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# A prospective observational study on the anatomical variations of recurrent laryngeal nerve and its application in the prevention of injury during thyroid surgery in a tertiary care centre

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## Abstract

**Background** Thyroid gland is the largest and most vascular structure among the endocrine glands. The recurrent laryngeal nerve and the superior laryngeal nerve are closely related to the thyroid gland; these nerves control voice and are vital in breathing. Anatomical preservation of the recurrent laryngeal nerve (RLN) is the gold standard in thyroid surgery. Visual identification of RLN has decreased the rates of permanent RLN palsy during thyroid and parathyroid operations. Prior knowledge about the branching patterns will help in predicting and preventing injury to the nerve during thyroid surgery.

**Aim and objectives** The aim of the study is to observe the terminal branching pattern of recurrent laryngeal nerve before its entry into the larynx.

**Methods** An observational study with 50 participants who fulfilled the inclusion and exclusion criteria were enrolled in the study. After a complete evaluation and pre-anaesthetic checkup, the patients were operated and intraoperative findings of RLN branching were recorded and compared for the study.

**Results** In our study, out of the 50 patients who underwent thyroid surgery during the course of the study, right-sided RLN branching was demonstrated in 25 patients (21 right hemithyroidectomy and 4 total thyroidectomy). Ten patients had RLN bifurcation, 7 had trifurcation, 5 had numerous branches, and 3 with no branching pattern were noted. Similarly, out of 29 patients (25 left hemithyroidectomy and 4 total thyroidectomy) in whom left-sided RLN branching was studied, bifurcation was seen in 10 patients, trifurcation in 12 patients, and multiple branching was observed in 7.

**Conclusion** The anatomical variations seen in RLN may increase the risk of vocal cord palsy due to its injury. Anatomical variations are categorized according to the original direction of the RLN and the number of terminal branches in the larynx. This classification aids in the identification and preservation of its branches, hence facilitating a safer thyroidectomy.

**Keywords** Recurrent laryngeal nerve, RLN, Recurrent laryngeal nerve branching, Anatomical variations of RLN

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## Background

The identification and preservation of critical structures form the foundation of the most significant part of head and neck surgery. Among the endocrine glands, the thyroid gland has the greatest vascular structure. The thyroid gland is intimately linked to the RLN and superior laryngeal nerves, which regulate voice and respiration. Vocal cord paralysis due to RLN injury is not an uncommon occurrence after thyroidectomies, with recent studies suggesting rates of transient paralysis up to 5 to 10% [1]. In 2015, the American Thyroid Association suggested that RLNs be found when dissecting a thyroid. In thyroid procedures, anatomic preservation of the RLN is considered the gold standard. The only way to stop iatrogenic nerve damage is to properly identify and expose it with caution [2].

Visual identification of RLN has decreased the rates of permanent RLN palsy during thyroid and parathyroid operations. The three most common approaches to the RLN dissection are lateral, inferior, and superior approaches [3]. However, unexpected post-operative RLN palsy is very common and remains one of the most frequent causes of medico legal litigation after thyroid and parathyroid surgery. Damage to RLN can cause hoarseness, difficulty in swallowing and breathing, and loss of voice. The safety of thyroid surgeries mainly depends on complete anatomical knowledge of arteries and nerves related to the gland and their anatomical variations.

The RLN has a variable course. This study therefore aims to bridge the gap by comprehending variation in the branching patterns of the RLN intraoperatively. Prior knowledge can be used to forecast outcomes and thus prevent injury.

## Methods

We performed 50 thyroid surgeries at a tertiary health center between 2022 and 2023 (46 hemithyroidectomy and 4 total thyroidectomy). The study was approved by the institutional ethics committee. Participants who fulfilled the inclusion and exclusion criteria were enrolled after taking written and well-informed consent. Complete evaluation and pre-anaesthetic check-ups were done for these patients. A laryngoscopy was done and documented for the patients prior to surgery. Inclusion criteria were as follows: patients between the age of 18–65 years, surgical thyroid diseases, including thyroid cancer, solitary adenoma, or multinodular goiter. The exclusion criteria included patients not giving consent for surgery, patients with history of prior neck surgeries, vocal cord impairment, and neck radiation.

Standard dissections of RLN were performed. The main parameters under the study were the anatomical characteristics and incidence of the RLN branching pattern. The original direction of RLN and the number of terminal branches to the larynx were noted. RLNs were identified during surgery and data was recorded when they were adequately exposed. The findings were interpreted and compared for final results.

Total patients	50
Males	08
Females	42
Benign tumour	46
Malignant tumour	04
Total thyroidectomy	04
Hemithyroidectomy	46
Right RLN examined	25
Left RLN examined	29

## Intraoperative dissection of RLN

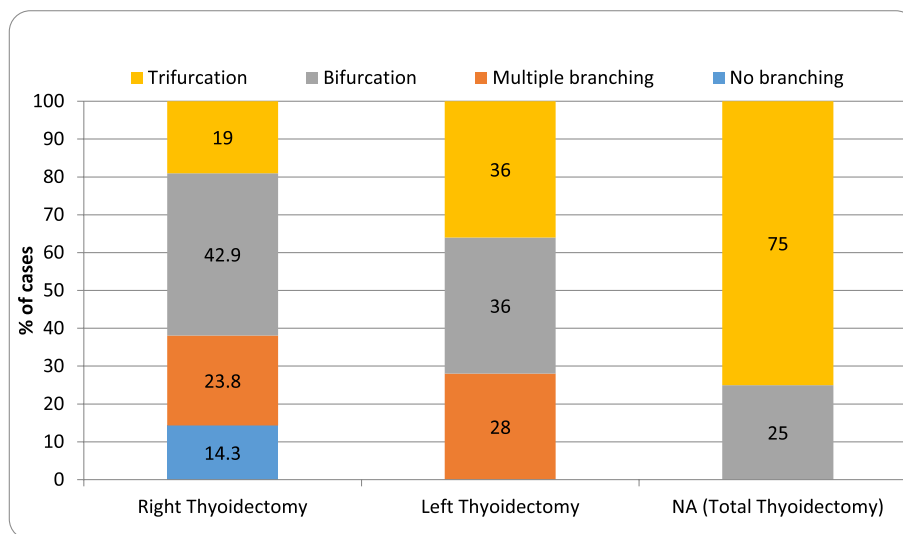
A 4–6 cm transverse collar incision was made, and superior and inferior sub-platysmal flaps were prepared. The thyroid region was entered through the strap muscles. The strap muscles were retracted laterally and the thyroid lobe anteromedially, the RLN was exposed, and the level of the thyroid lobe where it crosses the inferior thyroid artery. It was followed until the laryngeal entry point [4].

## Terminal branches of the RLN to laryngeal entry

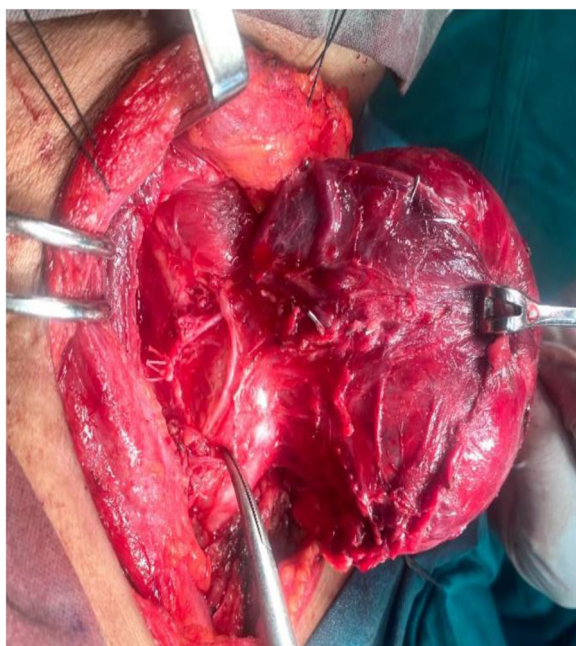
Bifurcation, trifurcation, and multiple branching were noted in most of the cases. No branching before entering the larynx was also observed in certain cases. The anatomical variations of left and right RLN were studied. Post-operative course and complications were also recorded if any.

## Results

In an observational study of 50 patients who underwent thyroid surgery, right-sided RLN branching was demonstrated in 25 patients (21 right hemithyroidectomy and 4 total thyroidectomy); bifurcation of RLN was seen in 10 patients, trifurcation in 7 patients, multiple branching was noticed in 5 patients, and no branching was seen in 3 patients (Figs. 1, 2, 3, and 4). Similarly, out of 29 patients (25 left hemithyroidectomy and 4 total thyroidectomy) in whom left-sided recurrent laryngeal nerve branching was studied, bifurcation was seen in 10 patients, trifurcation in 12 patients, and multiple branching was observed in 7. Postoperatively no patient experienced hoarseness or dyspnea.



**Fig. 1** Distribution of branching pattern of RLN according to the type of surgery performed



**Fig. 2** Bifurcation of recurrent laryngeal nerve before its entry into the larynx



**Fig. 3** Trifurcation of recurrent laryngeal nerve before its entry into the larynx

**Distribution of branching pattern according to the type of surgery performed**

Out of 21 right-sided hemithyroidectomy performed, 3 cases (14.3%) had no branching, 5 cases (23.8%) had multiple branching, 9 cases (42.9%) had bifurcation, and 4 cases (19.0%) had trifurcation in the study group.

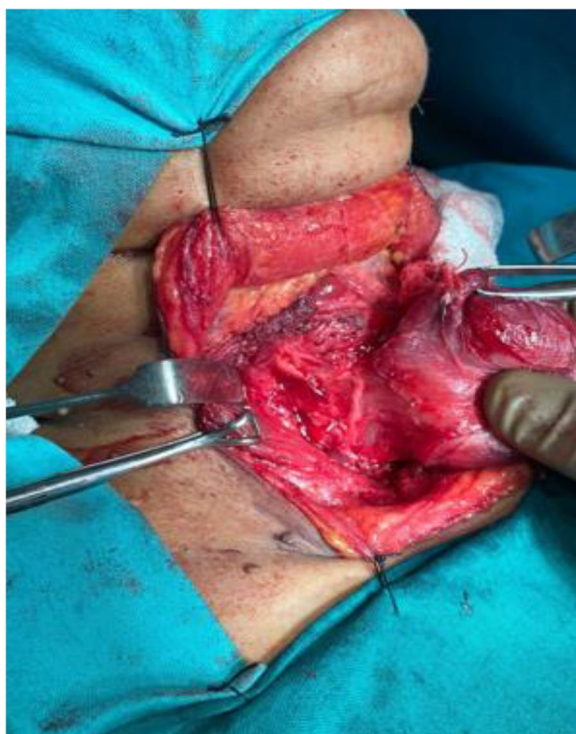
Out of 25 left-sided hemithyroidectomy performed, 7 cases (28.0%) had multiple branching, 9 cases (36.0%)

had bifurcation, and 9 cases (36.0%) had trifurcation in the study group.

Out of 4 total thyroidectomy performed, 1 case (25.0%) had bifurcation and 3 cases (75.0%) had trifurcation in the study group.

Of the total 50 cases that were operated, 3 cases (6.0%) had no branching, 12 cases (24.0%) had multiple branching, 19 cases (38.0%) had bifurcation, and 16 cases (32.0%) had trifurcation in the study group.

The distribution of the branching patterns did not differ significantly across different surgery types performed in the study group ( $P$ -value > 0.05) (Table 1).



**Fig. 4** No branching noted in the recurrent laryngeal nerve

**Discussion**

The RLN is one of the most important structures which needs attention during thyroid surgeries. Henry et al. (2016) carried out a comprehensive meta-analysis of extra laryngeal branches of the RLN. This study was conducted on cadaveric and intraoperative subjects, respectively, whereas our study included only intraoperative nerve findings [5]. In this study, bifurcation of the nerve was the most common finding consistent with our study. Henry et al. carried out this study on a total of 28,387 nerves. Chiang et al. in 2010 carried out a study to identify the variations in the anatomy of the RLN before

entering into the larynx [6]. The findings of the variations in recurrent laryngeal nerve were documented using intraoperative nerve monitoring and high-resolution photographs. In our study, we used only intraoperative photographs to document the variations in RLN.

In a prospective study conducted by Yin c. et al. in 2020 on 294 Chinese patients, 6 types of anatomical variations in RLN were taken into consideration which included non-recurrent laryngeal nerve also [7]. This study was similar to the present study on the lines that there is no significant difference ( $P > 0.5$ ) in the laterality between the RLN branching on the right and left sides. Makay et al. conducted a prospective study in 2008 which suggested that bifurcation of the RLN was seen in 22.5% and trifurcation in 1.6% which was lesser than our study findings [8]. Chen and his colleagues in 2014 found that overstretching of the RLN is less likely to occur on the left side due to the fact that it is better protected within the tracheoesophageal groove [9]. In this study, the anatomical variations in RLN in living patients who underwent thyroid surgeries were evaluated.

Lahey and Halstead in the twentieth century have confirmed the relationship between the attempts to preserve the RLN and patients’ normal voice [10]. The recurrent laryngeal nerves may be injured as a result of neck trauma, thyroid surgery, aortic aneurysm, esophageal cancer, mediastinal tumor, lung cancer, etc. Injury of the recurrent laryngeal nerve is clinically important. Having knowledge of RLN anatomy and its possible variations is critical for visual identification of the RLN which is the gold standard technique to preserve it. To be able to maintain the RLN function, all the branches must be preserved. Lack of awareness of the anatomical variations in the branching pattern of the RLN makes it vulnerable to damage by stretching, compression, retraction, or accidental sharp division during surgical procedures [10–12]. RLN injury may occur in cases of an undetected motor branch of RLN being divided unintentionally leading to an unexpected vocal cord dysfunction (7).

**Table 1** Distribution of branching pattern of recurrent laryngeal nerve according to the type of surgery performed

Branching pattern	Type of surgery							
	Right thyroidectomy		Left thyroidectomy		NA (total thyroidectomy)		Total	
	n	%	N	%	n	%	N	%
No branching	3	14.3	0	0.0	0	0.0	3	6.0
Multiple branching	5	23.8	7	28.0	0	0.0	12	24.0
Bifurcation	9	42.9	9	36.0	1	25.0	19	38.0
Trifurcation	4	19.0	9	36.0	3	75.0	16	32.0
<b>Total</b>	<b>21</b>	<b>100.0</b>	<b>25</b>	<b>100.0</b>	<b>4</b>	<b>100.0</b>	<b>50</b>	<b>100.0</b>

$P$ -value = 0.166<sup>NS</sup>

$P$ -value by chi-square test.  $P$ -value < 0.05 is considered to be statistically significant

NS statistically non-significant

## Conclusion

There was no significant difference in the extra laryngeal branching pattern of right and left RLN in the neck in the entire study population. The distribution of the branching pattern did not differ significantly across different surgery types performed on either side (right and left side) in the study group ( $P$ -value > 0.05).

## Limitations

First of all, the study group comprised 50 patients and hence it can be considered a relatively small study. The anatomic variation types which are classified as per the number of terminal branches in the larynx may help to simplify the identification and preservation of the branches of the RLN. In conclusion, the RLN has a high rate of branching and is highly variable, only a proper and complete understanding of the variant anatomy of the RLN can provide the best chance of a complication-free procedure for a safe thyroidectomy.

## Abbreviation

RLN Recurrent laryngeal nerve

## Acknowledgements

Not applicable

## Authors' contributions

DR Vitthal Dada Kale (VDK). DR Aishwarya Prajosh (AP). DR Shrinivas S. Chavan (SSC). DR Ananya Patra (APa). VDK provided the concept and design of the study, defined intellectual content, contributed in data analysis and statistical analysis was a major contributor in manuscript editing, and manuscript review. AP acquired data related to the study, analysed and interpreted data, contributed in literature search, data acquisition, data analysis, statistical analysis, manuscript preparation, and manuscript review, and is the corresponding author. SSC contributed in designing of study, revising the article, data analysis, statistical analysis, and manuscript review. APa contributed majorly in manuscript writing and interpreted the patient data regarding the branching pattern. All authors read and approved the final manuscript.

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Not applicable.

## Availability of data and materials

All data generated or analysed during the current study are available from the corresponding author on reasonable request.

## Declarations

### Ethical approval and consent to participate

Institutional Ethics Committee Department of Pharmacology Grant Government Medical College and Sir J.J. Group of Hospitals Byculla, Mumbai-400008 IEC Registration No. ECR/382/Inst/MH/2013/Rr-19. IEC Approval Meeting Date: 23rd September 2022 No. IEC/PG/920/Sep/2022. Well informed consent was obtained from the participants.

### Consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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