

The External Branch of the Superior Laryngeal Nerve

Its Topographical Anatomy as Related to Surgery of the Neck

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Objective: To determine the possible courses of the external branch of the superior laryngeal nerve (EBSLN) and its relationship to the superior thyroid artery (STA) to improve the chances of identifying and saving the nerve during head and neck surgery.

Design: Anatomical analysis of the exact topography of the EBSLN.

Subjects: Thirty-one perfusion-fixed human cadavers (ie, 62 preparations) of both sexes ranging in age from 50 to 94 years (mean, 78 years) with neither enlarged thyroid glands nor any other signs of abnormality in this region.

Results: Four types of relationship between the EBSLN, the upper pole of the thyroid gland, and the STA were

found. In 23 preparations (42%), the EBSLN crossed the STA more than 1 cm above the upper pole of the thyroid gland (type 1). In 15 preparations (30%), the EBSLN crossed the STA less than 1 cm above the upper pole of the thyroid gland (type 2). In 7 preparations (14%), the EBSLN crossed the STA under cover of the upper pole of the thyroid gland (type 3). In 7 preparations (14%), the EBSLN descended dorsal to the artery and only crossed the branches of the STA immediately above the upper pole of the thyroid gland (type 4).

Conclusion: The description of the variable course of the EBSLN and its categorization may help minimize the risk of iatrogenic lesions of the nerve during surgery.

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THE EXTERNAL branch of the superior laryngeal nerve (EBSLN) arises together with an internal branch from the superior laryngeal nerve (SLN), which is one of the uppermost branches of the 10th cranial nerve. The EBSLN first descends dorsolaterally to the carotid arteries, crosses them, and finally passes to the larynx close to the superior thyroid artery (STA), always lying profound to these vessels. The topographical relationship to the STA and the upper pole of the thyroid gland represents the key point for identifying the EBSLN during surgery of the neck. When these 2 landmarks are considered, identification and protection of the nerve are easy. After giving off some twigs to the pharyngeal plexus and the inferior pharyngeal constrictor, the EBSLN terminates mainly within the cricothyroid muscle.¹⁻⁷ Yet there is evidence that the EBSLN also contains some afferent fibers that mediate impulses from the cricothyroid joint and the mucous lining inside the cricothyroid membrane.^{8,9} Furthermore, some authors describe a supplementary motor innervation of some of the intrinsic laryngeal muscles by the EBSLN.¹⁰⁻¹² However, further investigations are needed on that question.

Nevertheless, iatrogenic lesions of the EBSLN clearly are much more common than is generally recognized.¹³ Since injury to this

nerve may cause transient or even persistent changes either in quality of voice or in deglutition, an attempt should be made to identify the EBSLN during surgery.^{2,14,15} Especially in partial laryngectomies, sufficient sensory innervation of the supraglottic area clearly helps to avoid postoperative aspiration and dysphagia.^{16,17} At present, available data on the exact topography of the EBSLN are sometimes ambiguous and confusing. Even the reported proportion of patients in which the EBSLN can actually be identified varies from 10% to 80%.^{2,3,18-21} Therefore, the aims of this study were to determine the course of the EBSLN in a sufficient number of subjects and to devise a method of typing the relationship between the EBSLN, the STA, and the upper pole of the thyroid gland.

RESULTS

Our typing is based on the work of Cernea et al.^{20,21} Because our results differ in some respects from those of Cernea et al, it was necessary to establish slightly different categories. On the basis of our findings, we divided the topographical relationship between the EBSLN, the STA, and the upper pole of the thyroid gland into 4 categories (**Figure 1**).

In type 1, the EBSLN crosses the STA more than 1 cm cranial to the upper pole of the thyroid gland. Occurring in 21 specimens (42%), this is clearly the most common type encountered in our specimens. The 3 afore-

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MATERIALS AND METHODS

Sixty-two hemilarynges were taken from 31 human bodies of both sexes (20 male and 11 female) donated to the Institute of Anatomy, University of Vienna, Vienna, Austria, ranging from 50 to 94 years (mean age, 78 years). The bodies were fixed as usual for anatomical dissection courses (4% phenolic acid and 0.5% formaldehyde).

Only specimens with neither enlarged thyroid glands nor any other sign of severe abnormality of that region were accepted. The anterior triangles of the neck were dissected by 1 of us (A.C.K.), who documented his findings immediately. Results had been verified independently by the other author (M.A.). To verify the data, cadavers were subsequently decapitated at the atlanto-occipital articulation, with the neck's viscera staying with the head. After this additional examination, the course and topographical relations of the EBSLN could be classified unequivocally in 52 hemilarynges. Within 7 hemilarynges, the EBSLN was injured during preparation. In 3 hemilarynges, the type of the EBSLN was difficult to determine after all the surrounding soft tissue that keeps the nerve in position had been dissected. These 3 preparations are described separately below.

mentioned preparations in which we had difficulty in typing probably also belonged to type 1.

In type 2, the EBSLN crosses the STA less than 1 cm cranial to the upper pole of the thyroid gland. In our material, 30% of the hemilarynges (15 preparations) could clearly be classified as type 2.

In type 3, the EBSLN crosses the STA while covered by the upper pole of the thyroid gland (total of 7 preparations [14%] in our study).

Type 4 refers to cases in which the EBSLN does not cross the trunk of the STA at all, but runs dorsal to the artery until it has ramified. In our material, we found 7 hemilarynges of that type (14%). Although the EBSLN does not cross the STA in these cases, it can easily be found, since it runs parallel to the artery slightly more profound and dorsal to it.

Within the 52 hemilarynges we dissected, the predominance of type 1 was obvious. The topographical relationship of the EBSLN on one side of the neck does not predict the course of the nerve on the other side. The types we defined occurred independently on the 2 sides. However, no other course of the EBSLN except the 4 types described above could be found.

To obtain quantitative data about the relationship of the SLN to the common carotid artery, the distance between the separation of the SLN from the vagal nerve and the bifurcation of the common carotid artery was measured (**Figure 2**). The distance between these 2 well-defined anatomical landmarks ranges between 2.9 and 5.6 cm, with a mean value of 4.1 cm on the right side and 4.27 cm on the left side.

COMMENT

The EBSLN innervates parts of the intralaryngeal mucous membrane and sends some motor fibers to intrinsic muscles of the larynx as well.^{8,10-12} Palsy of the EBSLN or an iatro-

genic lesion of the nerve might cause dysphonia and aspiration.^{16,17} The sensory deficit in the hypopharynx and supraglottic larynx interferes with the patient's ability to sense secretion and food particles in those areas. Especially in cases of tumor resection in which surgery of the anterior triangle of the neck is combined with partial laryngectomy or enlarged hypopharyngeal resections, jeopardizing the SLN deteriorates functional rehabilitation. Exact knowledge of the topographical anatomy of the SLN and its branches clearly helps identify and preserve this nerve during neck surgery.

The course of the EBSLN has been described by many authors.^{1,2,4-6,11,15,18,19,22-24} Most of the previous studies emphasized identification of the EBSLN at the upper pole of the thyroid gland, where the topography of the nerve shows much more variability in its relationship to the STA or may even be covered by the inferior pharyngeal constrictor muscle.^{2,3,11,15} Therefore, it seems easier to identify the EBSLN further cranially. Cernea et al^{20,21} tried to categorize the different courses of the EBSLN to facilitate identification of the nerve during surgery. Our results are similar to those of Cernea et al^{20,21}; however, we believe that our slightly different typing better reflects the possible courses of the nerve. In agreement with Cernea et al, we found type 1 to be the most common type. However, instead of the 62% type 1 they reported, type 1 was present in only 42% of our preparations. Our types 2 and 3 correspond to types 2a and 2b of Cernea et al, respectively. Whereas the number of type 2 cases (27% in our material and 11% in the examinations by Cernea et al) are quite different, type 3 was consistent between the studies (13% and 14%, respectively).

In addition, we introduce a new category, which we call type 4. This type was found in 13% of our dissection material. The question arises why previous investigators^{2,11,15,18,20-24} did not describe that course of the EBSLN. Since in these cases the nerve descends more dorsally than one would expect, its identification is more difficult. This may be one of the reasons why Cernea et al^{20,21} could not identify the EBSLN in 7% of their cases. The difference in number of each type between our material and that of Cernea et al might have resulted from the fact that we examined almost twice as many specimens. However, the exact circumstances regarding the different distribution still remain to be determined.

Identification of the EBSLN during surgery can be complicated by previous operations or by preoperative radiotherapy. We attempted to describe additional landmarks that guide the surgeon to the SLN, which in turn facilitates the identification of the EBSLN. Once the bifurcation of the common carotid artery has been identified, the branching of the SLN from the vagal nerve can be found an average of 4.18 cm in the cranial direction (Figure 2). Since the carotid bifurcation and the vagal nerve are easily accessible even under difficult conditions, identifying the nerve should pose no problem in any case. Measuring the distance to the base of the skull (jugular foramen, basion) might provide more exact data.⁵ However, these landmarks are comparably difficult to use in neck surgery and therefore not advisable.

Our results strongly suggest that categorization of the topographical variations of the EBSLN is possible. Since this study included 62 specimens, it is unlikely that the nerve will take a course different from those covered by our classification. Therefore, we believe that exact knowledge of

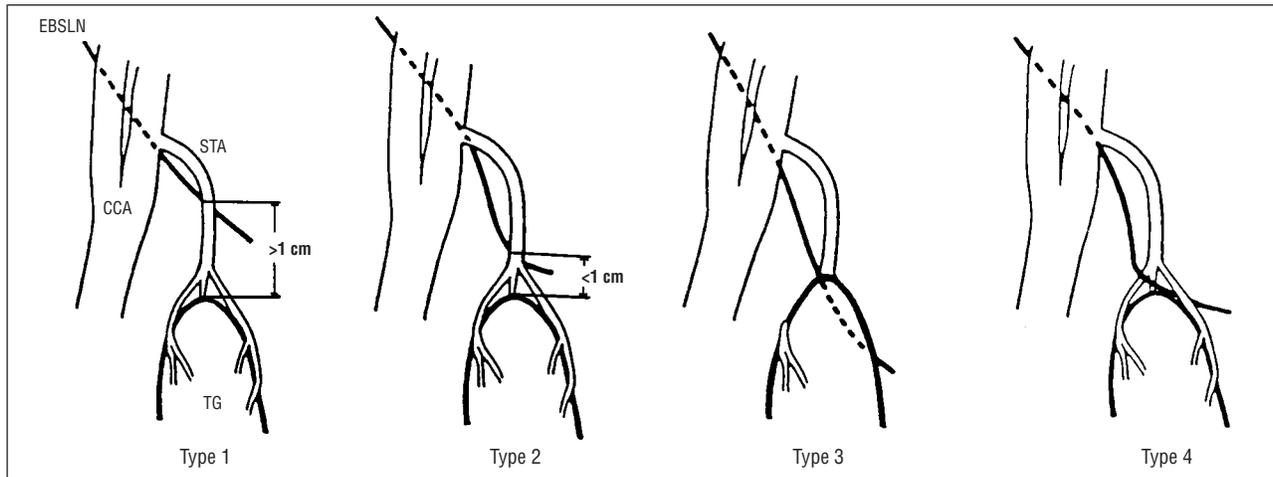


Figure 1. Classification of the possible courses of the external branch of the superior laryngeal nerve (EBSLN). In type 1, the nerve crosses the superior thyroid artery (STA) more than 1 cm above the upper pole of the thyroid gland (TG). In type 2, the nerve crosses the STA less than 1 cm above the upper pole of the TG. In type 3, the nerve crosses the STA under cover of the superior pole of the TG. In type 4, the nerve descends dorsal to the STA, crossing its branches immediately above the upper pole of the TG. CCA indicates common carotid artery.

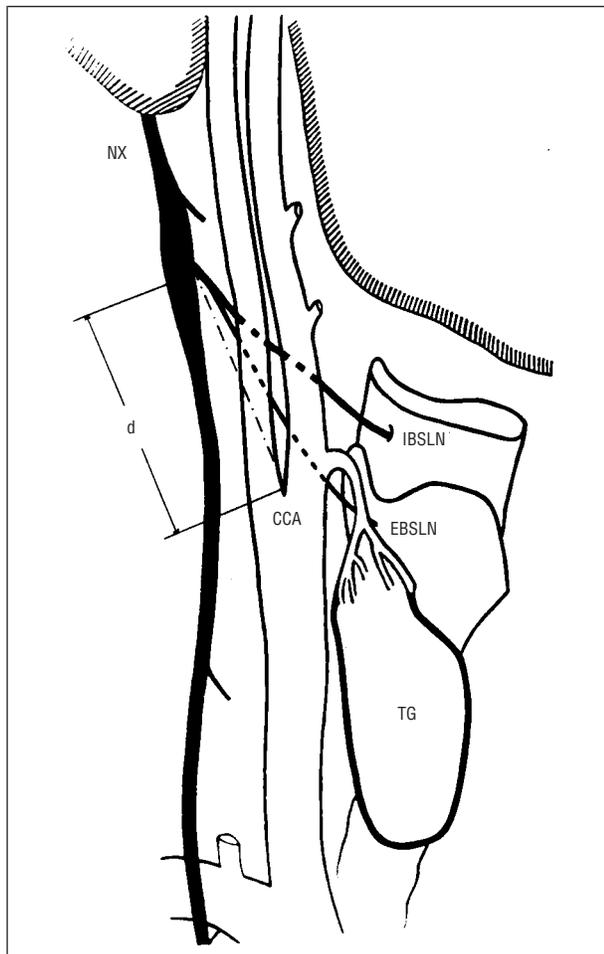


Figure 2. Topography of the superior laryngeal nerve and its branches. NX indicates 10th cranial nerve; d, the distance between the origin of the superior laryngeal nerve and the bifurcation of the common carotid artery (CCA), measured as indicated; IBSLN, internal branch of the superior laryngeal nerve; EBSLN, external branch of the superior laryngeal nerve; and TG, thyroid gland.

the relationship between the EBSLN, the STA, and the upper pole of the thyroid gland as presented herein may help identify the nerve during neck surgery.

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