# INTRODUCTION

Laryngeal cancer accounts for approximately one quarter of the head and neck malignancies worldwide, and the overall survival, disease free survival and laryngeal reservation are largely determined by the initial tumor stage at the time of the diagnosis ***(Agrawal and Ha, 2008).***

A vast majority of these cancers are squamous cell carcinoma (SCC). Tobacco smoking and alcohol consumption are important risk factors for laryngeal SCC, those patients have a higher risk for synchronous malignancies arising from the lung and aerodigestive tract ***(Agrawal and Ha, 2008).***

Early identification of malignant laryngeal neoplasms results in improved prognosis and functional outcomes. Imaging plays an integral role in the diagnosis, staging and long term follow up of cancer larynx ***(Agrawal and Ha, 2008).***

Cross sectional imaging with contrast enhanced CT allows excellent depiction of the entricate anatomy of the larynx and the characteristic pattern of submucosal tumor extension. It also provides vital information about the status of cervical nodal disease, systemic metastasis and any synchronous malignancies as well as post therapeutic tumor recurrence in these patients. Additionally, certain image based parameters like tumor volume and cartilaginous abnormalities have been used to predict the success of primary radiotherapy or surgery in these patients ***(Anderson et al, 2008).***

# Aim of the Work

This study aims at evaluating the diagnostic potentials and limitations of ultrasonography as an imaging technique used to diagnose and assess the extent of cancer larynx compared to computed tomography trying to spare to the patient its hazardous high dose of radiation exposure.

Chapter I

# ANATOMY OF THE LARYNX

The larynx, called the voice box, is an organ in the top of the neck of tetrapods ***(Online Etymology Dictionary, 2015)***.

The ancient Greek physician Galen described the larynx, as the "first and most important instrument of the voice" ***(Ferreti et al., 2015)***.

**Location:**

In adult humans, the larynx is a 2 inches long organ found in the anterior aspect of the neck at the level of the C3–C6 vertebrae. It connects the hypopharynx to the trachea ***(Ferreti et al., 2015).***

In newborn and infants, the larynx is initially at the level of the C2–C3 vertebrae, and is further forward and higher in position relatively in the adult body ***(Ferreti et al., 2015)***.

**Structure:**

The laryngeal skeleton consists of six cartilages: **three single** (epiglottic, thyroid and cricoid) and **three paired** (arytenoid, corniculate, and cuneiform). The hyoid bone is not a part of the larynx, although the larynx is suspended from the hyoid. The larynx extends vertically from the tip of the

epiglottis to the inferior border of the cricoid cartilage. Its interior is divided in supraglottis, glottis and subglottis ***(Ross and Pawlina, 2010).***

**Cartilages**:

**1. *Cricoid cartilage*:**

The cricoid cartilage is the only complete ring of cartilage in the larynx, formed of hyaline cartilage located at the inferior part of the larynx. It has the shape of a "signet ring," with a broad portion posteriorly (lamina of cricoid cartilage) and a narrower portion circling anteriorly (arch of cricoid cartilage). The posterior surface of the lamina contains 2 oval depressions, which serve as sites of attachment for the posterior cricoarytenoid muscles, separated by a vertical midline ridge that serves as an attachment to the esophagus.

The lower border of the cricoid cartilage is seen connected to the first tracheal ring by the cricotracheal ligament ***(Ross and Pawlina, 2010).***

**2. *Thyroid cartilage*:**

The thyroid cartilage is the largest of all the laryngeal cartilages. It is formed by right and left lamina that are separated posteriorly and joined together in the anterior midline at an acute angle, forming the laryngeal prominence, commonly known as the Adam's apple. The laryngeal prominence is more

apparent in men, because the angle between the 2 laminae is more acute in men (90°) compared to women (120°).

The 2 laminae are quadrilateral in shape and form the lateral surfaces of the thyroid cartilage that extend obliquely to cover the sides of the trachea ***(Ross and Pawlina, 2010).***

The posterior aspect of each lamina is elongated to form a superior horn and inferior horns. The medial surfaces of the inferior horns articulate with the outer posterolateral surface of the cricoid cartilage. The superior horn with the entire superior edge of the thyroid cartilage is attached to the hyoid bone by the thyrohyoid membrane ***(Ross and Pawlina, 2010).***

### *3. Epiglottis:*

The epiglottis is a leaf like shaped cartilage that moves down to form a lid over the glottis and protect the larynx from aspiration of foods or liquids during swallowing. It is attached by its stem to the inner aspect of the thyroid cartilage at the midline, about halfway between the angle of the laryngeal prominence and the inferior notch ***(Ross and Pawlina, 2010)***.

It is attached by the thyro-epiglottic ligament and projects postero-superiorly to cover the superior opening of the larynx. The midline of the superior surface of the epiglottis is also attached to the body of the hyoid bone by the hyoepiglottic ligament. The mucous membrane covering the upper anterior part of the epiglottis reflects over the sides of the epiglottis,

giving rise to the glosso-epiglottic folds ***(Ross and Pawlina, 2010).***

The aryepiglottic folds are mucosal folds on the posterior surface of the epiglottis. The depressions on either side of the median fold, between the root of the tongue and the epiglottis, are called the valleculae epiglottica ***(Ross and Pawlina, 2010)***. (See figure 1)

***4. Arytenoid cartilages*:**

The arytenoid cartilages form the part of the larynx to which the vocal ligaments and vocal folds are attached. They are pyramidal in shape and have 3 surfaces, an apex and a base. They are located superior to the cricoid cartilage in the posterior part of the larynx, with their bases articulating on either side to the upper border of the cricoid lamina ***(Ross and Pawlina, 2010)***.

The posterior surface of the arytenoid cartilage gives attachment to the arytenoid muscle. The anterolateral surface has 2 depressions for attachment to the false vocal cord (vestibular ligament) and the vocalis muscle. The apex of the cartilage is pointed and articulates with the corniculate cartilage ***(Ross and Pawlina, 2010)***.

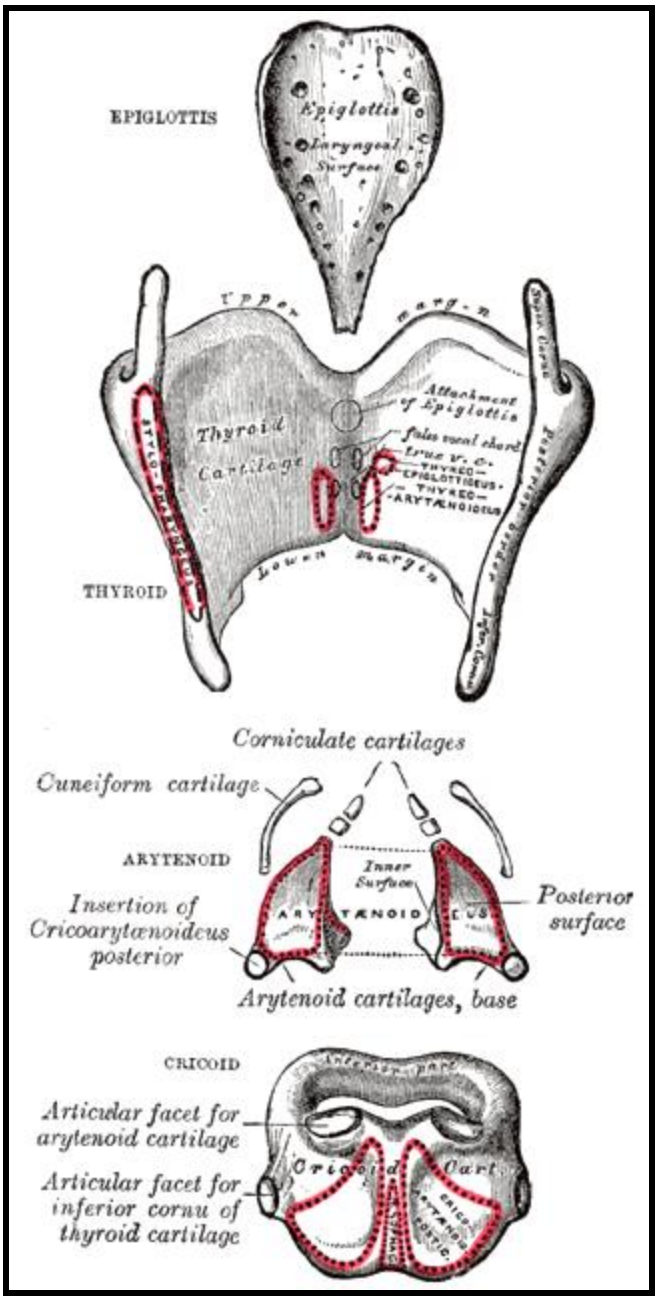


**Figure (1):** Cartilages of the larynx.

### *5. Corniculate cartilages*:

The corniculate cartilages are 2 small, conical cartilages that articulate with the apices of the arytenoid cartilages to extend them posteriorly and medially. They are located in the posterior parts of the aryepiglottic folds ***(Ross and Pawlina, 2010)***.

### *6.* Cuneiform cartilages:

The cuneiform cartilages are 2 small, club-shaped cartilages that lie in the aryepiglottic folds, anterior to the corniculate cartilages. They form small, whitish elevations on the surface of the mucous membrane anterior of the arytenoid cartilages ***(Ross and Pawlina, 2010)***. (See figure 2).

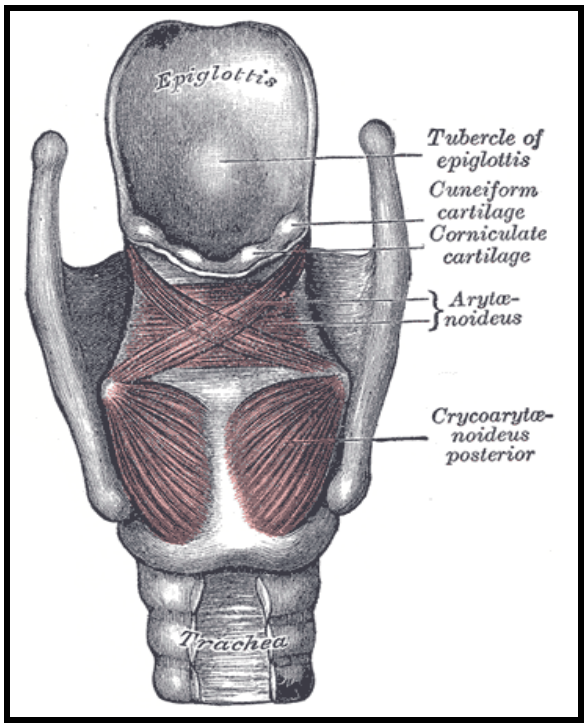


**Figure (2):** Cartilages of the larynx.

## Ligaments of the larynx:

### *Extrinsic ligaments*:

The thyrohyoid membrane is a broad fibroelastic ligament stretched between the superior border of the thyroid cartilage and the hyoid bone above. It contains an aperture on the lateral surfaces of each side for the superior laryngeal neurovascular bundle and lymphatics.

The hyoepiglottic ligament extends from the midline of the superior surface of the epiglottis to the body of the hyoid bone, located antero-superiorly. The cricotracheal ligament connects the lower border of the cricoid cartilage to the upper border of the first tracheal ring ***(Standring, 2008).*** (See figure 3)

### *Intrinsic ligaments*:

The conus elasticus is a submucosal membrane that extends superiorly from the anterior arch of the cricoid cartilage and attaches to the thyroid cartilage anteriorly and the vocal processes of the arytenoid cartilages posteriorly. The free superior margin of the conus elasticus is thickened to form the vocal ligament, which forms the vocal folds (true vocal cords) covered by mucosa ***(Standring, 2008).***

The quadrangular membrane extends between the lateral aspects of the epiglottis and the anterolateral surface of the arytenoid cartilages on each side. The free lower inferior margin of this membrane is thickened forming the vestibular

ligament, which forms the vestibular folds (false vocal cords) when covered by mucosa ***(Standring, 2008).***

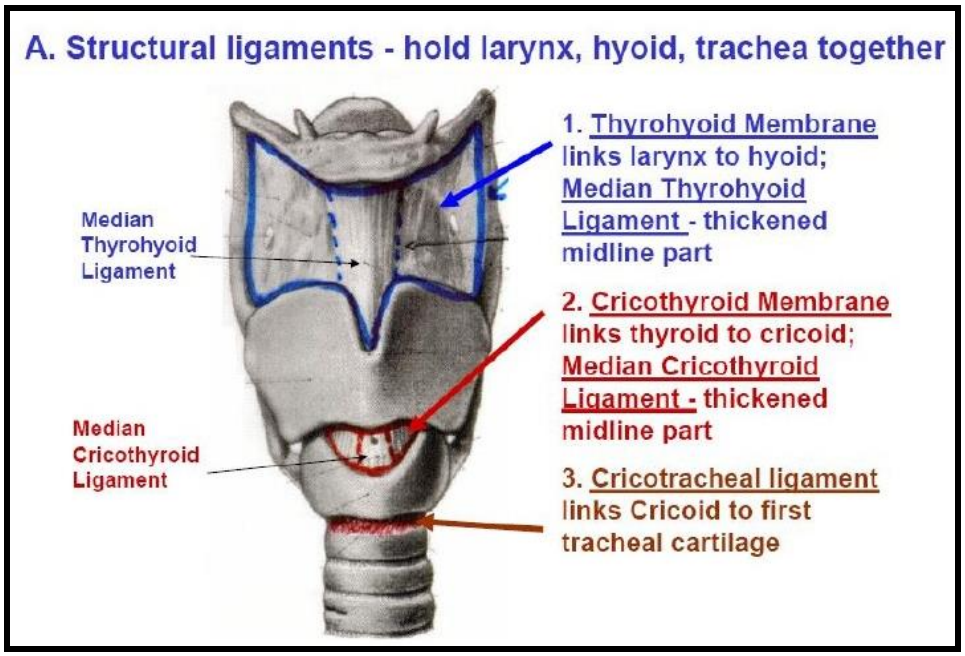


**Figure (3):** Ligaments of the larynx.

## Cavities of the larynx:

### *1. Laryngeal cavity:*

The laryngeal central cavity is tubular in shape and lined with mucosa. The superior aspect of the cavity (laryngeal inlet) opens into the pharynx, infero-posterior to the tongue. The inferior aspect of the cavity is continuous with the lumen of the trachea ***(Standring, 2008).***

The laryngeal cavity may be divided into 3 regions: **the vestibule, the middle**, and **the infraglottic space**. The vestibule is the upper part of the cavity, in between the

laryngeal inlet and the vestibular folds. The middle portion of the cavity is formed by the vestibular folds above and the vocal folds below. The infraglottic space is the lower segment of the cavity, in between the vocal folds and inferior opening of the larynx into the trachea ***(Standring, 2008).***

***2. Laryngeal ventricles and saccules*:**

On either side of the middle laryngeal cavity, between the vestibular and vocal folds, the mucosa bulges laterally to form cavities known as the laryngeal ventricles. The laryngeal saccules are tubular extensions of each ventricle antero-superiorly between the vestibular fold and the thyroid cartilage. The walls of these saccules contain many mucous glands that lubricate the vocal folds ***(Standring, 2008).***

***3. Rima vestibuli and rima glottidis*:**

The rima vestibuli is the triangular-shaped opening between the 2 vestibular folds. The apex lies anterior and the base is formed by the posterior wall of the laryngeal cavity. The rima glottidis is a narrower, triangular-shaped opening that lies beneath the rima vestibuli, formed by the 2 adjacent vocal folds ***(Standring, 2008).*** (See figure 4)

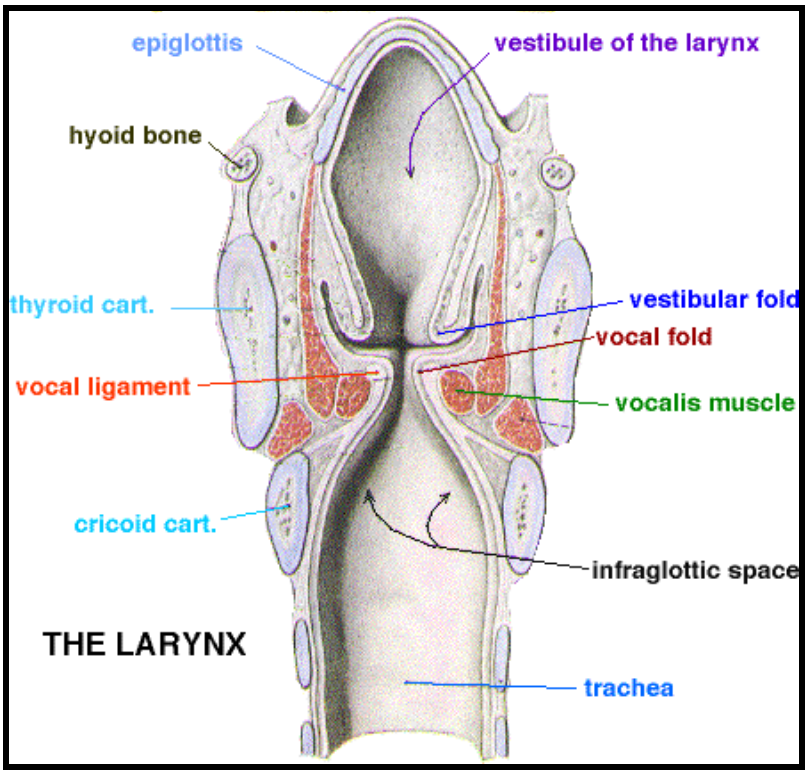


**Figure (4):** Cavities of the larynx.

## Muscles of the larynx:

### *1. Cricothyroid muscles*:

These muscles elevate the anterior arch of the cricoid cartilage and depress the posterior portion of the thyroid cartilage lamina. This produces tension and elongation of the vocal cords, resulting in higher-pitch phonation ***(Merati and Bielamowicz, 2006).***

### *2. Posterior cricoarytenoid muscles*:

The posterior cricoarytenoid muscles rotate the arytenoid cartilages laterally, thereby abducting the vocal cords. Their

action opposes that of the lateral cricoarytenoid muscles ***(Merati and Bielamowicz, 2006).***

### *3. Lateral cricoarytenoid muscles*:

The lateral cricoarytenoid muscles rotate the arytenoid cartilages medially, thereby adducting the vocal cords ***(Merati and Bielamowicz, 2006).***

### *4. Transverse arytenoid muscle*:

The transverse arytenoid muscle is a single muscle that extends between the posterior surfaces of each arytenoid cartilage. Its main function is adduction of the vocal cords ***(Merati and Bielamowicz, 2006).***

### *5. Thyroarytenoid muscles*:

They adduct the vocal folds and narrow the rima glottis ***(Merati and Bielamowicz, 2006).*** (See figure 5)

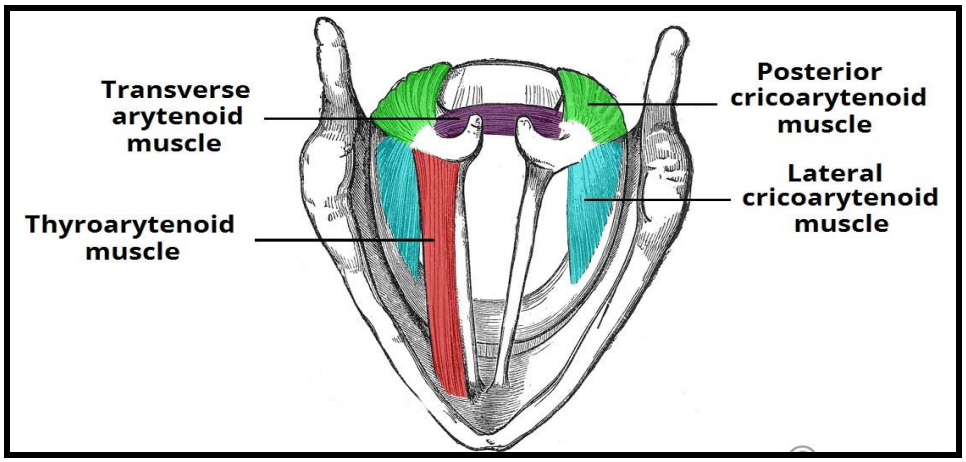


**Figure (5):** Extrinsic muscles of the larynx.