PROSPECTIVE EVALUATION OF VOCAL CORD FUNCTION WITH INTRA-OPERATIVE NERVE IDENTIFICATION IN TOTAL THYROIDECTOMY PATIENTS

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CERTIFICATE

This is to certify that this dissertation on ‘Prospective evaluation of vocal cord function with intra-operative nerve identification in total thyroidectomy patients’ is a bonafide dissertation by Dr. M. P. Kumaran conducted in Madras Medical College under the supervision and guidance of and is submitted to The TamilNadu Dr. M. G. R. Medical University, Chennai in partial fulfilment of the requirement for the M.Ch (Endocrine Surgery) degree.

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CONTENTS

The recurrent laryngeal nerve and the external branch of the superior laryngeal nerve are at risk of injury during total thyroidectomy. This may result in change of voice post-operatively. The recurrent laryngeal nerve is at particular risk due to its proximity to the inferior thyroid artery and the ligament of Berry. Injury to the recurrent laryngeal nerve may result in dreaded complications like stridor, loss of voice sometimes necessitating tracheostomy as a life saving procedure.

One's voice is one of the integral aspects of one's identity. Change of voice, to any degree, is not acceptable regardless of whether one is dependent on voice for one's profession. Post operative voice change is a major concern for the patients undergoing total thyroidectomy as well as for surgeons performing the surgery. This could be mild or it may be severe. While it is often transient, it could be permanent as well.

In order to analyze voice change after surgery, an objective method of assessment of the patient's voice is necessary, which depends on reliable and accurate feedback from the patients. This necessitates a questionnaire, which can be administered to the patients in question. In this respect, compliance of the patients can be ensured with a simple and relatively short questionnaire,

which is easy to understand. In addition, the questionnaire should be so constructed as to enable objective assessment of severity of the symptoms. This can be achieved by permitting the patients to grade each voice-related symptom on a simple scale on the basis of severity. Validation of the questionnaire affords credibility to this method of assessment.

Direct laryngoscopy, either with the naked eye, or with the help of a fibre-optic video-laryngoscope will enable objective assessment and documentation of vocal cord movement and function. By this method, vocal cord palsy, which occurs due to RLN injury, during thyroid surgery can be assessed objectively and documented.

With this background, this study was conducted in the Department of Endocrine Surgery, Madras Medical College with the following objectives.

1. Objective evaluation of voice and vocal cord status pre-operatively, with the help of a validated voice assessment score (VAS) and videolaryngoscopy (VLS), respectively.
2. Documentation of identification of the external branch of superior laryngeal nerve (EBSLN) and the recurrent laryngeal nerve (RLN) per-operatively.

3. Assessment of voice and vocal cord status post-operatively, on the 5^{th} post-operative day and again on the 180^{th} post-operative day with the help of VAS and VLS respectively.
4. Correlation of the post-operative VAS and vocal cord status.

REVIEW OF LITERATURE

Voice change in the post-operative period is one of the most bothersome complications in thyroid surgery, both for the patient and the operating surgeon. Regardless of the degree of surgical expertise, voice change after thyroid surgery is sometimes unavoidable, especially after difficult surgery. Although a significant number of patients undergoing thyroidectomy experience some change in voice after surgery, it is transient in the large majority.

There are various factors which influence voice change, including innocuous causes like acute upper respiratory infection including laryngitis, upper airway edema as a result of trauma during intubation, arytenoids dislocation and injury to the recurrent laryngeal nerve (RLN). In a small minority of subjects (0.3%), idiopathic vocal cord palsy is present pre-operatively as well [1].

Unilateral RLN injury will result in unilateral vocal cord palsy, which can present with post-operative aspiration and hoarseness of voice. Bilateral RLN injury can be dramatic in presentation. The patient may develop life-

threatening stridor in the immediate post-operative period, often immediately after extubation.

In order to minimize the rate of post-operative voice change, understanding voice production apparatus and process, including anatomy of the larynx, physiology and neurophysiology of voice production and the anatomy of the recurrent laryngeal nerves and their relation to the thyroid gland and the surrounding structures is essential. In addition to these, it is important to know about the patterns of clinical presentation of post-operative voice change, the methods of voice assessment and the methods of objective evaluation of vocal cord function. Knowledge of the natural history of events following surgery with regard to voice, including the pattern of recovery is essential.

2.1 ANATOMY OF THE LARYNX

The larynx is made up of a cartilaginous skeleton with many ligaments connecting the various cartilages, which provide attachment to various intrinsic and extrinsic muscles of larynx.

2.1.1 Cartilages of larynx

The larynx has paired as well as unpaired cartilages making up the skeleton. The thyroid, the cricoid and the epiglottic cartilages are the unpaired cartilages, aligned in the median plane. The arytenoid, cuneiform and the corniculate cartilages are the paired cartilages of the laryngeal framework. In addition, the hyoid bone provides support to the main framework of the larynx, although it is not a part of the larynx itself. A schematic representation of the laryngeal framework is included in Figures 1, 2 and 3.

2.1.2 Muscles of the larynx

The intrinsic muscles of the larynx, which are present entirely within the laryngeal framework, are primarily involved in movements of the vocal and vestibular folds. The intrinsic muscles of the larynx include the posterior cricoarytenoid, the lateral cricoarytenoids, the transverse arytenoids or the inter-arytenoids, the oblique arytenoids, the thyro-arytenoids, the vocalis and the crico-thyroid. The vocalis and the thyro-arytenoids are the muscles of the true vocal folds, while the crico-arytenoids, the inter-arytenoids and the crico-thyroid muscles attach the cricoids, thyroid and arytenoids cartilages. The majority of the laryngeal muscles are adductors of the vocal cords, while the posterior cricoarytenoids are believed to be the main abductors of the glottis aperture. The various muscles and their actions are listed in Box 1 overleaf. Their pictorial representation is as shown in Figures 4, 5 and 6.

2.1.3 The laryngeal lumen

The vocal and the vestibular folds are the most conspicuous structures in the laryngeal lumen, which extends from the epiglottic aperture above to the crico-tracheal junction below (Figure7). It is lined by the pseudo-

stratified ciliated columnar (respiratory) epithelium. The vocal folds are the true cords, while the vestibular folds are the false vocal cords.

Box 1: Intrinsic laryngeal muscles.

Muscle and innervation	**Action**
Posterior cricoarytenoid (RLN) Only abductor of the vocal cords [NS – RLN]	Abduction of vocal cords Open glottis by rotation of arytenoids on the cricoid Tenses cords during phonation
Lateral cricoarytenoid [NS – RLN]	Close glottis by rotating arytenoids medially
Transverse arytenoid / Inter-arytenoid [NS – RLN]	Close glottis Adduction of arytenoids – slide medially towards each other on the cricoid
Oblique arytenoid [NS – RLN]	Close glottis Synchronous with transverse arytenoid Closure of the glottic aperture especially during swallowing
Thyroarytenoid [Wide, fan-like muscle; 3 functional parts Thyroarytenoidus internus / Vocalis Thyroarytenoidus externus Thyroepiglotticus]	Adductor, tensor of free edge of vocal cord Major adductor of vocal folds Shortens vocal ligaments
Cricothyroid [NS – EBSLN]	Tenses the vocal cords

2.1.4 Anatomy of the recurrent laryngeal nerve

The recurrent laryngeal nerve (RLN), a branch from the vagus, is made up of myelinated and unmyelinated axons containing 1200 myelinated axons and thousands of unmyelinated axons [1]. It provides both sensory as well as motor innervations to the larynx.

The Vagus nerve contains three nuclei in the medulla oblongata - the Dorsal nucleus of vagus nerve, the Nucleus Ambiguus and the Nucleus of Tractus Solitarius. The dorsal nucleus is the parasympathetic nucleus, which innervates the heart, the involuntary muscles of the bronchi and the esophagus and the organs of the gastro-intestinal tract including the stomach, small bowel and parts of the large bowel. The nucleus of Tractus Solitarius is sensory to the pharynx, the larynx and the esophagus. The Nucleus Ambiguus, which is the motor nucleus of the Vagus, supplies the muscles of pharynx, larynx, hypo-pharynx and soft palate. So the RLN contains fibres from the Nucleus Ambiguus and the Nucleus of Tractus Solitarius.

Once the vagus nerve emerges from the medulla the recurrent laryngeal fibres occupy the anterior position as the vagus passes through the

jugular foramen on each side. There are a number of fascicles in the vagus nerve within the jugular foramen [2]. The nodose ganglion, which is present just caudal to the jugular foramen, gives off nerves that contribute to the pharyngeal plexus. The superior laryngeal nerve is given off from the vagus at this ganglion.

The vagus traverses the neck within the carotid sheath. The recurrent laryngeal nerves on either side are given off at different levels.

The right RLN is given off at the thoracic inlet at the point where the vagus passes anterior to the sub-clavian artery. The RLN loops around the sub-clavian artery, passing upwards and medially in relation to the pleura, behind the common carotid artery. In the neck, it is found in the para-tracheal areolar tissue, related to the postero-lateral aspect of the thyroid lobe as it passes upwards, ultimately approaching the trachea-esophageal groove as it exits the para-tracheal space and enters into the larynx at the crico-thyroid junction.

In about 1% of the subjects, this nerve emerges directly from the vagus at a much higher level, at the level of the thyroid gland and is not

recurrent. This may be associated with anomalous right subclavian artery [3].

On the left side, the vagus follows the carotid artery into the mediastinum where it lies in relation to the aortic arch [4]. The RLN is given off at the lower border of the aortic arch, at the level of the ligamentum arteriosum. It loops around the aortic arch and ascends behind it to approach the trachea-esophageal groove. It ascends in this groove to enter the neck, which it traverses in the above-said groove, postero-medial to the thyroid lobe. It exits the paratracheal space as it enters the larynx at the crico-thyroid junction.

On the right side, the RLN is approximately 5-6 cm long. It is much longer on the left side, with an approximate length of 10-12 cm [5].

The relationship of the RLN to the inferior thyroid artery (ITA) and its branches is significant [3]. Ligation of the inferior thyroid artery is an essential step during thyroid surgery and the RLN is at risk of injury by virtue of its relation to the ITA and its branches.

The left RLN passes postero-medial to the main twig of the ITA in 50%-55% of the subjects, while the right RLN is so related in 18% to 25%.

The RLN passes in front of the left ITA in 11%-12% of the population, while it is so on the right side in 26%-33%. The RLN passes in between the branches of the ITA in 33% on the left side and in 50% of the subjects on the right side [3].

The RLN enters the larynx deep to the inferior constrictor muscle and posterior to the crico-thyroid joint. Traditionally it is believed that the RLN divides into motor and sensory branches after entering the larynx. However, extra-laryngeal branches of the RLN are seen as well, in about 35% - 80% of the patients [6]. The motor branch, which is directed anteriorly, is made up of 500 – 1000 axons. The posterior cricoarytenoid muscle is supplied by a quarter of these.

The inferior thyroid artery supplies blood to the proximal RLN, while the distal, intra-laryngeal part of the RLN derives its blood supply from the inferior laryngeal artery.

A pictorial representation of the anatomy of the RLN, the EBSLN and their relations in the neck are as shown in Figures 8 and 9.

2.2 NEUROPHYSIOLOGY OF LARYNX AND PATHOPHYSIOLOGY OF VOCAL CORD PALSY

2.2.1 Neurophysiology of larynx

The primary functions of the larynx include protection of the tracheo-bronchial airway and vocalization, in addition to aiding the process of ventilation. When a person breathes silently, the glottic aperture is open, while it is closed during phonation or deglutition. The epiglottis, which is oriented in the form of a trapdoor, hinges down to close the airway during deglutition, while the epiglottic aperture is open during phonation.

The movement of the vocal folds, which is integral to the opening and closing of glottic aperture, is controlled by two sets of mutually antagonistic muscles. When the glottic aperture is open, the abductors of the vocal cords, the posterior cricoarytenoids, are contracted. Simultaneously, the adductors relax to facilitate smooth, synchronous vocal cord movement. When the glottis is closed, the adductors contract while the abductors relax. Tensing of the vocal folds, which is necessary for appropriate vocalization and modulation of pitch, is mediated by the thyroarytenoid and the cricothyroid

muscles. The cricothyroid muscles are in contraction during abduction as well as adduction of the cords [7].

The RLN and the internal branch of the SLN are responsible for sensory innervation of the laryngeal mucosa. The IBSLN supplies the supra-glottic larynx, while the RLN supplies the glottic aperture and infra-glottic larynx. Occasionally, there is cross-innervation of the sensory supply via the anastomosis of Galen, which is a communicating nerve between the RLN and the SLN.

Recently, several articles have been published that have revealed that each laryngeal muscle is not a single entity but rather an assembly of anatomically distinct compartments adapted for different functions. The intrinsic muscles, viz. the posterior cricoarytenoids, the thyro-arytenoids and the cricothyroid muscles, can be grouped into two to three functional compartments on the basis of fascial barriers and differences in the direction of orientation and the site of insertion of muscle fibres [7]. Muscle biochemistry studies support this theory of functional compartmentalization of the laryngeal muscles. The compartments of muscle receive innervations by separate nerve branches.

Han, et al. have demonstrated that the horizontal division of posterior cricoarytenoid muscle has a greater proportion of slow-twitch (type 1) fibres, as does the vocalis, which is the supero-medial division of the thyro-arytenoid muscle. In general, these slow-twitch fibres are adapted for tonic functions, like quiet respiration or vocalization [8].

The vocalis muscle, with its slow fibre composition, multilobar construction and muscle density, is suited for the accurate generation of sound used in communication. Bei-Lian, et al have reported that in some cases, the vocalis may receive additional innervation via the EBSLN, apart from the regular innervation through the RLN [9].

The idea of slow and fast motor units is fundamental to the laryngeal behavior. With many nerve branches and anostomotic channels, which terminate in plexuses, the innervation of larynx is intricate and complex.

Another aspect of vocal fold physiology which is integral to voice production is the phenomenon of the mucosal wave. This refers to the movement of the vocal fold in three dimensions. Movement of the cords along a two-dimesnional, seemingly axial plane is evident by laryngoscopy in natural light, regardless of whether it is direct or indirect. However, the

vocal cords move in three diemensions. Apart from abduction and adduction, the vocal folds move upwards and downwards as well, along the cranio-caudal axis.

In addition, rippling of the mucosa on the vocal cords is appreciable by strobo-videolaryngoscopy. The mucosal wave refers to this rippling movement, much akin to the ripples of waves that can be seen on the ocean from a beach. Like fingerprints and lip prints, the mucosal wave is unique to a particular individual, conferring identity to one's voice [1]. Alteration of the architecture of the vocal cords will result in alteration of the mucosal wave and consequent voice change.

2.2.2 Mechanism of voice production

Phonatory signals generated in the motor cortex proceed via bilateral brainstem nuclei (Nucleus Ambiguus) and through vagus nerves and their branches, the RLN and the SLN, on either side to reach the larynx. They terminate in the motor end plate of the intrinsic laryngeal muscles, resulting in the intrinsic muscular contraction. While the entire efferent process in

voice production can be accomplished in 90ms, it needs close coordination of the respiratory musculature [10].

Lalwani, et al. have described voice as a product of the semicyclical vibrations of the vocal cords [10]. Normal voice emanates from oscillation of the vocal cord mucosa as it moves relative to the underlying vocal cord musculature and the laryngeal skeleton. This cordal vibration is controlled by vocal cord muscular tension, the mucosal wave and other elastic vocal cord properties and aerodynamic forces of sub-glottic air as it passes through the relative constriction of the partially closed glottis. Cordal vibration is generated as the air expelled under pressure from the lung passes between the vocal cords and sets cords into oscillatory motion.

Vibration of the vocal cord is age and gender dependent. In addition to intrinsic muscles extrinsic muscles of the larynx are subject to contraction during phonation, singing, respiration, yawning and during swallowing. These extrinsic muscles make vertical laryngeal motion during the contraction. When this vertical movement is affected voice production may be compromised even if the glottis looks normal.

2.2.3 Mechanisms of nerve damage and regeneration

The various mechanisms of nerve injury that result in vocal cord paralysis include neuropraxia, axonotmesis and neurotmesis.

Neuropraxia refers to the loss of signal conduction as a result of demyelination without disruption of axons. Functional recovery occurs within days to months as a result of remyelination of the Schwann cell that lines these axons.

Axonotmesis refers to mechanical disruption, or transection, of the involved axons. Regeneration occurs in due course, after a period of weeks to months. It involves regeneration of the Schwann cells, which form the neural tubes into which the regenerating axons grow. Thus, structural continuity is established and is followed by recovery of nerve transmission.

Neurotmesis refers to mechanical disruption, transection or avulsion of the nerve or a part of it. After the injury, reinnervation may be inappropriate, inadequate or nonexistent. Inapprorpirate regeneration may result in the regenerating axons entering the endoneural sheaths randomly, thus resulting in cross-innervation, akin to that seen in Frey's syndrome after parotid surgery.

Dysfunctional reinnervation may result in simultaneous contraction of corresponding, mutually antagonistic groups of muscle fibres, resulting in dysfunctional cord mobility. This phenomenon is known as synkinesis [7]. Synkinetic contraction is a feature of chronic, vocal cord paralysis as a result of irreversible RLN injury.

In cases of extensive nerve injury, axonal and neural regeneration may be completely impeded by formation of neuromas at the cut ends of the nerve [7].

It is remarkable, though, that reinnervation of laryngeal muscles can and does occur in face of severe RLN injury. In their study, Crumly and McCabe [11] reported regeneration of the RLN after resection of a segment of the nerve 2.5cm in length and ligation of the cut ends. Reinnervation of PCA muscle was reported [12] even after resection of 10cm of the nerve and ligation of the stumps. The proximal stump was reported to be the source of regeneration.

2.3 VOCAL CORD PALSY

2.3.1 Epidemiology and Etiology

The exact incidence of RLN paralysis is difficult to estimate, since a significant proportion of patients - as many as 30% to 50% of them - with vocal cord paralysis may be asymptomatic [13]. Idiopathic RLN paralysis is one situation where the exact etiology for nerve paralysis is not known and its incidence can vary. According to Yumoto, et al. [14], the incidence of idiopathic RLN palsy in the population is between1.5% and 14%. According to some other reports, it was between 25.9% and 41.3%. The incidence of RLN paralysis is more common in the elderly, due increased incidence of malignancy, increased fragility and decreased potential for recovery.

While the RLN has a longer course on the left side, it is more obliquely oriented within the neck on the right side. So, the right RLN is more prone to injury in the neck when compared to the left RLN, but overall, the incidence of RLN injury is more on the left side. Pathological processes within the mediastinum including carcinoma of the lung, carcinoma of the esophagus, lymphoma, tuberculosis, sarcoidosis, silicosis and secondaries can cause RLN paralysis, especially on the left side.

Operations on the cervical spine through the anterior approach, carotid endarterectomy, thyroid surgery and skull base surgery are some of the common operations responsible for RLN paralysis. Thyroid surgery remains most common operation associated with RLN paralysis.

Vocal cord palsy associated with endotracheal intubation, which sometimes results from dislocation of the arytenoid cartilages, can occur due to compression of the nerve between the thyroid cartilage and arytenoids as well [15]. It is important to distinguish these two causes of intubation-associated vocal cord palsy.

Injury to the recurrent laryngeal nerves and the vagus nerves can occur anywhere along its course. Surgical and traumatic causes apart, certain other causes like vascular insults, viruses, bacterial infections and neurotoxic drugs have been implicated.

Nerve injury during surgery can be due to thermal injury, stretch, cutting, compression and vascular compromise. Surgically induced recurrent laryngeal nerve injury may not be recognized at the time of injury. The potential for recovery is generally proportional to the degree of injury. Primary anastomosis is recommended if the recurrent laryngeal nerve is cut.

Slow growing tumors that infiltrate the nerve generally allow compensation for paralysis and even with immobile fold symptoms may not be evident. The recovery time for RLN paralysis after carotid endarterectomy, anterior surgical approach to cervical spine and thyroidectomy with benign pathologic findings is shorter than for that after skull base surgery and thoracic surgery [15]. The latter, which are mainly performed in the setting of malignancy, require extensive dissection and so are associated with a more severe degree of injury when compared to the former group.

2.3.2 Laryngoscopy

Inspection of the vocal cords with the help of laryngoscopy is generally performed before, as well as after surgery. Pre-operative evaluation will enable confirmation of the vocal cord status. Vocal cord paralysis that may be present pre-operatively, can be confirmed. This will aid in determining the disease load and in evaluating the therapeutic options in case of thyroid malignancy. In the post-operative setting, laryngoscopy will enable diagnosis of post-operative vocal cord injury or paralysis. Fibre

optic laryngoscopy is a simple and well tolerated office procedure for surgical patients.

The appearance of the larynx should be symmetrical. During silent respiration, the glottic aperture assumes a triangular configuration, with the base directed posteriorly. In health, the triangle should be symmetrical. During phonation, the glottic aperture is closed and assumes a slit-like configuration in the median plane.

Unilateral vocal cord paralysis is visualized as thick, short, immobile vocal fold, associated with anterior prolapse of the ipsilateral arytenoid cartilage. In addition, the affected cord is displaced inferiorly so that during phonation, the mucosal edges of the two vocal cords don't appose each other. As a result, the voice is breathy and vocal fatigue occurs[1].

When both the cords are affected, as in bilateral RLN injury, both cords are immobile and oriented in the paramedian plane. Abduction, if possible at all, is very minimal. These patients often present with serviceable voice but with signs of upper airway obstruction. Not infrequently, the presentation is dramatic with stridor. Unless immediately managed, this condition is life-threatening.

Unilateral EBSLN injury, in the setting of which the vocal range and pitch is limited, may be observed as a rotation of the posterior larynx towards the side of the injury[16]. The affected cord is bowed and somewhat caudal with respect to that on the unaffected side.

Preoperative vocal cord paralysis was found in 70% of patients with invasive disease versus 0.3% of patients with benign thyroid lesions[15]. Preoperative vocal cord paralysis may be completely asymptomatic. Knowledge of preoperative paralysis is helpful in evaluating treatment options. For instance, in the setting of preoperative unilateral vocal cord palsy, when contra-lateral surgery is planned, tracheostomy may be necessary and this possibility has to be considered.

2.3.3 Voice assessment in patients undergoing thyroid surgery

The incidence of voice change in the immediate post-operative period after thyroid surgery is 30% [17]. Changes in voice character have been documented in the absence of laryngeal nerve injury as many as 30% of cases [17]. Lasting functional voice change after thyroid surgery has been observed in 14% of cases. Recent research shows that there are various

factors that influence post-operative voice change, apart from nerve injury [1].

The patterns of lymphatic drainage, blood supply and venous drainage of the larynx may be altered after surgery. The strap muscles, including the sternohyoid and the sternothyroid, may be adherent to the laryngeal framework, as a result of which the vertical movement of the larynx may be restricted. The mucosa overlying the cords may be injured or rendered edematous after endo-tracheal intubation. The cricothyroids, which are intimately related to the supero-medial border of the thyroid lobe, may be injured during dissection. In addition, although the thyroid bed may be structurally intact, movement may be splinted in the immediate post-operative period due to post-operative pain. Psychological aspects like pain threshold and pain perception may also influence post-operative voice.

Some of the most common voice-related symptoms after thyroid surgery are vocal fatigue, hoarseness and decreased voice stamina.

The voice symptoms in the immediate post operative period of total thyroidectomy patients usually are temporary. In the absence of nerve injury, they recover within a few weeks after surgery.

In a study by Watt-Boolsen, et al. [18], voice-related symptoms improved significantly after thyroid surgery. This was probably due to alleviation of mass effect of the goitre and improvement of thyroid status post-operatively.

2.4 TREATMENT OPTIONS FOR VOCAL CORD PALSY

As a result of glottic incompetence, the various functions of the larynx, including airway protection, breathing and voice production are impaired. The primary concern for the patient is dysphonia. The presentation of dysphonia is varied. Patients complain of various symptoms including insufficient loudness, vocal fatigue, globus sensation, hoarseness, impaired singing quality, breathlessness on speaking and laryngospasm. A wide spectrum of treatment options are available, ranging from voice therapy to injection laryngoplasty, medialization laryngoplasty and laryngeal reinnervation.

2.4.1 Voice therapy

The surgeon and the speech therapist must work as a team in the management of vocal cord paralysis. The speech therapist should be consulted soon after the diagnosis of vocal cord paralysis. The nearer the vocal fold is to the midline, the less breathy and hoarse the voice. The further away it is from the midline, the weaker the voice. Diplophonia or perception of two different frequencies occurs when the patient increases the

effort to attain glottic closure [19]. Odynophonia, or pain on vocalization, can occur as well.

Production of voice requires glottic competence sufficient for the mucosa of the vocal fold to vibrate. Changes in pitch occur with alteration in length, mass and tension of the vocal cord. In patients with vocal fold paralysis, impairment of vocal power and quality occur because of inadequate closure of vocal fold and loss of vocal fold bulk. The affected fold is flaccid, with a bowed edge.

The speech therapist evaluates the quality of voice and breathing pattern of the patient. It is important to understand the patient's vocal demands at work and at home. Dysphagia and other co morbid symptoms, if present, should be recorded.

Patients with unilateral or bilateral paresis with adequate glottic competence and patients with superior laryngeal nerve injury should be subjected to voice therapy. Patients undergoing surgical procedures for correction of vocal fold paralysis also benefit from voice therapy sessions.

In the past, forced adduction exercises were taught to help the uninvolved vocal fold to cross over the midline to achieve glottic closure

during phonation. These exercises were used successfully as well. Today most voice therapists avoid this technique for fear of creating supraglottic hyper functioning. However, pushing exercises are still used by some voice therapists to enable patients to achieve glottic closure.

Voice therapy aims to improve glottic closure without causing supraglottic hyper-function while developing abdominal support for breathing and improving intrinsic muscle strength. A variety of these therapy approaches are available. To mention a few, hard glottal attacks and pushing, half swallow boom, abdominal breathing, appropriate tone focus, accent method, lip and tongue trills, head, neck and shoulder relaxation are some of these [19].

2.4.2 Injection Laryngoplasty

Injection laryngoplasty was introduced in 1911 by Bruenning [20] for the purpose of correcting glottic insufficiency due to unilateral vocal fold immobility. The glottic defect was corrected by means of injection of liquid paraffin. However, due to operational difficulties, this technique was abandoned.

In 1955,Arnold [21] revisited injection laryngoplasty for unilateral vocal cord palsy. The principle behind this technique was to reposition the edge of the affected vocal cord medially, in order to decrease or eliminate the gap between the edges of the two cords. As a result, the affected cord, which was in the intermediate or paramedian position, would be medialized. Instead of the earlier practice of injection into the vocal cord, a foreign substance would be injected lateral to the cord, into thyro-arytenoid muscle or the paraglottic space – the space between this muscle and the vocal fold. This paraglottic space is away from the vibratory surface of the vocal fold. The viscosity of the injected substance would not affect on the movement of vocal fold.

2.4.3 Medialization laryngoplasty

Laryngeal framework surgery was conceptualized and described by Dr Isshiki in 1974 [22]. The concept of Isshiki's thyroplasty involves removal of the upper border of the thyroid ala to fashion an implant, which is inserted through a window in the thyroid cartilage into the paraglottic space. The goal of medialization laryngoplasty is improvement in glottic

closure with decreased effort in phonation, resolution of vocal fatigue, resolution of discomfort with voice use and restoration of normal vocal fold pitch, quality and range.

Anterior laryngeal support is provided via implants placed adjacent to the lateral aspect of the thyroarytenoid muscle. The posterior laryngeal procedure, which is performed to effect closure of a posterior glottal gap, includes adduction and repositioning of the arytenoid cartilage on the affected side, along with posterior flange thyroplasty [23].

2.4.4 Laryngeal reinnervation

Laryngeal reinnervation refers to surgical procedures performed to restore the neural connection to the intrinsic laryngeal muscles and the laryngeal mucosa. The functions of the RLN, the SLN or both nerves may be restored. After reinnervation, the motor as well as the sensory function may be restored. The techniques employed may be any one of the following, including end to end neural anastomosis, direct implantation of nerve into a muscle, the nerve muscle pedicle[NMP] technique and muscle-nerve-muscle methods. The nerve and muscle can be combined in many ways.

PATIENTS AND METHODS

This study was conducted over the past 15 months, from December 2011 to February 2013,spanning fifteen months in the Department of Endocrine Surgery, Madras Medical College. Consecutive patients undergoing total thyroidectomy were included in the study.

Informed consent was taken from all the patients who were included in this study. On admission, the thyroid functional status was assessed, pre-operative cytological diagnosis obtained and imaging studies were performed to ascertain the anatomical, biochemical and pathological diagnosis. Voice was assessed preoperatively with the help of the validated voice assessment score. Vocal cord status was confirmed by videolaryngoscopy. If required, the patients were adequately prepared pre-operatively before surgery.

Exclusion criteria

Patients with preoperative evidence of vocal cord palsy, revision thyroid surgery and additional neck dissection procedures for thyroid malignancy were excluded.

Validated Voice Assessment Scoring

The validated voice assessment score (VAS) consists of a questionnaire with fifteen symptoms, which was administered. The patients were advised to grade each symptom on a scale of 0 to 5, depending upon the severity of the individual symptoms. A score of 0 signify no symptom, while a score of 5 corresponds to maximum severity of the symptom.

The various voice-related symptoms included in the questionnaire were as follows – sore throat, hoarseness of voice, loudness of voice, loss of voice, cough, weak voice, mental depression, throat obstruction, presence of neck nodes, voice fatigue, ability to raise voice or the lack of it, variability of voice, voice straining, breakage of voice and loneliness as a result of voice change. The individual scores for each symptom were summed up to arrive at an overall voice assessment score for each patient.

Operative details

A low collar crease incision was employed, after which sub-platysmal flaps were raised. The sternohyoid muscles were retracted laterally, while

the sternothyroid muscles were divided close to the cranial attachment. On either side, the Reeve's space was dissected to look for the external branch of the superior laryngeal nerve (EBSLN). The peri-thyroidal areolar tissue was dissected on either side to identify the recurrent laryngeal nerve (RLN) throughout its course within the neck. Relation of the RLN to the inferior thyroid artery (ITA) and its branches was noted. These structures were identified and preserved, along with the parathyroid glands. Total thyroidectomy was performed.

Post-operative follow-up

The patients' voice was evaluated with the help of VAS again on the 5^{th} post-operative day. Vocal cord status post-operatively was assessed immediately after voice assessment on the same day, with the help of videolaryngoscopy (VLS). If post-operative complications including vocal cord palsy and post-operative hypocalcemia occurred, they were noted and appropriately managed. The patients were discharged when deemed fit.

Voice and the vocal cord status were assessed again on the 180^{th} post-operative day, with the help of VAS and VLS respectively. The findings

with regard to VAS and vocal cord palsy on the 5^{th} post-operative day as well as the 180^{th} post-operative day were documented, tabulated and analyzed.

Vocal cord palsy, if occurred, was deemed transient if the vocal cord function recovered within a period of 180 days post-operatively, as evidenced by VLS. If it persisted for longer than 180 days, it was considered permanent.

Statistical analysis

After tabulating, the data were analyzed with regards to the anatomical orientation of the RLN with respect to the ITA, the VAS on the 5^{th} post-operative day and the 180^{th} post-operative day and the rate of transient as well as permanent vocal cord palsy.

Analysis was performed using the Chi-squared test and Pearson's correlation. Multivariate analysis was performed with Logistic regression.

Statistical analysis was conducted with the help of the SPSS software (version 17.0).

RESULTS

A total of 105 patients were included in this study. Of these, 86(81.9 %) were women and 19 (18.1 %) were men. The patients were aged between 12 and 75 years, with a mean of 41.4 ± 13.7 years.

Sex of the Patient

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	19	18.1	18.1	18.1
	Female	86	81.9	81.9	100.0
	Total	105	100.0	100.0	

Of the total 105 patients, 74 (70.5%) had benign thyroid disease and 18(17.1%) had thyroid malignancy. 13 (12.5%) patients had thyroiditis.

Pathological Diagnosis

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Benign	74	70.5	70.5	70.5
	Malignant	18	17.1	17.1	87.6
	Thyroiditis	11	10.5	10.5	98.1
	Benign+ Thyroiditis	1	1.0	1.0	99.0
	Malignancy+Thyroiditis	1	1.0	1.0	100.0
	Total	105	100.0	100.0	

Among these 13 patients, thyroiditis was found co-existing with benign and malignant pathology in 1 patient each.

With regards to thyroid function at diagnosis, 75 patients (71.4%) were euthyroid, 24 (22.9%) were hyperthyroid and 6 patients (5.7%) were hypothyroid. None of the patients had pre-operative vocal cord palsy, since such patients were excluded at the outset.

The mean pre-operative voice assessment score for the 74 patients with benign thyroid pathology was 1.3 ± 3.3 ranging from 0 to 24 (Table 3). For the 18 patients with malignant pathology, the mean score was 4.6 ± 14.3, ranging from 0 to 61. In the 11 patients with thyroiditis alone, the mean score was 1.9 ± 2.8, with a range of 0 to 9. In the patients with thyroiditis co-existing with benign thyroid disease and malignant thyroid disease (one patient each), the score was 0.0. There was no significant difference between these groups with respect to the pre-operative voice assessment score ($p=0.423$).

Table 3: Pre-operative Voice Assessment Score

Pathological Diagnosis	Mean	N	Std. Deviation	Minimum	Maximum
Benign	1.27	74	3.270	0	24
Malignant	4.61	18	14.255	0	61
Thyroiditis	1.91	11	2.844	0	9
Benign+ Thyroiditis	.00	1	.	0	0
Malignancy+Thyroiditis	.00	1	.	0	0
Total	1.89	105	6.567	0	61

The overall rate of transient post-operative vocal cord palsy was 21.0% (22 of 105 patients). The incidence of transient post-operative vocal cord palsy with various pathological diagnoses has been detailed in Table 4.

			VC palsy at POD 5		
			no palsy	palsy	Total
Pathological Diagnosis	Benign	Count	64	10	74
		% within Pathological Diagnosis	86.5%	13.5%	100.0%

	Malignant	Count	10	8	18
		% within Pathological Diagnosis	55.6%	44.4%	100.0%
	Thyroiditis	Count	9	2	11
		% within Pathological Diagnosis	81.8%	18.2%	100.0%
	Benign+ Thyroiditis	Count	0	1	1
		% within Pathological Diagnosis	.0%	100.0%	100.0%
	Malignancy+Thyroiditis	Count	0	1	1
		% within Pathological Diagnosis	.0%	100.0%	100.0%
Total		Count	83	22	105
		% within Pathological Diagnosis	79.0%	21.0%	100.0%

Table 4

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.067[a]	4	.003
Likelihood Ratio	14.024	4	.007
Linear-by-Linear Association	7.594	1	.006

The mean voice assessment score on the 5th post-operative day for the 105 patients was 10.3 ± 10.2(0 – 43) (Plate 1). There was a significant difference in the mean scores among the groups ($p<0.05$), as shown in Plate 2. In addition, the mean voice assessment score on the 5th post-operative day was significantly more than that during pre-operative assessment when considered overall for the 105 patients in this study ($p < 0.0001$).

The overall rate of permanent vocal cord palsy was 7.6% (8 of 105 patients). Among the 74 patients with benign disease, 2 patients had permanent palsy (2.7%). Among the 18 patients with malignant thyroid disease, 4 patients (22.2%) had permanent vocal cord palsy. Of the 11 patients with thyroiditis, one patient had permanent vocal cord palsy (9.1%). There was no permanent vocal cord palsy in the lone patient with thyroiditis co-existent with benign disease. In the patient with thyroiditis and co-existent malignant disease, permanent vocal cord palsy was seen (100%).

There was a significant difference in the incidence of permanent vocal cord palsy between the benign and malignant subgroups ($p = 0.005$). Details of correlation of permanent vocal cord palsy with thyroid pathology are as shown in Plate 3.

When the laterality of vocal cord palsy on the 5th POD was analyzed (Plate 4), the incidence of left vocal cord palsy was 11.4% (12 out of 105 patients), while that on the right side was 8.6% (9 out of 105 patients). This difference in incidence was found to be statistically significant ($p < 0.005$). One patient had bilateral vocal cord palsy in the early post-operative period.

When transient post-operative vocal cord palsy was correlated with individual post-operative voice symptoms, significant correlation was established between transient post-operative vocal cord palsy and all the voice symptoms except for sore throat and cervical lymphadenopathy.

Patient with temporary vocal cod palsy were correlated with the voice assessment scores done on days 5 & 180. 83 patients had normal functioning vocal cords among the 105 patients and the rest 22 had vocal cord palsy done on day 5.we analysed the various parameters in the VAS on day 5 & 180 for its implication with the cord status. Among the 15 parameters in the VAS, all 13 parameters except sore throat & cervical lymphadenopathy had

an impact with greater scores in patients with temporary palsy than without palsy having a statistical difference($p<0.05$).

In those patients who developed vocal cord palsy, the incidence of transient palsy was correlated with the voice assessment score on post-op day 5 and the VAS on post-op day 180 (Plate 7a and 7b). There was significant correlation between the VAS on post-op day 5 and that on post-op day 180 ($p<0.005$). Those patients with vocal cord palsy who had high VAS on post-op day 5 had persistent high scores on day 180 as well. In such patients, there was a higher risk of permanent vocal cord palsy. This fact underscores the importance of voice assessment score for its prediction of permanent vocal cord palsy.

There was significant correlation ($p<0.005$) of the various parameters of VAS on post-op day 180 with vocal cord palsy, as shown in plate 9. The comparison of the pre-op VAS with that on post-op day 5 is as shown in plates 10 & 11. The comparison of the overall VAS on post-op day 5 with that on post-op day 180 is as shown in plates 12 & 13. The comparison of the overall pre-op VAS with that on post-op day 180 is as shown in plates 14 & 15.

Of the 105 patients who underwent surgery, EBSLN was identified on the left side in 94 patients. Of the remaining 11 patients, it was not identified. On analysis with the VAS on post-op days 5 and 180, it was found that this aspect correlated with VAS on post-op day 5($p=0.043$), but not with that on post-op day 180 ($p=0.78$).

With regards to the right EBSLN, it was identified in 96 patients, while it was not seen in the other 9 patients. On analysis with the VAS on post-op days 5 and 180, there was no correlation with the post-op VAS, either on day 5 ($p=0.106$) or on day 180 ($p=0.99$).

Correlation of temporary palsy with anatomical relationship of RLN

On left side when the relationship of RLN and ITA was analysed,in the majority of cases {n=92} RLN was deep to the ITA.In 9 cases RLN was in between branches of ITA where as in one case RLN was superficial to ITA and in three RLN was not identified.The rate of temporary vocal cord palsy was correlaeted with ITA and RLN relationship and there was no statistical significance ($p = 0.244$.)

On right side when the relationship of RLN and ITA was analysed,in the majority of cases {n=86} RLN was deep to the ITA.In 14 cases RLN was in between branches of ITA where as in one case RLN was superficial to ITA and in 4 cases RLN was not identified.The rate of temporary vocal cord palsy was correlaeted with ITA and RLN relationship and there was no statistical significance ($p = 0.76$).

Relation of RLN with ITA and correlation with vocal cord palsy

When vocal cord palsy was correlated with regard to the relation of RLN with ITA, the findings were as follows:

On the left side, the RLN was deep to the main trunk of the ITA in 92 patients, found coursing in between the ITA branches in 9 patients and found superficial to the main trunk of ITA in 1 patient. The RLN was not identified I on the left side in 3 patients.

On the right side, the RLN was deep to the ITA in 86 patients, found coursing in between the branches of the ITA in 8 patients and superficial to the main trunk of ITA in 4 patients. The RLN was not identified on the right side in 7 patients.

The rate of transient or permanent RLN palsy was not influenced by the RLN-ITA relationship on either side.

DISCUSSION

The incidence of transient RLN paralysis after thyroid surgery ranges from 2.6% to 7.2% according to various researchers [15]. With regards to permanent RLN paralysis, various studies have reported incidence ranging from 0.5% to about 1%[15].

In the present study, the incidence of transient RLN palsy was 21.0% and that of permanent RLN palsy was 7.6%. Evidently, the incidence of both types of RLN palsy were higher when compared with other similar studies.

In the present study, the post-operative vocal cord status was documented for each patient with the help of videolaryngoscopy (VLS). This is not a routine practice. In addition, the rate of RLN palsy, especially that of permanent RLN palsy, may be under-reported [1] due to follow-up issues. During thyroid surgery, the EBSLN and RLN are routinely sought and identified at this centre, which is a tertiary care, teaching institution. A significant proportion of the procedures are performed by surgeons with variable experience and as a result, the learning curve is a factor which has to be considered.

Moreover, the fact that most of the cases of transient palsy recover over a period of six months. Hence, regular follow up of the patients with VLS is important. Direct examination of the vocal cords by VLS, both pre-operatively and post-operatively (on post-op days 5 and 180) is a routine practice at this centre.

With regards to the exact time for laryngeal inspection after surgery and time of diagnosis of post-operative RLN palsy, there is no consensus. Different study groups advocate follow up at different times post-operatively. While some advocate examination in the immediate post-operative period, during extubation after surgery, some others are of the opinion that the optimum time for laryngoscopy is two months after surgery. If the vocal cord palsy persists even after two months post-operatively, then laryngoscopy is advocated at six months and again after one year.[25]

In the present study, patients with malignancy had the maximum risk of vocal cord palsy in the immediate post operative period. Risk of permanent injury was also high in this group. The incidence of transient palsy was 40% (8 out of 10 patients) in this group. The lone patient with malignancy and co-existent thyroiditis had permanent vocal cord palsy.

In those with thyroiditis (n=11), 2 patients (18.2%) developed transient palsy. The incidence in those with benign pathology was 13.5% (10 of 74 patients).

Mountain JC, et al. [26] have reported pattern of incidence somewhat similar to the present study, as regards thyroid pathology. In those with carcinoma, the incidence was 8%. Chronic lymphocytic thyroiditis was associated with an incidence of 5% for transient palsy. Risk of injury increases four-fold when the nerve is not identified. [26].

The increased rate of palsy present in malignancy may be due to difficult dissection encountered during surgery, apart from the possibility of malignant infiltration of the nerve. In thyroiditis, the chronic inflammatory infiltrate and the fibrosis prevalent in the perithyroidal tissues renders dissection difficult. This may render the RLN more vulnerable.

The incidence of left vocal cord palsy was 11.4% (12 out of 105 patients), while that on the right side was 8.6% (9 out of 105 patients). This difference in incidence was found to be statistically significant ($p < 0.005$). One patient had bilateral vocal cord palsy in the early post-operative period

and the patient recovered from vocal cord palsy in one side within six month and other side continue to have palsy even after six months.

In the present study, the relationship of the RLN to the ITA and its branches did not influence the rates of RLN injury, regardless of the side.

In the present study, a validated voice assessment score (VAS) was used as a tool for objective evaluation of laryngeal symptoms, both before surgery and in the post-operative period (POD 5 and POD 180). Individual symptoms were rated with the help of a score, on the basis of severity. Overall score for each assessment was calculated.

When compared to the delayed post-operative VAS (POD 180), the early post-operative score (VAS on POD 5) was significantly higher, when considered overall for the 105 patients in this study ($p < 0.0001$).

The mean post operative score was 10.3 ± 10.2. Also, there was a significant difference of the VAS with regards to various subgroups divided on the basis of histopathology ($p < 0.005$).

According to Byung-Joon Chun, et al., 30% of the patients experience voice alteration after thyroidectomy. Aluffi, et al. [27] have reported that

appropriate postoperative voice rehabilitation may improve voice in many patients. Early post operative therapy such as voice therapy may improve many of the symptoms.

When transient palsy was correlated with the VAS on POD 5 and POD 180, significant correlation was observed ($p < 0.05$) between the incidence of palsy and the VAS on POD 5 with regards to all the symptoms, except for sore throat and cervical lymphadenopathy. Patients who had permanent vocal cord palsy had higher VAS on POD 5, when compared to those who have temporary palsy. The VAS was persistently high after 180 days as well.

Of the 105 patients who underwent surgery, the left EBSLN was identified in 94 patients, while it was not seen in the other 11 patients. When analyzed with VAS on POD 5 and POD 180, VAS was higher in those in whom EBSLN was not seen ($p=0.043$), but there was no significant correlation with regards to VAS on POD 180 ($p=0.78$).

The right EBSLN was identified in 96 patients out of the 105. Whern analyzed with the VAS scores on POD 5 and 180, there was no significant statistical correlation for either score ($p = 0.106$ and $p = 0.99$, respectively).

CONCLUSION

In the present study, the incidence of transient vocal cord palsy after total thyroidectomy, as evidenced by videolaryngoscopy, was 21%. In about two-thirds of patients, the vocal cords recovered within 6 months of surgery, so that the incidence of permanent vocal cord palsy was 7.6%.

With regards to the validated voice assessment score, the score on the 5^{th} post-operative day was invariably higher than that pre-operatively. Vocal cord palsy was associated with a higher score post-operatively. Further, in those patients who had vocal cord palsy and high voice assessment scores on the 5^{th} post-operative day, persistently high scores on the 180^{th} post-operative day and permanent vocal cord palsy were likely.

Voice assessment scoring is a reliable, noninvasive method of assessment of vocal cord function, vocal cord palsy and pattern of recovery after thyroidectomy.

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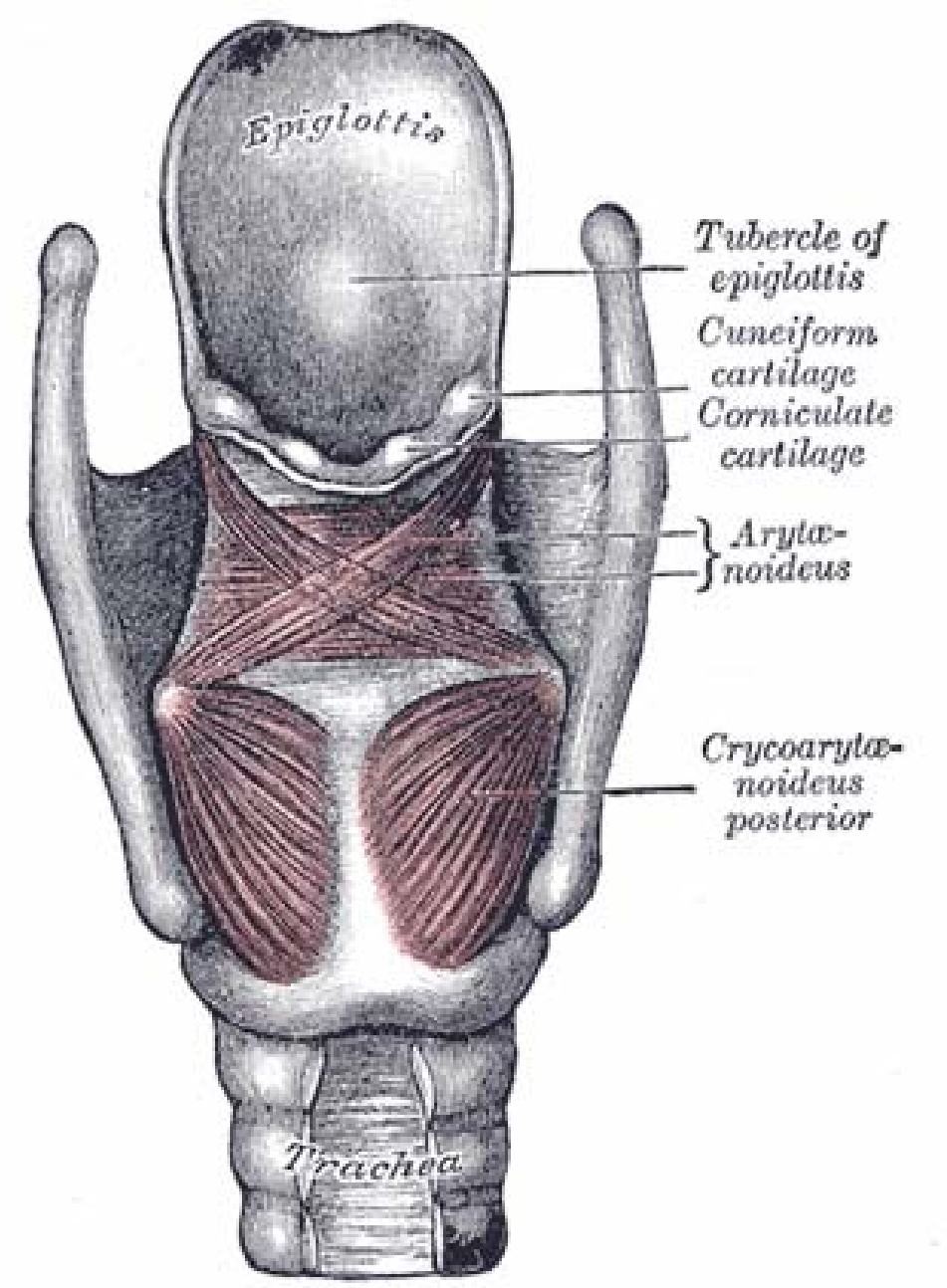


Figure 5: Laryngeal muscles - posterior view

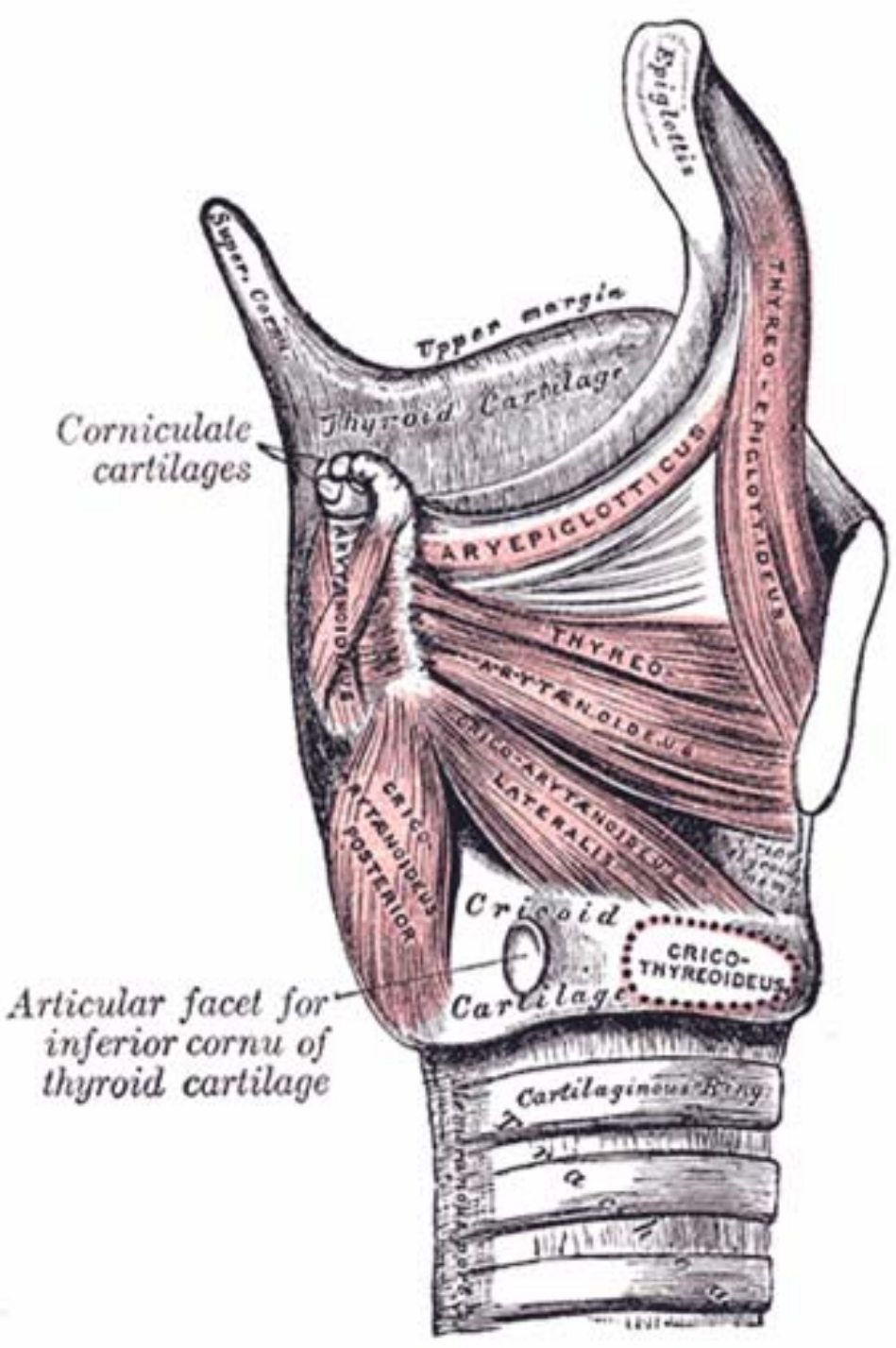


FIgure 4: Laryngeal muscles - anterolateral view

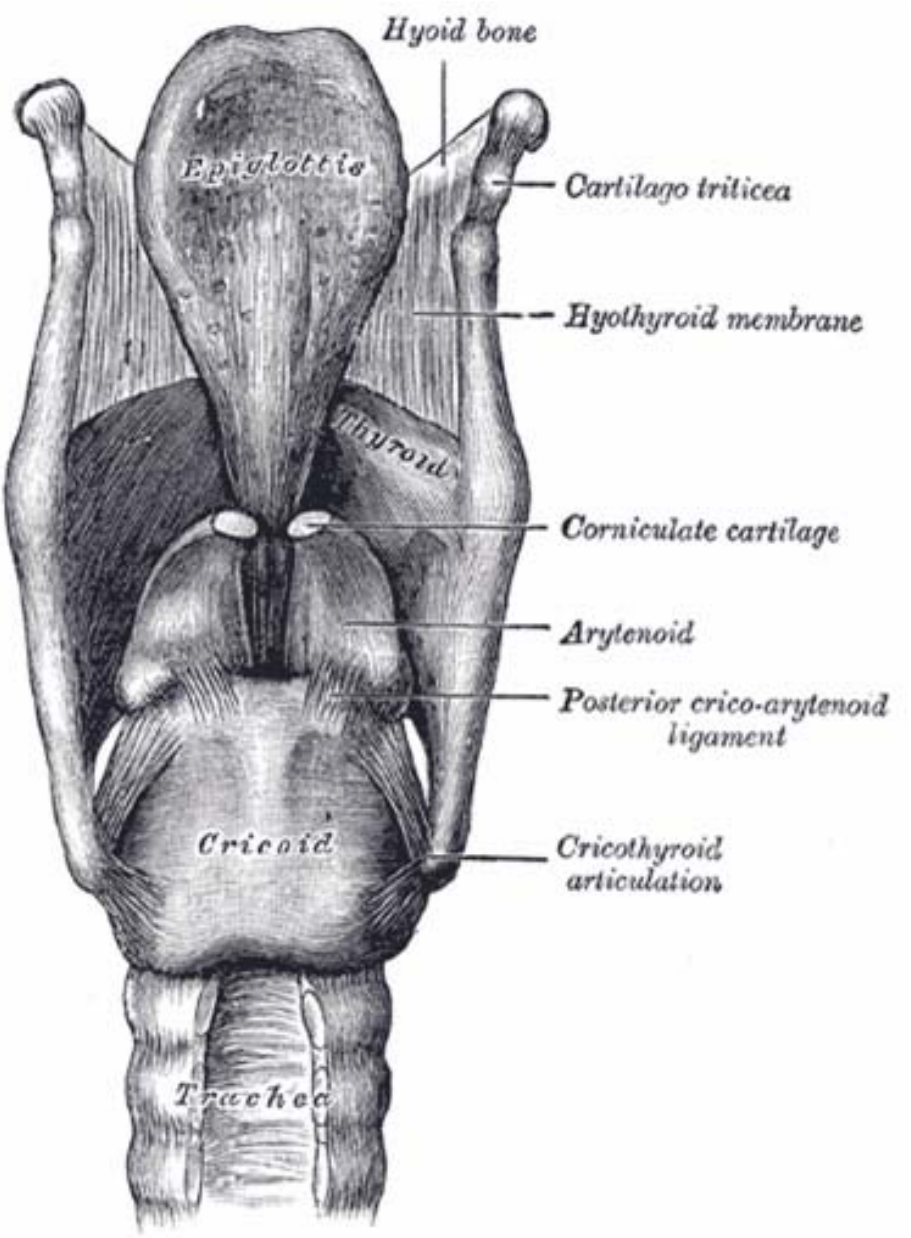


Figure 2: Laryngeal skeleton - posterior view

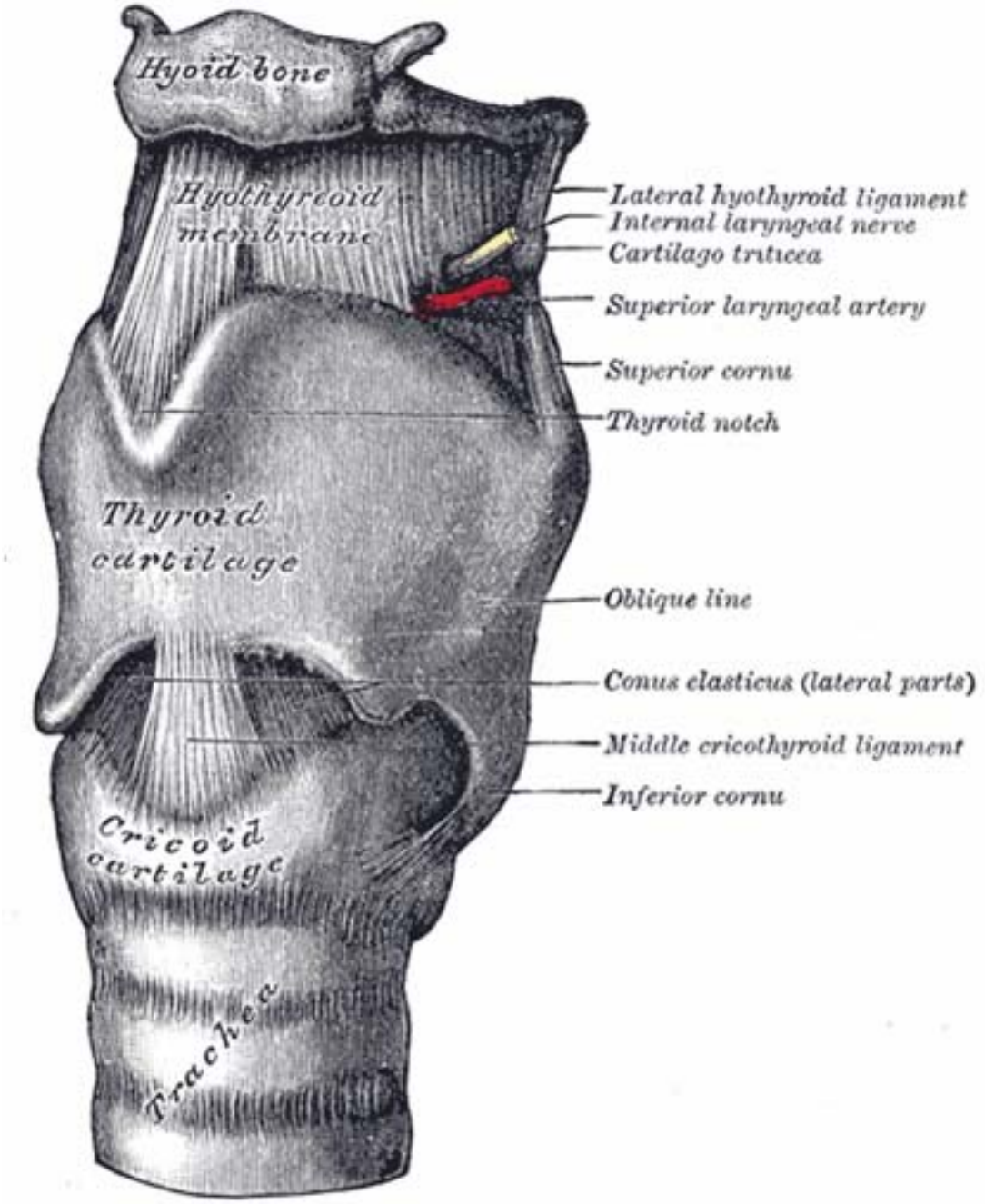


Figure 1: Laryngeal skeleton - anterolateral view

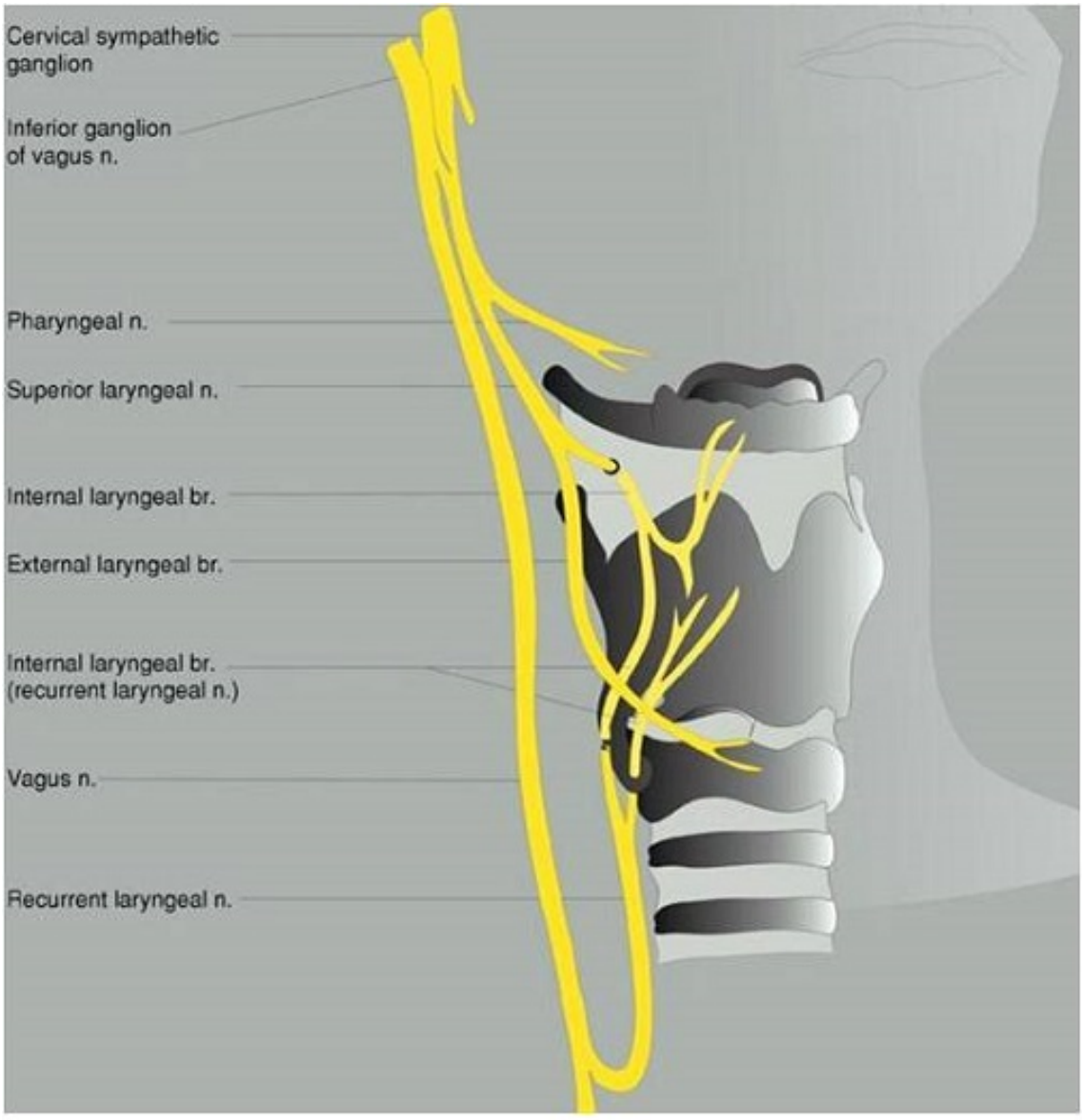


Figure 9: The RLN and the SLN in the neck

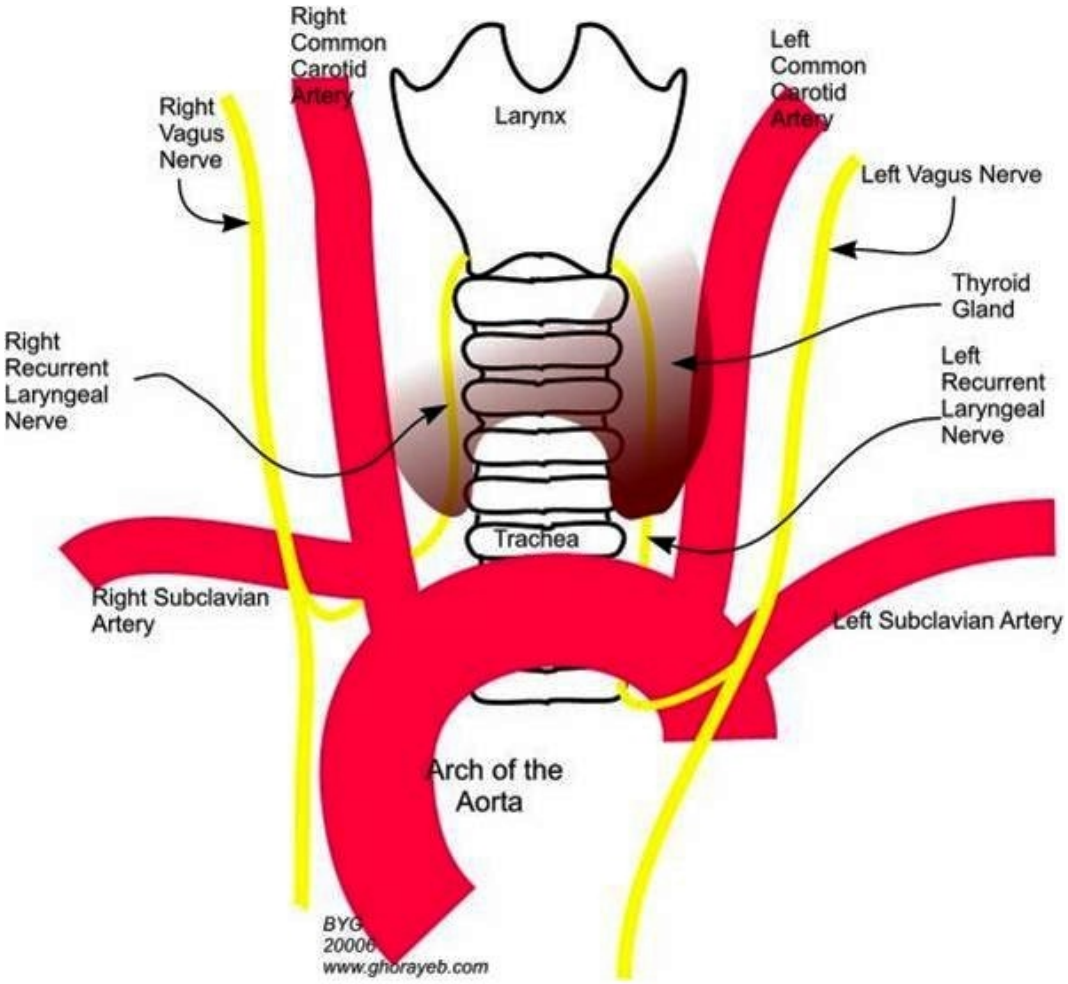


Figure 8: The course of RLN

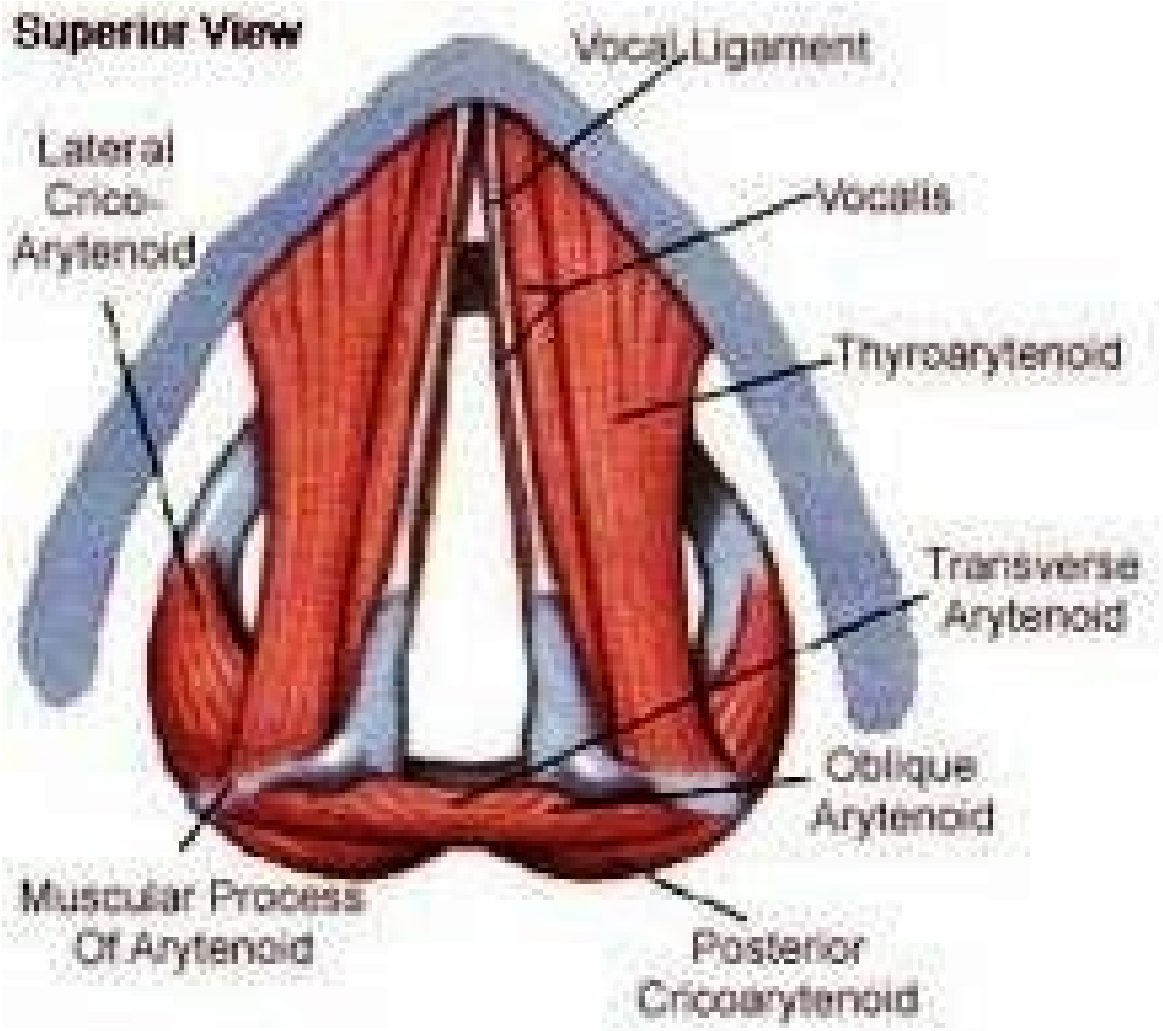


Figure 6: Vocal fold muscles

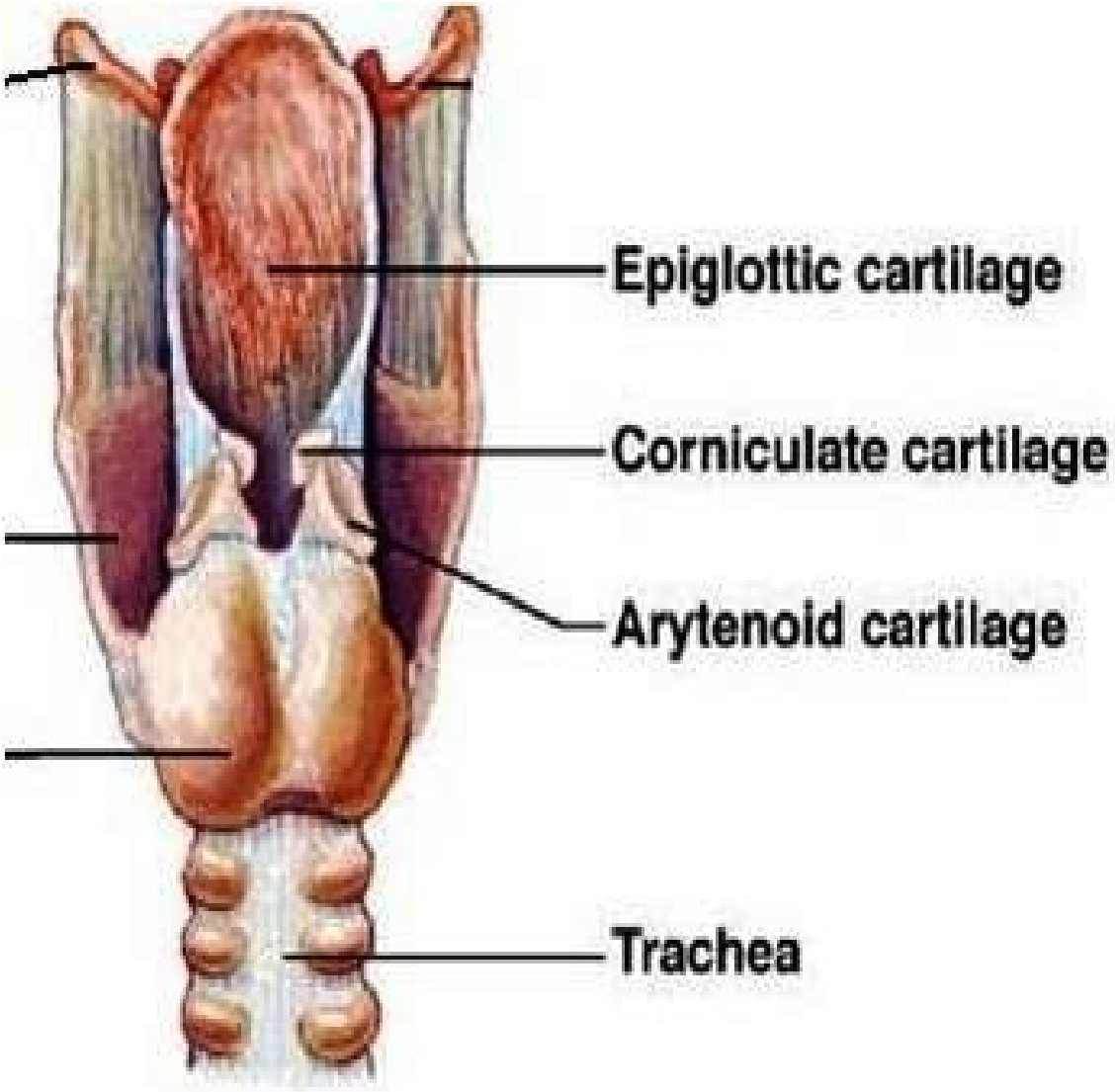


Figure 3: Laryngeal cartilages

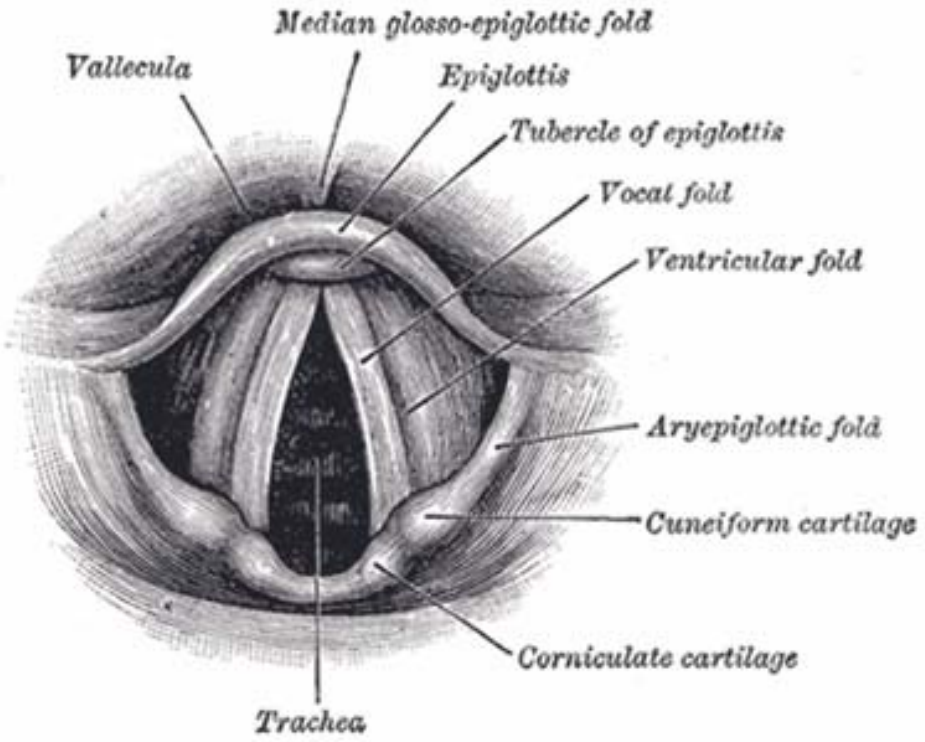


Figure 7: The laryngeal lumen as seen from above

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI -3

Telephone No : 044 25305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To
Dr .M.P.Kumaran
PG in MCH Endocrine Surgery
Madras Medical College, Chennai -3

Dear Dr .M.P.Kumaran

The Institutional Ethics committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled " Prospective evaluation of vocal cord function with intra-operative nerve identification in total thyroidectomy patients " No. 19112011

The following members of Ethics Committee were present in the meeting held on 22.11.2011 conducted at Madras Medical College, Chennai -3.

1.	Prof. S.K. Rajan. MD	-- Chairperson
2.	Prof.A. Sundaram MD Vice principal, Madras Medical College, Ch -3	-- Member Secretary
3.	Prof. R. Nandhini MD Director, Institute of Pharmacology ,MMC, Ch-3	-- Member
4	Prof. Pregna B. Dolia MD Director , Institute of Biochemistry, MMC, Ch-3	-- Member
5.	Prof. C. Rajendiran, MD Director , Inst. Of Internal Medicine, MMC, Ch-3	-- Member
6.	Prof. Md Ali MDDM Prof & Head , Dept. of MGE, MMC,Ch-3	-- Member
7. .	Prof. Shantha Ravishankar MD Prof of Neuropathology, MMC, Ch-3	-- Member
8.	Thiru. S. Govindsamy. BA BL	-- Lawyer
9.	Tmt. Arnold soulina MA	-- Social Scientist

We approve the proposal to be conducted in its presented form.

Sd/ chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

Member Secretary, Ethics Committee

Plate 10: Comparison of pre-op VAS with that on POD 5

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Sore Throat	.29	105	.743	.073
	Post 5 sore throat	1.47	105	1.373	.134
Pair 2	Pre Hoarseness	.16	105	.652	.064
	Post 5 Hoarseness	1.19	105	1.462	.143
Pair 3	Pre Loudness	.18	105	.769	.075
	Post 5 Loudness	.66	105	1.142	.111
Pair 4	Pre Loss of Voice	.09	105	.557	.054
	Post5 Loss of voice	.41	105	.997	.097
Pair 5	Pre Cough	.30	105	.759	.074
	Post5 Cough	1.27	105	1.085	.106
Pair 6	Pre Weak Voice	.13	105	.651	.064
	Post5 weak voice	.70	105	1.126	.110
Pair 7	Pre Mental Depression	.09	105	.557	.054
	Post5 Mental depression	.38	105	.934	.091
Pair 8	Pre Throat Obstruction	.17	105	.642	.063
	Post5 Throat Obstruction	.65	105	1.101	.107
Pair 9	Pre Cervical lymph nodes	.12	105	.675	.066
	Post5 Cervical LN	.17	105	.563	.055
Pair 10	Pre Voice tiredness	.11	105	.543	.053
	Post5 Voice tiredness	.52	105	1.001	.098
Pair 11	Pre inability to shout	.13	105	.651	.064
	Post5 inability to shout	.99	105	1.369	.134
Pair 12	Pre Voice Variability	.00	105	.000	.000
	Post5 voice variability	.64	105	1.084	.106
Pair 13	Pre Voice straining	.06	105	.435	.042
	Post5 Voice straining	.48	105	1.066	.104
Pair 14	Pre Voice Breaking	.09	105	.557	.054
	Post5 Voice Break	.66	105	1.117	.109
Pair 15	Pre Lonliness	.05	105	.488	.048
	Post5 Voice Loneliness	.21	105	.703	.069

Scoring Parameter	**P value**
Sore throat	0.03
Hoarsenes of voice	<.001
Loudness	<.001
Loss of voice	0.774
Cough	<.001
Weak voice	<.001
Mental depression	<.001
Throat obstruction	<.001
Cervical lymphadenopathy	1.00
Voice tiredness	<.001
Inability to shout	<.001
Voice variability	<.001
Voice straining	<.001
Voice break	<.001
Loneliness	<.001

Plate 9: Significance of various components of VAS on POD 180 and correlation with permanent vocal cord palsy

Scoring Parameter	P value
Sore throat	0.69
Hoarsenes of voice	<.001
Loudness	<.001
Loss of voice	0.008
Cough	<.001
Weak voice	<.001
Mental depression	0.004
Throat obstruction	0.010
Cervical lymphadenopathy	0.37
Voice tredness	0.02
Inability to shout	<.001
Voice variability	0.04
Voice straining	<.001
Voice break	0.003
Loneliness	0.002

Plate 8: Significance of various components of VAS on POD 5

Plate 7: Correlation of VAS on POD 5 with vocal cord palsy on POD 5

	VC palsy at POD 180	N	Mean Rank
Post 5 sore throat	no palsy	97	53.31
	VC palsy	8	49.19
Post 5 Hoarseness	no palsy	97	50.28
	VC palsy	8	85.94
Post 5 Loudness	no palsy	97	50.77
	VC palsy	8	80.00
Post5 Loss of voice	no palsy	97	51.56
	VC palsy	8	70.50
Post5 Cough	no palsy	97	50.51
	VC palsy	8	83.25
Post5 weak voice	no palsy	97	50.20
	VC palsy	8	86.94
Post5 Mental depression	no palsy	97	51.44
	VC palsy	8	71.88
Post5 Throat Obstruction	no palsy	97	51.25
	VC palsy	8	74.19
Post5 Cervical LN	no palsy	97	53.37
	VC palsy	8	48.50
Post5 Voice tiredness	no palsy	97	51.61
	VC palsy	8	69.81
Post5 inability to shout	no palsy	97	50.31
	VC palsy	8	85.56
Post5 voice variability	no palsy	97	51.69
	VC palsy	8	68.94
Post5 Voice straining	no palsy	97	50.46
	VC palsy	8	83.81
Post5 Voice Break	no palsy	97	50.96
	VC palsy	8	77.75
Post5 Voice Loneliness	no palsy	97	51.72
	VC palsy	8	68.56

Plate 6: Correlation of pre-op, POD 5 and POD 180 VAS

Pathological Diagnosis		Preop Voice Assesment Score	POD5 Voice Assesment Score	POD180 Voice Assesment Score
Benign	Mean	1.27	8.70	.50
	N	74	74	74
	Std. Deviation	3.270	9.401	1.682
	Minimum	0	0	0
	Maximum	24	43	10
Malignant	Mean	4.61	14.56	5.33
	N	18	18	18
	Std. Deviation	14.255	11.893	9.876
	Minimum	0	1	0
	Maximum	61	35	32
Thyroiditis	Mean	1.91	12.55	1.36
	N	11	11	11
	Std. Deviation	2.844	10.386	3.107
	Minimum	0	0	0
	Maximum	9	36	9
Benign+ Thyroiditis	Mean	.00	30.00	2.00
	N	1	1	1
	Std. Deviation	.	.	.
	Minimum	0	30	2
	Maximum	0	30	2
Malignancy+Thyroiditis	Mean	.00	9.00	15.00
	N	1	1	1
	Std. Deviation	.	.	.
	Minimum	0	9	15
	Maximum	0	9	15
Total	Mean	1.89	10.31	1.57
	N	105	105	105
	Std. Deviation	6.567	10.235	4.885
	Minimum	0	0	0
	Maximum	61	43	32

Plate 5: Mean VAS on POD 180

	N	Mean	Std. Deviation	Minimum	Maximum
Post180 sore throat	105	.18	.886	0	8
Post180 hoarseness	105	.18	.662	0	4
Post180 Loudnesse	105	.03	.293	0	3
Post180 Loss of Voice	105	.02	.195	0	2
Post180 Cough	105	.24	.687	0	3
Post180 weak voice	105	.14	.527	0	3
Post180 Mental depression	105	.10	.479	0	3
Post180 Throat Obstruction	105	.13	.573	0	4
Post180 Cervical LN	105	.00	.000	0	0
Post180 Voice tiredness	105	.14	.508	0	2
Post180_inability to shout	105	.13	.556	0	3
Post180 Voice Varaibility	105	.10	.479	0	3
Post180 Voice straining	105	.09	.395	0	2
Post180 Voice break	105	.10	.479	0	3
Post180_loneliness	105	.05	.350	0	3
VC palsy at POD 180	105	1.08	.267	1	2

Plate 4: Laterality of vocal cord palsy

			Total			
			0	Right side	Left side	Both sides
Pathological Diagnosis	Benign	Count	64	4	5	74
		% within Pathological Diagnosis	86.5%	5.4%	6.8%	100.0%
	Malignant	Count	10	3	5	18
		% within Pathological Diagnosis	55.6%	16.7%	27.8%	100.0%
	Thyroiditis	Count	9	1	1	11
		% within Pathological Diagnosis	81.8%	9.1%	9.1%	100.0%
	Benign+ Thyroiditis	Count	0	1	0	1
		% within Pathological Diagnosis	.0%	100.0%	.0%	100.0%
	Malignancy+Thyroiditis	Count	0	0	1	1
		% within Pathological Diagnosis	.0%	.0%	100.0%	100.0%
Total		Count	83	9	12	105
		% within Pathological Diagnosis	79.0%	8.6%	11.4%	100.0%

Plate 3: Correlation of permanent vocal cord palsy with thyroid pathology

			VC palsy at POD 180		Total
			no palsy	VC palsy	
Pathological Diagnosis	Benign	Count	72	2	74
		% within Pathological Diagnosis	97.3%	2.7%	100.0%
	Malignant	Count	14	4	18
		% within Pathological Diagnosis	77.8%	22.2%	100.0%
	Thyroiditis	Count	10	1	11
		% within Pathological Diagnosis	90.9%	9.1%	100.0%
	Benign+ Thyroiditis	Count	1	0	1
		% within Pathological Diagnosis	100.0%	.0%	100.0%
	Malignancy+Thyroiditis	Count	0	1	1
		% within Pathological Diagnosis	.0%	100.0%	100.0%
Total		Count	97	8	105
		% within Pathological Diagnosis	92.4%	7.6%	100.0%

Plate 2: Correlation of VAS with RLN palsy and histopathology

Pathological Diagnosis		Preop Voice Assesment Score	POD5 Voice Assesment Score
Benign	Mean	1.27	8.70
	N	74	74
	Std. Deviation	3.270	9.401
	Minimum	0	0
	Maximum	24	43
Malignant	Mean	4.61	14.56
	N	18	18
	Std. Deviation	14.255	11.893
	Minimum	0	1
	Maximum	61	35
Thyroiditis	Mean	1.91	12.55
	N	11	11
	Std. Deviation	2.844	10.386
	Minimum	0	0
	Maximum	9	36
Benign+ Thyroiditis	Mean	.00	30.00
	N	1	1
	Std. Deviation	.	.
	Minimum	0	30
	Maximum	0	30
Malignancy+Thyroiditis	Mean	.00	9.00
	N	1	1
	Std. Deviation	.	.
	Minimum	0	9
	Maximum	0	9
Total	Mean	1.89	10.31
	N	105	105
	Std. Deviation	6.567	10.235
	Minimum	0	0
	Maximum	61	43

Plate 1: Voice Assessment Score on POD 5 for those with transient RLN palsy

	N	Mean	Std. Deviation	Minimum	Maximum
Post 5 sore throat	105	1.47	1.373	0	10
Post 5 Hoarseness	105	1.19	1.462	0	5
Post 5 Loudness	105	.66	1.142	0	4
Post5 Loss of voice	105	.41	.997	0	4
Post5 Cough	105	1.27	1.085	0	4
Post5 weak voice	105	.70	1.126	0	4
Post5 Mental depression	105	.38	.934	0	4
Post5 Throat Obstruction	105	.65	1.101	0	4
Post5 Cervical LN	105	.17	.563	0	2
Post5 Voice tiredness	105	.52	1.001	0	3
Post5 inability to shout	105	.99	1.369	0	4
Post5 voice variability	105	.64	1.084	0	4
Post5 Voice straining	105	.48	1.066	0	4
Post5 Voice Break	105	.66	1.117	0	4
Post5 Voice Loneliness	105	.21	.703	0	3
VC palsy at POD 5	105	1.21	.409	1	2

Plate 11: Comparison of pre-op VAS with that on POD 5

		N	Correlation	Sig.
Pair 1	Pre Sore Throat & Post 5 sore throat	105	.122	.213
Pair 2	Pre Hoarseness & Post 5 Hoarseness	105	.098	.318
Pair 3	Pre Loudness & Post 5 Loudness	105	.268	.006
Pair 4	Pre Loss of Voice & Post5 Loss of voice	105	.109	.267
Pair 5	Pre Cough & Post5 Cough	105	.312	.001
Pair 6	Pre Weak Voice & Post5 weak voice	105	.067	.495
Pair 7	Pre Mental Depression & Post5 Mental depression	105	.214	.028
Pair 8	Pre Throat Obstruction & Post5 Throat Obstruction	105	.005	.962
Pair 9	Pre Cervical lymph nodes & Post5 Cervical LN	105	.045	.650
Pair 10	Pre Voice tiredness & Post5 Voice tiredness	105	.172	.079
Pair 11	Pre inability to shout & Post5 inability to shout	105	.185	.059
Pair 12	Pre Voice Variability & Post5 voice variability	105	.	.
Pair 13	Pre Voice straining & Post5 Voice straining	105	.190	.053
Pair 14	Pre Voice Breaking & Post5 Voice Break	105	-.091	.353
Pair 15	Pre Lonliness & Post5 Voice Loneliness	105	.251	.010

Plate 12: Correlation of overall VAS on POD 5 with that on POD 180

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post 5 sore throat	1.47	105	1.373	.134
	Post180 sore throat	.18	105	.886	.086
Pair 2	Post 5 Hoarseness	1.19	105	1.462	.143
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Post 5 Loudness	.66	105	1.142	.111
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Post5 Loss of voice	.41	105	.997	.097
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Post5 Cough	1.27	105	1.085	.106
	Post180 Cough	.24	105	.687	.067
Pair 6	Post5 weak voice	.70	105	1.126	.110
	Post180 weak voice	.14	105	.527	.051
Pair 7	Post5 Mental depression	.38	105	.934	.091
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Post5 Throat Obstruction	.65	105	1.101	.107
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Post5 Cervical LN	.17	105	.563	.055
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Post5 Voice tiredness	.52	105	1.001	.098
	Post180 Cervical LN	.00	105	.000	.000
Pair 11	Post5 inability to shout	.99	105	1.369	.134
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Post5 voice variability	.64	105	1.084	.106
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Post5 Voice straining	.48	105	1.066	.104
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Post5 Voice Break	.66	105	1.117	.109
	Post180 Voice break	.10	105	.479	.047
Pair 15	Post5 Voice Loneliness	.21	105	.703	.069
	Post180_loneliness	.05	105	.350	.034

Plate 12: Correlation of overall VAS on POD 5 with that on POD 180

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post 5 sore throat	1.47	105	1.373	.134
	Post180 sore throat	.18	105	.886	.086
Pair 2	Post 5 Hoarseness	1.19	105	1.462	.143
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Post 5 Loudness	.66	105	1.142	.111
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Post5 Loss of voice	.41	105	.997	.097
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Post5 Cough	1.27	105	1.085	.106
	Post180 Cough	.24	105	.687	.067
Pair 6	Post5 weak voice	.70	105	1.126	.110
	Post180 weak voice	.14	105	.527	.051
Pair 7	Post5 Mental depression	.38	105	.934	.091
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Post5 Throat Obstruction	.65	105	1.101	.107
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Post5 Cervical LN	.17	105	.563	.055
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Post5 Voice tiredness	.52	105	1.001	.098
	Post180 Cervical LN	.00	105	.000	.000
Pair 11	Post5 inability to shout	.99	105	1.369	.134
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Post5 voice variability	.64	105	1.084	.106
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Post5 Voice straining	.48	105	1.066	.104
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Post5 Voice Break	.66	105	1.117	.109
	Post180 Voice break	.10	105	.479	.047
	Post5 Voice Loneliness	.21	105	.703	.069

Plate 13: Correlation of VAS on POD 5 with that on POD 180

Plate 12: Correlation of overall VAS on POD 5 with that on POD 180

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post 5 sore throat	1.47	105	1.373	.134
	Post180 sore throat	.18	105	.886	.086
Pair 2	Post 5 Hoarseness	1.19	105	1.462	.143
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Post 5 Loudness	.66	105	1.142	.111
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Post5 Loss of voice	.41	105	.997	.097
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Post5 Cough	1.27	105	1.085	.106
	Post180 Cough	.24	105	.687	.067
Pair 6	Post5 weak voice	.70	105	1.126	.110
	Post180 weak voice	.14	105	.527	.051
Pair 7	Post5 Mental depression	.38	105	.934	.091
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Post5 Throat Obstruction	.65	105	1.101	.107
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Post5 Cervical LN	.17	105	.563	.055
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Post5 Voice tiredness	.52	105	1.001	.098
	Post180 Cervical LN	.00	105	.000	.000
Pair 11	Post5 inability to shout	.99	105	1.369	.134
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Post5 voice variability	.64	105	1.084	.106
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Post5 Voice straining	.48	105	1.066	.104
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Post5 Voice Break	.66	105	1.117	.109
	Post180 Voice break	.10	105	.479	.047
	Post5 Voice Loneliness	.21	105	.703	.069

		N	Correlation	Sig.
Pair 1	Post 5 sore throat & Post180 sore throat	105	.056	.568
Pair 2	Post 5 Hoarseness & Post180 hoarseness	105	.352	.000

Plate 12: Correlation of overall VAS on POD 5 with that on POD 180

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post 5 sore throat	1.47	105	1.373	.134
	Post180 sore throat	.18	105	.886	.086
Pair 2	Post 5 Hoarseness	1.19	105	1.462	.143
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Post 5 Loudness	.66	105	1.142	.111
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Post5 Loss of voice	.41	105	.997	.097
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Post5 Cough	1.27	105	1.085	.106
	Post180 Cough	.24	105	.687	.067
Pair 6	Post5 weak voice	.70	105	1.126	.110
	Post180 weak voice	.14	105	.527	.051
Pair 7	Post5 Mental depression	.38	105	.934	.091
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Post5 Throat Obstruction	.65	105	1.101	.107
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Post5 Cervical LN	.17	105	.563	.055
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Post5 Voice tiredness	.52	105	1.001	.098
	Post180 Cervical LN	.00	105	.000	.000
Pair 11	Post5 inability to shout	.99	105	1.369	.134
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Post5 voice variability	.64	105	1.084	.106
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Post5 Voice straining	.48	105	1.066	.104
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Post5 Voice Break	.66	105	1.117	.109
	Post180 Voice break	.10	105	.479	.047
	Post5 Voice Loneliness	.21	105	.703	.069

Pair 3	Post 5 Loudness & Post180 Loudnesse	105	.202	.039
Pair 4	Post5 Loss of voice & Post180 Loss of Voice	105	-.040	.682

Plate 12: Correlation of overall VAS on POD 5 with that on POD 180

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post 5 sore throat	1.47	105	1.373	.134
	Post180 sore throat	.18	105	.886	.086
Pair 2	Post 5 Hoarseness	1.19	105	1.462	.143
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Post 5 Loudness	.66	105	1.142	.111
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Post5 Loss of voice	.41	105	.997	.097
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Post5 Cough	1.27	105	1.085	.106
	Post180 Cough	.24	105	.687	.067
Pair 6	Post5 weak voice	.70	105	1.126	.110
	Post180 weak voice	.14	105	.527	.051
Pair 7	Post5 Mental depression	.38	105	.934	.091
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Post5 Throat Obstruction	.65	105	1.101	.107
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Post5 Cervical LN	.17	105	.563	.055
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Post5 Voice tiredness	.52	105	1.001	.098
	Post180 Cervical LN	.00	105	.000	.000
Pair 11	Post5 inability to shout	.99	105	1.369	.134
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Post5 voice variability	.64	105	1.084	.106
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Post5 Voice straining	.48	105	1.066	.104
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Post5 Voice Break	.66	105	1.117	.109
	Post180 Voice break	.10	105	.479	.047
	Post5 Voice Loneliness	.21	105	.703	.069

Pair 5	Post5 Cough & Post180 Cough	105	.288	.003
Pair 6	Post5 weak voice & Post180 weak voice	105	.380	.000

Plate 12: Correlation of overall VAS on POD 5 with that on POD 180

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post 5 sore throat	1.47	105	1.373	.134
	Post180 sore throat	.18	105	.886	.086
Pair 2	Post 5 Hoarseness	1.19	105	1.462	.143
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Post 5 Loudness	.66	105	1.142	.111
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Post5 Loss of voice	.41	105	.997	.097
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Post5 Cough	1.27	105	1.085	.106
	Post180 Cough	.24	105	.687	.067
Pair 6	Post5 weak voice	.70	105	1.126	.110
	Post180 weak voice	.14	105	.527	.051
Pair 7	Post5 Mental depression	.38	105	.934	.091
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Post5 Throat Obstruction	.65	105	1.101	.107
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Post5 Cervical LN	.17	105	.563	.055
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Post5 Voice tiredness	.52	105	1.001	.098
	Post180 Cervical LN	.00	105	.000	.000
Pair 11	Post5 inability to shout	.99	105	1.369	.134
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Post5 voice variability	.64	105	1.084	.106
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Post5 Voice straining	.48	105	1.066	.104
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Post5 Voice Break	.66	105	1.117	.109
	Post180 Voice break	.10	105	.479	.047
	Post5 Voice Loneliness	.21	105	.703	.069

Pair 7	Post5 Mental depression & Post180 Mental depression	105	.082	.406
Pair 8	Post5 Throat Obstruction & Post180 Throat Obstruction	105	.441	.000

Plate 12: Correlation of overall VAS on POD 5 with that on POD 180

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post 5 sore throat	1.47	105	1.373	.134
	Post180 sore throat	.18	105	.886	.086
Pair 2	Post 5 Hoarseness	1.19	105	1.462	.143
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Post 5 Loudness	.66	105	1.142	.111
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Post5 Loss of voice	.41	105	.997	.097
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Post5 Cough	1.27	105	1.085	.106
	Post180 Cough	.24	105	.687	.067
Pair 6	Post5 weak voice	.70	105	1.126	.110
	Post180 weak voice	.14	105	.527	.051
Pair 7	Post5 Mental depression	.38	105	.934	.091
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Post5 Throat Obstruction	.65	105	1.101	.107
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Post5 Cervical LN	.17	105	.563	.055
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Post5 Voice tiredness	.52	105	1.001	.098
	Post180 Cervical LN	.00	105	.000	.000
Pair 11	Post5 inability to shout	.99	105	1.369	.134
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Post5 voice variability	.64	105	1.084	.106
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Post5 Voice straining	.48	105	1.066	.104
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Post5 Voice Break	.66	105	1.117	.109
	Post180 Voice break	.10	105	.479	.047
	Post5 Voice Loneliness	.21	105	.703	.069
Pair 9	Post5 Cervical LN & Post180 Cervical LN	105	.	.	
Pair 10	Post5 Voice tiredness & Post180 Cervical LN	105	.	.	

Plate 12: Correlation of overall VAS on POD 5 with that on POD 180

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post 5 sore throat	1.47	105	1.373	.134
	Post180 sore throat	.18	105	.886	.086
Pair 2	Post 5 Hoarseness	1.19	105	1.462	.143
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Post 5 Loudness	.66	105	1.142	.111
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Post5 Loss of voice	.41	105	.997	.097
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Post5 Cough	1.27	105	1.085	.106
	Post180 Cough	.24	105	.687	.067
Pair 6	Post5 weak voice	.70	105	1.126	.110
	Post180 weak voice	.14	105	.527	.051
Pair 7	Post5 Mental depression	.38	105	.934	.091
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Post5 Throat Obstruction	.65	105	1.101	.107
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Post5 Cervical LN	.17	105	.563	.055
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Post5 Voice tiredness	.52	105	1.001	.098
	Post180 Cervical LN	.00	105	.000	.000
Pair 11	Post5 inability to shout	.99	105	1.369	.134
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Post5 voice variability	.64	105	1.084	.106
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Post5 Voice straining	.48	105	1.066	.104
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Post5 Voice Break	.66	105	1.117	.109
	Post180 Voice break	.10	105	.479	.047
	Post5 Voice Loneliness	.21	105	.703	.069

Pair 11	Post5 inability to shout & Post180_inability to shout	105	.292	.002
Pair 12	Post5 voice variability & Post180 Voice Varaibility	105	.166	.090

Plate 12: Correlation of overall VAS on POD 5 with that on POD 180

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post 5 sore throat	1.47	105	1.373	.134
	Post180 sore throat	.18	105	.886	.086
Pair 2	Post 5 Hoarseness	1.19	105	1.462	.143
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Post 5 Loudness	.66	105	1.142	.111
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Post5 Loss of voice	.41	105	.997	.097
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Post5 Cough	1.27	105	1.085	.106
	Post180 Cough	.24	105	.687	.067
Pair 6	Post5 weak voice	.70	105	1.126	.110
	Post180 weak voice	.14	105	.527	.051
Pair 7	Post5 Mental depression	.38	105	.934	.091
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Post5 Throat Obstruction	.65	105	1.101	.107
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Post5 Cervical LN	.17	105	.563	.055
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Post5 Voice tiredness	.52	105	1.001	.098
	Post180 Cervical LN	.00	105	.000	.000
Pair 11	Post5 inability to shout	.99	105	1.369	.134
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Post5 voice variability	.64	105	1.084	.106
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Post5 Voice straining	.48	105	1.066	.104
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Post5 Voice Break	.66	105	1.117	.109
	Post180 Voice break	.10	105	.479	.047
	Post5 Voice Loneliness	.21	105	.703	.069

Pair 13	Post5 Voice straining & Post180 Voice straining	105	.404	.000
Pair 14	Post5 Voice Break & Post180 Voice break	105	.230	.018

Plate 12: Correlation of overall VAS on POD 5 with that on POD 180

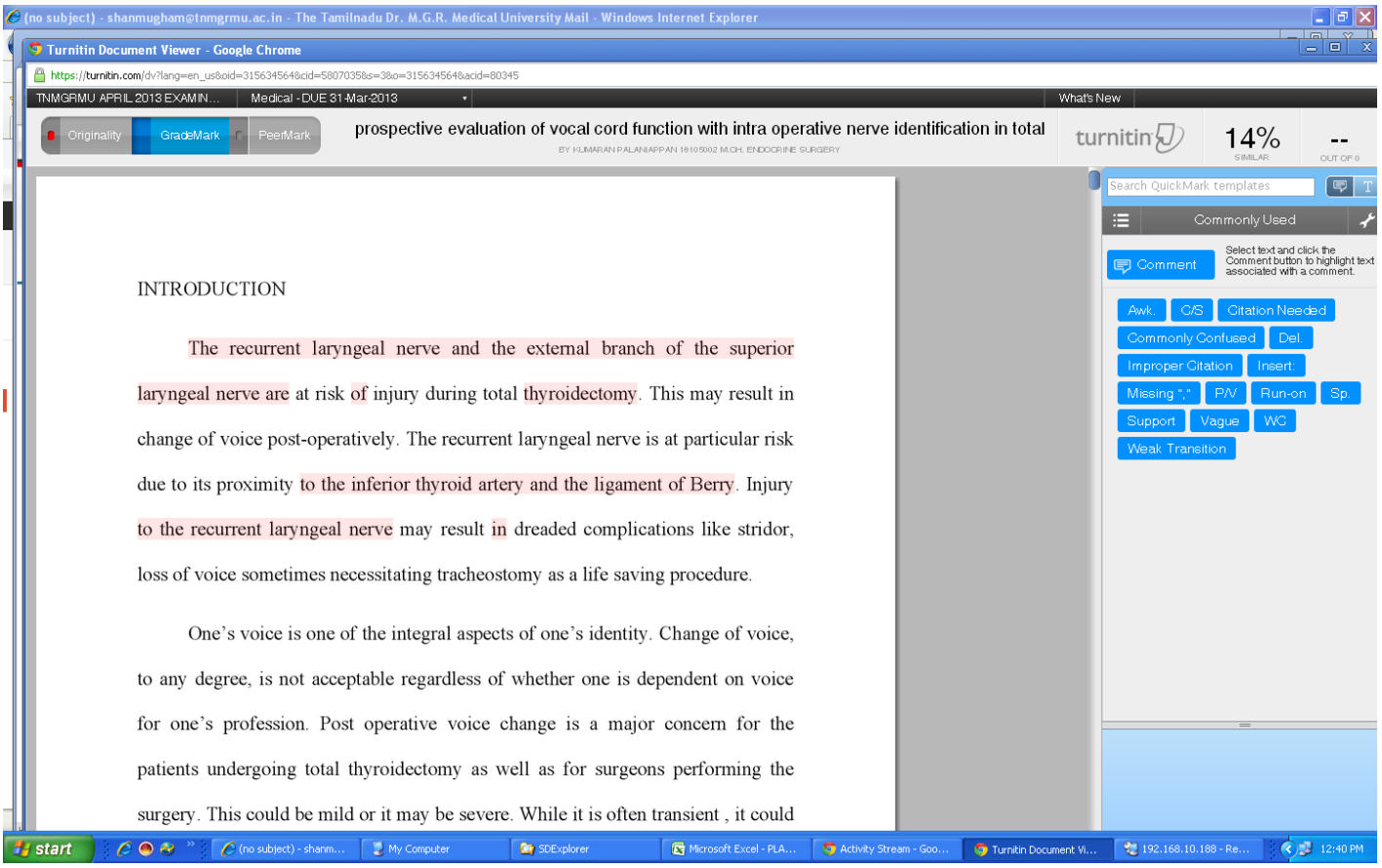
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post 5 sore throat	1.47	105	1.373	.134
	Post180 sore throat	.18	105	.886	.086
Pair 2	Post 5 Hoarseness	1.19	105	1.462	.143
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Post 5 Loudness	.66	105	1.142	.111
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Post5 Loss of voice	.41	105	.997	.097
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Post5 Cough	1.27	105	1.085	.106
	Post180 Cough	.24	105	.687	.067
Pair 6	Post5 weak voice	.70	105	1.126	.110
	Post180 weak voice	.14	105	.527	.051
Pair 7	Post5 Mental depression	.38	105	.934	.091
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Post5 Throat Obstruction	.65	105	1.101	.107
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Post5 Cervical LN	.17	105	.563	.055
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Post5 Voice tiredness	.52	105	1.001	.098
	Post180 Cervical LN	.00	105	.000	.000
Pair 11	Post5 inability to shout	.99	105	1.369	.134
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Post5 voice variability	.64	105	1.084	.106
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Post5 Voice straining	.48	105	1.066	.104
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Post5 Voice Break	.66	105	1.117	.109
	Post180 Voice break	.10	105	.479	.047
	Post5 Voice Loneliness	.21	105	.703	.069
Pair 15	Post5 Voice Loneliness & Post180_loneliness	105	.193	.048	

Plate 14: Correlation of pre-op VAS with that on POD 180 in permanent vocal cord palsy

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Sore Throat	.29	105	.743	.073
	Post180 sore throat	.18	105	.886	.086
Pair 2	Pre Hoarseness	.16	105	.652	.064
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Pre Loudness	.18	105	.769	.075
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Pre Loss of Voice	.09	105	.557	.054
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Pre Cough	.30	105	.759	.074
	Post180 Cough	.24	105	.687	.067
Pair 6	Pre Weak Voice	.13	105	.651	.064
	Post180 weak voice	.14	105	.527	.051
Pair 7	Pre Mental Depression	.09	105	.557	.054
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Pre Throat Obstruction	.17	105	.642	.063
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Pre Cervical lymph nodes	.12	105	.675	.066
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Pre Voice tiredness	.11	105	.543	.053
	Post180 Voice tiredness	.14	105	.508	.050
Pair 11	Pre inability to shout	.13	105	.651	.064
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Pre Voice Variability	.00	105	.000	.000
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Pre Voice straining	.06	105	.435	.042
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Pre Voice Breaking	.09	105	.557	.054
	Post180 Voice break	.10	105	.479	.047
Pair 15	Pre Lonliness	.05	105	.488	.048
	Post180_loneliness	.05	105	.350	.034

Plate 15: Correlation of pre-op VAS with that on POD 180 in permanent vocal cord palsy

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Sore Throat	.29	105	.743	.073
	Post180 sore throat	.18	105	.886	.086
Pair 2	Pre Hoarseness	.16	105	.652	.064
	Post180 hoarseness	.18	105	.662	.065
Pair 3	Pre Loudness	.18	105	.769	.075
	Post180 Loudnesse	.03	105	.293	.029
Pair 4	Pre Loss of Voice	.09	105	.557	.054
	Post180 Loss of Voice	.02	105	.195	.019
Pair 5	Pre Cough	.30	105	.759	.074
	Post180 Cough	.24	105	.687	.067
Pair 6	Pre Weak Voice	.13	105	.651	.064
	Post180 weak voice	.14	105	.527	.051
Pair 7	Pre Mental Depression	.09	105	.557	.054
	Post180 Mental depression	.10	105	.479	.047
Pair 8	Pre Throat Obstruction	.17	105	.642	.063
	Post180 Throat Obstruction	.13	105	.573	.056
Pair 9	Pre Cervical lymph nodes	.12	105	.675	.066
	Post180 Cervical LN	.00	105	.000	.000
Pair 10	Pre Voice tiredness	.11	105	.543	.053
	Post180 Voice tiredness	.14	105	.508	.050
Pair 11	Pre inability to shout	.13	105	.651	.064
	Post180_inability to shout	.13	105	.556	.054
Pair 12	Pre Voice Variability	.00	105	.000	.000
	Post180 Voice Varaibility	.10	105	.479	.047
Pair 13	Pre Voice straining	.06	105	.435	.042
	Post180 Voice straining	.09	105	.395	.039
Pair 14	Pre Voice Breaking	.09	105	.557	.054
	Post180 Voice break	.10	105	.479	.047
Pair 15	Pre Lonliness	.05	105	.488	.048
	Post180_loneliness	.05	105	.350	.034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What's New
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prospective evaluation of vocal cord function with intra operative nerve identification in total
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INTRODUCTION
The recurrent laryngeal nerve and the external branch of the superior laryngeal nerve are at risk of injury during total thyroidectomy. This may result in change of voice post-operatively. The recurrent laryngeal nerve is at particular risk due to its proximity to the inferior thyroid artery and the ligament of Berry. Injury to the recurrent laryngeal nerve may result in dreaded complications like stridor, loss of voice sometimes necessitating tracheostomy as a life saving procedure.
One's voice is one of the integral aspects of one's identity. Change of voice, to any degree, is not acceptable regardless of whether one is dependent on voice for one's profession. Post operative voice change is a major concern for the patients undergoing total thyroidectomy as well as for surgeons performing the surgery. This could be mild or it may be severe. While it is often transient , it could
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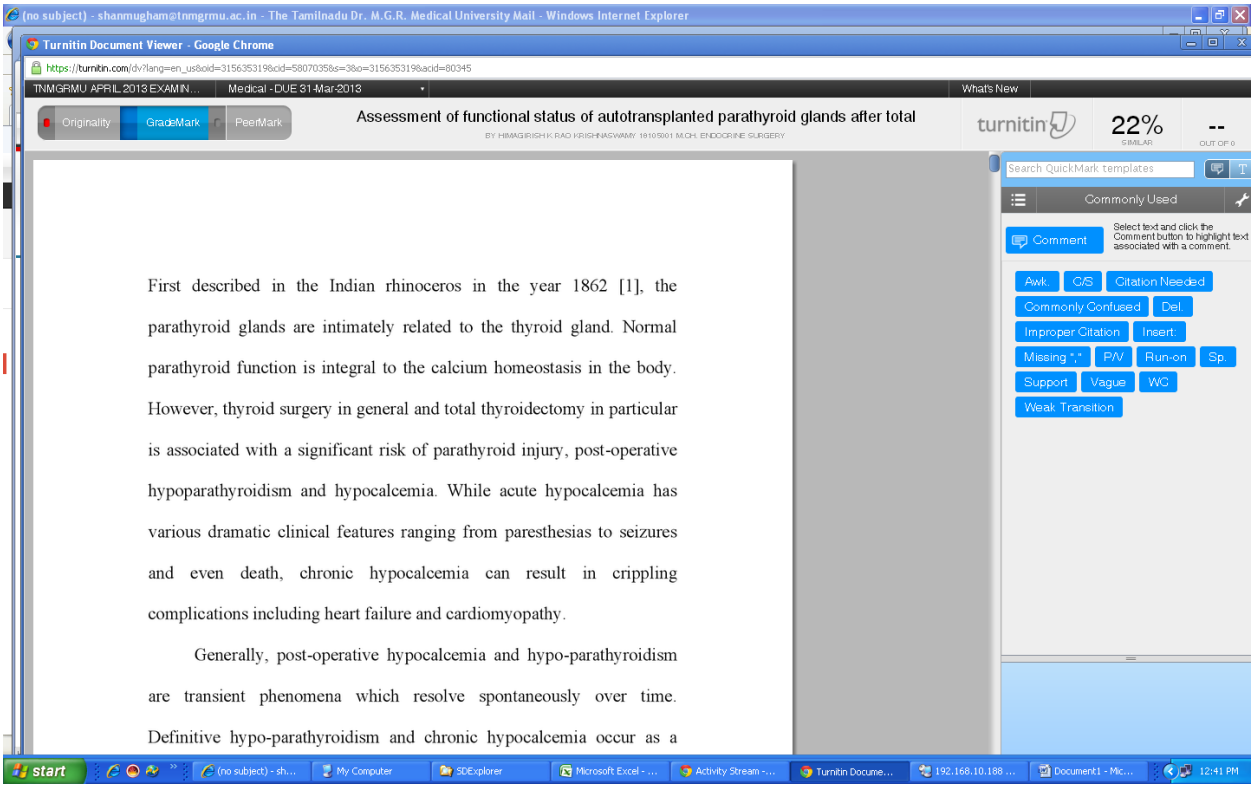
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What's New
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Assessment of functional status of autotransplanted parathyroid glands after total
BY HIMAGIRISH K RAO KRISHNASWAMY 1010501 M.CH. ENDOCRINE SURGERY
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First described in the Indian rhinoceros in the year 1862 [1], the parathyroid glands are intimately related to the thyroid gland. Normal parathyroid function is integral to the calcium homeostasis in the body. However, thyroid surgery in general and total thyroidectomy in particular is associated with a significant risk of parathyroid injury, post-operative hypoparathyroidism and hypocalcemia. While acute hypocalcemia has various dramatic clinical features ranging from paresthesias to seizures and even death, chronic hypocalcemia can result in crippling complications including heart failure and cardiomyopathy.
Generally, post-operative hypocalcemia and hypo-parathyroidism are transient phenomena which resolve spontaneously over time. Definitive hypo-parathyroidism and chronic hypocalcemia occur as a
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