

## **The Respiratory System in the Head and Neck**

### **The Nose**

The nose consists of the external nose and the nasal cavity, both of which are divided by a septum into right and left halves.

### **External Nose**

The external nose has two elliptical orifices called the nostrils, which are separated from each other by the nasal septum. The lateral margin, the ala nasi, is rounded and mobile.

The framework of the external nose is made up above by the nasal bones, the frontal processes of the maxillae, and the nasal part of the frontal bone. Below, the framework is formed of plates of hyaline cartilage.

### **Blood Supply of the External Nose**

The skin of the external nose is supplied by branches of the ophthalmic and the maxillary arteries. The skin of the ala and the lower part of the septum are supplied by branches from the facial artery.

### **Nerve Supply of the External Nose**

The infratrochlear and external nasal branches of the ophthalmic nerve (CN V) and the infraorbital branch of the maxillary nerve (CN V).

### **Nasal Cavity**

The nasal cavity extends from the nostrils in front to the posterior nasal apertures or choanae behind, where the nose opens into the nasopharynx. The nasal vestibule is the area of the nasal cavity lying just inside the nostril. The nasal cavity is divided into right and left halves by the nasal septum. The septum is made up of the septal cartilage, the vertical plate of the ethmoid, and the vomer.

### **Walls of the Nasal Cavity**

Each half of the nasal cavity has a floor, a roof, a lateral wall, and a medial or septal wall.

**Floor**

The palatine process of the maxilla and the horizontal plate of the palatine bone.

**Roof**

The roof is narrow and is formed anteriorly beneath the bridge of the nose by the nasal and frontal bones, in the middle by the cribriform plate of the ethmoid, located beneath the anterior cranial fossa, and posteriorly by the downward sloping body of the sphenoid.

**Lateral Wall**

The lateral wall has three projections of bone called the superior, middle, and inferior nasal conchae. The space below each concha is called a meatus.

**Sphenoethmoidal Recess**

The sphenoethmoidal recess is a small area above the superior concha. It receives the opening of the sphenoid air sinus.

**Superior Meatus**

The superior meatus lies below the superior concha. It receives the openings of the posterior ethmoid sinuses.

**Middle Meatus**

The middle meatus lies below the middle concha. It has a rounded swelling called the bulla ethmoidalis that is formed by the middle ethmoidal air sinuses, which open on its upper border. A curved opening, the hiatus semilunaris, lies just below the bulla. The anterior end of the hiatus leads into a funnel-shaped channel called the infundibulum, which is continuous with the frontal sinus. The maxillary sinus opens into the middle meatus through the hiatus semilunaris.

**Inferior Meatus**

The inferior meatus lies below the inferior concha and receives the opening of the lower end of the nasolacrimal duct, which is guarded by a fold of mucous membrane.

**Medial Wall**

The medial wall is formed by the nasal septum. The upper part is formed by the vertical plate of the ethmoid and the vomer. The anterior part is formed by the septal cartilage. The septum rarely lies in the midline, thus increasing the size of one half of the nasal cavity and decreasing the size of the other.

### **Mucous Membrane of the Nasal Cavity**

The vestibule is lined with modified skin and has coarse hairs. The area above the superior concha is lined with olfactory mucous membrane and contains nerve endings sensitive to the reception of smell. The lower part of the nasal cavity is lined with respiratory mucous membrane. A large plexus of veins in the submucous connective tissue is present in the respiratory region.

### **Function of Warm Blood and Mucus of Mucous Membrane**

The presence of warm blood in the venous plexuses serves to heat up the inspired air as it enters the respiratory system. The presence of mucus on the surfaces of the conchae traps foreign particles and organisms in the inspired air, which are then swallowed and destroyed by gastric acid.

### **Nerve Supply of the Nasal Cavity**

The olfactory nerves from the olfactory mucous membrane ascend through the cribriform plate of the ethmoid bone to the olfactory bulbs. The nerves of ordinary sensation are branches of the ophthalmic division (V1) and the maxillary division (V2) of the trigeminal nerve.

### **Blood Supply to the Nasal Cavity**

The arterial supply to the nasal cavity is from branches of the maxillary artery, one of the terminal branches of the external carotid artery. The most important branch is the sphenopalatine artery. The sphenopalatine artery anastomoses with the septal branch of the superior labial branch of the facial artery in the region of the vestibule. The submucous venous plexus is drained by veins that accompany the arteries.

### **Lymph Drainage of the Nasal Cavity**

The lymph vessels draining the vestibule end in the submandibular nodes. The remainder of the nasal cavity is drained by vessels that pass to the upper deep cervical nodes.

### **The Paranasal Sinuses**

The paranasal sinuses are cavities found in the interior of the maxilla, frontal, sphenoid, and ethmoid bones. They are lined with mucoperiosteum and filled with air; they communicate with the nasal cavity through relatively small apertures. The maxillary and sphenoidal sinuses are present in a rudimentary form at birth; they enlarge appreciably after the eighth year and become fully formed in adolescence.

### **Drainage of Mucus and Function of Paranasal Sinuses**

The mucus produced by the mucous membrane is moved into the nose by ciliary action of the columnar cells. Drainage of the mucus is also achieved by the siphon action created during the blowing of the nose. The function of the sinuses is to act as resonators to the voice; they also reduce the weight of the skull. When the apertures of the sinuses are blocked or they become filled with fluid, the quality of the voice is markedly changed.

### **Maxillary Sinus**

The maxillary sinus is pyramidal in shape and located within the body of the maxilla behind the skin of the cheek. The roof is formed by the floor of the orbit, and the floor is related to the roots of the premolars and molar teeth. The maxillary sinus opens into the middle meatus of the nose through the hiatus semilunaris.

### **Frontal Sinuses**

The two frontal sinuses are contained within the frontal bone. They are separated from each other by a bony septum. Each sinus is roughly triangular, extending upward above the medial end of the eyebrow and backward into the medial part of the roof of the orbit. Each frontal sinus opens into the middle meatus of the nose through the infundibulum.

### **Sphenoidal Sinuses**

The two sphenoidal sinuses lie within the body of the sphenoid bone. Each sinus opens into the sphenoethmoidal recess above the superior concha.

### **Ethmoid Sinuses**

The ethmoidal sinuses are anterior, middle, and posterior and they are contained within the ethmoid bone, between the nose and the orbit (Fig. 11-97). They are separated from the latter by a thin plate of bone so that infection can readily spread from the sinuses into the orbit. The anterior sinuses open into the infundibulum; the middle sinuses open into the middle meatus, on or above the bulla ethmoidalis; and the posterior sinuses open into the superior meatus.

The frontal sinus drains into the hiatus semilunaris, via the infundibulum, close to the orifice of the maxillary sinus on the lateral wall of the nose. It is thus not unexpected to find that a patient with frontal sinusitis nearly always has a maxillary sinusitis. The maxillary sinus is particularly prone to infection because its drainage orifice through the hiatus semilunaris is badly placed near the roof of the sinus. In other words, the sinus has to fill up with fluid before it can effectively drain with the person in the upright position.

### **Paranasal Sinuses and Their Site of Drainage Into the Nose**

<b>Sinus</b>	<b>Site of Drainage</b>
Maxillary sinus	Middle meatus through hiatus semilunaris
Frontal sinuses	Middle meatus via infundibulum
Sphenoidal sinuses	Sphenoethmoidal recess
Ethmoidal sinuses	
Anterior group	Infundibulum and into middle meatus
Middle group	Middle meatus on or above bulla ethmoidalis
Posterior group	Superior meatus

### **The Larynx**

The larynx is an organ that provides a protective sphincter at the inlet of the air passages and is responsible for voice production. It is situated below the tongue and hyoid bone and between the great blood vessels of the neck and lies at the level of the fourth, fifth, and sixth cervical vertebrae. It opens above into the laryngeal part of the pharynx, and below is continuous with the trachea. The larynx is covered in front by the infrahyoid strap muscles and at the sides by the thyroid gland.

The framework of the larynx is formed of cartilages that are held together by ligaments and membranes, moved by muscles, and lined by mucous membrane.

#### Cartilages of the Larynx

- **Thyroid cartilage:** This is the largest cartilage of the larynx and consists of two laminae of hyaline cartilage that meet in the midline in the prominent V angle (the so-called Adam's apple). The posterior border extends upward into a superior cornu and downward into an inferior cornu. On the outer surface of each lamina is an oblique line for the attachment of muscles.
- **Cricoid cartilage:** This cartilage is formed of hyaline cartilage and shaped like a signet ring, having a broad plate behind and a shallow arch in front. The cricoid cartilage lies below the thyroid cartilage, and on each side of the lateral surface is a facet for articulation with the inferior cornu of the thyroid cartilage. Posteriorly, the lamina has on its upper border on each side a facet for articulation with the arytenoid cartilage. All these joints are synovial.
- **Arytenoid cartilages:** There are two arytenoid cartilages, which are small and pyramid shaped and located at the back of the larynx. They articulate with the upper border of the lamina of the cricoid cartilage. Each cartilage has an apex above that articulates with the small corniculate cartilage, a base below that articulates with the lamina of the cricoid cartilage, and a vocal process that projects forward and gives attachment to the vocal ligament. A muscular process that projects laterally gives attachment to the posterior and lateral cricoarytenoid muscles.
- **Corniculate cartilages:** Two small conical-shaped cartilages articulate with the arytenoid cartilages. They give attachment to the aryepiglottic folds.
- **Cuneiform cartilages:** These two small rod-shaped cartilages are found in the aryepiglottic folds and serve to strengthen them.

- **Epiglottis:** This leaf-shaped lamina of elastic cartilage lies behind the root of the tongue. Its stalk is attached to the back of the thyroid cartilage. The sides of the epiglottis are attached to the arytenoid cartilages by the aryepiglottic folds of mucous membrane. The upper edge of the epiglottis is free. The covering of mucous membrane passes forward onto the posterior surface of the tongue as the median glossoepiglottic fold; the depression on each side of the fold is called the vallecula. Laterally the mucous membrane passes onto the wall of the pharynx as the lateral glossoepiglottic fold.

### **Membranes and Ligaments of the Larynx**

- **Thyrohyoid membrane:** This connects the upper margin of the thyroid cartilage to the hyoid bone. In the midline it is thickened to form the median thyrohyoid ligament. The membrane is pierced on each side by the superior laryngeal vessels and the internal laryngeal nerve, a branch of the superior laryngeal nerve.
- **Cricotracheal ligament:** This connects the cricoid cartilage to the first ring of the trachea.
- **Quadrangular membrane:** This extends between the epiglottis and the arytenoid cartilages. Its thickened inferior margin forms the vestibular ligament, and the vestibular ligaments form the interior of the vestibular folds.
- **Cricothyroid ligament:** The lower margin is attached to the upper border of the cricoid cartilage. The superior margin of the ligament, instead of being attached to the thyroid cartilage, ascends on the medial surface of the thyroid cartilage. Its upper free margin, composed almost entirely of elastic tissue, forms the important vocal ligament on each side. The vocal ligaments form the interior of the vocal folds (vocal cords). The anterior end of each vocal ligament is attached to the thyroid cartilage, and the posterior end is attached to the vocal process of the arytenoid cartilage.

### **Inlet of the Larynx**

The inlet of the larynx looks backward and upward into the laryngeal part of the pharynx. The opening is wider in front than behind and is bounded in front by the epiglottis, laterally by the aryepiglottic fold of mucous membrane, and posteriorly by the arytenoid cartilages with the corniculate cartilages. The cuneiform cartilage lies

within and strengthens the aryepiglottic fold and produces a small elevation on the upper border.

### **The Piriform Fossa**

The piriform fossa is a recess on either side of the fold and inlet. It is bounded medially by the aryepiglottic fold and laterally by the thyroid cartilage and the thyrohyoid membrane.

### **Laryngeal Folds**

#### **Vestibular Fold**

The vestibular fold is a fixed fold on each side of the larynx. It is formed by mucous membrane covering the vestibular ligament and is vascular and pink in color.

#### **Vocal Fold (Vocal Cord)**

The vocal fold is a mobile fold on each side of the larynx and is concerned with voice production. It is formed by mucous membrane covering the vocal ligament and is avascular and white in color. The vocal fold moves with respiration and its white color is easily seen when viewed with a laryngoscope.

The gap between the vocal folds is called the **rima glottidis** or glottis. The glottis is bounded in front by the vocal folds and behind by the medial surface of the arytenoid cartilages. The glottis is the narrowest part of the larynx and measures about 2.5 cm from front to back in the male adult and less in the female. In children the lower part of the larynx within the cricoid cartilage is the narrowest part.

### **Cavity of the Larynx**

The cavity of the larynx extends from the inlet to the lower border of the cricoid cartilage, where it is continuous with the cavity of the trachea. It is divided into three regions:

- The **vestibule**, which is situated between the inlet and the vestibular folds
- The **middle region**, which is situated between the vestibular folds above and the vocal folds below
- The **lower region**, which is situated between the vocal folds above and the lower border of the cricoid cartilage below

### **Sinus of the Larynx**

The sinus of the larynx is a small recess on each side of the larynx situated between the vestibular and vocal folds. It is lined with mucous membrane.

### **Sacculae of the Larynx**

The sacculae of the larynx is a diverticulum of mucous membrane that ascends from the sinus. The mucous secretion lubricates the vocal cords.

### **Muscles of the Larynx**

The muscles of the larynx may be divided into two groups: extrinsic and intrinsic.

#### **Extrinsic Muscles**

These muscles move the larynx up and down during swallowing. Note that many of these muscles are attached to the hyoid bone, which is attached to the thyroid cartilage by the thyrohyoid membrane. It follows that movements of the hyoid bone are accompanied by movements of the larynx.

- Elevation: The digastric, the stylohyoid, the mylohyoid, the geniohyoid, the stylopharyngeus, the salpingopharyngeus, and the palatopharyngeus muscles
- Depression: The sternothyroid, the sternohyoid, and the omohyoid muscles

#### **Intrinsic Muscles**

Two muscles modify the laryngeal inlet:

- Narrowing the inlet: The oblique arytenoid muscle
- Widening the inlet: The thyroepiglottic muscle

Five muscles move the vocal folds (cords):

- Tensing the vocal cords: The cricothyroid muscle
- Relaxing the vocal cords: The thyroarytenoid (vocalis) muscle
- Adducting the vocal cords: The lateral cricoarytenoid muscle
- Abducting the vocal cords: The posterior cricoarytenoid muscle
- Approximates the arytenoid cartilages: The transverse arytenoid muscle

### Movements of the Vocal Folds (Cords)

The movements of the vocal folds depend on the movements of the arytenoid cartilages, which rotate and slide up and down on the sloping shoulder of the superior border of the cricoid cartilage.

The rima glottidis is opened by the contraction of the posterior cricoarytenoid, which rotates the arytenoid cartilage and abducts the vocal process. The elastic tissue in the capsules of the cricoarytenoid joints keeps the arytenoid cartilages apart so that the posterior part of the glottis is open.

**Table 11-12 Intrinsic Muscles of the Larynx**

Muscle	Origin	Insertion	Nerve Supply	Action
<b>Muscles Controlling the Laryngeal Inlet</b>				
Oblique arytenoid	Muscular process of arytenoid cartilage	Apex of opposite arytenoid cartilage	Recurrent laryngeal nerve	Narrows the inlet by bringing the aryepiglottic folds together
Thyroepiglottic	Medial surface of thyroid cartilage	Lateral margin of aryepiglottic fold	Recurrent laryngeal nerve	Widens the inlet by pulling the aryepiglottic folds apart
<b>Muscles Controlling the Movements of the Vocal Folds (Cords)</b>				
Cricothyroid	Side of cricoid cartilage	Lower border and inferior cornu of thyroid cartilage	External laryngeal nerve	Tenses vocal cords
Thyroarytenoid (vocalis)	Inner surface of thyroid cartilage	Arytenoid cartilage	Recurrent laryngeal nerve	Relaxes vocal cords
Lateral cricoarytenoid	Upper border of cricoid cartilage	Muscular process of arytenoid cartilage	Recurrent laryngeal nerve	Adducts the vocal cords by rotating arytenoid cartilage
Posterior cricoarytenoid	Back of cricoid cartilage	Muscular process of arytenoid cartilage	Recurrent laryngeal nerve	Abducts the vocal cords

cricoarytenoid	cricoid	of	arytenoid	laryngeal	cords	by	rotating
	cartilage		cartilage	nerve			arytenoid cartilage
Transverse	Back	and	Back	and	medial	Recurrent	Closes posterior part of
arytenoid	medial surface		surface		of	laryngeal	rima glottidis by
	of arytenoid		opposite arytenoid		nerve		approximating
	cartilage		cartilage				arytenoid cartilages

The rima glottidis is closed by contraction of the lateral cricoarytenoid, which rotates the arytenoid cartilage and adducts the vocal process. The posterior part of the glottis is narrowed when the arytenoid cartilages are drawn together by contraction of the transverse arytenoid muscles.

The vocal folds are stretched by contraction of the cricothyroid muscle. The vocal folds are slackened by contraction of the vocalis, a part of the thyroarytenoid muscle.

### **Nerve Supply of the Larynx**

#### **Sensory Nerves**

- Above the vocal cords: The internal laryngeal branch of the superior laryngeal branch of the vagus.
- Below the level of the vocal cords: The recurrent laryngeal nerve.

#### **Motor Nerves**

All the intrinsic muscles of the larynx except the cricothyroid muscle are supplied by the recurrent laryngeal nerve. The cricothyroid muscle is supplied by the external laryngeal branch of the superior laryngeal branch of the vagus.

### **Blood Supply of the Larynx**

- Upper half of the larynx: The superior laryngeal branch of the superior thyroid artery
- Lower half of the larynx: The inferior laryngeal branch of the inferior thyroid artery

### **Lymph Drainage of the Larynx**

The lymph vessels drain into the deep cervical group of nodes.

## **The Trachea**

### **Description**

The trachea is a mobile cartilaginous and membranous tube. It begins as a continuation of the larynx at the lower border of the cricoid cartilage at the level of the sixth cervical vertebra. It descends in the midline of the neck. In the thorax the trachea ends at the carina by dividing into right and left principal (main) bronchi at the level of the sternal angle (opposite the disc between the fourth and fifth thoracic vertebrae).

The fibroelastic tube is kept patent by the presence of U-shaped cartilaginous bars (rings) of hyaline cartilage embedded in its wall. The posterior free ends of the cartilage are connected by smooth muscle, the trachealis muscle.

The mucous membrane of the trachea is lined with pseudostratified ciliated columnar epithelium and contains many goblet cells and tubular mucous glands.

Relations of the Trachea in the Neck.

- **Anteriorly:** Skin, fascia, isthmus of the thyroid gland (in front of the second, third, and fourth rings), inferior thyroid vein, jugular arch, thyroidea ima artery (if present), and the left brachiocephalic vein in children, overlapped by the sternothyroid and sternohyoid muscles.
- **Posteriorly:** Right and left recurrent laryngeal nerves and the esophagus
- **Laterally:** Lobes of the thyroid gland and the carotid sheath and contents

### **Nerve Supply of the Trachea**

The sensory nerve supply is from the vagi and the recurrent laryngeal nerves.

### **Blood Supply of the Trachea**

The upper two thirds is supplied by the inferior thyroid arteries and the lower third is supplied by the bronchial arteries.

### **Lymph Drainage of the Trachea**

Into the pretracheal and paratracheal lymph nodes and the deep cervical nodes