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Identification and preservation of External Branch of the Superior Laryngeal Nerve during thyroid surgeries at Nepal Medical College and Teaching Hospital

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ABSTRACT

Background & Objectives: The most common reason for thyroid surgery is the presence of benign or malignant nodules. Subjective voice disturbance after thyroidectomy is very common, even without injury to the recurrent laryngeal nerves. One possible cause for postoperative dysphonia is injury to the External branch of superior laryngeal nerve (EBSLN). Cernea classification, which we followed in this study, is one of the most popular worldwide classifications of the EBSLN. The study was conducted with objectives to identify and classify EBSLN according to Cernia classification in Nepalese population and help surgeons understand the anatomy of the EBSLN and to preserve the nerve during thyroidectomy. **Materials & Methods:** A prospective observational case series of seventy-nine patients, who were diagnosed with thyroid neoplasms and underwent thyroid surgeries at the tertiary centre of Kathmandu between 1st January 2015 to 31st December 2016. All procedures were performed by transverse collar incision. We classified the anatomy of the EBSLN using Cernea classification. **Results:** There were total of 79 patients. Most common diagnosis and surgery were colloid goitre and hemithyroidectomies respectively. A total of 94 EBSLNs were evaluated. Cernia Type I was observed in 27.66%, type IIa in 46.80%, and type IIb in 14.89%. Incidences of types IIa and IIb, which put patients at greater risk for intra-operative injury, were observed in 61.70% in our study. The nerve could not be identified in 10.64%. **Conclusion:** It is possible to increase the rate of nerve identification and avoid the nerve injury even in the absence of sophisticated equipment.

Key words: External branch of superior laryngeal nerve; Identification; Preservation; Thyroidectomy

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INTRODUCTION

The most common reason for thyroid surgery is the presence of nodules or tumors on the thyroid gland. Nodules may be benign or malignant. In the early nineteenth century, thyroid surgery was associated with high mortality rates because of lack of meticulous dissection techniques and asepsis. Complications that arise after thyroid surgery may be associated with infection, hemorrhage, hormonal problems and laryngeal nerve injury. Voice alteration after thyroidectomy is usually caused by recurrent laryngeal nerve (RLN) or external branch of superior laryngeal nerve (EBSLN) injury. Billroth in 1877 reported 36% injury to RLN during thyroidectomy following which surgeons have attempted to preserve it.[1] Studies have shown that subjective voice disturbance after thyroidectomy is very common, even without injury to the recurrent laryngeal nerves. One possible cause for postoperative dysphonia is injury to the EBSLN.[2,3]

The superior laryngeal nerves arise from the inferior ganglion of the tenth cranial nerve, descend alongside the pharynx posterior to and then medial to the internal carotid artery, and then divide into a larger internal branch and a smaller external branch. The external branch of the superior laryngeal nerve (EBSLN) courses deep to the superior thyroid artery and vein from superolateral to inferomedial and inserts at the cricothyroid muscle medial to the superior pole of the thyroid gland. The EBSLN provides the motor supply to the cricothyroid muscle thus it also involves in phonation. The nerve is vulnerable to injury during thyroidectomy as the surgeon dissects and ligates the superior thyroid vascular pedicle. Injury to the superior laryngeal nerve leads to reduction in fundamental frequency reach that causes the vocal fatigue in the singers after excessive vocal use. The injury may lead to objective alterations in voice quality, even in the non singers.[4,5] However EBSLN has received minimal attention, prompting Delbridge to declare it the “neglected nerve in thyroid surgery”.[6]

The advances in surgical techniques, recognition of the presence of parathyroids, identification and preservation of RLN and EBSLN has resulted in lesser morbidity.[7] In spite of several intra-operative techniques that have been described to minimize injury, current advanced diagnostic techniques still demonstrate EBSLN injury in 5% to 30% of post thyroidectomy patients.[8,9]

Based on the course of the EBSLN, classifications were put forward by Cernea,[10, 11] Friedman,[12] Selvan,[13] and Kiermer.[14] Cernea classifications, which we followed in this study, is one of the most popular worldwide. (Table 1)

We have tried to evaluate the rate of identification and variations in course of the EBSLN in the thyroidectomies performed over a two year period at our centre using standard thyroidectomy technique and thus this study aims to identify and classify EBSLN in Nepalese population according to Cernia and help surgeons understand the anatomy of the EBSLN and thus increasing the chance of preserving the nerve during thyroidectomy.

Table 1: Cernea Classification

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

MATERIALS AND METHODS

Sample: A total of seventy-nine patients, who were diagnosed with thyroid neoplasms and underwent thyroid surgeries at the Department of ENT and Head and Neck, Nepal Medical College and Teaching Hospital, Attarkhel, Jorpati, Kathmandu, Nepal between 1st January 2015 to 31st December 2016 were included in this study. Ethical clearance was taken from the Institutional Review Board.

Exclusion criteria were:

1. Previous thyroid surgery or other surgery involving neck.
2. Previous history of radiation to the neck.
3. Neuromuscular disease.
4. Patients who did not give consent.

Surgical method

All procedures were performed by senior surgeons by transverse collar incision using the classic open thyroidectomy method. The standardized approach was used for each superior pole. The sternohyoid muscle was retracted laterally and if required, the sternothyroid muscle was divided at its midpoint. The gland was retracted inferolaterally while the sternothyroid muscle was bluntly dissected upward, after which the avascular space between the larynx and the superior thyroid pole was opened bluntly. During this dissection, the lateral surface of the cricothyroid muscle was exposed and the EBSLN was identified. Its course was traced laterally to the point where it crossed the superior thyroid vessels. No sharp dissection or electrocautery was used at the superior pole. We then dissected the remainder of the attachments of the thyroid gland. For each patient, we recorded the laterality of the procedure. If identifying the relationship was difficult due to lower incision or large gland, the additional incision was made laterally in previous incision. We classified the course of anatomy of the EBSLN into types I, IIa, and IIb using Cernea classification (table 1) and it is marked as “Could not be identified” in those patients whom it could not be identified.

RESULTS

There were total of 79 patients. Out of them, there were 74 (93.7%) females and five (6.3%) males. The mean age of the patient was 38.35years (range, 20-75) with standard deviation of 12.58.

Table 2: Diagnosis

Diagnosis	Frequency	%
Colloid goitre	52	65.82
Follicular neoplasm	7	8.86
Hashimotos thyroiditis	1	1.27
Hurtle cell neoplasm	1	1.27
Multinodular goiter	3	3.80
Papillary cell Carcinoma	15	18.99
Total	**79**	**100**

The benign disease was found in 64 cases (81.01%) and malignant disease was found in 15 cases (18.99%).Among the benign diseases, the most common diagnosis was Colloid goiter, which was found in 52 patients (65.82%). The Follicular neoplasm was found in seven cases (8.86%) and multinodular goiter was found in three cases (3.80%). Hashimotos thyroiditis and hurtle cell neoplasm, each was found in one patient. The malignant disease, papillary cell carcinoma was found in 15 cases (18.99%). (Table 2)

The most common surgery performed was the hemithyroidectomies. Right and left hemithyroidectomies were performed in 37 (46.84%) and 24 (30.38%) patients respectively. The Near-total thyroidectomies were performed in three (3.80%) cases. The total thyroidectomies with central compartment clearance were performed in 11(13.92%) and the total thyroidectomies with neck dissection were done in four (5.06%) patients. (Table 3)

Table 3: Operative procedures

Procedure	Frequency	%
Hemithyroidectomy	61	77.22
Right	37	
Left	24	
Near total thyroidectomy	3	3.80
Total thyroidectomy with central compartment clear-ance	11	13.92
Total thyroidectomy with Neck dissection	4	5.06
Total	**79**	**100**

Ninety-four superior pole dissections were done. Out of 94 superior pole dissections, 84 EBSLNs (89.36%) were identified but ten EBSLNs (10.64%) could not be identified. The identified EBSLNs were classified as type I, IIa, or IIb according to Cernea classification. Type I was observed in 26 of 94 nerves (27.66%), type IIa EBSLN in 44 (46.80%), and type IIb EBSLN in 14 (14.89%). Incidences of types IIa and IIb EBSLNs, which put patients at greater risk for intra-operative injury, were observed in 58 of 94 nerves (61.70%) in our study. On the right side, forty-eight EBSLNs were identified, but six could not be identified. Among identified, 14 were type I, 26 were type IIa and eight were type IIb. Likewise, on the left side, thirty -six EBSLNs were identified, but four could not be identified. Among identified, 12 were type I, 18 were type IIa and 6 were type IIb. (Table 4)

DISCUSSION

The superior laryngeal nerve originates from the vagus nerve. After descending along the side of the pharynx, it branches into the internal and the external laryngeal nerves. The internal laryngeal nerve provides sensory innervations to the glottis and laryngeal vestibule through the thyro-hyoid membrane. The smaller, external branch of superior laryngeal nerve (EBSLN) innervates the cricothyroid muscle. This muscle tenses the vocal cords and comes into play at frequencies above 150 Hz, so it is particularly involved in producing the high tones of the female voice.[10, 12, 15-18] The principle of surgery is the identification of the structure in order to preserve it. Different

Table 4: Gender, Laterality and Cernia classification of EBSLN

Cernia Type	Male	Female	Total	Right	Left	Total
I	1	25	26	14	12	26
IIa	2	42	44	26	18	44
IIb	2	12	14	8	6	14
Could not be identified	2	8	10	6	4	10
Total	7	87	94	54	40	94

identification rates of the EBSLN have been quoted by authors with few not performing routine identification.[17] The techniques used for the intraoperative identification of nerve have included, the inspection of the distal part of the inferior constrictor muscle and individual ligation of the superior thyroid vessels, [11, 19-22] use of 2.5 times magnification loupe and nerve stimulator or monitoring using a bipolar electrode in cricothyroid muscle during nerve stimulation. [14, 23, 24] Eckley[4] recorded hoarseness, loss of high range, vocal fatigue, breathiness and volume disturbance for the production of loud phonation. The high coloratura sopranos (like Galli- Curci) seemed to have the worst phonatory problems in patients with EBSLN injury. In non-singer patients with EBSLN damage, Robinson[5] found a significant drop in maximum phonation time and range of phonation frequencies. The percentage of jitter and shimmer, and the noise-to-harmonics ratio were also abnormally high. Moran and Castro[18] deliberately traumatized the external laryngeal nerve during thyroidectomies with forceps. They observed that unilateral trauma produced hoarse, monotonous voice for five to seven days that subsequently seemed to return to normal while bilateral damage had the same effect plus fatigue, which persisted for at least three months and was permanent in one case.

In 1992, Cernea[10] proposed a classification of EBSLN based on the potential risk of injury to the nerve during thyroid surgery according to its relationship with the upper edge of the superior thyroid pole; the author found the highest risk in cases with large goitre.

The EBSLN classification was also described by Friedman[12] and Kierner.[14]

The former has described three variants of the EBSLN as detailed below:

Type 1: The nerve runs superficial to the inferior constrictor muscle.

Type 2: The nerve penetrates the lower part of the inferior constrictor muscle.

Type 3: The nerve runs deep to the inferior constrictor muscle.

The Type 3 variant may account for the fact that many authors state that the nerve could not be identified in the region of the upper pole of the thyroid gland during thyroid surgery. We feel the non identification rate of 10.64% in our study is also probably due to the prevalence of the Type III Friedman variant, which cannot be identified in routine thyroid surgery as it lies completely buried under the fibers of the inferior constrictor muscle of the pharynx. In our study, we had positive identification rate of 89.36%. Rate of intraoperative nerve identification has been reported to vary from 10 to 80%.[14]

Aina and Hisham[25] have reported lack of any added benefit of nerve stimulator in identifying type II nerves which were low lying and vulnerable. Page[26] in a study of 50 thyroidectomies also felt systemic search for EBSLN is not useful. In our study, we relied on visual identification alone due to lack of equipment. As a protocol, we spend only few minutes in an attempt to identify the EBSLN in cricothyroid space after lateralization of the superior pedicle. We avoided extensive dissection for search of EBSLN. In our study, types IIa and IIb EBSLN, which put patients at greater risk for injury during thyroidectomy, were observed in 58 (61.70%) of 94 nerves. In similar studies done in western population, Cernea[27] reported that 37% of all patients had either type IIa or IIb EBSLNs, while Kierner[14] reported 44%, and Seven 28 reported 48%. In similar study done in Eastern populations, Aina[29] reported 83.7% of patients with type IIa or IIb, and Chuang[30] reported 77.8%. This difference may be relatively well explained by racial variations between Western and Eastern population. It is difficult to explain the differences between our results and those of others. One possible explanation is the manner in which the superior pole is exposed. The dissections of the superior pole in cadaver may result in a perspective of the nerve that varies from that obtained by surgical exposure, especially the technique used in the present series, where the lateral surface of the cricothyroid muscle was exposed and the EBSLN was identified. Its course was traced laterally to the point where it crossed the superior thyroid vessels. No sharp dissection or electrocautery was used at the superior pole prior to identification of this point.

CONCLUSION

Surgeons should pay more attention to preserve the external branches of superior laryngeal nerve during thyroid surgeries. It can be done by using a combined technique of lateralization of the superior pole along with careful dissection in avascular cricothyroid space and intraoperative nerve identification and capsular dissection, skeletonization and individual ligation of superior pole vessels. Cernia types IIa and IIb EBSLN, which put patients at greater risk for injury during thyroidectomy, were observed in most of the cases in this study, but still it is possible to increase the rate of nerve identification and avoid the nerve injury even in the absence of sophisticated equipment like intraoperative nerve monitoring.

REFERENCES

1. Delbridge L. Total thyroidectomy: the evolution of surgical technique. ANZ J Surg. 2003; 73(9):761-8. https://doi.org/10.1046/j.1445-2197.2003.02756.x. PMID: 12956795.
2. Lombardi CP, Raffaelli M, Alatri L, Marchese MD, Rigante M, Paludetti G, et al. Voice and swallowing changes after thyroidectomy in patients without inferior laryngeal nerve injuries. Surgery. 2006;140(6):1026-32. https://doi.org/10.1016/j.surg.2006.08.008. PMID: 17188153.
3. Sinagra DL, Montesinos MR, Tacchi VA, Moreno JC, Fakci JE, Mezzadri NA. Voice changes after thyroidectomy without recurrent laryngeal nerve injury. J Am Coll Surg. 2004;199(4):56–60. https://doi.org/10.1016/j.jamcollsurg.2004.06.020. PMID: 15454138.
4. Eckley CA, Sataloff RT, Hawkshaw M, Spiegel JR, Mandel S. Voice range in superior laryngeal nerve paresis and paralysis. J Voice. 1998;12(3):340–8. https://doi.org/10.1016/S0892-1997(98)80024-6.
5. Robinson JL, Mandel S, Sataloff RT. Objective voice measures in non-singing patients with unilateral superior laryngeal nerve paresis. J Voice 2005;19(4):665-7. https://doi.org/10.1016/j.jvoice.2005.04.001. PMID: 16129578.
6. Delbridge L. The 'neglected' nerve in thyroid surgery: the case for routine identification of the external nerve. ANZ J Surg. 2001;71(4):199. https://doi.org/10.1046/j.1440-1622.2001.02120.x. PMID: 11355722.
7. Surgeon's approach to the thyroid gland: surgical anatomy and the importance of technique. World Journal of Surgery. 2000;24(8): 891–897. https://doi.org/10.1007/s002680010173. PMID: 10865032.
8. Teitelbaum BJ, Wenig BL. Superior laryngeal nerve injury from thyroid surgery. Head Neck. 1995;17(1):36–40. https://doi.org/10.1002/hed.2880170108.
9. Stojadinovic A, Shaha AR, Orlikof RF, Nissan A, Kornak MF, Singh B et.al. Prospective functional voice assessment in patients undergoing thyroid surgery. Ann Surg. 2002;236 (6): 823-32. https://doi.org/10.1097/00000658-200212000-00015. PMID: 12454521.
10. Cernea CR, Ferraz AR, Nishio S, Dutra A Jr , Hojaij FC, dos Santos LR. Surgical anatomy of the external branch of the superior laryngeal nerve. Head Neck. 1992;14:380–3. https://doi.org/10.1002/hed.2880140507. PMID: 1399571.
11. Cernea CR, Ferraz AR, Furlani J, Monteiro S, Nishio S, Hojaij FC, et al. Identification of the external branch of the superior laryngeal nerve during thyroidectomy. Am J Surg. 1992;164(6):634-9. https://doi.org/10.1016/S0002-9610(05)80723-8.
12. Friedman M, LoSavio P, Ibrahim H. Superior laryngeal nerve identification and preservation in thyroidectomy. Arch Otolaryngol Head Neck Surg. 2002;128:296–303. https://doi.org/10.1001/archotol.128.3.296. PMID: 11886347.
13. Selvan B, Babu S, Paul MJ, Abraham D, Samuel P, Nair A. Mapping the compound muscle action potentials of cricothyroid muscle using electromyography in thyroid operations: a novel method to clinically type the external branch of the superior laryngeal nerve. Ann Surg. 2009;250:293–300. https://doi.org/10.1097/SLA.0b013e3181b17342. PMID: 19638904.
14. Kierner AC, Aigner M, Burian M: The external branch of the superior laryngeal nerve: its topographical anatomy as related to surgery of the neck. Arch Otolaryngol Head Neck Surg.1998;124:301–3. https://doi.org/10.1001/archotol.124.3.301.
15. Aina EN, Hisham A. External laryngeal nerve in thyroid surgery: recognition and surgical implications.ANZ J Surg. 2001;71:212–4. https://doi.org/10.1046/j.1440-1622.2001.02078.x.
16. Aluffi P, Policarpo M, Cherovac C, Olina M, Dosdegani R, Pia F. Post-thyroidectomy superior laryngeal nerve injury. Eur Arch Otorhinolaryngol. 2001;258:451–4. https://doi.org/10.1007/s004050100382. PMID: 11769989.
17. Loré JM, Kokocharov SI, Kaufman S, Richmond A, Sundquist N. Thirty-eight year evaluation of a surgical technique to protect the external branch of the superior laryngeal nerve during thyroidectomy. Ann Otol Rhino Laryngol.1998;107: 1015–22. https://doi.org/10.1177/000348949810701204. PMID: 9865631.
18. Moran RE, Castro AF. The superior laryngeal nerve in thyroid surgery. Ann Surg. 1951; 134:1018-21. https://doi.org/10.1097/00000658-195112000-00011.
19. Jonas J, Bahr R. Neuromonitoring of the EBSLN during thyroid surgery. Am J Surg. 2000;179: 234-6. https://doi.org/10.1016/S0002-9610(00)00308-1.
20. Lennquist S, Cahlin C, Smeds S. The superior laryngeal nerve in thyroid surgery. Surgery 1987;107: 1015-22.
21. Lekacos NL, Miligos ND, Tzaedis PJ, Majiatis S, Patoulis J. The superior laryngeal nerve in thyroidectomy. Am Surg. 1987; 53(10): 610-2. PMID: 3674608.
22. Choksy SA, Nicholson ML. Prevention of voice changes in singers by using a nerve stimulator to identify the external laryngeal nerve. Br J Surg. 1996; 83: 1131-2. https://doi.org/10.1002/bjs.1800830831.
23. Mermelstein M, Nonweiler R, Rubinstein EH. Intraoperative identification of laryngeal nerves with laryngeal electro myography. Laryngoscope. 1996;106:752-5. https://doi.org/10.1097/00005537-199606000-00016. PMID: 8656962.
24. Echeverri A, Flexon PB. Electrophysiological nerve stimulation for identifying of recurrent laryngeal nerve in thyroid surgery: Review of 70 consecutive thyroid surgeries. Am Surg. 1998;64:328-33. PMID: 9544143.
25. Aina EN, Hisham AN. External laryngeal in thyroid surgery: is the nerve stimulator necessary? Eur J Surg. 2001;167:662-5. https://doi.org/10.1080/11024150152619282. PMID: 11759734.
26. Page C, Laude M, Legars D, Foulon P, Strunski V. The external laryngeal nerve: surgical and anatomic considerations. Report of 50 total thyroidectomies. Surg Radiol Anat. 2004;26:182-5. https://doi.org/10.1007/s00276-003-0214-y. PMID: 14648040.
27. Cernea CR, Nishio S, Hojaij FC. Identification of the external branch of the superior laryngeal nerve (EBSLN) in large goiters. Am J Otolaryngol. 1995;16:307–11. https://doi.org/10.1016/0196-0709(95)90058-6.
28. Seven H, Calis AB, Vural C, Turgut S. Microscopic thyroidectomy: a prospective controlled trial. Eur Arch Otorhinolaryngol. 2005;262:41–4. https://doi.org/10.1007/s00405-004-0740-1. PMID: 15744511.
29. Aina EN, Hisham AN. External laryngeal nerve in thyroid surgery: recognition and surgical implications. ANZ J Surg. 2001;71:212–4. https://doi.org/10.1046/j.1440-1622.2001.02078.x.
30. Chuang FJ, Chen JY, Shyu JF, Su CH, Shyr YM, Wu CW et al. Surgical anatomy of the external branch of the superior laryngeal nerve in Chinese adults and its clinical applications. Head Neck. 2010;32:53–7. PMID: 19475549.