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Identification and Preservation of the External Laryngeal Nerve during Thyroid surgery: Surgical and Anatomic Considerations

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ABSTRACT

Iatrogenic injuries of external branch of superior laryngeal nerve (EBSLN) during thyroid surgery are not uncommon due to the possibility of anatomic variations in the relationship of this nerve with superior thyroid vessels and the result may be devastating to those patients who rely on their voices professionally. The study included 2 groups. Group A was a prospective nonrandomized analytical series of all consecutive patients undergoing thyroidectomies for various conditions in Surgical Unit II, Shaikh Zayed Postgraduate Medical Complex, Lahore, Pakistan during a three years period (November 2004 – November 2007). This group consisted of 133 patients. Male to female ratio was 1:3. Mean age was 35.22 years (range: 17-71 years). Ninety one (68.42%) patients had bilateral dissection (total, sub-total or near-total thyroidectomies) and 42 (31.57%) had unilateral dissection (hemithyroidectomy / lobectomy and isthumusectomy). Thus, a total of 224 superior polar dissections were carried out. Three (3.296 %) patients out of the 91 patients in the bilateral dissection group had asymmetrical nerves. Eighty one (60.9%) patients had benign disease, 32 (24.06%) had malignancy and 20 (15.03%) had toxic goiter. Nerve could not be identified in 42 (18.75%) polar dissections {positive identification in 182 (81.25%) polar dissections}. Three (2.25 %) patients in this study had clearly documented EBSLN injury as determined by voice changes, patient interview and IDL. In Group B, the anterior neck triangles of 19 embalmed human cadavers (i.e. 38 neck half preparations) of both sexes and variable ages with neither enlarged thyroid glands nor any other signs of abnormality in this region were dissected in the dissection halls of two medical colleges in Lahore. The course and topographical relations (especially in relation to the superior thyroid vessels, superior pole of the thyroid and the cricothyroid muscle) of the EBSLN as well as bilateral asymmetry were noted as for Group A. Nerves were classified according to classification of Cernea et al. Good knowledge of the anatomy and relations of the EBSLN with meticulous dissection and skeletonisation and individual ligation of the superior polar vessels is the key to success.

Keywords: External branch of superior laryngeal nerve, thyroidectomy

INTRODUCTION

Most studies have emphasized the importance of preservation of the Recurrent Laryngeal Nerve during thyroidectomy. Nevertheless, knowledge of intra-operative localization and anatomical variations of the External Branch of the Superior Laryngeal Nerve (EBSLN) is essential for surgeons who perform operations on the thyroid gland to prevent intra-operative injury to it during thyroid surgery.

Iatrogenic injuries of external branch of superior laryngeal nerve (EBSLN) during thyroid surgery are not infrequent due to the possibility of anatomic variations in the relationship of this nerve with superior thyroid vessels. The reported risk of EBSLN injury in the literature varies from 0.3 to 13%.[1] As operative injury to EBSLN may cause

only vague or subtle changes, it is often overlooked. Accurate documentation of this injury requires detailed analysis. Many surgeons do not routinely identify the nerve although the nerve is at risk during thyroid surgery and the consequences of such an injury are serious for patients who depend on control of pitch and a clear and forceful voice, like singers or professional speakers.[2,3]

AIMS AND OBJECTIVES

1 To review the anatomy of the distal EBSLN as it is encountered during thyroid surgery.
2 To document the rate of identification of this nerve during thyroidectomies carried out for various conditions.
3 To evaluate our own operative technique and suggest reliable techniques for its safe identification and preservation during these operations.

PATIENTS AND METHODS

We studied two groups of patients. The first group (Group A) was a prospective nonrandomized analytical series of all consecutive patients undergoing thyroidectomies for various conditions in Surgical Unit II, Shaikh Zayed Postgraduate Medical Complex, Lahore, Pakistan during a three years period (January 2005 – January 2008). Data was collected which included information regarding intra-operative identification of the EBSLN and the method of ligation of the superior polar vessels (mass ligation of the superior thyroid vessels at or immediately below their entry to the upper pole or capsular dissection, skeletonization and individual ligation of these vessels). The course, topographical relations (especially in relation to the superior thyroid vessels, superior pole of the thyroid and the cricothyroid muscle) and cases of bilateral asymmetry were noted. The disease and the extent of resection of the thyroid were also noted. Evidence of iatrogenic injury to the EBSLN such as changes of voice in pitch, range, intensity, fatigability, and quality of the singing voice as assessed by questionnaires/interviews followed by clinical examination/indirect laryngoscopy was also recorded. All patients underwent a detailed interview for voice evaluation, including weakness or fatigue after use, inability to reach high pitch or change in fundamental speaking frequency preoperatively and also on the 3rd and 15th postoperative days. Preoperative indirect laryngoscopy was done in all the patients and was repeated once postoperatively between 10th and 15th postoperative days for signs of EBSLN injury (rotation of posterior glottis towards side of the lesion and bowing and displacement of affected vocal cord). Voice changes lasting less than six months were defined as temporary; permanent changes were classified as mild or severe according to whether or not they interfered with the patients' way of life. These patients were again referred to an ear, nose, and throat surgeon for examination, including indirect laryngoscopy, and also to a speech therapist.

Exclusion criteria included previous major neck surgery including esophageal, laryngeal or thyroid surgery and previous neck irradiation. A patient with previous history of penetrating trauma to the neck followed by extensive cervical exploration was also excluded from this study.

The operations were performed by all grades of surgeons which included consultants, senior registrars and senior residents. The residents operated under the direct supervision of a consultant or a senior registrar.

If a patient had a 'bilateral' operation as in a total, near-total or sub-total thyroidectomy, each side of the gland was counted as one (was considered as a separate unit).

The operative procedure included elevation of the superior and inferior platysmocutaneous flaps in the facioplatysmal plane via a transverse collar incision approximately a thumbs' breadth above the clavicles. Strap muscles were divided in midline after suture ligation of the anterior jugular veins. Ligation of the Anterior Jugulars was carried out only in patients in whom it was anticipated that the strap muscles would require to be divided transversely for ease of access. After elevation of the straps from the underlying gland, ligation of lateral or middle thyroid veins was carried out which allowed complete medial rotation of the ipsilateral thyroid lobe. This was followed by dissection of the superior pole keeping close to the

capsule of the gland until the entire pole was encircled with a thick silk suture which would serve for lateral traction so as to facilitate dissection and identification of the EBSLN in the cricothyroid space where the nerve could easily be identified in the majority of cases. However, aggressive attempts at extensive dissection to identify a nerve which could not be found within a few minutes was resisted and discouraged. Although mass ligature of the superior poles was carried out in some cases, an effort was always made to carry out capsular dissection, skeletonization and individual ligation of the superior pole vessels so as to minimize the risk of injury to the EBSLN; especially in cases where we failed to identify the nerve.

Nerves were classified as per classification proposed by Cernea et al[4]

- Type 1 - Crosses STA >1 cm above upper pole.
- Type 2a - Crosses STA <1 cm above upper pole.
- Type 2b - Crosses STA under cover of upper pole.

Type 2b is the most "dangerous" configuration and most likely to be injured if blind mass ligation of the superior pole vessels is carried out without prior identification of the nerve.

Main outcomes measured were
1. Number of intra-operatively identified nerves
2. Incidence of EBSLN injury
3. Type of nerve
4. Number of 'at risk' nerves
5. Presence of bilateral asymmetry

In the second group (Group B) embalmed human cadavers of both sexes and variable ages with neither enlarged thyroid glands nor any other signs of abnormality in this region were dissected in the dissection halls of two medical colleges in Lahore (Figs. 1 and 2). The course and topographical relations (especially in relation to the superior thyroid vessels, superior pole of the thyroid and the cricothyroid muscle) of the EBSLN as well as bilateral asymmetry were noted as for Group A.

Fig. 1. Cadaveric Dissection. (Black Arrow= Left EBSLN, Red Arrow= Superior Thyroid Artery)

Fig. 2. Cadaveric Dissection. (Black Arrow = Right EBSLN, Red Arrow= Superior Thyroid Artery).

RESULTS

In Group A, a total of 133 patients were included in this study out of a total of 141 patients who had thyroid surgery during the study period. Eight patients were excluded from the study on account of reasons already described in the materials and methods.

Male to female ratio was 1:3. Mean age was 35.22 years (range: 17-71 years).

Ninety one (68.42%) patients had bilateral dissection (total, sub-total or near-total thyroidectomies) and 42 (31.57%) had unilateral

dissection (hemithyroidectomy/lobectomy and isthumusectomy). Thus, a total of 224 superior polar dissections were carried out.

One hundred and sixteen patients had individual ligation of the superior polar vessels while 17 underwent mass ligation of the superior thyroid vessels at or immediately below their entry to the upper pole.

Three (3.296 %) patients out of the 91 patients in the bilateral dissection group had asymmetrical nerves. Eighty one (60.9%) patients had benign disease, 32 (24.06%) had malignancy and 20 (15.03%) had toxic goiter. Nerve could not be identified in 42 (18.75%) polar dissections {positive identification in 182 (81.25%) polar dissections}.

Identified nerves were classified according to classification of Cernea et al (Table 1)

Table 1. EBSLN Classification (Group A)

Type of Nerve (According to Classification of Cernea et al)	*n* (%) *n* = Number of polar Dissections
Type 1	64 (35.16%)
Type 2a	104 (57.14%)
Type 2b	14 (7.69%)
Not Identified	42 (18.75%)
TOTAL	224

Three (2.25 %) patients in this study had clearly documented EBSLN injury as determined by voice changes, patient interview and IDL. In only one of these patients voice change was considered to be permanent i.e. lasting greater than 6 months and till she was lost to follow up. In the remaining 2, voice change was only transient and the complaints resolved in 2 and 3 months. All 3 belonged to the group of patients in whom a formal search for the EBSLN had not been carried out and mass ligature of the superior polar vessels had been carried out (3/17=17.64%).

In addition to these three patients with voice change accountable to clearly documented EBSLN injury, there were five other patients in whom the EBSLN and the Recurrent Laryngeal Nerves had been formally identified and individual ligation of the superior polar vessels carried out. Yet these patients had transient short term voice change which fortunately resolved in a few weeks after surgery.

In the second group (Group B) 19 embalmed human cadavers (i.e. 38 neck half preparations) of both sexes ranging in age from approximately* 30 to 70 years (mean, 50 years) were dissected The course and topographical relations (especially in relation to the superior thyroid vessels, superior pole of the thyroid and the cricothyroid muscle) of the EBSLN was noted and Identified nerves were classified according to classification of Cernea et al (Table2).

Table 2. EBSLN Classification (Group B)

Type of Nerve (According to Classification of Cernea et al)	*n* (%) *n* = Number of polar Dissections
Type 1	14 (36.84%)
Type 2a	19 (50%)
Type 2b	05 (13.15%)
TOTAL	38

Bilateral asymmetry was not noted in any of the subjects in this group.

DISCUSSION

Injury to the recurrent laryngeal nerve is a well-recognized complication of thyroid surgery. Injury to the superior laryngeal nerve is less documented, perhaps due to the difficulty in recognizing its manifestations. Risk of injury to the superior laryngeal nerve during thyroidectomy is significant, and the result may be devastating to those patients who rely on their voices professionally[3]

Cernea et al[4,5] were the first to describe an comprehensive classification. A fourth type of nerve was found by Kierner et al[6] who described a fourth type of nerve which does not cross the superior thyroid artery but runs dorsal to it until it ramifies. The percentage of high risk EBSLN has been reported to range from 15 to 68%.[7]

In our study, 7.69% (Group A) and 13.15%

(Group B) of the nerves were type IIb nerves, which is comparable with most of the previous anatomical studies. We did not recognize any Type 4 nerves, as described by Kierner et al[6], in either of the two groups in our study. We speculate that some of the 18.75% "not identified" nerves in our Group A may have been Type 4 nerves.

A review of literature reveals great variation in EBSLN Identification and injury rates across different studies, with identification rates ranging from 33% to 93%, while injury rates have been reported between 0% and 58%[5,8-15]

The EBSLN injury rate in our own series was 2.25%. However, all 3 of these injuries occurred in patients in whom the EBSLN had not been identified and mass ligature of the superior thyroid vessels had been carried out at or just below the level of insertion of these vessels. Two of these patients were operated by consultants and one by a senior registrar grade. One of these patients was operated for a small diffuse toxic goiter which had bled excessively during surgery and the other 2 had huge endemic simple multinodular goiters. There was no nerve injury seen in any of the cases in which the nerve had been identified and careful individual ligation of the superior polar vessels had been carried out. Although this was a small series, it was our impression that the nerve injury rate was influenced by careless technique, intra-operative bleeding, toxicity and in hugely enlarged glands.

In our study, we had positive EBSLN identification of 81.25% which is comparable with the results of other authors. We relied on visual identification alone for identification of the nerve. No aids for intra-operative identification of nerve like the use of a magnification loupe, nerve stimulator or neuromonitoring using a bipolar electrode in cricothyroid muscle during nerve stimulation were used[16,17] Other authors have also questioned the routine use of expensive or fancy aids for EBSLN identification.[18]

CONCLUSION

We believe that a few extra minutes spent in an attempt to identify the EBSLN in the cricothyroid space after gentle lateral retraction of the superior pole are well worth the effort for safe identification and preservation of the nerve. Aggressive or extensive attempts to find the nerve are not to be recommended. "Over-dissection" of the nerve when it has been found is also not advisable as it may lead to devascularization injury of the nerve – "expose the nerve; do not explore it" is sound advice. Good knowledge of the anatomy and relations of the EBSLN, meticulous dissection and skeletonisation and individual ligation of the superior polar vessels is the key to success.

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