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(CASE REPORT)

Non-recurrent inferior laryngeal nerve: An overlooked anatomical variant: A case series of four patients

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Abstract

Background: Identification and preservation of the recurrent laryngeal nerve (RLN) are essential steps in thyroid surgery to prevent vocal cord dysfunction. The non-recurrent inferior laryngeal nerve (NRILN) represents a rare anatomical variant, most commonly occurring on the right side, and is associated with an increased risk of iatrogenic nerve injury due to its atypical course. Awareness of this variant and its anatomical predictors is crucial for safe surgical practice.

Cases: We report a case series of four patients undergoing thyroidectomy in whom a right-sided NRILN was identified intraoperatively. The patients included three women and one man, aged 45–55 years, all operated on for benign thyroid disease or indeterminate nodules. In each case, the RLN was not found in its usual position within the tracheoesophageal groove. Careful dissection revealed a slender, non-recurrent nerve branching directly from the cervical vagus nerve and coursing transversely toward the larynx. In one patient, preoperative imaging demonstrated an aberrant right subclavian artery, raising suspicion for NRILN prior to surgery. Intraoperative nerve monitoring was used in all cases and aided in nerve identification and preservation. No postoperative vocal cord dysfunction occurred.

Discussion: NRILN is an uncommon but clinically significant anatomical variant that poses a heightened risk of nerve injury if unrecognized. Its presence is strongly associated with aberrant vascular anatomy, particularly *Arteria Lusoria*, which may be detected using preoperative ultrasonography or cross-sectional imaging. Early suspicion, meticulous surgical technique, and the use of intraoperative nerve monitoring are key strategies for minimizing morbidity.

Conclusion: Although rare, NRILN should be anticipated when the RLN is not identified in its expected location or when vascular anomalies are present. Preoperative imaging and intraoperative nerve monitoring, combined with thorough anatomical knowledge, are effective tools for preventing nerve injury and ensuring optimal surgical outcomes during thyroidectomy.

Keywords: Recurrent Laryngeal Nerve; Non-Recurrent Laryngeal Nerve; Thyroidectomy; *Arteria Lusoria*; Intraoperative Nerve Monitoring

1. Introduction

Thyroidectomy is one of the most commonly performed procedures in endocrine surgery, and preservation of the recurrent laryngeal nerve (RLN) remains a critical step to prevent postoperative vocal cord dysfunction and related

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morbidity. Injury to the inferior laryngeal nerve may result in dysphonia, aspiration, and reduced quality of life, making accurate anatomical identification essential during thyroid dissection [1,4].

The recurrent laryngeal nerve usually follows a predictable course within the tracheoesophageal groove after looping around the subclavian artery on the right and the aortic arch on the left. However, anatomical variations may occur and significantly increase the risk of iatrogenic injury. Among these, the non-recurrent inferior laryngeal nerve (NRILN) is a rare but clinically important variant, with an estimated prevalence of less than 1%, occurring predominantly on the right side [1,3]. Its atypical transverse course from the cervical vagus nerve directly to the larynx makes it particularly vulnerable during thyroid surgery if not anticipated [1,5].

The presence of NRILN is closely associated with embryological vascular anomalies, particularly an aberrant right subclavian artery (*Arteria Lusoria*), which may be detected preoperatively using ultrasonography or cross-sectional imaging [1–3,9]. Recognition of these predictive signs can facilitate safer surgical planning and reduce the risk of nerve injury. Intraoperative nerve monitoring (IONM) has emerged as a valuable adjunct for early identification and functional confirmation of nerve anatomy in challenging cases [4,6].

Although isolated case reports and reviews have described NRILN, intraoperative experience remains limited because of its rarity. Reporting such cases is important to improve awareness among surgeons and reinforce practical strategies for safe thyroidectomy [3,5,6].

The aim of this case series is to describe four cases of right-sided NRILN identified during thyroidectomy, highlight their intraoperative anatomical features, and discuss the role of preoperative imaging, meticulous dissection, and intraoperative nerve monitoring in preventing nerve injury.

2. Patients and Observations

2.1. Case 1

A 45-year-old female presented with a thyroid nodule and no personal or familial history of thyroid disease. Surgery was recommended due to the size of the nodule, which measured approximately 3.6 cm. The nodule showed no signs of extending into the superior thoracic region.

During the thyroidectomy, an anatomical variation was noted. The right inferior laryngeal nerve (RLN) was not located in its typical position either posterior or anterior to the right inferior thyroid artery or adjacent to the right inferior parathyroid gland. Instead, a white, thread-like structure appeared laterotracheally on the right side, extending perpendicularly towards the trachea at the cricotracheal junction. This structure was traced and identified as the right non-recurrent inferior laryngeal nerve (NRILN). Despite this unusual anatomical course, the thyroidectomy was carried out without any complications.

Postoperative indirect laryngoscopy confirmed normal vocal cord mobility.

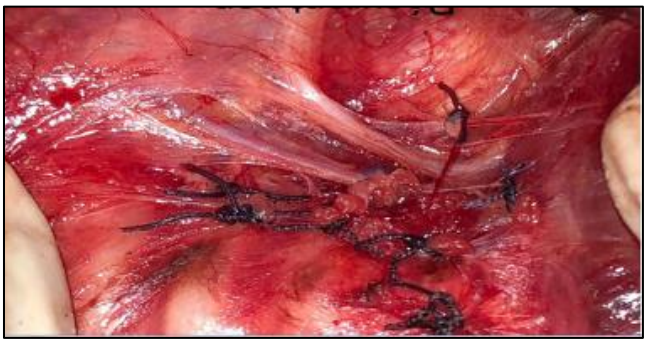

Figure 1 Intraoperative view in Case 1 demonstrating a right non-recurrent inferior laryngeal nerve (NRILN) arising directly from the cervical vagus nerve and coursing transversely toward the larynx, without a recurrent loop around the subclavian artery

2.2. Case 2

The second patient was a 55-year-old female with no history of thyroid disease in her family. Similar to Case 1, she presented with a thyroid nodule, also measuring 3.6 cm, requiring surgery. There were no signs of the nodule extending into the thoracic region.

During the surgical procedure, the same anatomical variation of the right inferior laryngeal nerve (NRILN) was identified. The nerve was not found in its usual position and, instead, a white, thread-like structure was observed laterotracheally on the right side, extending towards the cricotracheal angle. This structure was identified as the right NRILN after careful dissection. The thyroidectomy was completed successfully without any complications.

Postoperative evaluation through indirect laryngoscopy confirmed that the patient had normal vocal cord mobility on both sides.

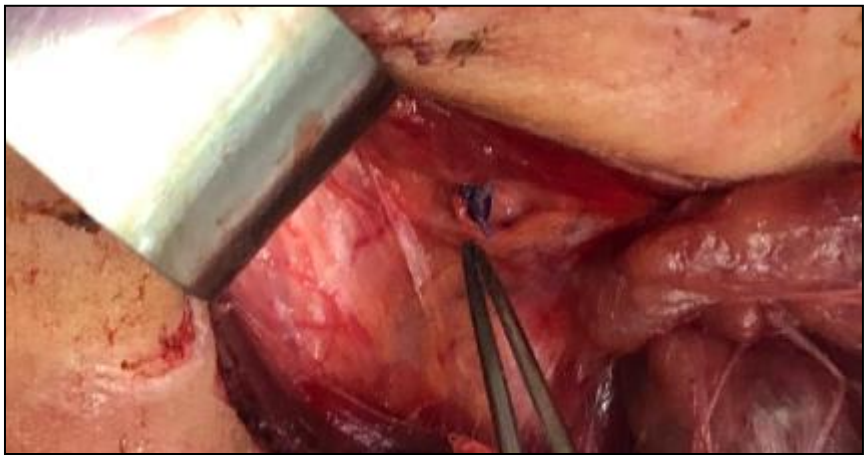

Figure 2 Intraoperative representation in Case 2 showing a right non-recurrent inferior laryngeal nerve (NRILN) identified lateral to the trachea, following a horizontal course to the cricotracheal junction and lacking the typical recurrent trajectory within the tracheoesophageal groove

2.3. Case 3

A 51-year-old male with no familial history of thyroid cancer presented with a suspicious thyroid nodule. The nodule was 1.8 cm in size (EU-TIRADS 5) and had cytological results categorized as Bethesda III, suggesting a higher risk of malignancy.

During the thyroidectomy, the right inferior laryngeal nerve (RLN) was again absent from its typical anatomical location. A white, thread-like structure was observed laterotracheally on the right, extending towards the cricotracheal junction. Upon further dissection, this was confirmed as the right non-recurrent inferior laryngeal nerve (NRILN). Despite this variation, the procedure was successfully completed without complications.

The left recurrent laryngeal nerve followed its typical path in the tracheoesophageal groove, and postoperative laryngoscopy revealed normal bilateral vocal cord movement.

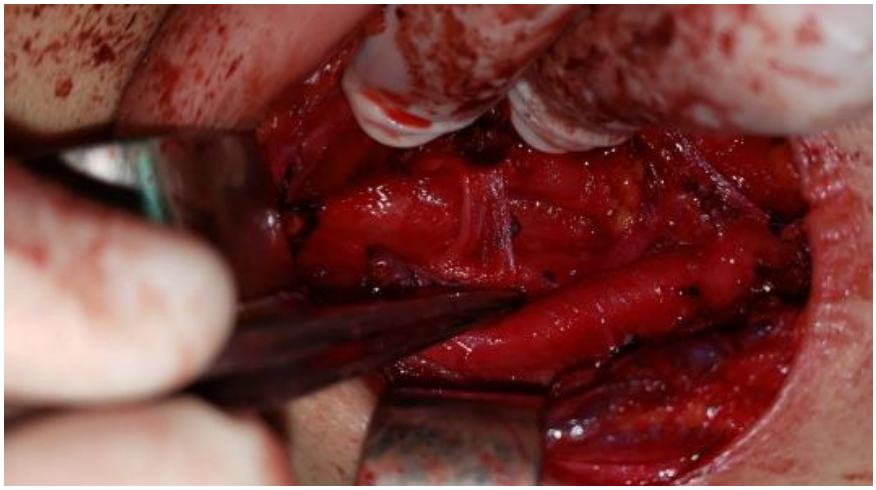

Figure 3 Intraoperative finding in Case 3 illustrating a right non-recurrent inferior laryngeal nerve (NRILN) emerging from the vagus nerve and entering the larynx at a higher cervical level, in close relation to the inferior thyroid artery

2.4. Case 4

The fourth patient, a 52-year-old female, presented with a palpable thyroid nodule and intermittent neck discomfort, but no dysphonia or dysphagia. An ultrasound revealed a hypoechoic lesion in the right thyroid lobe measuring 3.8 cm, graded as EU-TIRADS 4, with cytology categorized as Bethesda III.

During surgery, the recurrent laryngeal nerve (RLN) was not found in its expected position within the tracheoesophageal groove or adjacent to the inferior thyroid artery. Instead, a slender, whitish cord-like structure was noted, emerging directly from the right vagus nerve. The nerve followed a non-looping path to the cricotracheal junction before entering the larynx alongside the inferior thyroid artery. This structure was confirmed as the right non-recurrent inferior laryngeal nerve (NRILN).

The left recurrent laryngeal nerve was found in its usual location, within the tracheoesophageal groove. The patient had an uneventful recovery, and postoperative indirect laryngoscopy confirmed normal vocal cord mobility.

Histological examination confirmed benign thyroid disease without evidence of malignancy.

3. Discussion

The non-recurrent inferior laryngeal nerve (NRILN) remains an uncommon but clinically important anatomical variant in thyroid surgery. Contemporary reviews and pooled analyses consistently report a prevalence below 1%, occurring almost exclusively on the right side, whereas left-sided NRILN is exceptionally rare and usually associated with major laterality and aortic arch anomalies, such as situs inversus or right-sided aortic arch [1–3]. In the present case series, all NRILNs were right-sided, which is consistent with the distribution reported in large anatomical and surgical studies [1,3].

The primary clinical relevance of NRILN lies in its association with a significantly increased risk of iatrogenic injury. Systematic reviews and meta-analyses demonstrate that the incidence of nerve injury in the presence of NRILN ranges between 6% and 14%, compared with approximately 1–2% for normally recurrent laryngeal nerves [1,5,8]. A recent meta-analysis reported a pooled injury risk of approximately 7%, corresponding to a nearly fourfold increase compared with standard anatomy [8]. This elevated risk is largely attributable to the atypical course of the nerve, which often runs more horizontally and superiorly, making it vulnerable during capsular dissection and ligation of the inferior thyroid artery [1,5].

In contrast, favorable outcomes are consistently reported when NRILN is identified early and preserved using meticulous dissection techniques. In the present series, no postoperative vocal cord dysfunction was observed, which aligns with recent reports indicating that the decisive factor in preventing nerve injury is early recognition rather than the anatomical variation itself [5,6]. These findings support current recommendations emphasizing heightened awareness and systematic nerve identification when expected landmarks fail.

The embryological basis of NRILN is well established and explains its strong association with vascular anomalies. During normal development, the recurrent laryngeal nerves descend into the thorax and loop around derivatives of the branchial arch arteries before ascending to the larynx. NRILN most commonly arises when the right subclavian artery originates aberrantly from the distal aortic arch (*Arteria Lusoria*), eliminating the arterial structure that would normally draw the nerve caudally [1,3].

In this setting, the inferior laryngeal nerve branches directly from the cervical vagus nerve and follows a non-recurrent, transverse course to the larynx [1,3]. This embryological mechanism explains why the vast majority of NRILNs are right-sided. Left-sided NRILN is exceedingly rare and requires complex embryological conditions, including a right-sided aortic arch and absence of the ligamentum arteriosum, typically in the context of situs inversus [3,10].

Several studies report that 80–90% of right-sided NRILNs are associated with *Arteria Lusoria* [1,8]. The small proportion of NRILNs without identifiable vascular anomalies may represent misidentified neural branches or extremely rare developmental variants [3]. From a practical standpoint, the close embryological relationship between NRILN and *Arteria Lusoria* provides a rational basis for preoperative vascular assessment as a predictive tool.

Surgical identification of NRILN requires deviation from standard thyroidectomy protocols when the recurrent laryngeal nerve is not found in its expected location. Multiple authors emphasize that failure to identify the RLN within the tracheoesophageal groove should immediately prompt suspicion of NRILN [1,5]. Continued inferior dissection without reassessment significantly increases the risk of traction or transection injury to a short, non-recurrent nerve.

Recommended strategies include expanding the dissection superiorly and laterally, particularly along the carotid sheath, where the nerve may be identified emerging directly from the vagus and coursing transversely toward the cricotracheal junction [5,6]. In our series, this approach consistently led to identification of the NRILN and avoidance of injury.

The use of intraoperative nerve monitoring (IONM) is especially valuable in cases of suspected NRILN. IONM allows functional confirmation of nerve identity and may provide early clues to non-recurrent anatomy, such as absence of electromyographic response following distal vagal stimulation [4,6]. Several reviews and clinical studies support the role of IONM as an adjunct in anatomically complex or high-risk thyroid surgery, contributing to reduced nerve injury rates when combined with visual identification [4,6]. Our experience corroborates these findings, as neuromonitoring facilitated early recognition and safe preservation of the nerve in all patients.

Preoperative imaging plays an important role in predicting NRILN by identifying associated vascular anomalies, particularly *Arteria Lusoria*. Although the laryngeal nerve itself is not directly visualized on routine imaging, vascular anatomy serves as a reliable surrogate marker [1,2]. In our series, imaging was reviewed in cases with unexpected intraoperative anatomy, and in one patient, contrast-enhanced CT clearly demonstrated an aberrant right subclavian artery, prospectively alerting the surgical team to the likelihood of NRILN.

Cross-sectional imaging with CT or MR angiography is considered the reference standard for delineating *Arteria Lusoria*, with reported sensitivity and specificity approaching 100% [2,9]. While routine CT imaging for all thyroidectomy patients is not justified given the rarity of NRILN, targeted imaging is recommended when suspicious vascular anatomy is detected on ultrasound or when clinical symptoms such as dysphagia lusoria are present [2,9].

Ultrasonography, particularly Doppler examination of the cervical vessels, has emerged as a practical and non-invasive screening tool. The absence of the normal brachiocephalic trunk bifurcation—commonly referred to as the negative "Y sign"—is highly predictive of an aberrant right subclavian artery and, by extension, NRILN [2,7]. Reported sensitivity of this sign ranges from 98–100%, with a near-perfect negative predictive value [2,7]. However, specificity may vary depending on operator experience and patient anatomy, with values ranging from 80% to 95% in different series [2,7].

Despite the possibility of false-positive findings, the clinical consequence of over-prediction is increased surgical vigilance rather than harm. Studies demonstrate that preoperative identification of vascular predictors of NRILN is associated with lower rates of nerve injury and improved surgical outcomes [2,9]. Our findings support this approach, as anticipation of NRILN based on imaging facilitated careful operative planning and successful nerve preservation.

4. Conclusion

NRILN is a rare but clinically significant anatomical variant that substantially increases the risk of nerve injury during thyroid surgery if unrecognized. The findings of this case series are consistent with contemporary literature regarding

prevalence, embryological origin, and surgical implications. Integration of preoperative vascular imaging, systematic intraoperative nerve identification, and intraoperative nerve monitoring represents the most effective strategy for minimizing morbidity. Heightened awareness and anticipation of NRILN—particularly in the presence of *Arteria Lusoria*—remain essential to ensuring optimal surgical outcomes.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that they have no conflicts of interest related to this work.

Statement of ethical approval

This study was conducted in accordance with recognized ethical standards and complied with the principles of the Declaration of Helsinki. Institutional ethical approval was obtained where applicable in accordance with local regulations.

Statement of informed consent

Written informed consent was obtained from all patients for participation and for the publication of anonymized clinical data and intraoperative images.

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