

ORIGINAL ARTICLES

RELATIONSHIP BETWEEN THE RECURRENT LARYNGEAL NERVE AND THE INFERIOR THYROID ARTERY: A STUDY IN CORPSES

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CAMPOS BA et al. - Relationship between the recurrent laryngeal nerve and the inferior thyroid artery: a study in corpses. *Rev. Hosp. Clín. Fac. Med. S. Paulo* 55(6):195-200, 2000.

The anatomical relationship between the recurrent laryngeal nerve (RLN) and the inferior thyroid artery (ITA) was studied in 76 embalmed corpses, 8 females and 68 males. In both sexes, the RLN lay more frequently between branches of the ITA.; it was found in this position in 47.3% of male corpses and 42.8% of female ones. On the right, RLN was found between branches of the ITA in 49.3% of the cases, anterior to it in 38.04%, and posterior in 11.26%. On the left, the RLN lay between branches of the ITA in 44.45%, posterior to the ITA in 37.05%, and anterior to it in 18.05% of the cases. In 62.68% of the cases, the relationship found on one side did not occur again on the opposite side. There was a significant difference ($p < 0.05$) in the distribution of the 3 types of relationships between the RLN and the ITA, on the right and on the left. Racial variations could contribute to an explanation of the differences observed by authors of different countries in the relationship between the RLN and the ITA.

DESCRIPTORS: Anatomy. Recurrent laryngeal nerve. Inferior thyroid artery. Thyroid gland. Thyroidectomies.

Galen was the first to describe the recurrent laryngeal nerve (RLN) as a branch of a cranial nerve⁴⁷.

The vagus nerve is formed by the end of the fifth week of embryonic development, and the branch that will originate the RLN becomes apparent by the end of the sixth week. This branch of the vagus nerve is associated with the sixth branchial arch of the embryonic pharynx, and it passes directly to the larynx. The embryo's system of aortic arches is associated with the pharynx. The vagus branch lies caudal to the aortic arches.

With the embryo's development, the neck elongates, and the larynx moves cranially while the aortic arch and associated vessels remain in the thorax, and, with them, the vagus

branch. This branch, reaching the larynx directly when first developed, now forms the adult's characteristic recurrent loop¹⁶.

Therefore, the course of the RLN is determined by the pattern of development of the arteries with which it becomes related, and the variations of this pattern will determine variations in the anatomical disposition of this nerve¹⁶. Gray et al.¹⁶ had, at great length, described the embryonic development of the RLN as well as diverse possibilities of variations.

If the RLN develops without alterations, it will originate from the vagus

nerve and, on the right, surrounds the right subclavian artery, and on the left, surround the aortic arch. Before reaching its point of penetration in the larynx, the RLN ascends in the neck in the tracheoesophageal groove in most of the cases^{1,4,14,37}. During this ascending passage, the RLN will cross the inferior thyroid artery (ITA).

Injury to the RLN is one of the most frequent and important causes of morbidity in thyroidectomies. The knowledge of its passage and of its anatomical relationships is essential in order to avoid such an injury. The objective of the present work was to study in corpses the relationship that the RLN establishes with the ITA, as well as to analyze some factors that can influence this relationship.

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METHOD

From July 1995 to July 1999, 76 embalmed corpses were dissected, 8 females and 68 males.

Access to the neck was achieved through a longitudinal incision in the median line associated with a curved transverse incision, creating 2 triangular flaps that were retracted laterally, allowing ample access to both sides of the neck. The recurrent laryngeal nerve (RLN) was dissected at its crossing point with the inferior thyroid artery (ITA).

There were 9 corpses with unilateral traumatic injuries to the RLN because of dissection, 5 injuries on the right and 4 on the left. The 9 injured sides were not included in the study. The 9 sides that had not been injured were added to the 134 sides of 67 corpses with no injury, totaling 143 complete sides, 71 on the right and 72 on the left.

The RLN was classified in accordance with its position, anterior, posterior, or between branches of the ITA.

The influence of the considered side (right or left) on the position of the RLN was analyzed. The influence of the sex of corpses on the position of the RLN was not analyzed due to the great difference in the available number of male and female specimens.

Statistical analysis of the results was conducted using the chi-square (χ^2) test. The results were considered significant at $p < 0.05$.

RESULTS

The position of the recurrent laryngeal nerve (RLN) found in male and female corpses is presented in table 1. In both sexes, the RLN lay more frequently between branches of the inferior thyroid artery (ITA), in 47.30% of male and 42.80% of female corpses. The available number of female corpses for

dissection was small in relation to the number of male ones. Thus, the analysis of the difference in the distribution of the 3 types of relationships between the RLN and the ITA between the two sexes, was not performed. In one case in a male corpse, a right RLN originated a branch before crossing the ITA and involved one of the branches of this artery. Variations such as a non-recurrent laryngeal nerve or the absence of the ITA were not found in this study.

The relationship between the considered side (right and left) and the position of the RLN in relation to the ITA was analyzed (Table 2). On both sides, the RLN lay more frequently between branches of the ITA. This occurred in 49.3% of the cases on the right side and in 44.45% of the cases on the left side. There was a significant difference ($p < 0.05$) in the distribution of the 3 types of relationships of the RLN with the ITA between the right and left sides.

The possible combinations between

right and left sides found in this study were grouped (Table 3). In this study, we used only corpses in which both sides were complete, a total of 67 specimens. The most common combinations were: the RLN between branches of the ITA on the right and the left sides (23.88%); the RLN between branches of the ITA on the right and posterior to the artery on the left side (19.4%).

There was bilateral agreement in 37.32% of the cases ($n=25$). In 62.68% ($n=42$), the relationship found on one side did not occur again on the opposing side.

DISCUSSION

Some conditions can cause recurrent laryngeal nerve (RLN) palsy^{15,34,41,42}. Surgical injuries produce 11 to 32% of these^{31,42}. Some procedures that may result in injury to the RLN are: thyroidectomies, parathyroidectomies, ex-

Table 1 - Relationship between the recurrent laryngeal nerve (RLN) and the inferior thyroid artery (ITA) in male and female corpses.

Relationship	Males		Females	
	n	%	N	%
RLN anterior to the ITA	36	27.90	4	28.60
RLN posterior to the ITA	31	24.03	4	28.60
RLN between branches of the ITA	61	47.30	6	42.80
RLN branching off and involving one branch of the ITA	1	0.77	-	-
Total	129	100	14	100

Table 2 - Relationship between the recurrent laryngeal nerve (RLN) and the inferior thyroid artery (ITA), considering the side of the neck.

RLN position	Right side		Left side		Both sides	
	n	%	n	%	n	%
Anterior to the ITA	27	38.04	13	18.05	40	27.97
Posterior to the ITA	8	11.26	27	37.05	35	24.47
Between branches of the ITA	35	49.3	32	44.45	67	46.86
RLN branching off and involving 1 branch of the ITA	1	1.4	-	-	1	0.7
Total	71	100	72	100	143	100

Table 3 - Combinations of the recurrent laryngeal nerve (RLN) positions considering both sides in the same corpse.

Position of the RLN		n	%
Right side	Left side		
Anterior to the ITA	Anterior to the ITA	5	7.46
Posterior to the ITA	Posterior to the ITA	4	5.97
Between branches of the ITA	Between branches of the ITA	16	23.88
Anterior to the ITA	Between branches of the ITA	11	16.42
Anterior to the ITA	Posterior to the ITA	9	13.43
Posterior to the ITA	Between branches of the ITA	1	1.5
Posterior to the ITA	Anterior to the ITA	3	4.47
Between branches of the ITA	Anterior to the ITA	4	5.97
Between branches of the ITA	Posterior to the ITA	13	19.4
The RLN branching off and involving one branch of the ITA	Between branches of the ITA	1	1.5
Total		67	100

ITA: inferior thyroid artery

cision of Zenker's diverticulum, esophagectomies, tracheoplasties, neck dissections, correction of a patent ductus arteriosum, mediastinoscopy, and others^{11,31,42}.

Thyroidectomy is the surgery in which this injury occurs most frequently. According to Titcher⁴², thyroidectomy accounts for 35.71% of surgical causes of injury to the RLN, and accounts for 3.73% of all causes. The incidence of injury to the RLN in thyroidectomies ranges from 0 to 12%^{22,24,25,28,33,36,40}. This injury occurs more frequently when a branch of the ITA is inadvertently sectioned. In an attempt to achieve hemostasis, the nerve is clipped and/or separated with the arterial branch^{24,25,32,36,37}.

Although some authors^{30,33} defend the display of the RLN only in specific situations, most agree that the routine display of the RLN is essential for its protection^{4,14,18,21,22,24,25,28,31,36,37,39,40}. Lahey²⁴, performing the routine display of the RLN in 3000 cases, obtained a reduction in the incidence of injury from 1.5 to 0.3%. The same author in a subsequent work, systematically visualized the nerve, in more than 3446

thyroidectomies with no injury²⁵. However, excessive manipulation and dissection must be avoided so the nerve is brought under visual control without risk of compromising its vascularization. To this end, the ITA functions as a fixed reference point for the location of the r.l.n.^{22,25,33,36}. The knowledge of the relationship between the RLN and the ITA is also important for the exteriorization of the thyroid lobe^{12,37}.

Reed³² described 28 different types of relationships between the RLN and the ITA, classifying them in 3 main types. Freschi¹⁴ considered 8 possible relationships between these two structures. Most authors, beyond the classic anatomy textbooks, recognize 3 types of relationships between the RLN and the ITA, as follows^{1-5,7,8,10,12,13,15,19,20,26,29,32,36,37,41,45}:

- a) RLN anterior to ITA;
- b) RLN posterior to ITA;
- c) RLN between branches of ITA.

Simon³⁶, after the dissection of 86 nerves in 43 corpses, affirmed that the usual relationship is the one in which the RLN establishes by passing poste-

riorly the ITA. The anterior orientation of the nerve in relation to the artery was occasional, while its position between the arterial branches was a rare finding. Lahey²⁴, based on surgical findings, had a similar opinion.

Analyzing 17 studies which reported this relationship, when considering the both sides as a set, 16 showed that the RLN is more frequently located posterior to the ITA, between 39.08% to 75.58% of the time^{1-5,7,8,12,13,19,20,26,32,36,37,39,45}.

Considering right and left sides separately, differences appear. On the left, in 15 analyzed works, 14 showed the predominance of the posterior position of the nerve in relation to the artery^{1-5,8,12,19,20,26,32,36,37,39,45}.

On the right, the variation is larger. Analyzing the same 15 works, 8 showed that the RLN passes more frequently between the branches of the ITA. In 5, the RLN passed posterior to the ITA in most cases, and in only 2 studies was it placed anterior to the artery with higher frequency^{1-5,8,12,19,20,26,32,36,37,39,45}.

Flament et al.¹² in France, found the RLN between the branches of the ITA in most cases, both on the right and on the left side. In the sample presented here, we found similar results to those of the French author: the RLN lay between the branches of the ITA in 46.86%, anterior to the branches in 27.97%, and posterior to the branches in 24.47% of the cases when considering both sides.

On the left side, the RLN lay between branches of the ITA in 44.45%, posterior in 37.05%, and anterior to the arterial branches in 18.05% of the cases.

On the right, the RLN lay between branches of the ITA in 49.3%, anterior in 38.04%, and posterior in 11.26% of the cases. In 1 case, on the right, the RLN branched off before crossing the ITA, and it surrounded one of its branches. In the works in which this variation was found, it occurred from

1% to 5.4% of the cases, when considering both sides^{3,32}.

Reed³² in the U.S.A., found different relationships on the two sides in 17% of the cases. Hirata¹⁹ in Japan, found the same relationship on the two sides in 40% of male corpses and in 28.6% of female ones. Sturniolo³⁹ in Italy, found the same relationship on both the sides in 51.2% of the cases. The same author found a different relationship between the two sides 48.8% of the time. In the sample presented here, only in 37.32% of the cases did the orientation found on one side occur again in the opposing side.

The most frequent combinations in our study were: the RLN between the branches of the ITA on the right and on the left (23.88% of the cases); and the RLN between the branches of the ITA on the right and posterior on the left (19.4% of the cases).

Hirata¹⁹ in Japan, found a significant difference in the percentile distribution of the 3 types of relationships of the RLN with the ITA between the two sides. He did not find a significant difference between males and females. This author found that the difference between the two sides could be attributed to the difference in the anatomical course of the RLN on the right and on the left. In the present sample, the results of this analysis are similar to the ones of the Japanese author. The difference between the two sides (right and left) of the orientation of the RLN in relationship to the ITA was significant. Among us, Costa et al.⁸ have not found a significant difference in the relationship between the RLN and the ITA between the two sides.

The factors that determine these observed differences in the anatomical variations of the RLN are still not established. Pereira³⁰ and Lages²³ in independent works, when reporting cases of non-recurrent laryngeal nerve, *in vivo* and in a corpse respectively, emphasized that the racial factor should

receive greater attention. Both findings had occurred in crossbred female individuals, according to the authors. Steinberg et al.³⁸ in South Africa, dissected 180 nerves in 90 corpses that were not embalmed. Among the corpses, 80% were of black race, 12% were of Caucasian race, and 8% were of Asian race. The authors found, regarding its relationship with the ITA, the RLN had divided into 2 main branches in 68% of the cases. In a small percentage, one of these branches was also subdivided. In 75% of the dissections, the branches of the RLN interdigitated with the branches of the ITA. There was no such thing as a constant relationship between these two structures.

It would be interesting to analyze the influence of racial differences on the relationship between the RLN and the ITA, based on works of different nationalities^{1-5,7,8,12,13,19,20,26,32,36,38,45} (Table 4), that were done primarily in populations with well-defined racial features. In those studies, which were

carried out on embalmed corpses, these racial features are frequently lost. This fact, as well as the great racial miscegenation found among us, were the reasons why this analysis was not carried out in the present sample. But even those works where data were obtained from corpses during autopsy, or in surgical cases, there is no information permitting a racial characterization of the samples and a rigorous evaluation of the data from this standpoint.

The idea that the RLN is more frequently posterior to the ITA, and moreover, expecting this relationship to repeat on both sides, gives the surgeon a false sense of security. If the nerve lies anterior to, or between the branches of the ITA, the withdrawal of the thyroid gland from its stream bed results in the withdrawal of the nerve, with injury being more likely than when the nerve is posterior to the i.t.a.^{12,37}. Understanding of this concept is essential, especially when the surgeon must perform a total thyroidectomy. In these cases, some authors prefer to ligate the ITA and its

Table 4 - Relationship between the recurrent laryngeal nerve (RLN) and the inferior thyroid artery (ITA). Results of other authors considering right and left sides together.

Author	Year	Country	Number of visualized nerves	RLN anterior to the ITA(%)	RLN posterior to the ITA(%)	RLN between branches of the ITA(%)
Fowler & Hanson ¹³	1929	U.S.A.	400	26	65.5	8.5
Berlin ⁴	1935	U.S.A.	140	32.14	53.57	14.29
Reed ³²	1943	U.S.A.	506	18.6	39.1	36.5
Bachhuber ³	1943	U.S.A.	200	14.5	44	40.5
Simon ³⁶	1943	U.S.A.	86	17.44	75.58 *	6.98*
Armstrong & Hinton ²	1951	U.S.A.	100	34	43	23
Bowden ⁵	1955	U.K.	58	18.97	41.38	34.48
Wade ⁴⁵	1955	U.K.	200	10.5*	47.5	34.5
Hunt et al. ²⁰	1968	Australia	151	29	57	9
Skandalakis et al. ³⁷	1976	U.S.A.	204	20.6	41.6	37.3
Chang-Chien ⁷	1980	Taiwan	100	24	56	20
Flament et al. ¹²	1983	France	•	19.45	30.2	50.35*
Al-Salihi & Dabbagh ¹	1989	Iraq	212	23.11	53.78	23.11
Hirata ¹⁹	1992	Japan	784	18.65	46.25	35.1
Lekacos et al. ²⁶	1992	Greece	191	16	51	33
Costa et al. ⁸	1997	Brazil	98	37.76*	39.08	22.44
Sturniolo et al. ³⁹	1999	Italy	280	31.1	43.2	25.7
Campos & Henriques	2000	Brazil	143	27.97	24.47 *	46.86

*minimum and maximum percentage value for each position.

• based on dissection of 100 corpses and on 600 surgical interventions upon thyroid gland.

branches next to glandular parenchyma, without approaching its trunk, in order not to include the RLN and at the same time, not to compromise the irrigation of the parathyroids^{6,40}.

Therefore, the identification and visual control of the RLN and the ITA, as well as the determination of their anatomical relationships, are essential principles for diminishing morbidity related to thyroidectomies.

CONCLUSIONS

On the right side in most cases, the recurrent laryngeal nerve (RLN) was

found between the branches of the inferior thyroid artery (ITA), followed by, in decreasing order of frequency, positions anterior and posterior to the artery.

On the left, the RLN was also placed more frequently between the branches of the ITA, followed by, in decreasing order of frequency, positions posterior and anterior to the ITA.

There was a statistically significant difference ($p < 0.05$) in the distribution of these 3 types of relationships between right and left sides.

In 62.68% of the cases, the relationship found on one side did not occur again on the opposing side.

Racial variations could contribute

to the explanation of the differences observed in the relationship between the RLN and the ITA.

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RESUMO

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CAMPOS BA e col. - Relação entre o nervo laríngeo recorrente e a artéria tireóidea inferior: um estudo em cadáveres. **Rev. Hosp. Clín. Fac. Med. S Paulo** 55(6):195-200, 2000.

A relação anatômica entre o nervo laríngeo recorrente (NLR) e a artéria tireóide inferior (ATI) foi estudada em 76 cadáveres formolizados, sendo oito do sexo feminino e 68 do sexo masculino. Em ambos os sexos, o NLR se

colocou mais freqüentemente entre ramos da ATI, sendo encontrado nessa posição em 47,3% das vezes no sexo masculino e 42,8% das vezes no sexo feminino. À direita, o NLR foi encontrado entre ramos da ATI em 49,3% dos casos, anteriormente em 38,04% e posteriormente em 11,26%. À esquerda, o NLR se colocou entre ramos da ATI em 44,45% das vezes, posteriormente em 37,05% e anteriormente em 18,05%. Em 62,68% das vezes a relação encontrada em um lado não se

repetiu no lado oposto, no mesmo cadáver. Houve diferença significativa ($p < 0,05$) na distribuição dos três tipos de relação entre o NLR e a ATI, entre os lados direito e esquerdo. Variações raciais poderiam contribuir para explicar as diferenças observadas por autores de diferentes países na relação entre o NLR e a ATI.

DESCRITORES: Nervo laríngeo recorrente. Artéria tireóide inferior. Glândula tireóidea. Tireoidectomias.

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