VOCAL FOLD AUGMENTATION

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BY

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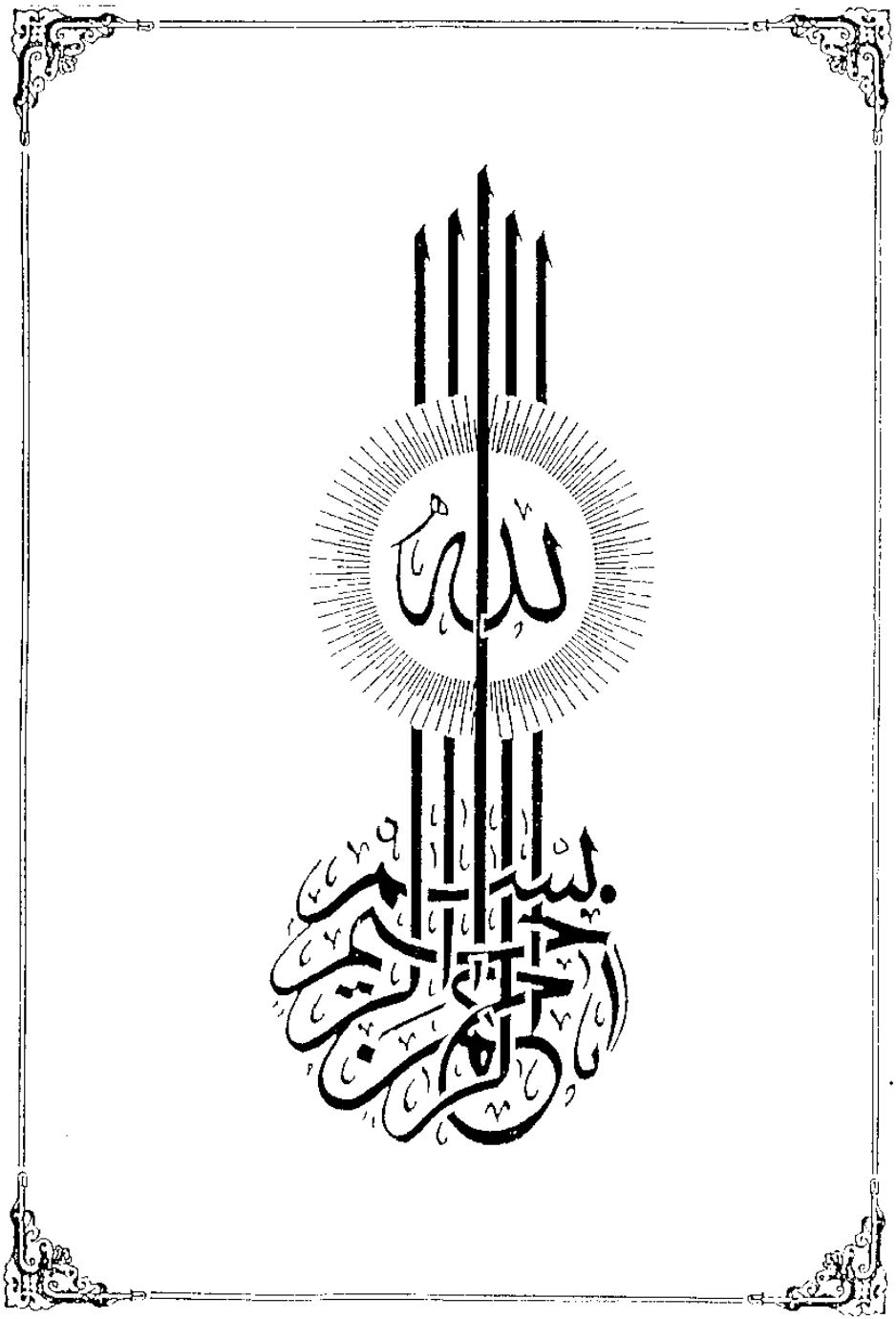
TO MY FATHER



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Tarek Essam El Ekiary

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INTRODUCTION

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Displacement of the vocal fold by its medialization (medio pexy) has been tried to overcome aspiration, inability to cough and severe voice insufficiency in cases of paralytic conditions of the larynx with excessive glottal waste. Several techniques and methods to achieve this goal were tried.

In 1915 Payr made a medialization of the paralyzed vocal fold by "wing door thyroplasty". In 1948 Morison displaced the arytenoid cartilage toward the midline under general anaesthesia "the reverse King operation". In 1952 Muerman made an incision in the medial part of the thyroid cartilage and inserted a piece of rib cartilage between the thyroid ala and the inner perichondrium. In 1955 Opheim dispensed with the costal cartilage Muerman has used. He used a part of the ipsilateral thyroid cartilage taken from its upper edge instead. Emam (1963) used a similar technique with fairly good voice results. Denecke (1964) devised a new surgery in which the "thyroarytenoid tendon" is divided, the arytenoid is displaced medially and sutured in position against a wedge of cartilage taken from the posterior edge of the thyroid cartilage. Montogomery (1966) reported "cricoarytenoid arthrodesis" through a laryngo-fissure approach. Bernstein and Holt (1967) corrected the abducted position of the paralyzed vocal fold by transposition of the sternohyoid muscle between the thyroid cartilage and the inner perichondrium. Sawashimi (1968)

combined Muerman's and Opheim's procedure by inserting a piece of cartilage through a median vertical incision of the thyroid cartilage. Mundich (1970) pulled the arytenoid cartilage toward the lower horn of the thyroid cartilage with sutures. Kamer and Som (1972) inserted a piece of cartilage from the lower rim of the thyroid cartilage between the thyroid ala and the inner perichondrium opposite the paralyzed vocal fold. Isshiki (1974) used a Silastic implant placed between the thyroid cartilage and inner thyroid perichondrium for vocal fold medialization (thyroplasty type I).

These varieties of surgical procedures, external (laryngeal framework surgery) and internal (direct arytenoid and vocal fold manipulations) did not gain general acceptance. The mere multiplicity of the techniques divulges the unsatisfactory vocal results of those procedures.

The failure of permanent positive improvement of the voice function may be attributed to imprecise displacement and approximation of the vocal fold (as in external techniques) or scarring of part of the fold that may interfere with its vibratory motion (as in internal methods), accordingly, vocal fold augmentation through intra-fold injection of inert materials in order to displace the vocal fold medially were attempted and developed.

Historic review of used materials :

The technique of vocal fold augmentation is old. It was first devised in 1911 by Brüning, who injected hard paraffin into the paralyzed fold. The technique, once abandoned due to side effects of paraffin, was revived by Arnold (1963) using Teflon® paste and has come into wide clinical use as a safe and reliable procedure.

The injectable substance should have the following properties (Arnold, 1962):

1- It must be well tolerated by the tissues.

2- It must not be resorbed in time.

3- It must be finely dispersed in a harmless vehicle in order to be injectable through the long needle of Brünings syringe.

Montgomery (1979) stated that "Teflon® had proven to be well tolerated by human tissues" and that "there were no carcinogenic effects of Teflon®".

Teflon® (polytef paste) has become more and more the treatment of choice in cases of unilateral vocal fold paralysis not responding to voice therapy. Teflon® is injected in the paralyzed vocal fold to move it to midline so that the functioning vocal fold meet it and close the glottis (Hammerberg, Fritzell and Schiratzki, 1981).

There are, however, problems associated with technical

errors including improper visualization, problems with the handling of the Brüning syringe, and improper placement of the implant. Also, there is common unavoidable reaction to Teflon® including post-operative edema and expectoration of blood or Teflon® during the initial post-operative period (Rubin, 1965 and Horn & Dedo, 1980). These problems though common are usually not clinically significant. Although more troublesome problems such as seroma and granuloma formation around the injected Teflon® in the vocal fold have been reported (Stone et al, 1970). These complications are fortunately uncommon.

Another material, silicon was tried. Silicon fluid was found to be too quickly absorbed when injected into the vocal fold (Rubin, 1965). Silastic (cold vulcanised Silicon rubber), however, have been used successfully for paralytic dysphonia because of their minimal tissue reaction and reduced absorbability. Phycon was used by Fukuda (1970). Hydron (hydrophilic gel) was used by Kresa et al,(1973) who inserted a rod-shaped implant of the material, into the atrophic or paralyzed vocal fold with satisfactory results. Gelfoam (Schramm et al., 1978) was used in cases of glottic incompetence which are though to be temporary and as a diagnostic test if doubt exists as to the efficacy of permanent injection. Absorption of the injected gel foam is gradual over a period of six to ten weeks allowing time for glottic compensation. The injection may be repeated

without adverse effects until the paralysis resolves or intervention of permanent nature is indicated. (Ford et al., 1984) used Collagen as an implant because it occurs naturally and it closely imitates nature and yet may be modified to produce little host reaction but long-term animal studies are necessary to confirm the apparent success of injected collagen to persist without significant shrinkage.

Teflon® or Silicon may be injected through a needle passing submucosally into the lateral part of thyroarytenoid muscle via the crico-thyroid space. This procedure can be done with minimal preparation of the patient and while the patient is sitting fully cooperative and the larynx being monitored through a naso-laryngo-fibroscopic video monitoring on a T.V.screen. This operative procedure allows optimal conditions for achieving best results with least invasive steps.

The greatest advantages of intrafold injection are its surgical simplicity and the satisfactory result obtained in most cases.

The reasons for changing the materials used for injection are either because of their complications or the non-consistent vocal results. This latter may be due to improper selection of patients or to inadequate complementary voice therapy.

STRUCTURE OF THE VOCAL FOLD

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The vocal folds and the space between them is described as the glottis. The anterior or phonatory glottis is bound by the 2 vocal folds and is roughly triangular in shape. It extends from anterior commissure where the apex of the triangle exists and extends posteriorly to the tip of the vocal process of the arytenoid cartilage. The vocal fold exhibit a fold structure so long there is a ventricle above it. The point, the ventricular fold ends posteriorly at the vocal process, indicates the end of the vocal fold. Thus the vocal fold bounding the anterior glottis is essentially membranous except a very small part at the tip of the vocal process where a cartilagenous vocal fold may be described. Posterior to the vocal fold the glottis exhibits a tubular structure that has lateral walls and a posterior wall. There is no such a structure as a posterior commissure. The Posterior glottis is wider in cross sectional area than the anterior triangular glottis and is more alleged to the vertical axis of the trachea. This part of the glottis is referred to as the respiratory glottis (Hirano et al, 1985).

1- In Frontal Section:

Hirano (1981), stated that in frontal section through middle of the membraneous portion of a human vocal fold, one can differentiate the following five layers : - **(Fig. 1)**

(1) The epithelium, which is of the squamous cell type. It can

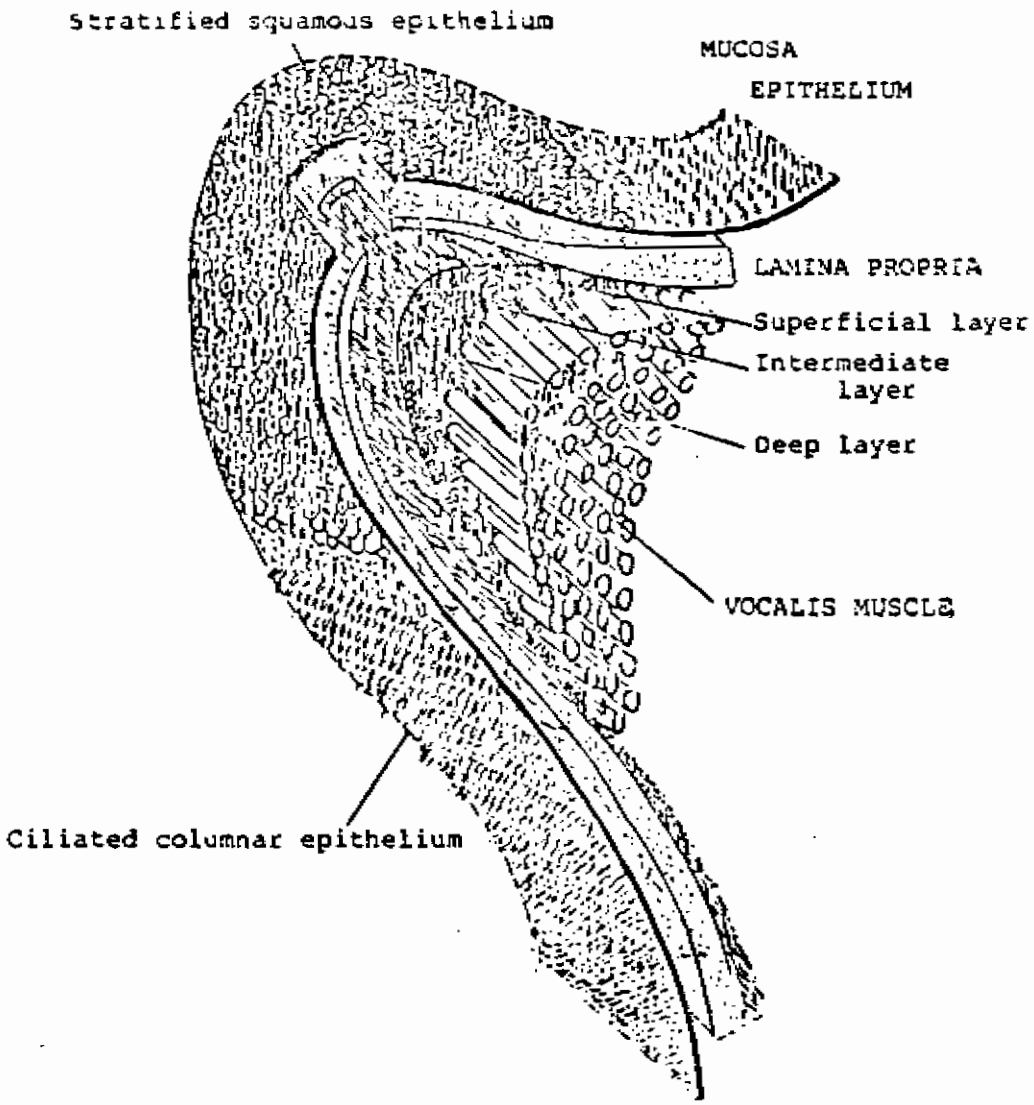

Fig. (1) :

A schematic presentation of the human vocal fold

be regarded as a thin capsule whose purpose is to maintain the shape of the vocal folds.

(2) Lamina propria which consists of :-

a) The superficial layer of lamina propria, which consists of loose areolar connective tissue fibres and matrix. It can be regarded as somewhat like a mass of soft gelatin.

b) The intermediate layer of lamina propria, which consists chiefly of elastic connective tissue fibres parallel to the longitudinal axis of the vocal fold and can be likened to a bundle of soft rubber bands.

c) The deep layer of lamina propria, which consists of collagenous fibres parallel to the longitudinal axis of the vocal fold and something like a bundle of cotton thread.

(3) The thyro-arytenoid muscles, which constitutes the main body of the vocal fold and is like a bundle of rather stiff bands. The fibres of the thyroarytenoid muscle run in longitudinal bundles parallel to the long axis of the vocal fold from thyroid attachment anterioly to the posterior attachment at the vocal process and antero-lateral surface of the arytenoid.Hirano (1981), also stated that from the mechanical point of view, the five layers can be reclassified into three sections : The cover, consisting of epithelium and