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The Anatomical Variation of Recurrent Laryngeal Nerve in Relation to Inferior Thyroid Artery in Thyroid Surgeries

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Abstract

Background: This study was conducted to assess the Anatomical Variation of Recurrent Laryngeal Nerve in Relation to Inferior Thyroid Artery in thyroid surgeries.

Material and methods: Patient records from thyroidectomy (with or without parathyroidectomy) procedures utilizing intraoperative neural monitoring (IONM) were retrospectively analyzed. The study focused on identifying anatomical variations of the recurrent laryngeal nerve (RLN) and its association with the inferior thyroid artery (ITA), as well as exploring their connection to vocal cord paralysis (VCP). There were total 90 subjects who had been divided into three groups of 30 each on the basis of type of the nerve involved. Group 1 comprised of subjects in which anterior RLN was involved. Group 2 comprised of subjects in which posterior RLN was involved and Group 3 comprised of subjects in which LN between the branches of ITA was involved. All the results were evaluated.

Results: Among the subjects in which anterior RLN was involved, branching was seen in 16 subjects and non-branching was observed in 14 subjects. Among the subjects in which posterior RLN was involved,

branching was seen in 11 subjects and non-branching was observed in 18 subjects. Among the subjects in which RLN between the branches of ITA was involved, branching was seen in 10 subjects and non-branching was observed in 20 subjects. The overall incidence of vocal cord paralysis (VCP) observed in the study was 5.2%, with temporary VCP accounting for 4.9% and permanent VCP for 0.3% (see Table 5). When comparing nerve branching patterns, both the total VCP rate and the rate of temporary VCP were significantly elevated in cases involving branching recurrent laryngeal nerves (RLNs) compared to non-branching ones. The total VCP rates also varied based on the anatomical relationship between the RLN and the inferior thyroid artery (ITA): 8.6% when the RLN passed anterior to the ITA, 3.4% when it was posterior, and 1.7% when it traversed between ITA branches, with these differences reaching statistical significance.

Conclusion: Anterior crossing of the recurrent laryngeal nerve (RLN) over the inferior thyroid artery (ITA) and the presence of RLN branching are common anatomical variations that elevate the risk of vocal cord paralysis (VCP) during thyroidectomy. These variations are typically undetectable before surgery.

Keywords: Recurrent Laryngeal Nerve, Inferior Thyroid Artery, Anatomy

Introduction

The anatomical connection between the recurrent laryngeal nerve (RLN) and the inferior thyroid artery (ITA) is variable. Typically, the ITA originates from the thyrocervical trunk and provides blood supply to the thyroid gland, whereas the RLN, a mixed nerve, is a branch of the vagus nerve. On the right side, the RLN generally courses anterior to the ITA, while on the left side, it typically runs posterior to the ITA. Occasionally, the RLN traverses between the branches of the ITA.[1] During a thyroidectomy, the recurrent laryngeal nerve (RLN) faces the potential for iatrogenic damage. This complication is among the most significant associated with thyroid surgery, affecting 2-5% of patients who do not have nerve variations, leading to issues with voice and swallowing.[2] To mitigate these complications, it is essential to employ a meticulous surgical technique to locate the inferior thyroid artery (ITA), which serves as a critical landmark for identifying the RLN. The association between the artery and the nerve has been examined over the past century, resulting in the development of various classification systems.[2,3] This study was conducted to assess the Anatomical Variation of Recurrent Laryngeal Nerve in Relation to Inferior Thyroid Artery in thyroid surgeries.

Material and methods

Patient records from thyroidectomy (with or without parathyroidectomy) procedures utilizing intraoperative neural monitoring (IONM) were retrospectively analyzed. Each side of the neck that underwent surgery was examined individually. The study focused on identifying anatomical variations of the recurrent laryngeal nerve (RLN) and its association with the inferior thyroid artery (ITA), as well as exploring their connection to vocal cord paralysis (VCP). There were total 90 subjects who had been divided into three groups of 30 each on the basis of type of the nerve involved. Group 1 comprised of subjects in which anterior RLN was involved. Group 2 comprised of subjects in which posterior RLN was involved and Group 3 comprised of subjects in which LN between the branches of ITA was involved. The nerves of the patients, which were exposed until the entry point of the larynx were included in this study. Following lobectomy, the identification of

malignancy in the pathology report led to the consideration of the completion thyroidectomy side as the primary intervention. The study assessed the anatomical relationship between the recurrent laryngeal nerve (RLN) and the inferior thyroid artery (ITA). Extra laryngeal branching of the RLN was defined as branching occurring more than 5 mm before the nerve entered the larynx, with all resulting branches subsequently entering the larynx. All the results were evaluated using SPSS software.

Results

Table 1: Distribution of subjects based on the type of nerve involved

Groups	Number of subjects	Percentage
Group 1 (Anterior RLN)	30	33.33
Group 2 (Posterior RLN)	30	33.33
Group 3 (RLN between the branches of ITA)	30	33.33
Total	90	100

There were 30 subjects in each group. Group 1 comprised of subjects in which anterior RLN was involved. Group 2 involved subjects in which posterior RLN was involved. Group 3 involved subjects in which the RLN between branches of ITA was involved.

Table 2: Comparison of the relation patterns of recurrent laryngeal nerve to inferior thyroid artery regarding the clinical and anatomical features

Parameters	Anterior RLN (n=30)	Posterior RLN (n=30)	RLN between the branches of ITA (n=30)
Neck side			
Right	20	21	15
Left	10	9	15
RLN branching			
Non-branching	14	18	20
Branching	16	12	10
Branching distance	3 ± 1.56	1.59 ± 0.87	3.15 ± 1.3

The mean age of the subjects in which anterior RLN was involved was 45.2 ± 11.2 years. The mean age of the subjects in which posterior RLN was involved was 46.1 ± 14.7 years. The mean age of the subjects in which RLN between the branches of ITA was involved was 48.36 ± 5.6 years. The mean BMI of the subjects in which anterior RLN was involved was 26.8 ± 4.2 kg/m^2. The mean BMI of the subjects in which posterior RLN was involved was 27.5 ± 3.1 kg/m^2. The mean BMI of the subjects in which RLN between the branches of ITA was involved was 26.4 ± 5.3 kg/m^2. There were 29 males and 11 females in which anterior RLN was involved. There were 20 males and 10 females in which posterior RLN was involved. There were 16 males and 14 females in which RLN between the branches of ITA was involved. Among the subjects in which anterior RLN was involved, branching was seen in 16 subjects and non-branching was observed in 14 subjects. Among the subjects in which posterior RLN was involved, branching was seen in 11 subjects and non-branching

was observed in 18 subjects. Among the subjects in which RLN between the branches of ITA was involved, branching was seen in 10 subjects and non-branching was observed in 20 subjects.

The overall incidence of vocal cord paralysis (VCP) observed in the study was 5.2%, with temporary VCP accounting for 4.9% and permanent VCP for 0.3% (see Table 5). When comparing nerve branching patterns, both the total VCP rate and the rate of temporary VCP were significantly elevated in cases involving branching recurrent laryngeal nerves (RLNs) compared to non-branching ones. The total VCP rates also varied based on the anatomical relationship between the RLN and the inferior thyroid artery (ITA): 8.6% when the RLN passed anterior to the ITA, 3.4% when it was posterior, and 1.7% when it traversed between ITA branches, with these differences reaching statistical significance.

Discussion

Recurrent laryngeal nerve (RLN) palsy represents the most prevalent and severe complication following thyroid surgery. The visual identification of the RLN during such procedures has been correlated with reduced rates of palsy. Although this method is advocated as the gold standard for RLN management, it does not ensure success in preventing postoperative vocal cord paralysis.[4] Anatomical variations of the RLN, including extra-laryngeal branches, distorted RLN pathways, interconnections between the RLN and the inferior thyroid artery, as well as the presence of a non-recurrent laryngeal nerve, may contribute to nerve damage resulting from visual misidentification.[5]

Consequently, intraoperative confirmation of both functional and anatomical integrity of the RLN is essential for conducting a safe thyroid operation.[6,7]

This study was conducted to assess the Anatomical Variation of Recurrent Laryngeal Nerve in Relation to Inferior Thyroid Artery in thyroid surgeries.

In this study, among the subjects in which anterior RLN was involved, branching was seen in 16 subjects and non-branching was observed in 14 subjects. Among the subjects in which posterior RLN was involved, branching was seen in 11 subjects and non-branching was observed in 18 subjects. Among the subjects in which RLN between the branches of ITA was involved, branching was seen in 10 subjects and non-branching was observed in 20 subjects.

The overall incidence of vocal cord paralysis (VCP) observed in the study was 5.2%, with temporary VCP accounting for 4.9% and permanent VCP for 0.3%. Aygum N et al[8] evaluated of the risk associated with recurrent laryngeal nerve (RLN) paralysis in relation to its anatomical variations. A total of 1070 neck sides were included in this study. The rate of extralaryngeal branching was found to be 35.5%. Among the RLNs, 45.9% were located anterior and 44.5% posterior to the ITA, while 9.6% crossed between the branches of the ITA. The overall rate of VCP was 4.8%, with transient VCP at 4.5% and permanent VCP at 0.3%. The incidence of both total and transient VCP was significantly greater in nerves exhibiting extralaryngeal branching compared to those without branching (6.8% vs. 3.6%, p = 0.018; 6.8% vs. 3.2%, p = 0.006, respectively). The total VCP rates were recorded at 7.2%, 2.5%, and 2.9% for RLNs crossing anteriorly, posteriorly, and between the branches of the ITA, respectively (p = 0.003). A significant difference was also noted in the transient VCP rates (p = 0.004). The anterior crossing pattern was associated with an increase in total and transient VCP rates by factors of 2.8 and 2.9,

respectively. The frequent anatomical variations of the RLN crossing the ITA anteriorly and RLN branching contribute to an elevated risk of VCP during thyroidectomy, which cannot be anticipated preoperatively.[8]

In the present study, when comparing nerve branching patterns, both the total VCP rate and the rate of temporary VCP were significantly elevated in cases involving branching recurrent laryngeal nerves (RLNs) compared to non-branching ones. The total VCP rates also varied based on the anatomical relationship between the RLN and the inferior thyroid artery (ITA): 8.6% when the RLN passed anterior to the ITA, 3.4% when it was posterior, and 1.7% when it traversed between ITA branches, with these differences reaching statistical significance. Ling XY et al[9] investigated the anatomical variations of the recurrent laryngeal nerve (RLN) with respect to its positioning relative to the inferior thyroid artery (ITA) and to assess the prevalence of the nonrecurrent laryngeal nerve (NRLN). The databases searched included MEDLINE, Web of Science, MEDITEXT, AMED, CINAHL, Cochrane, ProQuest, Pubmed, and ScienceDirect. The search utilized terms such as "inferior thyroid artery," "recurrent laryngeal nerve," "nonrecurrent laryngeal nerve," and "anatomical variation." Additionally, the reference sections of the identified articles were examined for further relevant studies. All references from the articles were scrutinized to uncover any articles that may have been overlooked during the database search. This study encompassed a total of 8,655 RLN sides. Among these, 1,813 (20.95%; 95% confidence interval (CI) 20.09, 21.82) exhibited a Type A configuration of the RLN in relation to the ITA, 2,432 (28.10%; 95% CI 27.15, 29.06) displayed a Type B configuration, and 4,410 (50.95%; 95% CI 49.89, 52.01) demonstrated a Type C configuration between the RLN and the ITA. A subsequent search yielded 38,568 recurrent laryngeal sides, with only 221 (0.57%; 95% CI 0.5, 0.65) cases of NRLN documented. The RLN is predominantly located in a posterior position concerning the ITA, and the occurrence of NRLN is notably low, affecting merely 0.57% of the population.[9]

Conclusion

Anterior crossing of the recurrent laryngeal nerve (RLN) over the inferior thyroid artery (ITA) and the presence of RLN branching are common anatomical variations that elevate the risk of vocal cord paralysis (VCP) during thyroidectomy. These variations are typically undetectable before surgery.

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