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Identification of external branch of superior laryngeal nerve during thyroid surgery: a prospective study

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ABSTRACT

Background: Identification of external branch of superior laryngeal nerve (EBSLN) according to Cernea et al classification and to describe a surgical technique of superior pole dissection to preserve EBSLN during thyroid surgeries.
Methods: The study was done over 2 years period in a tertiary care hospital. 105 nerves were studied among the 90 patients who underwent thyroid surgeries. Avascular dissection over the JOLL'S triangle was carried out and identified EBSLN were classified according to Cernea et al classification. Individual ligation of superior pole vessels was carried out after identifying the nerve. Outcome was studied relating the identified nerve with sides of thyroidectomy performed, size of thyroid gland and nerves at risk according to Cernea et al classification.
Results: Of the 105 nerves studied, in 81.90% of patients the nerve was identified. There were 34.88% of Type 1 nerves, 52.33% of Type 2A nerve and 12.79% of Type 2B nerves identified. Less number of nerves could be identified on the left side. Type 2B nerves were more common on left side inspite of less number of dissections carried out on left. Type 2 variation was more common in large goiters.
Conclusions: Careful dissection should be done in superior pole in avascular cricothyroid space, with lateralization of superior pole and individual identification of superior pole vessels once the nerve is identified. Identification of the nerve is mandatory in all patients who undergo thyroid surgery for optimal functions of the larynx. These results showed a better identification of nerves by proper surgical techniques without use of any sophisticated equipments.

Keywords: EBSLN, Joll's triangle, Cernea Classification, goiters

INTRODUCTION

Thyroidectomy is a common surgical procedure. Major concern in thyroid surgery is morbidity due to injury to anatomical structures.[1] Three important structures that are necessary to be preserved during thyroid surgery are, the Recurrent laryngeal nerve (RLN), Parathyroid glands and the external branch of superior laryngeal nerve (EBSLN).[2] Enormous work had been done on ways to preserve the RLN and parathyroid glands, less attention was given to EBSLN.[3] In fact it is described as a 'neglected' nerve in thyroid surgery; despite the fact that injury to this nerve can cause significant disability.[4] Unilateral injury to EBSLN may result in mild voice huskiness; however bilateral injury can result in devastating consequences. In most individuals, these changes tend to be a nuisance, but it can be catastrophic in voice professionals.[4]

It needs meticulous dissection to avoid injury to the EBSLN, thus it is of utmost importance to have adequate knowledge on anatomical variations of course of this nerve. Cernea et al were the first to describe an objective classification for the anatomical variations and risk

during surgery.[5] Most texts acknowledge the fact that the nerve is in close relation to the superior thyroid artery; there has not been to the best of our knowledge an anatomic study to relate the position of the EBSLN to the superior pole of the thyroid gland and the superior thyroid artery. So in this study we aim to identify the EBSLN in all cases of thyroid surgeries and classify its position according to Cernea et al classification and also note its relation to the superior thyroid artery.[5] By doing this study we attempt to find out ways and means to reduce damage to EBSLN during thyroid surgery, further reducing the surgical morbidity.

METHODS

This is a prospective nonrandomized study conducted on 90 patients undergoing thyroidectomy procedures from October 2013 to October 2015 in ENT Department of Indira Gandhi Govt. Medical College, Nagpur; a tertiary care centre in Central India. Patients of either sex who presented with complaints of neck swelling, confirmed to be thyroid on investigation and subjected to thyroid surgery were included in this study. Conditions like anaplastic carcinoma of thyroid, preexisting abnormal vocal cord function, previous neck irradiation and past surgery involving cervical exploration were excluded from this study. All these patients underwent a detailed examination including indirect laryngoscopic examination and videolaryngoscopy for preoperative vocal cord assessment.

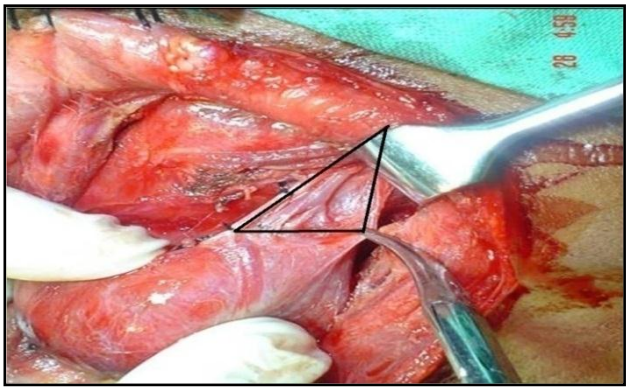

Figure 1: Nerve identified in Joll's triangle.

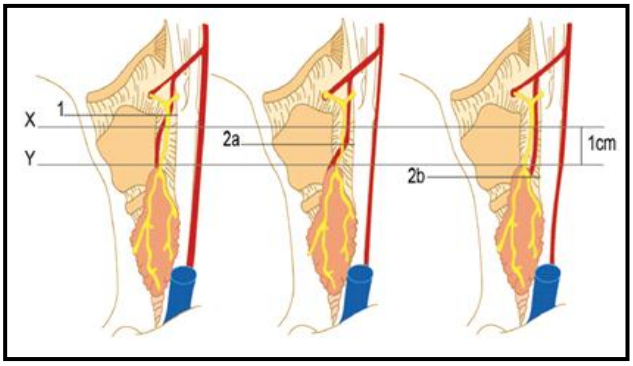

Figure 2: Cernea classification of EBSLN.

All surgical procedure was standardized and done by single surgeon to avoid operational bias. Standard Kocher's incision was taken, thyroid gland exposed after raising the subplatysmal flap. Strap muscles were separated in midline. Gland was exposed & superior pole dissection was meticulously performed. Superior pole was mobilized carefully preventing injury to the ESLBN. Joll's triangle was identified, dissection carried out in avascular plane (Figure 1). Precautions were taken not to ligate or cauterize any vessel till the nerve was identified. Once the nerve was identified, the distance of the nerve from the superior pole of thyroid was measured using a caliper. The identified nerve was classified according to Cernea et al classification (Figure 2). Also the relation of the nerve with the superior thyroid artery was noted. Individual ligation of superior pole vessels were then carried out. Main outcome measures were the type of nerve according to Cernea et al, nerves at risk, nerves identified in relation to sides, nerves identified in relation to size of goiter.[5]

RESULTS

In our series a total of 105 nerves were studied among 90 patients. Mean age group was 34.44% (range 31-40 years). Male: female ratio was 1:6.5. Of the total 90 patients, 16.67% dissections was carried on both sides and 83.33% were unilateral dissections. Right sided dissections were 74.67%, left sided were 25.33% (Table 1). Colloid goiter was the commonest histological subtype accounting for 76.67%, followed by adenomatous goiter in 7.78%, Thyroiditis in 6.67%, follicular neoplasms in 4.44%, papillary carcinoma in 3.33% and follicular carcinoma in 1.11% Table 2). Small goiter (weight <100 g) were seen in 19 (23.33%), and large goiter (>100g weight) were seen in 67 (76.67%) patients (Table 3).

Table 1: Distribution of the patients according to the side of Hemithyroidectomy performed.

S No	Hemithyroidectomy	Percentage (%)
1	Right side	74.67
2	Left side	25.33
	Total	100

Table 2: Distribution of patients according to the histological subtypes of thyroid swelling.

S No	Histological subtypes	Percentage (%)
1	**Colloid goiter**	76.67
2	**Thyroiditis/Hashimoto thyroiditis**	6.67
3	**Adenomatous goiter**	7.78
4	**Follicular neoplasms**	4.44
5	**Papillary carcinoma**	3.33
6	**Follicular carcinoma**	1.11
	Total	100

Table 3: Distribution of patients according to the size of thyroid swelling.

S No	Size of swelling	Percentage (%)
1	**Small goiter (SG)**	23.33
2	**Large goiter (LG)**	76.67
	Total	100

Table 4: Showing identified EBSLN according to Cernea classification during thyroidectomy.

S No	Identified EBSLN classification according to Cernea	Percentage (%)
1	**Type I**	34.88
2	**Type 2A**	52.33
3	**Type 2B**	12.79
	Total	100

A total of 105 sides were dissected, in which the nerves could be identified in 86 sides i.e. 81.90%. In the remaining 18.10% cases, the nerve could not be identified. On applying Cernea et al classification to the identified nerves, Type 1 nerves were found in 30 (34.88%), Type 2A in 45 (52.33%) and Type 2B in 11 (12.79%) (Table 4). We tried to compare the identified and non-identified nerves with the sides of dissection; we found that of the identified nerves (n=86), 64 (74.42%) were on the right side and only 22 (25.58%) were on left side. Similarly of the unidentified nerves (n=19), 12(63.16%) were on the left side compared to 7(36.84%) on the right side (Table 5). Thus we found that nerve identification was obviously less on left side compared to right side. This difference was found to be statistically significant (p=0.00275). All the identified nerves were seen to be lying medial to the superior thyroid artery in our study.

Table 5: Showing the EBSLN studied with sides during thyroidectomy.

Nerves [EBSLN]	Side		P value
	Right in %	Left in %	
Identified	74.42	25.58	0.00275
Not identified	36.84	63.16	

Table 6: Comparing identified EBSLN with the sides during thyroidectomy.

Identified EBSLN Nerves according to Cernea	Side of nerves identified on		P value
	Right in %	Left in %	
Type 1	37.5	27.27	>0.05
Type IIA	54.69	45.46	>0.05
Type IIB	07.81	27.27	<0.05
Total	100	100	-

Table 7: Comparing identified EBSLN with size of the goiter during thyroidectomy.

Nerves identified according to Cernea	Size of goiter		P value
	Small in %	Large in %	
Type I	36.67	63.33	>0.05
Type 2A	15.56	84.44	<0.05
Type 2B	9.10	90.90	

We compared the types of nerves identified according to Cernea's classification on either side. On the right side (n=64), Type 1 nerves were 24 (37.5%), Type 2A were 35 (54.69%) and Type 2B were 5 (7.81%); similarly on left side (n=22), Type 1 nerves were 6 (27.27%), Type 2A were 10 (45.46%) and Type 2B were 6 (27.27%). On comparing type of nerve identified with sides, we found that Type 2B nerves were more common on left side compared to right, in spite of less number of left sided dissections. This difference was statistically significant (p<0.05) Table 6.

On comparing type of nerve identified with size of goiter, in small goiters (n=19), Type 1 nerves were identified in 11 (57.89%), type 2A were seen in 7 (36.84%) and Type 2B were seen in 1 (5.26%); whereas in large goiters (n=67), Type 1 nerves were present in 19 (28.35%), Type 2A were seen in 38 (56.71%) and Type 2B were seen in 10 (14.92%) cases. On analyzing the data it was found that 84.44% of the total Type 2A nerves identified & 90.90% of the total Type 2B nerves identified were seen in large goiters compared to only 15.56% and 9.10% of respective types in small goiters. Thus the Type 2 variants of EBSLN (high risk variants) were seen more commonly in Large goiter and the result was statistically significant (p<0.05) Table 7.

All the patients underwent post-operative video-laryngoscopic and videostroboscopic voice evaluation to find out integrity of EBSLN and none of our patients had features of nerve palsy.

DISCUSSION

The EBSLN arises from the superior laryngeal nerve a branch of vagus nerve. This nerve descends deep to the superior thyroid artery, crosses the cricothyroid space which is potentially avascular. The nerve enters the cricothyroid muscle with the cricothyroid artery[6]. EBSLN is closely intimated with superior pole of thyroid and superior thyroid artery, thus rendering the nerve vulnerable to injury during dissection of superior pole. The nerve gets stretched during retraction or during ligation of superior pole vessels.[7] The conventional method of ligating superior pole vessels close to gland without identifying the nerve carried a risk of 10% injury to nerve.[8] Various studies have been carried out to define anatomy of EBSLN, its identification and injury rates. But no international guidelines have been formed. This study was aimed at identifying the nerve and ways to prevent its injury.

In our study the intraoperative nerve identification was done by careful dissection in an avascular cricothyroid space, with lateralization of superior pole and individual ligation of vessels, with no use of cautery. By this technique the identification rate of 81.90% was achieved. Studies done for identification of nerve showed an identification rate of 33% to 93%, with injury rates from 0% to 58% (Table 8).

Table 8: Showing identification rates of EBSLN by using various surgical techniques.

Study	Patient evaluation	Surgical technique	Identification rates (%)
Lennquist et al[4]	Laryngoscopy, questioning	Inspection of distal part of constrictor for nerve but no muscle dissection	72
Cernea et al[5]	EMG, voice evaluation	Nerve stimulator compared with no nerve search done by residents and attending physicians	93
Jonas & Bahr et al[6]	Laryngoscopy, voice evaluation	Neuromonitoring to find nerve	37.8
Lore et al[7]	Laryngoscopy, questioning	Not necessary to expose the nerve	33
Kark et al[8]	Laryngoscopy, oscilloscopy, Questioning	Looked at nerve identified versus not identified	84
Our study	Laryngoscopy	Identifying the nerve, with individual ligation of superior pole vessels	81.90

In our study, the Type 2 (2A+2B) pattern was seen in 65.12% of patients, thus carrying more risk of injury to the nerve. Study conducted by Aina et al showed a risk of 82.2%, Mishra et al with 63.79%, Hwang et al with 83.7%.[9-11] Our study showed that left sided nerves were less commonly identified than right side. Study done by Naidoo et al showed that the shortest distance between superior pole and EBSLN on right side was 5.76 mm and for left 6.17 mm.[12] Thus this variation of distance of was found more common in left side. This indicates that left sided dissection should be carried out carefully till the nerve is identified. This study also showed that the Type 2B pattern was most commonly seen on left side than right, despite of the fact that less number of dissection was carried out in left side. This study proved that variation of nerve and risk of injury to the nerve is more common on left side, thus indicating a careful and meticulous dissection needs to be performed on left sided goiters.

The results showed that as the gland size increases the Type 2 pattern of nerve was identified commonly, with incidence of 87.67% for large goiters and 12.33% for small goiters. Similar results were seen in study by Cernea et al.[5] Our study also revealed a considerable higher frequency of type 2B nerve with large goiters, the results being statistically significant. Study conducted by Aina et al showed type 2B in 51.3% of patients. These results showed that nerve identification is easy in larger goiters but the risk of injury is more. So larger goiters needs proper ligation of superior pole vessels.

In our series 19 (18.10%) of nerves were not identified. This could be because of various branching pattern of the nerve and with sometimes difficult dissection of superior pole due to bloody field and larger gland size. Study by Friedman et al described three variations of the nerve in relation to inferior constrictor muscle in cadavers, which may be difficult or impossible to be identified.[13] In our study, however, these variations were not considered and no extensive dissection for the search of nerve was done. In these situations where the nerve could not be identified, our dissections were restricted close to the gland capsule and ligating vessels close to the pole.

We followed visual identification the nerve by performing a standard technique in superior pole, without use of any equipment. Our technique of identifying Joll's triangle, dissection in avascular cricothyroid space, with identifying nerve followed by ligating vessels was done in a sequential procedure thus reducing the risk of nerve injury and also protocol for identifying the nerve. All these patients underwent postoperative video-laryngoscopy, videostrobolaryngoscopy to assess an objective function of EBSLN. None of our patients had an injury to the EBSLN.

CONCLUSION

Preservation of EBSLN is important for optimal functions of the larynx. So intraoperative identification is must in all cases of thyroidectomies. Following a careful dissection in the avascular cricothyroid space with lateralization of the superior pole of thyroid, intra operative nerve identification followed by individual ligation of superior pole vessels without cauterization will increase the rate of nerve identification and avoids nerve injury. So by using proper dissection method, identification and preservation of the EBSLN is possible even in the absence of any sophisticated equipments.

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