



BIOMETRICS OF THE SUSPENSORY LIGAMENT OF THE THYROID AND ITS CORRELATION WITH THE MORPHOMETRY OF THE THYROID GLAND IN CADAVERS OF HUMAN FETUSES

ORIGINAL ARTICLE

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ABSTRACT

Introduction: Berry's ligament (BL) is a known anatomical structure, which connects the thyroid gland to the tracheal wall, but its biometry has so far been little explored. **Objective:** In the present study, we sought to perform the BL biometry, correlating it with the morphometry of the thyroid gland. **Material and method:** Without the aid of optical instruments, the BL of 24 thyroid glands of human fetuses were dissected. With the gland in an anatomical position, the biometric data of the BL and the gland were taken. The data were treated statistically to establish the correlation between the length and height of the BL with the biometric data of the thyroid gland. **Result:** Significant correlations were found at the 5% level for the width of the thyroid gland and the weight of the gland, as well as for the length of the left lobe and the width of the right and left thyroid lobes, all in relation to the length of the LB and also the length in relation to the width of the gland and the isthmus of the thyroid gland. There was no significant correlation between the BL height and the morphometric findings of the right and left lobes and the isthmus of the thyroid gland. **Conclusion:** Knowledge of the anatomy of the BL is essential to prevent, in particular, injuries to the RLN, during thyroidectomy or parathyroidectomy.

Keywords: Berry's Ligament, Suspensory ligament of thyroid gland, Recurrent Laryngeal Nerve, Tubercle of Zuckerkandl, Thyroid gland, Biometry.



1. INTRODUCTION

The suspensory ligament of the thyroid or Berry's ligament (LB) is a dense condensation of the pretracheal vascular fascia that posteriorly connects the thyroid gland to the cricotracheal structures of the first to third tracheal rings (SASOU, NAKAMURA, KURIHARA, 1998; ARDITO *et al.*, 2004; RANDOLPH *et al.*, 2011; ASGHARPOUR *et al.*, 2012; NGO NYEKI, 2015; SRITHARAN *et al.*, 2016; MANTALOVAS *et al.*, 2022). It is a region considered very vulnerable to injuries during thyroidectomy, due to the medial location of the BL in relation to the course of the recurrent laryngeal nerve (RLN), where it penetrates the larynx (THOMPSON, OLSEN, HOFFMAN, 1973; LORÉ, KIM, ELIAS, 1977; ARDITO *et al.*, 2004; ASGHARPOUR *et al.*, 2012). The location of the RLN in relation to the BL is controversial, and it has been emphasized that its identification decreases the incidence of nerve injury during thyroidectomy (LORÉ, KIM, ELIAS, 1977; DELBRIDGE *et al.*, 1992). A better understanding of the frequency with which the RLN penetrates the BL may reduce complications, as traction-related injuries are associated with the RLN during the course of its penetration into the BL (HUNT, POOLE, REEVE, 1968; ARDITO *et al.*, 2004). Furthermore, until now, data on the biometrics of the BL and the thyroid gland, as well as their histological characteristics, have rarely been described. In the present study, we sought to perform the BL biometry, correlating it with the morphometry of the thyroid gland.

2. MATERIAL AND METHODS

This is a descriptive anatomical study with morphometric data about the suspensory ligament of the thyroid gland. The BL were dissected (Figure 1) from 24 thyroid glands of human fetal cadavers belonging to the laboratory of human anatomy of the Department of Morphology of the Federal University of Sergipe, obtained in accordance with Law No. 8501 of November 30, 1992, which provides for the use of unclaimed cadavers in research. Of the 24 glands, 12 were from male fetuses and 12 from female fetuses. The age of the fetuses ranged from 20.3 to 36.8 weeks with a mean of 26.3 weeks. In male fetuses the age ranged from 22 to 36.8 weeks with a mean of 27.3 weeks and in females the mean was 25.3 weeks and ranged from 20.3



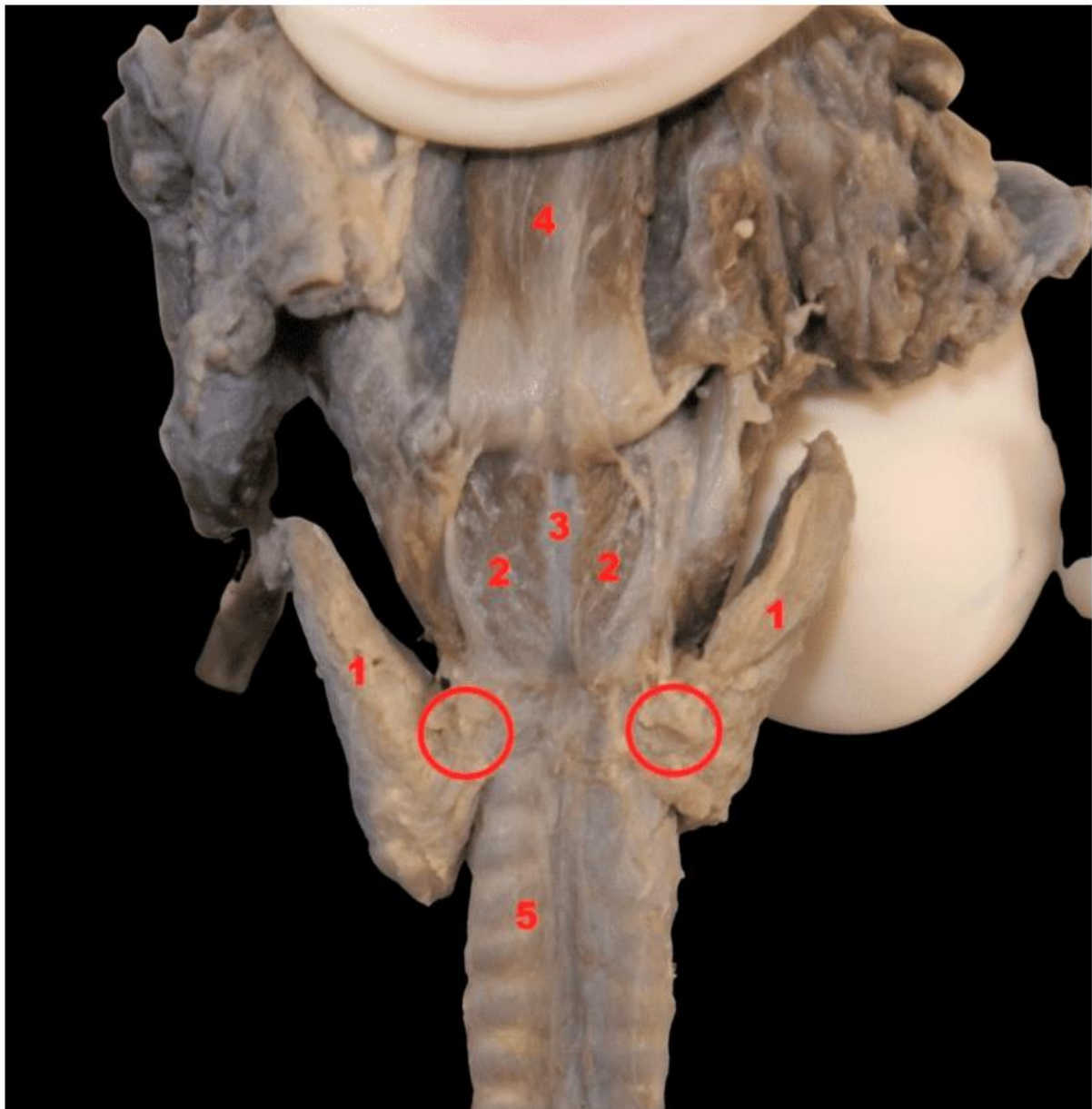
to 31.7 weeks. In the dissection, a skin incision was made, followed by the removal of the infrahyoid muscles, in which the thyroid gland surrounded by its false and true capsules was exposed. The samples included in the study were normal and without any pathology detected macroscopically. Thyroid glands that presented anatomical variations and developmental anomalies were excluded, such as: agenesis, partial or complete absence of the isthmus, accessory thyroid tissue, ectopic thyroid tissue and pyramidal lobe.

The biometric data of the BL and the thyroid gland were taken with the gland in its anatomical location, performed with the aid of a digital caliper with a precision of 0.01 mm. Afterwards, the thyroid gland was removed from its bed, dried with a sponge and blotting paper and weighed on a digital scale with a precision of 0.01 g. No attempt was made to remove the parathyroid glands as their weight was described as negligible (SNYDER *et al.*, 1975).

3. STATISTICAL ANALYSIS

Categorical variables were described using absolute and relative frequency, percentage. Continuous variables were described using mean, standard deviation, median and interquartile range. Pearson's correlation between morphometric variables was estimated and tested. The significance level adopted was 5% and the software used was R Core Team 2021.

Figure 1. Thyroid suspensory ligament or Berry's ligament (circle)



Source: Authors, 2023.

Legend

1. Lobes of the thyroid gland
2. Posterior cricoarytenoid muscles
3. Cricoid cartilage
4. Esophagus
5. Trachea



4. RESULT

The BL of 24 thyroid glands dissected from human fetal cadavers belonging to the laboratory of human anatomy of the Department of Morphology of the Federal University of Sergipe, were obtained in accordance with the Law, which allows the use of unclaimed cadavers in research. Of the 24 glands, 12 were from male fetuses and 12 from female fetuses. The age of the fetuses ranged from 20.3 to 36.8 weeks, with a mean of 26.3 weeks. In male fetuses, the age ranged from 22 to 36.8 weeks with an average of 27.3 weeks and in females, the average was 25.3 weeks and ranged from 20.3 to 31.7 weeks.

Table 1 shows the averages of the morphometric data of the BL and the thyroid gland of fetuses. The mean age in weeks was 26.3 (SD: 4.6) and median 26.1 (IQR: 21.9-29.5) with a mean fetal height of 330 mm (SD: 104.8 mm) and median of 337 mm (IIQ: 302-375 mm). The mean width of the thyroid gland was 13.1 mm (SD: 2.8 mm) and median 12.7 mm (IQR: 11.5-13.7). The mean weight of the thyroid gland was 0.3 g (SD: 0.2 g) and median 0.2 g (IQR: 0.2-0.5 g). The length of the thyroid lobe had a mean of 11.7 mm (SD: 2.1 mm) and a median of 11.9 mm (IQR: 10.4-13.3 mm) on the right side and a mean of 10.8 mm (SD: 2.6 mm) and median of 11.6 mm (IQR: 8.9-12.6 mm) on the left side. The mean thyroid lobe width was 4.6 mm (SD: 1.2 mm) and median 4.6 mm (IQR: 3.8-5 mm) on the right side and mean 4.7 mm (SD: 1.4 mm) and median of 4.2 mm (IQR: 3.7-6.3 mm) on the left side. The width of the isthmus of the thyroid gland had a mean of 5.5 mm (SD: 2.1 mm) and a median of 5.1 mm (IQR: 4.3-6.4 mm), while its height had a mean of 4.8 mm (SD: 1.9 mm) and median of 4.6 mm (IQR: 3.5-5.7 mm). The average length of the BL was 1.5 mm (SD: 0.6 mm) and a median of 1.4 mm (IQR: 1-2 mm) on the right side and an average of 1.2 mm (SD: 0.4 mm) and median of 1.1 mm (IIQ: 1-1.4 mm) on the left side, while height had a mean of 2.8 mm (SD: 0.7 mm) and a median of 2.8 mm (IQR: 2.3-3 mm) on the right side and a mean of 2.6 mm (SD: 0.7 mm) and median of 2.7 mm (IQR: 2.4-3.2 mm) on the left side.



Table 1. Morphometry of the thyroid gland and BL

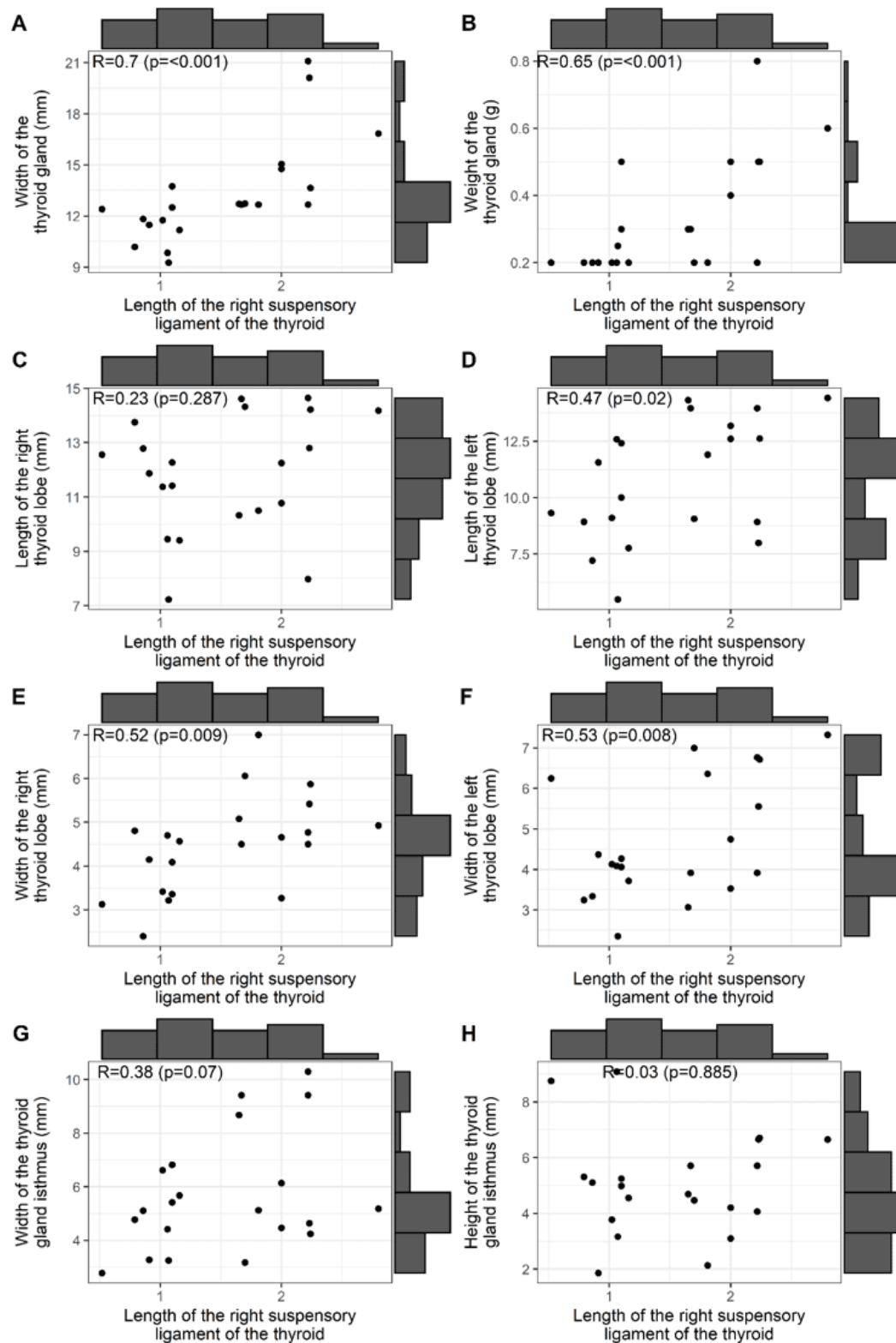
	n	%	Mean	SD	Median	Q1	Q3
Sex							
Female	12	50					
Male	12	50					
Age (weeks)			26.3	4.6	26.1	21.9	29.5
Fetal height (mm)			330.0	104.8	337.0	302.0	375.0
Width of the thyroid gland (mm)			13.1	2.8	12.7	11.5	13.7
Thyroid gland weight (g)			0.3	0.2	0.2	0.2	0.5
Thyroid lobe length (mm)							
Right			11.7	2.1	11.9	10.4	13.3
Left			10.8	2.6	11.6	8.9	12.6
Thyroid lobe width (mm)							
Right			4.6	1.2	4.6	3.8	5.0
Left			4.7	1.4	4.2	3.7	6.3
Width of the isthmus of the thyroid gland (mm)			5.5	2.1	5.1	4.3	6.4
Height of the isthmus of the thyroid gland (mm)			4.8	1.9	4.6	3.5	5.7
Length of the suspensory ligament of the thyroid (mm)							
Right			1.5	0.6	1.4	1.0	2.0
Left			1.2	0.4	1.1	1.0	1.4
Height of the suspensory ligament of the thyroid (mm)							
Right			2.8	0.7	2.8	2.3	3.0
Left			2.6	0.7	2.7	2.4	3.2

Source: Authors, 2023.

Legend: n – absolute frequency. % – percentage relative frequency. SD – standard deviation. Q1 – First Quartile. Q3 – Third Quartile. IIQ – Interquartile Range

Figure 1 shows the correlations between the length of the BL and: the width and weight of the thyroid gland (A and B); length and width of the thyroid gland lobes (C, D, E, F); and width and height of the thyroid isthmus (G, H). It can be seen that significant correlations occurred at the 5% level for thyroid gland width (R: 0.7, positive and strong) and gland weight (R: 0.65, positive and median). Correlations also occurred for left lobe length (R: 0.47, positive and median) and right and left thyroid lobe width (R: 0.52 and 0.53, positive and median).

Figure 1. Correlation between right thyroid suspensory ligament length and thyroid gland morphometry



Source: Authors, 2023.

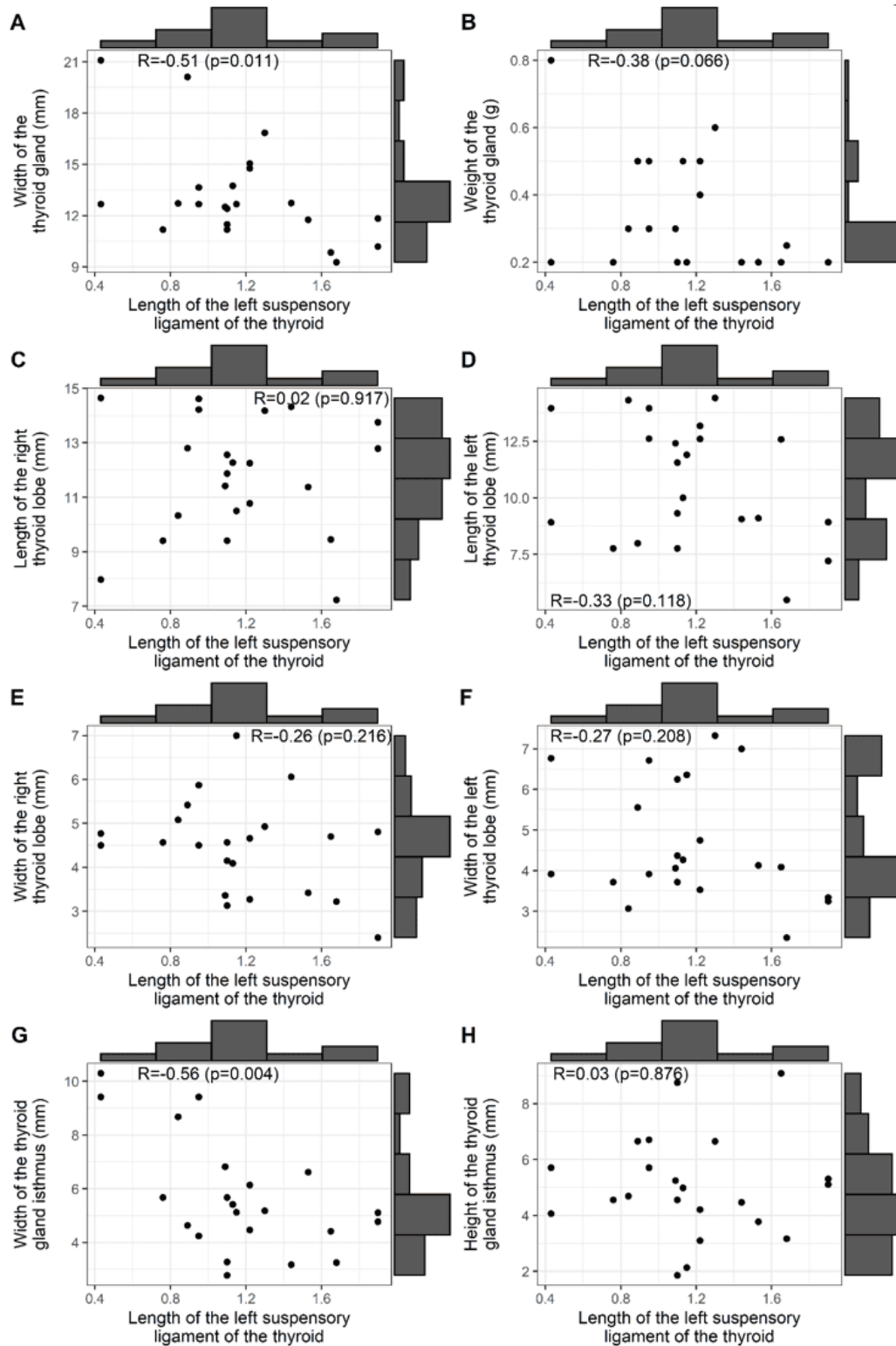
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Figure 2 shows the correlations between the length of the BL and: the width and weight of the thyroid gland (A, B); the lengths of the right and left lobes of the thyroid gland (C, D); the widths of the right and left lobes of the thyroid gland (E, F); the width and height of the isthmus of the gland (G, H). It can be noted that only correlations at the 5% level were significant for the width of the thyroid gland (R: 0.51, positive and median) and the width of the isthmus of the thyroid gland (R: -0.56, negative and median).

Figure 2 - Correlation of the BL length with: width and weight, length and width of the right and left lobes and the width and height of the isthmus of the thyroid gland



Source: Authors, 2023.

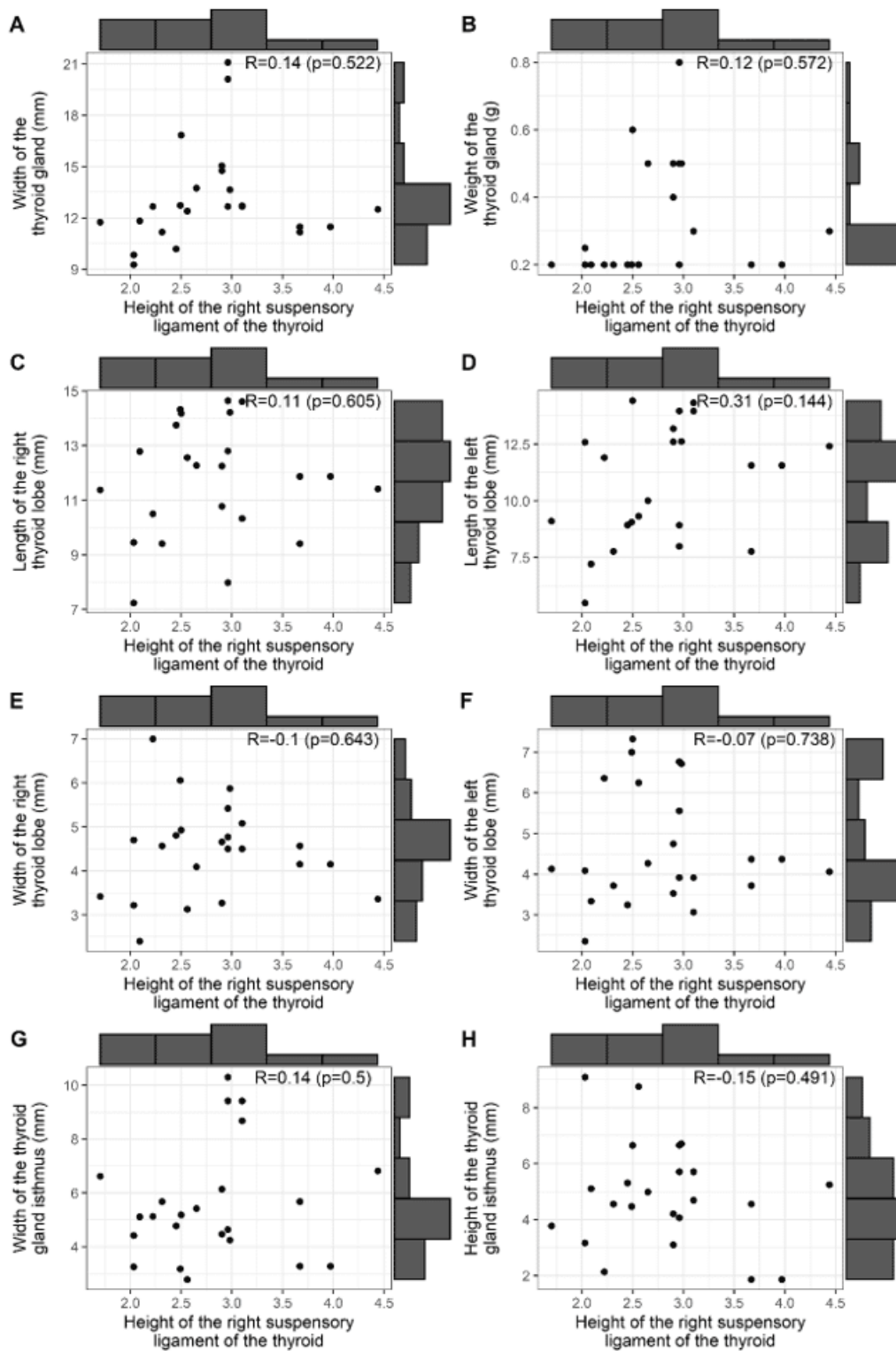
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Figure 3 shows the correlations between the height of the right BL of the thyroid gland, with: the width and weight of the thyroid gland (A, B); the lengths of the right and left lobes of the thyroid gland (C, D); the widths of the right and left lobes of the thyroid gland (E, F); the width and height of the isthmus of the gland (G, H). Note that there was no significant correlation between the height of the BL and the morphometric findings of the thyroid gland and the isthmus of the gland.

Figure 3 - Correlation of BL height with: width and weight, lengths and widths of the right and left lobes, and width and height of the isthmus of the thyroid gland



Source: Authors, 2023.

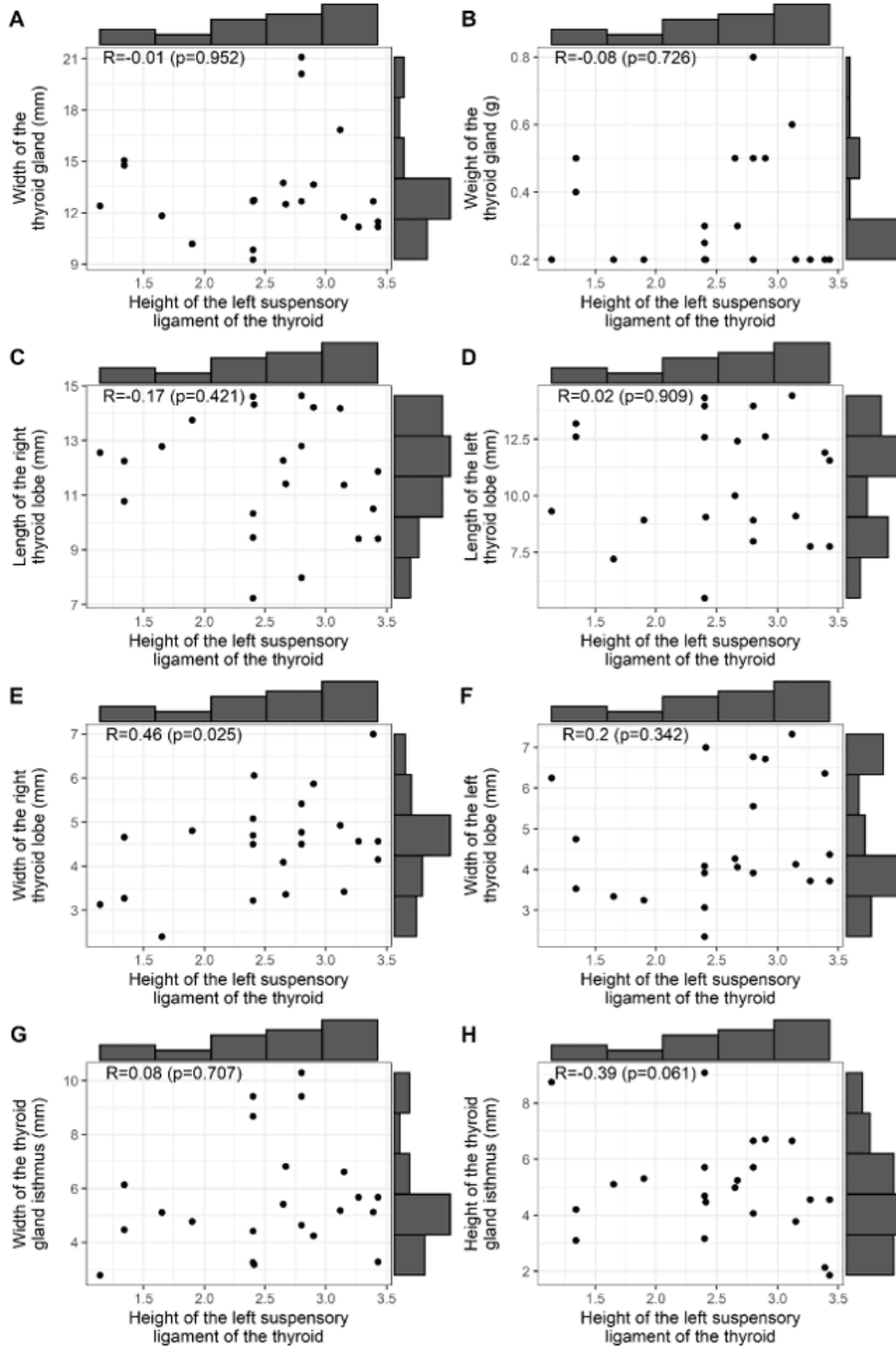
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Figure 4 represents the correlations between the height of the left BL of the thyroid gland and: the width and weight of the thyroid gland (A, B); the lengths of the right and left lobes of the thyroid gland (C, D); the widths of the right and left lobes of the thyroid gland (E, F); the width and height of the isthmus of the gland (G, H). Note that there was no significant correlation between the height of the BL and the morphometric findings of the thyroid gland and the isthmus of the gland.

Figure 4 - Correlation of the height of the left thyroid gland BL with: the width and weight of the thyroid gland, the lengths of the right and left lobes of the thyroid gland, the widths of the right and left lobes of the thyroid gland and the width and height of the gland isthmus



Source: Authors, 2023.

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5. DISCUSSION

The thyroid gland, although easily detached from the trachea by forceps, was not separated, according to BL Sasou, Nakamura, Kurihara (1998), they described the BL as a whitish band of connective tissue connecting the thyroid gland to the tracheal wall, when the thyroid gland was separated from the trachea and lifted anteriorly. For Sritharan *et al.*, (2016), it would be a dense condensation of the pre-tracheal vascular fascia that connected the thyroid to the cricotracheal structures posteriorly. In our study, the BL was also observed as a whitish band of connective tissue that connected the thyroid gland to the tracheal wall. For SERPELL, (2010) this relatively avascular fibrous layer, the true BL, would be found medially and deeply to the recurrent laryngeal nerve (RLN).

Sasou, Nakamura, Kurihara, (1998); Serpell, (2010); Sritharan *et al.* (2016), described the BL in adults as a dense fibrous band from the cricoid cartilage to the first and third tracheal rings, firmly fixing the thyroid gland to the larynx and tracheal wall. They found a ligament length that ranged from 8 to 14 mm (mean of 11.5 mm) and width from 2 to 7 mm (mean of 4.4 mm). In the present study, in human fetuses, the length of the BL ranged from 0.52 to 2.24 mm on the right (mean of 1.5 mm) and on the left from 0.43 to 1.68 mm (mean of 1.2 mm) height ranged from 1.7 to 4.44 mm (mean 2.8 mm) on the right and 1.14 to 3.43 mm (mean 2.6 mm) on the left. In the literature, a relationship between injury to the RLN and the BL has often been pointed out. RLN injury is one of the most serious complications of thyroidectomy, and the BL has been referred to as the most frequent site of nerve injury. According to the American Society for Head and Neck Surgery, voice changes after thyroidectomy have ranged from 30 to 87%, while NLR damage is underestimated (3 to 5%) and appears to be approaching 10% (JEANNON *et al.*, 2009; FRANCIS *et al.*, 2014; FUNDAKOWSKI *et al.*, 2018). For Chiang *et al.*, (2010); Chiang *et al.*, (2011), post-thyroidectomy voice disorders generally approach a proportion of 10%. Before the use of intraoperative neurostimulation, the only test approved for RLN injury was postoperative laryngoscopy and evaluation of the vocal cords, whenever the injury escaped intraoperative recognition. The ability to define the exact time and region of injury



intraoperatively was made possible by a loss of signal during NLR stimulation (MARCUS *et al.*, 2003; SNYDER *et al.*, 2008; CHIANG *et al.*, 2010; CHIANG *et al.*, 2011; DIONIGI *et al.*, 2015; STOPA *et al.*, 2017; WU *et al.*, 2017; LIU *et al.*, 2018; MANTALOVAS *et al.*, 2022). According to SNYDER *et al.* (2008), injured nerves are usually intact intraoperatively (0.45%) and have been attributed to a type of functional nerve injury during thyroidectomy. Chiang *et al.*, (2008) mentioned that functional nerve injuries constitute more than 75% of all injuries. This type of damage would occur as a result of traction pressures acting on the BL during central rotation of the thyroid gland.

Intraoperatively, the RLN can be identified by various techniques, such as palpation, intraoperative monitoring, and direct inspection provided by key anatomical landmarks such as the BL, tracheoesophageal sulcus, inferior thyroid artery, and the midpoint of the posterior border of the thyroid gland or Zukerkandl's tubercle. The relationship of the nerve to these landmarks is variable (Henry *et al.*, 2017), but improves the sensitivity of intraoperative nerve monitoring (PATRA *et al.*, 2022).

Authors such as Sasou, Nakamura, Kurihara (1998); Botelho *et al.*, (2012), proposed the BL as a reliable anatomical landmark to locate the RLN intraoperatively. However, this has not yet been widely accepted and implemented as standard practice (ASGHARPOUR *et al.*, 2012). Some data showed wide variations in the location of the RLN in relation to the BL: the nerve would course superficially to the BL, with a variation from zero to 100% (CAKIR *et al.*, 2006; NOUSSIOS *et al.*, 2020); meanwhile, the penetrating pattern would vary from 0 to 31.6% (CAKIR *et al.*, 2006; HUNT *et al.*, 1968; LEOW, WEBB, 1998; SASOU, NAKAMURA, KURIHARA, 1998; PRADEEP *et al.*, 2012).

6. CONCLUSION

Knowledge of the BL biometry, and its anatomical relationship with the thyroid gland and RLN, are essential to prevent, in particular, RLN injuries, during thyroidectomy or parathyroidectomy.



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