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Level VI lymph nodes: an anatomic study of lymph nodes located between the recurrent laryngeal nerve and the right common carotid artery.

Linfonodos do nível VI: estudo anatômico dos linfonodos localizados entre o nervo laríngeo recorrente e a artéria carótida comum direita.

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A B S T R A C T

Objective: to describe the presence of lymph nodes and their relationships with demographic and anthropometric characteristics in a specific region, not yet described in anatomy compendiums, called by us Recurrent Carotid Recess (RCR) and located among the right recurrent laryngeal nerve, the right common carotid artery, and the right inferior thyroid artery. **Methods:** 32 right cervical regions were harvested from cadavers within 24 hours *post-mortem*. The fibro-fatty tissue of the RCR was resected and prepared with formalin fixation. It was then subjected to an increasing sequence of alcohols (70%, 80%, and 90%), subsequently to a solution of Xylol, and finally to a solution of Methyl Salicylate, respecting the time required for each step. The macroscopic study was carried out on the diaphanized piece, observing the presence or not of lymph nodes. When present, they were photographed and their measurements were gauged with a digital caliper. In the microscopic study, hematoxylin-eosin staining was used to confirm the lymph node. **Results:** the presence of lymph nodes was observed in 22 (68.75%) of the 32 specimens. The number of lymph nodes ranged from zero to six (mean of 1.56±0.29), per cadaver, and their mean size was 7.82mmx3.86mm (longitudinal x transversal diameters). **Conclusion:** the relationship between anthropometric data and presence of lymph nodes in the RCR (Fisher's exact test) was significant for medium-height individuals (p=0.03) and also white ones (p=0.04).

Keywords: Cadaver. Carcinoma, Papillary. Anatomy Regional. Recurrent Laryngeal Nerve. Thyroid Gland.

INTRODUCTION

This work describes a specific region not yet reported in anatomy compendiums. The territory in question is locatedamong the right recurrent laryngeal nerve, the right common carotid artery, and the right inferior thyroid artery, and we called it Recurrent Carotid Recess (RCR). We can discuss its clinical importance taking as an example the carcinoma of the thyroid gland, including all its subtypes. This is the most common malignant endocrine neoplasia in humans, and its prevalence showed a steady and accentuated increase in the last three decades[1].

When there are metastases of this primary site, the lymph nodes are the main compromised organs. The perivisceral lymph nodes are located in the central compartment of the neck, defined as level VI, which is delimited laterally by the common carotid arteries, inferiorly by the jugular notch, and superiorly by the hyoid bone[2], and that coincides with the muscular triangle, described in the anatomy compendiums.

The reason for the existence of a differentiated territory in this triangle or compartment has its bases in anatomy: the recurrent laryngeal nerve on the right, bypassing inferiorly the right subclavian artery, penetrates the central compartment of the neck, far from the tracheoesophageal groove, which does not occur on the left. Thus, the right recurrent laryngeal nerve divides the paratracheal lymph nodes into two compartmental groups: one anterior and the other posterior. This posterior region, whose location is hidden, may be the site of metastases[3].

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It is worth mentioning that the surgical approach of this space causes greater morbidity due to the syntopy of the structures of the RCR and of the lymph nodes located there, as there is a necessity to mobilize the right recurrent laryngeal nerve in order to remove the fibro-fatty tissue that contains the lymph nodes.

This study aims to verify the presence of lymph nodes in the region located among the right common carotid artery, the right inferior thyroid artery, and the right recurrent laryngeal nerve, to describe them, and to evaluate if there is a correlation between anthropometric factors and these studied lymph node characteristics.

METHODS

Study conducted at the Faculty of Medicine of Universidade de São Paulo (USP), in the Human Structural Topography Discipline, and approved by the Ethics Committee under the number 203/16.

Thirty-two adult cadavers, with a maximum *post-mortem* interval of 24 hours, of both genders, and of different ethnicities and biotypes, were included in this study. Previous cervical surgical manipulation and head and neck neoplasms were exclusion criteria. The corpses came from the Death Verification Service of the Medical School of Universidade de São Paulo (SVOC-FMUSP), Brazil. Initially, demographic data (such as gender, age, and race), as well as anthropometric data (such as biotype, height, and weight), were collected and recorded in a specific table.

Each corpse was then placed in the horizontal dorsal decubitus position with the head in hyperextension position. An incision was made in the anterior aspect of the thorax in the horizontal direction towards the two acromions. This incision extended to the superficial cervical fascia. From this plane, the myocutaneous flap was elevated in the cranial direction up to the level of the thyroid cartilage. After this step, a vertical incision was made in the midline of the superficial and pre-tracheal cervical fascia, exposing the thyroid gland. This incision extended from the thyroid cartilage to the jugular notch. The dissection extended between the thyroid gland and the sternohyoid and sternothyroid muscles on the right, with the bending of these muscles laterally. With this maneuver, the territory between the right carotic sheath and the trachea was exposed, individualizing the thyroid gland, and, through a thorough dissection of this region, the area to be studied (RCR) was exposed. In this way, the following structures were visible: inferior thyroid artery (upper limit), recurrent laryngeal nerve, common carotid artery, brachiocephalic trunk (lateral and inferior border), pre-vertebral fascia, and esophagus, in the deep plane, as well as, in some cases, the right cervical pleura (Figure 1).

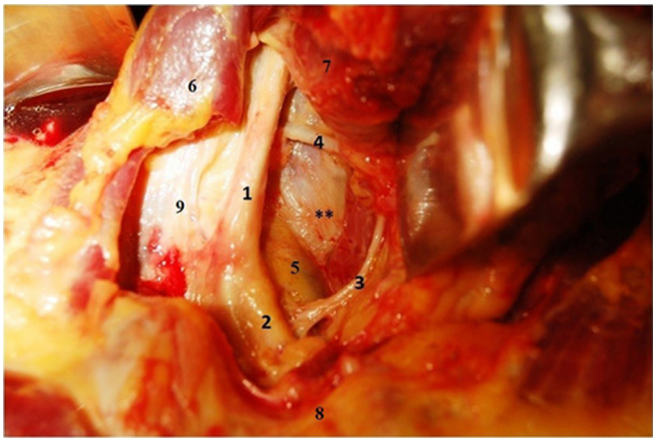

Figure 1. ***Recurrent Carotid Recess; 1) right common carotid artery; 2) brachiocephalic trunk; 3) right recurrent laryngeal nerve; 4) right inferior thyroid artery; 5) pulmonary pleura; 6) sternocleidomastoid muscle (partially sectioned); 7) thyroid gland; 8) jugular notch.*

All the fibro-fatty tissue located in this space was resected in bloc (Figure 2) and each one received identification with its own numbering (from 01 to 32) and its respective SVOC-FMUSP identification number. This material was fixed for 24 hours in 10% buffered formaldehyde, with pH between 7.2 and 7.4. After this period, the piece was transferred to a sequence

of increasing concentration of alcoholic solutions (70%, 80%, and 90%), remaining for seven days at each concentration. The material was then placed in Xylol solution for nine days. After this period, the specimen was transferred to a methyl salicylate solution, remaining for seven days. At the end of this process, the specimen was analyzed for lymph node count and for photographic recording with a digital camera (Figure 3).

The macroscopic evaluation of the lymph nodes found in the RCR in relation to the number and to the longitudinal (greater axis) and transversal (smaller axis) diameters was performed, using a digital caliper. Data were included in a specific table.

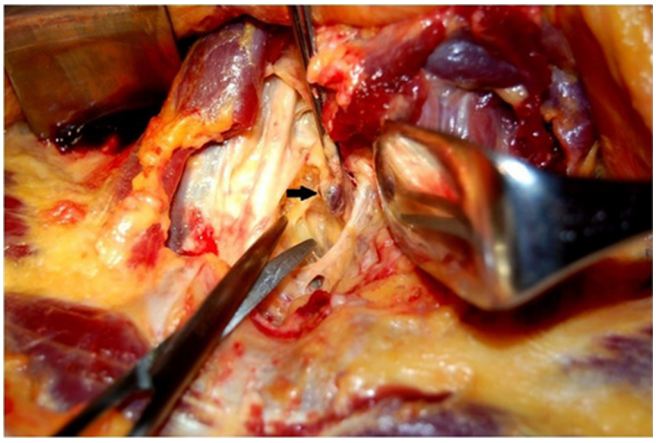

Figure 2. *Dissection of the fibro-fatty tissue of the Recurrent Carotid Recess with lymph node exposure (arrow).*

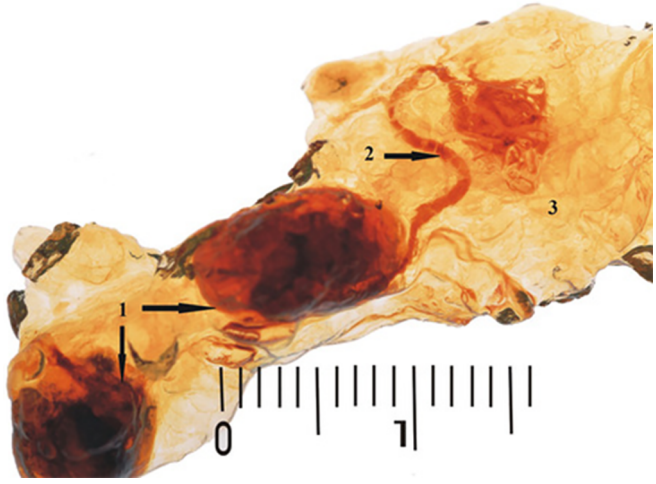

Figure 3. *Diaphanized piece of the Recurrent Carotid Recess showing: 1) lymph nodes; 2) lymphatic vessel; and 3) fibro-fatty tissue.*

Microscopic evaluation of lymph nodes was performed after hematoxylin-eosin staining, and all histological slides were analyzed by a single investigator using an optical microscope.

Numerical variables were described by number of lymph nodes and dimensions associated with the standard deviation. The 95% confidence interval (CI) was calculated considering the presence of level VI lymph nodes, according to Wilson's method. The nominal variables were described by frequency (%). Fisher's exact test was used to correlate anthropometric data with the presence or absence of lymph nodes in this region. The correlation of these data was calculated by the Spearman's test. We considered alpha of 0.05 and a study power of 80%, using the Stata v14 program (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP).

RESULTS

Data related to the demographic characteristics of the sample studied here are described in table 1, which shows the characteristics of age, gender, weight, height, race, and anthropometric data (short, medium-height, and tall individuals), recorded in this study population. In this work, there was predominance of medium-height white males.

The dissection indicated the presence of lymph nodes in 22 (68.75%) of the 32 cadavers with 95%CI (15.19-47.31). In cases where they were found, the mean was 1.56±0.29 lymph nodes per cadaver. The relationship between the presence of lymph nodes and medium-height specimens (p=0.03) was observed (Table 2).

The significant relationship between race and the presence of lymph nodes (p=0.04) was also demonstrated (Table 3).

Table 1. *Demographic characteristics of the study population.*

Age (years)	66.75±13.89
Gender	
Male	20/32 (62.5%)
Female	12/32 (37.5%)
Weight (Kg)	63.1±12.36
Height (m)	1.66±0.09
Race	
White	21/32 (65.62%)
Black	10/32 (31.25%)
Yellow	1/32 (3.12%)
Anthropometric data	
Short	8/32 (25%)
Medium-height	15/32 (46.88%)
Tall	9/32 (28.12%)

Table 2. *Relationship between anthropometric data and the presence of lymph nodes in the RCR (Fisher's exact test).*

Anthropometry	Absence of lymph node	Presence of lymph node	Total
Short	2	6	8
Medium-height	6	3	9
Tall	2	13	15

Table 3. *Relationship between race and the presence of lymph nodes in the RCR (Fisher's exact test).*

Race	Absence of lymph node	Presence of lymph node	Total
Yellow	1	0	1
White	8	12	20
Black	1	10	11

Correlation coefficients were demonstrated using Spearman's test (r=-0.35, p=0.05). No relationship was found between body mass index (BMI) and the presence of lymph nodes (p=0.461).

DISCUSSION

Tufano[3] describes that the right recurrent laryngeal nerve, after bypassing inferiorly the right subclavian artery, penetrates the central compartment of the neck, far from the tracheoesophageal groove, dividing the paratracheal lymph nodes located there into two compartmental groups: one anterior and the other posterior. Metastases and/or recurrence, when present, occur in the paratracheal lymph nodes of the posterior compartment. Studying this region, we found that, in addition to the lymph nodes located posterior to the right recurrent laryngeal nerve, as described by Tufano, there were lymph nodes in a posterolateral region to this nerve, in a space delimited between it and the right inferior thyroid and right common carotid arteries.

Classical anatomy treatises, such as Testut and Latarjet[4], describe lymphatic drainage of the neck in two lymph node groups: one

superficial and the other deep. The deep group is composed of lymph nodes distributed along the internal jugular vein (internal jugular chain). They are considered lateral lymph nodes. There are also the median lymph nodes, which are the pre-laryngeal, pre-tracheal, and the pre-thyroid ones. Moore and Dalley[5] describes that the drainage of the thyroid gland is initially performed to the pre-laryngeal, pre-tracheal, and paratracheal lymph nodes, and, that, in turn, drain to the upper and lower deep cervical lymph nodes, following towards the left thoracic ducts and right lymphatic ducts. We observed that, although all these anatomy treatises cite the paratracheal lymph nodes, the territory we detached and its respective lymph nodes (RCR) are not mentioned.

Capelli[6] performed a cadaveric study quantifying the cervical lymph nodes of the lateral compartment (levels I to IV), aiming to determine a minimum number of lymph nodes in a cervical lymphadenectomy, as well as the number of lymph nodes at each level of cervical lymphadenectomy. Although we searched in Capelli's study a relationship between anthropometric and demographic data and the presence of lymph nodes found at each level, similarly to what we did in our study, we could not find the central compartment, level VI, as it was not studied.

In turn, Tavares *et al*.[7] performed an anatomical study on cadavers, dissecting 30 central compartments to demonstrate the variability of the number of lymph nodes in this region, which ranged from two to 42. Lymph nodes specifically located lateral to the right recurrent laryngeal nerve varied in number from zero to 11, similarly to the results we found. However, their work presented no anthropometric relationship. In our study, the lymph nodes found in the RCR ranged from zero to six.

Ofo *et al.*[8] also performed an anatomical study on cadavers, in which 28 central compartments were dissected to quantify lymph nodes in this region. The central compartment was subdivided into four regions: pre-laryngeal, right and left pre-tracheal, and paratracheal. The number of lymph nodes found in the compartment ranged from one to 16, with a mean of four. In the paratracheal region, the number ranged from zero to seven, with a mean of four too. The size of the lymph nodes found throughout the compartment ranged from 0.5 to 21 mm, with a mean of 2.9mm. Here, there was also similarity to our results, since the number of lymph nodes in our study ranged from zero to six, and the mean size was of 7.82x3.86mm (longitudinal x transversal diameters). Despite the similarity of results, the work of Ofo *et al*.[8] did not perform any correlation with anthropometric data, as what was done in our study.

The existence of lymph nodes in the RCR was confirmed by this study. The number of these organs varied from zero to six in the studied specimens. Considering only those in which the lymph nodes were present, an average amount of 1.56±0.29, per cadaver, was obtained. Their size ranged from 0.9 to 5.39 mm in the transversal diameter (smaller axis), with a mean of 2.47mm, and, in the longitudinal diameter (greater axis), it ranged from 1.36 to 11.64 mm, with a mean of 5.08mm.

We concluded that there was anthropometric correlation, with the presence of lymph nodes in the medium-height (p=0.03) and white (p=0.04) corpses.

RESUMO

Objetivo: *descrever a presença de linfonodos e suas relações com características demográficas e antropométricas em uma região específica ainda não descrita pelos compêndios de anatomia, por nós denominada de Recesso Carotídeo Recorrencial (RCR), localizada entre o nervo laríngeo recorrente direito, a artéria carótida comum direita e a artéria tireoidea inferior direita.* **Métodos:** *foram dissecadas 32 regiões cervicais à direita de cadáveres com até 24 horas de post mortem. O tecido fibrogorduroso do RCR foi ressecado e preparado com fixação em formol. Em seguida, foi submetido a uma sequência crescente de álcoois (70%, 80% e 90%), posteriormente a uma solução de Xilol e, por fim, a uma solução de Salicilato de Metila, respeitando o tempo necessário de cada etapa. O estudo macroscópico foi realizado na peça diafanizada, observando a presença ou não de linfonodos. Quando presentes, foram fotografados e suas medidas foram aferidas com um paquímetro digital. No estudo microscópico, foi utilizada a coloração hematoxilina-eosina para confirmação do linfonodo.* **Resultados:** *observou-se a presença de linfonodos em 22 dos 32 espécimes (68,75%), com o número de linfonodos por cadáver variando de zero a seis (média de 1,56±0,29) e tamanho com média de 7,82mmx3,86mm (diâmetros longitudinal x transversal).* **Conclusão:** *a relação entre dados antropométricos e presença de linfonodos no RCR (teste exato de Fischer) foi significante para indivíduos normolíneos (p=0,03) e também significante entre a etnia branca (p=0,04).*

Descritores: *Cadáver. Carcinoma Papilar. Anatomia Regional. Nervo Laríngeo Recorrente. Glândula Tireoide.*

REFERENCES

1. Pellegriti G, Frasca F, Regalbuto C, Squatrito S, Vigneri R. Worldwide increasing incidence of thyroid cancer: update on epidemiology and risk factors. J Cancer Epidemiol. 2013;2013:965212.
2. Robbins KT, Shaha AR, Medina JE, Califano JA, Wolf GT, Ferlito A, Som PM, Day TA; Committee for Neck Dissection Classification, American Head and Neck Society. Consensus Statement on the classification and terminology of neck dissection. Arch Otolaryngol Head Neck Surg. 2008;134(5):536-8.
3. Tufano RP, Clayman G, Heller KS, Inabnet WB, Kebelew E, Shaha A, Steward DL, Tuttle RM; American Thyroid Association Surgical Affairs Committee Writing Task Force. Management of recurrent/persistent nodal disease in patients with differentiated thyroid cancer: a critical review of the risks and benefits of surgical intervention versus active surveillance. Thyroid. 2015;25(1):15-27.
4. Testut L, Latarjet A. Compêndio de anatomia descriptiva. 22a ed. Barcelona: Salvat; 1979. p.336.
5. Moore KL, Dalley AF. Anatomia orientada para a clínica. 5a ed. Rio de Janeiro: Guanabara Koogan; 2007. p.1002.
6. Capelli FA. Quantificação dos linfonodos em espécimes de esvaziamento cervical: estudo morfológico [dissertação]. São Paulo: Universidade de São Paulo; 2016.
7. Tavares MR, Cruz JA, Waisberg DR, Toledo SP, Takeda FR, Cernea CR, et al. Lymph node distribution in the compartment of the neck: an anatomic study. Head Neck. 2014;36(10):1425-30.
8. Ofo E, Thavaraj S, Cope D, Barr J, Kapoor K, Jeannon JP, et al. Quantification of lymph nodes in the central compartment of the neck: a cadaveric study. Eur Arc Otorhinolaryngol. 2016;273(9):2773-8.

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