

## STUDY ON RECURRENT LARYNGEAL NERVE: ITS POSITION AND RELATIONSHIP WITH INFERIOR THYROID ARTERY

Roshan S <sup>\*1</sup>, Varsha R Bhivate <sup>2</sup>, Nivedita Pandey <sup>3</sup>, Smita Bhagwanrao Shinde <sup>4</sup>.

<sup>\*1</sup> MBBS, MD, Associate Professor, Kanachur Institute of Medical Sciences, Mangalore, Karnataka, India.

<sup>2</sup> MBBS, MD, Assistant Professor, Terna Medical College, Nerul, Navi, Mumbai, Maharashtra, India

<sup>3</sup> MBBS, MD, Associate Professor, B.P Koirala Institute of Health Sciences, Dharan, Nepal.

<sup>4</sup> MBBS, MD, Assistant Professor, MGM Medical College, Aurangabad, Maharashtra, India.

### ABSTRACT

**Background:** The recurrent laryngeal nerve crossing the inferior thyroid artery is often considered to be the most vulnerable location when performing a thyroidectomy because of many varieties of nerve – artery relations at this site. Injury to the recurrent laryngeal nerve is one of the most frequent and important causes of morbidity in thyroidectomies and is feared by both patient and surgeon.

**Objective:** To locate the position of the Recurrent Laryngeal nerve and observe the relationship with the Inferior Thyroid artery near the lower pole of the thyroid gland.

**Materials and Methods:** The observation was performed by dissecting fifty human cadavers at anatomy department dissection hall of MGM Medical College, Navi Mumbai, Maharashtra as per objective of the study.

**Results:** The results showed that Recurrent Laryngeal Nerve lying within the tracheo-oesophageal groove was 88% (44 cases) on right side and 92% on the left, the difference however was not significant ( $p > 0.05$ ). It was also observed that the nerve was lying lateral to tracheo-oesophageal groove in the remaining cases.

In relationship between the Inferior thyroid artery and recurrent laryngeal nerve, on the right side the nerve was found in 66% instances posterior to the artery and in 34% in between the branches. On the left side the nerve was found in 74% posterior to the artery and in 26% in between the branches.

**Conclusion:** Variations in the relationship of Recurrent Laryngeal nerve and inferior thyroid arteries are well documented in literature. To ensure safety of recurrent laryngeal nerve during thyroid surgery, surgeons should have extensive knowledge of position of recurrent laryngeal nerve and its relationship with inferior thyroid artery.

**KEY WORDS:** Recurrent Laryngeal nerve, Inferior thyroid artery, Cadaver, Tracheo-oesophageal groove, Lower pole of thyroid gland.

**Address for Correspondence:** Dr. Roshan S., Reshma nivas, LIG 74, KHB Colony, Bondel, Kavoor post, Mangalore – 575015 Karnataka, India. PH: +91-9480077030 (Mob)

**E-Mail:** [kmcroshan@gmail.com](mailto:kmcroshan@gmail.com)

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### INTRODUCTION

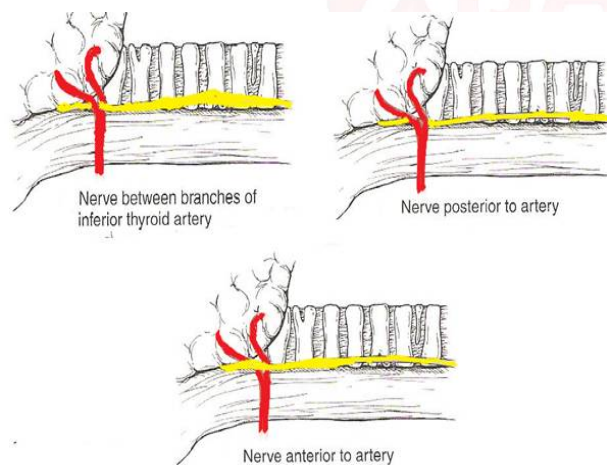
The thyroid gland is a well vascularized gland. Dissection and cutting of the thyroid vessels is

an essential part of every thyroid operation. Additionally the recurrent laryngeal nerve crossing the inferior thyroid artery is often

considered to be the most vulnerable location when performing a thyroidectomy. Injury to the recurrent laryngeal nerve is one of the most frequent and important causes of morbidity in thyroidectomies [1,2].

The varying relations of the recurrent laryngeal nerves near the larynx are important in thyroid surgery. The nerve always does not lie in a protected position in the trachea-oesophageal groove but may be slightly anterior to it (more often on the right) and it may be markedly lateral to the trachea at the level of the lower part of the thyroid gland. On the right, the nerve is often anterior to, or posterior to, or intermingles with the terminal branches of the inferior thyroid artery. On the left, the nerve is usually posterior to the artery, though occasionally anterior to it. The nerve may be lateral or medial to the lateral ligament (ligament of Berry) of the thyroid gland, and sometimes may be embedded in it [3]. (Fig 1)

**Fig. 1:** Relationship between Recurrent Laryngeal Nerve and Inferior Thyroid Artery.[4, 15]



In view of this importance, many investigators have investigated anatomic configuration between the nerve and artery in cadavers or patients and frequently described 3 types: the recurrent laryngeal nerve was in front of or behind the inferior thyroid artery or between its branches and also about position of recurrent laryngeal nerve, whether it lies in tracheo-oesophageal groove, lateral to groove or far anterior. Complete or incomplete unilateral or bilateral laryngeal paralysis is a condition liable to supervene in the operations on the thyroid gland due to traumatization of the recurrent laryngeal nerve resulting in paralysis of all intr-

-insic muscles of the larynx except cricothyroid muscle. So damage to this nerve can cause important vocal, breathing and swallowing difficulties. Moreover this palsy can be responsible for major psychological and social difficulties for patients.

Since thyroid surgery is one of the most frequently done routine surgery and is one of the most common procedures with serious complication, neurovascular relationships around the thyroid gland have been extensively studied in cadavers as well as in surgical cases by various authors especially in the nineteenth and twentieth centuries. Thus surgeons and anatomists have explored various procedures and used many techniques to protect the recurrent laryngeal nerve from injury, thus making thyroid surgery safer and more efficient. However cases of injury to the recurrent laryngeal nerve still occur, their cause being the inexperience of the surgeon in some cases, but insufficient knowledge of the anatomic basis on the recurrent laryngeal nerve is the cause in majority of cases [1].

To achieve a safe and effective operation on the thyroid gland by avoiding any injury to the nerve demands a thorough knowledge of all types and relationships between both the recurrent laryngeal nerve and the inferior thyroid artery and their branches. So in this present work we have studied the relationship that recurrent laryngeal nerve establishes with inferior thyroid artery and position of recurrent laryngeal nerve.

## MATERIALS AND METHODS

The present study was conducted on 50 formalin preserved cadavers in Department of Anatomy, MGM Medical College, Navi Mumbai, Maharashtra during June 2009 to December 2011. The study technique consisted of dissection and observations of various parameters. The study protocol was prepared in the form of a proforma. Dissection was done by procedures suggested in Cunningham [5] and was done as following:

Skin was reflected laterally by midline incision from chin to sternum and Platysma was reflected upwards.

Incision and reflection of investing layer of deep fascia was performed.

Sternocleidomastoid muscles of both sides were retracted laterally, or whenever needed sternal and clavicular heads were cut and reflected upwards.

Infrahyoid muscles were identified and cut from the hyoid bone and thyroid cartilage and reflected downwards.

Thyroid gland was exposed.

Position of recurrent laryngeal nerve was observed and documented.

Relationship of the recurrent laryngeal nerve was observed with respect to inferior thyroid artery at the lower pole of the thyroid gland.

**RESULTS AND OBSERVATIONS**

**Position of the recurrent laryngeal nerve:** The Recurrent Laryngeal Nerve was found to be lying within the tracheo-oesophageal groove in 88% (44 cases) on right side and 92% on the left, the difference however was not significant ( $p>0.05$ ). It was also observed that the nerves were situated lateral to tracheo-oesophageal groove in 12% (6 cases) on right and 8% (4 cases) on left. (Table 1) (Table 2, Fig 2)(Table 3, Fig 3).

**Relationship between Inferior Thyroid artery and Recurrent Laryngeal Nerve:** On the right side the nerve was found in 66% instances posterior to the artery and in 34% in between the branches. On the left side the nerve was found

**Table 1:** Position of Recurrent Laryngeal Nerve.

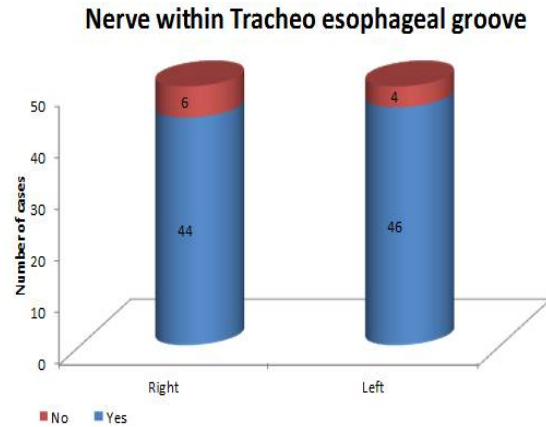
Position of RLN	Side		Total
	Right	Left	
Within the Tracheo-oesophageal groove	44	46	90
Lateral to Tracheo-oesophageal groove	6	4	10
Lateral to trachea	0	0	0
Lateral to oesophagus	0	0	0
<b>Total</b>	<b>50</b>	<b>50</b>	<b>100</b>

**Table 2:** Number and percentage of Recurrent Laryngeal Nerve Within the Tracheo-oesophageal groove.

	SIDE		Total
	Right	Left	
<b>No Count</b>	6	4	10
<b>%</b>	12.00%	8.0%	10.00%
<b>Yes Count</b>	44	46	90
<b>%</b>	88.00%	92.00%	90.00%
<b>Total Count</b>	<b>50</b>	<b>50</b>	<b>100</b>
<b>%</b>	<b>100%</b>	<b>100%</b>	<b>100.00%</b>

$\chi^2=.444$   $p=.505$  ns

**Fig. 2:** Bar diagram showing Number of Recurrent Laryngeal Nerve Within the Tracheo-oesophageal groove.

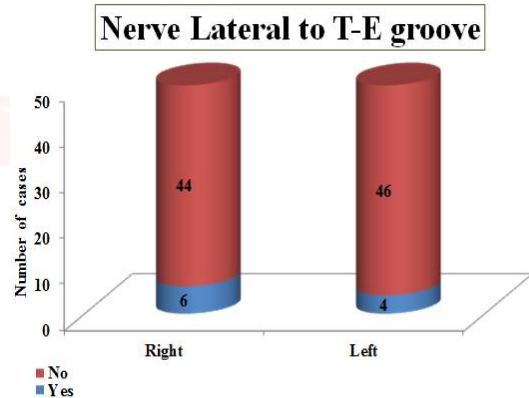


**Table 3:** Number and percentage of Recurrent Laryngeal Nerve Lateral to Tracheo-oesophageal groove.

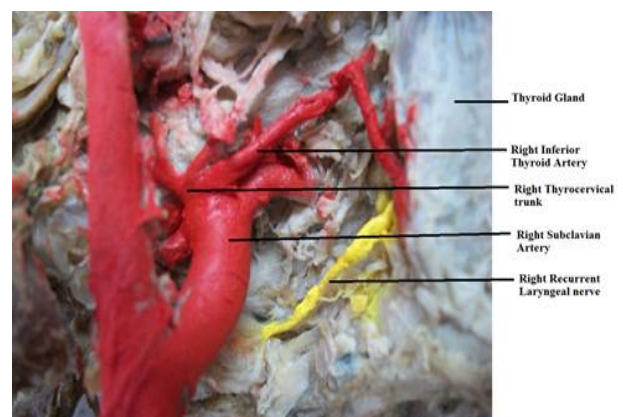
	SIDE		Total
	Right	Left	
<b>No Count</b>	44	46	90
<b>%</b>	88.00%	92.0%	90.00%
<b>Yes Count</b>	6	4	10
<b>%</b>	12.00%	8.00%	10.00%
<b>Total Count</b>	<b>50</b>	<b>50</b>	<b>100</b>
<b>%</b>	<b>100%</b>	<b>100%</b>	<b>100.00%</b>

$\chi^2=.444$   
 $p=.505$  ns

**Fig. 3:** Bar diagram showing Number of Recurrent Laryngeal Nerve Lateral to Tracheo-oesophageal groove



**Fig. 4:** Dissection showing relationship between Recurrent Laryngeal Nerve and Inferior Thyroid artery at lower pole of thyroid gland.



**Table 4:** Relationship of Recurrent Laryngeal Nerve to the Inferior Thyroid Artery at the lower pole of the Thyroid Gland.

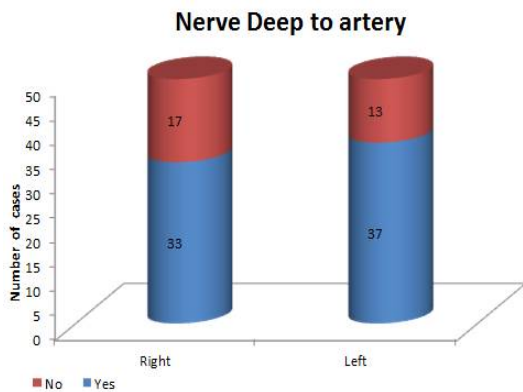
Relation of RLN to ITA	Side		Total
	Right	Left	
Superficial to artery	0	0	0
Deep to artery	33	37	70
Between the Glandular Branches	17	13	30
Artery between the branches of the Nerve	0	0	0
<b>Total</b>	<b>50</b>	<b>50</b>	<b>100</b>

**Table 5:** Number and Percentage of Recurrent Laryngeal Nerve Deep to Inferior Thyroid Artery.

$\chi^2 = .762$   
 $p = .383$  ns

	SIDE		Total
	Right	Left	
<b>No Count</b>	17	13	30
<b>%</b>	34.00%	26.0%	30.00%
<b>Yes Count</b>	33	37	70
<b>%</b>	66.00%	74.00%	70.00%
<b>Total Count</b>	<b>50</b>	<b>50</b>	<b>100</b>
<b>%</b>	100%	100%	100.00%

**Fig. 5:** Bar diagram showing Number of Recurrent Laryngeal Nerve Deep to Inferior Thyroid Artery.



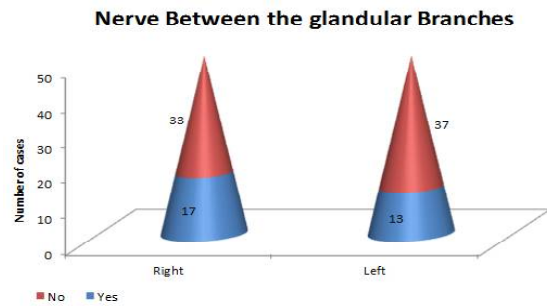
in 74% On the left side the nerve was found in 74% On the left side the nerve was found in 74% posterior to the artery and in 26% in between the branches. The difference was not significant statistically ( $p > 0.05$ ). (Fig 4) (Table 4), (Table 5, Fig 5) (Table 6, Fig 6)

**Table 6:** Number and Percentage of Recurrent Laryngeal Nerve between the Glandular Branches of Inferior Thyroid Artery.

$\chi^2 = .762$   
 $p = .383$  ns

	SIDE		Total
	Right	Left	
<b>No Count</b>	33	37	70
<b>%</b>	66.00%	74.0%	70.00%
<b>Yes Count</b>	17	13	30
<b>%</b>	34.00%	26.00%	30.00%
<b>Total Count</b>	<b>50</b>	<b>50</b>	<b>100</b>
<b>%</b>	100%	100%	100.00%

**Fig. 6:** Bar diagram showing Number of Recurrent Laryngeal Nerve Between Glandular Branches of Inferior Thyroid Artery.



**DISCUSSION**

**Position of the recurrent laryngeal nerve:** Various studies regarding the position of recurrent laryngeal nerve in relation to tracheo-oesophageal groove indicate that it is indeed variable.

John Elias Skandalkis and Stephen Wood Gray (1994), have explained about the relationship of recurrent laryngeal nerve to tracheo-oesophageal groove in 102 cases. They stated that on the right side 42 were present in tracheo-oesophageal groove, 55 anterior to groove and 5 were posterior to groove. On left 57 were present in tracheo-oesophageal groove, 39 anterior to groove and 6 were posterior to groove [6].

Charles Brunicardi F et al. (2005), has explained in Schwartz's Principles of Surgery textbook, that the recurrent laryngeal nerve on the right side, in 64% cases lies in tracheo-oesophageal groove, 28% lateral to trachea and 8% lie far anterior. On the left, 77% nerve lies in tracheo-oesophageal groove, 17% lateral to trachea and 6% lies far anterior [4].

In the present study 50 cadavers were dissected. On the right side the Recurrent Laryngeal Nerve was lying within the tracheo-oesophageal groove in 88% (44 cases) and 92% (46 cases) on the left, the difference however was not significant ( $p > 0.05$ ). It was also observed that the nerves were situated lateral to tracheo-oesophageal groove in 12% (6 cases) on right and 8% (4 cases) on left.

**Relationship between Inferior Thyroid artery and Recurrent Laryngeal Nerve:** To compare the data of various studies pertaining to the relationship between the recurrent laryngeal nerve and the inferior thyroid artery is indeed

difficult. From various quoted figures it is obviously impossible to establish any statistically valid conclusions.

It is important to spare RLN because damage to this nerve can cause important vocal, breathing and swallowing difficulties. Some conditions can cause recurrent laryngeal nerve palsy. Surgical injuries produce 11 to 32% of these. Some procedures that may result in injury of to the RLN are: thyroidectomies, parathyroidectomies, excision of Zenker’s diverticulum, esophagectomies, neck dissections and others. Thyroidectomy is the surgery in which the RLN injury occurs most frequently. The incidence of injury to the RLN in thyroidectomies ranges from 0 to 12%. This injury occurs more frequently when a branch of the ITA is inadvertently sectioned [1,7].

Henry Hollinshead W (1982), stated three chief relations between the recurrent laryngeal nerve and the inferior thyroid artery. On the right side in 47-50% of instances the nerve is between the branches, 26-33% in front of the branches and 18-25% behind the branches. On the left side, 50-55% behind the branches, 33% between the branches and 11-12% in front of the branches [8].

Henry Hollinshead W (1982), in his textbook has tabulated the combined series of Taguchi (1889) and Fowler and Hanson (1929), totalling 522 sides, it would appear that the nerve is more commonly posterior to the artery than anterior to it, in 299 instances it was posterior and in 114 anterior. Taguchi described it as passing between the branches of the artery in 75 of his 122 cases, while Fowler and Hanson reported the nerve as between the branches of artery in only 34 of their series of 400 [8].

Bachhuber (1943), in his series of 200 sides on the right side found the nerve posterior to artery in 33%, anterior in 18% and passing between the branches of the vessel in 48%. On the left side the nerve was posterior to artery in 55%, anterior in 11% and between the branches in 33% [8].

Campos BA and Paulo Roberto Ferreira Henriques (2000), in their study on 76 cadavers found in both sexes the recurrent laryngeal nerve lay more frequently between the branches of the inferior thyroid artery. On the right side, the re-

current laryngeal nerve was found between the branches of artery in 49.3% of the cases, anterior to it in 38.04% and posterior in 11.26%. On the left, nerve lay between the branches of artery in 44.45%, posterior to it in 37.05%, and anterior to it in 18.05% of the cases [7].

In Oxford textbook of Surgery, Peter J Moris and William C. Wood (2000), have quoted that on right side in 47-50% the recurrent laryngeal nerve lies in between the branches of inferior thyroid artery, in 23-26% the nerve lies anterior to the artery and in 18-25% the nerve lies posterior to artery. On the left side, in 50-55% the nerve lies posterior to artery, in 33% it lies in between the branches of artery and in 11-12% the nerve lies anterior to the artery [9].

In the present study by dissecting 50 cadavers, on the right side the nerve was found in 66% instances posterior to the artery and in 34% in between the branches. On the left side the nerve was found in 74% posterior to the artery and in 26% in between the branches. However the difference was not significant statistically.

From the various studies discussed above, it is not possible to establish any conclusions statistically; the situations appear even more complicated by the fact that in 253 bodies, Reed found a total of 28 different types. In only 17% of bodies the relations of the nerve to the artery were alike on both sides. (Table 7).

**Table 7:** Studies on relationship between Recurrent Laryngeal Nerve and Inferior Thyroid Artery.

Author	No. of sides	Superficial to artery		Deep to artery		Between the glandular br.	
		Rt	Lt	Rt	Lt	Rt	Lt
Hollinshead (1982)	-	26-33%	11-12%	18-25%	50-55%	47-50%	33%
Bachhuber (1943)	200	18%	11%	33%	55%	48%	33%
Campos BA et al (2000)	152	38.04%	11.05%	11.26%	37.05%	49.30%	44.45%
Balasubramanian T (2006)	-	30.00%	20%	20%	50%	50%	30%
Schwartz (2005)	-	37%	24%	53%	69%	7%	6%
Present Study (2011)	100	-	-	66%	74%	34%	26%

**CONCLUSION**

In the present study recurrent laryngeal nerve was found in the tracheo-oesophageal groove in 90% of cases, of which 88% was on right side and 92% on left side. It was found that the nerve is lateral to groove in 10% cases with 12% on right and 8% on left side. Recurrent Laryngeal nerve was deep to the Inferior Thyroid Artery

near the lower pole of thyroid gland in 70% of cases. It was more common on left side in 74% compared to right side where it was found in 66% which was statistically not significant. The Recurrent Laryngeal nerve was found between the branches of artery in 30% of cases, with 26% on left side and 34% on right side.

The Recurrent Laryngeal Nerve, being intimately related to the Inferior Thyroid Artery and also sometimes found outside the tracheo-oesophageal groove the chances of damaging the nerve during thyroid surgeries are high. Since the nerve also intermingles with the main trunk or the branches of artery, chances of dividing the nerve or its branches are also common. From the various studies carried out on relationship between this nerve and artery, it is impossible to establish any conclusions statistically.

It is this varying but close relation between the inferior thyroid artery and recurrent laryngeal nerve that makes it dangerous to attempt to control bleeding at this level by the use of hemostats, and that has led to the practice of ligating the artery well laterally [8].

Though various patterns can be seen regarding the neurovascular relationship, during surgery it is crucial that inferior thyroid artery and recurrent laryngeal nerve are identified separately thereby ensuring their safety during thyroid surgery. Even though relationship was not proved statistically significant by various studies, achieving a safe and effective operation on the thyroid gland is the goal of all surgeons. Hence to avoid any injury to the nerve in thyroid surgery, a thorough knowledge of position of recurrent laryngeal nerve and its relationship with the inferior thyroid artery and its branches is of utmost importance.

**Conflicts of Interests: None**

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