

Correlation between the Cernea Classification of External Branch of Superior Laryngeal Nerve in Relation to the Ultrasound-based Volume of Thyroid Gland

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Abstract

Introduction: Goiter is a very common problem dealt with by surgeons. Surgical treatment of thyroid requires removal of a part (hemi) or whole of the gland (total thyroidectomy). The external branch of the superior laryngeal nerve (EBSLN) is an important but less researched structure to be preserved during surgery. Various studies have described the incidence of different types of EBSLN, but have not described regarding the relationship between the change in volume of the gland to the nerve. **Materials and Methods:** A prospective analysis of 100 patients who underwent total thyroidectomy in our department was done. All patients underwent preoperative ultrasonography and the volume of the gland was calculated. Intraoperatively, the EBSLN was identified and preserved prior to ligating the superior thyroid vessels. The nerve was classified as per the Cernea classification. The gland was divided into high and low volume, taking 20 ml as the cutoff. The incidence of Type 2 nerve in a low-volume gland was compared with that of a high-volume gland. **Results:** In 100 patients (200 nerves), 191 nerves were identified. The nerve was type 1 in 56/200 (28%), Type 2a in 116/200 (58%), and Type 2b in 19/200 (9%) patients. In large-volume glands, Type 2 nerve was more common (87%). **Conclusion:** Dissection of thyroid gland requires expertise to preserve the EBSLN. Large volume glands pose a more difficult challenge, as the gland is more closer to the nerve.

Keywords: Cernea classification, EBSLN, gland volume, laryngeal nerve, thyroidectomy

INTRODUCTION

Laryngeal nerve injuries are a major complication of thyroidectomy causing lasting morbidity. Various studies have emphasized the effect of injury to the recurrent laryngeal nerve. However, in its lesser cousin, the external branch of superior laryngeal nerve (EBSLN), changes following injury have not been exclusively studied. EBSLN is an important branch functioning to help in tensing the vocal cord. It comes into play at frequencies above 150 Hz,^[1] so it is particularly involved in producing the high tones. This can be particularly significant for individuals using their voice professionally. The incidence of EBSLN injury in patients undergoing thyroidectomy is reported to be up to 58%.^[2] Different authors from time to time have tried to describe the anatomy of the EBSLN and its relation to the superior thyroid vessels and hence there are various surgical and anatomical classifications mentioned in literature for EBSLN.^[3,4] However, the most widely accepted typing was proposed by Cernea *et al.*^[5]

The nerve is at a high risk, when it is in close proximity to the gland, as in Cernea's Type 2a and 2b. Although there are multiple articles showing the incidence of the different types of EBSLN, literatures on comparing the volume of the gland with the type of EBSLN are scarce. We hypothesized that, in a large volume gland, the superior pole of the thyroid gland will be closer to the EBSLN and hence there will be more incidence of Type 2a and b nerves in such goiters.

MATERIALS AND METHODS

This prospective observational study was done on a cohort undergoing total thyroidectomy from May 2014 to June 2016.

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Patients with recurrent goiter and previous surgical procedures on the neck were excluded from the study. All patients were subjected to complete clinical examination, thyroid function studies (free T4 and thyroid-stimulating hormone), ultrasound examination (US), and aspiration cytology of the nodules. Thyroid volume was calculated based on US measurements of anteroposterior, transverse, and craniocaudal direction. The volume of each lobe was calculated using rotational ellipsoid formula ($V_{\text{ellipsoid}} = \pi/6 \times \text{length of the lobe [cm]} \times \text{breadth of the lobe [cm]} \times \text{width of the lobe}$).^[6,7] The volume of each lobe was considered separately for the assessment of relation of lobe to EBSLN. Based on volume in milliliters, lobes were categorized into Grade 1 (<20 ml) and Grade 2 (>21 ml).

The EBSLN was identified by direct vision in cricothyroid space on both sides, and the relation of nerve to the upper pole of thyroid gland and superior thyroid vessels was recorded separately on either side. The relation of EBSLN to superior pole was defined based on the classification proposed by Cernea *et al.*^[5] as follows:^[3] Type 1 in which the nerve crosses the artery more than 1 cm from the superior pole, Type 2a in which the EBSLN crosses the artery <1 cm and above the superior pole, and in Type 2b in which the EBSLN crosses the artery below the superior pole.

Statistical analysis

Each lobe was considered as single unit, and the relation to the EBSLN was considered separately. SPSS version 17 Illinois, NY, USA, was used for calculation. Chi-square test was used to calculate the association between the variables.

RESULTS

The study comprised 100 patients with a mean age of 32 ± 9 years undergoing total thyroidectomy, of which 83 were female.

The mean volume of the right lobe was 13.02 ml and that of the left lobe was 26.13 ml. There were 15 Grade-2 lobes on the right side and 24 on the left side. Among the 200 EBSLNs at risk, 191 were identified that included 96 on the right side and 95 on the left side.

The relationship of EBSLN to superior pole categorized based on volume of the lobes is summarized in Table 1.

DISCUSSION

The superior laryngeal nerve branches out from the vagus nerve at the base of the skull and descends toward the superior pole of the thyroid along the internal carotid artery.^[8] At the level of the superior cornu of the hyoid bone about 2–3 cm above the superior pole of the thyroid gland, it divides into two branches – the internal laryngeal nerve and the EBSLN. The EBSLN is often an overlooked nerve as the symptoms of its injury in the postoperative period are very less.

Injury to this nerve causes difficulty in attaining a high pitch to the voice, which is often overlooked. At the region of the

Table 1: Volume of each lobe correlated with position of EBSLN

	Type-1 (%)	Type-2a (%)	Type-2b (%)	Total
Right lobe Grade-1	24 (30)	50 (62)	7 (8)	81
Right lobe Grade-2	3 (20)	10 (67)	2 (13)	15
Left lobe Grade-1	27 (38)	38 (53.5)	6 (8.5)	71
Left lobe Grade-2	2 (8)	18 (75)	4 (17)	24
Total	56 (29)	116 (61)	19 (10)	191
Features	Type-1 (%)	Type-2a (%)	Type-2b (%)	Total
Lobes with Grade-1	51 (33.5)	88 (58)	13 (8.5)	152
Lobes with Grade-2	5 (13)	28 (72)	6 (15)	39
Total	56 (29)	116 (61)	19 (10)	191

superior pole, about 1 cm of the entrance of the superior thyroid artery into the thyroid capsule, the nerve generally takes a medial course to enter the cricothyroid muscle and innervate it. There can be injury to the EBSLN in up to 58% of patients undergoing thyroidectomy.^[9-11] The EBSLN innervates the cricothyroid muscle, which is the only tensor of the vocal cord, required to produce high pitched sound. It comes into play at frequencies above 150 Hz,^[11] so it is particularly involved in producing the high tones. This can be particularly significant for individuals using their voice professionally.

Intraoperatively, the EBSLN can be identified in the space of Reeves, also formerly known as the sternothyroid laryngeal triangle, which is bounded laterally by the superior pole of the thyroid gland of the corresponding side, medially by the inferior constrictor muscle and cricothyroid, and anteriorly by the sternothyroid muscle. On meticulous dissection in this triangle after retracting the superior pole of the thyroid gland, the EBSLN and the superior thyroid vessels can be identified. After identifying the EBSLN, it can be classified as per the Cernea classification into Type 1 and Type 2 (a or b).

Although there are other named classifications such as Selvan *et al.*^[8] and Friedman *et al.*,^[12] for the classification of the EBSLN, Cernea classification^[5,13] is the most widely accepted. In 1998, Kierner *et al.*^[14] proposed another similar classification as that of Cernea's in which they added a fourth category of EBSLN running dorsal to the superior thyroid pedicle, observed in 13% of dissected specimens. In our study, EBSLN was identified in 95% of the cases (Type 1-28%, Type 2a - 58%, and Type 2b - 9% and was not identified in the rest 5%). There are various literatures with conflicting views on the incidence of the type of nerves at risk (Type 2).^[3,15,16]

In our study, the incidence of Type 2a nerve is the most common, followed by Type 1 and Type 2b. This result is similar to few of the previously reported incidences.^[2,3,15-19]

It has also reinforced that, in a high-volume gland, the incidence of a Type 2 nerve is more common. Similar reports were published in 2016 by Ravikumar *et al.*^[2] They classified goiters as large volume and small volume with a cutoff of 50 cc and they also reported a higher incidence of Type 2 nerves

in large volume glands (89.4%). Type 2b nerves were more common in toxic (37.9%) than nontoxic lobes (5.46%).^[20] In their study, they have also mentioned a higher incidence of Type 1 nerves in nontoxic thyroid cases. The toxic state of the gland may predispose the gland to be more vascular, thereby increasing its volume.

Limitations

In our study, all the nerves were identified by visual identification, by virtue of which 95% of the nerves were identified but 9/200 nerves (4.5%) could not be identified. Intraoperative nerve monitoring^[21] may have helped in identifying those nerves, which is the current recommendation.

CONCLUSION

As the data suggest, there is a significant increase in the incidence of Type 2 nerve in large volume glands, thereby making it more prone to injury during dissection. Hence, dissection of a large volume gland should be more meticulous than a low-volume gland, especially in the space of Reeves. The EBSLN should be identified and preserved before ligating the superior pole vessels. Care must also be taken to avoid stretch of the vascular structures, and energy devices should be used carefully while dissecting the superior thyroid pole, in order to prevent iatrogenic injury.

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Conflicts of interest

There are no conflicts of interest.

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