Chapter 26: The temporomandibular joint, pharynx and larynx

The Temporomandibular Joint

This is a synovial joint of a condyloid (modified hinge) variety between the condyle of the mandible and the mandibular fossa and articular tubercle of the squamous temporal bone. The hemicylindrical condyle is directed medially and slightly backwards, the temporal articular surface is concavoconvex from behind forwards, extending from the squamotympanic fissure to the front of the articular tubercle. The articular surfaces are covered with fibrocartilage, unlike most other synovial joints.

Ligaments

(a) Capsular

The capsular ligaments are attached around the neck of the mandible and to the articular margins on the temporal bone.

(b) Capsular Thickenings

The lateral ligament - a strong band passing downwards and backwards from the inferior surface of the zygomatic arch to the back of the mandible, so limiting backward movement.

(c) Accessory Ligaments

(i) Sphenomandibular ligament - passes from the spine of the sphenoid to the lingula of the mandible.

(ii) Stylomandibular ligament - a thickening of the deep layer of the cervical fascia passing from the styloid process to the posterior border of the ramus of the mandible.

Intracapsular Structures

A fibrocartilaginous disc, whose margins are attached to the capsule, completely divides the joint cavity into superior and inferior compartments each with its own synovial membrane. The disc has a concave undersurface and a concavoconvex upper surface. The lateral pterygoid tendon is attached to the anterior aspect of the capsula and to the disc.

Functional Aspects

Movement

The mandible may be depressed, elevated, protruded and retracted as in opening and closing the mouth, and moved from side to side as in grinding movements. However, movement at the joints has two components, each occurring in a separate compartment of the joint.
(a) Gliding occurs in the upper compartment. The condyle of the mandible and the articular disc move together over the articular surface.

(b) Hinge movement occurs in the lower compartment. The condyle of the mandible articulates with the undersurface of the articular disc.

In mandibular movements these components are never completely dissociated and movement at one joint must be accompanied by movement at the other. In depression and elevation both components are equally involved but in protrusion, retraction and grinding movements the gliding component is predominant. Some of these details may be demonstrated by radiological means.

Depression takes place about an axis passing through the lingulae. The condyles are pulled forwards by lateral pterygoid and the body is pulled downwards by geniohyoid, digastric and mylohyoid acting from the fixed hyoid bone. The movement is assisted by gravity.

Elevation is around the same axis and is produced by masseter, temporalis and medial pterygoid.

Protrusion is produced by lateral and medial pterygoid.

Retraction is produced by the posterior fibres of temporalis.

Grinding movements are composed of alternating protrusion and retraction on the two sides and are brought about by the appropriate muscles. In chewing, the mandible is moved from side to side and at the same time is elevated by masseter and temporalis, the muscles of tongue and cheek keeping the food between the teeth.

**Stability**

This varies with the position of the mandible. The joint is most stable when the mandible is fully elevated because (a) the condyle lies within the articular fossa, (b) occlusion of the teeth prevents further upwards movement, (c) the lateral ligament is taut in this position, preventing posterior dislocation. Contraction of the muscles is important in maintaining this position, and in sleep or under anaesthesia the jaw drops open. In the resting position the teeth are separated slightly.

When the mandible is depressed the above factors are absent. The condyle lies on the articular tubercle and the integrity of the joint is dependent on the tone of the muscles and the strength of the capsule. Forward dislocation is the commonest form of displacement.

**Blood Supply**

This is from superficial temporal and maxillary arteries.
**Nerve Supply**

This is from auriculotemporal and masseteric nerves.

**Relations**

Laterally - skin and superficial fascia.

Medially - sphenomandibular ligament, auriculotemporal nerve and the middle meningeal artery.

Anteriorly - lateral pterygoid.

Posteriorly - the parotid gland and related structures, the auriculotemporal nerve and the tympanic plate of the temporal bone.

The chorda tympani emerges from the petrotympanic fissure just behind the capsule of the joint.

**Muscles of Mastication**

These muscles are all attached to the mandible and are supplied by the mandibular division of the trigeminal nerve.

1. **Masseter**.

   **Attachments**

   Superior - lower border of the anterior two-thirds of the zygomatic arch.

   Inferior - the fibres descend to the lateral surface of the ramus and angle of the mandible.

   **Action**

   Elevation of the mandible.

2. **Temporalis**

   **Attachments**

   Superior - lateral surface of the skull below the temporal line.

   Inferior - from their wide upper attachment, the fibres converge on to a narrow tendon which is attached to the coronoid process and the anterior border of the ramus of the mandible. The anterior fibres are vertical, the posterior are horizontal.
**Action**

The anterior fibres elevate and the posterior fibres retract the mandible.

**Temporal fascia** - a dense sheet covering temporalis muscle. It has a continuous attachment to the temporal line above and the zygomatic arch below, and is continuous with the epicranial aponeurosis.

3. **Medial Pterygoid**

**Attachments**

Superior - by two heads which embrace the lower fibres of lateral pterygoid - the deep from the medial surface of the lateral pterygoid plate, and the superficial from the maxillary tuberosity.

Inferior - the medial surface of the ramus and angle of the mandible.

**Action**

Elevation and protrusion of the mandible.

4. **Lateral Pterygoid**

**Attachments**

Anterior - by two heads - the upper from the infratemporal surface of the greater wing of the sphenoid, and the lower from the lateral surface of the lateral pterygoid plate.

Posterior - the neck of the mandible, and the capsule and intra-articular disc of the temporomandibular joint.

**Action**

Protrusion and depression of the mandible.

**Infratemporal Fossa**

This fossa lies below the base of the skull behind the maxilla and pterygoid plates of the sphenoid bone and in front of the carotid sheath. It is limited mediially by the pharynx and laterally by temporalis and the ramus of the mandible. Inferiorly it is continuous with the fascial spaces of the neck.

The fossa contains the lateral and medial pterygoid muscles, the mandibular division of the trigeminal nerve and its branches, the maxillary artery and branches, the pterygoid venous plexus, and the sphenomandibular ligament.
The Pharynx

This is a muscular tube extending from the base of the skull to the level of the 6th cervical vertebra where it is continuous with the oesophagus. It is about 14 cm long. It lies behind, and communicates with, the nose, mouth and larynx, from above downwards, and is correspondingly divided into the naso-, oro- and laryngo-pharynx. Posteriorly it lies on the prevertebral fascia and muscles. Laterally it is related from above downwards to the auditory tube, the styloid process and its muscles, the carotid sheath and its contents, and the thyroid gland.

The walls of the pharynx have mucous, submucous and muscular coats.

(a) The mucous coat is continuous with that of the nose, auditory tube, oral cavity, larynx and oesophagus; in the nasopharynx it is lined with respiratory epithelium, and in the remainder with stratified squamous epithelium.

(b) The submucosa is thickened superiorly, where the muscular coat is deficient, to form the pharyngobasilar fascia which is attached to the base of the skull.

(c) The muscular coat comprises the superior, middle and inferior constrictor muscles, and the salpingo-, stylo- and palatopharyngeus muscles.

The superior constrictor is attached anteriorly to - (i) the hamulus of the medial pterygoid plate, (ii) the retromolar fossa on the mandible and (iii) between these attachments, to the pterygomandibular raphe.

The middle constrictor is attached anteriorly to - (i) the lower part of the stylohyoid ligament, (ii) the lesser horn of the hyoid bone and (iii) the greater horn of the hyoid bone.

The inferior constrictor is attached anteriorly to - (i) the oblique line on the thyroid cartilage, (ii) the fascia over cricothyroid and (iii) the lateral aspect of the cricoid cartilage.

Each constrictor fans out from its anterior attachment, passing posteriorly around the pharynx to join its fellow of the opposite side in a fibrous midline raphe. The raphe extends from the pharyngeal tubercle, on the basilar part of the occipital bone, down to the oesophagus. Owing to the posterior spreading of the muscles, the pairs overlap. The inferior lies outside the middle, which is itself outside the superior.

The salpingopharyngeus, stylopharyngeus and palatopharyngeus muscles are attached superiorly to the auditory tube, the styloid process and the soft palate respectively. They descend to blend with the inner surfaces of the constrictors and gain attachment to the posterior aspect of the lamina of the thyroid cartilage.

The muscles of the pharynx are concerned in swallowing. They are supplied by the vagus nerve via the pharyngeal plexus, with the exception of stylopharyngeus (supplied by the glossopharyngeal nerve). The cell bodies are all in the nucleus ambiguus.
Between the superior constrictor and the base of the skull, the pharyngobasilar fascia is pierced by the auditory tube; between the superior and middle constrictors, stylopharyngeus and styloglossus and the glossopharyngeal nerve enter the pharyngeal wall; between the middle and inferior muscles pass the internal laryngeal nerve and the superior laryngeal artery to supply the larynx. The recurrent laryngeal nerve enters the region by ascending deep to the inferior constrictor.

On rare occasions, the pharyngeal mucosa may bulge through the defect between the thyroid and cricoid components of the inferior constrictor, producing an acquired pharyngeal pouch.

The Interior Of The Pharynx

The nasopharynx

The nasopharynx lies behind the two posterior nasal openings (choanae). On each lateral wall are the opening of the auditory tube and a ridge produced by salpingopharyngeus. A small diverticulum behind the ridge is the pharyngeal recess and longus capitis bulges into the posterior wall. A submucous aggregation of lymphoid tissue, the pharyngeal tonsil (adenoids), is present. Superiorly the cavity is limited by the base of the occipital bone and the body of the sphenoid. Below, it communicates with the oropharynx through the pharyngeal isthmus, a constriction which may be closed by the backward-projecting, mobile soft palate.

The oropharynx

This extends down to the level of the upper border of the epiglottis where it is continuous with the laryngopharynx. Anteriorly it communicates through the faucial isthmus with the oral cavity. Below the faucial isthmus is the tongue, which lies partly in the pharynx and partly in the oral cavity. In the lateral wall of the faucial isthmus are two folds of mucous membrane, the anterior and posterior arches of the fauces. They are produced, respectively, by palatoglossus (extending from the undersurface of the palate to the side of the tongue) and palatopharyngeus (extending from the undersurface of the palate to the lateral wall of the pharynx). The palatine tonsil is situated between the anterior and posterior arches.

The laryngopharynx

This extends from the oropharynx to the oesophagus. Anteriorly are the opening of the larynx and the posterior surfaces of the arytenoid and cricoid cartilages. The cavity extends forwards on each side of the larynx and the recesses so formed are the pyriform fossae. Each fossa is bounded laterally by the mucous membrane over the lamina of the thyroid cartilage and medially by the mucous membrane over the aryepiglottic folds and the arytenoid and cricoid cartilages. The lumen of the pharynx is narrowest near its union with the oesophagus, the cricopharyngeal sphincter.

Blood supply: Branches from the ascending pharyngeal, superior thyroid, lingual, facial and maxillary arteries. Venous blood passes through the pharyngeal venous plexus to the internal jugular vein.
**Nerve supply:** Mainly through the **pharyngeal plexus** on the outer surface of the middle constrictor. The plexus is formed by:

(i) Sensory fibres in pharyngeal branches of the glosso pharyngeal and vagus nerves.

(ii) The pharyngeal branch of the vagus carrying motor fibres from the nucleus ambiguus to all pharyngeal muscles except stylopharyngeus. The fibres to the stylopharyngeus pass from the nucleus ambiguus in the glosso pharyngeal nerve.

(iii) Branches from the cervical sympathetic chain.

The nasopharynx receives an added sensory supply from the pharyngeal branch of the maxillary nerve (through the pterygopalatine ganglion) and the laryngopharynx receives sensory branches from the internal and recurrent laryngeal nerves.

**Lymph drainage:** The nasopharynx drains to the retropharyngeal lymph nodes and the remainder of the pharynx to other nodes in the deep cervical lymph chain.

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**The Tonsil**

The tonsil (palatine tonsil) is a mass of lymph tissue situated in a fossa on the lateral wall of the faucial isthmus. It is variable in size, being usually larger in children. It is oval in shape, possessing upper and lower poles. The pitted medial surface is covered by stratified squamous epithelium and there is usually a well marked supratonsillar cleft between the upper pole and the superior wall of the fossa. The deep surface of the tonsil has a fibrous capsule and by this it is firmly attached antero-inferiorly (where vessels enter it) to its fossa. The tonsil is related anteriorly to the palatoglossal arch, posteriorly to the palatopharyngeal arch, superiorly to the soft palate and inferiorly to the tongue. Its medial surface projects into the oropharynx and the lateral surface lies on the superior constrictor which separates it from the facial artery and the carotid sheath.

**Blood supply:** Tonsillar branches from the facial, lingual and ascending pharyngeal arteries. Venous blood passes to the pharyngeal venous plexus.

**Lymph drainage:** To the deep cervical lymph chain especially the jugulodigastric node.

The palatine tonsil develops from the second pharyngeal pouch. Aggregations of lymph tissue surround the upper part of the pharynx: the palatine tonsil below the palate, the lingual tonsil in the posterior third of the tongue, the tubal tonsil around the opening of the auditory tube, and the pharyngeal tonsil (adenoids) beneath the mucous membrane of the roof and posterior wall of the nasopharynx. The palatine tonsils and adenoids are frequently enlarged in children as the result of recurrent throat infections. In some cases enlargement may interfere with breathing, phonation and, by blocking the auditory tube, with hearing. Surgical removal is then indicated.
The Auditory Tube

This passes from the lateral wall of the pharynx to the anterior wall of the middle ear. It is about 4 cm long and is directed upwards, backwards and laterally. The lateral third lies within the petrous temporal bone, the medial two-thirds is mainly cartilaginous but is completed inferiorly by fibrous tissue. The tube is lined by ciliated columnar epithelium with many mucous glands. It is supplied by the ascending pharyngeal artery and its veins pass to the pterygoid venous plexus. Its nerve supply is from the pharyngeal branch of the maxillary nerve and its lymph vessels pass to the retropharyngeal lymph nodes.

The tube serves to equalize the pressure on the two sides of the tympanic membrane. Salpingopharyngeus and tensor and levator veli palatini are attached to and pull on the medial part, and thus swallowing opens the tube. In the child the tube is wider and more horizontal, and infection is more likely to spread from the nasopharynx to the middle ear.

Styloid Muscles

The styloid process is a bony projection of the temporal bone; it gives attachment to three muscles and a ligament. The muscles are active in swallowing; they are described in their order of attachment from above downwards.

Stylopharyngeus descends between the internal and external carotid arteries and enters the pharynx between the superior and middle constrictors. It blends with the middle constrictor and is attached to the posterior border of the thyroid cartilage. It is supplied by the glossopharyngeal nerve. Stylohyoid descends to the hyoid bone, splitting around the intermediate tendon of digastric. It is supplied by the facial nerve. Styloglossus passes anteriorly between the internal and external carotid arteries and between the superior and middle constrictors to the side of the tongue. It is supplied by the hypoglossal nerve. The stylohyoid ligament passes from the tip of the styloid process to the lesser horn of the hyoid bone and gives attachment to the middle constrictor. The styloid process, the stylohyoid ligament and the lesser horn are remnants of the 2nd pharyngeal arch cartilage.

Development of the pharynx and pharyngeal (branchial) arches

In the walls of the primitive foregut, from which the pharynx develops, six pharyngeal arches are formed on each side. They are numbered from before backwards. The arches consist of a mesenchymal mass lined internally with pharyngeal endoderm and covered externally with ectoderm. The furrows between the arches externally form the pharyngeal clefts and internally the pharyngeal pouches. Each arch is supplied by a cranial nerve and a central artery joins the ventral and dorsal aortae. Its mesenchyme forms a cartilaginous bar and striated muscle. During early development the 5th arch is obliterated, while the others undergo considerable modification, contributing to the formation of the face, mouth, pharynx and larynx. The nerve of the 1st arch is the trigeminal; 2nd, the facial; 3rd, the glossopharyngeal; 4th, the superior laryngeal; and the 6th, the recurrent laryngeal nerves.
Arch derivatives

1. Ectodermal

The 1st pharyngeal cleft forms the external acoustic meatus. The other clefts are obliterated by an ectodermal fold from the 2nd arch (the operculum) growing caudally over them. If it remains unfused, a cervical sinus develops. Remnants may also persist as a congenital defect known as a branchial cyst.

2. Mesenchymal

(a) Cartilage: 1st arch - the malleus and incus, the sphenomandibular ligament and Meckel's cartilage; 2nd arch - the stapes, styloid process, stylohyoid ligament and the lesser horn and upper part of the body of the hyoid bone; 3rd arch - the greater horn and the lower part of the body of the hyoid bone; 4th and 6th arches - cartilages of the larynx.

(b) Muscle: 1st arch - the muscles of mastication and the tensor veli palatini and tensor tympani; 2nd arch - the muscles of facial expression and other muscles supplied by the facial nerve; 3rd arch - stylopharyngeus; 4th and 6th arches - muscles of the pharynx, soft palate and larynx.

(c) Arteries: The arteries form the paired aortic arches uniting the ventral and dorsal aortae. The 1st and 2nd arches disappear; the 3rd forms part of the common and internal carotid arteries; the 4th forms the subclavian artery on the right and the aortic arch on the left. The 6th arch forms the pulmonary arteries; on the right the artery loses its connection with the dorsal aorta but this persists on the left as the ductus arteriosus of the fetus.

3. Endodermal

The 1st pharyngeal pouch forms the auditory tube, the middle ear, and mastoid antrum; the 2nd pouch contributes towards the tonsil; the 3rd, the thymus and inferior parathyroid gland; and the 4th, the superior parathyroid gland and possibly the C-cells of the thyroid gland which produce calcitonin.

Modifications in the ventral parts of the upper arches in the floor of the mouth give rise to the tongue, the thyroid gland and the respiratory tube.

Deglutition

Swallowing (deglutition) is the act by which fluid or a bolus of food is passed from the mouth to the stomach. Radiological examination, using radiopaque material, has greatly helped in understanding the processes involved in swallowing.

The first stage (oral phase) is voluntary and involves passage of food from the mouth to the oropharynx. The mandible is fixed, with the teeth occluded, by the muscles of mastication. The tongue is tensed, by its intrinsic muscles, and raised by the palatoglossus and muscles acting on the hyoid bone (geniohyoid, mylohyoid, stylohyoid and digastric). The
tongue, from the tip backwards, is pressed against the hard palate so forcing the food into the oropharynx.

In the second stage (pharyngeal phase), which is largely involuntary, food is passed to the lower end of the pharynx. It is initiated by food touching the arches of the fauces, the soft palate, the posterior wall of the oropharynx or the epiglottis. It involves closing off the nasopharynx, closing off the larynx, cessation of respiration and shortening of the pharynx.

The pharyngeal isthmus is closed by tensing and raising the soft palate with tensor and levator veli palatini, and the simultaneous approximation of the walls of the pharynx to the posterior free border of the palate. The latter movement is produced by contraction of palatopharyngeus and the upper fibres of superior constrictor.

The larynx is closed by approximation of the epiglottis and arytenoid cartilages. Contraction of the aryepiglottic muscles is assisted by passive bending back of the epiglottis by the bolus of food. Liquids pass round the sides of the epiglottis. The larynx is raised by contracting the palatopharyngeus, salpingopharyngeus, stylopharyngeus and thyrohyoid muscles. The mucous membrane also rises, and when the larynx drops back some of the mucous membrane lags behind, so helping to close the opening. The pharynx is shortened by the pharyngeal muscles raising the larynx. The vocal folds are adducted and respiration is inhibited.

Finally food is passed by the inferior constrictor into the oesophagus. This stage (oesophageal phase) is involuntary and is initiated by food stimulating the walls of the lower pharynx and oesophagus. Peristaltic waves pass food on to the stomach. The soft palate and larynx return to their initial positions and respiration is recommended. When food is in the mouth, it can be spat out; in the oropharynx it can be coughed out; beyond this, it has to be vomited out.

The Larynx

This is part of the respiratory passage between the pharynx and the trachea. It forms a sphincter protecting the inlet of the trachea and includes the vocal folds. It is situated in the neck anterior to the laryngopharynx and opposite the 3rd-6th cervical vertebrae. A lobe of the thyroid gland and the carotid sheath lie on each side, and it is covered anteriorly by the infrahyoid muscles and the deep (investing) layer of fascia of the neck.

The skeleton of the larynx is formed of a number of cartilages which surround its lumen. These are the unpaired thyroid, cricoid and epiglottic and the paired arytenoid cartilages. Articulations occur at the cricothyroid and crico-arytenoid joints which are acted upon by the muscles of the larynx. The epiglottis and part of the arytenoid cartilages are yellow elastic cartilage, the rest are hyaline cartilage and tend to calcify in later adult life.

Cartilages

Thyroid cartilage - this comprises two thin quadrilateral laminae united anteriorly at an angle of 120° in the female and 90° in the adult male. The angle forms the median subcutaneous laryngeal prominence and above this the laminae are separated by the palpable
V-shaped **thyroid notch.** The free posterior border of each lamina extends superiorly and inferiorly as the superior and inferior horns respectively. On the outer surface of the lamina, an oblique line passes downwards and forwards from the superior horn to the inferior border. The inferior horn articulates with the cricoid cartilage.

The upper border of the cartilage gives attachment to the thyrohyoid membrane. The thyrohyoid, sternothyroid and inferior constrictor muscles are attached to the oblique line, and the palatopharyngeus, salpingopharyngeus and stylopharyngeus muscles to the posterior border. Cricothyroid is attached to the inferior horn and adjacent lower border of the lamina. To the posterior aspect of laryngeal prominence are attached the epiglottic cartilage above, and below it the vocal ligament, the thyroarytenoid muscle and the cricothyroid ligament.

**Cricoid cartilage** - this is situated at the lower border of the larynx and completely encircles it. It is the shape of a signet ring, possessing a broad posterior lamina and a narrow anterolateral arch. Each lateral surface has an articular facet for the inferior horn of the thyroid cartilage; the upper border of the lamina has two facets for the arytenoid cartilages.

To the upper border of the arch are attached the conus elasticus and the cricothyroid ligament; cricothyroid and lateral cricoarytenoid muscles are attached to the other lateral surfaces. The posterior cricoarytenoid muscle passes to the back of the lamina.

**Epiglottic cartilage (epiglottis)** - this is a leaf-shaped cartilage. Its narrow inferior end is attached to the back of the laryngeal prominence of the thyroid cartilage and its free broad upper end projects upwards behind the tongue. The sides gives attachment to the aryepiglottic membrane and the thyroepiglottic and aryepiglottic muscles. It is covered on its upper anterior and all its posterior surfaces by mucous membrane.

**Arytenoid cartilages** - each arytenoid cartilage is the shape of a three-sided pyramid, possessing medial, posterior and anterolateral surfaces; the base is inferior and articulates with the lamina of the cricoid. It projects anteriorly as the vocal process and laterally as the muscular process. The anterior border gives attachment to the aryepiglottic membrane; the muscular process to the lateral and posterior cricoarytenoid muscles; the vocal process, to the vocal ligament; the anterolateral surface, to the thyroarytenoid muscle. The aryepiglottic muscle passes to the apex and continues downwards and medially to the back of the cartilage of the opposite side as the oblique arytenoid muscle. The transverse arytenoid muscle passes between the posterior surfaces of the two cartilages.

**Joints, Membranes and Ligaments**

**Cricothyroid joints** - are plane synovial joints between the inferior horns of the thyroid cartilage and the lateral aspect of the cricoid. They possess a lax capsule. Rotary movement of the thyroid cartilage about the transverse axis through the two joints, and some anteroposterior gliding occur.

**Cricoarytenoid joints** - are plane synovial joints between the base of the arytenoid cartilages and the facets on the upper border of the cricoid lamina. Rotation and gliding of the arytenoid cartilages occur; lateral gliding is accompanied by downward displacement because of the obliquity of the joint.
Conus elasticus - this ligament is formed of yellow elastic tissue. Each half is triangular in shape, having an upper free border deep to the thyroid lamina and a lower attachment to the cricoid cartilage. In front it is continuous with the ligament of the opposite side. The union is reinforced anteriorly and forms the cricothyroid ligament. The upper free border of the conus extends from the back of the laryngeal prominence of the thyroid cartilage to the vocal process of the arytenoid cartilage and is thickened to form the vocal ligament. This is covered with mucous membrane and forms the vocal fold (true vocal cord).

Aryepiglottic (quadrangular) membrane - extends from the side of the epiglottis to the anterior border of the arytenoid cartilage. The free superior border forms the aryepiglottic ligament and the free inferior border the vestibular ligament. The lower thickening forms the vestibular fold (false vocal cord).

Thyrohyoid membrane - is a fibrous membrane uniting the upper border of the thyroid cartilage to the inferior surface of the body and greater horns of the hyoid bone. Between the hyoid bone and the membrane is a small midline bursa. The lateral extremities of the membrane are thickened to form the lateral thyrohyoid ligaments. The membrane is pierced by the superior laryngeal artery and the internal laryngeal nerve.

Muscles

With the exception of the transverse arytenoid these are paired muscles.

Cricothyroid - extends from the inferior horn and adjacent lower border of the thyroid cartilage to the outer anterolateral surface of the cricoid.

Posterior cricoarytenoid - passes from the posterior surface of the lamina of the cricoid to the muscular process of the arytenoid.

Lateral cricoarytenoid - passes from the outer lateral surface of the cricoid arch to the muscular process of the arytenoid.

Transverse arytenoid - is attached to the posterior surface of both arytenoid cartilages.

Aryepiglottic - passes from the lateral border of the epiglottis along the upper border of aryepiglottic membrane to the apex of the arytenoid cartilage. The muscle continues to the back of the arytenoid of the opposite side and is here called the oblique arytenoid muscle.

Thyroarytenoid - passes from the back of the laryngeal prominence along the outer surfaces of the conus elasticus to the anterolateral surface of the arytenoid cartilage. Some fibres are attached to the free border of the ligament and form the vocalis muscle, other pass upwards to the side of the epiglottis forming the thyroepiglottic muscle.

Interior Of The Larynx

The superior opening of the larynx is bounded anteriorly by the epiglottis, laterally by the aryepiglottic folds, and posteriorly by the apices of the arytenoid cartilages and the
transverse arytenoid muscle. Within the larynx two pairs of parallel horizontal folds are present in the lateral walls. The upper is the vestibular fold (false vocal cord), the lower is the vocal fold (true vocal cord). The gap between the vocal folds is known as the **rima glottidis**. A lateral recess of mucous membrane between the vestibular and vocal folds is known as the **sinus** of the larynx. This is large in some mammals but is rarely so in humans.

**Blood supply:** Laryngeal branches of the superior and inferior thyroid arteries and their accompanying veins.

**Nerve supply:** The mucous membrane is supplied by the internal laryngeal nerve above the vocal folds and the recurrent laryngeal nerve below. The former enters the larynx by piercing the thyrohyoid membrane, the latter by ascending posterior to the cricothyroid joint and deep to the inferior constrictor muscle. Cricothyroid is supplied by the external laryngeal nerve, the other muscles by the recurrent laryngeal nerve.

**Lymph drainage:** Efferent vessels pass to both upper deep cervical and pretracheal nodes.

**Histology:** The vocal folds are lined by stratified squamous epithelium; the larynx above and below is lined by respiratory epithelium.

**Embryology:** The pulmonary diverticulum arises ventrally in the pharyngeal floor between the 4th and 6th arches. It passes caudally in front of the oesophagus. The larynx develops from the cartilages and muscles of the 4th and 6th pharyngeal arches. The cricoid may be a modified tracheal ring; it is the only complete cartilaginous ring in the respiratory tract.

**Movements Of The Larynx**

During vocalisation movements of the thyroid and arytenoid, cartilages alter the length, tension and position of the vocal folds. In swallowing, the whole larynx is raised and then lowered, and the epiglottis is approximated to the arytenoid cartilages.

(a) **Movements of the thyroid cartilage** - forward rotation at the cricothyroid joints lengthens the vocal folds and is produced by cricothyroid; the movement is reversed by thyroarytenoid.

(b) **Movements of the arytenoid cartilages** - occur at the cricoarytenoid joints, and are gliding and rotatory.

(i) **Gliding** - lateral gliding separates the cartilages, thus abducting the vocal folds and producing an inverted V-shaped rima glottidis. The combined action of the lateral and posterior cricoarytenoid muscles are involved, and counteracted by the transverse arytenoid muscle.

(ii) **Rotation** - lateral rotation separates the vocal process and thus abducts the vocal folds. In this case a <>-shaped rima glottidis is produced. The movement is produced by
posterior cricoarytenoid and counteracted by lateral cricoarytenoid. The posterior cricoarytenoid is the only muscle which, acting alone, abducts the vocal folds.

(c) *Vocalis increases the tension* in the vocal fold.

(d) *Raising and lowering the larynx:* The larynx is raised by palatopharyngeus, salpingopharyngeus, stylopharyngeus and thyrohyoid. It is lowered by the infrahyoid muscles aided by gravity.

(e) *Approximation of the epiglottis to the arytenoid cartilage* may be produced by the aryepiglottic muscles but probably occurs passively in swallowing.

The larynx functions as a sphincter and in vocalisation. Direct visualisation of the region is possible with the help of a laryngoscope. The sphincter action prevents food entering the trachea and also closes the larynx when increased intrathoracic pressure (eg, before coughing) or intra-abdominal pressure (eg, in micturition, defaecation, vomiting) is required. Sound is produced by columns of air passing through the larynx, usually in expiration. The frequency of the sounds emitted varies with the movement, length and tension of the vocal folds, and the intensity with the volume of air expired. The resonance of the sound is increased by the large spaces in the lungs, pharynx, mouth and nose. Hoarseness or loss of voice may result from improper function of the laryngeal muscles.

An incision through the skin, cervical fascia and the cricothyroid membrane, enters the larynx below the true vocal cords. It provides an alternative to tracheostomy when inserting an artificial airway, for example in acute upper respiratory obstruction. This is particularly so in children, where the relatively short neck makes the upper trachea less accessible. A tracheostomy may also be used to assist ventilation, allow bronchial toilet, to decrease the dead space and as an elective procedure before head and neck surgery.