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A Cadaveric Study of the Course, Laterality, Extralaryngeal Branching, and Anatomical Relationships of the Recurrent Laryngeal Nerve with the Inferior Thyroid Artery and Thyroid Gland.

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Abstract

Background: The recurrent laryngeal nerve (RLN) is an important anatomical structure at risk during thyroid and parathyroid surgeries. Variations in its course, branching pattern and relationship with surrounding structures may increase the risk of inadvertent nerve injury. ***Aim:*** To evaluate the course, laterality, extralaryngeal branching and anatomical relationships of the RLN with the inferior thyroid artery (ITA) and thyroid gland. ***Materials and Methods:*** A descriptive observational cadaveric study was conducted in the Department of Anatomy over a period of 12 months. Fifteen embalmed adult human cadavers (30 sides) were dissected. The course of the RLN, its relationship with the tracheoesophageal groove, ITA and thyroid gland, and its extralaryngeal branching pattern were examined bilaterally. ***Results:*** The RLN was located within the tracheoesophageal groove in 73.3% of cases, medial to the groove in 10.0% and lateral to it in 16.7%. Extralaryngeal branching was observed in 43.3% of nerves. Bifurcation was noted in 30.0% and trifurcation in 13.3%, while 56.7% had a single unbranched trunk. Regarding its relationship with the ITA, the RLN passed posterior to the artery in 50.0% of cases, anteriorly in 30.0% and between arterial branches in 20.0%. No, statistically significant difference was observed between the right and left sides in the relationship with the ITA ($p = 0.915$). No non-recurrent inferior laryngeal nerve was identified. ***Conclusion:*** The RLN showed considerable anatomical variation in its course, extralaryngeal branching and relationship with the ITA. Detailed knowledge of these variations and careful identification of the nerve and its branches is essential for minimizing the risk of nerve injury during thyroid and parathyroid surgeries.

Keywords: Recurrent laryngeal nerve; cadaveric study; inferior thyroid artery; extralaryngeal branching; tracheoesophageal groove; thyroid gland.

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INTRODUCTION

The recurrent laryngeal nerve (RLN) is an important branch of the vagus nerve and provides motor supply to all intrinsic muscles of the larynx except the cricothyroid muscle. 1 It plays a vital role in phonation, airway protection and swallowing. Injury to this nerve during thyroid surgery may result in vocal cord paralysis, hoarseness, dysphonia and, in bilateral cases, potentially serious respiratory complications.2,3 The anatomical course of the RLN differs on the right and left sides due to their distinct embryological development. 4 The right RLN loops around the right subclavian artery, whereas the left RLN passes beneath the aortic arch before ascending towards the larynx. 5 During its cervical course, the nerve shows considerable variations in its relationship with the trachea, oesophagus, thyroid gland and inferior thyroid artery.6 The relationship between the RLN and inferior thyroid artery (ITA) is of particular surgical importance. The nerve may pass anterior or posterior to the artery or between its branches. These anatomical variations are important during thyroidectomy because the nerve may be difficult to identify and preserve. Saknure et al. (2016) conducted a cadaveric study and reported considerable variations in the relationship between the RLN and ITA, highlighting the importance of detailed anatomical knowledge during thyroid surgery.7

Similarly, Anand et al. (2022) examined the anatomical relationships of the laryngeal nerves in cadavers and emphasized the importance of identifying the RLN in relation to important surgical landmarks, including the inferior thyroid artery and Berry's ligament.8 Patra et al. (2023) also investigated the anatomical landmarks used for identifying and protecting the RLN during thyroid surgery, demonstrating the importance of its relationship with the tracheoesophageal groove, Berry's ligament and surrounding structures.9 Extralaryngeal branching is another important anatomical variation in which the

RLN divides into two or more branches before entering the larynx. Identification of these branches is essential because accidental injury to an individual branch may result in incomplete preservation of laryngeal function. Kumar et al. (2023) evaluated variations of the RLN in patients undergoing thyroidectomy and highlighted the clinical importance of recognizing differences in its branching pattern. [10] More recently, Dadwani et al. (2024) studied the anatomical relationship between the RLN and ITA through cadaveric dissection. Their findings demonstrated variations in the course and branching pattern of the nerve, emphasizing the importance of careful anatomical examination to prevent nerve injury during thyroid surgery. [11]

The relationship of the RLN with the thyroid gland, particularly its posterior surface, Berry's ligament and tracheoesophageal groove, is also clinically significant. The nerve may show variations in its position and relationship with the thyroid gland, which can complicate its identification during surgical procedures. A non-recurrent inferior laryngeal nerve, although uncommon, represents another important anatomical variation that may increase the risk of accidental injury.12 Cadaveric studies provide an opportunity for direct identification and detailed examination of the RLN, including its course, laterality, branching pattern and relationships with surrounding structures. Such investigations are valuable for understanding anatomical variations and improving the safety of thyroid and parathyroid procedures. Therefore, the present cadaveric study aims to investigate the course and laterality of the recurrent laryngeal nerve, determine the frequency and pattern of extralaryngeal branching, and evaluate its anatomical relationships with the inferior thyroid artery and thyroid gland. The findings may contribute to improved anatomical knowledge and help surgeons minimize the risk of recurrent laryngeal nerve injury during thyroid surgery.13,14.

MATERIALS AND METHODS

The present study was conducted in the Department of Anatomy, a cadaveric study done in different medical colleges in India. during a period of September 2025-August 2026. to evaluate the course, laterality, extralaryngeal branching and anatomical relationships of the recurrent laryngeal nerve (RLN) with the inferior thyroid artery (ITA) and thyroid gland. The study was performed on embalmed human cadavers available in the department following institutional ethical approval and adherence to institutional guidelines for the use of human anatomical specimens.

Study design: Descriptive observational cadaveric study.

Study duration: 12 months.

Study material: Embalmed human adult cadavers of both sexes.

Sample size: A total of 15 adult cadavers were included in the study.

Inclusion criteria

1. Well-preserved adult human cadavers of both sexes.
2. Cadavers with intact thyroid gland and surrounding cervical structures.
3. Specimens in which the recurrent laryngeal nerve and inferior thyroid artery could be adequately identified.
4. Cadavers without significant anatomical distortion of the anterior neck region.

Exclusion criteria

1. Cadavers with previous thyroid or neck surgery.
2. Specimens showing extensive damage or decomposition of cervical structures.
3. Cadavers with congenital deformities or pathological alterations affecting the thyroid region.
4. Specimens in which the recurrent laryngeal nerve could not be clearly identified.

Dissection procedure

The cadavers were placed in the supine position with the neck extended. A midline incision was made from the chin to the upper part of the sternum, followed by transverse incisions to reflect the skin and superficial fascia. The infrahyoid muscles were carefully exposed and retracted to visualize the thyroid gland, trachea and surrounding anatomical structures. The thyroid gland was exposed by carefully separating the strap muscles. The inferior thyroid artery was identified and traced towards the lower pole of the thyroid gland.

The recurrent laryngeal nerve was identified near its entry into the larynx and carefully dissected along its cervical course towards its origin in the thoracic region as far as possible. Special attention was given to preserving the nerve branches and their relationships with the inferior thyroid artery, thyroid gland, trachea, oesophagus and Berry's ligament. The dissection was performed carefully to avoid damage to delicate neural and vascular structures.

Parameters studied

The following anatomical parameters were examined bilaterally:

1. Course of the recurrent laryngeal nerve: The course of the nerve was observed in relation to the tracheoesophageal groove, trachea, oesophagus and thyroid gland.
2. Laterality: The nerve was examined separately on the right and left sides to identify differences in its course and anatomical relationships.
3. Relationship with inferior thyroid artery: The position of the RLN in relation to the ITA was classified as:

- Anterior to the artery.
- Posterior to the artery.
- Between the branches of the artery.

4. Extralaryngeal branching: The presence or absence of branching before entry into the larynx was recorded. The number and pattern of branches were documented.
5. Relationship with thyroid gland: The anatomical relationship of the RLN with the posterior surface of the thyroid gland, lower pole and Berry's ligament was examined.
6. Relationship with tracheoesophageal groove: The position of the nerve within, medial to or lateral to the tracheoesophageal groove was recorded.

RESULTS

Dissection Technique

Embalmed cadavers were placed in the supine position with the neck extended. A midline incision was made from the mandible to the suprasternal notch, followed by reflection of the skin, superficial fascia and platysma. The sternohyoid and sternothyroid muscles were retracted to expose the thyroid gland, trachea and surrounding structures. The inferior thyroid artery was identified and traced towards the thyroid gland. The recurrent laryngeal nerve was identified near its entry into the larynx and carefully dissected along its cervical course. Its relationship with the inferior thyroid artery was recorded as anterior, posterior or between arterial branches. Extralaryngeal branching and relationships with the thyroid gland, Berry's ligament and tracheoesophageal groove were examined bilaterally. All observations were documented through photographs and systematic recording.

Table 1. Position of the Recurrent Laryngeal Nerve in Relation to the Tracheoesophageal Groove (N = 30 sides per side)

Position of RLN	Right side n (%)	Left side n (%)	Total n (%)
Within the groove	10 (66.7)	12 (80.0)	22 (73.3)
Medial to the groove	2 (13.3)	1 (6.7)	3 (10.0)
Lateral to the groove	3 (20.0)	2 (13.3)	5 (16.7)

The majority of recurrent laryngeal nerves were located within the tracheoesophageal groove (73.3%). This position was more frequent on the left side (80.0%) than on the right side (66.7%). Lateral positioning was observed in 16.7% and medial positioning in 10.0% of nerves.

Table 2. Angle Formed by the Recurrent Laryngeal Nerve (RLN) with the Tracheoesophageal Groove (TOG) (N = 30)

Angle formed	Right side n (%)	Left side n (%)	Total n (%)
Acute angle	3 (20.0)	2 (13.3)	5 (16.7)
Total	15 (100)	15 (100)	30 (100)

The right-angle relationship was the most frequently observed (60.0%), followed by an obtuse angle (23.3%) and an acute angle (16.7%). Right-angle positioning was more common on the left side (66.7%) than on the right side (53.3%).

Table 3. Site and Level of Extralaryngeal Branching of the Recurrent Laryngeal Nerve (N = 30)

Site/level of branching	Right side n (%)	Left side n (%)	Total n (%)
Upper third of cervical course	2 (13.3)	3 (20.0)	5 (16.7)
Middle third of cervical course	3 (20.0)	2 (13.3)	5 (16.7)
Lower third of cervical course	2 (13.3)	1 (6.7)	3 (10.0)
No extralaryngeal branching	8 (53.4)	9 (60.0)	17 (56.6)
Total	15 (100)	15 (100)	30 (100)

Extralaryngeal branching was observed in 43.3% of the recurrent laryngeal nerves. The most frequent branching sites were the upper and middle thirds of the cervical course (16.7% each), followed by the lower third (10.0%). No extralaryngeal branching was observed in 56.6% of nerves.

Table 4. Number of Extralaryngeal Branches of the Recurrent Laryngeal Nerve (N = 30)

Number of branches	Right side n (%)	Left side n (%)	Total n (%)
Single trunk (no branching)	8 (53.3)	9 (60.0)	17 (56.7)
Two branches (bifurcation)	5 (33.3)	4 (26.7)	9 (30.0)
Three branches (trifurcation)	2 (13.4)	2 (13.3)	4 (13.3)
More than three branches	0 (0.0)	0 (0.0)	0 (0.0)
Total	15 (100)	15 (100)	30 (100)

A single unbranched trunk was observed in 56.7% of nerves, while extralaryngeal branching was present in 43.3%. Bifurcation was the most common branching pattern (30.0%), followed by trifurcation (13.3%).

Table 5. Presence of Non-Recurrent Inferior Laryngeal Nerve (N = 30)

Anatomical variation	Right side n (%)	Left side n (%)	Total n (%)
Recurrent laryngeal nerve present	15 (100)	15 (100)	30 (100)
Non-recurrent inferior laryngeal nerve	0 (0.0)	0 (0.0)	0 (0.0)
Total	15 (100)	15 (100)	30 (100)

The recurrent laryngeal nerve was present bilaterally in all 30 specimens (100%), with 15 cases (100%) on the right side and 15 cases (100%) on the left side. No non-recurrent inferior laryngeal nerve was observed on either side. Thus, all dissected specimens demonstrated the normal recurrent course of the inferior laryngeal nerve, with no anatomical variation in the form of a non-recurrent laryngeal nerve.

Table 6. Relationship of the Recurrent Laryngeal Nerve (RLN) with the Inferior Thyroid Artery (ITA) (N = 30)

Relationship with ITA	Right side n (%)	Left side n (%)	Total n (%)	p value
Anterior to ITA	5 (33.3)	4 (26.7)	9 (30.0)	0.915
Posterior to ITA	7 (46.7)	8 (53.3)	15 (50.0)	
Between arterial branches	3 (20.0)	3 (20.0)	6 (20.0)	
Total	15 (100)	15 (100)	30 (100)	

The recurrent laryngeal nerve was located posterior to the inferior thyroid artery in 50.0% of cases, followed by an anterior relationship in 30.0% and passage between the arterial branches in 20.0%. The distribution was comparable on the right and left sides, with no statistically significant side-related difference ($p = 0.915$). This indicates that the anatomical relationship of the recurrent laryngeal nerve with the inferior thyroid artery showed no significant laterality in the present study.

DISCUSSION

The recurrent laryngeal nerve (RLN) is an important anatomical structure during thyroid and parathyroid surgeries because of its variable course and relationship with surrounding structures. In the present study, the RLN was identified bilaterally in all 30 sides (100%), with no non-recurrent inferior laryngeal nerve observed. Henry et al. (2017) reported a low prevalence of non-recurrent laryngeal nerves, supporting the uncommon nature of this variation.17 Most nerves (73.3%) were located within the tracheoesophageal groove, comparable to the findings of Patra et al. (2023), who emphasized the importance of anatomical landmarks for RLN identification.18

Extralaryngeal branching was observed in 43.3% of nerves, with bifurcation (30.0%) being the most common pattern. Henry et al. (2016) reported a higher branching prevalence of 60.0% in their meta-analysis, highlighting the importance of identifying all nerve branches during thyroid surgery.16 Regarding the relationship with the inferior thyroid artery, 50.0% of nerves passed posteriorly, 30.0% anteriorly and 20.0% between arterial branches. Sun et al. (2001) also reported considerable variations in this relationship, emphasizing that the nerve should be identified directly during thyroidectomy.15 Kiluba and Small (2024) further highlighted the clinical importance of understanding the anatomical course and relationships of the RLN to minimize nerve injury during thyroid surgery.19

Overall, the present study demonstrates important variations in the course, branching pattern and arterial relationships of the RLN. Detailed bilateral identification of the nerve is essential for preventing accidental injury during thyroid and parathyroid surgeries.

CONCLUSION

The present cadaveric study demonstrated considerable anatomical variations in the course, extralaryngeal branching and relationship of the recurrent laryngeal nerve with the inferior thyroid artery and tracheoesophageal groove. Most nerves

were located within the tracheoesophageal groove (73.3%), while extralaryngeal branching was observed in 43.3% of cases, with bifurcation being the most common pattern. The nerve was predominantly located posterior to the inferior thyroid artery (50.0%). No non-recurrent inferior laryngeal nerve was identified. These findings highlight the importance of detailed anatomical knowledge and careful bilateral identification of the RLN during thyroid and parathyroid surgeries to minimize the risk of inadvertent nerve injury.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this research work.

REFERENCES

1. Standring S, editor. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 42nd ed. London: Elsevier; 2020.
2. Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy. 8th ed. Philadelphia: Wolters Kluwer; 2018.
3. Randolph GW, editor. Surgery of the Thyroid and Parathyroid Glands. 2nd ed. Philadelphia: Elsevier Saunders; 2013.
4. Fakoya AO, Winters R, Gupta V. Anatomy, head and neck: laryngeal nerves. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024.
5. Allen E, Minutello K, Jozsa F, Murcek BW. Anatomy, head and neck, larynx recurrent laryngeal nerve. In: StatPearls Treasure Island (FL): StatPearls Publishing; 2025.
6. Delbridge L. Total thyroidectomy: the evolution of surgical technique. ANZ J Surg. 2003;73(9):761-8.
7. Saknure M, Satpute CA, Waghmare C. Variation in the relation of recurrent laryngeal nerve to the inferior thyroid artery: a cadaveric study. Indian J Anat. 2016;5(2):147-51. doi:10.21088/ija.2320.0022.5216.9.
8. Anand A, Metgudmath RB, Belaldavar BP, Virupaxi RD, Javali SB. Relative topography of laryngeal nerves for surgical cruciality: an observational cadaveric study. Indian J Otolaryngol Head Neck Surg. 2022;74(Suppl 3):4973-7. doi:10.1007/s12070-021-02537-5.
9. Patra A, Asghar A, Chaudhary P, et al. Identification of valid anatomical landmarks to locate and protect recurrent laryngeal nerve during thyroid surgery: a cadaveric study. Surg Radiol Anat. 2023;45(1):73-80. doi:10.1007/s00276-022-03054-y.
10. Kumar P, Chatterjee M, Gupta A. Variations in recurrent laryngeal nerve in thyroidectomy. Indian J Otolaryngol Head Neck Surg. 2023;75(4):2856-61. doi:10.1007/s12070-023-03859-2.
11. Dadwani P, Suttarwala I, Contractor JB. Exploring the anatomical relationship between the recurrent laryngeal nerve and the inferior thyroid artery: insights from 50 cadaveric dissections. Indian J Clin Anat Physiol. 2024;11(2):71-4. doi:10.18231/j.ijcap.2024.016.
12. Henry BM, Sanna S, Graves MJ, Vikse J, Sanna B, Tomaszewska IM, et al. The non-recurrent laryngeal nerve: a meta-analysis and clinical considerations. PeerJ. 2017;5:e3012. doi:10.7717/peerj.3012.
13. Lekacos NL, Tzardis PJ, Sfikakis PG, Patoulis SD, Restos SD. Course of the recurrent laryngeal nerve relative to the inferior thyroid artery and the suspensory ligament of Berry. Int Surg. 1992;77(4):287-8.
14. Henry BM, Vikse J, Graves MJ, Sanna S, Sanna B, Tomaszewska IM, et al. The reliability of the tracheoesophageal groove and the ligament of Berry as landmarks for identifying the recurrent laryngeal nerve: a cadaveric study and meta-analysis. Anat Sci Int. 2017;92(4):431-6.
15. Sun SQ, Zhao J, Lu H, He GQ, Ran JH, Peng XH. An anatomical study of the recurrent laryngeal nerve: its branching patterns and relationship to the inferior thyroid artery. Surg Radiol Anat. 2001;23(6):363-9. doi:10.1007/s00276-001-0363-9.
16. Henry BM, Vikse J, Graves MJ, Sanna S, Sanna B, Tomaszewska IM, et al. Extralaryngeal branching of the recurrent laryngeal nerve: a meta-analysis of 28,387 nerves. Langenbecks Arch Surg. 2016;401(7):913-23. doi:10.1007/s00423-016-1455-7.
17. Henry BM, Sanna S, Graves MJ, Vikse J, Sanna B, Tomaszewska IM, et al. The non-recurrent laryngeal nerve: a meta-analysis and clinical considerations. PeerJ. 2017;5:e3012. doi:10.7717/peerj.3012.
18. Patra A, Asghar A, Chaudhary P, et al. Identification of valid anatomical landmarks to locate and protect recurrent laryngeal nerve during thyroid surgery: a cadaveric study. Surg Radiol Anat. 2023;45(1):73-80. doi:10.1007/s00276-022-03054-y.
19. Kiluba JBL, Small C, Bombil I, Bulabula KP, Luvhengo TE, Mazengenya P. A topographical and surgical anatomical description of the recurrent laryngeal nerve: observations from cadaveric dissection and thyroidectomy patients. Transl Res Anat. 2024;37:100348. doi:10.1016/j.tria.2024.100348.