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# **Original Research Article**

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# A descriptive study on the surgical anatomy of external laryngeal nerve in patients undergoing thyroidectomies at a tertiary care center in South India

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## **ABSTRACT**

**Background:** The superior laryngeal nerve divides into two branches, external and internal at the level of the hyoid bone. The relationship of the external branch with the superior thyroid artery and the upper pole of the thyroid gland is variable. Due to this it is at risk of injury while ligating the superior pedicle during thyroidectomy.

**Methods:** The position of the external laryngeal nerve in 110 patients undergoing thyroidectomy in a tertiary care center in south India over a period of one year was assessed. The nerves were identified by opening up the Reeve's avascular plane near the superior pole of the thyroid gland. The positions were identified and classified based on Cernea's classification. Data was analyzed using SPSS 16.0 version.

**Results:** The nerve could be identified on the left side in 109 cases (99.1%) and 106 cases (96.4%) on the right side. Cernea's IIa was the most common position on the left side (46.4%), followed by IIb (35.5%) and I (17.3%). On the right side IIb was the most common position (40%), followed by IIa (36.4%) and I (20%). Overall the most common position was IIa (41.36%).

**Conclusions:** It is possible to identify the external laryngeal branch of the superior laryngeal nerve with careful dissection. Large proportion of the position of the external laryngeal nerve is IIB, which would be at very high risk of injury if the superior pedicle is ligated without identifying it.

Keywords: Cernea's classification, External laryngeal nerve, Nerve injury, Superior thyroid pedicle, Thyroidectomy

# **INTRODUCTION**

Thyroid disorders and surgeries have been known and performed ever since the 1st century AD.<sup>1</sup> There have been numerous modifications in the techniques with better understanding of the anatomy and the physiology of the thyroid gland. Initial thyroid surgeries were tormented with complications involving the associated nerves and parathyroids. Later the association of these complications with the diverse vascular supply and positions were understood. The complications came down drastically when the importance of parathyroids and recurrent laryngeal nerves preservation started being

stressed. Even though we have crossed a decade of modern thyroid surgeries, very little importance is being given to the identification of external laryngeal branch of the superior laryngeal nerve. The complications associated with the ELN injury were not given importance by the patient or the treating doctor. The best way to avoid injury to nerves during thyroidectomy is by identifying and preserving them, in contrast to earlier belief that injury is best avoided by not looking for them. In this era, in which by surgery we aim at not just treating the disease but to bring back the patient to best possible normalcy, it is injustice on the surgeon's part to cause a voice change which could have easily been avoided by

spending another minute or two on dissection and identification of the nerve.

The external laryngeal nerve which is a branch of the superior laryngeal nerve and which supplies the cricothyroid muscle is not routinely identified by surgeons during thyroidectomy, as it is a very fine nerve and its course is highly variable.<sup>2-11</sup> Its injury results in loss of the high pitch of the voice and injury to the superior laryngeal nerve results in choking on swallowing food and liquids due to the epiglottic sensation being lost. In order to prevent injury to the nerve, surgeons routinely ligate the superior thyroid artery with its venae comitantes very close to the superior pole of the thyroid without tracing out the nerve course. But at times, when the nerve has a variable course as per the Cenea's classification and especially in Cernea's 2b types injury occurs. And significant cases of Cernea's 2a is also under risk. A full understanding of the anatomy of the superior laryngeal nerve and its branches, could prepare the surgeon to reduce this risk of damage.

Injury to the ELN may result in transient loss of high pitched voice but often may lead to permanent change. Patients like Orators, Singers and Teachers who heavily depend on their voices may lose their livelihood.

There have been studies on the ELN both on cadavers and patients, which have shown that the percentages of nerves which are at risk are many folds higher than those which are well away. There could be an argument that the injury would less with experience and high volume. Even in a high volume centre for thyroidectomies like ours, every once in a while we have patients having undergone thyroidectomy with superior laryngeal nerve injury. This led us to start analyzing the roots to this problem.

This study was started in view of tackling this issue. Now we have started identifying the ELN during routine thyroidectomies and thus preventing its injuries. At many instances we do a thyroidectomy for cosmetic and due to the patients wish for it. Correcting the deformity at the cost loss of voice would not be an acceptable solution. At the end a surgery without any complications is what brings solace in the stressful life of a surgeon. The aim of the study was to determine the feasibility of identification of the external branch of the superior laryngeal nerve during routine thyroidectomy, to describe the surgical anatomy of external branch of superior laryngeal nerve patients undergoing thyroidectomy based on Cernea's classification.<sup>2,11</sup>

## **METHODS**

Descriptive study was designed for patients who undergo thyroidectomy from August 2015 to November 2015 at a tertiary care center in South India for 4 months. Based on the study conducted by Mishra AK et al, the proportion of external branch of superior laryngeal nerve feasible for identification was 92.31%.<sup>13</sup>

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\begin{split} p &= 92.31\% = 0.9231 \\ q &= 07.64\% = 0.0769 \\ d &= absolute \ precision = 5\% = 0.05 \\ Z \ at \ 95\% \ C.I &= 1.96 \\ Sample \ size \ (N) &= (Z\alpha^2pq) \div (d^2) \\ &= (1.96x1.96x0.9231x0.769) \div (0.05x0.05) \\ &= 109 \ ^{\circ} \ 110 \\ Sample \ size \ 110 \end{split}
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#### Inclusion criteria

- Adult patients
- Both nerves taken as separate items for my sample size

## Exclusion criteria

- Very large thyroids in which anatomy is bound to be disturbed, are not included
- With previous history of thyroid surgery

Intra-operative relationship between the Superior thyroid artery and the External laryngeal nerve will be assessed and classified according to Cernea's Classification.<sup>2,11</sup>

# **Technique**

- 'Lateralization' of upper pole and dissection of avascular cricothyroid space called Reeve's avascular space.
- Identification of external laryngeal branch of the superior laryngeal nerve.
- Skeletonization and individual ligation of superior thyroid vessels.

# Cernea's classification.<sup>2,11</sup>

Type 1

Nerve crossing the superior thyroid vessels 1 or more cm above a horizontal plane through the upper border of the superior thyroid pole.

Type 2a

Nerve crossing the vessels less than 1 cm above the horizontal plane.

Type 2b

Nerve crossing the vessels below the horizontal plane

# **RESULTS**

Total number of patients who underwent thyroidectomy is 110. Of those 12 were males and 98 were females.

The youngest person in the study group is 24 years old, the oldest person is 71 years old and the mean age is 44.08 years (Table 2).

The youngest male is 24 years old, the oldest male is 64 years old and mean age is 42.67 years old. The youngest female is 25 years old, the oldest female is 71 years old

and mean age is 44.26 years old. Of the 110 patients who underwent thyroidectomy, 107 were total thyroidectomies and 3 were hemi-thyroidectomies (Table 3).

Table 1: Distribution of patients undergoing thyroidectomy based on sex.

	Frequency	Percent	Valid percent	Cumulative percent
Males	12	10.9	10.9	10.9
Females	98	81.1	81.1	100
Total	110	100	100	

Table 2: Age distribution of patients undergoing thyroidectomy.

	Mean	44.8
Total population	Standard deviation	10.364
	Minimum	24
	Maximum	71
Male	Mean	42.67
	Standard deviation	12.601
Iviale	Minimum	24
	Maximum	64
	Mean	44.26
Female	Standard deviation	10.120
	Minimum	24
	Maximum	71

On the right side nerve and was identified in 106 persons and could not be identified in 1 person (Table 4). On the left side nerve was identified in 109 cases and could not be identified in 1 person (Table 5). Of the 106 right sided nerves that were identified, 22 were I, 40 were IIa and 44 were IIb in position. Of the 4 persons that are not classified, 3 underwent hemi thyroidectomy and in 1 nerve could not be identified (Table 6).

Table 3: Distribution of study population based on procedure.

	Frequency	Percent
Total thyroidectomy	107	97.3
Hemi thyroidectomy	3	2.7
Total	110	100

Table 4: Identification of right sided nerves.

Nerve	Frequency	Percent	Valid percent	Cumulative percent
Visible	106	96.4	96.4	96.4
Not visible	1	0.9	0.9	97.3
Not applicable *	3	2.7	2.7	100
Total	110	100	100	

Table 5: Identification of left sided nerves.

Nerve	Frequency	Percent	Valid percent	Cumulative percent
Visible	109	99.1	99.1	99.1
Not visible	1	0.9	0.9	100
Total	100	100	100	

Table 6: Classification of right sided nerves based on position.

Type	Frequency	Percent	Valid percent	Cumulative percent
I	22	20.0	20.0	20.0
IIA	40	36.4	36.4	56.4
IIB	44	40.0	40.0	96.4
Not applicable	4	3.6	3.6	100
Total	110	100	100	

Of the 109 nerves that were identified 19 were I, 51 were IIa and 39 were IIb in position. The nerve could not be identified in 1 person (Table 7). In males, 16% of the

nerves were I, 67% were IIa and 17% were IIb in position (Table 8). In women, 20% of the nerves were I, 33% were IIa and 43% were IIb in position. 4% could not be

identified. Considering both sexes together, 20% of the nerves were I, 36% were IIa and 40% were IIb in position. 4% could not be identified. In males 17% of the

identified left sided nerves were I, 50% were IIa and 33% were IIb (Table 9).

Table 7: Classification of left sided nerves based on position.

Type	Frequency	Percent	Valid percent	Cumulative percent
I	19	17.3	17.3	17.3
IIA	51	46.4	46.4	63.6
IIB	39	35.5	35.5	99.1
Not applicable	1	0.9	0.9	100
Total	110	100	100	

Table 8: Position of the right side nerves versus gender.

			Position right				
		I	IIA	IIB	Not applicable	Total	
	Count	2	8	2	0	12	
Males	% within sex	16.7%	66.7%	16.7%	0	100%	
	% within position right	9.1%	20.0%	4.5%	0	10.9%	
	Count	20	32	42	4	98	
Females	% within sex	20.4%	32.7%	42.9%	4.1%	100%	
	% within position right	90.9%	80.0%	95.5%	100.0%	89.1%	
	Count	22	40	44	4	110	
Total	% within sex	20.0%	36.4%	40.0%	3.6%	100%	
	% within position right	100%	100%	100%	100%	100%	

Table 9: Position of the left side nerves versus gender.

		Position left				Total
		I	IIA	IIB	Not applicable	
	Count	2	6	4	0	12
Males	% within sex	16.7%	50%	33.3%	0	100%
	% within position left	10.5%	11.8%	10.3%	0	10.9%
	Count	17	45	35	1	98
Females	% within sex	17.3%	45.9%	35.7%	1.0%	100%
	% within position left	89.5%	88.2%	89.7%	100.0%	89.1%
	Count	19	51	39	1	110
Total	% within sex	17.3%	46.4%	35.5%	0.9%	100%
	% within position left	100%	100%	100%	100%	100%

Table 10: Position of the right sided nerves based on age groups.

		Position r	Position right			■ Total
		I	IIA	IIB	Not applicable	Total
	Count	10	12	24	2	48
<40	% within the age category	20.8%	25.0%	50.0%	4.2%	100%
	% within position right	45.5%	30%	54.5%	50%	43.6%
	Count	12	26	10	2	50
41-60	% within the age category	24%	52%	20%	4%	100%
	% within position right	54.5%	65%	22.7%	50%	45.5%
	Count	0	2	10	2	12
>60	% within the age category	0%	16.7%	83.3%	0%	100%
	% within position right	0%	5%	22.7%	0%	10.9%
	Count	22	40	44	4	110
Total	% within the age category	20%	36.4%	40%	3.6%	100%
	% within position right	100%	100%	100%	100%	100%

		Position le	eft			— Total	
		I	IIA	IIB	Not applicable	Total	
	Count	10	25	12	1	48	
<40	% within the age category	20.8%	52.1%	25%	2.1%	100%	
	% within position left	52.6%	49%	30.8%	100%	43.6%	
	Count	7	26	17	0	50	
41-60	% within the age category	14%	52%	34%	0%	100%	
	% within position left	36.8%	51%	43.6%	0%	45.5%	
	Count	2	0	10	0	12	
>60	% within the age category	16.7%	0%	83.3%	0%	100%	
	% within position left	10.5%	0%	25.6%	0%	10.9%	
	Count	19	51	39	1	110	
Total	% within the age category	17.3%	46.4%	35.5%	0.9%	100%	
	% within position left	100%	100%	100%	100%	100%	

Table 11: The position of the left sided nerves based on age groups.

In females 17% of the identified left sided nerves were I, 46% were IIa and 36% were IIb. 1% of the nerves could not be identified. In patients younger than 40 years - 10 persons have I, 12 persons have IIA and 24 persons have IIB (Table 10). In patients between 41-60 years - 12 persons have I, 26 persons have IIA and 10 persons have IIB. In patients above the age of 60, 2 were IIA and 10 were II

In patients younger than 40, 10 were I, 25 were IIA and 12 IIB. In patients between 40 - 61, 7 were I, 26 were IIA and 17 IIB on the left side. In patients older than 60, 2 were I, none were IIA and 10 IIB on the left side (Table 11).

# **DISCUSSION**

# The feasibility of identification of the external laryngeal branch of the superior laryngeal nerve

The present study shows that the external laryngeal nerve can be identified in almost all the cases. Only in 1 out of the 110 cases studied, the nerve could not be identified.

In the study conducted by Mishra AK et al, titled "The external laryngeal nerve in thyroid surgery: the 'no more neglected' nerve" in Sanjay Gandhi Postgraduate institute in Lucknow, they dissected superior poles in 78 patients undergoing thyroidectomy. The nerves could be identified in 72 (92.31%). <sup>13</sup>

Pagedar NA et al conducted a study in Department of Otolaryngology, University of Lowa, Ontario, Canada on 178 patients undergoing thyroidectomy over a period of 4 years. The study was titled as "External branch of the Superior laryngeal nerve". 3 of 178 nerves (1.7%) could not be identified using the routine technique. 15

Aina EN et al conducted a study on the external laryngeal nerve in thyroid surgeries Kuala Lumpur Hospital, Malaysia from February 1998 to February 1999. <sup>16</sup> A total of 202 external laryngeal nerves were identified during thyroid surgery, which was 92.7 %.

# Classification of the position of the external laryngeal nerve during thyroidectomy

The present study showed that in general Cernea IIa is the most common position of external laryngeal nerve (41.36%). On the left side Cernea IIa is the most common position of external laryngeal nerve (46.4%) whereas on the right side Cernea IIb is the most common position (40%).

In the study done by Mishra AK et al, titled "The external laryngeal nerve in thyroid surgery: the 'no more neglected' nerve" they introduced a novel method of lateralization of the superior pole of the thyroid to identify the external laryngeal nerve. They dissected superior poles in 78 patients undergoing thyroidectomy. The nerves could be identified in 72 (92.31%). There were 22 (28.2%) type I, 42 (53.54%) IIa and 8 (10.25%) IIb 'at risk' nerves.

Cernea CR et al conducted a study in Sao Paulo medical school, Brazil, on the anatomical variations of the external laryngeal nerve by dissecting the superior poles of the thyroid in 15 fresh cadavers. He study was titled as "Surgical anatomy of the external branch of the superior laryngeal nerve". This was later on called as Cernea's classification of the external laryngeal nerve. 37% of the nerves were type 2, ie, crossing the superior thyroid pedicle less than 1 cm above the superior thyroid pole. It is notable that 20% were type 2b, ie, crossing the vessels below the upper border of the pole, having been considered "high risk."

Pagedar NA et al conducted a study in Department of Otolaryngology, university of Lowa, Ontario, Canada on 178 patients undergoing thyroidectomy over a period of 4 years. The study was titled as "External branch of the

Superior laryngeal nerve". 3 of 178 nerves (1.7%) could not be identified using the routine technique. The nerves was found in the highest-risk position (Cernea type 2b) in 48.3% of cases, and in the lowest-risk position (Cernea type 1) in 7.3%.

Aina EN et al conducted a study on the external laryngeal nerve in thyroid surgeries Kuala Lumpur Hospital, Malaysia. A total of 150 consecutive patients undergoing thyroidectomy from February 1998 to February 1999. The study was titled as, "External laryngeal nerve in thyroid surgery: recognition and surgical implications". The frequency of the ELN documented crossing the avascular space were: type 1 nerve- 35 (17.3%), type 2a- 113 (56%); and type 2b- 54 (26.7%).

### **CONCLUSION**

In present study, on the surgical anatomy of the external laryngeal nerve we have found that it is possible to identify the external laryngeal nerve with little effort in almost all cases and large proportion of the position comes under high risk.

Thus it was concluded that the best way to preserve the external laryngeal nerve during thyroidectomy is by identifying the nerve and then staying away from it. Every surgeon should make a conscious attempt to look for the nerve during thyroidectomy do decrease the significant morbidity associated with the injury.

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Ethical approval: The study was approved by the

 $institutional\ ethics\ committee$ 

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