

THE PARTICIPATION OF THE SUPERIOR AND INFERIOR THYROID ARTERIES IN THE VASCULARIZATION OF THE THYROID GLAND

Maria Cristina Bunea^{1*}, I. Constantin¹, S. Tudorache³, Lavinia Maria Rusali², P. Bordei¹
“Ovidius” University of Constanta,

1. Preclinical Department I - Anatomy

2. Department III - Endocrinology

“Titu Maiorescu” University of Bucharest,

3. Preclinical Department - Anatomy

*Corresponding author. E-mail: crisantis_cristy@yahoo.com

THE PARTICIPATION OF THE SUPERIOR AND INFERIOR THYROID ARTERIES IN THE VASCULARIZATION OF THE THYROID GLAND (Abstract): **Background and aim:** This study aims to evaluate the level of vascularization within the thyroid gland by analyzing the diameters of the Romanian population’s superior and inferior thyroid arteries. **Materials and methods:** Our study was performed on angiographies by computed tomography on a LightSpeed VCT64 Slice CT on 317 thyroid arteries, 168 arteries on the right side, and 149 on the left side. The measurements of the diameters of the superior and inferior thyroid arteries were compared between sides (left/right) and sexes. **Results:** The diameter of the superior thyroid artery, right and left, we’re observed on a number of 176 cases, finding it to be between 1.6-4.3 mm. The right superior thyroid artery was between 1.8-4.3 mm in diameter while the left artery was between 1.6-2.8 mm in diameter. The diameter of the inferior thyroid artery, right and left, on a number of 141 cases was found to be between 1.2-4.1 mm, the right one was between 1.7-3.9 mm and the left was between 1.2-4.1 mm. **Conclusions:** The variances in the diameters of the two arteries result in fluctuation in their respective contributions to the vascular supply of the thyroid gland. **Keywords:** THYROID ARTERIES, SUPERIOR THYROID ARTERY, INFERIOR THYROID ARTERY, MORPHOMETRY.

INTRODUCTION

The thyroid gland is most commonly vascularized by two thyroid arteries: the superior thyroid artery (STA), with its origin in the carotid system (external carotid and common carotid, either at the level of its terminal branch or from the arterial trunk below the terminal branch) and the inferior thyroid artery (ITA) with its origin in the subclavian artery (either directly from the arterial trunk or via a thyrocervical trunk). Occasionally, there may be a

third thyroid artery, Neubauer’s thyroid ima, present in about 10% of cases according to Paturet (1) and Moore (2). According to Jelev (3) and Roshan (4), the STAs were unique and present in all cases, and Jelev (3), finds the absence of the ITA only in the right side, without being replaced by the ima, resulting in the vascular compensation of the organ being provided by the STA, which therefore has a larger caliber. Esen (5) could not identify the right ITAs in 14 cases (2.2% of cases) and left ITAs in

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45 cases (7% of cases), with both ITAs absent in six cases (0.9% of cases). According to Lippert (6), the inferior thyroid artery may be missing in 3% of cases, being supplanted by the superior thyroid.

The research was conducted to identify variances in the arterial vascularization of the thyroid gland and to emphasize the differences in arterial patterns between the left and right sides, as well as between the superior and inferior.

MATERIALS AND METHODS

The angiographies conducted via computed tomography (CTA) were reviewed retrospectively. The study focused on the Romanian Caucasian population.

The study has the accord of the local Ethics Commission (34490 / 08.08.2019) within the institution of "Sf. Apostol Andrei" Clinical County Emergency Hospital from Constanța and respects the principles of the General Regulation on Personal Data Protection (EU) 679/2016. The research was conducted following the guidelines outlined in the Helsinki Declaration and adhering to all applicable national regulations concerning patient studies. Additionally, informed consent was obtained from all participants involved in the study.

Our study was performed on a number of 317 thyroid arteries, 168 arteries on the right side, and 149 on the left side. In male subjects, there were 158 thyroid arteries (49.84% of cases), 82 cases on the right side (51.90% of cases), and 76 on the left side (40.10% of cases). In female subjects, there were 159 thyroid arteries (55.43% of cases), 86 cases on the right side (54.09% of cases), and 73 arteries on the left side (45.91% of cases).

The study involved measuring the diameters of the superior and inferior thyroid arteries, comparing them bilaterally and

superior with inferior, as well as by sex. It is noted that not all anatomical landmarks were consistently observed in the cases studied, with each landmark being observed in a specific number of cases as outlined in the results. Diameters were not measured in cases with an ima thyroid artery, and the origin of the thyroid arteries was not factored into the measurements.

The inclusion criterion in the study was disease-free arteries, while patients after neck surgery and with atherosclerosis were excluded. The mean ages of the males and females were 66.5 ± 17.5 and 51.5 ± 30.5 years, respectively.

RESULTS

For the diameter of the STA, on the right and left sides, we followed 176 cases and found it to be between 1.6-4.3 mm. The right STA in 90 cases was between 1.6-3.9 mm in diameter and the left STA in 86 cases was between 1.8-4.3 mm in diameter. In 84 cases in the male gender, the diameter of the STA was between 1.8-3.3 mm, in 44 cases the diameter of the right STA was between 1.8-3.3 mm, and in 40 cases the diameter of the left STA was between 1.8-2.8 mm. In female subjects, in 92 cases, the diameter of the STA was between 1.6-4.3 mm, in 46 cases the diameter of the right STA was between 1.6-3.9 mm, and in 46 cases the diameter of the left STA was 1.8-4.3 mm.

The diameter of the right and left ITA in 141 cases was found to be between 1.2-4.1 mm. The right ITA in 78 cases was between 1.7-3.9 mm in diameter and the left ITA in 63 cases was between 1.2-4.1 mm in diameter. In 74 cases of male subjects, the ITA diameter was between 1.2-4.1 mm, in 38 cases the right ITA diameter was between 1.7-3.5 mm, and in 36 cases the left ITA diameter was between 1.2-4.1

mm. In female subjects, the ITA diameter was between 1.7-3.9 mm in 67 cases, for the right ITA it was between 1.7-3.9 mm in 40 cases and for the left ITA, it was between 1.9-3.6 mm in 27 cases.

DISCUSSION

On a total of 80 CTA, we compared right/left STA diameters, finding that in 30 cases (37.50% of cases) the right STA diameter was larger than the left STA diameter with differences ranging from 0.1-1.5 mm. In 44 cases (55.0% of cases) the left STA diameter was larger with differences ranging from 0.1-1.4 mm. In 6 cases (7.5% of cases) the diameters of the two arteries were equal.

In males, from 44 cases (55.0% of cases), the diameter of the right STA was larger in 14 cases (31.82% of cases), with differences ranging from 0.1-1.3 mm.(fig. 1). In 28 cases (63.64% of cases), the diameter of the left STA was larger, with differences ranging from 0.1-1.0 mm. In 2 cases (4.55% of cases) the diameter of the right STA was equal to that of the left STA. (fig. 2).

In females, out of 36 cases (45.0% of cases), the diameter of the right STA was larger in 16 cases (44.44% of cases), with differences ranging from 0.1-1.5 mm. Also, in 16 cases (44.44% of cases), the diameter of the left STA was larger, with differences ranging from 0.1-1.4 mm. (fig. 3). In 4 cases (11.11% of cases) the diameter of the right STA was equal to the diameter of the left STA.

For Gursharan (7) and Ozgur (8), the STA is the main source of arterial blood for the thyroid gland. According to Paturet (1), the superior thyroid artery is relatively bulky, and when the superior thyroid artery is very thin, the one on the opposite side is usually larger, supplanting it.

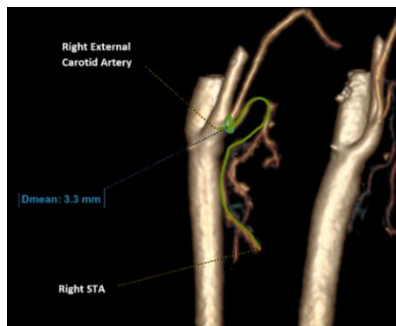


Fig. 1. The diameter of the right STA is 3.3 mm (male subject)

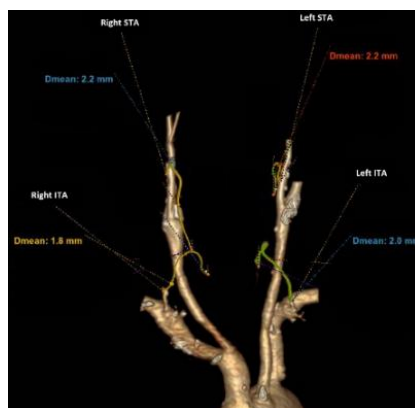


Fig. 2. The diameter of the right STA is 2.2 mm, equal to the diameter of the left STA; the diameter of the left ITA is 2.0 mm larger than the diameter of the right ITA (1.8 mm) by 0.2 mm (male subject)

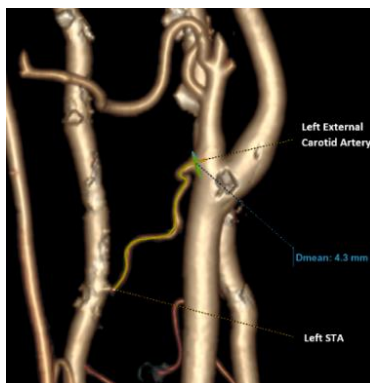


Fig. 3. The diameter of the left STA is 4.3 mm (female subject)

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Different authors have identified differences in the caliber of the STA in cadavers, ranging from 1.04-6.1 mm (tab. I).

Comparing the results found by us with those reported in the literature, it appears that at the minimum measure level, it is smaller than that found by several authors (4, 10, 13, 14) with differences of 0.1-4.3 mm, larger than Ozgur (8 (right side)) and

Troupis (12) with 0.3-0.74 mm and equal to the diameter found by Ozgur (8 (left side)). The maximum diameter found by us is smaller than that found by some authors (4, 7 (right and left), 10) with differences of 0.1-1.8 mm and larger than the diameter found by various authors (1, 12, 13, 14) with differences of 1.0-1.8 mm.

TABLE I.
Diameter of the superior thyroid artery in literature

Authors	Type of study	Diameter of STA (mm)
Fujimoto (1974) (9)	cadaver	3.3 (R); 2.7 (L)
Zhao (1999) (10)	cadaver	1.9
Jelev (2001) (3)	cadaver	4.4
Ozgur (2008) (8)	cadaver	1.5-6.1 (R); 1.8-5.5 (L)
Vazquez (2009) (11)	cadaver	2.6
Troupis (2014) (12)	cadaver	1.04
Sung-Yoon (2016) (13)	cadaver	4.4
Personal cases	CTA	Male subjects (1.8-3.3) R: 1.8-3.3; L: 1.8-2.8 Female subjects: (1.6-4.3) R: 1.6-3.9; L: 1.8-4.3

On a total of 91 CTA, we compared the diameters of the ITA right/left, finding that in 30 cases (32.97% of cases) the right ITA diameter was larger than the left ITA diameter with differences ranging from 0.1-1.5 mm. In 56 cases (61.54% of cases) the diameter of the left ITA was larger with differences ranging from 0.1-1.4 mm. In 5 cases (5.49% of cases) the diameters of the two arteries were equal. In male subjects, in 45 cases (49.45% of cases), the right ITA diameter was larger in 22 cases (48.89% of cases), with differences ranging from 0.1-1.3 mm. Also, in 22 cases

(48.89% of cases), the left ITA diameter was larger with differences ranging from 0.1-1.0 mm (fig. 4) In only one case (2.22% of cases) was the right ITA diameter equal to the left ITA diameter. In female subjects, in 46 cases (50.55% of cases), the diameter of the right ITA was larger in 8 cases (17.39% of cases), with differences ranging from 0.1-1.5 mm (fig. 5). In 34 cases (73.91% of cases) the diameter of the left ITA was larger, with differences ranging from 0.1-1.4 mm. In 4 cases (8.70% of cases) the diameter of the right ITA was equal to that of the left ITA.

In the literature, we did not find the value of the ITA diameter, but the size of the artery was only mentioned in general, Testut (14) states that the ITA volume varies greatly, depending on the development of the thyroid gland and being the inverse of the ITA on the opposite side. Roshan (4), found that the ITA is usually the largest artery of the normal thyroid gland, ITA at the entrance to the hilum, representing the main functional blood source of the gland.

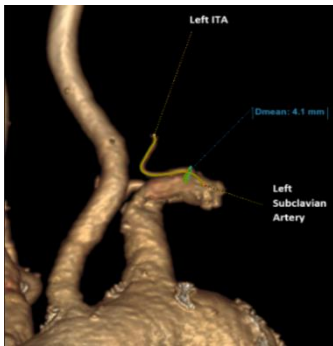


Fig. 4. The left ITA diameter is 4.1 mm (male subject)

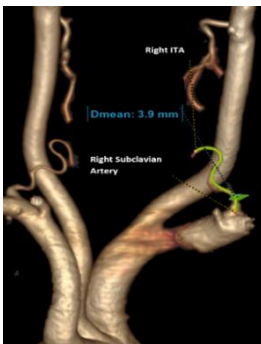


Fig. 5. The diameter of the right ITA is 3.9 mm (female subject)

We compared the diameter of the STA with the diameter of the corresponding ITA in 133 cases and found that in 66 cases

(49.62% of cases) the diameter of the STA was larger by 0.1-2.0 mm (fig. 6). In 64 cases (48.12% of cases) the diameter of the ITA was larger by 0.1-2.2 mm, and in 3 cases (2.26% of cases) the diameter of the two arteries was equal. In male subjects, in 76 cases (57.14% of cases), the diameter of the STA was larger in 38 cases (50.0% of cases) with differences of 0.1-1.6 mm. In 36 cases (47.37% of cases), the diameter of the ITA was larger with differences of 0.1-2.3 mm. In 2 cases (2.63% of cases) the diameter of the two arteries was equal. In female subjects, in 57 cases (42.86% of cases), the diameter of the STA was larger in 28 cases (49.12% of cases), with differences between 0.1-2.3 mm. Also, in 28 cases (49.12% of cases) the ITA diameter was larger with differences between 0.2-1.7 mm. In only one case (1.75% of cases) the diameter of the two arteries was equal.

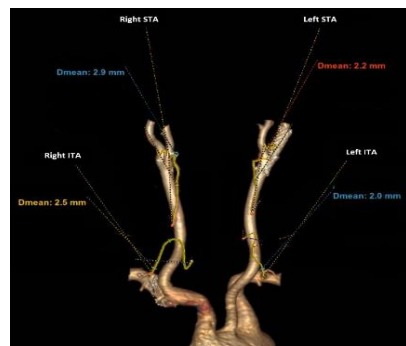


Fig. 6. The diameter of the right STA is 2.9 mm and the right ITA diameter is 2.5 mm, being 0.4 mm smaller; the diameter of the left STA is 2.2 mm, and the left ITA diameter is 2.0 mm, being 0.2 mm smaller; the diameter of the right STA is 0.5 mm larger than the diameter of the left STA; the diameter of the right ITA is 0.5 mm larger than the diameter of the left ITA (female subject)

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In reviewing scientific literature, we did not come across specific citations regarding the morphometric variances in external diameter values between the superior and inferior thyroid arteries. However, we did find general information on this topic. Thus, Paturet (1) and Testut (14) noted that the volume of the inferior thyroid artery is inversely proportional to that of the superior thyroid artery on the corresponding side, as well as the inferior thyroid artery on the opposite side. As noted by Paturet (1), the superior thyroid artery typically has a significant size, with its caliber usually being slightly smaller than or equivalent to that of the inferior thyroid artery. A balancing effect is observed between the calibers of these arteries and the two superior thyroid arteries. In cases where one superior thyroid artery is thin, the one on the opposite side tends to be larger to ensure proper arterial blood supply to the gland. In a study conducted by Lippert (6), it was observed through dissections that the inferior thyroid artery typically has a larger size in comparison to the superior thyroid artery, indicating that it serves as the main artery supplying the gland. Additionally, Testut (14) notes that the volume of the inferior thyroid artery is inversely proportional to that of the superior thyroid artery on the same side.

CONCLUSIONS

There is consistent variability in percentages among different authors, often showing significant differences over the same or similar time periods. We did not come across any literature analyzing the origin of the artery based on sex, despite

known differences between males and females. Few authors provide detailed percentages on the origin of thyroid arteries comparing right to left, also disparities between the two are present. It should be noted that the percentages reported may vary depending on the methodology employed.

We have not observed any instances of missing or duplicated thyroid arteries (superior or inferior) in our study. The diameters of the thyroid arteries we identified showed variations, indicating that these arteries' roles in the thyroid gland's vascular supply may vary as well. Thus, of the total cases, the right ITA was larger in diameter in 10.57% of cases and the left ITA was larger in diameter in 6.90% of cases. In the male subjects, in the right thyroid arteries, the diameter of the right STA was larger than the diameter of the right ITA in the same proportion that the diameter of the right ITA was larger than the diameter of the right STA. In female subjects, the right ITA diameter was larger than the right ITA diameter in 5.36% of cases, and the right ITA diameter was larger than the left ITA diameter in 10.52% of cases. The equality of the diameters of the two thyroid arteries, superior and inferior, was greater in females in 2.70% of cases. The minimum and maximum diameters were frequently found in only one case.

CONFLICT OF INTEREST AND FUNDING

The authors declare no conflicts of interest. This research received no external funding.

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