# Introduction

Head and neck cancer includes malignant tumors arising from a variety of sites in the upper aerodigestive tract. The most common histologic type is squamous cell carcinoma, and most common sites are the oral cavity, the oropharynx, the hypopharynx and the larynx. Worldwide, squamous cell carcinoma of the head and neck is the sixth most common neoplasm, and despite advances in therapy, long-term survival in those patients is poor. Primary surgery followed by chemoradiation, or primary chemoradiation, are the standard treatment options for patients with locally advanced (stages 3–4b) squamous cell carcinoma **(Cripps *et al.*, 2010)**.

Limited mobility of the vocal folds is a subjective term but includes those situations in which there is still a suggestion of movement during phonation or inspiration. Limitation can be caused by weight of a bulky tumor or moderate degree of invasion of the thyroarytenoid muscle by cancer or extension of the growth along the superior surface of the vocal fold **(Kirchner, 1977).**

There are different mechanisms of vocal fold fixation, in supraglottic carcinoma the most frequent cause of fixation of the ipsilateral vocal fold is a deep massive tumor invasion of the arytenoids eminence and the second most frequent cause is an extensive invasion into the thyroarytenoid muscle. On the other hand vocal fold fixation in cases of glottic carcinoma is caused by extensive thyroarytenoid muscle involvement **(Hirano *et al.*, 1991).**

The primary goal in treating laryngeal and hypopharyngeal squamous cell carcinoma is to achieve local control of the tumor while preserving functions of speech and swallowing without a permanent tracheostomy **(DeSanto *et al.*, 1995).**

From the time the first laryngectomy was performed by Billroth in 1873, multiple drives have been made to find effective surgeries in order to avoid total laryngectomy. During the twentieth century, ENT practitioners have focused their efforts on developing partial surgeries instead of total laryngectomy. Toward the end of the fifties, most partial laryngectomy techniques were pretty well established, but were used for incipient lesions (T1 and T2). However, those partial surgeries were not indicated as priority for advanced tumors (T3 or T4). From then on, new surgical procedures are evolving for large T2 and T3 tumors **(Lefebvre, 2006).**

Various conservative laryngeal resection procedures have been described for this purpose. Traditionally, preservation of cord mobility is necessary in order to perform partial laryngectomy procedures such as supraglottic or supracricoid laryngectomy **(Sparano *et al.*, 2005).**

Nonsurgical approaches to preservation of the larynx in the treatment of laryngeal carcinoma include either radiation alone or chemotherapy and radiation in combination. In light of the common use of total laryngectomy, these nonsurgical approaches have often been referred to as "organ-preservation" strategies **(Weinstein, 2001).**

Many studies have been performed in order to widen the indications for conservative procedures. Much of the knowledge is gained through the studies of whole-organ sections of the laryngectomy specimens, which are compared with the preoperative examination of the individual cases **(Katilmiş *et al.*, 2007).**

# Aim of the study:

The objective of the present study is to verify histopathologically vocal fold's muscular infiltration in cases of cancer larynx with impaired or fixed vocal fold in an attempt to assess the possibility of conservation surgery instead of total laryngectomy.

# 1. Anatomy

## 1.1Embryology of the larynx:

The larynx develops from cranial most part of laryngotracheal diverticulum. The lining epithelium is derived from endoderm of the diverticulum. These endodermal cells proliferate and completely obliterate the lumen of the larynx. Later on the cells in the lumen breakdown and recanalization of the larynx takes place. During recanalization the endodermal cells form two folds; these are the ventricular folds and vocal folds extending anteroposteriorly in the lumen of the larynx.

The supraglottic larynx is derived from the buccopharyngealprimordium, which develops from the third and fourth branchial arches. The glottis and subglottis are derived from the tracheobronchial primordium from the sixth branchial arch and are formed by the union of lateral furrows that develop on each side of the tracheobronchial primordium. Therefore the larynx has a dual blood supply and lymphatic drainage **(Armstrong and Netterville, 1995).**

The supraglottis arises from the buccopharyngealprimordium (arch 3 and 4) without a midline merger, suggesting the risk of bilateral neck disease, because no midline barrier occurred. Also, the inferior extent of supraglottis is the inferior false vocal cord and the ventricle is an anatomic barrier to the supraglottic tumor spread. In the past, it was thought that according to the embryologic compartmentalization theory, the embryologic fusion planes form an embryologic barrier that prevent supraglottic tumors from crossing the laryngeal ventricle and involve the true vocal cord. However, recently it was evident that incidence of spread of supraglottic carcinoma to the glottic level is between 20% and 54%, most commonly through the paraglottic space producing transglottic carcinoma independent of ventricular invasion **(Weinstein *et al.*, 1995).**

The glottic region is formed by paired structures that fuse in the midline. Therefore, lymphatics drain unilaterally. The vocal folds have sparse lymphatics. Therefore, glottis cancers must invade deeply before getting access to lymphatic channels. These factors explain the lower incidence of lymphatic metastasis in glottic SCC, as well as the propensity for unilateral metastases **(Tucker and Smith, 1962).**

Cartilages of the larynx develop from the $4^{th}$ and $6^{th}$ arch mesoderm. The fourth and sixth arch cartilages form the various cartilages of the larynx including thyroid, cricoid, arytenoid, corniculate and cuneiform cartilages. The epiglottis develops from the caudal part of the hypobranchial eminence **(Sudhir, 2008).**

The muscles of the larynx develop from the mesoderm of 4$^{th}$ and 6$^{th}$ pharyngeal arches. Therefore these muscles are supplied by nerve of the 4$^{th}$ arch (superior laryngeal) and 6$^{th}$ arch (recurrent laryngeal nerve)**(Sudhir, 2008)**

## 1.2 Intrinsic laryngeal muscles:

The intrinsic muscles of the larynx are responsible for altering the length, tension, shape, and spatial position of the vocal folds by changing the orientation of the muscular and vocal processes of the arytenoids with the fixed anterior commissure. Traditionally, the muscles are categorized into vocal fold adductors, abductor and tensor muscles **(Rosen and Simpson, 2008).** All the intrinsic muscles of the larynx are supplied by the recurrent laryngeal nerve except the cricothyroid, which is supplied by the external branch of the superior laryngeal nerve **(Beasley, 2008).**

It may be helpful to think of two sets of three muscles. One set is associated with the quadrangular membrane and includes the thyroarytenoid, thyroepiglottic, and aryepiglottic muscles. The other set acts on the arytenoid cartilage and consists of the posterior cricoarytenoid, lateral cricoarytenoid, and interarytenoid muscles (transverse arytenoid and oblique arytenoid). Another muscle, the vocalis, is a longitudinally arranged group of muscle fibers paralleling the vocal fold, although in reality these fibers are probably part of the thyroarytenoid muscle (Figure 1) **(Cummings *et al.*, 1998).**

According to their main actions, the laryngeal musculature may be divided into three functional groups:

(i) Muscles varying the rima glottides (which may be subdivided into constrictors and a single dilator); which are Lateral cricoarytenoid, transverse arytenoid, thyroarytenoid and posterior cricoarytenoid.

(ii) Muscles regulating tension in the vocal ligaments; which are cricothyroid, thyroarytenoid/vocalis and posterior cricoarytenoid.

(iii) Muscles modifying the laryngeal inlet (the so-called ‘sphincter aditus’) which are oblique arytenoid, thyroepiglottic and aryepiglottic muscles **(Pretterklieber, 2003).**

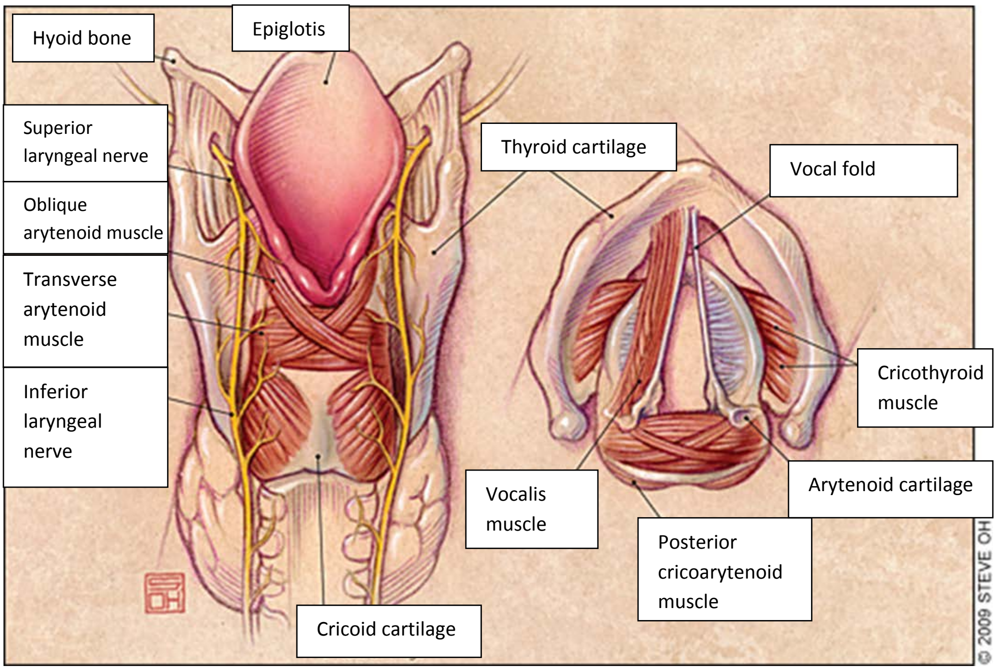


Figure 1: Shows intrinsic muscles of the larynx from different views **(Feierabend and Shahram, 2009)**

## ***1.2.1 Cricothyroid Muscle:***

Cricothyroid is the only intrinsic muscle that lies outside the cartilaginous framework of the larynx **(Beasley, 2008).** The cricothyroid muscle does not attach to the arytenoid cartilages and thus can act only indirectly on the vocal folds. They are positioned along the lateral aspects of the cricoid cartilage, with fibers running dorsoventrally. The cricothyroid muscle approximates the thyroid and cricoid cartilages ventrally toward each other via rotation of the synovial cricothyroidjoint. This movement causes tension of the vocal folds as the connection between the arytenoid cartilages and thyroid cartilage is stretched (Figure 2, 5) **(Thomas and Staecker., 2006).**

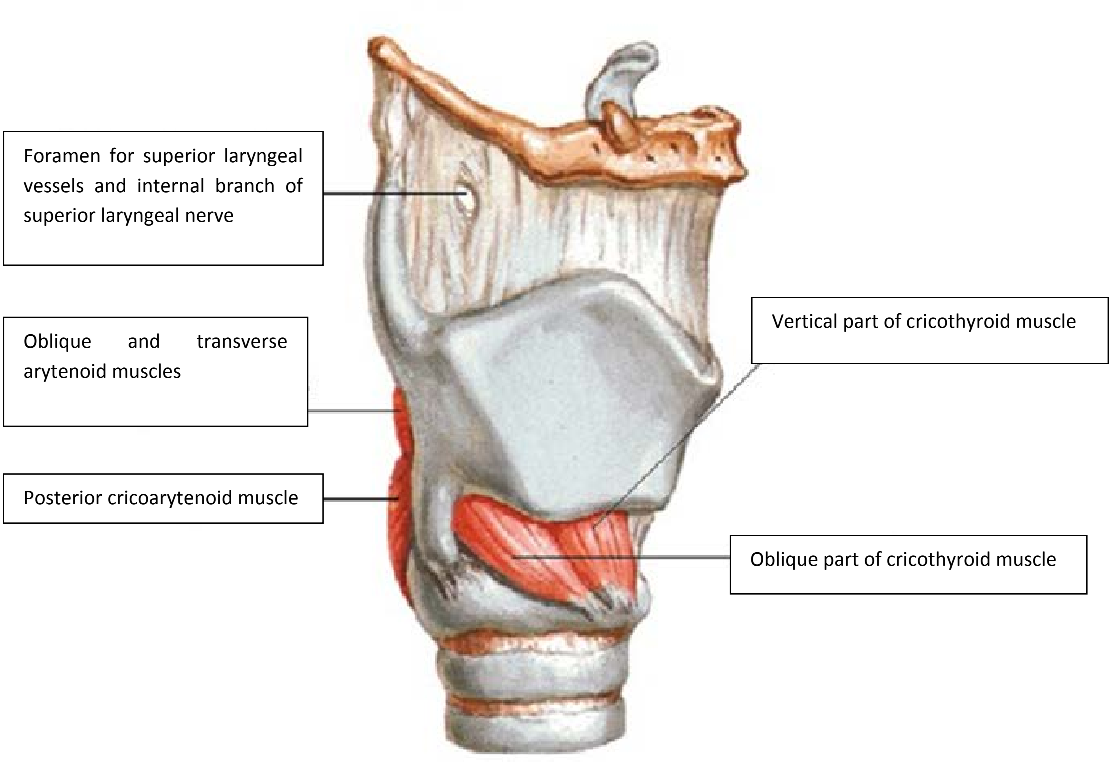


Figure 2: Shows intrinsic muscles of the larynx from right lateral view. **(Netter, 2006)**

### ***1.2.2 Thyroarytenoid Muscle:***

The thyroarytenoid muscle consists of two main muscle bellies, the internus and the externus. The thyroarytenoidexternus inserts anteriorly at the anterior commissure (Broyles' ligament), and posterolaterally on the lateral surface of the arytenoid. During contraction of this portion of the muscle, the vocal process is brought closer to the anterior commissure and the vocal folds are shortened and adducted. The thyroarytenoidinternus arises from the anterior commissure and inserts onto the vocal process of the arytenoid cartilage. During contraction, the vocal folds are shortened and thickened. This portion of the thyroarytenoid is also known as the vocalis muscle. In isolation, this action serves to lower the resonant frequency of the vocal folds. In most cases, there is a significant superior extension of the thyroarytenoid muscle into the false vocal folds, often referred to as the ventricularis muscle (Figure 3, 5) **(Rosen and Simpson, 2008).**

The thyroepiglottic muscle has been observed in 86 % of human individuals and may be regarded as an upward elongation of the thyroarytenoid muscle into the lateral edge of the epiglottis. The compound sphincter of the laryngeal inlet is counteracted by the thyroepiglottic muscles, which widen the inlet by abducting the aryepiglottic folds (Figure 3) **(Bannister *et al.*, 1995).**

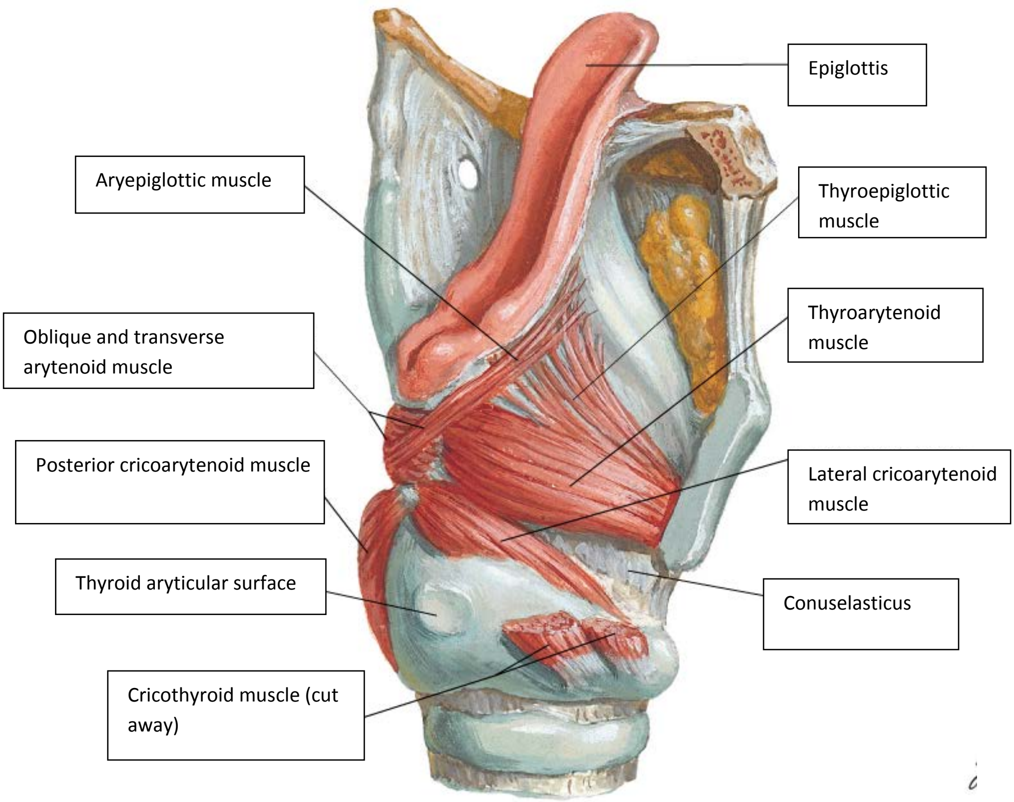


Figure 3: Shows intrinsic muscles of the larynx (lateral dissection) **(Netter, 2006)**

## ***1.2.3 Cricoarytenoid Muscles:***

The cricoarytenoid muscles arise, as their name implies from either the posterior or the lateral surface of the cricoid cartilage and insert on the arytenoid cartilage. The muscles are somewhat fan shaped, with the apex of their fibers inserting on the muscular process of the arytenoid cartilage. The origin of the posterior cricoarytenoid muscle is quite expansive, essentially covering the entire posterior aspect of the cricoid lamina. The fibers arising from the more superior aspect tend to be horizontal (superomedial belly), whereas those arising from the inferior aspect of the lamina have a more oblique course (inferolateral belly) (Figure 4) **(Bryant *et al.*, 1996).**

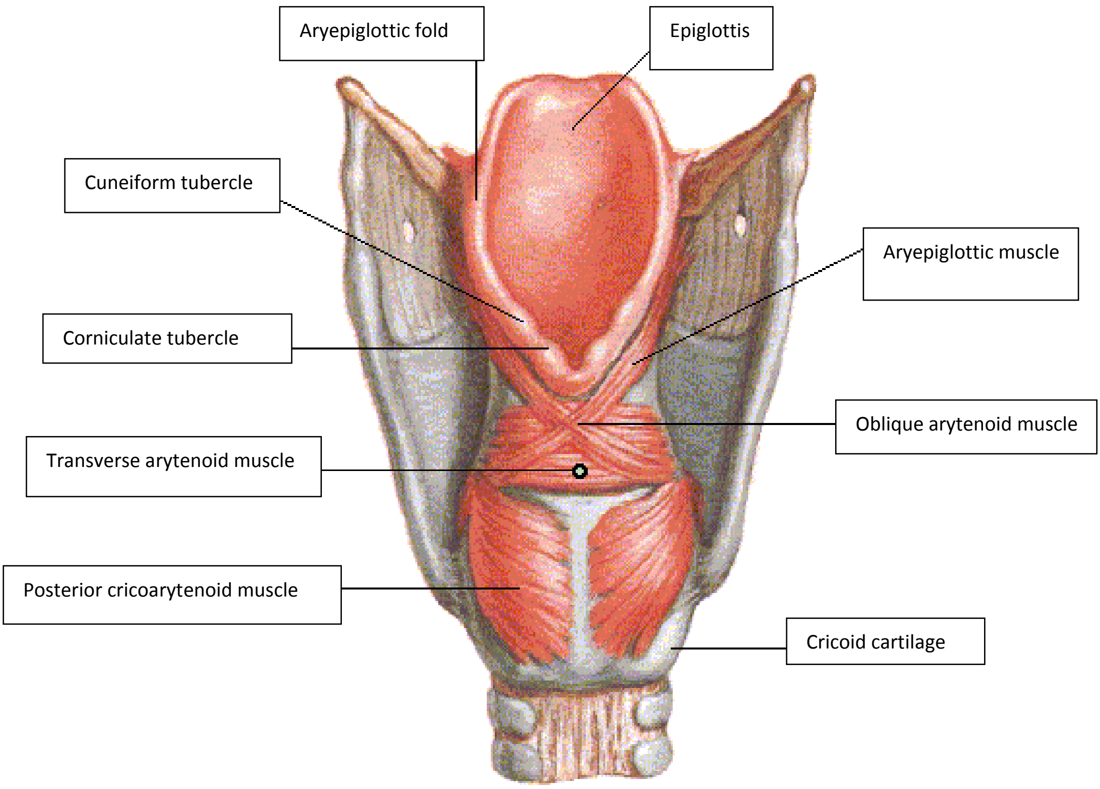

Figure 4: Shows intrinsic muscles of the larynx from posterior view **(Netter, 2006)**

The superomedial belly, when contracting, rotates the arytenoid cartilage laterally around an oblique ascending axis through the cricoarytenoid joint (the so-called ‘rocking motion’) **(Prades*et al.*, 2000).** It also draws the arytenoid cartilage backwards and thus increases the tension of the vocal ligament, assisting the cricothyroid muscle. The inferolateral belly represents the true laryngeal dilator, for its ascending fibres draw the arytenoid cartilages laterally by a sliding motion and thus widen the rima glottides (Figure 5) **(Bryant *et.al.*, 1996).**