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**QUESTION 1: Discuss the anatomy of the tongue and comment on its applied anatomy.**

**INTRODUCTION:**

The tongue (L. *lingua*; G. *glossa*) is a unique flexible mobile muscular organ covered with mucous membrane. The tongue in its uniqueness can assume variety of shapes and positions.

**LOCATION:**

It is partly in the oral cavity and partly in the oro-pharynx.

**FUNCTIONS:**

The tongue has several functions and it includes:

1. Articulation (forming of words during speaking)
2. Squeezing food into the oro-pharynx as part of deglutition (swallowing)
3. The tongue is also involved with mastication (chewing) and oral cleansing.
4. Taste (The tongue especially with the use of taste buds could be used to taste: Sweet, Salt, Sour, Bitter, Umami)

**PARTS AND SURFACES:**

The tongue has 3 parts and 2 surfaces.

* PARTS

The parts of the tongue are: Root, Body and Apex.

1. The **root of the tongue** is the attached posterior portion which extends between the mandible, hyoid and the nearly vertical posterior surface of the tongue.
2. The **body of the tongue** is the anterior, approximately 2/3rd of the tongue between root and apex.
3. The **apex (tip) of the tongue** is the anterior end of the body which rest against the incisor teeth.

The body and apex of the tongue are extremely mobile.

* SURFACES

The surfaces of the tongue are: Superior and the Inferior surface of the tongue

1. The **superior and posterior surface** of the tongue is called the *'Dorsum of the tongue or the top of the tongue'.*
2. The **inferior surface** of the tongue is commonly referred to as the *Underside of the tongue*. It usually rest on the floor of the mouth.

The two (2) surfaces of the tongue is separated a margin which is related on each side to the lingual gingivae and the lateral teeth.

* THE DORSUM OF THE TONGUE

This is characterized by a V-shaped groove called the **Terminal sulcus** of the tongue, the angle of which points posteriorly to a small pit called **Foramen cecum**. The dorsum of the tongue is divided by by the terminal sulcus transversely into 2 parts, which are:

1. Presulcal anterior part in the oral cavity proper
2. Postsulcal posterior part in the oro-pharynx.

The **anterior aspect** of the tongue is divided by the midline groove into *Right and Left parts*. The mucosa of the anterior part of the tongue is relatively thin and closely attached to the underlying muscle. The anterior part of the tongue is rough as a result of the presence of numerous **small lingual papillae**.

The mucosa of the **posterior aspect** of the tongue is thick and freely movable. It has no lingual papillae but the underlying lymphoid nodules give this part of the tongue an irregular cobblestone appearance. The lymphoid nodules are known collectively as **Lingual tonsils**.

NOTE THAT:

* The anterior part of the tongue is divided by the midline groove into *right and left parts.*
* The foramen cecum which is a small pit which is frequently absent is the non-functional remnant of the proximal part of the embryonic thyroglossal duct from which the thyroid gland developed.
* The pharyngeal part of the tongue constitutes the anterior wall of the oro-pharynx. It can be only inspected with a mirror or downward pressure on the tongue depressor.
* THE INFERIOR SURFACE OF THE TONGUE

This is covered with thin, transparent mucous membrane. This surface is connected to the floor of the mouth by the midline fold called the **frenulum of the tongue**. The frenulum allows the anterior part of the tongue to move freely. On each side of the frenulum, a deep lingual vein is visible through the thin mucous membrane. A **sublingual caruncle (papilla)** is present on each side of the base of the frenulum of the tongue that includes the - *opening of the submandibular duct* from the submandibular salivary gland.

**LINGUAL PAPILLAE AND TASTE BUDS:**

* LINGUAL PAPILLAE

The lingual papillae are what caused the rough appearance/texture of the anterior aspect of the tongue. The lingual papillae begin development during the 8th week of gestation. These papillae are into 4, they are:

1. **Vallate papillae**: They can also be called *Circumvallate papillae.* They are large and flat topped. It lies directly anterior to the terminal sulcus and is arranged in a V-shaped row. They are arranged by deep circular trenches, the wall of which is studded by ***taste buds***. The ducts of the serous glands of the tongue open into the trenches.
2. **Foliate papillae**: They are small lateral folds of the lingual mucosa. They are poorly developed in humans.
3. **Filiform papillae**: They are long and numerous. They contain afferent nerve endings that are sensitive to touch. These scaly projections are pinkish gray and are arranged in V-shaped rows that are now parallel to the terminal sulcus except at the apex, where they tend to arrange transversely.
4. **Fungiform papillae**: They are mushroom-shaped pink or red spots scattered among the filiform papillae, but most numerous ate the apex and margins of the tongue.

* TASTE BUDS

Taste buds contain taste receptor cells which are also known as **gustatory cells**. Taste buds are cell nests in the papillae and they are develop during the 11-13th week by inductive interaction between the epithelial cells of the tongue and invading gustatory (related to taste) nerve cells from the Chorda Tympani, glossopharyngeal and vagus nerves. On average, the human tongue has 2,000-8,000 taste buds. The average lifespan of these are estimated to be 10 days.

Most taste buds develop on the dorsum of the tongue and some develop on the palatoglossal (palate and tongue) arches, palate, posterior surface of epiglottis and the posterior wall of the oro-pharynx. The taste buds are involved in detecting the 5 elements of taste perception: Sweet, Salty, Sour, Bitter and Umami (A new taste bud identified by a Japanese scientist named *Kikunae Ikeda* in the early 1900s, it is said to be stimulated by monosodium glutamate).

1. Sweet taste buds are on the tip of the tongue
2. Salt taste buds are on either side of the front of the tongue
3. Sour taste buds are behind the salt taste buds
4. Bitter taste buds are way back on the dorsum of the tongue.

**MUSCLES OF THE TONGUE:**

The tongue is essentially a mass of muscles that is mostly covered by *mucosa* (mucous membrane). They are into two (2), they are:

1. Extrinsic muscles
2. Intrinsic muscles.

In general, *extrinsic muscles* alter the position of the tongue, while the *intrinsic muscles* alter the shape the tongue. The four (4) intrinsic and four (4) extrinsic muscles in each half of the tongue are separated by a median fibrous **lingual septum**. This septum merges posteriorly with the **lingual aponeurosis** (which is a touch sheet of connective tissue, the lamina propria deep to the dorsal mucous membrane of the tongue into which lingual muscles insert)

* EXTRINSIC MUSCLES OF THE TONGUE

These muscles originate outside of the tongue and attach to it. They mainly move the tongue because they can alter its shape as well. They are into four (4) and they are: ***Geniglossus, Hyoglossus, Styloglossus and Palatoglossus***.

* INTRINSIC MUSCLES OF THE TONGUE

These muscles have their attachments entirely within the mouth and are not attached to bone. They are into four (4) and they are: ***Superior and Inferior longitudinal, Transverse and Vertical muscles***.

* Superior and Inferior longitudinal tongue muscles act together to make the tongue *short and thick* to retract the protruded tongue.
* Transverse and Vertical tongue muscles act simultaneously to make the tongue *long and narrow* which may push the tongue against the incisor teeth or protrude the tongue from the open mouth (especially when acting with the posterior inferior part of the geniglossus).

**VASCULATURE OF THE TONGUE**

* ARTERIAL SUPPLY

The arteries of the tongue are derived from the **lingual artery**, which arises from the *External carotid artery*. The lingual artery passes deep to the hypoglossus muscle. The lingual artery is into two, and they are: **Deep and Dorsal Lingual Arteries**.

* Dorsal lingual arteries supply the root of the tongue.
* Deep lingual arteries supply the body of the tongue.

Note that:

The deep arteries communicate with each other near the apex of the tongue, while the dorsal lingual arteries are prevented from communication by the lingual septum.

* VEINOUS DRAINAGE

The veins of the tongue are the **dorsal lingual vein** which accompanies the lingual artery. The deep lingual vein veins, which begins at the apex of the tongue, runs posteriorly beside the lingual frenulum to join the **sublingual vein**. The sublingual veins in elderly people are often varicose (enlarged and tortuous). Some or all of the veins may drain into the IJV (Internal Jugular Vein) or they may do so indirectly by joining first to form the **lingual vein** that accompanies the initial part of the lingual artery.

* LYMPHATIC DRAINAGE

This is exceptional. Most of the lymphatic drainage converges towards and follows the venous drainage. However, lymph from the tip of the tongue, frenulum, and central lower lips runs an independent course. Lymph from different areas of the tongue drains via 4 routes, they are:

1. Lymph from the *root of the tongue* drains bilaterally into the **superior deep cervical lymph nodes**.
2. Lymph from the *medial part of the body* drains bilaterally and directly to the **inferior deep cervical lymph nodes**.
3. Lymph from the right and left *lateral parts of body* drains to thesubmandibular **lymph nodes on the ipsilateral side**.
4. The *apex and frenulum* drains to the **submental lymph nodes**, the medial portion draining bilaterally.

Note that:

All lymph from the tongue ultimately drains to the deep cervical nodes and passes via the jugular venous trunks into the venous system at the right and left venous angles.

**INNERVATION OF TONGUE**

All the muscles of the tongue except the *palatoglossus*, receive motor innervations from the CN XII, the **hypoglossal nerve**. Palatoglossus is a palatine muscle which is supplies by *Pharyngeal plexus*.

* For general sensation (touch and temperature), the mucosa of the anterior two-thirds of the tongue is supplied by the *lingual nerve* which is a branch of the CN V3 (mandibular nerve)
* For spencial sensation (taste), this part of the tongue except for the vallate papillae is supplied by the C*horda tympani nerve*, a branch of CN VII (Facial nerve). The chorda tympani join the lingual nerve in the infratemporal fossa and runs anteriorly in its sheath.
* The mucosa of the posterior third of the tongue and vallate papillae is supplied by the lingual branch of the *glossopharyngeal nerve* (CN IX).
* Some special sensation of a small area of the tongue just anterior to the epiglottis is supplied by the twigs of **internal laryngeal nerve** which is a branch of the vagus nerve (CN X).

Note that:

These sensory nerves also carry **parasympathetic secreto-motor fibers** to the serous glands of the tongue.

**CLINICAL ANATOMY OF THE TONGUE**

1. Injury to the Hypoglossus nerve:

Trauma such as fractured mandible may injure the hypoglossal nerve (CN XII), which may result in the paralysis and eventual atrophy of one side of the tongue. The tongue deviates to the paralyzed side during protrusion because of the action of the unaffected genioglossus muscle on the other side.

1. Lingual Carcinoma

A lingual carcinoma in the posterior part of the tongue metastasizes to the superior deep cervical lymph nodes on both sides. However, a tumor in the anterior part usually does not metastasize to the inferior deep cervical lymph nodes until late in the disease. Because the nodes are closely related to the IJV- Internal Jugular Vein, metastases from the tongue may be distributed through the submental and submandibular regions and along the IJV's in the neck

1. Lingual Frenectomy

A frenulum of the tongue extending further interiorly towards the apex (tongue-tie) interferes with the tongue movements and may affect speech. In unusual cases, a frenectomy (cutting the frenulum) in infants may be necessary to free the tongue for normal movements and speech.

1. Paralysis of Genioglossus

When the genioglossus muscle is paralyzed, the tongue has the tendency to fall posteriorly and obstructing the airway and presenting the risk of suffocation. The total obstruction of the genioglossus muscles occurs during general anesthesia. Thus, an airway is inserted in an anesthetized person to prevent the tongue from relapsing.

**QUESTION 2: Write an essay on the air sinuses.**

Paranasal sinuses are air cavities that help to circulate the air that is breathed in and out of the respiratory system. Paranasal sinuses are air-filled extensions of the respiratory part of the nasal cavity onto the following cranial bones: *Frontal bone, Ethmoid bone, Sphenoid bone and Maxillary bone*. They are named according to bones in which they are located. The sinuses invade the surrounding bone continuously and marked extensions are common in the crania of older people.

* FRONTAL SINUSES

The sinus is related to the frontal bone, hence the name Frontal sinus. There are two frontal sinuses, the *right and left frontal sinuses*, which are located between the outer and inner tables of the frontal bone, posterior to the superciliary arches and the root of the nose.

The frontal sinuses (right and left) each drain through the **frontonasal duct** into the *ethmoidal infundibulum*, which in turn opens into the *semilunar hiatus* of the middle nasal meatus. Often, a frontal sinus has two parts:

1. A vertical part in the squamous part of the frontal bone.
2. A horizontal part in the orbital part of the frontal bone.

One or both parts may be large or small. When the supra-orbital part is large, its roof forms the floor of the anterior cranial fossa and its floor forms the roof of the orbit.

NOTE THAT:

* The frontal sinuses are innervated by the branches of the *supraorbital nerves* (CN V1)
* The frontal sinuses are usually detectable in children by the age of 7 years
* The right and left frontal sinuses are rarely of equal size and the septum separating them is not usually situated entirely in the median plane. The frontal sinuses vary in size from approximately 5 mm to large spaces extending laterally into the greater wing of sphenoid bone.
* ETHMOIDAL SINUSES

The ethmoidal sinuses (cells) are small invaginations of the mucous membrane of the middle and superior nasal meatus into the ethmoid bone between the nasal cavity and the orbit. The ethmoidal cells are into 3, they are:

1. **Anterior** ethmoidal cells: The anterior ethmoidal cells drain directly or indirectly into the middle nasal meatus through the ethmoidal infundibulum.
2. **Middle** ethmoidal cells: They open directly into the middle meatus and are sometimes called *"Bullar cells"* because they form the ***ethmoidal bulla***, which is a swelling on the superior border of the semilunar hiatus.
3. **Posterior** ethmoidal cells: They open directly into the superior meatus.

NOTE THAT:

* The ethmoidal cells are supplied by the *anterior and posterior ethmoidal branches of the nasociliary nerves* (CN V1)
* The ethmoidal cells are usually not visible in plain radiographs before the age of 2 years.
* SPHENOIDAL SINUSES

These sinuses are located in the body of the sphenoid, but they may extend into the wings of the sphenoid bone. They are unevenly divided and separated by the bony septum and because of the extensive pneumatization (formation of the air cells), the body of the sphenoid is fragile. Only thin plates of the bone separate the sinuses from several important structures such as: Optic nerves and Optic chiasm, Pituitary gland, the ICA- Internal Carotid Arteries and the Cavernous sinuses.

The spehnoidal sinuses are derived from a posterior ethmoidal cell that begins to invade the sphenoid at approximately 2 years of age. In some people, several posterior ethmoidal cells invade the sphenoid, giving rise to multiple sphenoidal sinuses that open separately into the *sphenoethmoidal recess*. The posterior ethmoidal arteries the posterior ethmoidal nerves that accompany the arteries supply the sphenoidal sinuses.

* MAXILLARY SINUSES

These are the largest of the paranasal sinuses. They occupy the bodies of the maxillae and they communicate with the middle nasal meatus. The maxillary sinus has:

1. Apex: The apex of the maxillary sinus extends toward and often into the zygomatic bone
2. Base: The base of the maxillary sinus forms the inferior part of the lateral wall of the nasal cavity
3. Roof: The roof of the maxillary sinus is formed by the floor of the orbit
4. Floor: The floor of the maxillary sinus is formed by the alveolar part of the maxilla. The root of the maxillary teeth, particularly the first two molars, often produces conical elevations in the floor of the sinus.

Each maxillary sinus drains by one or more openings called **maxillary ostium** into the middle nasal meatus of the nasal cavity by the way of the semilunar hiatus.

The **arterial supply of the maxillary sinus** is mainly from the *superior alveolar branches of the maxillary artery*. However, branches of the descending and greater palatine arteries supply the floor of the sinus.

The **innervation of the maxillary sinus** is from the anterior, middle and posterior superior alveolar nerves which are branches of maxillary nerve.

* CLINICAL CORRELATES.

1. Infections to the Ethmoidal cells:

If the nasal drainage is blocked, infections to the ethmoidal cells may break through the fragile medial wall of the orbit. Severe infections from this source may cause blindness because some posterior ethmoidal cells lie close to the optic canal, which gives passage to the optic nerve and ophthalmic artery. Spread of infection from these cells could also affect the dural sheath of the optic nerve causing *optic neuritis*.

1. Sinusitis:

Due to the fact that the paranasal sinuses are continuous with the nasal cavities through apertures that open into them, infection may spread from the nasal cavities producing inflammation and swelling of the mucosa of the sinuses (sinusitis) and local pain. Sometimes, several sinuses are inflamed (parasinusitis) and swelling of the mucosa may block one or more opening of the sinuses into the nasal cavities.

1. Infection of Maxillary sinuses:

The maxillary sinuses are the most commonly infected because their ostia (openings) are commonly small and located high in their superomedial walls. When the mucous membrane of the sinus is congested, the maxillary ostia are often obstructed. Because of their high location of the ostia, when the head is erect, it is impossible for the sinuses to drain until they are full and also because the ostia of the right and left sinuses lie on the medial sides (i.e., are directed toward each other), when lying on one's side only the upper sinus (e.g., the right sinus if lying on the left side) drains. A cold or allergy involving both sinuses can result in nights of rolling from one side to side in an attempt to keep the sinuses drained. A maxillary sinus can be cannulated and drained by passing a cannula from the naris through the maxillary ostium into the sinus.