Examination of Anatomical Variations of the Recurrent Laryngeal Nerve (RLN) Relative to the Inferior Thyroid Artery (ITA)

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Aim

This study examines the anatomical variations of the recurrent laryngeal nerve (RLN) relative to the inferior thyroid artery (ITA) within cadavers in a unique population..

Abstract

The RLN is an important structure to maintain when performing thyroidectomy as it innervates the intrinsic musculature of the larynx resulting in voice production, airway protection, and breathing. Several anatomical landmarks have been used to help identify RLNs during thyroidectomy to prevent injury, which may result in dysphonia, aspiration, and obstruction of the airway. The objective of this study was to examine the RLN relative to the ITA using a cadaver model within a unique population (El Paso being largely Hispanic). 25 nerves, from 13 cadavers, were dissected to document the anatomic variation, laterality of RLN, gender of cadaver, and bilateral combination per cadaver. Overall, 18 nerves traveled posterior and 7 traveled anterior to the ITA. Left RLNs showed 11 travel posterior and 2 anterior, where right RLNs showed 7 travel posterior and 5 anterior. Posterior-posterior was the most common bilateral combination where both RLNs traveled posterior to the ITA with 58.3% of the cadavers having this combination. While 84.6% of left RLNs traveled posterior to the ITA, only 58.3% of right RLNs traveled posterior to the ITA. Thus, the ITA is a much less reliable anatomical landmark when isolating the RLN as it can be damaged when isolating the ITA if there is an anterior variation. The current data from this study further shows a similar distribution of anatomical variations in the unique population of the cadavers compared to previously reported data in the literature.

Introduction

Thyroidectomy is a commonly performed procedure indicated in removing thyroid masses, compressive goiters, and thyrotoxicosis refractory to medical management. While thyroidectomy is a common procedure, it carries a significant risk of injuring the RLN. The RLN innervates the intrinsic muscles of the larynx (except the cricothyroid muscle) and as a result, plays a role in voice production, airway protection, and breathing. Injury to the RLN can thus result in hoarseness, dysphonia, aspiration, and airway obstruction with worse symptoms if bilateral RLNs are injured. During thyroidectomy, the RLN is identified to avoid such injury; thus, appropriate anatomical knowledge and surgical techniques are necessary to avoid intraoperative injury. Anatomical structures important to identification of the RLNs include the tracheoesophageal groove, Berry's ligament, the ITA, posterior border of the thyroid gland, and the tubercle of Zuckerkandl. Further, the RLN is identified intraoperatively by its insertion posterior to the cricothyroid joint. Previous studies have examined the anatomical variations of the RLN and ITA and this study aimed to examine the relationship in a unique patient population as the cadavers were from patients within El Paso, a city where 80% of the population is Hispanic.

Methods

Cadavers from the anatomy lab of Texas Tech HSC El Paso Paul L. Foster School of Medicine from November 2024 - January 2025 were used to dissect the RLN and surrounding structures (thyroid gland and ITA). In total, 13 cadavers and 25 nerves were examined and no interventions were implemented. One nerve was previously removed and not included in this study.

Three authors contributed to the dissection of the RLNs. RLNs were traced from their origin (branch of Vagus nerve) to their insertion (posterior to the cricothyroid joint). Similarly, ITAs were traced off their origin from the thyrocervical trunk to their insertion into the inferior pole of the thyroid gland. Results were documented marking the anatomic variation, laterality, gender of cadaver, and bilateral combination. Anatomical variations were determined based off where the RLN and ITA crossed.

Results were analyzed using Fisher's Exact tests; p-values < 0.05 indicated statistical significance.

Results

Twenty-five RLNs were studied on 13 cadavers; 1 nerve was previously removed and unable to be classified. Overall, 18 nerves traveled posterior, 7 traveled anterior, and 0 traveled between the ITA branches. On the right side, 7 traveled posterior and 5 traveled anterior. Contralaterally, 11 traveled posterior and 2 traveled anterior. No significant difference in anatomical variation was found between right and left RLNs ($p = 0.202$).

On the left, 5 RLNs for males and 6 RLNs for females traveled posterior while 1 traveled anterior for both genders. On the right, males had higher variation with 3 nerves traveling posterior and 4 traveling anterior. Females had 4 traveling posterior and 1 traveling anterior on the right. Based on gender, right and left RLNs were not significantly different, suggesting gender does not affect anatomical variation ($p = 0.293$ and 1.0).

When comparing the anatomical position of the RLN on both sides of the neck, 61.5% of cadavers had both RLNs posterior or anterior to the ITA branches. The most common RLN combination observed was posterior-posterior (53.8%). However, no significant difference was found among RLN combinations, suggesting no prevalent combination ($p = 0.417$).

Overall, we did not observe any RLNs traveling in between the branches of the ITA. We also did not observe any non-recurrent RLNs.

Table 1: Location of RLN compared to ITA (p=0.202)

	Total	Right side	Left side
Posterior	18	7	11
Anterior	7	5	2

Table 2: Location of RLN compared to ITA based on gender and laterality (p=0.293 and 1.0)

	Male	Female
Right side		
Posterior	3	4
Anterior	4	1
Left side		
Posterior	6	5
Anterior	1	1

Table 3: Bilateral combinations of anatomical variations of the RLN and ITA (p=0.417)

		Right Side	
		Posterior	**Anterior**
Left Side	**Posterior**	7	4
	Anterior	0	1

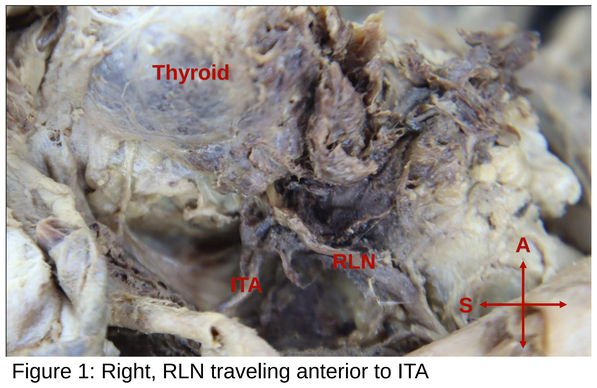

Figure 1: Right, RLN traveling anterior to ITA

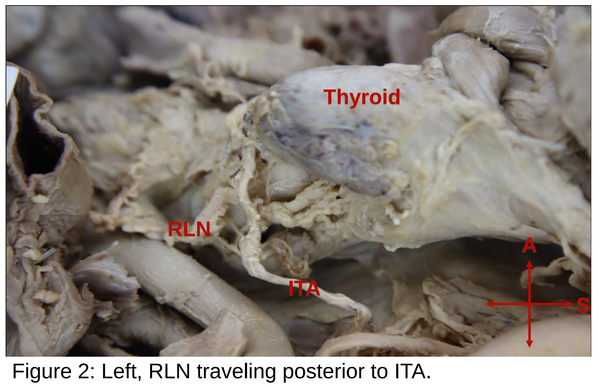

Figure 2: Left, RLN traveling posterior to ITA.

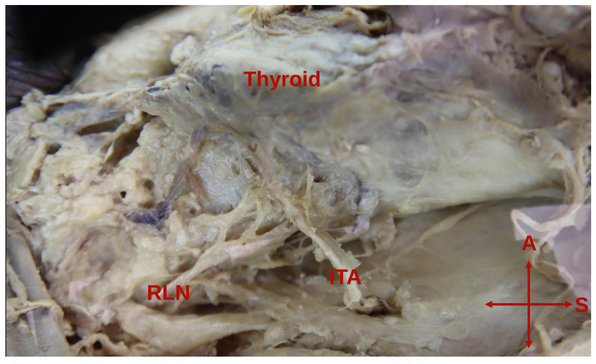

Figure 3: Left, RLN traveling posterior to ITA

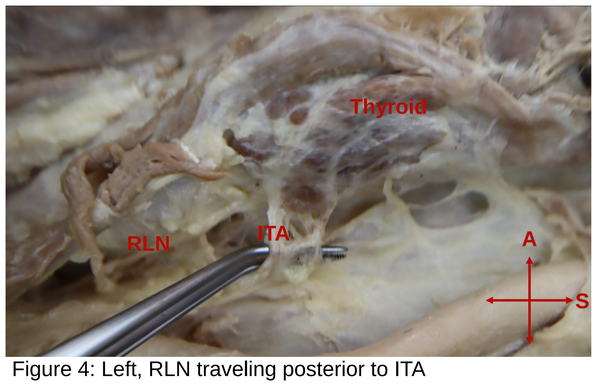

Figure 4: Left, RLN traveling posterior to ITA

Discussion

- Campos et al. found that the RLN traveled in between the branches of ITA most commonly on both sides of the body.
- 16 previous studies[2-3, 6-7, 9, 12-13, 15-17, 20-21, 23-24, 26] showed that the most common bilateral combination was posterior-posterior.
- 14 other previous studies[3, 6-7, 9, 12-13, 15-17, 20-21, 23-24, 26] showed predominance of posterior anatomy on the left side of the body.
- The current data from this study reflects similarly to previously published data where the predominant bilateral combination is a posterior-posterior combination and the predominant anatomical variation of left RLNs is posterior to the ITA. Further, right RLNs have higher anatomical variation and there is no predominant anatomical variation.

Conclusion

- The left RLN predominately travels posterior to the ITA, but this does not preclude that a patient may have an anterior variation of the RLN.
- The right RLN has higher variation with mixed results of which variation predominates. When isolating the right RLN, the ITA should not be used as there is high variation in the anatomy on the right.
- Anterior variations are more likely to be injured as the thyroid is dissected and the tracheoesophageal groove is exposed.

Limitations

This study included 13 cadavers from the cadaver lab at Texas Tech HSC Paul L. Foster School of Medicine in total. While this is an adequate sample for observation of total anatomical variations based on laterality and bilateral combination, more cadavers are needed to examine for gender based differences in this population. In this study, there were no significant differences between the male and female cadavers when examining left RLNs. In contrast when examining right RLNs, there is not a statistically significant difference between the two genders, but there is an observational difference where male right sided RLNs have high anatomic variability, but females showed 80% posterior right RLNs in a sample of 5 cadavers. More male and female cadaver observations may show a statistically different observation in this unique patient population. Further, in this study, no observations were made of non-recurrent RLNs or RLNs traveling in between branches of the ITA. Observing both these anatomical variations may give a more comprehensive view of the distribution of the anatomical variations present in this patient population.

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