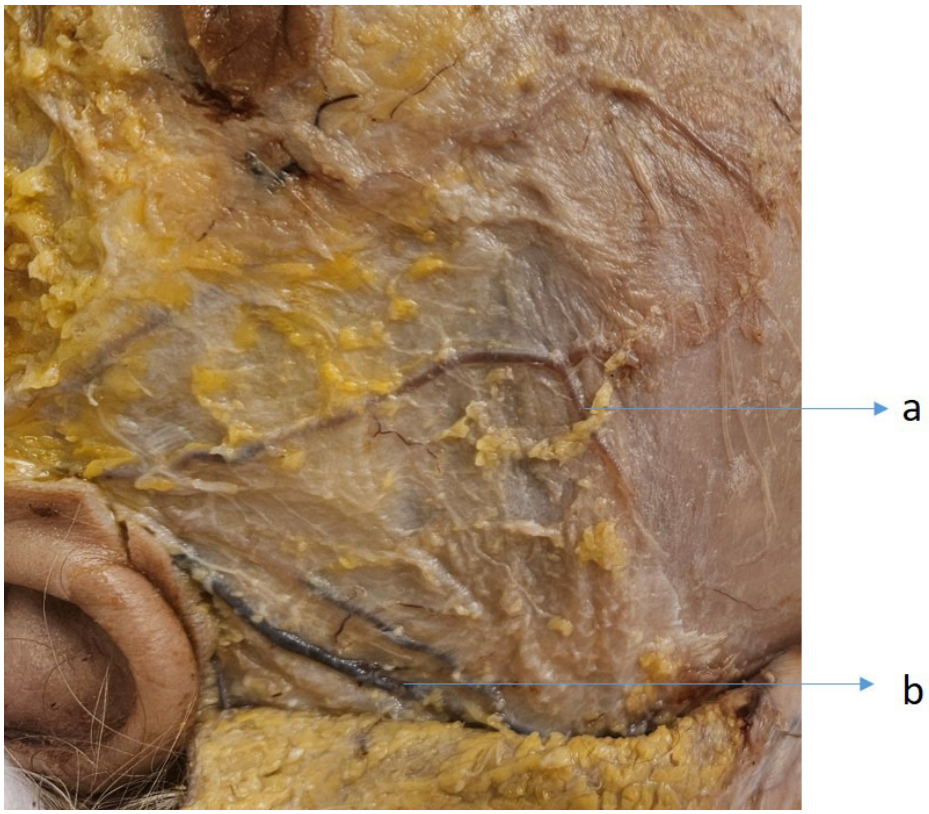


Fig. I.6.4

Fig. I.6.5

Fig. I.6. 6

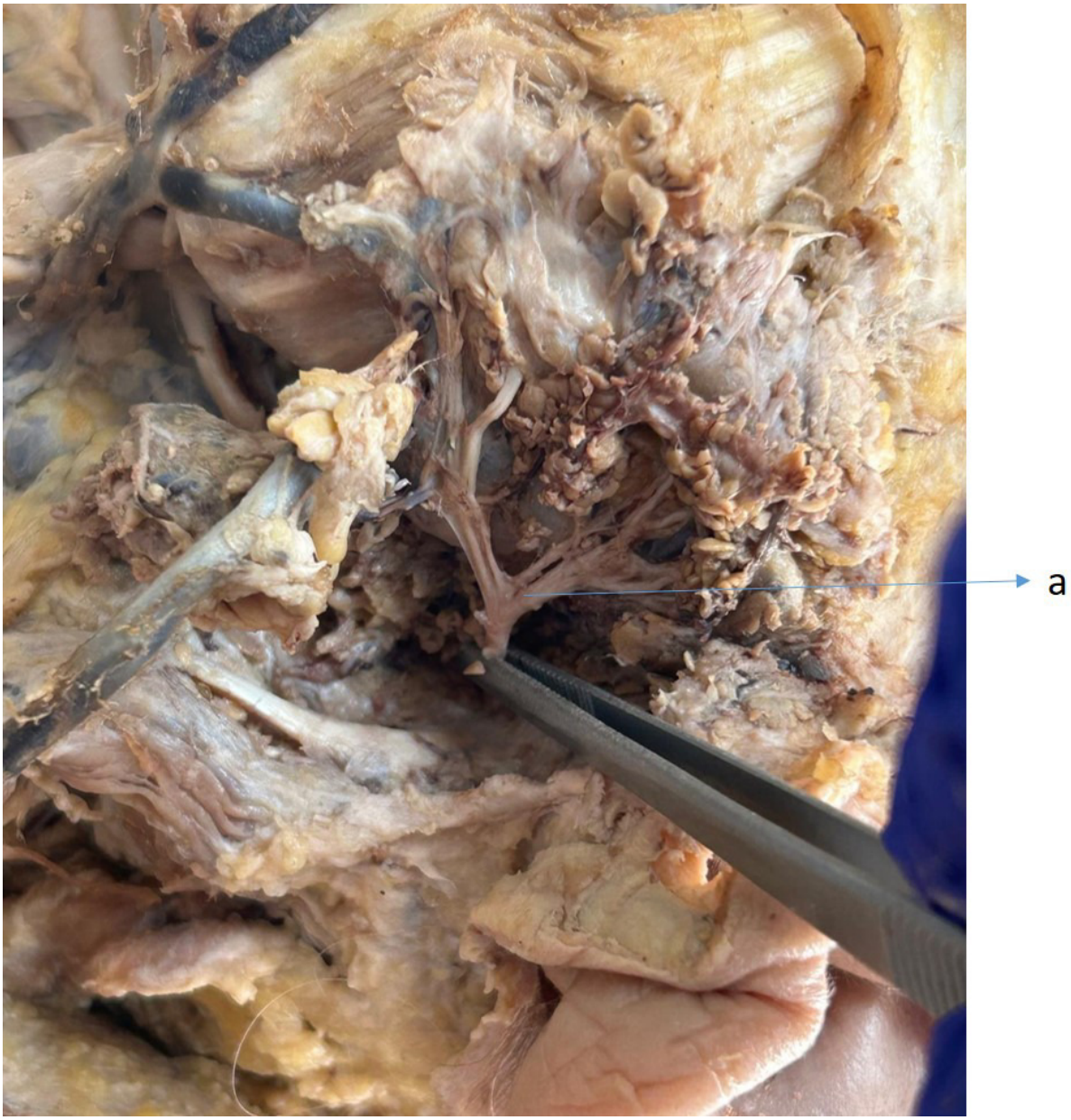


Fig. I.6.7. Facial nerve

Answers

A.MCQs

1. Hypoglossal nerve. That`s why- hypoglossal nerve moves the tongue and its muscles, but the protusion is made with genioglossus. An unilateral palsy of the hypoglossal nerve will deviate the tongue in protusion
2. Facial nerve. That`s why-facial nerve is the sfincter of the eye. Levator palpebrae superioris elevates the upper lid, oculomotor moves the eyeball
3. Noninvasive tests (CT, RMN). Initial diagnosis –hematoma
4. Osteomalacia and rickets
5. Epidural hematoma (biconvex mass)

B. Bones

Fig I.6.1.a,b Craniosynostosis (inner and outer aspect of the calvaria)-lambdoid suture is affected. The sagittal suture the suture is widened compensatory. The calvaria in I.6.1a image has bone areas of variable thickness, suggestive of different ossification of the bone centers.

I.6.2Skull with metopic suture and wormian bone in the lambda suture

C. Dissection

Fig.I.6.3. a-components of the medial frontal pedicle; b- components of the lateral frontal pedicle

Fig.I.6.4 a-temporal artery; b-temporal vein

Fig.I.6.5. a-facial artery;b-facial vein; c-parotid duct

Fig.I.6.6. a-depressor anguli oris muscle;b-submandibular salivary gland; c-buccinator muscle; d-retromandibular vein; e-masseter muscle;f-parotid gland (dissected)

Fig.I.6.7. a-facial nerve

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CHAPTER II. THE UPPER, LOWER LIMB AND POSTERIOR REGIONS OF THE TRUNK

ALEXANDRA CORINA FAUR
LUCIAN SORIN BOLINTINEANU
ALINA MARIA ȘIȘU

II.1. The upper limb

II.1.1. Dissection of the axilla with the study of the walls and contents, anatomical and clinical aplications

The axilla is located at the root of the upper limb between the upper thoracic wall and the arm. It cand be imagined as a quadrulater piramid shaped space containing noble anatomical elements that decend to the upper limb and lie in soft fatty tissue. In the following material we will discuss the four walls of the axila, it's base and apex and the contents that give this region many clinical aplications, aswell as technical surgical difficulties [1,2].

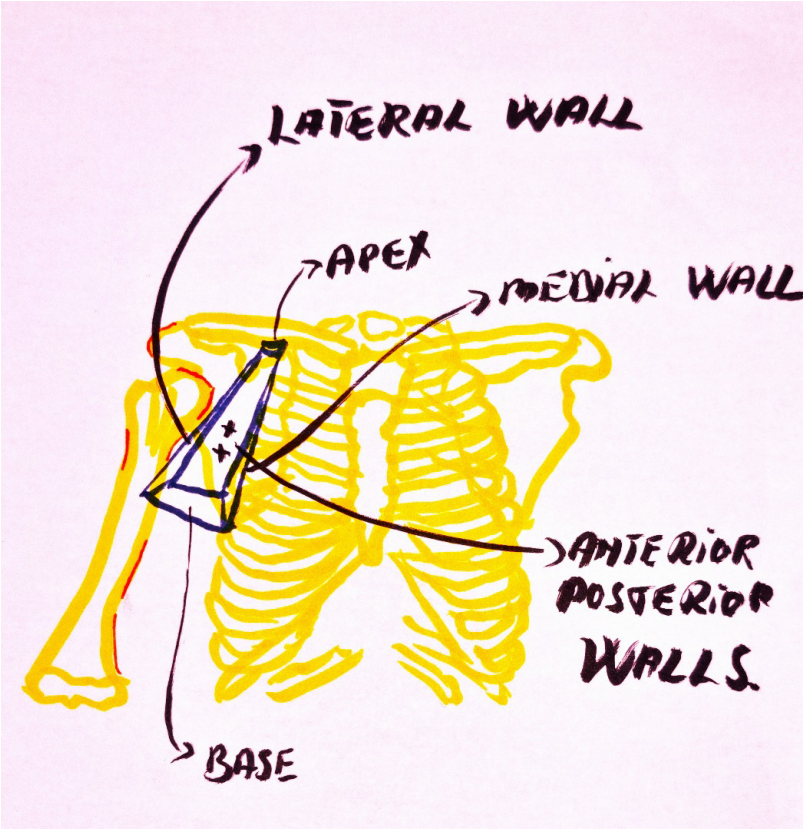

Fig. II.1: location and shape of axilar region.

In geometrical terms the axila has the shape of a quadrangular pyramid with the long axis oriented obliquely from superior to inferior and from medial to lateral (**fig.II.1**). It's apex is sitiuated proximally and medially and it's base is sitiuated distally and laterally. It has an anterior wall, posterior, medial and lateral wall [1].

The four walls of the axilla are limited as follows [1,2] :

Anterior wall

Is formed by the pectoralis major and minor muscles and subclavius muscle and presents the following boundaries:

-superiorly = the clavicle.

-inferiorly = the inferior margin of the pectoralis major muscle.

-laterally = the medial margin of the deltoid muscle.

-medially = an imaginary line that unites the coracoid process of the scapula with the inferior margin of the pectoralis major muscle.

Posterior wall (fig II.2.2)

Is formed by the subscapularis muscle, latissimus dorsi muscle and terres major muscle. The way these muscles insert and intertwine, three geometrical spaces take birth with anatomic relevance:

-**a**-the birondo tricipital triangle is bounded by terres major muscle inferiorly, terres minor muscle superiorly and the long head of the triceps brachialis muscle laterally. This triangle contains the subscapulary vessels.

-**b**-the humero-rondo-tricipital triangle: bounded by the humerus laterally, terres major muscle superiorly and the long head of the triceps brachialis muscle medially. This triangle gives passage to the radial nerve and deep brachial artery.

-**c**-the humero-birondo-tricipital quadrulaterus bounded by the humerus laterally, long head of the triceps brachialis muscle medially, terres minor muscle superiorly and terres major muscle inferiorly. This space gives passage way to the axillary nerve and the posterior humeral circumflex arteries.

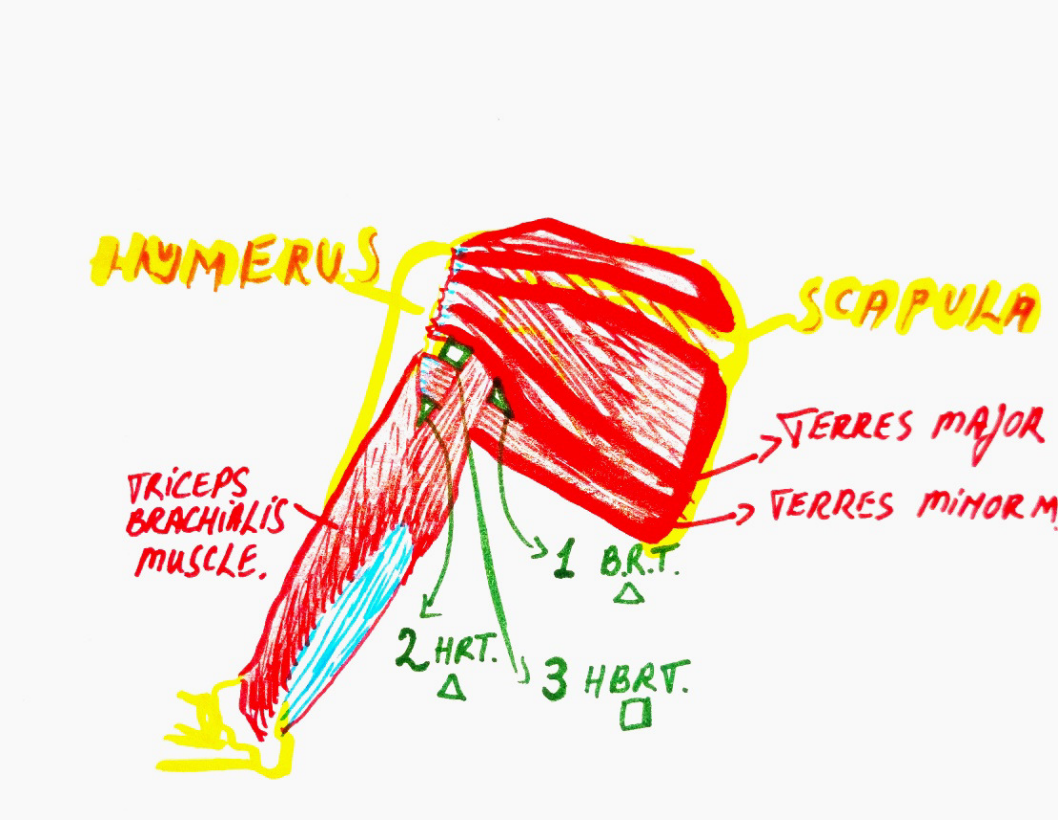

Fig. II.2: muscles of the posterior wall of the axila and anatomical spaces containing noble structures. BRT-birondo tricipital triangle. HRT-humero rondo tricipital triangle. HBRT-humero birondo tricipital quadrulaterus.

Medial wall

Is formed by the serratus anterior muscle, first 5 ribs and intercostal muscles.

Lateral wall

Is formed by the coracobrachialis muscle, biceps brachialis muscle and the intertbercular groove of the proximal humerus.

The medial and lateral walls are best visualized on a transverse section demonstrating the boundaries of the axila. (**fig. II.3**).

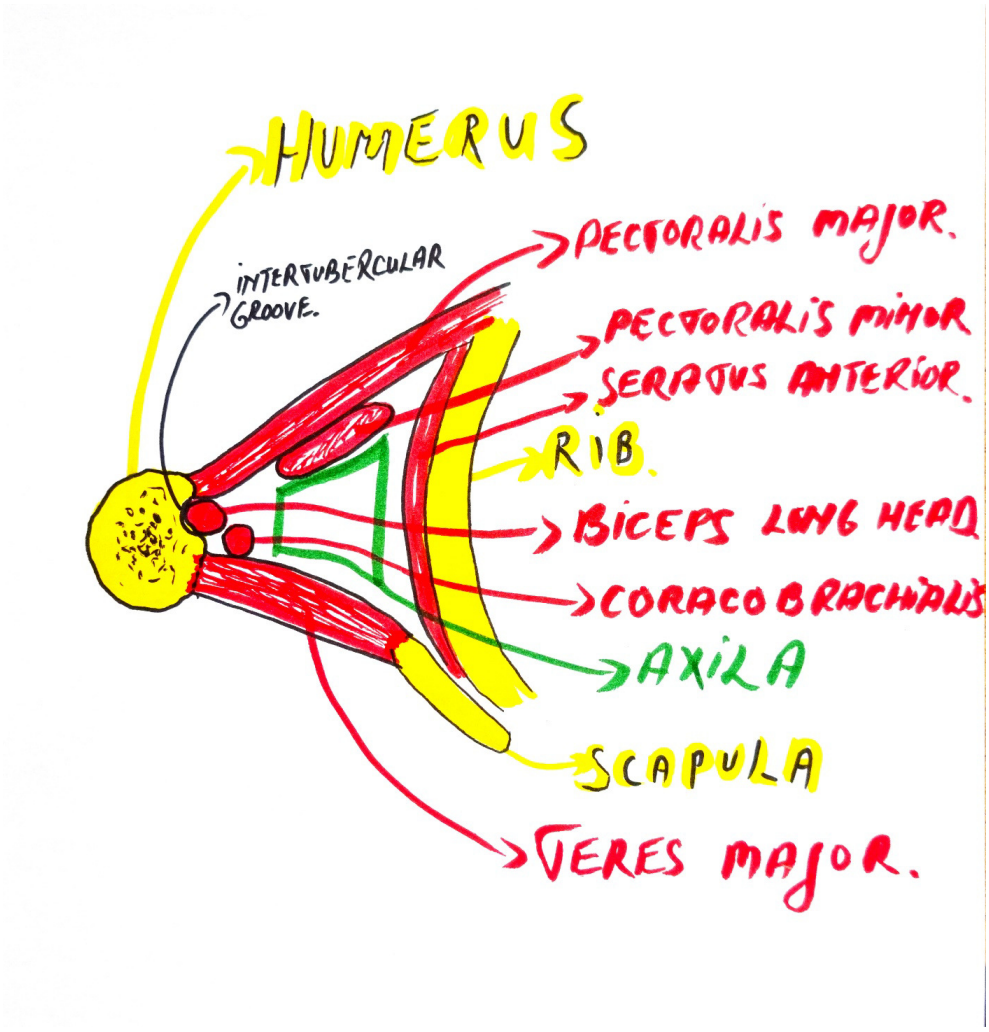

Fig. II.3: transverse section demonstrating the walls of the axilla, mainly the medial and lateral walls.

Contents of the axila make this region a challenging one especially from the surgical technique point of view, because within the axila we can find the brachial plexus with its terminal nerves, the axillary artery and vein, accompanied by limfatics organized in 5 groups of limphnodes with clinical importance. All these structures lie in a soft subcutaneous fatty tissue that allows for good clinical examination of the contents.

The axillary artery (fig.II.4): continues the subclavian artery and is continued distally by the brachial artery. Within the axila it has three segments relative to its relations to the pectoralis minor muscle as follows:

-first segment : is considered from the scalenus anterior muscle until the medial border of the pectoralis minor muscle. Branches include: *superior thoracic artery* and a few *inconstant subscapular arteries.*

-second segment is the portion of the axillary artery that lies behind the pectoralis minor muscle. Branches of this segment include: *thoraco-acromial artery* and *lateral thoracic artery.*

-third segment extends from the lateral border of the pectoralis minor to the point where the axillary artery becomes the brachial artery which is at the level of the inferior border of pectoralis major muscle. Branches of this segment include: *subscapular artery*, *anterior and posterior circumflex arteries.*

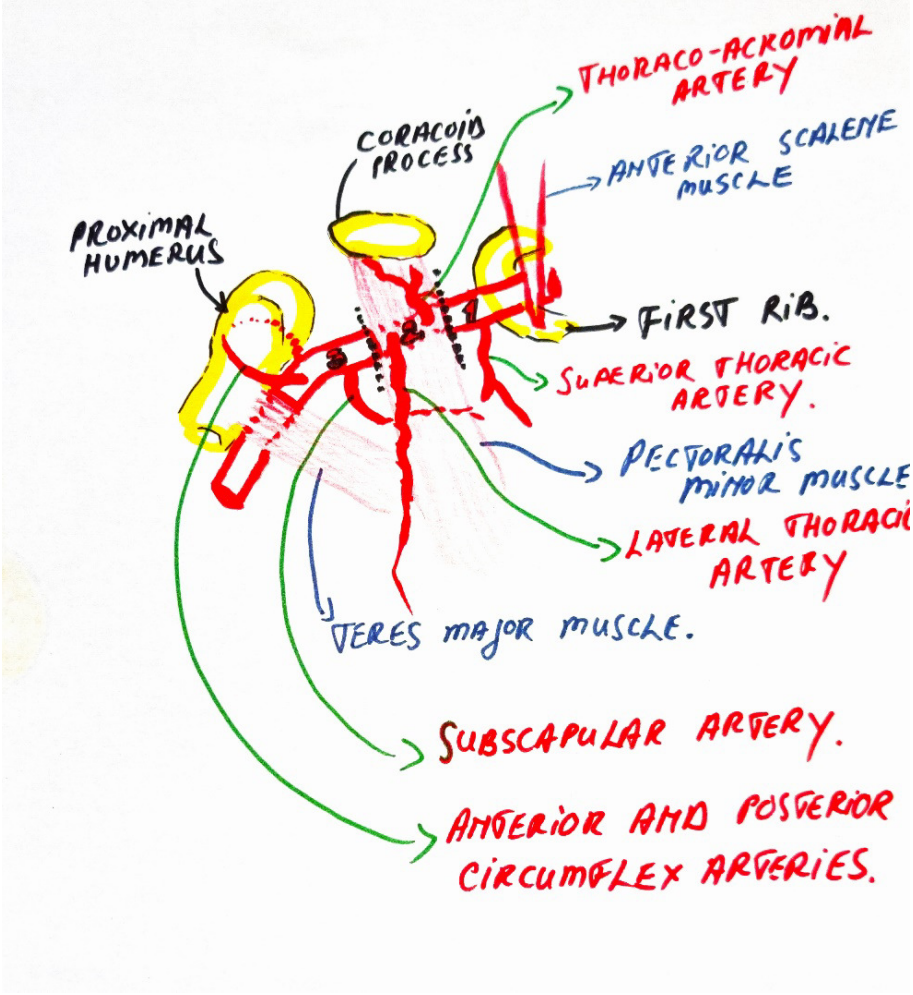

Fig. II.4: Axillary artery with its three segments and main branches in relation to the pectoralis minor muscle.

The axilary vein has omonim tributaries as the arterial branches and drain in the subclavian vein.

The Brachial plexus is formed from the nerve roots C5-T1, and form a complex network of nerve fibers that supply sensitive and motor innervation to the entire upper limb[1,2,3,4].

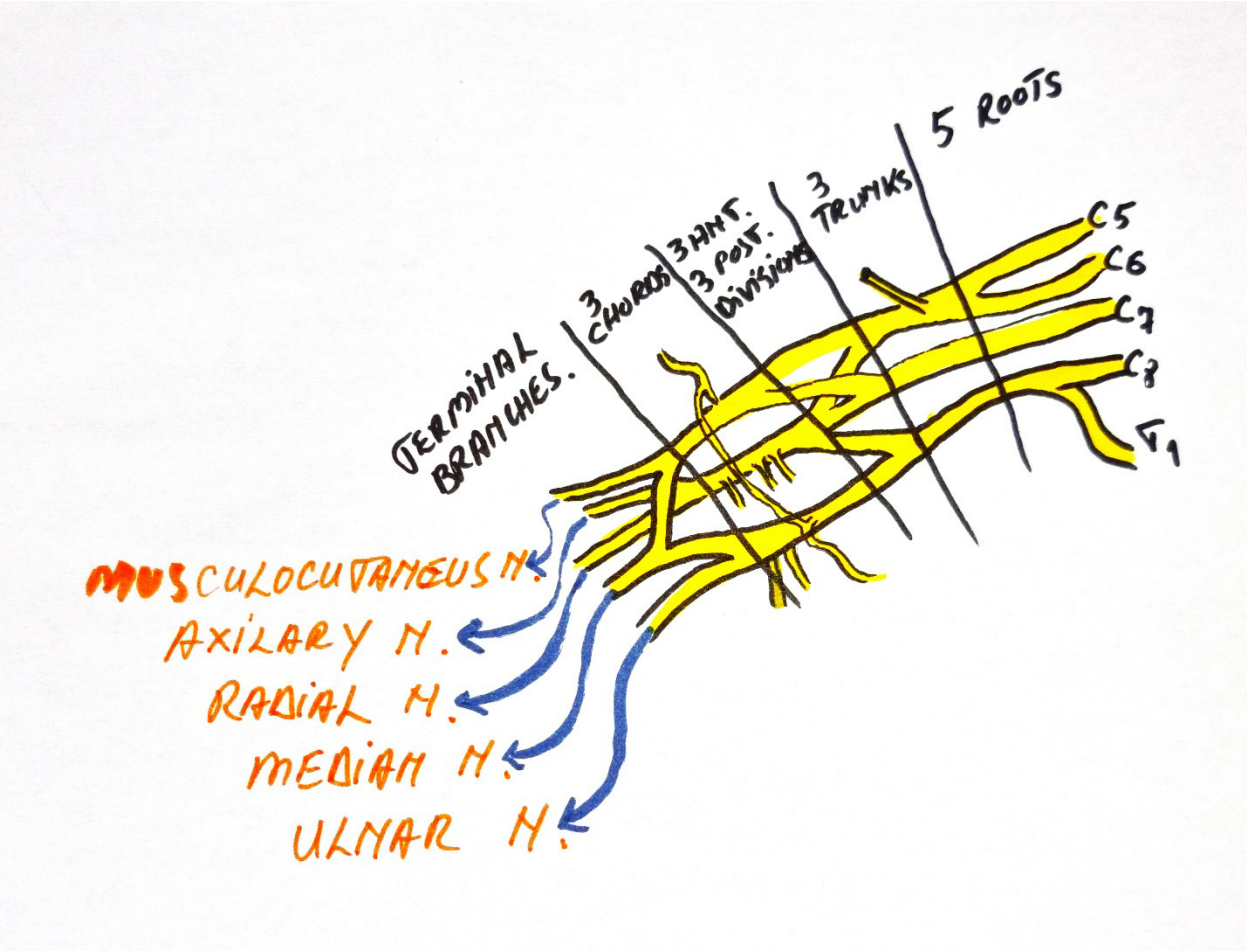

Fig. II .5: Image of the brachial plexus with major terminal branches.

Limfatics in the axila are represented by limphnodes with great clinical value in breast cancer treatment for example. The limphnodes are organized in five groups as follows (**fig. II.6)**:

-pectoral group

-apical group

-central group

-lateral group

-posterior group

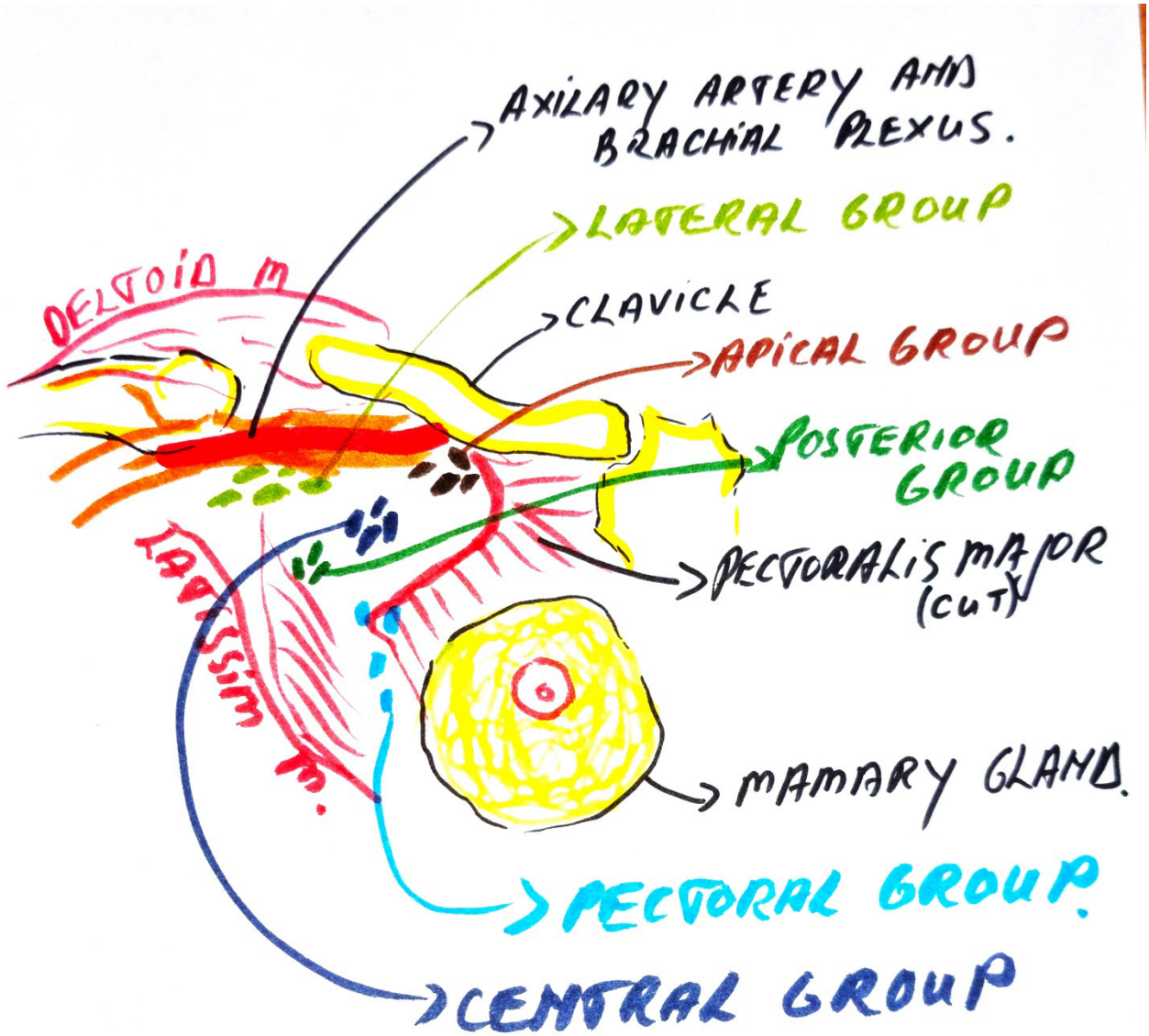

Fig. II.6: Groups of limphnodes in the axila.

Clinical correlations [3,4,5,6,7] :

1. Clinical examination of the contents of the axila is realised by placing the pacient's hand on the examiner's shoulder so that the muscles that bound the axila are relaxed and the contents can be carefully palpated by examining all four walls of the axila. Pulse can be palpated at the axilary artery. Examination usually is targeted at palpating abnormal masses most commonly represented by enlarged limphnodes or sometimes subcutaneous glands with diverse pathology.

In breast cancer management, axillar limphnodes present crucial importance in staging the disease, pre-operative planning and therapeutic management altogether. Therapeutic approach is defined by the extent of the disease, presence of metastatic limphnodes, the first station being the axillar nodes, and the first node is called the santinel node. [3,4,5,6].

2. The axilla is the location for axillary block. This is a minimally invasive procedure that obtains anesthesia of the entire upper limb with minimal side effects and very good pain control post-operatively as the effect lasts for 24 hours. Using sonography the anesthesiologist targets the brachial plexus and individually numbs all chords around the axillary artery injecting local anestetic under visual guidance. Loco regional blocks are becoming extremely popular because of the minimal systemic side effects and very good anesthesia of the desired region, together with post-operative pain control. The learning curve however is a bit longer and technically it is more difficult that general anesthesia. [3,4,5,6].

3. Brachial plexus pathology can vary enormously from post-traumatic elongation lesions to partial or total tears, scar complications after axillar surgery can lead to compression syndromes and so on. Axilar region surgery is difficult and challenging because of the noble structures it contains and because of the complex anatomy. Understanding the anatomy is key in approaching brachial plexus pathology. However neurologists do have a tool to asses integrity or partial lesions opposed to complete nerve damage by placing electrodes on specific terirories of the hand and forearm and assessing nerve function. This is called Nerve Conduction Speed test and can make the difference for example between brachial plexus pathology or carpal tunnel syndrome . [3,4,5,6,7].

References:

1. Anatomia membrului superior; Virgiuliu Niculescu; UMFT
2. Netter Atlas of Human Anatomy: Classic Regional Approach
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II.1.2. Dissection and study of the anterior regions of the upper limb, anatomical and clinical aplications.

The anterior regions of the upper limb from proximal to distal include: the deltoid region, the anterior brachial region, anterior elbow region, anterior antebrachial region, anterior wrist and palmar regions, each with particular clinical relevance and various medical pathologies [1,2] . Skin is usually thinner in the anterior regions and in the male anatomy it has little to no hairs opposed to the posterior regions. Subcutaneous tissue is lax containing the superficial network of veins, used most commonly for blood draw[1]. The superficial veins (**Fig. II 7**) finally drain in the axillary vein and subclavian vein.

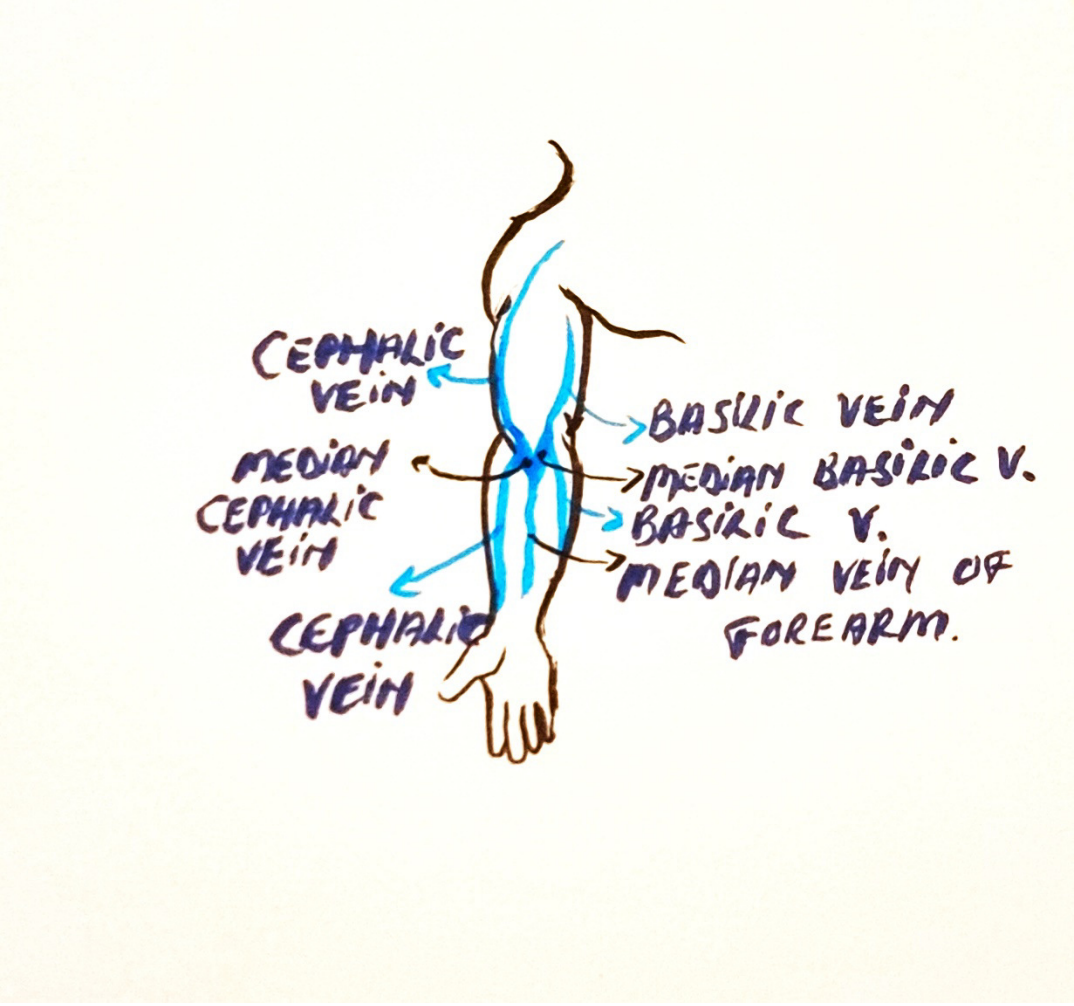

Fig. II. 7: Superficial veins of the anterior regions of the upper limb.

Clinical correlations [3,4,5]

Most commonly used for drawing blood is the median cephalic vein, more lateral in the anterior elbow region, because in the medial side the brachial artery is deeper but can still be injured with inappropriate technique.

Deep to the subcutaneous tissue is the brachial and atebrachial fascia covering the muscular compartments.

Muscles of the anterior regions[1] are represented by:

1. **The deltoid muscle:**
    a. origin: the origin of the deltoid muscle differs depending on the parte of the muscle as follows: the anterior fibers originate from the anterior margin of the distal third of the clavicle, the middle fibers originate from the lateral margin of the acromion and the posterior fibers originate fron the inferior lip of the posterior margin of the spine of the scapula.
    b. Insertion: the muscle decends and inserts on the deltoid tuberosity of the lateral surface of the humerus.
    c. Action: also differs depending on the three parts of the muscle as follows: the anterior fibers project the arm anteriorly and medially rotate the arm on the thorax, the middle fibers abduct the arm and the posterior fibers project the arm posteriorly and laterally rotate the arm on the trunk.
    d. Innervation: axillary nerve.

Clinical correlations [3,4,5,6,7]

The deltoid region is most commonly used for upper limb intramuscular injections and vaccines. Even though it looks like such an elementary procedure, location of the needle placement can actually injure the axillary nerve. This being said the correct location for injections is found by palpating the border of the acromion on the lateral side of the shoulder and approximately 3-4 cm (three fingers width) inferiorly is the correct location. Going more superiorly close to the acromion could harm the rotator cuff mechanism of the shoulder, going inferiorly could harm the axillary nerve. [3,4,5].

2. **Biceps Brachialis muscle**: presents two heads with different origins proximally and one single tendon distally
    a. Origin:- long head of the biceps originates from the supraglenoid tubercle immediately above the glenoid cavity of the scapula.
        - short head of the biceps originates from the coracoid process of the scapula, together with the coracobrachialis muscle as a single common tendon.
    b. Insertion: tuberosity of the radius.
    c. Action: main action is flexion and supination of the forearm on the arm. It's action on the arm is adduction through the short head and abduction with medial rotation through the long head of the muscle.
    d. Innervation: musculocutaneus nerve from the brachial plexus.

Clinical correlations **[3,4,5,6,7]**

The biceps brachialis muscle has a fusiform muscular body that can be easily palpated on the anterior region of the arm. Medial to the biceps we can also palpate the medial bicipital sulcus where we can feel the pulse to the brachial artery, accompanied by the deep brachial veins, median nerve and ulnar nerve for the first two thirds of the arm. Distally the ulnar nerve transitions posteriorly to pass posterior to the medial epicondyle of the hummerus.[3].

3. **Coracobrachialis muscle:**
    a. Origin: on the tip of the coracoid process together with the short head of the biceps.
    b. Insertion: medial surface of the humerus in the middle third.
    c. Action: flexion and adduction of the arm on the trunk when anchoring on the thorax, and lowering the scapula ehen anchoring on the hummerus.
    d. Innervation: musculocutaneus nerve from the brachial plexus, which pierces the coracobrachialis muscle and travels inferiorly inbetween the biceps brachi muscle and the brachialis muscle towards the lateral region of the elbow.

4. **Brachialis muscle:**
    a. Origin: inferior lip of the deltoid tuberosity of the lateral surface of the humerus and intermuscular fascia of the arm.
    b. Insertion: tuberosity of the ulna.

c. Action: the strongest flexor of the forearm on the arm and tensor of the articular capsule of the elbow.
d. Innervation: from the musculocutaneus nerve, rarely innervated by the radial nerve.

Clinical correlations:

Because the brachialis muscle is the strongest flexor of the elbow, contrary to popular belief, complete biceps ruptures do not mean that the patient can no longer do flexion of the elbow. Most patients have no trouble with flexion and even have 80% strength. What is evident while inspection is what we call Popeye sign inspired by the cartoon character, caused by muscular retraction of the body of the biceps muscle. Indication for surgical repair of the long head of the biceps for example, is strictly related to age and aesthetic reasons rather than functional impairment. [3].

Muscles of the forearm [1,2] :

At the level of the anterior region, there are generally the flexor muscles of the hand and fingers and they are arranged on three muscle planes from superficial to deep as follows:

First plane or superficial plane:

1. **The pronator teres muscle**
   a. Origin: through two heads: - humeral head originating on the anterior surface of the medial epicondyle of the distal humerus.
      - ulnar head originating on the coronoid process of the ulna.
   b. Insertion: in the middle 1/3, on the lateral surface of the radius.
   c. Action: pronator of the forearm and flexion of the forearm on the arm through the humeral head.
   d. Innervation: median nerve.

2. **The flexor carpi radialis muscle:**
   a. Origin: on the anterior face of the medial epicondyle, the antebrachial fascia and the intermuscular septum of the forearm.
   b. Insertion: the volar surface of the base of the second metacarpal at the level of the hand.

c. Action: flexor of the hand on the forearm, weak flexor of the forearm on the arm, weak abductor of the hand on the forearm and pronator of the forearm.
d. Innervation: median nerve.

3. **The palmaris longus muscle:**

a. Origin: the anterior face of the medial epicondyle, the antebrachial fascia and the intermuscular septum of the forearm.
b. Insertion: the palmar aponeurosis.
c. Action: it is a weak flexor of the hand on the forearm, and of the forearm on the arm. 15 % of the population lacks the palmaris longus muscle so it can be considered an inconstant muscle.
d. Innervation: median nerve.

Clinical correlations:

The palmaris longus tendon can be absent in about 5 % of healthy population, with no functional impairment. However most of us do have this tendon and it can gain medical importance when in need of reconstructive surgery of the hand. The palmaris longus tendon is harvested most frequently for hand ligament reconstruction surgeries or tendon reconstructions that need augmentation. Harvesting the palmaris longus leaves no functional deficit to hand movements.

4. **The flexor carpi ulnaris muscle:**

a. Origin: through two heads: - humeral head originating on the medial epicondyle and intermuscular septum.
- ulnar head with its origin on the medial side of the olecranon and on the posterior edge of the ulna.
b. Insertion: pisiform bone at the level of the hand.
c. Action: flexor and adductor of the hand on the forearm.
d. Innervation: ulnar nerve.

The second or intermediate plane of muscles:

5. **The flexor digitorium superficialis muscle :**

a. Origin: through two muscle heads:

- humeral head with its origin on the anterior face of the medial epicondyle and the medial face of the coronoid process of the ulna.

- radial head with its origin on the anterior edge of the radius.

b. Insertion: middle phalanx of fingers 2-5.

c. Action: flexion of the middle phalanx on the proximal phalanx, flexion of the fingers on the hand, flexion of the hand on the forearm and forearm on the arm. It is also an adductor of the hand and brings the fingers together.

d. Innervation: median nerve

.

The third or deep plane of muscles:

6. **The flexor digitorium profundus muscle:**

a. Origin: the upper two thirds on the anterior and medial surface of the ulna, and on the interosseous membrane of the forearm.

b. Insertion: base of distal phalanges.

c. Action: flexor of the distal phalanx on the middle one, of the hand on the forearm and adductor of the hand.

d. Innervation: the medial fibers are innervated by the ulnar nerve and the lateral fibers by the median nerve.

7. **The flexor policis longus muscle:**

a. Origin: anterior surface of the radius and on the interosseous membrane.

b. Insertion: base of the distal phalanx of the thumb.

c. Action: it is a flexor of the distal phalanx of the thumb and the proximal phalanx on the first metacarpal.

d. Innervation: anterior interosseous nerve, deep branch from the median nerve.

8. **The pronator quadratus muscle:**

a. Origin and Insertion: It is inserted on the anterior surface of the ulna and the radius in the most distal part of the forearm, with it's fibers oriented transversely to the axis of the forearm

b. Action: pronator of the forearm.

d. Innervation: anterior interosseous nerve from the median nerve.

Vascular supply (Fig.2.8) of the superior member comes from the axillary artery that continues with the brachial artery at the level of the inferiuor border of pectoralis major tendon. In the initial part of the brachial artery the first branches are the anterior circumflex artery and posterior circumflex artery that go around the proximal humerus giving arterial supply to the deltoid aswell as the scapulohumeral joint and head of the humerus. Also in the initial part the brachial artery gives the profunda brachii artery that decends posteriorly to loop around the humerus shaft together with the radial nerve.

In the midpart of the brachial artery it gives two ulnar collateral pranches that decend and anastomose with ulnar recurrent branches and supply the elbow joint and muscles. O the lateral side the profunda brachi anastomoses wit the radial recurrent artery from the radial artery.

At the level of the elbow the brachial artery splits into the ulnar artery that decends on the medial side of the forearm and the radial artery that decends on the lateral side of the forearm and distal to the wrist joint anastomose to form the deep and superficial palmar arches. From the ulnar artery in it's initial part we have the common interosseous trunk that splits in anterior interosseous and posterior interosseous arteries supplying the deep muscular compartments of the forearm.

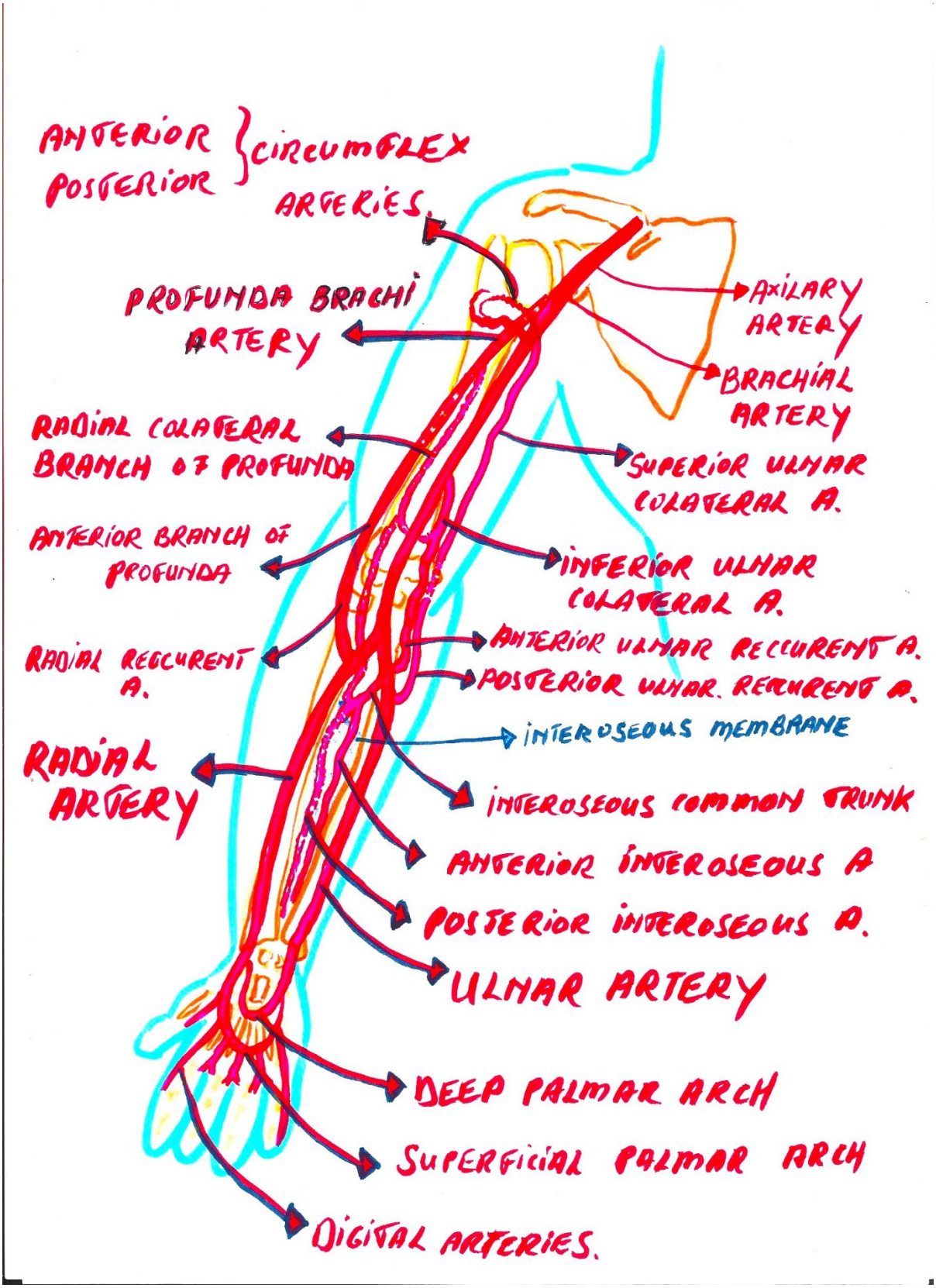

Fig. II. 8. Arterial supply of the superior member.

Innervation of the superior member is given by the terminal branches of the brachial plexus with the main mixt nerves: **median**, **ulnar** and radial, musculocutaneous, axillary and the brachial and antebrachial cutaneous nerves, as described in the images below. (Fig.II.9-11).

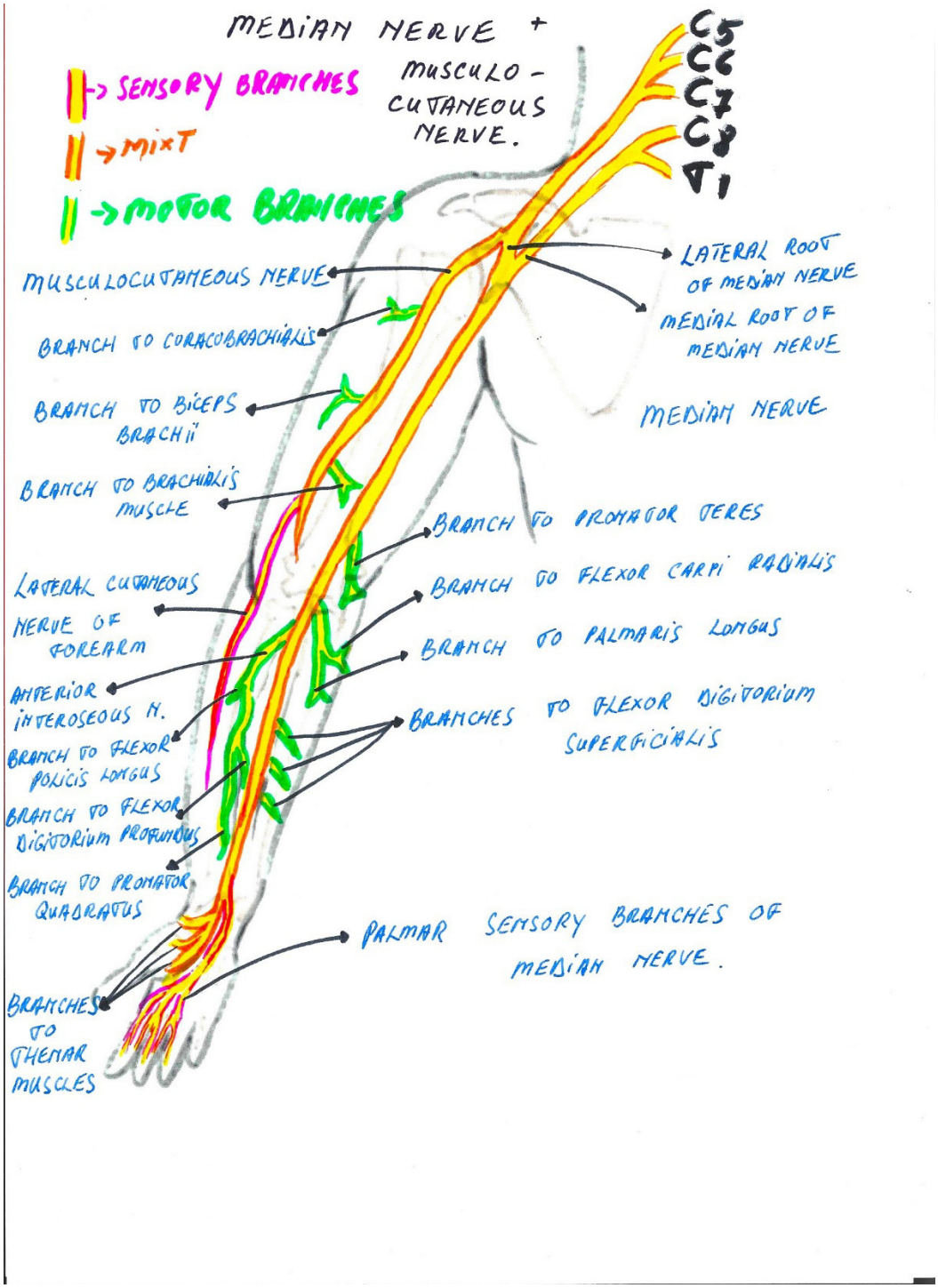

Fig. II.9. Median and musculocutaneous nerves.

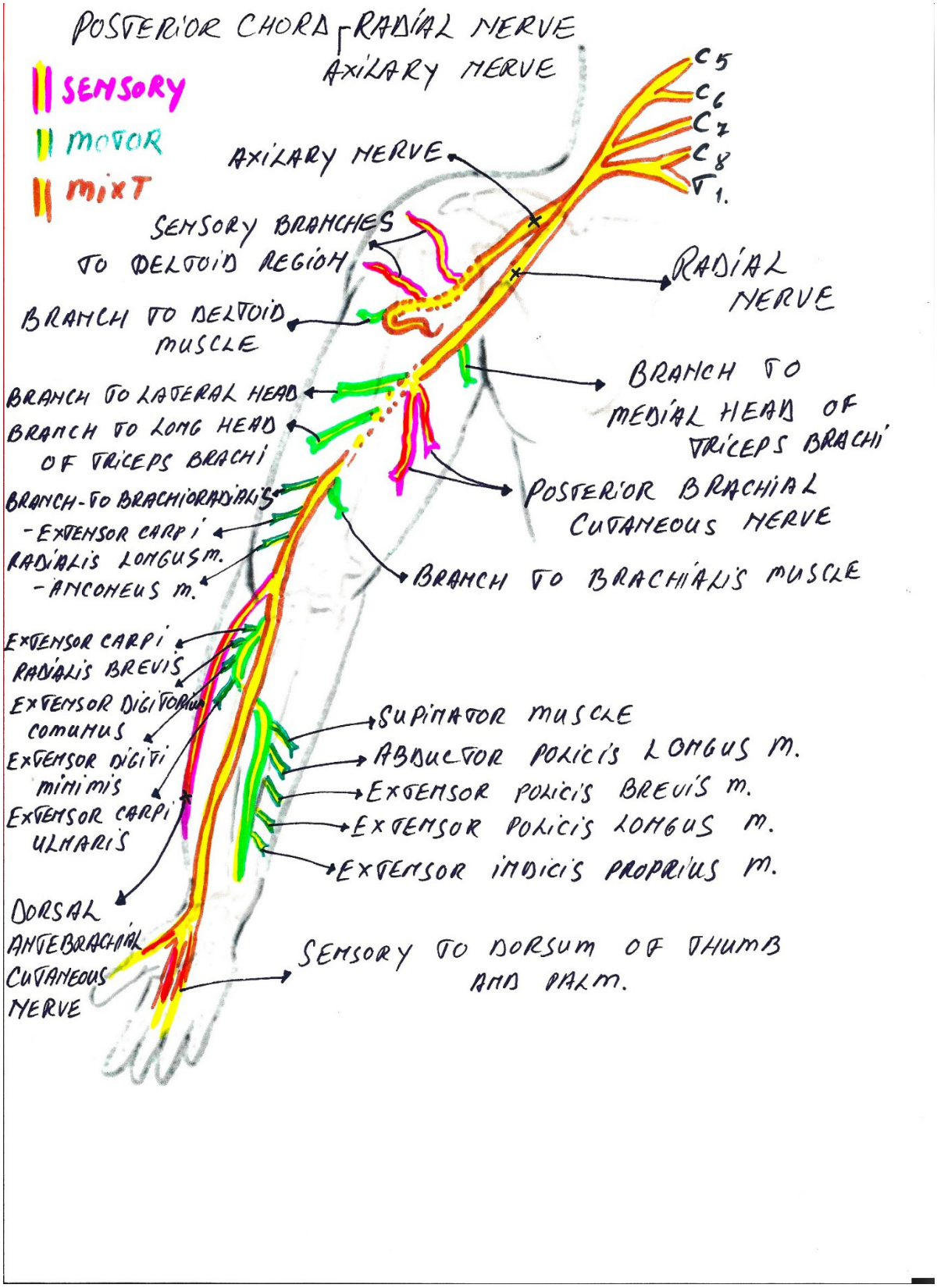

Fig. II. 10. Radial nerve

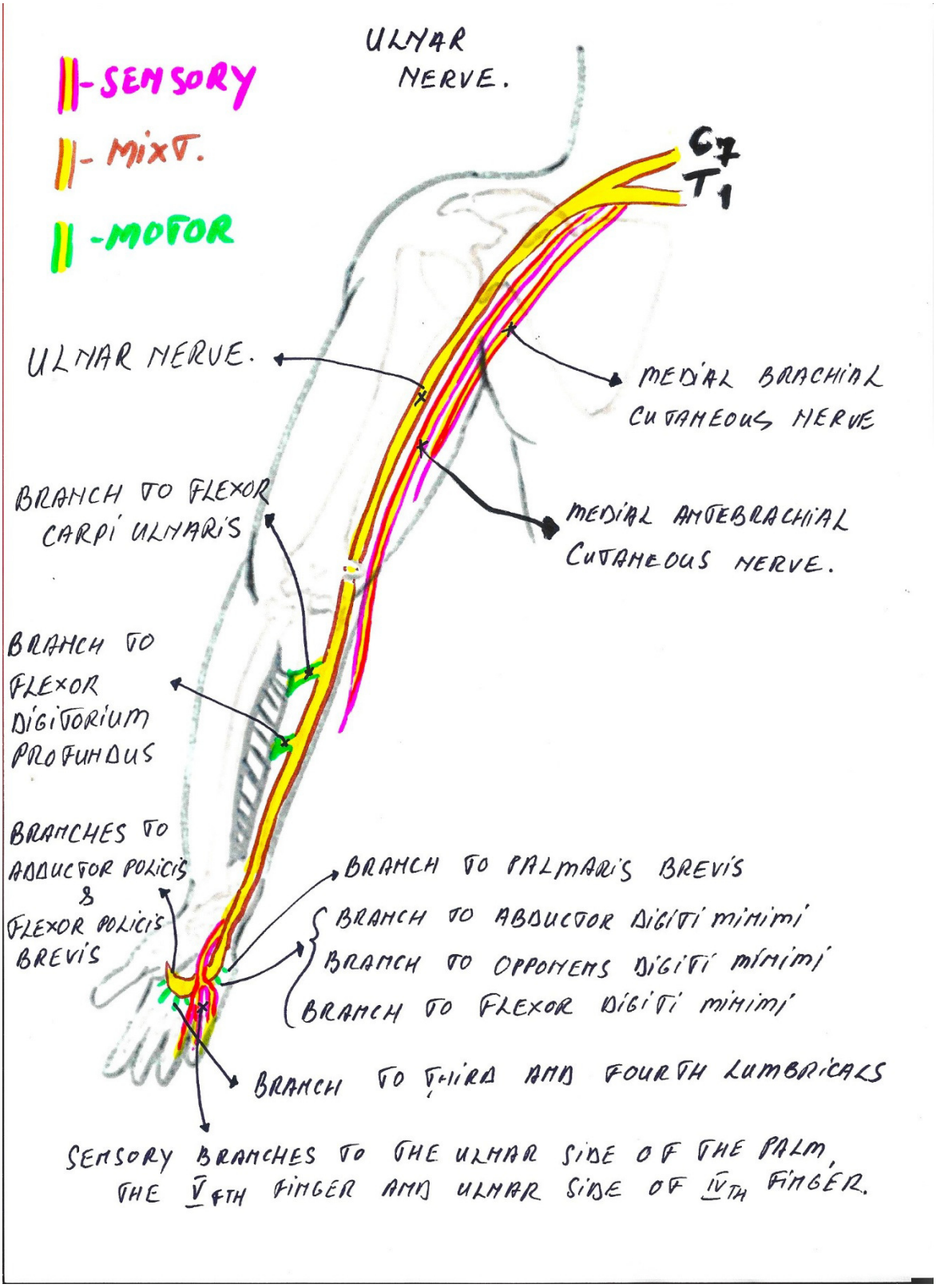

Fig. II.11. Ulnar nerve.

Clinical correlations:

Proximal origin of all flexor muscles of the forearm is represented by a comon tendon attaching to the medial epicondyle of the hummerus. In some people because of chronic overload and continuous repetitive movemens, this common tendon suffers from degenerative changes causing chronic pain. This condition is called medial epicondylitis or otherwise known as “golfer’s elbow” . When playing golf the swinging motion loads the common flexor tendon coupled with the forced valgus of the elbow leading to inflammation of the origin.

Distal tendons of the superficial and deep flexors of the digits pass through the flexor retinaculum and under the transverse ligament of the wrist together with the median nerve that spreads to give sensitive inervation to fingers 2-3-4. This ligament extends from the hook of the hamate to the trapezium and closes an osteoligamentous tunnel known as the carpal tunnel. With chronic movements of the hands and wrong positions while working at some point the flexor tendons get chronic inflammation and thickening. This translates to chronic pressure on the median nerve the result being pain in the wrist, numbness of fingers 2-3-4 and in later more severe cases loss of fine mobility. Patients complain that they cannot sow anymore, or manipulate small objects etc. . Treatment consists in transverse ligament release with relieving pressure on the median nerve and complete recovery within weeks or months in most cases. [3,4,5,6,7].

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1. Anatomia membrului superior; Virgiuliu Niculescu; UMFT
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II.1.3. Dissection and study of the posterior regions of the upper limb, anatomical and clinical aplications

The posterior regions of the upper limb include the scapular region, the deltoid region, posterior brachial region, posterior elbow, posterior antebrachial region, posterior wrist and dorsal surface of the hand. The skin in the posterior regions in the male have hair folicules.

Muscles of the posterior arm and forearm [1,2] are:

1. **Triceps muscle** (single muscle in the posterior compartment of the arm) : originates proximally from three muscular heads as follows
   a. Origin:- long head originates from the infraglenoid tubercle, immediately inferior to the glenoid cavity of the scapula.
   -lateral head originates from the lateral intermuscular septum and posterior surface of the humerus.
   -medial head originates from the medial intermuscular septum and posterior surface of the humerus.
   b. Insertion: olecranon of the ulna
   c. Action: extension of the forearm on the arm, and through the action of the long head adduction of the arm on the trunk.
   d. Innervation: branches from the radial nerve, from the brachial plexus.

Clinical correlations

The triceps muscle has intimate relations with the radial nerve and deep brachial artery that spiral around the humerus in the radial groove from posterior/superior to lateral to the humerus in the middle third and anterior in the distal third of the humerus. The proximal tip of the tricipital tendon is the most constant landmark to identify the underlying radial nerve when dissecting the muscle as the location of the nerve passing in an oblique direction is approximately 1cm proximal to the level of the tip of the tendon.

2. **The extensor digitorium muscle :**

a. Origin: lateral epicondyle of the humerus, radial collateral ligament, deep surface of the antebrachial fascia and intermuscular fibrous septum.

b. Insertion: the posterior surface of the base of the middle phalanx and the dorsal surface of the metacarpals.

c. Action: extensor of the distal phalanx on the middle one, of the proximal one on the metacarpal, of the hand on the forearm and of the forearm on the arm.

d. Innervation: posterior interosseous nerve, deep branch of the radial nerve.

3. **The extensor digiti minimi muscle :**

a. Origin: the lateral epicondyle of the humerus, the antebrachial fascia and the intermuscular fibrous septum.

b. Insertion: the last two phalanges of the fifth finger.

c. Action: extensor of the fifth finger.

d. Innervation: small branch from the posterior interosseous nerve.

4. **The extensor carpi ulnaris muscle :**

a. Origin: the lateral epicondyle of the humerus and the antebrachial fascia (humeral head), on the posterior edge of the ulna (ulnar head).

b. Insertion: base of the fifth metacarpal.

c. Action: extensor and adductor of the hand.

d. Innervation: posterior interosseous nerve.

5. **Anconeus muscle:**

a. Origin: lateral epicondyle of the humerus.

b. Insertion: posterior surface of the proximal ulna.

c. Action: extensor of the forearm on the arm.

d. Innervation: radial nerve.

6. **The abductor policis longus muscle:**

a. Origin: the posterior surface of the ulna and radius and on the interosseous membrane.

b. Insertion: base of the first metacarpal.

c. Action: abductor of the pollicis on the hand and of the hand on the forearm.

d. Innervation: posterior interosseous nerve from the radial nerve.

7. **The extensor policis brevis muscle:**

a. Origin: the posterior surfaces of the ulna and radius and the interosseous membrane.

b. Insertion: base of the proximal phalanx of the thumb.

c. Action: extensor and abductor of the thumb on the forearm.

d. Innervation: posterior interosseous nerve from the radial nerve.

8. **The extensor policis longus muscle:**

a. Origin: the posterior surface of the ulna and on the interosseous membrane.

b. Insertion: distal phalanx of the thumb.

c. Action: extensor and abductor of the pollicis on the hand.

d. Innervation: posteriuor interosseous nerve.

9. **The extensor muscle of the index**

a. Origin: the posterior surface of the ulna and the interosseous membrane.

b. Insertion: metacarpophalangeal joint of the index finger.

c. Action: extensor of the index.

d. Innervation: posterior interosseous nerve.

Muscles of the forearm: lateral compartment:

10. **The brachioradialis muscle**

a. Origin: the lateral edge of the humerus in its distal portion and on the lateral intermuscular septum.

b. Insertion: styloid process of the radius.

c. Action: flexor of the forearm on the arm. It is also a weak supinator and pronator of the forearm.

d. Innervation: radial nerve.

11. **The extensor carpi radialis longus muscle:**

a. Origin: the lateral edge of the humerus in the distal third and the lateral intermuscular septum.

b. Insertion: posterior face of the base of the second metacarpal.

c. Action: extensor and abductor of the hand, flexor of the forearm on the arm, supinator of the forearm.

d. Innervation: radial nerve.

12. **The extensor carpi radialis brevis muscle:**

a. Origin: the lateral humeral epicondyle and the radial collateral ligament of the elbow joint.

b. Insertion: base of the 3rd metacarpal.

c. Action: extensor and abductor of the hand on the forearm.

d. Innervation: posterior interosseous nerve.

13. **The supinator muscle**

a. Origin: the rough surface under the radial notch of the ulna and the ridge of the supinator muscle, the radial collateral ligament, the annular ligament, the lateral epicondyle of the humerus.

b. Insertion: lateral face of the radius.

c. Action: supinator of the forearm.

d. Innervation: posterior interosseous nerve.

Clinical correlations [3,4,5,6,7]

The posterior elbow has three main bony landmarks that form at 90 degrees flexion, an equilateral triangle Figure II. 12.

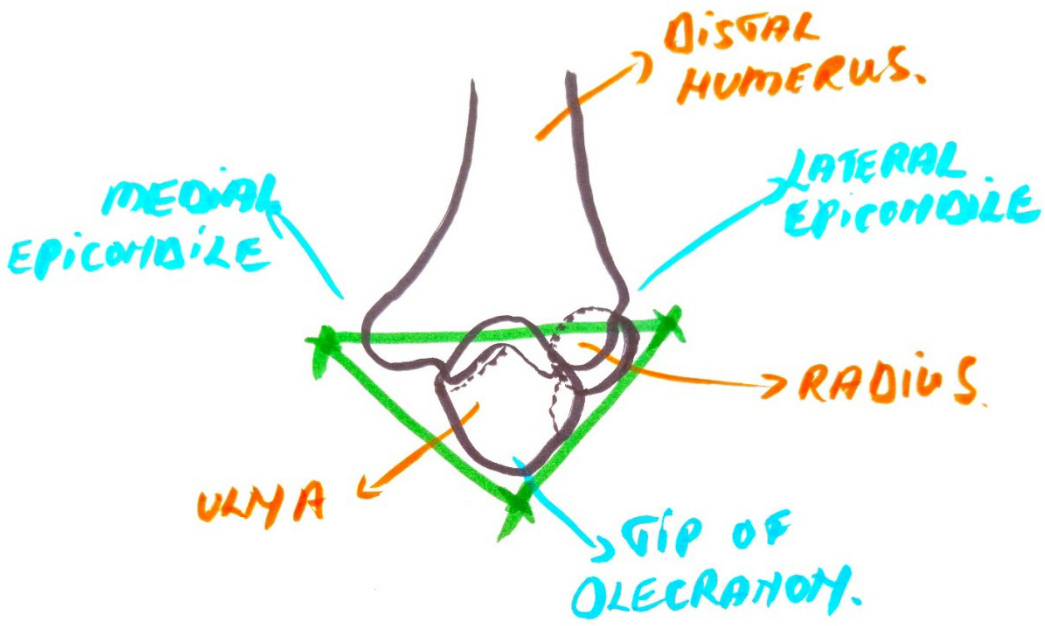

Fig. II.12. Equilateral triangle of the elbow.

The bony landmarks are the lateral and medial epicondiles and the tip of the olecranon and can easily be palpated as they lie under the skin. This triangular relation is essential in examining any elbow with trauma because the triangle is lost in dislocations or fractures. Whenever the Triangle is no longer equilateral and it becomes asimetrical further imaging examinations are necessary to exclude fractures or dislocations. Elbow dislocation is not as common as shoulder dislocation, and always happens during falls with the elbow fully extended and the hand fixes on the ground. More common especially in the elderly are olecranon fractures when the force of the triceps avulses the olecranon. These fractures always need surgical repair because the force of the triceps will always lead to displacement and the extensor mechanism is interrupted. If it is not reduced and heals with displacement patient lose most of elbow mobility and also face chronic pain with joint arthrosis in the near future.

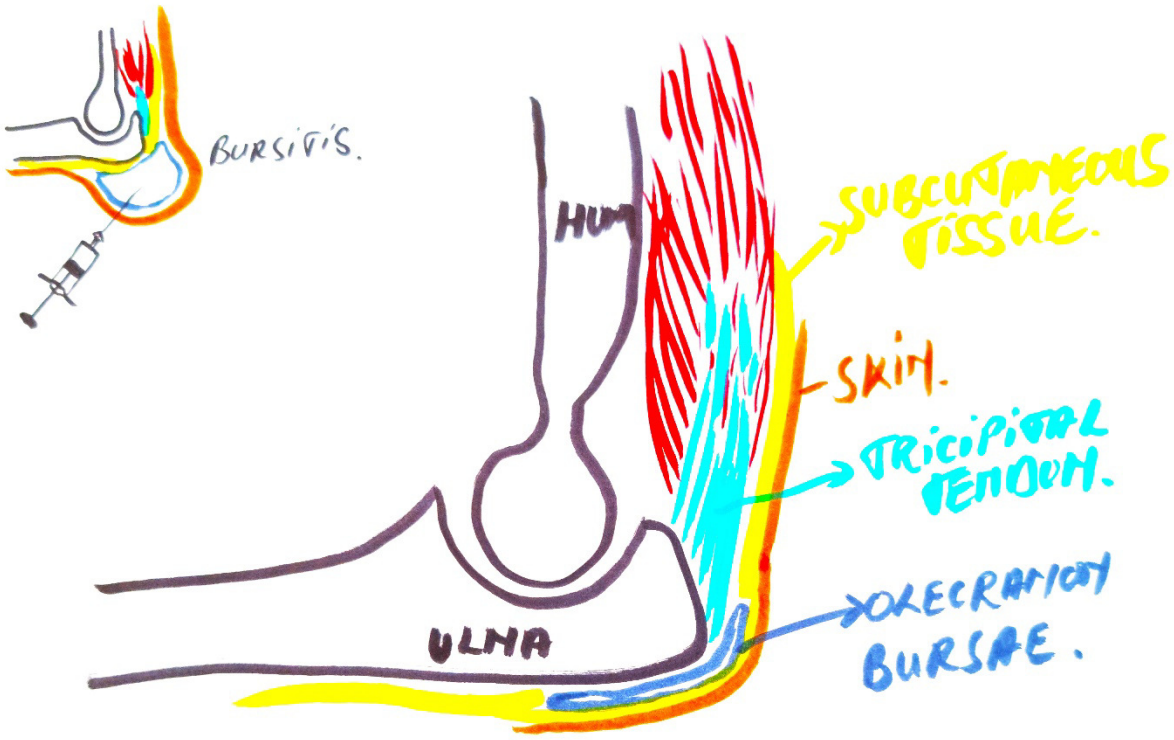

Fig. II.13. Anatomy of the olecranon bursae

Another common pathology around the elbow is called bursitis. This represents the acute inflammation of the olecranon bursa either after acute trauma or because of chronic friction trauma on the elbow. The bursa helps skin slide on superficial bony proeminences around our joints similar to the leyers of an empty pouch. With acute inflammation it gets filled with effusion and becomes extremely painfull because of pressure and baroreceptors. Treatment consists in aspiration and steroid injection and if this is not efficient surgical dissection and removing the bursa solves the problem.

When discussing the anterior regions of the upper limb we discussed medial epicondylitis also called golfer's elbow. On the posterior region of the elbow the exact same pathology can happen on the leteral side of the elbow and it is called lateral epicondilitis or tennis elbow. All the extensors attach throu a common tendon to the lateral epicondyle. In chronic overuse of the extensors this gets chronic inflammation and pain can be debilitating with certain movements for months. The tendon suffers degenerative changes and complete recovery is very slow. Treatment can include steroid injections and rarely surgery.

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II.2. Dissection and study of the posterior regions of the trunk. Dissection of the gluteal region and the study of muscular and vasculo-nervous formations; anatomical and clinical application

II.2.1. Generalities and stratigraphy

The posterior wall of the trunk presents a thoracic part (Dorsum thoracis) and an abdominal part (Dorsum abdominis).

The thoracic part extends between a conventional horizontal line passing through the spinous process of the C7 vertebra and the 12th rib. The abdominal portion of the back of the trunk extends from the 12th rib to the superior strait of the pelvis.

Stratigraphy:

Posterior thoracic wall

1. Skin is thick and innervated by the posterior branches of the thoracic spinal nerves;
2. Superficial fascia;
3. Deep fascia;
4. Muscles [1, 2]

- extrinsic muscles that connect the upper limb to the trunk:

- Trapezius
- Latissimus dorsi
- Rhomboideus major
- Rhomboideus minor
- Serratus – posterior and superior
- Serattus – posterior and inferior

- erector spinae
- intrinsic muscles:

- External intercostal muscles
- Internal intercostal muscles
- Subcostalis muscles

5. Intercostal spaces with intercostal neurovascular bundle consisting of intercostal vein, artery, nerve, and intercostal lymph nodes and vessels. The neurovascular bundle is located in the subcostal groove at the level of the lower edge of each rib.
6. Endothoracic fascia;
7. Parietal pleura.

8. The bony plane includes the bodies of the thoracic vertebrae, the intervertebral discs, the posterior end of the ribs, and the intercostal spaces.

Clinical correlations:

- Traumatic injuries, herpes zoster, or thoracic spondylosis can cause pain that requires local regional anesthesia. Considering the disposition of the intercostal neurovascular bundle, anesthesia of the intercostal nerves is performed at the level of the lower border of the overlying rib.
- In the case of the presence of air or fluid in the pleural cavity, thoracentesis is performed for diagnostic or therapeutic purposes, at the level of the upper border of the underlying rib to avoid injury to the intercostal neurovascular bundle.

Posterior abdominal wall

1. Skin
2. Superficial fascia
3. Deep fascia

Fascia iliaca covers the psoas major and iliacus muscle;

The thoraco-lumbar facia encloses the quadratum lumborum muscle.

3. Muscles:

- Psoas major
- Iliacus
- Psoas minor
- Quadratus lumborum
- Transversus abdominis

4. The bony plane includes the lumbar vertebrae L1-L5, the posterior extremity of the ribs, the intercostal spaces, and the iliac fossae of the coxal bones.

5. The vascular plan that includes the abdominal aorta, inferior vena cava, azygos vein, hemiazygos vein, lymph nodes and vessels, cisterna chyli and thoracic duct, subcostal nerves, ventral branches of lumbar nerves and lumbar sympathetic chains.

Clinical correlation:

The role of the posterior abdominal wall:

- trunk extension;
- stabilizes the position of the trunk;

- antagonist of the previous belt;
- maintains the straightness of the spine;
- reduced in the abdominal press.

II.2.2. The regions of the back (Regiones dorsi)

They are represented by the vertebral region, the scapular region, the auscultation triangle, the infrascapular region, the lumbar region, the sacral region, and the coccygeal region.

II.2.2.1. The vertebral region (Regio vertebralis)

It includes all the soft parts located posterior to the spine.

Limits:

- lateral (right, left) – the conventional vertical line through the medial border of the ;
- inferior – the conventional horizontal line through the L5 spinous process.

II.2.2.2. Scapular region (Regio scapularis)

It is a region of the back that has the scapula as its central element and includes three fossae, supraspious, infraspinous, and subscapular.

Stratigraphy

Supraspinous fossa

- skin;
- subcutaneous cellular tissue;
- trapezius muscle;
- fatty cell tissue;
- supraspinous fascia;
- supraspinatus muscle;
- supraspinous fossa at the level of the posterior surface of the scapula.

Infraspinous fossa

- skin;
- subcutaneous cellular tissue;
- the superficial muscle plane formed by the deltoid, trapezius muscle, and latissimus dorsi muscles;
- infraspinous fascia;

- the deep muscle plane formed by the infraspinatus, teres major, and teres minor muscles;
- infraspinous fossa at the level of the posterior surface of the scapula.

Subscapular fossa
- the subscapular fossa at the costal face of the scapula;
- the subscapularis muscle covered by its fascia.

II.2.2.3. The auscultation triangle (Trigonum auscultations)

It is an intermuscular space limited:

- superior and medial by the trapezius muscle,
- superior and lateral by the rhomboid muscle
- inferior by the latissimus dorsi muscle.

The area of the triangle contains the fascia covering the VII rib and adjacent intercostal spaces.[3]

Clinical correlations:

• At the level of this triangle, pulmonary auscultation of the upper segments of the lower lung lobes can be performed. The area of the triangle can be increased if the subject flexes the trunk and crosses the arms in front of the chest or if they raise the upper limbs above the head.

II.2.2.4. Infrascapular region (Regio infrascapularis)

It includes all the soft parts located below the scapula, between the scapular region and the lumbar region.

II.2.2.5. Lumbar region (Regio lumbalis)

Includes all the soft parts corresponding to the 5 lumbar vertebrae and the adjacent muscles

Clinical correlation [4] **:**

In the lumbar region, there are two weak regions of the trunk wall where lumbar hernias can occur. They are the lumbar triangle and the superior lumbar triangle.

• Lumbar tringle (Trigonum lumbale) or Petit triangle through which lower lumbar hernias can occur. Boundaries: posteriorly by the latissimus dorsi muscle, anteriorly by the external oblique muscle, and inferiorly by the iliac crest. The floor of this triangle is formed by the internal oblique muscle.

• Superior lumbar triangle (Trigonum lumbale superius) Grynfeltt¬ and Lesshaft triangle, through which superior lumbar hernias can occur. Boundaries: superolateral by the 12th rib, laterally by the internal oblique muscle, medially by the erector spinae muscles, and superomedially by the serratus posterior and inferior muscle. The floor is formed by the transversalis fascia, and the roof by the latissimus dorsi muscle.[5]

II.2.2.6. Sacral region (Regio sacralis). Includes the soft parts located posterior to the sacrum.

II.2.2.7. Coccygeal region (Regio coccygea). Includes the soft parts located posterior to the coccyx.

MCQ

1. Petiti's triangle is a weak area of the abdominal wall through which can occur:

A. Femoral hernias
B. Direct inguinal hernias
C. Lower lumbar hernias
D. Umbilical hernias
E. Diaphragmatic hernias

Correct answear: C

2. Which of the following statements about the intercostal neurovascular bundle and clinical procedures are correct?

A. The intercostal neurovascular bundle is located at the upper border of each rib.
B. Intercostal nerve anesthesia is performed at the lower border of the overlying rib.
C. The neurovascular bundle contains the intercostal vein, artery, nerve, and lymph nodes.
D. Thoracocentesis is performed at the lower border of the rib to avoid injuries of the intercostal vessels and nerves.
E. The traumatic injuries of the neurovascular bundle can cause pain that requires local anesthesia.

Correct answear : B, C, E

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II.3. The lower limb

II.3.1. Dissection of the anterior regions of the lower limb.

II.3.1.1. Muscular lacuna and vascular lacuna

Between the inguinal ligament and the anterior edge of the coxal bone, there is a space divided by the ilio-pectineal arch into two compartments: lateral-muscular lacuna and medial-vascular lacuna.[1.2]

Table 1. The contained elements of the muscular lacuna and vascular lacuna.

	Muscular lacuna	Vascular lacuna
Contained elements	- Iliopsoas muscle - Femoral nerve - The femoral cutaneous nerve of the thigh	- Femoral artery - Femoral vein - Cloquet's lymph node - Femoral branch of Genitofemoral nerve

Clinical application:

At the level of the vascular lacuna between the inguinal ligament (anterior), pectinate ligament (posterior), lacunar ligament of Gimbernat (medial), and femoral vein (lateral) the femoral ring is delimited. The femoral ring limits the femoral canal superiorly and medially and represents a weak region of the abdominal wall through which femoral hernias can occur. These occur more frequently in women and in situations in which the femoral ring widens due to intense physical exertion or in situations that lead to increased intra-abdominal pressure.[1]

II.3.1.2. Sheath of femoral vessels

It is a duplication of the broad fascia around the femoral artery and vein located in the upper part of the thigh, between the vascular lacuna and the tendinous hiatus of the adductor magnus muscle.[1,2]

It has three parts:

- the femoral canal corresponding to Scarpa's femoral triangle at the level of which the femoral artery is located laterally and the femoral vein is located medially.

- the subsartorial canal located deep to the tailor muscle at the level of which the femoral artery passes from the lateral to the anterior and the femoral vein passes from the medial to the posterior

- the adductor canal in which the femoral vein passes from the posterior to the lateral and the femoral artery from the anterior to the medial

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1. Monica Adriana Vaida, Nawwaf Sebastian Damen, Adelina Maria Jianu, Corina Matu – Anatomie Clinique, Notes de Cours, Tome I, Membres, Editura „Victor Babeş", Timişoara 2024, 71 pag, ISBN general: 978-606-786-420-5, ISBN Vol. I: 978-606-786-419-9.
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II.3.1.3. Anterior region of the thigh

The anterior face of the thigh is crossed obliquely from superior and laterally inferiorly and medially by a muscle strap determined by the sartorius muscle. On either side of it, the muscular reliefs of the two vastus muscles, medial and lateral, can be recognized. Scarpa's femoral trigone is described in the supero-medial part of the anterior femoral region.

Stratigraphy

The soft and mobile skin is provided with hairs, sweat and sebaceous glands.

Subcutaneous loose cellular tissue contains superficial vessels and nerves:

The arteries are represented by branches that come from the deeper femoral artery. The veins are represented by the great saphenous vein and smaller branches that drain into the femoral vein at the level of Scarpa's femoral trigone. Lymphatics are represented by lymphatic vessels and superficial inguinal lymph nodes that flow into the lower group of superficial inguinal nodes;

The superficial nerves are branches of: the lateral femoral cutaneous nerve (N. cutaneus femoris lateralis), the femoral branch of the genitofemoral nerve (N. genitofemuralis; R. femoralis), the iliohypogastric nerve (N. iliohypogastricus; N. iliopubicus), the ilioinguinal nerve (N . ilioinguinalis), the obturator nerve (N. obturatorius).

The aponeurotic layer is represented by the covering fascia of the thigh, also called fascia lata (Fascia lata).

The subaponeurotic layer consists of muscles, vessels and deep nerves.

The muscular plane [1,2,3] contains the deep vessels and nerves and is made up of muscles arranged in three plans:

• The superficial muscle plane includes the Sartorius muscle located medially and the tensor muscle of the fascia lata (M. tensor fasciae latae) located laterally.

• The middle muscle plane includes the quadriceps femoris muscle with its four portions, namely the M. rectus femoris, the M.vastus lateralis ,M. vastus intermedius and the M. vastus medialis;

• The deep muscle plane is represented by the M. gracilis, the M. pectineus and the M. adductor longus, M. adductor brevis and M. adductor magnus.

1. The sartorius muscle
   a. Origin: anterior superior iliac spine
   b. Insertion: superior medial surface of the tibia
   c. Innervation: the femoral nerve

d. Action: At the hip it flexes, weakly abducts, and rotates the thigh laterally. At the knee, it can flex the leg; when the knee is flexed, it also rotates the leg medially.

2. Tensor of fascia lata muscle

a. Origin: anterior superior iliac spine.

b. Insertion: It inserts distally to the IT band, which comprises the fascial aponeurosis of the gluteus maximus and the tensor fascia latae.

c. Innervation: the superior gluteal nerve and the first sacral nerve roots.

d. Action: together with the gluteus medius and gluteus minimus it internally rotates and abducts the hip and with the gluteus maximus via the IT band it abducts the hip. It contributes with the rectus femoris in flexion of the hip.

Acts on the tibia through the IT band's attachment to the Gerdy tubercle on the lateral tibia. The TFL is an accessory knee flexor, though its action is only significant when the knee is flexed more than 30 degrees. It stabilises the knee when it is in full extension

3. Quadriceps femoris muscle

a. Origin: Acording to the four components of the quadriceps: Rectus femoris originates on the anterior inferior iliac spine and supraacetabular groove.

Vastus medialis originates on the intertrochanteric line, pectineal line of femur, linea aspera and the medial supracondylar line of the femur.

Vastus lateralis originates on the intertrochanteric line, greater trochanter, gluteal tuberosity and linea aspera of the femur.

Vastus intermedius originates on the anterior surface of the femoral shaft.

b. Insertion: all four components of the quadriceps confluence together and distal to the patela, through the patellar tendon, insert on the tibial tuberosity, forming the very strong extensor mechanism of the knee.

c. Innervation: femoral nerve.

d. Action: on the hip joint: Thigh flexion (rectus femoris only); on the knee joint: Leg extension.

4. Gracilis muscle

a. Origin: anterior body of the pubis, inferior pubic ramus and ischial ramus.

b. Insertion: Medial surface of proximal tibia at the level of the pes anserinus.

c. Innervation: Obturatory nerve.
d. Action: on the hip joint: Thigh flexion and thigh adduction; on the knee joint: leg flexion and leg internal rotation.

5. Pectineus muscle
a. Origin: the pectineal line of the pubis.
b. Insertion: pectineal line of the femur and linea aspera of the femur.
c. Innervation: Femoral nerve and obturatory nerve.
d. Action: on the hip joint: thigh flexion, thigh adduction, thigh external rotation and thigh internal rotation; it is also a pelvic stabilizer.

6. Adductor longus muscle
a. Origin: Body of the pubis, inferior to the pubic crest and lateral to the pubic symphysis.
b. Insertion: Middle third of the linea aspera of the femur on the medial lip.
c. Innervation: obturatory nerve.
d. Action: on the hip joint: thigh flexion, thigh adduction and thigh external rotation; It also contributes to pelvic stabilization.

7. Adductor brevis muscle
a. Origin: anterior body of the pubis, inferior pubic ramus.
b. Insertion: Linea aspera of the femur on the medial lip.
c. Innervation: Obturator nerve.
d. Action: on the hip joint: thigh flexion, thigh adduction and thigh external rotation; It also contributes to pelvic stabilization.

8. Adductor magnus muscle
a. Origin: the adductor part originates on the inferior pubic ramus and ischial ramus. The ischiocondylar part originates on the ischial tuberosity.
b. Insertion: the adductor part inserts on the gluteal tuberosity, linea aspera- medial lip, and medial supracondylar line. The ischiocondylar part inserts on the adductor tubercle of femur.

c. Innervation: adductor part: Obturatory nerve. Ischiocondylar part: tibial division of sciatic nerve.

d. Action: The adductor part: On the hip joint - thigh flexion, thigh adduction and thigh external rotation.

Hamstring part: on the hip joint - Thigh extension, thigh internal rotation The entire muscle contributes to pelvic stabilization.

Deep vessels and nerves:

• The arteries are represented by: the femoral artery that enters the popliteal space and takes the name of the popliteal artery;

• The veins are represented by the femoral vein;

• The lymphatics are represented by lymph nodes located on the path of the femoral vessels, the most representative of which are Cloquet's lymph node and Rosenmüller's lymph node;

• The nerves are represented by: the femoral nerve which enters giving rise to muscular branches.

The osteoarticular layer is represented by the anterior face of the body of the femur.

In plastic surgery, we note that the skin of the thigh has the fissure lines arranged parallel to the longitudinal axis of the lower limb, and the one in the lateral region is often used for the grafting of deficient regions.

SCARPA'S FEMORAL TRIGON (TRIGONUM FEMORIS)

Limits

• Lateral – the medial edge of the sartorius muscle;

• Superior – inguinal fold;

• Medial – the lateral border of the adductor longus muscle.

The femoral triangle is a muscular interstitium, which contains nerves and the main vessels of the lower limb. The inguinal ligament, located at the upper limit of the triangle, has the role of a retinaculum, which protects the femoral vessels during flexion movements of the thigh.

The contents of the femoral triangle (Fig.II.14), from the lateral to the medial side:
The femoral nerve - located lateral to the femoral artery, outside the "femoral sheath", has a short path and divides into terminal branches.
Femoral sheath/sheath of femoral vessels, which contains:

- Femoral artery
- The femoral vein
- The deep inguinal lymph nodes

Assessment of pain and swelling in this area it is mostly caused by the following:

- Abscesses
- Cellulitis
- Haematoma
- Nodal enlargement
- Femoral artery aneurysm
- Femoral vein thromobplebitis
- Femoral hernias (mostly at proximal opening, a weak areas in the lower abdominal wall)

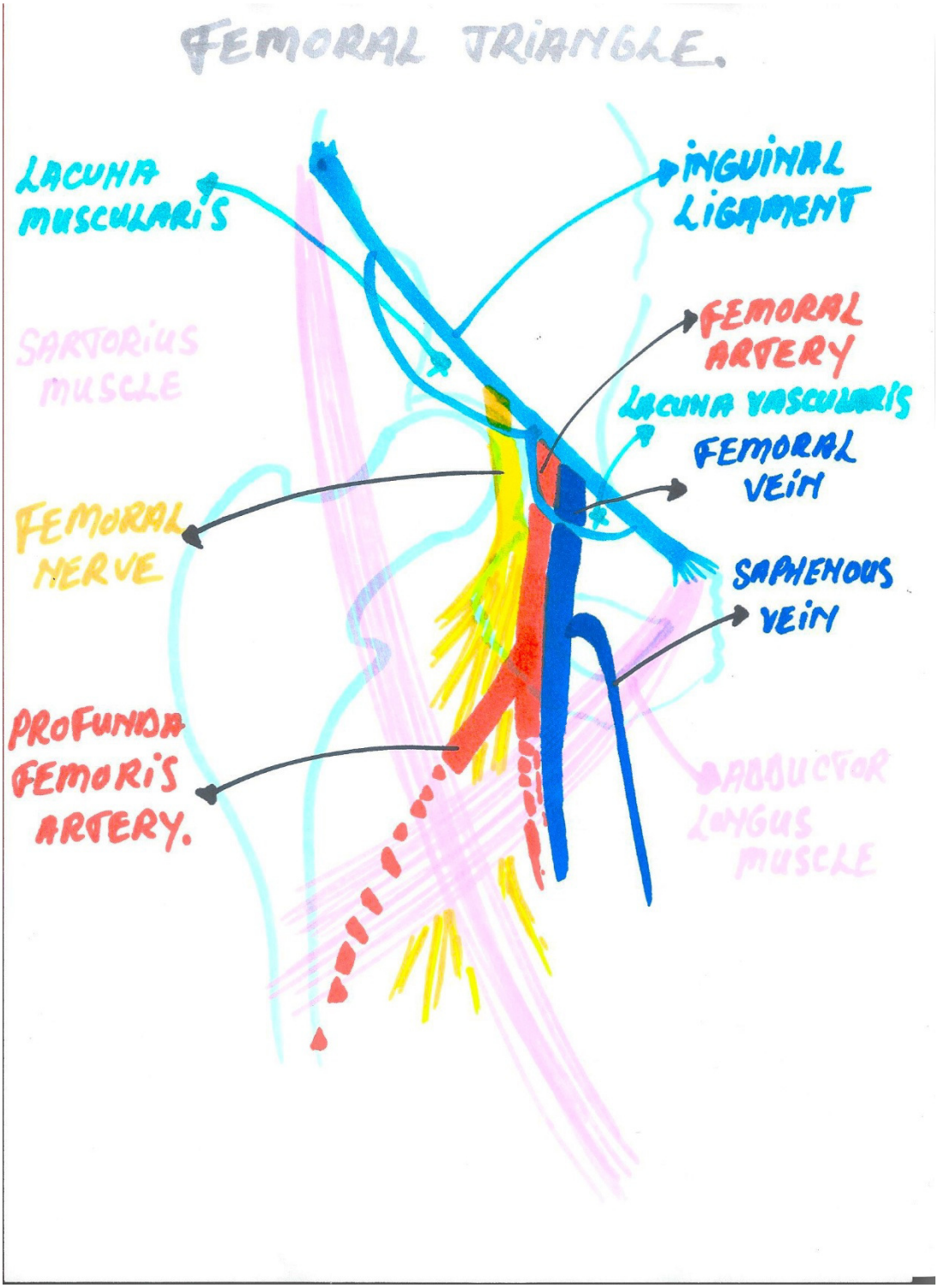

Fig. II.14. Femoral triangle, boundaries and content.

Clinical correlations:

The area is also commonly used for the following:

- Femoral pulse palpation
- Drawing blood from the femoral artery
- Vascular catheterization for interventional and corrective procedures
    - Provides access to ipsilateral and contralateral leg, abdominal, thoracic and cerebral vessels
    - Femoral artery catherization to access the aortic arch through the abdominal and descending aorta as well as the left side of the heart.
        - Used in aortic valve replacements, angiography and angioplasty
    - Femoral vein: Access right side of heart via inferior vena cava.
        - Used with patent foramen ovale repair.

II.3.1.4. Anterior region of the knee

The anterior region of the knee presents in the center a triangular prominence determined by the patella, from the level of which a flattened cord can be observed inferiorly, extending to the tuberosity of the tibia, represented by the patellar tendon. On one side and the other of the patella there are two depressions, which sometimes appear as two vertical grooves, determined by the tendinous expansions of the vastus muscles, called the patella fins. The top of the patella corresponds to the femoral-tibial joint line in both extension and flexion of the knee.

Stratigraphy

The skin is thick and mobile.

The subcutaneous, loose cellular tissue, represented by the superficial fascia, contains the vessels and

the superficial nerves and two serous bursae, the prepatellar subcutaneous serous bursa (Bursa subcutanea prepatellaris) and the infrapatellar subcutaneous bursa (Bursa subcutanea infrapatellaris).

Superficial vessels and nerves

• arteries are represented by small superficial branches

• the veins are represented by small vessels to which the great saphenous vein is added medially;

• lymphatics are represented by small vessels and lymph nodes that flow into the lower group of superficial inguinal lymph nodes;

• the nerves are represented by: branches from femoral cutaneous nerve;
branch of the saphenous (anteromedial); branches of the femoral nerve (Rr. cutanei anteriores) (anterior).
All these branches anastomose forming a patellar nerve plexus.
The musculo-aponeurotic layer is represented by:
• the crural fascia (Fascia cruris)
• the tendon of the quadriceps femoris muscle it continues with the ligament of the patella (Lig. patellae). The ligament of the patella stretches between the tip of the patella and the tubercle of the tibia and gives insertion through its edges to the medial patellar retinaculum (Retinaculum patellae mediale) and the lateral patellar retinaculum (Retinaculum patellae laterale);
• the suprapatellar serous bursa (Bursa suprapatellaris)
• the tendons of the aponeurotic formation called "goose paw", respectively the tendons of the sartorius, gracilis and semitendinosus muscles.
Deep vessels and nerves
• the arteries are represented by the deep arterial circle of the knee located between patella and the tendon of the quadriceps femoris muscle and formed by the union of the superior, medial and lateral genicular arteries with the inferior, medial and lateral genicular arteries, branches of the popliteal artery
• the veins accompany the arteries and flow into the popliteal vein;
• lymphatics are represented by small lymphatic vessels that drain lymph into
popliteal lymph nodes;
• nerves are represented by branches from the tibial nerve (N. tibialis) and from the nerve common fibula (N. fibularis communis; N. peroneus communis).
The osteoarticular layer is represented by the anterior face of the knee joint.

Clinical corralations:

Puncture of the knee joint is usually performed on the antero-lateral face of the joint at the level of the lateral border of the base of the patella. The puncture is made at the intersection of the two perpendicular lines drawn, one a finger's width above the base of the patella, the other 1-2 cm parallel to the lateral edge of the patella. We will give the needle an oblique direction towards the subquadriciptal center, the needle will have a horizontal direction, perpendicular to the longitudinal axis of the femur. It is recommended to compress the fundus of the subquadriciptal sac during the puncture of the knee, because this maneuver prevents us from injuring the patella and at the same time facilitates the evacuation of the intra-articular fluid;

II.3.1.5. Anterior region of the leg

It presents a vertical ridge corresponding to the anterior edge of the tibia, very sensitive and therefore very painful in traumas, and in the extended leg a longitudinal groove can be observed that delimits the anterior muscle group from the lateral muscle group. Superior to the border with the knee, three bony eminences can be palpated: the tuberosity of the tibia, Gerdy's anterior tibial tubercle and the head of the fibula.

The course of the great saphenous vein can be seen medially.

Stratigraphy

The skin, thin and slightly mobile, is provided with bristles.

Subcutaneous cellular tissue consisting of superficial fascia and cello-adipose tissue in which the superficial vessels and nerves are found:

• arteries originate in the anterior tibial artery;

• veins form a tributary network of the great saphenous vein or the small saphenous vein;

• the lymphatics are represented by vessels and lymph nodes located some medially along the great saphenous and others laterally along the small saphenous vein;

• the nerves come from the lateral sural cutaneous nerve (N. cutaneus surae lateralis)

The aponeurotic layer is represented by the crural fascia, continuous superiorly with fascia lata, and lower with the retinaculum of the flexors.

The subaponeurotic layer consists of muscles, vessels and deep nerves.

The muscular plane comprises the muscles arranged in two lodges:

• the anterior compartment includes: M. tibialis anterior the M. extensor digitorum longus, M. extensor hallucis longus and M. fibularis tertius ; M. peroneus tertius);

• the lateral compartment includes: M. fibularis longus; and the M. fibularis brevis;.

Deep vessels and nerves

• the arteries are represented by the anterior Arteria tibialis .

• the veins are represented by the anterior tibial veins

• lymphatics are located along the blood vessels

• the nerves are branches of the tibial nerve and the deep peroneal nerve (N. fibularis profundus; N. peroneus profundus).

The osteoarticular layer is represented by the body of the tibia and fibula joined by the interosseous membrane, the medial malleolus and the lateral malleolus.

1. Tibialis anterior muscle
   a. Origin: Lateral surface of the tibia and interosseous membrane
   b. Insertion: Medial cuneiform bone and base of the first metatarsal
   c. Innervation: deep fibular nerve
   d. Action: on the talocrural joint: foot dorsiflexion; on the subtalar joint: foot inversion.

2. Extensor digitorium longus muscle
   a. Origin: on the medial surface of the fibula in the proximal third , lateral tibial condyle and interosseus membrane
   b. Insertion: distal and middle phalanges of digits 2-5
   c. Innervation Deep fibular nerve
   d. Action: on the metatarsophalangeal and interphalangeal joints 2-5: toe extension; on the talocrural joint: foot dorsiflexion; on the subtalar joint: Foot eversion.

3. Extensor halucis longus muscle
   a. Origin: middle third of the medial surface of the fibula and interosseous membrane.
   b. Insertion: base of the distal phalanx of the great toe.
   c. Innervation: deep fibular nerve.
   d. Action: on the metatarsophalangeal and interphalangeal joint 1: toe extension; on the talocrural joint: foot dorsiflexion.

4. Fibularis tertius muscle
   a. Origin: Medial surface of the fibula in the distal third, anterior surface of the interosseous membrane , anterior intermuscular septum.
   b. Insertion: dorsal surface of the base of the fifth metatarsal.
   c. Innervation: deep fibular nerve
   d. Action: on the talocrural joint: foot dorsiflexion; on the subtalar joint: foot eversion

5. Fibularis longus muscle
    a. Origin: head of the fibula, proximal 2/3 of lateral surface of fibula and intermuscular septum.
    b. Insertion: the medial cuneiform bone and first metatarsal bone.
    c. Innervation: superficial fibular nerve
    d. Action: on the talocrural joint: foot plantar flexion;
    On the subtalar joint: foot eversion; Supports longitudinal and transverse arches of foot.

6. Fibularis brevis muscle
    a. Origin: distal 2/3 of the lateral surface of fibula, anterior inermuscular septum
    b. Insertion: tuberosity of the 5th metatarsal bone
    c. Innervation: superficial fibular nerve
    d. Action: on the talocrural joint: foot plantar flexion: on the subtalar joint: Foot eversion.

Clinical correlations:

1. The skin is exposed to a greater extent than that of the thigh and knee in some trauma, sports, traffic accidents.

The crack lines run parallel to the longitudinal axis of the leg.

The lateral malleolus is pointed, elongated, its tip being located 3 cm below the tibiotalar joint line and 1 cm below the medial malleolus. It is the frequent site of fractures the bones of the leg, and the skin covering of the lower extremity of the fibula can often be damaged in these fractures (open fractures).

2. In complete ruptures of the achiles tendon, in some cases the fibularis brevis tendon is detached of the base of the fifth metatarsal and retracted proximal to be used as reinforcement in the reconstruction of the Achiles tendon. No functional deficit is seen after recovery because of this. The benefits include a much stronger repair with the ability to start recovery alot sooner which leads to rapid end point recovery.

3. Drop Foot sign: The anterior tibialis muscle is the strongest dorsiflexor of the foot and is innervated by the deep peroneal nerve, with fibers originating from L4-L5 nerve roots.

L4-L5 is also the most common level for herniated discs and usually these will be the roots compressed by the herniated fragment. Taking this into account loosing muscle strength when doing dorsiflexion or loosing dorsiflexion alltogether can be a decisive factor for indicating surgical treatment for lumbar hernia, because neurologiucal deficits are a clear sign that the pathology has gone past the reversible stage and progression leads to serious locomotor issues.

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II.3.1 6. The dorsum of the foot

The dorsal region of the foot is located between the ankle joint and the toes, representing the upper surface of the foot.[1]

Stratigraphy:

1. Skin

2. Subcutaneous cellular tissue with the superficial nerves and vessels (dorsal venous network of the leg which medially unites with medial marginal vein and forms the greater saphenous vein and lateral with the lateral marginal vein and forms the small saphenous vein)

3. Dorsal fascia of the foot

4. Subaponeurotic layer with muscles, deep vessels, and nerves :

- the muscles are disposed in two plans :
    - superficial plan with the tendons of anterior tibial, fibularis tertius, and extensor digitorum longus.
    - deep plan with extensor hallucis brevis and extensor digitorum brevis.
- the vessels and the nerves:

- dorsalis pedis artery and veins;
- medial and lateral branches of the deep peroneal nerve.

5. Tarsus skeleton

Clinical correlations [2]**:**

- The pulse at the dorsalis pedis artery can be palpated on the dorsal aspect of the foot at the level of the first intermetatarsal space and is very important for the evaluation of peripheral ischemia.

MQS

1. Which of the following are true?

A. The dorsalis pedis artery is a continuation of the anterior tibial artery
B. The tibial nerve provides sensory innervation to the dorsal aspect of the thigh.
C. The extensor digitorum brevis is located on the dorsum of the foot.
D. The dorsalis pedis artery is normally palpable in plantar surface of the foot.
E. The fibular nerve has no role in dorsal foot innervation.

Correct answers: A,C

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II.3.2. Disection of the posterior regions of the inferior limb

II.3.2.1. Posterior femoral region

The posterior femoral region or the posterior region of the thigh represents the anatomic regions posterior to the femur, and can be devided into gluteal region superiorly, posterior region of the thigh and posterior region of the knee or popliteal region inferiorly.

a. Gluteal region:

Stratigraphy [1,2]

• The skin: it is mobile, thicker than in the anterior femoral region, it thickens from the bottom to the top towards the gluteal fold and the gluteal region; contains hair follicles.

• Subcutaneous cellular tissue, variably developed contains numerous superficial vascular-nervous elements:

Small cutaneous arterial branches originating from:

- inferior gluteal artery
- medial femoral circumflex artery
- perforating arteries (from the deep femoral artery).

The superficial veins of the region drain to the great saphenous vein and to the accessory saphenous vein (CRUVEILHIER's vein). At the level of the posterior femoral region, through the anastomotic vein or femoral-popliteal vein of GIACOMINI, the communication between the system of the great saphenous vein and the system of the small saphenous vein is achieved.

The lymph of the superficial structures of the region is drained towards the infero-medial and infero-lateral groups of the superficial inguinal lymph nodes.

The superficial cutaneous nerves of the region come from:

- posterior branch of the lateral femoral cutaneous nerve, terminal branch of the lumbar plexus
- posterior femoral cutaneous nerve or small sciatic nerve, collateral branch of the sacral plexus
- cutaneous branch from the anterior branch of the obturator nerve
- medial cutaneous branch of the femoral nerve

Muscles of the gluteal region[1,2,3] :

1. Gluteus maximus
    a. Origin: Lateroposterior surface of sacrum and coccyx, gluteal surface of ilium (behind posterior gluteal line), thoracolumbar fascia, sacrotuberous ligament
    b. Insertion: Iliotibial tract, gluteal tuberosity of femur
    c. Innervation: Inferior gluteal nerve
    d. Function: Extension, external rotation, abduction and adduction of the thigh

2. Gluteus medius muscle

a. Origin: Gluteal surface of ilium (between anterior and posterior gluteal lines)
b. Insertion: Lateral aspect of greater trochanter of femur
c. Innervation: Superior gluteal nerve
d. Function: Abduction and internal rotation of thigh; pelvis stabilization

3. Gluteus minimus
    a. Origin: Gluteal surface of ilium (between anterior and inferior gluteal lines)
    b. Insertion: Anterior aspect of greater trochanter of femur
    c. Innervation: Superior gluteal nerve
    d. Function: Abduction and internal rotation of thigh; pelvis stabilization

4. Piriformis muscle
    a. Origin: Anterior surface of the sacrum between the S2 and S4, Gluteal surface of ilium near the posterior inferior iliac spine
    b. Insertion: Apex of greater trochanter of femur
    c. Innervation: Nerve to piriformis (S1-S2)
    d. Function: on the hip joint: thigh external rotation, thigh abduction from flexed hip and stabilizes the head of the femur in the acetabulum

5. Gemellus superior muscle
    a. Origin: Ischial spine
    b. Insertion: medial surface of the greater trochanter of the femur
    c. Innervation: nerve to obturator internus (L5-S2)
    d. Function on the hip joint: thigh external rotation, thigh abduction from flexed hip and stabilizes the head of the femur in the acetabulum

6. Obturator internus muscle
    a. Origin: the ischiopubic ramus and the posterior surface of the obturator membrane
    b. Insertion: medial surface of the greater trochanter of the femur
    c. Innervation: nerve to obturator internus (L5-S2)
    d. Function: on the hip joint: thigh external rotation, thigh abduction from flexed hip and stabilizes the head of the femur in the acetabulum

7. Inferior gemellus muscle
    a. Origin: ischial tuberosity
    b. Insertion: medial surface of the greater trochanter of the femur
    c. Innervation:nerve to quadratus femoris (L4-S1)
    d. Function: on the hip joint: thigh external rotation, thigh abduction from flexed hip and stabilizes the head of the femur in the acetabulum

8. Obturator externus muscle
    a. Origin: anterior surface of the obturator membrane, bony crest surrounding the obturatory foramen
    b. Insertion: the trochanteric fossa of the femur
    c. Innervation: obturator nerve (L3-L4)
    d. Function Hip joint: Thigh external rotation, Thigh abduction (from flexed hip), Thigh adduction (secondary function); Stabilizes head of femur in acetabulum

9. Quadratus femoris muscle
    a. Origin: ischial tuberosity
    b. Insertion: intertrochanteric crest of the femur
    c. Innervation: nerve to quadratus femoris (L5-S1)
    d. Function: in the hip joint: thigh external rotation and stabilizes the head of the femur in the acetabulum

Vessels and nerves

Arteries [2,3]

Although the posterior femoral region does not benefit from the presence of its own arterial trunk, it presents a special anastomotic arterial network formed by branches of the inferior gluteal artery, medial femoral circumflex artery and perforating arteries (from the deep femoral artery, branch of the femoral artery).

Veins are homonymous with arteries and have the opposite path to them.

The deep lymphatics of the posterior femoral region drain to the internal iliac lymph nodes.

The deep nerves are represented by:

- sciatic nerve (greater sciatic nerve)
- femoral cutaneous nerve.

b. The posterior region of the thigh

The posterior region of the thigh contains strong flexor muscles of the knee that often suffer injuries in athletes. The muscles are as follows:

1. Biceps femoris muscle:
   a. Origin: long head originates on the inferomedial impression of the ischial tuberosity and the sacrotuberous ligament ; the short head originates on the linea aspera of the femur , lateral lip, and the lateral supracondylar line of the femur;
   b. Insertion: lateral aspect of the head of the fibula
   c. Action: on the hip joint: thigh extension and thigh external rotation;
   On the knee joint: leg flexion, leg external rotation and stabilizes the pelvis
   d. Innervation: long head: tibial division of sciatic nerve (L5-S2)
   short head: common fibular division of sciatic nerve (L5-S2)

2. Semimembranosus muscle
   a. Origin: Superolateral impression of ischial tuberosity
   b. Insertion: medial condyle of tibia
   c. Action: on the hip joint: thigh extension and internal rotation; on the knee joint: flexion and internal rotation of the leg; It also stabilizes the pelvis
   d. Innervation: tibial division of the sciatic nerve (L5 – S2)

3. Semitendinosus muscle
    a. Origin: posteromedial impression of the Ischial tuberosity
    b. Insertion: proximal end of the tibia below the medial condyle at the level of pes anserinus
    c. Action: on the hip joint: thigh extension, thigh internal rotation and also stabilizes the pelvis.
    -on the knee joint: leg flexion and leg internal rotation.
    d. Innervation: tibial division of sciatic nerve

c. **The posterior region of the knee (also called popliteal fossa).**

When the leg is flexed on the thigh, the region appears excavated, bounded by four musculotendinous reliefs which delimits a rhomboidal space represented by the popliteal fossa (Fig. II.15).

When the leg is in extension on the thigh, at the level of the posterior region of the knee, instead of the popliteal fossa, a bulge appears, produced by the fat body of the popliteal space.

In the depth of the popliteal fossa the pulse of the popliteal artery can be palpated.

Stratigraphy

Skin it is fine, thin, mobile on the underlying planes shows transverse folds during the flexion movement of the calf on the thigh

Subcutaneous cellular tissue it is of variable thickness has an areolar structure,

it continues with the subcutaneous cellular tissue of the neighboring regions.

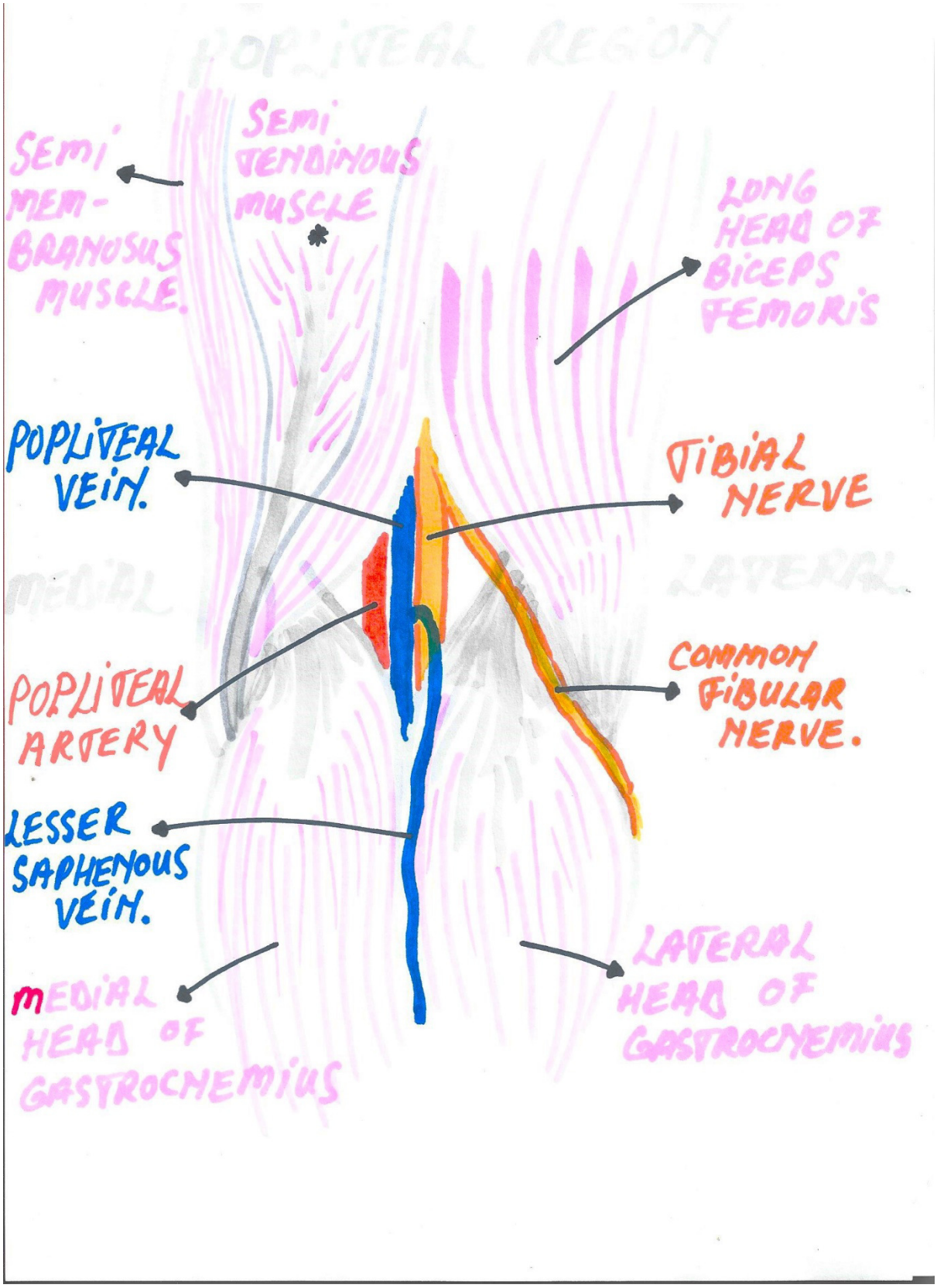

Fig. II.15: popliteal fossa with vasculo-nervous structures and lateral boundaries.

Superficial muscle plane:

It is represented by the muscles that delimit the popliteal fossa:

- biceps femoris muscle - supero-lateral
- semitendinosus muscle - supero-medial - superficial
- the semimembranous muscle - supero-medial - deep
- medial head of the gastrocnemius muscle - medial
- the lateral head of the gastrocnemius muscle and the plantar muscle – lateral

The content of the popliteal fossa is represented by:

- popliteal adipose body - formed by an abundant cellulo-adipose tissue
- popliteal artery and its branches
- popliteal vein and its tributaries
- deep popliteal lymph nodes
- tibial nerve (internal popliteal sciatic nerve)
- common fibular nerve (external popliteal sciatic nerve) - terminal branches of the sciatic nerve

The deep vessels and nerves of the posterior region of the knee are represented by:

- popliteal artery with its branches
- popliteal vein with its tributaries
- vessels and deep popliteal lymph nodes,
- the terminal branches of the sciatic nerve the tibial nerve

The deep nerves of the posterior region of the knee are represented by the two terminal branches of the sciatic nerve:

- common fibular nerve or external popliteal sciatic nerve
- tibial nerve or internal popliteal sciatic nerve

In the region of the knee, the skin is thick on the anterior face, thin on the posterior face, with the fissure lines arranged transversely, a fact to remember in various incisions for abscesses, suppurative bursitis or in some arthrotomies. At the level of the heads of the popliteal rhombus, the skin has vertical crack lines. In this region the incisions they must be horizontal.

II.3.2.2. The posterior region of the leg.

Skin: it is thick and mobile, covered with sparse hair.

Subcutaneous cellular tissue - of variable thickness contains numerous superficial vascular-nervous elements:

Small arteries.

The veins form an anastomotic network with large meshes:

- The great saphenous vein runs medially upwards
- The small saphenous vein runs posteriorly between the heads of the gastrocnemius together with the sural nerve.

Superficial lymphatics:

- medial to the region follow the course of the great saphenous vein
- sides of the region follow the course of the small saphenous vein

Superficial nerves are represented by:

- The medial sural cutaneous nerve
- The lateral sural cutaneous nerve
- The communicating fibular branch
- The sural nerve

The superficial muscle lodge [1,2,3], located between the superficial and deep sheets of the crural fascia, is an exclusively muscular lodge.

It contains:

- the gastrocnemius muscle
- soleus muscle

which merge and give rise to the triceps surae muscle.

1. The gastrocnemius muscle:
    a. Origin: the lateral head originates on the upper posterolateral surface of lateral condyle of the femur while the medial head originates on the posterior surface of medial femoral condyle and the popliteal surface of femoral shaft
    b. Insertion: posterior surface of the calcaneus via the calcaneal tendon also called the Achilles Tendon (because it is considerred a weak spot= essential for the ability to walk, yet immediately under the skin= vulnerable.
    c. Innervation: tibial nerve
    d. Function: on the talocrural joint it does foot plantar flexion while on the knee joint it does leg flexion.

2. The soleus muscle:
    a. Origin: on the soleal line, medial border of the tibia, the head of the fibula, and posterior border of fibula
    b. Insertion: posterior surface of calcaneus via cthe alcaneal tendon also caslled the Achilles Tendon
    c. Innervation: tibial nerve (S1, S2)
    d. Function: on the talocrural joint it does foot plantar flexion

The deep muscle compartment [1,2,3] is delimited by the deep sheet of the crural fascia and the osteofibrous plane of the region and is a musculo-vascular-nervous compartment.
Contains:

- Muscles: posterior tibial M., M. flexor digitorum longus, M. flexor hallucis longus.
- Vascular-nervous bundles: Posterior tibial artery, Posterior tibial veins, Tibial nerve, Fibular artery, Fibular veins

3. Posterior tibialis muscle:
    a. Origin: the posterior surface of the tibia, the posterior surface of the fibula and the interosseous membrane
    b. Insertion: the tuberosity of the navicular bone, all cuneiform bones, cuboid bone, and bases of the metatarsal bones 2-4
    c. Actions: on the talocrural joint it does foot plantarflexion; on the subtalar joint it does foot inversion. It supports medial longitudinal arch of foot.
    d. Innervation: tibial nerve

4. Extensor digitorium longus muscle:
    a. Origin: the proximal half of the medial surface of the fibula, lateral tibial condyle and interosseus membrane
    b. Insertion: distal and middle phalanges of digits 2-5
    c. Action: on the metatarsophalangeal and interphalangeal joints 2-5 it does toe extension; on the talocrural joint it does foot dorsiflexion; on the subtalar joint it does foot eversion;
    d. Innervation: deep fibular nerve.

5. Extensor hallucis longus:
    a. Origin: middle third of the medial surface of the fibula and interosseous membrane
    b. Insertion: base of the distal phalanx of the great toe
    c. Action: on the metatarsophalangeal and interphalangeal joint 1 it does toe extension; on the talocrural joint it does foot dorsiflexion
    d. Innervation: deep fibular nerve.

Clinical correlations **[4,5,6]**

Compartment syndrome is an increase in pressure inside a fascial compartment containing muscles, which restricts blood flow and causes pain. Because the facia is not elastic and the muscle tissue swells very quickly generally in crush trauma, at a certain point the intra-compartment pressure rises close to that of sistolic pressure so blood flow to the extremity is altered.

Symptoms include:

- pain in a muscle – this may feel like a burning pain or a deep ache (moving the body part can make the pain even worse)
- swelling or bulging of the muscle
- numbness, weakness or pins and needles
- tightness or difficulty moving the affected body part

  Compartment syndrome is very dangerous and if not recognised clinically it leads to extensive muscle necrosis with major debilitating consequences. It shoud be careffully excluded in any crush injury because of its poor evolution and results.

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II.3.2.3. Plantar region

The plantar region contains the soft tissue situated below the bones of the foot.[1]

Stratigraphy [1, 2, 3] :

1. Skin
2. Subcutaneous cellular tissue with superficial vessels and nerves: branches from posterior tibial artery, lateral plantar artery, plantar venous arch.
3. Plantar aponeurosis
4. Muscles are divided into three plans:
    - middle plan: lumbrical muscles, flexor digitorum brevis muscle, plantar interossei muscles, adductor hallucis muscle.
    - lateral plan: abductor digiti minimi, flexor digiti mini brevis.
    - medial plan : flexor hallucis longus muscle, abductor hallucis muscle, flexor hallucis brevis muscle
5. Deep vessels and nerves:
    - arteries: medial plantar artery, lateral plantar artery, dorsal artery
    - veins accompany the arteries
    - nerves: medialis and lateral plantar nerve.
6. Tarsal and metatarsal bones

Clinical correlations [2]:

- A flat or hollow foot is a deformity caused by the collapse of a part of the arch of the foot.
- Plantar fasciitis, is inflammation of the plantar fascia caused by overuse, of footwear. Presents heel pain, especially with the first step in the morning.
- Injuries or compressions of the medial, lateral plantar nerves or tibial nerve can lead to muscle weakness, affecting balance, numbness, or pain.

MCQ

1. Which of the following ins located in the middle mjscular layer of the plantar region?
    A. Flexor digitorum brevis
    B. Abductor digiti minimi
    C. Plantar aponurosis
    D. Flexor hallucis brevis
    E. Medial plantar artery

Correct answer: A

2. Which of the following regarding clinical conditions of the posterior femoral region are correct?

A. A deep intramuscular injection in the posterior thigh carries a risk of sciatic nerve injury.

B. Injury to the sciatic nerve in the posterior thigh can cause weakness in knee flexion.

C. Prolonged compression of the posterior thigh (e.g., from sitting on a hard surface) may cause transient sciatic nerve symptoms.

D. The short head of the biceps femoris is innervated by the tibial portion of the sciatic nerve.

E. Hamstring strains commonly occur in activities involving rapid acceleration or deceleration.

Correct answers: A, B, C, E

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CHAPTER III. THE ABDOMEN

CĂTĂLIN-FLAVIUS PRODAN-BĂRBULESCU
ADRIAN EMIL LĂZĂRESCU
NAWWAF SEBASTIAN DAMEN

III.1. Antero-lateral Abdominal Wall

III.1.1. General features

The abdomen is the most voluminous segment of the human trunk, it is an anatomical and functional segment that houses the majority of digestive and extradigestive viscera, being a particularly complex composition, made up of skeletal parts, fixed or with limited mobility, on which its insertions, active muscular or musculo-aponeurotic structures are found, arranged in various planes and formations, which give it certain anatomical or functional characters (1,2).

The anterior abdominal wall serves as a protective layer for the abdominal contents and plays an important role in respiration, posture, and various movements of the trunk. It consists of several layers, including skin, subcutaneous tissue (which contains the superficial fascia), muscles, and their aponeuroses (1,2).

The importance of the abdominal walls and contents is particularly great in anatomy and general surgery since it represents an important segment of the body where a rich and varied bouquet of pathologies occur and obviously where surgical interventions designed to treat these digestive and extra-digestive pathologies occur (3,4).

Etymologically, the word comes from the Latin 'abdōmen', and its origins are disputed: one theory links it to the verb 'abdere' (to hide), suggesting its role in protecting the internal organs, while another hypothesis associates it with 'adeps, adipis' (fat), reflecting the accumulation of adipose tissue in this region(5).

III.1.2. The limits

The limits of the anterolateral abdominal wall are:

1. **Superiorly and superficial**: xiphoid process at the midline, and laterally by the right and left costal margins.
2. **Inferiorly and superficial**: The anterior part of the iliac crest, the fold of the inguinal ligament that runs between the anterior superior iliac spine and the pubic tubercle. The

pubic tubercle, pubic crest, and pubic symphysis complete the inferior boundary at the pubic region.

3. **Laterally**: The lateral boundary is defined by the midaxillary line, which separates the anterior abdominal wall from the posterior abdominal wall. This line runs vertically through the armpit and is a reference point for differentiating the anterior and posterior sections of the abdominal region(3).

III.1.3. Stratigraphy

Stratigraphy of the anterolateral abdominal wall

The layers of the front abdominal wall are as follows, arranged from superficial to deep:

1. Tegument or skin.
2. Camper's fascia (just at the level of right iliac fossa, hypogastrium and left iliac fossa)
3. Scarpa's fascia, an elastic form of fibrous tissue, is the membranous layer that makes up the superficial fascia.
4. External oblique muscle and Rectus abdominis (medially most superficial)
5. Oblique muscle.
6. Transversus abdominis muscle.
7. Transversalis fascia.
8. Parietal Peritoneum (1,6).

Rectus Abdominis (rectus abdominis)

The rectus abdominis exists as a long flat muscle structure that spans from the breastbone to the pubic bone on the front abdominal wall. Multiple transverse tendons divide the muscle into sections which create the well-known six-pack shape when the muscle becomes defined.

Muscular attachments: The rectus abdominis muscle connects to the cartilages of ribs 5-7 along with the xiphoid process of the sternum before attaching to the pubic symphysis and pubic crest.

Action: The muscle functions to flex the trunk while helping to compress the abdominal cavity which generates elevated intra-abdominal pressure. The muscle functions to perform trunk bending motions while helping maintain body position (3,4).

External Oblique of the Abdomen (External Oblique)

The external oblique is a flat muscle located on the sides and front of the abdomen, with fibers oriented obliquely downwards and forwards, like a trouser collar.

Muscular attachments: It originates from the outer 5-12 ribs and inserts on the iliac crest, the inguinal ligament, and the linea alba of the abdomen.

Action: The external oblique is essential in the rotation and lateral flexion of the trunk and also plays a role in compressing the abdominal cavity. This muscle aids in torsion movements of the trunk and supports the stability of the trunk during power movements (3,4).

The internal oblique muscle of the abdomen (Internal Oblique)

The internal oblique muscle of the abdomen lies beneath the external oblique and has fibers facing in the opposite direction, i.e. upwards and forwards.

Muscular attachments: It originates from the thoracolumbar fascia, the iliac crest, and the inguinal ligament, and its insertion occurs on ribs 10-12, the linea alba, and the upper pubis.

Action: The internal oblique, along with the external oblique, contributes to the rotational and lateral flexion movements of the trunk. This muscle also helps to compress the abdominal cavity and plays an important role in stabilizing the trunk and protecting the internal organs (3,4).

Transverse abdominis muscle (Transversus Abdominis)

The transverse abdominis muscle is the deepest of the abdominal wall muscles and has its fibers oriented horizontally around the abdominal cavity.

Muscular attachments: It originates from the thoracolumbar fascia, ribs 7-12, the iliac crest, and the inguinal ligament and inserts on the linea alba and the symphysis pubis. This muscle plays a crucial role in increasing intra-abdominal pressure and stabilizing the trunk.

Action: It is important for the protection of the internal organs and helps in maintaining the right posture and thus plays an important role in supporting and stabilizing the body, especially during activities like heavy lifting or forceful movements (3,4,7).

III.2. Projection of Abdominal Organs

The projections of abdominal organs are commonly mapped using the **nine-region system** of the abdomen, which divides the area into **nine quadrants** using two horizontal and two vertical lines. This system is essential for clinical examination, surgical approaches, and diagnostic imaging (3,4,7,8).

III.2.1. Abdominal Regions

The abdomen is divided into nine regions **using:**

1. **Two horizontal planes:**
    a. **Subcostal plane:** Passes through the inferior border of the 10th costal cartilage.
    b. **Transtubercular plane:** Passes through the iliac tubercles and the body of the L5 vertebra.
2. **Two vertical planes:**
    a. Midclavicular planes: Run vertically from the midpoint of each clavicle to the midpoint of the inguinal ligament (2,4).

This division creates the following **nine regions (table III.1):**

Table III.1. Anatomo-clinical division of anterolateral wall.

Regions	Borders
Epigastric	Between the subcostal plane and diaphragm
Right hypochondriac	Right of the epigastric region
Left hypochondriac	Left of the epigastric region
Umbilical	Between subcostal and trans tubercular planes, centered around the umbilicus
Right lumbar (flank)	Right of the umbilical region
Left lumbar (flank)	Left of the umbilical region
Hypogastric (suprapubic)	Below the trans tubercular plane
Right iliac (inguinal)	Right of the hypogastric region
Left iliac (inguinal)	Left of the hypogastric region (4)

III.2.2. Projections

The following is a general projection of abdominal organs in the nine quadrants:

Table II.2. Projections of the abdominal viscera on the anterolateral abdominal wall.

Region	Main Organs Present
Epigastric	Stomach, left hepatic lobe, pancreas (head and body), duodenum
Right hypochondriac	Right hepatic lobe, gallbladder, choledochal duct, right kidney, hepatic flexure of the colon
Left hypochondriac	Fundus and body of the stomach, spleen, tail of the pancreas, left kidney, splenic flexure of the colon
Umbilical	Jejunum and Ileum, transverse colon, body of the pancreas
Right lumbar	Ascending colon, right kidney
Left lumbar	Descending colon, left kidney
Hypogastric	Small intestine, sigmoid colon, rectum, urinary bladder (if distended), uterus (in females)
Right iliac	Cecum, appendix, terminal ileum, right ovary and fallopian tube
Left iliac	Sigmoid colon, left ovary, and fallopian tube (4).

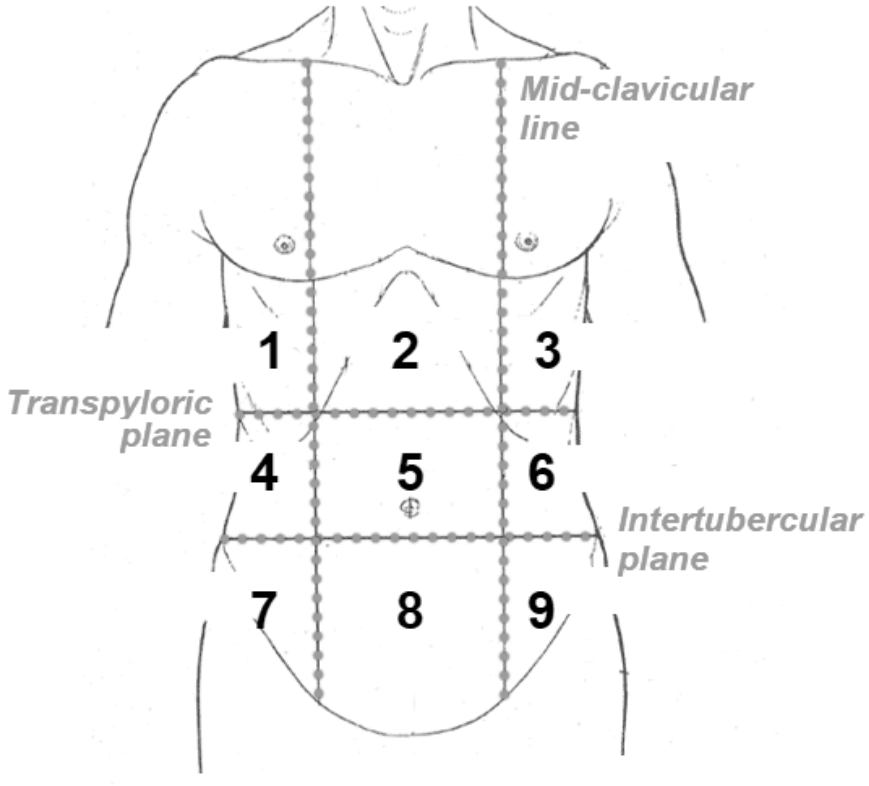

Fig. III.1. The division of antero-lateral abdominal wall

III.3. Inguinal Canal

III.3.1. General anatomy

The inguinal canal is a short, oblique passage running downward and inward through the lower abdominal wall, located above and parallel to the inguinal ligament. It serves as a conduit for structures traveling from the abdominal cavity to the external genitalia. Clinically, the inguinal canal is of particular significance due to its potential as a weak area in the abdominal wall, making it a common site for hernias (4,8,9).

Another anatomy-clinically relevant landmark is the fact that the inguinal canal is located superior to Malgaigne's line (which connects the SIAS to the pubic tubercle) topographically delimiting the inguinal region from the femoral region, having as a corresponding topographic differentiation of an inguinal hernia (located superior to Malgaigne's line) from a femoral hernia (located inferior to Malgaigne's line).

In terms of direction, the inguinal canal runs obliquely from posterior to anterior, from superior to inferior, and from lateral to medial, thus creating a sharp angle between the Poupart inguinal ligament and the inguinal canal of 15-20 degrees (3).

In terms of length, the inguinal canal is 4-5 cm long (3).

Stratigraphy of the inguinal canal involves the following layers from superficial to deep: integument, subcutaneous cellular tissue represented in the form of a ligamentous structure called Petrequin's ligament, which has the function of attaching the inguinal ligament (Poupart) to the integument of the inguinal fold, thus forming a cutaneous retraction in this area, the so-called inguinal plica.

Also in the subcutaneous cellular tissue, in terms of fasciae, we must describe Camper's fascia (superficial) and Scarpa's fascia (deep)(3,4,10).

Within the subcutaneous cellular tissue are the branches of the superficial superficial superior external collateral arteries and the homonymous veins. From the lymphatic point of view, this region is inhabited by Lejars' supra-inguinal lymph nodes.

From the point of view of the nerves that cross this area, we find: nerve threads of the genito-femoral nerve.

The next layer is represented by the aponeurosis of the external oblique muscle, which is shiny white.

Subsequently, the inguinal canal is properly accessed, meeting the contents of the canal and the posterior wall, up to the parietal peritoneum.

Fig. III.2. Inguinal canal anatomy and structures

Bogros' space

The retro inguinal space (or Bogros' space) is the extraperitoneal space located deep in the inguinal ligament. It is bounded by the anterior transverse fascia, posterior peritoneum, and lateral iliac fascia. This preperitoneal space communicates with the prevesical space of Retzius.

In surgical procedures such as groin hernia repair, the Bogros space can be approached using laparoscopic techniques to access the area without making large incisions. This allows surgeons to reach preperitoneal hernias, which are often difficult to diagnose due to their deep localization. Modern approaches help to minimize risks and speed up the patient's recovery.

Even if it is not a term commonly used in daily practice, understanding and correctly identifying the Bogros space is crucial for inguinal surgery, preventing possible complications and ensuring effective treatment of hernias. Thus, this space plays a significant role in minimally invasive interventions, contributing to the long-term success of surgical procedures.

III.3.2. Walls

The inguinal canal is bordered by anterior, posterior, superior (roof), and inferior (floor) walls.

1. **Anterior wall**: Formed by the aponeurosis of the external oblique muscle, reinforced laterally by the internal oblique muscle. The anterior wall is further supported by the **inguinal ligament**, which forms the base of the canal and plays a crucial role in its structure and integrity.
2. **Posterior wall**: **Ttransversallis fascia is reinforced by 4 formations: the conjoint tendon, Hesselbach's ligament, Henle's ligament, and Colles' ligament.**
3. **Superior wall (roof)**: Composed of the transversal **fascia, internal oblique**, and **transversus abdominis muscles,** which together form the **conjoint tendon**. The roof is also supported by the **falciform ligament**, which connects the liver to the anterior abdominal wall, though it is not a direct component of the inguinal canal.
4. **Inferior wall (floor)**: Defined by the **inguinal ligament**, which forms the base of the canal, and thickened medially by the **lacunar ligament(1,3,9)**.

Fig. III.3. Walls and boundaries of the inguinal canal

Ligamentary structures

These ligaments, along with the muscles and fascia of the abdominal wall, provide crucial support to the inguinal canal. Their anatomical positioning and interactions are significant in various surgical procedures, particularly those involving hernia repair and abdominal wall reconstruction (3,4).

1.The Hesselbach's interfoveolar ligament is a fibrous condensation of the endo abdominal fascia (transversal) in the shape of an italicized letter “S”(3).

2. Henle's ligament or the internal inguinal ligament strengthens the fascia tranversalis in its entire medial segment (3).

3. Colles' ligament or reflex ligament originates from the external oblique muscle on the opposite side and crosses the midline to insert on the pubic bone and pectinate crest.

4. Hesselbach's Trigon, “deserves all the attention” of readers and connoisseurs, because it is the most preferred site in the occurrence of direct inguinal hernias, because it is an area of minimal resistance, at the level of the posterior wall of the inguinal canal, consisting only of the transversal fascia (endo abdominal) and limited by Hesselbach's ligament (lateral) and the Tendon conjunct; Henle's ligament and Colles' ligament (medial) and Thompson's iliopubic band (inferior/basal) (3).

5. Cooper's Ligament (Pectineal Ligament)

The pectineal line of the superior pubic ramus supports Cooper's ligament as a strong fibrous structure which functions as an essential anatomical structure in the inguinal region. The McVay repair technique relies on Cooper's ligament as its main anchor point for sutures because Sir Astley Cooper named this ligament. The TEP and TAPP laparoscopic hernia repair procedures use Cooper's ligament as an optimal mesh fixation point because it provides stronger anchorage than the surrounding fascial planes. The consistent anatomy and substantial tensile strength of this landmark make it essential for surgeons who perform both open and minimally invasive inguinal hernia repairs (3).

6. Lacunar Ligament (Gimbernat's Ligament)

The lacunar ligament exists as a triangular fibrous expansion which extends from the medial end of the inguinal ligament to attach to the pectineal line through a posterior curve. The anatomical structure Gimbernat's ligament named after Spanish anatomist Antonio de Gimbernat serves as the medial border of the femoral ring thus making it vital for femoral hernia anatomy understanding. The constricted shape of the lacunar ligament's free edge creates a barrier that surgeons must identify during surgical procedures for strangulated femoral hernias. The femoral vessels run close to this structure while it defines potential hernia sites so surgeons need to handle it with care during lower inguinal and upper femoral region procedures (3).

The surgical anatomy of the inguinal canal also involves a posterior normalization of the anatomical elements, which is particularly useful in laparoscopic and robotic approaches to surgery.

III.3.3. Rings

The two openings to the inguinal canal are referred to as the deep (internal) ring and the superficial (external) ring**.** These two rings provide passage for various structures through the inguinal canal(4).

Table III.3 Content of the inguinal canal.

Male Content	Female Content
Spermatic cord – Contains the following structures:	**Round ligament** – Originates from the uterine horn and passes through the inguinal canal to attach to the labia majora.
- **Testicular artery** – Branch of the abdominal aorta that supplies blood to the testes.	- **Ovarian artery** – Branch of the abdominal aorta that supplies blood to the ovaries.
- **Pampiniform plexus** – A network of veins that drain blood from the testes. The veins converge to form the **testicular veins**, which drain into the inferior vena cava (right) or the renal vein (left).	- **Ovarian veins** – Drain blood from the ovaries into the inferior vena cava (right) or renal vein (left).
- **Vas deferens** – A muscular tube that transports sperm from the epididymis to the urethra.	**Ilioinguinal nerve** – A branch of the **L1 spinal nerve that** provides sensory innervation to the labia majora, mons pubis, and medial thigh.
- **Artery of Simpson** – A small branch from the **inferior epigastric artery** that supplies the **cremaster muscle** and contributes to the blood supply of the spermatic cord.	**Ilioinguinal nerve** – A branch of the **L1 spinal nerve that** provides sensory innervation to the labia majora, mons pubis, and medial thigh.
Ilioinguinal nerve – A branch of the **L1 spinal nerve**, which provides sensory innervation to the scrotum and anterior thigh.	**Genital branch of the genitofemoral nerve** – A branch of the **L1-L2 spinal nerves**, provides sensory innervation to the labia majora and motor innervation to the cremaster muscle.
Genital branch of the genitofemoral nerve – A branch of the **L1-L2 spinal nerves**, provides motor innervation to the **cremaster muscle** and sensory innervation to the skin of the scrotum.	**Gonadal vessels (Ovarian)** – Include the ovarian arteries and veins that supply and drain the ovaries.
Gonadal vessels (Testicular) – The **testicular arteries** (branching from the abdominal aorta) supply the testes, and the **testicular veins** drain into the inferior vena cava (right) or renal vein (left).	**Gonadal vessels (Ovarian)** – Include the ovarian arteries (from the abdominal aorta) and ovarian veins (drain into the inferior vena cava or renal vein)(4,8).

III.3.4. Umbilicus

The stratigraphy of the umbilical region includes several anatomical layers that are essential in abdominal surgery, and the Richet fascia plays an important role in this context. These layers are arranged in a top-down sequence and are essential for the stability of the abdominal wall(3,8).

1. Skin: The outer layer of the umbilical region, thin and sensitive, is the first layer to be affected following surgery.

2. Subcutaneous tissue: Beneath the skin is the subcutaneous tissue, which contains collagen and elastin fibers, providing protection to blood vessels and nerves in the area.

3. Superficial fascia: A layer of connective tissue that surrounds the abdominal muscles and supports the internal structures, and is important in surgical procedures involving the abdominal wall.

4. Abdominal muscles (rectus abdominis): Beneath the superficial fascia are the abdominal muscles, which are responsible for maintaining the integrity of the abdominal wall.

5. Richet's fascia: The Richet's fascia is a fibrous layer located between the abdominal muscles and the deep fascia, which plays a crucial role in supporting the abdominal wall, especially in the umbilical area. It is particularly important in preventing umbilical hernias and protecting the internal structures.

6. Deep fascia: This is a fibrous layer that surrounds the abdominal muscles and supports the integrity of the abdominal wall. The deep fascia helps maintain the stability of the region.

7. Parietal peritoneum(3,4).

The umbilicus is of major importance in surgical anatomy as it is the point of insertion of the umbilical cord, which connects the fetus to the placenta during intrauterine development(3,4).

Embryologically, the umbilicus is formed during the first weeks of pregnancy, when the umbilical cord carries nutrients and oxygen to the fetus, and excretory products are excreted through it. After birth, the umbilical cord detaches, leaving behind the umbilical scar, which is a landmark area in abdominal surgery. In surgery such as umbilical hernias, it is essential to maintain the integrity of the region to prevent complications(4,11).

The omphalo-enteric canal is a temporary structure that occurs in the early stages of fetal development. It is a duct that connects the fetal primitive gut to the yolk sac (which contains nutrients for the fetus in the early stages of development). The omphalo-enteric canal is normally only active in the first few weeks of fetal life and closes completely around the 7th week of development (4).

III.4. Rectus Abdominis Sheath

The rectus abdominis sheath is a cylindrical canal that contains and envelops the two rectus abdominis muscles. The two sheaths of these muscles together form a double fibrous sheath, on either side of the white abdominal line.

The two sheaths of the rectus abdominis are also known as Velpeau's "double channel of the rectus".

In terms of extension, this sheath lies between the thorax and the pubis, is flattened anteroposteriorly, and consists of the anterior aponeuroses of the external oblique, internal oblique, transverse transversus abdominis, and fascia transversalis(1,3).

III.4.1. Constitution

The formation of the rectus sheath differs from above to below in the following manner:

1. Above the level of the arcuate line of Douglas:

(a) The anterior wall is constituted by the union of the aponeurosis of the external oblique with the anterior lamina of the aponeurosis of the internal oblique.

(b) The posterior wall is formed by the fusion of the aponeurosis of the transversus abdominis with the posterior lamina of the aponeurosis of the internal oblique (1,3).

2. Below the level of the arcuate line of Douglas:

(a) The anterior wall is constituted by the aponeuroses of all three flat muscles (the aponeuroses of the transversus abdominis and internal oblique are fused, whereas the aponeurosis of the external oblique remains separate).

(b) The posterior wall is constitued only by the fascia transversalis.

In both the upper and lower portion of the rectus sheath, these two sheaths do not communicate with each other, only have intimate relations through the abdominal linea alba (1,3).

III.4.2. Content

Table III.4. Content of the rectus abdominis sheath

Portion of the sheath	Anterior surface of the rectus muscle	Muscles	Posterior surface of the rectus muscle	Contained structures
Above the arcuate line	Anterior blade of the sheath: aponeuroses of the external oblique muscles + anterior half of the aponeurosis of the internal oblique	Rectus abdominis	Posterior lamina of the sheath: posterior half of the aponeurosis of the internal oblique + aponeurosis of the transverse abdominal muscle	- Superior epigastric artery and satellite veins - Perforating branches of the intercostal (T7–T11), subcostal (T12) nerves
At the level of the arcuate line	Only the anterior lamina present, all aponeuroses pass anteriorly	Rectus abdominis	The posterior blade disappears – the muscle is in direct contact with the fascia transversalis	Superior epigastric artery and satellite veins - Perforating branches of the intercostal (T7–T11), subcostal (T12) nerves
Below arcuate line	All aponeuroses of the lateral muscles pass anteriorly to the muscles	Rectus abdominis	Absent: the muscle rests directly on the fascia transversalis	- The inferior epigastric artery and its veins - Perforating branches from the inferior epigastric - The iliohypogastric, ilioinguinal and subcostal nerves can pass near or through the sheath

Fig. III.4. Rectus Abdominis Sheath

Within each sheath is the rectus abdominis muscle, the pyramidal muscle, the inferior epigastric vessels, and a layer of cellular tissue.

The retromuscular cellular tissue seated below the arch of Douglas and above the pubis is increasingly more developed the closer you get to the distal end of the sheath. It corresponds to the anterior intraparietal space, the so-called Leuser's suprapubic cavum, lying between the posterior aspect of the rectus abdominis muscle and the anterior aspect of the fascia transversalis (1,3).

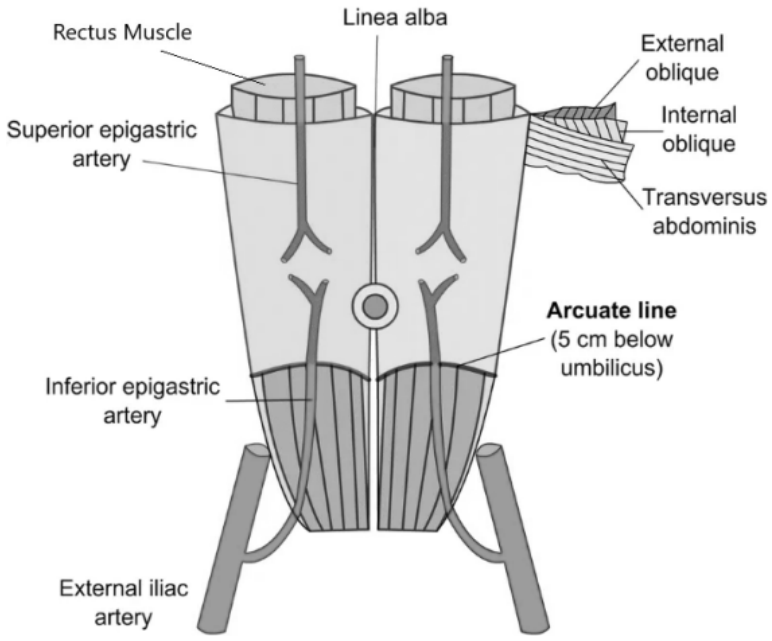

Fig. III.1. Anastomosis between superior epigastric artery and inferior epigastric artery

III.4.3. Vascular supply

III.4.3.1. Arterial supply

The superior epigastric artery originates from the internal thoracic artery, a branch of the subclavian artery. It descends into the anterior wall of the abdomen, penetrating the sheath of the rectus abdominis muscle and lying posterior to it.

Its important branches include muscle branches to the rectus abdominis, anterior perforating branches that cross the sheath and muscle to vascularise the skin of the upper abdomen, and anastomotic branches with the inferior epigastric artery. The perforating branches are accompanied by branches of the intercostal nerves (T7-T11) and the subcostal nerve (T12), which provide motor and sensory innervation of the upper abdominal wall(12,13).

The inferior epigastric artery arises from the external iliac artery just above the inguinal ligament. It ascends obliquely, enters the sheath of the rectus abdominis through the arcuate line and anastomoses with the superior epigastric artery(12,13).

Its main branches are the muscular branches to the rectus abdominis, the cutaneous perforating branches that traverse the muscle and aponeurosis to vascularise the skin of the lower abdomen, and the pubic branches that anastomosise with branches of the obturator artery. The perforating branches are accompanied by the subcostal (T12), iliohypogastric and ilioinguinal (L1) nerves, contributing to the innervation of the lower abdominal area(12,13).

Goinard and Gurtlert's long arterial pathway is a continuous vertical vascular axis formed by anastomoses between the superior epigastric artery, derived from the internal thoracic artery, and the inferior epigastric artery, a branch of the external iliac artery. This pathway provides an important collateral vascularisation of the anterior abdominal wall and is of surgical interest in reconstructive surgery or in cases of obstruction of the main circulation(12,13).

III.4.3.2. Venous drainage

The superior epigastric veins accompany the superior epigastric artery and are formed in the thickness of the rectus abdominis muscle. They drain blood from the upper anterior wall of the abdomen and adjacent integuments. These veins ascend and drain into the internal thoracic vein, which in turn drains into the brachiocephalic vein. The superior epigastric veins participate in the collateral circulation between the upper and lower cav cav systems and may become dilated in cases of central venous obstruction.

The inferior epigastric veins accompany the inferior epigastric artery and drain blood from the lower portion of the anterior abdominal wall. They ascend obliquely, penetrate the sheath of the rectus abdominis and drain into the external iliac vein. Through anastomoses with the superior epigastric veins, they form an important shunt pathway in lower veno-caval blockage syndromes and are involved in the abdominopelvic collateral circulation networks.

III.4.4. Innervation

In the sheath of the rectus abdominis there may be terminal branches of the nerves of the lumbar plexus, which pass through or close to the muscle, especially in the lower portion of the sheath, below the arcuate line. These nerves are not constantly within the sheath, but may perforate or accompany vascular structures in the vicinity, having significant surgical and clinical importance(14).

The iliohypogastric nerve, originating from the L1 root, passes posteriorly through the transverse abdominal and internal oblique muscle, then approaches the rectus abdominis sheath, where it emits cutaneous branches that may traverse the rectus muscle and reach the integument of the hypogastric region. It provides sensitive innervation of the suprapubic skin and motor innervation to the lower abdominal muscles(14).

The ilioinguinal nerve, also from the L1, has a similar but more inferior course, accompanying the spermatic cord (in men) or the round ligament (in women) through the inguinal canal, but before entering the canal, it may pass through or in close proximity to the

rectus sheath, contributing to innervation of the pubic tegument, the scrotum magnus or labia majora, and the proximal region of the thigh(14).

The subcostal nerve (T12), which belongs in part to the lumbar plexus, descends obliquely and anteriorly, perforating the lateral abdominal muscles and penetrates the sheath of the rectus abdominis, where it may accompany perforating vascular branches, providing motor innervation to the rectus abdominis and sensory innervation to the skin of the lower anterolateral region(14).

These nerve branches have a close relationship with the perforating branches of the inferior epigastric artery, which is why they can be injured in surgery in the hypogastric region, especially in inguinal hernia operations or low transverse Pfannenstiel-type incisions(14).

III.4.5. Clinical landmarks

Clinical note: the absence of the posterior wall below the arcuate line increases vulnerability to trauma or during surgery (e.g. caesarean section, hernioplasty), and perforating nerves may be injured, causing chronic postoperative pain or local paresthesias. The Rives-Stoppa operation is a modern and effective surgical technique used in the treatment of large ventral and inguinal hernias, based on the principle of placing a synthetic prosthesis (mesh) in the retromuscular space between the rectus abdominis muscle and its posterior sheath, anterior to the fascia transversalis.

This method allows a wide and stable coverage of the hernia defect without tensioning the tissues, favouring the biological integration of the mesh and significantly reducing the risk of recurrence.

Access is made through a median incision, the planes are dissected down to the avascular Bogros-Retzius space, and the prosthesis is fixed without sutures in the deep plane. Advantages of the method include a low complication rate, effective protection against recurrence and good postoperative tolerance, and it is particularly recommended in patients with recurrent or complex hernias(15,16).

III.5. Clinical Applications

III.5.1. Langer's Lines

Langer's lines, also known as skin tension lines, are the predominant orientation of collagen fibres in the dermis, first described by anatomist Karl Langer in the 19th century. These lines reflect the natural direction in which the skin tends to stretch and contract, and are of major importance in surgery because incisions made parallel to Langer's lines heal faster, with more aesthetic scars and a lower risk of scar dehiscence or hypertrophy. They vary by body region and are essential in planning skin incisions (17).

III.5.2. Surgical Incisions

Midline

An incision that is made through the linea alba. It can be extended the whole length of the abdomen by curving around the umbilicus. The linea alba is poorly vascularised, so blood loss is minimal, and major nerves are avoided. It can be used in any procedure that requires access to the abdominal cavity (4,17).

Paramedian

Similar to the median incision, but is performed laterally to the linea alba, providing access to more lateral structures (kidney, spleen and adrenals). This method ligates the blood and nerve supply to muscles medial to the incision, resulting in their atrophy (4,17).

Kocher

A Kocher incision begins inferior to the xiphoid process and extends inferolaterally in parallel to the right costal margin. It is mainly used to gain access for gall bladder and/or biliary tree pathology (4,17).

Two modifications and extensions of the Kocher incision are possible:

- Chevron / rooftop incision or modification – the extension of the incision to the other side of the abdomen. This may be used for oesophagectomy, gastrectomy, bilateral adrenalectomy, hepatic resections, or liver transplantation
- Mercedes Benz incision or modification – the Chevron incision with a vertical incision and break through the xiphisternum. This may be used for the same indications as the Chevron incision, however classically seen in liver transplantation (4,17).

McBurney

A McBurney is a called a ‘grid iron’ incision, because it consists of two perpendicular lines, splitting the fibres of the muscles without cutting them – this allows for excellent healing. **Pfannenstiel** The Pfannenstiel incision is a low transverse surgical incision made above the pubic symphysis, about 2-3 cm above the pubic symphysis, following the skin tension line (Langer's line). It provides excellent access to the pelvis and is commonly used in gynaecological and obstetric surgery, especially for caesarean section (4,17).

III.5.3. Anatomical Points and Lines

Several reference points and anatomical lines are used to describe the surface projections of abdominal organs:

- **Xiphoid Process:** Marks the lower border of the sternum, related to the **cardiac orifice of the stomach (T10-T11).**
- **Costal Margin**: Important for the projection of the liver, gallbladder, and spleen.
- **McBurney’s Point**: Located **two-thirds** of the distance from the umbilicus to the right anterior superior iliac spine (ASIS); corresponds to the **base of the appendix.**
- **Murphy’s Point**: Located at the junction of the **right midclavicular line and costal margin**, used to assess gallbladder pain.
- **Lanz’s Point**: Located on the **right third of a line between both ASIS**, an alternative site for the appendix base.
- **Traube’s Space**: A crescent-shaped area over the left lower ribs, used to assess spleen enlargement.
- **Roux's Point**: Used to describe the pyloric region of the stomach, located on the **left midclavicular line at the level of the subcostal plane.**
- **Linea Alba**: A fibrous structure running vertically from the **xiphoid process to the pubic symphysis**, a key reference for surgical incisions.
- **Linea Semilunaris**: A curved line marking the lateral edge of the rectus abdominis, important in **hernia assessments** (4,17,18)**.**

III.5.4. Clinical and Surgical Importance

- Right Upper Quadrant (RUQ) Pain**:** Common in cholecystitis, hepatitis, hepatic abscess**.**
- Left Upper Quadrant (LUQ) Pain: Related to gastric ulcer, pancreatitis, splenic infarction**.**
- Right Lower Quadrant (RLQ) Pain**:** Classical in appendicitis (McBurney's point)**.**
- Left Lower Quadrant (LLQ) Pain**:** Often related to diverticulitis, sigmoid volvulus**.**

- Epigastric Pain**:** Seen in gastritis, GERD, peptic ulcer disease**.**
- Hypogastric Pain**:** Common in bladder infections, pelvic inflammatory disease (18)**.**

McBurney incision is performed at McBurney's point (1/3 of the distance between the ASIS and the umbilicus) and is used in an open appendicectomy (4,17).

III.5.5. Inguinal Hernia

A hernia is defined as the protrusion of an organ or fascia through the wall of a cavity that normally contains it. Classification of inguinal hernias according to the location of the hernial sac:

1. External oblique (indirect) hernias - form through the lateral inguinal fossa, outside the inferior epigastric artery; the hernial sac develops within the common fibrous sheath of the spermatic cord, usually anterior to its elements
2. Direct hernias - a rare form that occurs through the medial inguinal fossa, medial to the inferior epigastric artery and lateral to the umbilical cord; they are considered hernias of weakness, and the hernial sac remains independent of the spermatic cord
3. Internal oblique hernias - are an exceptional variety that develop in the space between the fibrous cord of the obliterated umbilical artery and the urachus.

External oblique hernias, being the most common, present two distinct forms of clinical and anatomical manifestation. This differentiation is essential for the surgical approach and for understanding the mechanism of hernia formation. The classification of these subtypes is based on the relationship between the hernia sac and the inguinal canal, as well as communication with adjacent structures.

The first variety, represented by hernias with closed duct, is characterized by the presence of a hernial sac with the bottom located at different levels along the course of the spermatic cord, without communication with other cavities (9,19,20).

Surgical treatament of inguinal hernias

In terms of surgical treatment of inguinal hernias, there is much debate as to the optimal method. Over time, approximately 280 different surgical procedures have been developed to treat inguinal hernias based on the surgical approach and methods of hernia sac management and abdominal wall reconstruction. Numerous surgical methods exist because the inguinal region has a complex anatomy that requires individualized surgical approaches for each clinical situation.

The surgical classification through approach includes the traditional crural arch parallel incision together with Babcock's horizontal incision and Mac Vay's and Anson's incisions and Maingot's incision. The Lawson abdominal approach serves as an alternative method which enables surgeons to access the hernia through the peritoneal side. The treatment of hernia sacs involves different surgical approaches because surgeons either perform upper extremity ligation only or release and invaginate the sac or follow current protocols for complete release and sac ligation and excision.

The evolution of parietal defect reconstruction started with Forgue and Kimbarovski's abandoned prefunicular procedures before moving to modern retrofunicular procedures including Bassini and Shouldice techniques. Through the right sheath relaxing incision Halsted created an operative device which enables significant relaxation of the conjoint tendon and provides tension-free suturing capabilities.

The current technical procedures consist of two distinct approaches which include partial posterior wall reconstruction through deep inguinal orifice recalibration for children with indirect inguinal hernias and total posterior wall reconstruction.

The second group of operations includes procedures that use the transversalis terminale aponeurosis and transversalis fascia fixation to the inguinal ligament (Lichtenstein) or the iliopubic tract (Madden-Condon) or both structures (Shouldice) or the Cooper ligament (Mc Vay).

The current plastic procedures consist of parietal autoplasties with only great oblique and rectus abdominis aponeurotic plasty remaining in use together with prosthetic plasty that places synthetic prostheses behind the fascia transversalis beyond the inguinal canal posterior wall boundaries (Rives and Lichtenstein techniques). The preperitoneal treatment with preperitoneal prosthesis mounting (Nyhus and Stoppa techniques) provides multiple benefits through its ability to define parietal defects and achieve high sac ligation and direct visualization of the hernial orifice. The technique is suitable for sliding hernias and bisacral inguinal hernias and bilateral recurrent hernias and inguinal hernias with cryptorchidism and femoral hernias.

MCQ's:

1. Question: A 41-year-old man presents to the doctor with pain in the right hypochondrium, which can sometimes radiate to the back. He mentions that the pain started recently and is accompanied by nausea and a bitter taste in his mouth. Which condition is most likely in this case?

A) Femoral hernia
B) Cholelithiasis (gallstones)
C) Urinary tract infection
D) Diverticulitis
E) Inguinal hernia

Correct answer: B) Cholelithiasis (gallstones)
Explanation: Pain in the right hypochondrium, associated with nausea, bitter taste and possibly radiating to the back, is a classic symptom of cholelithiasis or gallstones. It often occurs due to the presence of stones in the gallbladder, which can block the bile ducts and cause intense pain. This type of pain is also often more intense during a heavy meal, especially after eating fatty foods.

2. A 25-year-old man presents to the emergency room with abdominal pain that started about 12 hours ago. Initially the pain was localised in the epigastric area but is now concentrated in the right iliac region. The patient describes the pain as intense, continuous, colicky, with progressive intensification. He also mentions nausea but no vomiting. He also reports a slight fever (38°C) in the last 6 hours.

The medical history reveals no major medical conditions and the patient has no history of previous abdominal surgery. His diet is normal with no excessive alcohol consumption or other habits suggesting other causes.Abdominal palpation: positive Blumberg's sign (pain on deep palpation followed by rapid release). Clinical Question: What is the most likely diagnosis for this patient and what should be the next steps in investigation and treatment?

A) Acute appendicitis
B) Acute cholecystitis
C) Diverticulitis
D) Acute gastritis
E) Acute pancreatitis

Correct answer: A) Acute appendicitis

Explanation: Pain in the right iliac region with positive Blumberg's sign, mild fever and gradual onset of symptoms are typical features of acute appendicitis. The pain usually starts in the epigastric region and then localises to the right hypochondrium, and finally concentrates in the right iliac region as the inflammation of the appendix progresses.

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III.6. Abdomino-Pelvic Cavity: Anatomical dissection and clinical applications

III.6.1. Opening the abdominal cavity

The practice of opening the abdominal cavity for dissection has a long and rich history, dating back to ancient civilizations. Early attempts to understand the internal anatomy of the human body were often limited by the lack of scientific knowledge and the taboo surrounding cadaveric dissection. The first recorded instances of human dissection can be traced to ancient Egypt, where priests performed ritual embalming and, inadvertently, some form of anatomical exploration. However, it was not until the Renaissance that dissection became a formalized practice in the Western world (1,2).

The pivotal work of **Andreas Vesalius** in the 16th century revolutionized anatomy by emphasizing direct observation and dissection of human cadavers. His landmark work, *De humani corporis fabrica* (1543), provided a detailed and accurate description of human anatomy, fundamentally changing the understanding of the body's structures. Vesalius' approach to dissection laid the groundwork for modern surgical practices, including the methods for safely opening the abdominal cavity. Over time, advancements in surgical techniques, antiseptics, and anesthesia further refined the process of abdominal exploration, making it an essential practice not only in anatomy but also in the development of modern medicine and surgery(1,2).

1. Accesing the greater peritoneal cavity

To initiate the dissection of the abdominal cavity on a cadaver, first position the body in the supine posture and establish a sterile environment to minimize the risk of contamination. A longitudinal incision is then made along the linea alba using a scalpel, extending from the xiphoid process to the pubic symphysis**.** Careful dissection through the subcutaneous adipose tissue and the external oblique aponeurosis follows. Subsequently, blunt dissection is employed to separate the internal oblique and transversus abdominis muscles. If necessary, the rectus sheath is opened to facilitate exposure. Upon retracting the muscle layers, a controlled incision is made through the peritoneum using either scissors or a scalpel, ensuring that underlying organs, such as the intestines or major vasculature, are not inadvertently damaged (3,4).

During the procedure, small vessels encountered should be cauterized or clamped using electrocautery or hemostatic forceps to prevent excessive bleeding. In the case of larger vessels, ligation with absorbable sutures is indicated to ensure hemostasis. Once the abdominal

cavity is adequately exposed and the required anatomical structures are visualized, the dissection site must be closed in anatomical layers.

The peritoneum and muscular layers are sutured, followed by closure of the skin with absorbable sutures to promote healing and reduce scarring. This systematic approach to opening the abdominal cavity allows for optimal exposure of the abdominal organs while maintaining structural integrity and minimizing potential complications.

Fig. III.6. Greater peritoneal cavity. Viscera in situ

III.6.2. Peritoneum

Anatomy of the Peritoneum: Schematic Overview

1. General Structure:
    - **Parietal Peritoneum**: Lines the abdominal wall.
    - **Visceral Peritoneum**: Covers abdominal organs.
    - **Peritoneal Cavity**: Potential space between the parietal and visceral peritoneum, containing serous fluid (3,5,6).
2. **Regions of the Peritoneum:**
    - **Supramezocolic Compartment**:
        - **Above** the transverse mesocolon.
        - Contains the stomach, liver, and spleen.

Fig. III.7. Supramesocolic compartment.

- **Inframezocolic Compartment**:
  - **Below** the transverse mesocolon.
  - Contains the small intestine, large intestine (excluding the cecum), and mesentery (3,5,6).

Fig. III.8 Inframesocolic comparment.

Ligaments:

- **Lesser Omentum**: Connects the liver to the stomach and duodenum.
  - Composed of **hepatogastric ligament** and **hepatoduodenal ligament**.
- **Greater Omentum**: Hangs from the greater curvature of the stomach and the first part of the duodenum, draping over the intestines.
- **Falciform Ligament**: Connects the anterior abdominal wall to the liver.
- **Gastrosplenic Ligament**: Connects the stomach to the spleen.
- **Splenorenal Ligament**: Connects the spleen to the left kidney.
- **Hepatocolic Ligament**: Connects the liver to the transverse colon.
- **Phrenicocolic Ligament**: Connects the diaphragm to the left colic flexure (3).

4. **Mesenteries:**
   - **Mesentery of the Small Intestine**: Supports the jejunum and ileum, containing blood vessels, nerves, and lymphatics.
   - **Mesocolon**: Attaches the colon to the posterior abdominal wall, divided into:
     - **Transverse Mesocolon**
     - **Sigmoid Mesocolon**
   - **Mesorectum**: Supports the rectum (4,7–9).

Fig. III.9. Mesenter of the small intestine.

5. **Intraperitoneal vs. Extraperitoneal Organs:**
    - **Intraperitoneal Organs** (completely surrounded by peritoneum):
        - Stomach
        - Small intestines (jejunum, ileum)
        - Cecum
        - Spleen
        - Liver
        - Gallbladder
        - Transverse colon
        - Sigmoid colon
    - **Extraperitoneal Organs** (lie outside or only partially covered by peritoneum):
        - Kidneys
        - Ureters
        - Pancreas (except tail)
        - Adrenal glands
        - Rectum (lower third)
        - Aorta
        - Inferior vena cava (4,7–9).

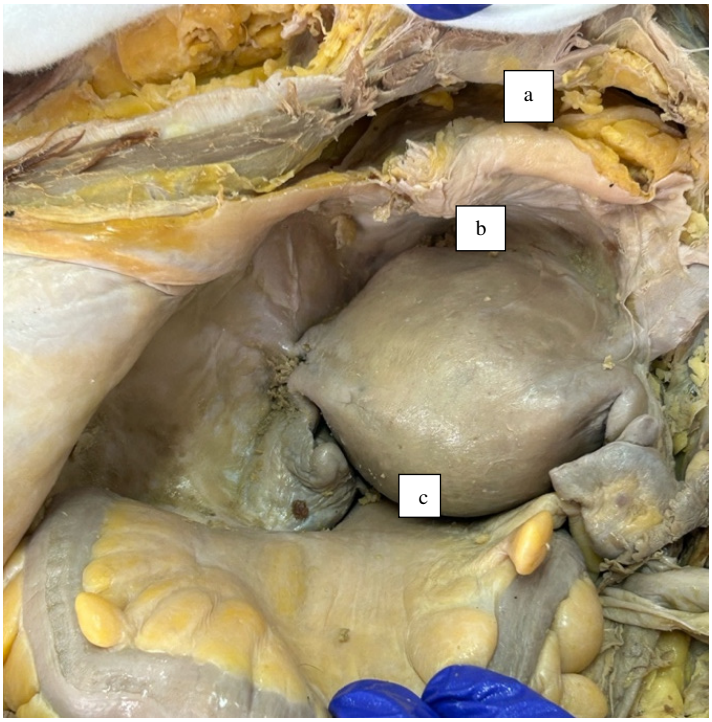
6. **Peritoneal Spaces:**
    - **Subphrenic Space**: Located between the diaphragm and the liver, divided into right and left subphrenic spaces.
    - **Subhepatic Space**: Lies beneath the liver, dividing into right and left compartments.

Fig. III.10. Subphrenic (a) and Subhepatic (b) peritoneal spaces.

Foramen of Winslow: Communication between the greater sac and lesser sac (epiploic foramen).

Fig. III.11. Epiplooic foramen of Winslow (natural acces point in the lesser peritoneal cavity).

- **Douglas Pouch** (Rectouterine Pouch in females, Rectovesical Pouch in males): Most dependent part of the peritoneal cavity in the pelvic region.
- **Retzius Space**: Space between the pubic symphysis and bladder (extraperitoneal).
- **Bogros Space**: Located between the mesorectum and peritoneum in the lower abdomen.
- **Paracolic Gutter**: Lateral to the colon, important in fluid collection and the spread of infections (3).



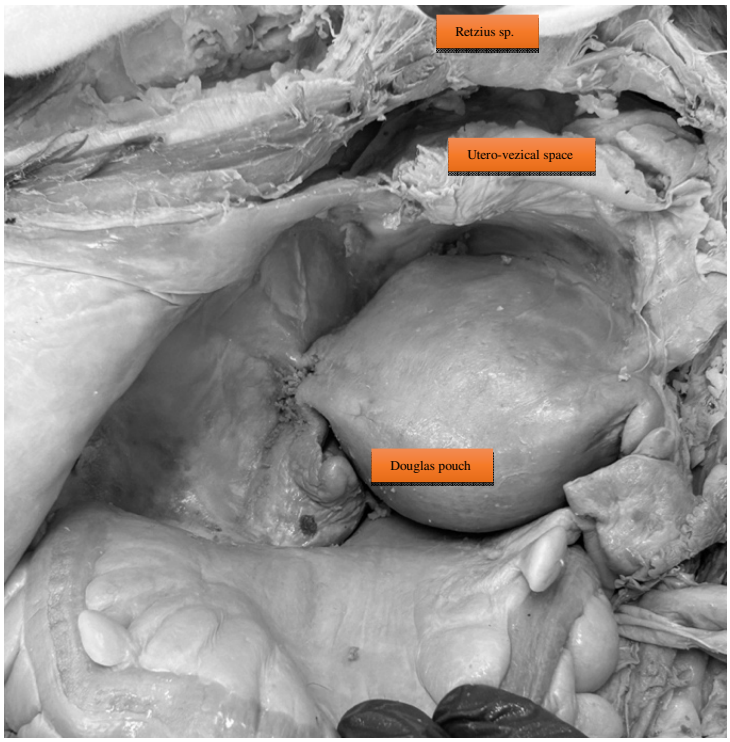


Fig. III.12(A,B). Pelvic peritoneal spaces (pouches)

Lesser peritoneal cavity

The omental bursa or lesser sac is a hollow space that is formed by the greater and lesser omentum and its adjacent organs. It communicates with the greater sac via the epiploic foramen of winslow, which is known as the general cavity of the abdomen that sits within the peritoneum, but outside the lesser sac(3,10).

This space has well-defined borders which are represented by certain organs or their parts, so they are quite easy to spot and form a mental image of the omental bursa. In addition, like anything in anatomy, the omental bursa doesn't just exist as a standalone and isolated entity, but rather it communicates with several other spaces and recesses found throughout the body.

Table III.4. Omental bursa/lesser sac borders, communications and clinical importance

Borders	Anteriorly - caudate lobe of liver, posterior gastrocolic ligament, lesser omentum Left - left kidney, left adrenal gland Posteriorly – pancreas Right - epiploic foramen, lesser omentum, greater sac
Communications	Superior recess, splenic recess, inferior recess, folds and recesses around the cecum and duodenum
Clinical	Congenital anomalies, hematomas, bilomas, abscess, pancreatitis, neoplasms, hydatid cyst, tuberculosis infection, mechanical irritation

Fig. III.13. Lesser peritoneal cavity (omental bursa).

The borders of the omental bursa are demarcated as follows:

- **superiorly** by the caudate lobe of the liver;
- **anteriorly** by the hepatogastric ligament, posterior surface of the stomach, gastrocolic ligament and lesser omentum;
- to the **left,** it is limited by the gastrosplenic and splenorenal ligaments, peritoneum of the left kidney and left suprarenal gland;
- **posteriorly** it is walled off by peritoneum of the diaphragm, pancreas and duodenum;
- to the **right**, the omental (epiploic foramen) and lesser omentum can be found and the greater sac beyond that;
- **inferiorly**, it is limited by the transverse mesocolon.

The hollow is filled with a capillary film and is nearly closed, with the exception of its communication with the larger sac and the entrance through the omental foramen. The superior recess of the omental bursa, which runs cranially between the diaphragm and the posterior layers of the liver's coronary ligament, makes up the majority of the structure.

To the left, between the stomach and the splenic ligaments, is the splenic recess. Lastly, between the stomach and the transverse colon, the inferior recess of the omental bursa stretches caudally. A variety of tiny peritoneal folds, recesses, and fossae are other noteworthy anatomical features that appear to gather primarily around the duodenum and cecum (3,10).

Routes for acces in omental bursa

The omental bursa (or bursa omentalis, also known as the retrogastric space) is a virtual cavity located posterior to the stomach and anterior to the pancreas, which is part of the peritoneal cavity. Anatomical access to this bursa can be achieved by several routes, direct or indirect, natural or surgical.

The main access routes are described below:

Epiploic foramen (Winslow) - the main natural route

Description: This is the normal anatomical communication between the omental bursa and the greater peritoneal cavity.

Anatomical limits:

Anterior: the free edge of the hepatoduodenal ligament (containing the portal triad - portal vein, hepatic proper artery and choledochal duct).

Posterior: inferior vena cava.

Superior: caudate lobe of the liver.

Inferior: first portion of the duodenum.

Clinical importance: the preferred route in laparoscopic surgery for access to the omental bursa.

Through the gastrocolic ligament (common surgical access)

Description: The gastrocolic ligament is part of the greater omentum, between the stomach and the transverse colon.

By severing it, the omental bursa cavity is opened.

Use: commonly used in pancreatic surgery (e.g. pancreatectomies), posterior gastric wall interventions or in drainage of retrogastric collections.

3. Through the transverse mesocolon

Description: Indirect access by elevating the transverse colon and opening the mesocolon (possibly after separation of the greater omentum).

Importance: Useful in some surgical manoeuvres in the pancreatic area.

4. Through the gastrosplenic ligament

Description:This ligament connects the stomach to the spleen and contains the short gastric vessels.

Access: It can be used surgically to access the left side of the omental pouch, especially in procedures on the tail of the pancreas or spleen.

5. Through the hepatogastric ligament (free part of the lesser omentum)

Description: This is the thin part of the lesser omentum between the liver and the lesser curve of the stomach.

Access: possible by gentle dissection, especially useful in minimally invasive or laparoscopic approaches (3,10).

III.6.3. Organs and vascular formations

Supramezocolic Organs: The supramezocolic region is the area above the transverse mesocolon and contains organs primarily associated with the upper gastrointestinal system. These organs include:

1. **Stomach**: Located in the upper left quadrant, the stomach is positioned between the diaphragm and the small intestine.
2. **Liver**: Located in the right hypochondrium, it spans from the diaphragm to the right upper quadrant.
3. **Spleen**: Positioned in the left upper quadrant, near the diaphragm, it lies posterior to the stomach.
4. **Pancreas**: Located retroperitoneally, extending across the midline from the duodenum to the spleen.
5. **Duodenum (first part)**: Located just below the liver and pancreas, it connects the stomach to the jejunum.
6. **Omentum**: The greater and lesser omenta are also part of the supramezocolic region, providing fat storage and immune function.

Inframezocolic Organs: The inframezocolic region lies beneath the transverse mesocolon and includes the lower parts of the digestive tract. These organs include:

1. **Small Intestine (Jejunum and Ileum)**: Positioned centrally and inferiorly in the abdomen, they are responsible for nutrient absorption.
2. **Large Intestine (Cecum, Ascending Colon, and Transverse Colon)**: The ascending colon lies on the right, while the transverse colon crosses horizontally through the abdomen.
3. **Kidneys**: Positioned retroperitoneally, the kidneys are located on either side of the spine, near the lumbar region.
4. **Ureters**: They run from the kidneys to the bladder, located bilaterally in the retroperitoneal space.
5. **Rectum**: The lower part of the large intestine, located in the pelvic cavity, leading to the anus.

The division between supramezocolic and inframezocolic regions is primarily dictated by the position of the transverse mesocolon, which separates the upper (supramezocolic) and lower (inframezocolic) abdominal contents. This distinction has clinical significance, especially in surgeries involving abdominal organs or the assessment of abdominal pathology.

Stomach – Clinical Anatomy

The stomach exists as a muscular hollow organ that forms a J shape in the upper left quadrant of the abdomen while extending under protection from the lower ribs. The stomach links the esophagus at the gastroesophageal junction (cardia) to the pylorus before it joins the duodenum.

The stomach contains five distinct parts which include the cardia, fundus, body, antrum and pyloric canal. The different regions of the stomach matter during both endoscopic procedures and surgical removals. The stomach expands after eating because of its internal mucosal folds known as rugae while its three muscular layers (longitudinal circular and oblique) work together to perform churning and mechanical digestion.

The stomach receives its arterial supply mainly through branches of the celiac trunk which include the left gastric artery and the right gastric artery and the right and left gastroepiploic arteries that stem from the hepatic artery and the gastroduodenal and splenic arteries and the short gastric arteries that stem from the splenic artery. The vessels create interconnections along both the lesser and greater curvatures. The venous drainage system follows arterial patterns to reach the portal vein. The gastric and gastroepiploic lymph nodes

receive lymphatic drainage from the stomach which becomes essential during gastric cancer staging (D1 and D2 dissections).

The stomach receives its nerve supply through parasympathetic fibres from the vagus nerve and sympathetic fibres from the celiac plexus.

The stomach plays a central role in various medical conditions which include gastritis alongside peptic ulcer disease gastric outlet obstruction and gastric cancer. Peptic ulcers tend to develop along the lesser curvature especially at the incisura angularis location.

Posterior gastric ulcers can cause severe complications through their erosion of the pancreas (resulting in referred back pain) or of a vessel (such as the splenic artery) leading to fatal bleeding. The success of gastrectomy or partial gastric resections depends on precise knowledge of vascular and lymphatic anatomy to prevent ischemic complications and ensure oncological clearance in malignancy cases.

Spleen – Clinical Anatomy

The spleen stands as the biggest lymphoid organ which resides in the left upper quadrant under protection from the 9th to 11th ribs. The spleen exists behind the stomach while in front of the diaphragm and left kidney. The peritoneal cavity suspends the spleen through the gastrosplenic and splenorenal ligaments which also carry vital vascular and lymphatic structures. The spleen displays two surfaces: a diaphragmatic surface and a visceral surface which receives impressions from the stomach and left kidney and colon and pancreas. The spleen's capsule together with its parenchyma remains thin and fragile which makes it highly susceptible to injury.

The splenic artery enters the hilum after splitting into multiple branches from its origin as a tortuous celiac trunk branch. The superior mesenteric vein unites with the splenic vein to create the portal vein which serves as the venous return pathway. The lymphatic drainage moves through splenic vessels to reach the pancreaticosplenic nodes and sympathetic innervation comes from the celiac plexus. The splenic hilum near the tail of the pancreas requires special attention during distal pancreatectomy or splenectomy because it poses a risk of iatrogenic pancreatic injury or fistula formation.

The spleen becomes enlarged due to infections such as Epstein–Barr virus and malaria as well as hematologic disorders like leukemia and lymphoma and portal hypertension. The enlargement of the spleen to massive proportions makes it more susceptible to rupture from minimal physical trauma. A ruptured spleen requires immediate surgical intervention because of its blood-rich nature which leads to dangerous internal bleeding. The surgical removal of the

spleen for treating idiopathic thrombocytopenic purpura (ITP) requires postoperative vaccination against encapsulated organisms including Streptococcus pneumoniae to prevent overwhelming post-splenectomy infection (OPSI).

Liver - Clinical Anatomy

The liver exists as the largest lobed gland that spans between the right hypochondrium and extends through the epigastrium before reaching the left hypochondrium. The falciform ligament separates the diaphragm into a larger right lobe and a smaller left lobe while the viscerel surface features fissures for the ligamentum teres and the ligamentum venosum. The liver presents with anatomical lobes which do not align with its functional segments since these segments follow the distribution of hepatic artery portal vein and bile duct structures. The liver contains eight Couinaud segments that maintain their own vascular supply and drainage and biliary pathways which enable surgeons to remove each segment separately.

The Couinaud classification divides the liver into three main parts which consist of the left segments II-IV and the right segments V-VIII and the caudate segment I. The liver functions as two separate parts through the middle hepatic vein which passes through the main portal fissure. The right hepatic vein divides the right lobe into two segments while the left hepatic vein divides the left lobe into two segments. Segment I functions as a special case since it draws its blood supply from the right and left portal pedicles while directly draining into the inferior vena cava making it less susceptible to certain pathologies and potentially allowing it to remain when hepatic outflow obstruction occurs. The detailed segmentation serves as a fundamental element for liver surgery planning because it minimizes surgical complications while preserving liver tissue during segmentectomy lobectomy and living donor liver transplantation procedures.

General Surgeons need to understand hepatic segmentation because it serves as an essential tool for treating focal liver lesions (FLLs) and hepatocellular carcinoma (HCC) and cholangiocarcinoma by determining proper diagnostic imaging and treatment strategies for segmental lesions. The therapeutic approaches of radiofrequency ablation and TACE and liver resection require segmental vascular maps to clear cancerous tissues while maintaining sufficient liver tissue volume. Segmental anatomy serves as a valuable tool for the treatment of portal hypertension through TIPS (transjugular intrahepatic portosystemic shunt) interventions. The caudate lobe (segment I) shows hypertrophy in patients who have chronic portal vein thrombosis or Budd Chiari syndrome. The successful treatment of lesions and protection of vessels and bile ducts requires interventional radiologists and hepatobiliary surgeons to combine Couinaud segmentation with imaging technologies including CT and MRI and intraoperative US.

Pancreas – Clinical Anatomy

The pancreas exists as an upper abdominal glandular organ that runs across the duodenum to reach the spleen. As an organ the pancreas functions with two different roles: exocrine by secreting digestive enzymes through pancreatic ducts and endocrine by producing hormones including insulin and glucagon from the islets of Langerhans. The pancreas contains five identifiable sections including its head which rests within the duodenum curve near the common bile duct while its tail reaches the hilum of the spleen via the splenorenal ligament. The organ extends its tissue across the aorta and vertebral column before reaching the tail which stops at the splenic hilum. The processus uncinatus hooks backwards to the left of the superior mesenteric vessels, the neck lies in front of the confluence of the portal vein. It extends over the aorta and vertebral column and the tail extends to the hilum of the spleen, encased in the splenorenal ligament, often near to the splenic vessels.

Segmental consideration does not follow a formal Couinaud-type segmentation like the liver does not, but vascular segmentation is still clinically relevant. Blood flow to the pancreatic head along with its uncinate process originates from the superior pancreaticoduodenal artery (derived from the gastroduodenal artery) and the inferior pancreaticoduodenal artery (derived from the superior mesenteric artery) which creates a dense anastomotic network. The body and tail receive their blood supply through branches of the splenic artery that include the dorsal, great, and caudal pancreatic arteries. The venous system follows a comparable pattern to arterial circulation by directing blood towards the portal vein. The main pancreatic duct (duct of Wirsung) connects from the tail to the head where it joins the common bile duct at the ampulla of Vater while the accessory duct (Santorini) serves as an alternative drainage pathway. The vascular and ductal anatomy of the pancreas requires thorough understanding to guide pancreatic surgery procedures including pancreaticoduodenectomy (Whipple's procedure) and distal pancreatectomy.

Acute and chronic pancreatitis together with pancreatic adenocarcinoma and cystic lesions (e.g. IPMN) and neuroendocrine tumours of the pancreas represent significant clinical conditions. The pancreatic head produces painless jaundice through either bile duct compression or invasion by tumors which confirms malignancy. The surgical approach for tumor removal depends on tumor position and segment involvement through Whipple's procedure for head tumors and distal pancreatectomy for tail lesions while splenectomy becomes necessary when vascular proximity requires it. The processus uncinatus stands behind the superior mesenteric vessels which makes its removal challenging. Segmental localization serves as a critical factor for EUS-guided drainage of pancreatic pseudocysts and targeted biopsy of lesions

during minimally invasive procedures. Knowledge of ductal anatomy enables better diagnosis and management of pancreas divisum and ductal strictures because these conditions affect recurrent pancreatitis and biliary obstruction.

Small intestine – Clinical Anatomy

The small intestine exists as a 6 to 7 meter long coiled intraperitoneal organ which extends from the pylorus to the ileocecal valve. The small intestine consists of three sections: the duodenum followed by the jejunum and finishing with the ileum. The duodenum presents as a C-shaped retroperitoneal structure except its first part while it encircles the pancreas head. The major duodenal papilla serves as the point where the biliary and pancreatic secretions enter the duodenum. The jejunum occupies the left upper quadrant with its proximal two-fifths section while the ileum with its distal three-fifths occupies the right lower quadrant before reaching the ileocecal junction. The jejunum features a denser wall structure and more noticeable plicae circulares folds together with greater vascularization when compared to the ileum.

The superior mesenteric artery (SMA) delivers jejunal and ileal branches which form arterial arcades and vasa recta to provide blood supply. The duodenum derives its blood supply from two separate sources including the superior pancreaticoduodenal artery which stems from the celiac trunk via the gastroduodenal artery and the inferior pancreaticoduodenal artery that branches from the SMA to create a vital anastomotic link between these two vascular systems. The venous drainage follows the arterial pattern to reach the superior mesenteric vein before it enters the portal vein. The small intestine requires extensive lymphatic drainage which holds important clinical value when patients develop malignancies or experience infections or inflammatory bowel disease.

Medical conditions affecting the small intestine include intestinal obstruction and Crohn’s disease as well as malabsorption syndromes and neoplastic diseases such as carcinoid tumors and adenocarcinoma. Helicobacter pylori infections primarily cause ulcers in the initial portion of the duodenum which may lead to severe bleeding through arterial erosion. The location of Meckel's diverticulum occurs about 60 cm from the ileocaecal valve on the antimesenteric border which sometimes results in bleeding or obstruction. Small bowel volvulus along with intussusception most frequently occur in the jejunum and ileum sections especially within pediatric patients. Small bowel resection surgeries require preserving mesenteric blood supply to prevent ischemia and short bowel syndrome which demonstrates the essential need for accurate anatomical knowledge in clinical practice.

VASCULAR SUPPLY

The **abdominal aorta** is the continuation of the thoracic aorta and supplies the majority of the abdominal organs and structures. It bifurcates at the level of the **L4 vertebra** into the **common iliac arteries**. Before this bifurcation, the abdominal aorta gives off several important branches, which can be classified into **collateral** and **terminal branches**.

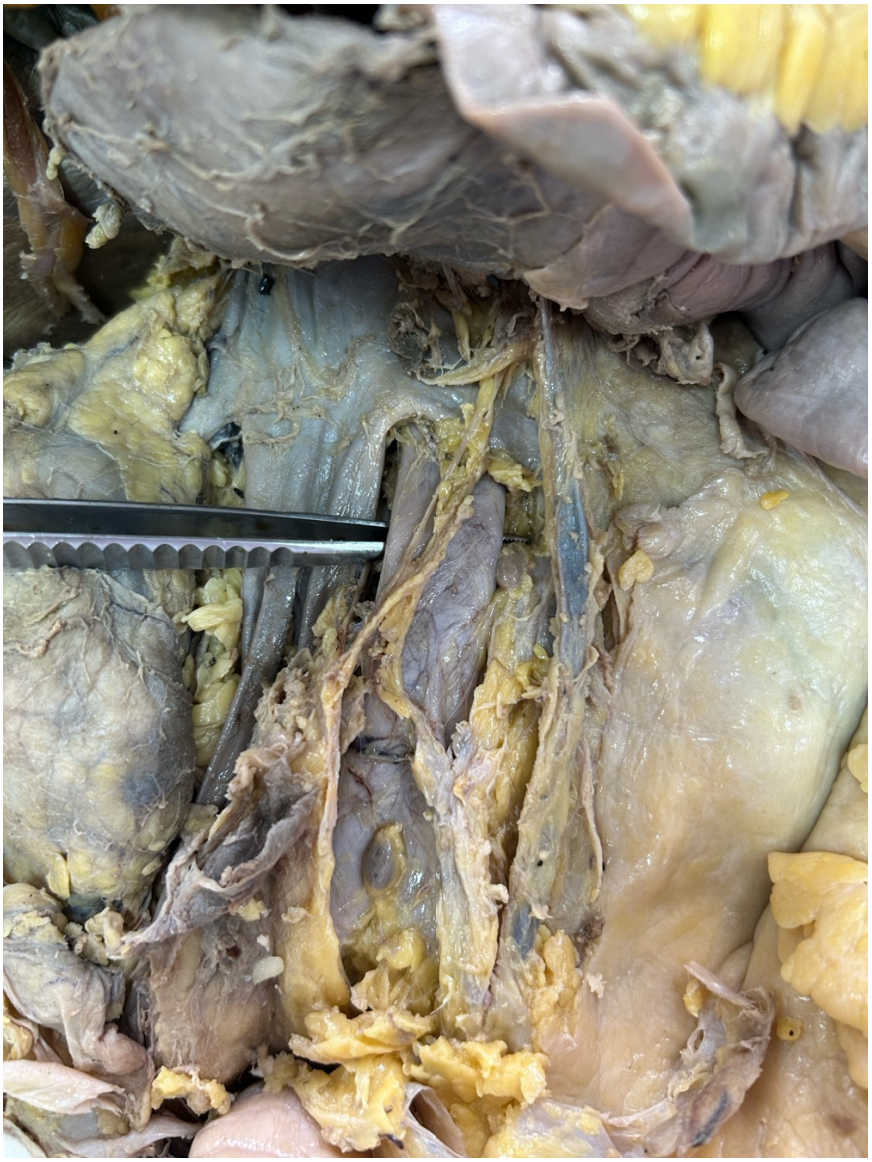


Fig. III.14. Abdominal Aorta

Collateral Branches:

Collateral branches of the abdominal aorta are those that provide blood supply to various abdominal structures, including the **gastrointestinal tract**, **kidneys**, and **pelvic organs**. These branches typically anastomose (connect) with other vessels, ensuring a continuous blood supply in case of blockages.

1. **Celiac Trunk** (T12):
    - **Branches**:
        - **Left Gastric Artery**: Supplies the lesser curvature of the stomach and the lower esophagus.
        - **Common Hepatic Artery**: Supplies the liver, gallbladder, stomach, and duodenum.
        - **Splenic Artery**: Supplies the spleen, pancreas, and parts of the stomach.

Fig. III.15. Celiac trunk and its branches

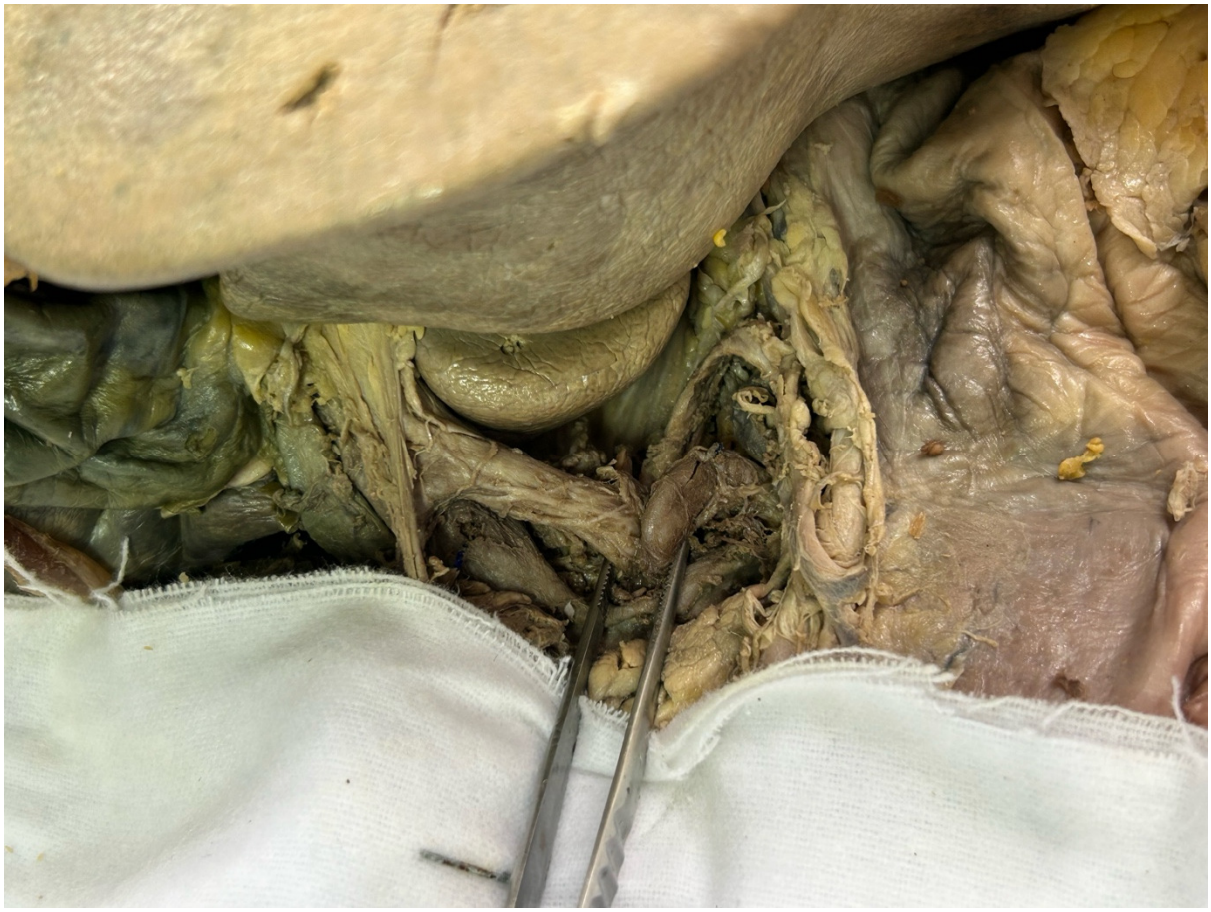


Fig. III.16. Celiac trunk and its branches

2. **Superior Mesenteric Artery (SMA)** (L1):
    - **Branches**:
        - **Inferior Pancreaticoduodenal Artery**: Supplies the pancreas and duodenum.
        - **Jejunal and Ileal Arteries**: Supply the jejunum and ileum (small intestine).
        - **Right Colic Artery**: Supplies the ascending colon.
        - **Middle Colic Artery**: Supplies the transverse colon.

Fig. III.17. Superior mesenteric artery

3. **Inferior Mesenteric Artery (IMA)** (L3):
    - **Branches**:
        - **Left Colic Artery**: Supplies the descending colon.
        - **Sigmoidal Arteries**: Supply the sigmoid colon.
        - **Superior Rectal Artery**: Supplies the rectum.

4. **Renal Arteries** (L1-L2):
    - Supply the kidneys and parts of the adrenal glands.
5. **Lumbar Arteries** (L1-L4):
    - Supply the muscles and skin of the lower back, as well as the spinal cord and vertebrae.

6. **Median Sacral Artery** (L4):
    - Supplies the sacrum, coccyx, and part of the pelvic organs.

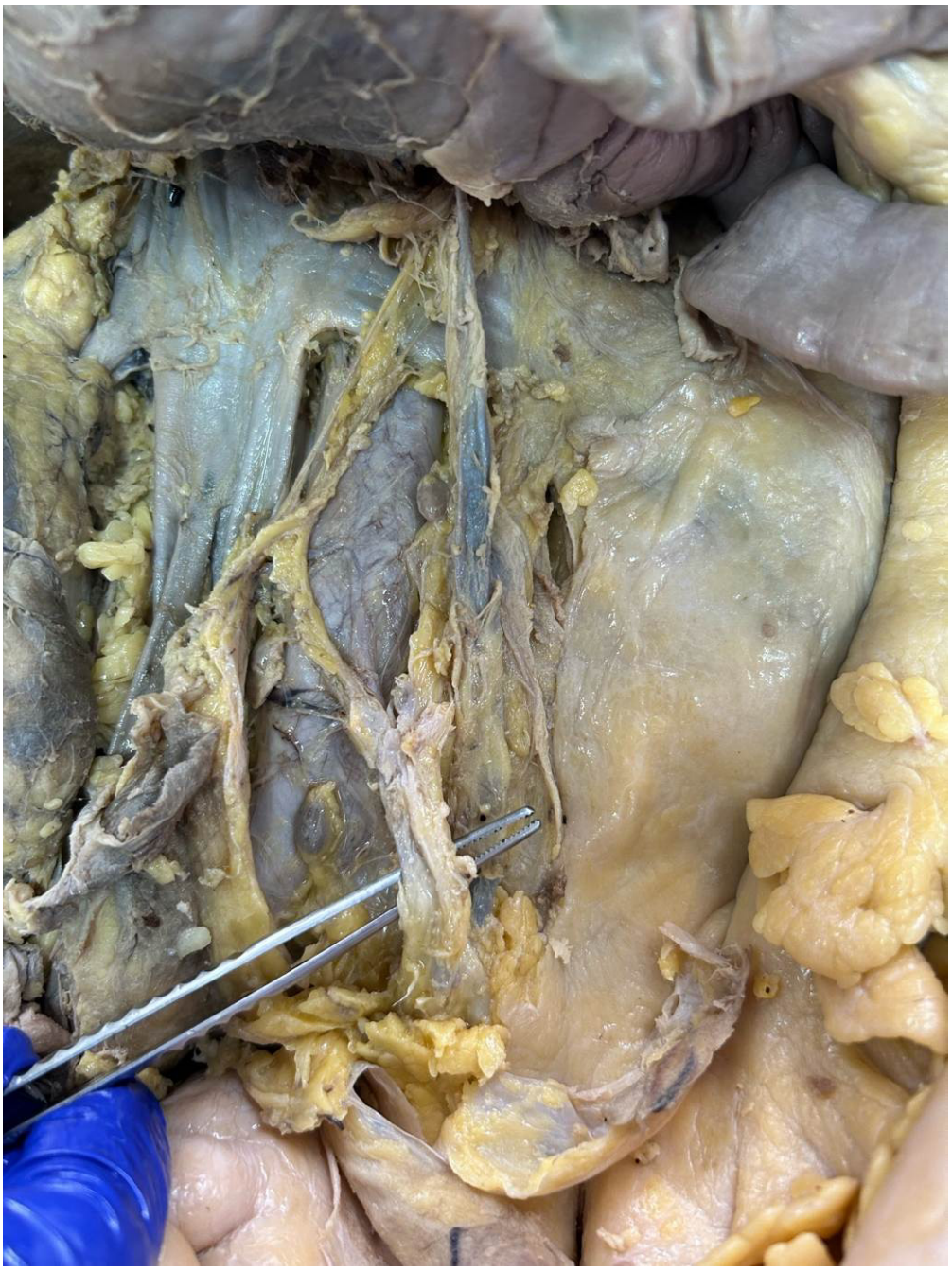


Fig. III.18. Inferior mesenteric artery

Terminal Branches:

The terminal branches of the abdominal aorta are those that represent the final bifurcation of the artery.

1. **Common Iliac Arteries** (L4):
    - The abdominal aorta bifurcates into the right and left common iliac arteries at the level of L4.
    - Each common iliac artery divides into:
        - **Internal Iliac Artery**: Supplies the pelvic organs, gluteal region, and parts of the perineum.
        - **External Iliac Artery**: Continues into the lower limb as the **femoral artery**.

In summary, the **collateral branches** of the abdominal aorta supply various abdominal organs, including the gastrointestinal tract, kidneys, and lumbar spine. The **terminal branches** are the common iliac arteries, which further supply the lower limbs and pelvic structures. Understanding these branches is crucial in abdominal surgeries, as they provide vital blood supply to multiple organs, and their preservation is essential for maintaining organ function.