Branching Patterns of Recurrent Laryngeal Nerve in Thyroidectomy Patients

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ABSTRACT

Background: Historically, the Recurrent laryngeal nerve (RLN) has been considered to branch after it enters the larynx, but numerous studies have demonstrated that it often branches before. The wide variability of this extra laryngeal branching (ELB) has significant implications for the risk of iatrogenic injury. Accurate knowledge of anatomical variations of the recurrent laryngeal nerve (RLN) provides information to prevent inadvertent intraoperative injury.

Objectives: Our study aimed to assess extra laryngeal branching of recurrent laryngeal nerve to find out branching patterns of RLN and to study whether there is any correlation between right and left side branching of RLN.

Materials and Methods: This was a retrospective analysis conducted on patients of Thyroid surgeries that is total and Near-total thyroidectomies. This cross-sectional study was conducted in Hayatabad Medical Complex Peshawar from 1st Jan 2014 till 31st Dec 2020, with total of 269 patients. We excluded hemi thyroidectomies and recurrent cases.

Results: The prevalence of single branching RLN was found to be 29.3% with 79 out of 269 patients. The branching pattern was found not statistically significant with age and gender. Surgeons need to pay special attention to the branching pattern of RLN so as to preserve it during surgery.

Conclusion: The anatomy of the RLN is highly variable, and ELB is likely to have been underreported in intraoperative studies. Because of its high likelihood, the possibility of ELB needs to be assessed in patients to prevent iatrogenic injury and long-term postoperative complications.

Key Words: Total thyroidectomy, Recurrent laryngeal nerve.Extralaryngeal branching.

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INTRODUCTION

In the second century BC, Galen described Recurrent Laryngeal Nerve (RLN) as "a nerve that descends from the brain to the heart, then reversed the course and ascends to the larynx and makes the vocal cords to move."[1] After the Noble laureate Kocher publication in 1909, thyroid surgery became a relatively safe procedure.[2] A hallmark of the approved surgical technique of thyroidectomy is to diligently look for and visually identify the recurrent laryngeal nerves bilaterally in the tracheoesophageal groove during surgery.[3]

The RLN is the nerve of 6th branchial arch. As the larynx is caudal to arches initially, the RLN innervates larynx directly. As the neck elongates and 4th and 6th arch vessels descend into chest, the vessels of the 6th arch entrap the RLN and bring it into mediastinum[4]. Since the right 6th branchial artery degenerates and left persist as ductus arteriosus, the left RLN is more elongated and ascends from a more caudal position[5]. The RLN supply all the instrinic muscles of the larynx except the cricothyroid muscle. After exiting the upper mediastinum, the RLN travels cranially in the tracheoesophageal groove, in close proximity to the thyroid gland, parathyroid glands and the branches of the inferior thyroid artery.[6] The RLN after crossing the Berry's ligament finally enters into the larynx. Overall , the course of recurrent laryngeal nerve is important to understand as it can be damaged at any place along its path.[7]

Because of its distinctive anatomical relationships, the RLN is prone to injury during thyroidectomy, especially at the sites of Berry's ligament, tubercle of Zukerkundle, tracheoesophageal groove, both upper and lower thyroid poles and during level VI lymph nodes dissection. [8] There are different anatomical variations of the RLN which increases the risk for its damage. These include the variable relationship of the RLN with the inferior thyroid artery branches, the nonrecurrent laryngeal nerve, and the extra-laryngeal branching (ELB) of the nerve.[9] Due to different branching of recurrent laryngeal nerve , the nerve injury is more even in patients having total endoscopic thyroidectomies.[10]

The lack of awareness of the RLN's anatomical differences and branching pattern is concerning, putting the safety of neck surgical therapies at risk. This study adds to the body of knowledge by elucidating the variability of RLN and its branching pattern which will help to improve the safety of neck procedures. Despite the fact that earlier studies have identified differences in the RLN, we set out to dissect a large number of thyroids in

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order to thoroughly explore the variations in branching patterns, as well as the possible danger of nerve damage caused by the variants. Also most of the studies were conducted in Europe and other countries lacking data of our area, that's why this study was done on indigenous population. So in this study, we will find different branching patterns of RLN and whether there is any correlation between right and left side branching of RLN.

MATERIAL AND METHODS

This study was carried out in the Hayatabad Medical Complex ENT unit, Peshawar from 1st January 2014 till 31st Dec 2020. It was retrospective Cross-Sectional Study included 269 patients who underwent total or near-total thyroidectomies. Sample size was calculated using 90% Confidence Interval, 5% margin of error and 47% prevalence of branching pattern of RLN[11] and P <0.05 level of significance using WHO software for sample size determination.

Sampling Selection:

Patients having benign thyroid disease, multinodular goitre and patients having no previous surgery were included in this study. There was no age limit for the subjects. Patients having any type of thyroid malignancy, revision surgeries and neck dissection were excluded from the study. The nerve and its branches were identified visually and by 2.5 surgical loupes during surgery on both right and left sides by only two surgeons in all procedures to exclude bias. Patients fulfilling above criteria were included in this study and procedure was explained and informed consent obtained from the patients. Ethical approval for the study was obtained from ethical committee of the institute (277/HEC/B&PS/22, dated: 05-08-2022). Proper history and examination was done preoperatively and vocal cord movements were examined endoscopically in all preop patients to exclude any preop vocal cord paralysis and relevant investigations done for GA fitness.

Statistical Analysis:

The data was recorded on a proforma and descriptive statistics were analyzed using SPSS 20 to determine the frequencies for variables like age, gender etc. Chi-square test was applied on variables and statistical significance was set as P<0.05. Comparison was also done between right and left side of branching patterns of nerve using crosstables.

RESULTS

A total of 269 patients were included in the study after meeting the study criteria. And both right and left sides of the RLNs of each patient are examined making a total of 538 RLN were identified in this study. As branching patterns of both sides have to be compared so hemithyroidectomy patients are not included in this study. The minimum age was 14 years and the maximum age was 69 years with a standard deviation mentioned in Table 01. The gender distribution and type of surgeries are shown in tables 02 Figure 01 respectively.

In our study, the most common branching pattern was the double branching pattern which was seen in 140 (52.04%) patients followed by a single branching pattern which was identified in 79 (29.3%) patients. Figure 02 shows the frequency of different branching patterns of RLN identified in our study.

Similar branching patterns were seen on both sides except in one patient who had a single branching pattern on the right side as compared to a double branching pattern on the left side of the Thyroid gland. No significant association was identified of the different branching patterns of RLN with age, gender as shown in Tables 3 & 4.

Table 1. Descriptive Statistics

Total Patients	269
Mean Age	38.8773
Std. Deviation	11.21116

Table 2. Gender Wise Distribution

Gender	Frequency	Percentages (%)
Male	78	29.0
Female	191	71.0
Total	**269**	**100.0**

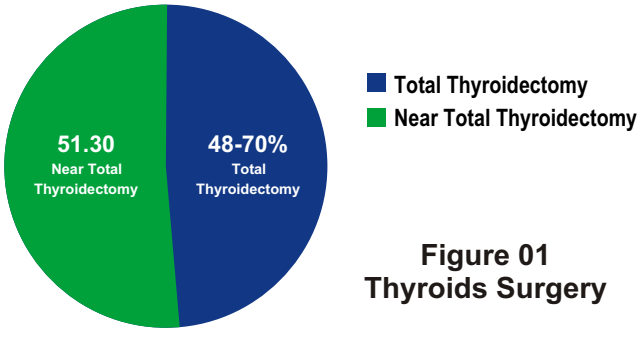


Figure 01
Thyroids Surgery

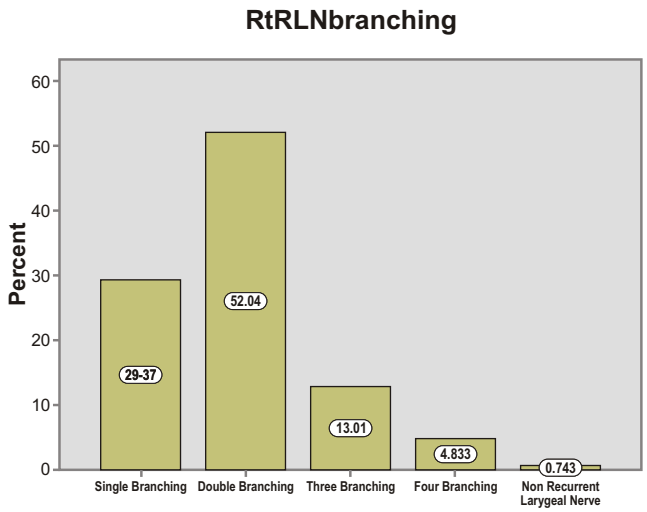


Figure 02. RtRLNbranching

DISCUSSION

Injury to RLN has been a common complication after thyroidectomies, preservation of the RLN is mandatory for a patient's normal voice after thyroid operations.[12,13] Meta analysis of 25,000 cases suggest the incidence of temporary and permanent injury to RLN is 9.8% and 2.3% respectively despite strenuous attempts to identify and preserve the nerves.[14,15] The RLN and its different variations can be identified by means of nerve monitoring and direct vision alone.[16]

According to several published series, the RLN divides in 30-78% of cases before its entry into the larynx.[17] Brandon et al showed in their study that extra-laryngeal branching prevalence was about 60%.[18] Dai et al. and Cakir et al in their studies showed similar results, while other publications showed 5 % to 100 % overall prevalence.[19,20]

In our study RLN bifurcations were more prevalent as reported in the literature. In our study double branching patterns were more common and the majority of cases (52.04%) observed as double branching. This type of branching pattern (bifurcation) was seen bilaterally in our study. Analysis done by Brandon et al on 16,618 nerves showed bifurcation branching type most common having 51.1% prevalence and second common type was single branch pattern having 42% prevalence.[18]

In our study, the second most common pattern 79 (29.3%) patients observed with a single branch, of which 22 were males and 57 were females, coincides with a meta-analysis by Bradon et al.[15]

Contrary to our study Beneragama mentioned that all variations including bifurcations and trifurcations are more frequent in the right side.[21]

In our study 35 (13.01%) patients were having triple branching, 13 (4.83%) patients were having four branches. Ardito et al in his series reported that RLN trifurcation is much rarer than bifurcation. The rate of trifurcation has been reported to be 0.9% in his series involving 2626 nerve dissections.[22]

2 patients (0.74%) had non-recurrent laryngeal nerve patterns in our study. In 1823 Stedman first reported the Non Recurrent laryngeal nerve, in which the nerve comes directly from the Vagus nerve and enters into the larynx without descending in the neck.[23] Non Recurrent laryngeal nerve is documented in 0.3-0.8% of patients on the right side and is rarely reported in 0.004% of patients on the left side.[24]

In our study, there was almost no difference in branching patterns between the left and right sides. Also, there is no correlation between branching patterns with the age and gender of the patient. Similar to the study done by Mehmet et al, no significant difference was found between the right and left sides in terms of the branching pattern (p=0.471).[11]

CONCLUSION

Extra-laryngeal branching of RLN is a common anatomical variation and during surgery, these anatomical variations in RLN should be recognized and preserved by tracing it along its whole course in the neck up to its level of entry into the larynx. Injury to any branch of RLN may cause postoperatively changes in voice, even if the surgeon is sure that the nerve integrity is preserved. Therefore, one should carefully look for nerves and their branches during surgery.

Moreover, thyroid surgery should be carried out by experienced head and neck surgeons who have the adequate knowledge of the anatomical diversity of the RLN and the experience to identify and manage the difficult variation of the nerve.

Table 3. Gender * Right RLN Branching Cross Tabulation

		RtRLNbranching					Total
		Single Branching	Double Branching	Three Branching	Four Branching	Non Recurrent Laryngeal Nerve	
Gender	Male	22	41	10	4	1	78
	Female	57	99	25	9	1	191
Total		**79**	**140**	**35**	**13**	**2**	**269**

Table 4. Gender * Left RLN Branching Cross Tabulation

		LtRLNbranching				Total
		Single Branching	Double Branching	Three Branching	Four Branching	
Gender	Male	22	42	10	4	78
	Female	58	99	25	9	191
Total		**80**	**141**	**35**	**13**	**269**

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AUTHOR'S CONTRIBUTION
The following authors full fill authorship criteria as per ICMJE guidelines;

Nizam S, Adnan: Idea conception, drafting the work, final approval, agreed to be accountable for all the work.
Khan W: Design of the work, data acquisition, critical rivision, final approval, agreed to be accountable for all the work.
Anwar K: Data analysis, drafting of the work, final approval, agreed to be accountable for all the work.
Rehman F: Data interpretation, critical revision, final approval, agreed to be accountable for all the work.