LARYNGOTRACHEAL STENOSIS

ESSAY

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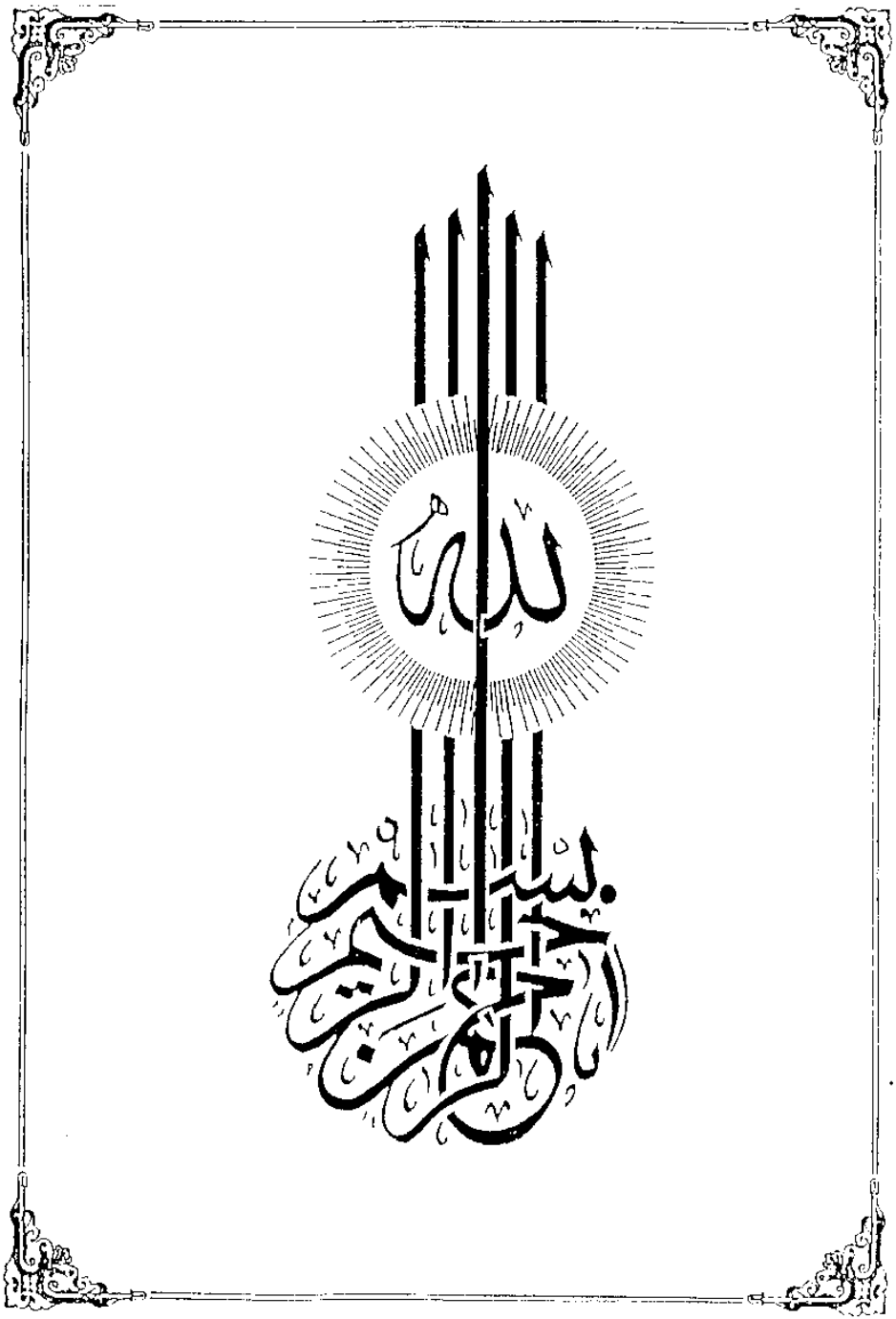

TO MY WIFE AND SON

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INTRODUCTION

LARYNGOTRACHEAL STENOSIS

Introduction

Stenosis of the larynx and/or trachea can present perplexing problems. While not new, these clinical entities now most often result from different causes than previously. But whatever the cause, the clinical problems are the same. The surgeon facing them must select the most effective method in their management.

The available methods are of 2 general categories: First, endoscopic methods which include traditional dilatations and newer techniques utilizing stents and laser excision of stenotic areas, all having the advantage of lessened morbidity.

Second, open surgical methods which involves excision of stenotic lesions followed by reconstruction, but require perhaps greater costs in time and resources, with greater potential morbidity.

Both methods can be effective if used properly.

The aim of this essay is to review the etiology and management of stenosis of the larynx and trachea.

ANATOMY & PHYSIOLOGY

DEVELOPMENT OF THE LARYNX AND TRACHEA

The rudiments of the respiratory tree appear in the 4th week as a midline ventral respiratory diverticulum of the foregut known as the laryngotracheal groove, which is first posterior to the hypobranchial eminence. The groove deepens and its lips fuse to form a septum converting the groove into a tube anterior to the oesophagus. Fusion starts at the caudal end and extends cranially but does not involve the cranial end of the groove, leaving a small orifice just behind the hypobranchial eminence. The orifice represents the primitive aditus of the larynx, through which the tube opens in the pharynx. The endodermal lining of the tube develops to be the epithelial lining of the respiratory tract.

The larynx develops from the cranial end of the laryngotracheal tube, it is bounded ventrally by the caudal part of the hypobranchial eminence and on each side by the ventral ends of the sixth arch. The succeeding part of the tube forms the trachea while from its caudal end two lateral out growths arise and form the stem bronchi and the right and left lung buds.

Two arytenoid swellings appear on either side of the groove cranially, and a small cleft is present between them which usually remains occluded until the third month of intrauterine life. The two swellings enlarge, become approximated to each other and to the caudal part of the hypobranchial eminence, and from it develops the epiglottis.

As the arytenoid swellings enlarge, they convert the slit laryngeal opening into a "T" shaped cleft, the arytenoid swellings lie on either sides of the vertical limb while the epiglottis is separated from the arytenoids by the horizontal limb.

With the upgrowth of the arytenoid swellings and the deepening of the primitive aryepiglottic folds forming the

walls of the vestibule, a new definitive aperture is formed above the level of the primitive aperture, and the latter now corresponds to the level of the glottis.

The arytenoid swellings differentiate into the arytenoid and corniculate cartilages and the fold joining them to the epiglottis becomes the aryepiglottic fold, in which the cuneiform cartilages are developed as derivatives of the epiglottis.

The thyroid cartilage develops during the first fetal month for the ventral end of the forth branchial arch, it appears as two lateral plates, each chondrifies from two centres and gets united in the midline by a fibrous membrane in which another chondrification centre develops.

The cricoid cartilage develops during the sixth week from the sixth arch, it arises from two cartilagenous centres which unite ventrally and gradually extend to fuse on the dorsal surface of the tube.

The larynx is supplied by the superior laryngeal and recurrent laryngeal nerves which are the branchial nerves of the fourth and sixth arches respectively. On the left side the recurrent laryngeal nerve passes posterior to the ductus arteriosus which is the sixth arch artery, while on the right side, the dorsal part of the sixth arch and the whole of the fifth disappear, the nerve is therefore found on the caudal aspect of the fourth aortic arch, which becomes the subclavian artery.

The sphincter and dilator muscles of the larynx arise from the mesoderm of the sixth arch. Both groups are derived from the inner constrictor layer of the primitive pharynx.

The paired cricothyroid muscles are derived from the outer ring of musculature surrounding the primitive pharynx.

ANATOMY OF THE LARYNX

The larynx is situated at the upper end of the trachea and, in adult men, lies opposite the third to sixth cervical vertebrae. It is somewhat higher in children and in women.

The skeleton of the larynx is composed of cartilages, interconnected by ligaments and moved by muscles. It is lined by a mucous membrane continuous with that of the pharynx and trachea.

Until puberty, the larynx of the male differs little in size from that of the female. At puberty, the female larynx increases only slightly, where as the male larynx undergoes a considerable increase in size of all cartilages with development of the prominent thyroid notch in the midline of the neck.

In adult men the larynx is about 44 mm long, 43 mm across and 35 mm in its anteroposterior extent. In adult women it is 36 mm long, 41 mm across and 26 mm in its anteroposterior diameter.

Skeletal Elements:

The skeletal elements of the larynx are composed of cartilage. The cartilages are moved with respect to one another by muscles and recoil because of elastic ligaments and membranes within and without the larynx.

The thyroid, the cricoid, and the greater part of the arytenoid cartilages are composed of hyaline cartilage. The thyroid cartilage undergoes progressive calcification from about 25 years of age.

The corniculate, cuneiform, epiglottis, and apices of the arytenoid cartilages are composed of elastic fibrocartilage and do not undergo ossification.

Laryngeal Articulations

Cricothyroid Joint

Between the inferior cornu of the thyroid cartilage and the corresponding articulate facet on the cricoid cartilage. It is a simple synovial joint, reinforced by the anterior, inferior, and prominent posterior cricothyroid ligaments. Rotation of the cricoid cartilage on the thyroid cartilage occurs about an axis passing transversely through the joint.

Cricoarytenoid

Each arytenoid cartilage articulates with the cricoid cartilage by means of a synovial joint that is strengthened by capsular ligaments and by the firm posterior cricoarytenoid ligaments.

Two major movements occur at this joint. The first occurs through an axis running obliquely through the arytenoid, thereby producing a rotation with either abduction or adduction of the vocal process. The second movement is a complex gliding and tipping motion, either laterally and downward following the slope of the cricoid facet or medially toward the opposite arytenoid cartilage.

Intrinsic Muscles

All the intrinsic muscles of the larynx are paired except for the transverse arytenoid muscle (interarytenoid muscle). They are:

1. *Muscles that open and close at the glottis*: the lateral and posterior cricoarytenoids, and the transverse arytenoid (interarytenoid) muscle.
2. *Muscles that control the tension of the vocal ligaments*: the thyroarytenoid, the vocalis, and the cricothyroid.
3. *Muscles that alter the shape of the laryngeal inlet*: the aryepiglottic and thyroepiglottic muscles.

Laryngeal Membranes

Conus Elasticus

Arising from the cricoid is a fibroelastic membrane that attaches anteriorly in the midline to the lower border of the thyroid cartilage. This part is thick and strong and forms the cricothyroid ligament. Laterally the conus elasticus is much thinner, it is attached in front to the inner surface of the thyroid angle and behind to the tip of the vocal process of the arytenoid. Its free upper border is slightly thickened end constitutes the vocal ligament.

Quadrangular Membrane

The fibroelastic quadrangular membrane extends between the arytenoids and epiglottis. Its free lower border, attached anteriorly to the thyroid cartilage, constitutes the vestibular fold (false vocal cord). The upper border, which is longer, forms the aryepiglottic fold containing the tiny cuneiform cartilage.

Thyrohyoid Membrane

This fibroelastic membrane extends between the hyoid bone above and the thyroid cartilage below, being separated from the posterior surface of the body of the hyoid by a bursa that facilitates upward movement of the larynx during deglutition. The lateral (thyrohyoid ligaments form the thickened posterior border of the membrane, these ligaments sometimes contain small cartilaginous nodules called cartilago triticea. While the thickened median portion of the membrane forms the median thyrohyoid ligament. The membrane is pierced on each side by the superior laryngeal vessels and internal laryngeal nerve.

Mucous Membrane of the Larynx

This lines the whole cavity, it is continuous above with that of the mouth and laryngopharynx, below with that of the trachea. It is closely attached to the walls over the true

vocal cords, the epiglottis, and the corniculate and cuneiform cartilages. Elsewhere it is loosely attached and therefore liable to become swollen from effusion.

The anterior surface of the suprahyoid epiglottis faces the tongue and is lined by thick stratified squamous epithelium with numerous submucosal glands. Over the laryngeal surface of the epiglottis is found low stratified squamous epithelium.

Pseudostratified ciliated columnar epithelium covers the inferior portions of the false cords, the ventricles, and the subglottic region. Non-keratinizing squamous epithelium covers the free margins of the vocal cords.

Although the epithelium of the vocal cord closely adheres to the underlying vocal ligament, a potential subepithelial space called Reinke's space exists, it runs the length of the vocal cord. It is limited above and below by the linea arcuata, small indentations in the vocal cord that mark the junction of the squamous and columnar epithelium.

Mucous glands are plentiful on the ventricles, saccules, posterior surface of epiglottis and margins of aryepiglottic folds with none on the free edges of the vocal cords.

Blood Supply of the Larynx

The arterial supply of the larynx is primarily by branches of the superior and inferior thyroid arteries. The superior thyroid artery sends a laryngeal branch supplying the supraglottic region, while the inferior laryngeal branch of the inferior thyroid artery supplies the subglottic region. The cricothyroid branch of the superior thyroid artery supplies parts of the subglottic area.

Venous drainage is through the superior laryngeal veins which accompany the artery and empty into the superior thyroid vein, which in turn opens into the internal jugular vein. Those veins accompanying the inferior laryngeal artery

join the inferior thyroid vein, which opens subsequently into the left brachiocephalic vein.

Lymphatic Drainage of the Larynx

The edges of the vocal cords divide the lymphatic system of the larynx into 2 parts:

- *Supraglottic above the vocal cords:* the vessels drain into the pre-epiglottic and upper deep cervical nodes.
- *Subglottic below the vocal cords:* the vessels drain to the prelaryngeal, pretracheal and lower deep cervical nodes.

The vocal cords themselves have practically no lymphatic vessels.

Nerve Supply of the Larynx

All the larynx is innervated by the vagus nerve. The superior laryngeal nerve's internal branch provides sensory innervation to all of the lining of the larynx above the vocal cords. The external branch innervates the cricothyroid muscle. All the other muscles of the larynx as well as the mucous membranes below the vocal folds are supplied by the recurrent laryngeal nerves.

The Interior of the Larynx

The laryngeal inlet: is bounded superiorly by the free edge of the epiglottis and on each side by the aryepiglottic fold. Posteriorly, the inlet is completed by the mucous membrane that passes between the two arytenoid cartilages.

The ventricle (sinus) of the larynx: is located between the ventricular and vocal folds. From the anterior part of the ventricle, a pouch (the saccule) extends between the vestibular fold and the inner surface of the thyroid cartilage.

The rima glottidis: is an elongated fissure situated between the vocal cords anteriorly and the vocal processes