

A cadaveric study of morphometry and variations of the thyroid gland

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Abstract

Aim: To estimate dimensions of thyroid gland and look for frequent anatomic variations of it.

Methods: 60 specimens (52 male, 8 female) of thyroid gland were studied in the Department of Anatomy. Position of the lobe & isthmus of thyroid gland was noted in relation to the thyroid cartilage and trachea. Length, transverse diameter, and anteroposterior diameter of lobes & isthmus as well as thyroid gland weight was measured. The thyroid gland was looked for any anatomical variations.

Results: The mean value of right lobe length was (4.69cm vs 4.6cm) and left lobe was (4.48cm vs 4.11cm). The transverse diameter of right lobe was found to be (1.94cm vs 1.93cm) whereas for the left lobe it was noted as (2.07 vs 1.71cm). The anteroposterior diameter of right lobe was (1.10cm vs 0.87cm) and left lobe was (1.03cm vs 0.96cm). The mean length of isthmus was (1.31cm vs 1.24cm) and width was found to be (1.71cm vs 1.68cm). Thyroid gland weight was measured as 14.9 g & 12.48 g in males & females respectively. Pyramidal lobe and levator glandulae thyroideae were observed in 27(45%) and 12(20%) thyroid specimens respectively. Isthmus was absent in one case.

Conclusion: A sound knowledge of normal anatomy and awareness of variant forms of thyroid gland enable the surgeons to achieve the goal of safer thyroid operations.

Keywords: Thyroid gland, thyroidectomy; pyramidal lobe, levator glandulae thyroideae

Introduction

Complex multicellular organisms developed with the process of evolution. For regulation and control of these multitude of cells two control systems developed nervous system & endocrine system ^[1].

Thyroid the largest gland which is unpaired, H- shaped and highly vascular gland. Its weight is usually 25g but this varies. It has right and left lobes and these are connected in the lower parts by small median isthmus. Pyramidal lobe arises upwards from isthmus or any one lobe of the thyroid gland. Levator glandulae thyroideae is a fibrous or fibromuscular strap which extends from isthmus or pyramidal lobe to the hyoid bone ^[2]. The anatomy of the thyroid gland has a wide range of clinical implications and applications. It helps the physician to perform a proper physical examination, evaluate various images (ultrasonographic, computed tomographic, magnetic resonance) and to perform thyroidectomies ^[3].

Variations of the thyroid gland have received the attention of anatomists and surgeons since

long. Common thyroid gland variations are pyramidal lobe, thyroglossal cyst and agenesis of isthmus or lateral lobes [4]. these anatomic variations can cause recurrent thyroid disease or problems during thyroid surgery. Incomplete removal of thyroid tissue or pyramidal lobe may result into persistent or recurrent thyroid cancer [5]. recently minimally invasive thyroid surgery has been performed successfully. Accurate knowledge of thyroid gland anatomy, its relationship and anatomical variations are of practical importance in context of minimally invasive thyroidectomy [6].

The thyroid gland is indispensable to the anatomists, endocrinologists, surgeons & even otolaryngologists. This ignited our curiosity to study the anatomy of the thyroid gland and its variations in detail.

Materials & Methods

The study of various measurements of the thyroid gland was done in 60 thyroid specimens obtained from 60 cadaver's embalmed using 10% formalin. Of these sixty specimens 8 were female specimens and 52 were male specimens. Any cadaver in which the thyroid gland had been deformed or damaged was not considered for the study. Neck region was dissected carefully using the standard dissection kit and thyroid gland was exposed. Length, transverse diameter (TD) & anteroposterior diameter (APD) of the lateral lobes of the thyroid gland was measured on both sides. Length & width of isthmus was also measured. Interval between upper pole of thyroid gland & superior thyroid tubercle of thyroid cartilage was measured to define extent of lateral lobe superiorly. Tracheal rings were palpated to see its relation with isthmus and base of lobe of thyroid gland. Measurements were done using divider & scale. Thyroid gland was removed & its weight was measured using "electronic single pan weighing balance".

SPSS program was used for statistical analysis of all the measurements taken. Mean, standard deviation & range were calculated. To compare the mean differences of parameters on right & left sides Students T test was used. There was a great disparity in the number of male and female specimens due to which the mean differences of parameters in males and females were not estimated.

Results

The dimensions of the thyroid gland & the details of statistics are given in Table 1& 2. Right lobe length was significantly higher than left lobe length. The TD and APD diameter of right & left lobes were not statistically different.

Table 1: The Dimensions of Lobes of Thyroid Gland

Parameter	Sex	Minimum (cm)	Maximum (cm)	Mean (cm)	S.D
Right lobe length	Male	3.2	6.2	4.69	0.59
	Female	3.8	5.5	4.6	0.65
Left lobe length	Male	2	5.7	4.48	0.62
	Female	3.5	4.7	4.11	0.51
TD of Right lobe	Male	1	3.1	1.94	0.45
	Female	1.2	2.6	1.93	0.41
TD of Left lobe	Male	1.2	3	2.07	0.43
	Female	0.8	2.2	1.71	0.48
APD of Right lobe	Male	0.6	2.1	1.10	0.34
	Female	0.7	1.1	0.87	0.15
APD of Left lobe	Male	0.5	2.3	1.03	0.36
	Female	0.6	1.2	0.96	0.25

(TD-Transverse Diameter, APD-Antero-Posterior Diameter)

Table 2: The Other Dimensions of Thyroid Gland

Parameter	Sex	Minimum (cm)	Maximum (cm)	Mean (cm)	SD
Length of isthmus	Male	0.5	2.2	1.31	0.39
	Female	1	1.4	1.24	0.12
Width of isthmus	Male	0.7	3.3	1.71	0.59
	Female	0.8	3	1.68	0.73
Distance bet SP of TG & TC (Rt side)	Male	0.3	2.6	1.19	0.43
	Female	0.9	1.5	1.07	0.24
Distance bet SP of TG & TC (Lt side)	Male	0.4	2.7	1.33	0.46
	Female	1	1.6	1.28	0.24
Weight of thyroid gland	Male	6.9	35.4	14.96	6.20
	Female	6.6	20.5	12.48	4.40

(SP-Superior Pole, TG-Thyroid Gland, TC-Thyroid Cartilage)

The isthmus was related most commonly opposite the 2nd & 3rd tracheal rings. The fourth tracheal ring was found to be related with the isthmus in half the cases and in very few cases the first and fifth tracheal ring was also related with the isthmus. The base of lobe was related to 4th & 5th tracheal rings in majority of cases on both sides. Thyroid gland weighted as 14.96gm in males & 12.48gm in females.

Pyramidal lobe was found in 22(42.3%) male cadavers and in 5(62.5%) female cadavers. We observed pyramidal lobe originating from isthmus, right and left lobe in 16, 7 and 4 cadavers respectively. Levator glandulae thyroideae was found in 10(29.2%) male cadavers and 2 (25%) female cadavers (figure 1). The isthmus was absent in one of the female cadaver (figure 2).

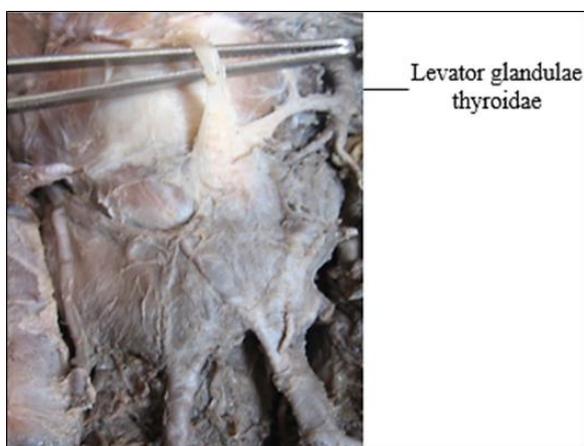


Fig 1: Illustration showing levator glandulae thyroideae



Fig 2: Illustration showing absence of isthmus

Discussion

Thyroid gland is bi lobed structure connected by isthmus. The gland is known for variations in its size & shape.

The mean value of length of lateral lobe was significantly higher on right side than on the left side. Present study data was compared with studies done by other authors (Table 3).

Table 3: Comparison of Parameters of Thyroid Gland with Different Studies

Parameter	Length		TD		AP diameter		Isthmus	
	Right	Left	Right	Left	Right	Left	Length	Width
Harjeet <i>et al.</i>	4.04	3.82	2.41	2.29	1.40	1.35	1.34	1.15

Prakash <i>et al.</i>	4.43	4.21	2.54	2.63	1.69	1.7	-	-
Joshi SD <i>et al.</i>	4.32	4.22	-	-	1.13	1.18	1.1	1.85
Dixit <i>et al.</i>	5.29	4.95	-	-	-	-	2.25	-
Alfatani <i>et al.</i>	4.12	3.62	1.75	1.9	-	-	2.78	-
Sultana <i>et al.</i>	-	-	-	-	-	-	09.3	1.22
Present Study	4.64	4.29	1.93	1.89	0.98	0.99	1.27	1.69

(TD-Transverse Diameter)

Right lobe length in this study was greater than the study of Harjeet *et al.* [7], Joshi SD *et al.* [8] And Prakash *et al.* [9] but lesser than the study of Dixit *et al.* [10] left lobe length was measured as 4.48cm and 4.11 cm in males and females respectively which is comparable to study of Joshi SD *et al.* [8] And Prakash *et al.* [9] but lesser than study of Alfatani *et al.* [11] Average transverse diameter of right & left lobe was nearer to the findings of Alfatani *et al.* [11] but far away than the findings of Harjeet *et al.* [7], Prakash *et al.* [9] In the present study anteroposterior diameter (thickness) was almost same on both sides and it is lesser than study of Harjeet *et al.* [7], Joshi SD *et al.* [8] Length & width of isthmus was found to be 1.27cm and 1.69cm respectively. These findings are nearer to findings of Joshi SD *et al.* [8] but higher than study of Sultana SZ *et al.* [12] The most common location of the isthmus was second and third tracheal ring in males and females in the present study which is comparable to Berkovitz BK [2], Botha JR [13] and Joshi SD *et al.* [8].

The superior pole of thyroid gland on right side was found at higher location than on left side. Berkovitz BK [2] states that, bases of the lateral lobes are in level with the fourth or fifth tracheal rings whereas according to Botha JR [13] bases of the lateral lobes were related with the fifth or sixth tracheal rings. We noticed that the fourth and fifth tracheal rings were related with the bases of lateral lobes on both sides in males as well as in females. Insufficient or excessive descent of thyroglossal duct results into variable positions of the thyroid gland [14]. Thyroid gland weight was measured as 14.9 g & 12.48 g in males & females respectively in this study. These findings are same as findings of Harjeet *et al.* [7], but lesser than the study of Tanriover O *et al.* [15], Pankow BG *et al.* [16].

Marshall studied variations in the size and shape of the thyroid gland in 1895. These variations include pyramidal lobe, absent right or left lobe, incomplete or absent isthmus and unsymmetrical lateral lobes [4]. Thyroid incongruity or conformation is present due to problems with descent of thyroid gland or recession of thyroglossal duct [5].

Incidence of pyramidal lobe in this study was found to be 45% which closely resembles with the incidence found in study by Marshall (43%) [5] and Skandalakis (50%) [6]. Study of Braun EM *et al.* [5] involving 31 female and 29 male cadavers, found that pyramidal lobe was existed in 62% of males and 45% of females. We observed pyramidal lobe in 42% of males and in 62.5% of female cadavers and this is exactly the reverse of what Braun EM *et al.* [5] found in their study. The present study as well as study by Harjeet A *et al.* [7] suggested that pyramidal lobe originated more frequently from the isthmus. Pyramidal lobe is residual fibrous tract but can be enlarged in pathological conditions. Benign nodules and cancer may also develop into it [17].

We noted levator glandulae thyroideae in 29.2% in males and 25% in females. Study of Harjeet A *et al.* [7] reported incidence of levator glandulae thyroideae as 22.9% and 10.6% in males and females respectively. Study of Joshi SD *et al.* [8] & Dixit D *et al.* [10] showed that it occurred in 30% and 7.31% cases respectively. The present study showed higher values both in males and females than found in study of Harjeet A *et al.* [7] and Dixit D *et al.* [10].

In one of the specimens glandular tissue was absent at the site of isthmus. The illustration of this finding is shown in fig. 2. Both the lobes were lying separately over the trachea and connected with the pre tracheal fascia. Neurovascular relations of the gland were normal and no ectopic thyroid tissue seen. Incidence of absent isthmus was found to be 1.66% in this study. Marshall [5] studied the thyroid gland in 60 children and observed agenesis of isthmus

in 10% of cases. Study of Ranade *et al.* [18] noticed absent isthmus in 33% cases whereas study of Harjeet *et al.* [7] reported it in 7.9% of thyroid glands. Williams *et al.* [8] observed absent isthmus in 0.024% cases and Oya [8] noticed it in 4% of cases.

Absent isthmus is uncommon in humans [7]. It is usually present with other anomalies like absent lateral lobe or ectopic thyroid tissue. High separation of thyroglossal duct results into two separate lobes and absent isthmus [19]. Agenesis of isthmus is usually asymptomatic and identified only when present with other thyroid pathologies. Absence of isthmus can be detected with the help of Scintigraphy, ultrasonography and computed tomography. Surgeons should be aware of the absence of isthmus while performing Trans-thyroid tracheostomy to avoid undue complications [20].

Conclusion

This study provides information regarding several anatomical parameters of the thyroid gland such as position, length, anteroposterior and transverse diameter and variations of it. The data obtained will be helpful in accurate physical examination and planning of thyroid surgery as well as to minimize the iatrogenic mishaps during the surgery.

Abbreviations

TD: Transverse diameter.

APD: Anteroposterior Diameter.

SPSS: Stastical Package for the Social Sciences.

Conflict of Interest: None.

References

1. Chakrabarti, Ghosh HN, Sahana SN. Chakrabarti, Ghosh, Sahanas Human Physiology. Second edition. Calcutta: The New Book Stall, 1984, 671-673.
2. Berkovitz BKB, Neck. In: Standring S, editor. Gray's Anatomy: The Anatomical Basis of Clinical Practice. Thirty-ninth edition. Elsevier Churchill Livingstone, 2005, 560-564.
3. Clark OH. Surgical Anatomy. In: Ingbar SH, Braverman LE, Editors. The Thyroid-A Fundamental and Clinical Text. Sixth edition. Philadelphia: JB. Lippincott Company, 1991, 563-571.
4. Bhatnagar KP, Nettleton GS, Wagner CE. Subisthemic Accessory Thyroid Gland in Man: A Case Report and a Review of Thyroid Anomalies. Clical Anatomy. 1997;10:341-344.
5. Braun E, Windisch G, Wolf G, *et al.* The Pyramidal Lobe: Clinical Anatomy and its Importance in Thyroid Surgery. Surg and Radiol Anat. 2007;29(1):21-7.
6. Skandalakis JE, Carlson GW, Colborn GL, *et al.* Neck. In: Skandalakis JE editor. Surgical Anatomy: The Embryonic and Anatomic Basis of Modern Surgery. 1st edition. Anthens: Paschalidis Medical Publications Ltd. 2004;1:47-73.
7. Harjeet A, Sahni D, Jit I, *et al.* Shape, Measurements and Weight of the Thyroid Gland in Northwest Indians. Surg. Radio Anat. 2004;26:91-95.
8. Joshi SD, Joshi SS, Daimi SR, *et al.* The Thyroid Gland and its Variations: A Cadaveric Study. Folia Morphol. 2010;69(1):47-50.
9. Prakash Rajini T, Ramachandran A, *et al.* Variations in the anatomy of the thyroid gland: clinical implications of a cadaver study. Anat. Sci. Int. 2012;87:45-49. Doi: 10.1007/s12565-011-0115-9. Epub 2011 Sep.

10. Dixit D, Shilpa MB, Harsh MP, *et al.* Agenesis of isthmus of thyroid gland in adult human cadavers: A case series. *Cases Journal*. 2009;2:6640.
11. Alfatani EA, Zaki AI, El- Haggagy A, *et al.* Anatomical Variations of the Thyroid Gland. *Life Sci J*. 2014;11(9):922-926.
12. Sultana SZ, Khalil M, Khan MK, *et al.* Incidence of Presence and Variation in Anatomical Position of Isthmus of Thyroid Gland in Bangladeshi Cadaver. *Bangladesh Journal of Anatomy*. 2011 Jan;9(1):26-29.
13. Botha JR. The Thyroid, Thymus and the Parathyroid Glands. In: Decker GAG, du Plessis DJ, editors. *Lee McGregor's Synopsis of Surgical Anatomy*. Twelfth edition. John Wright & Sons Ltd, 1986, 198-205.
14. Moore KL, Persaud TVN. *The developing human: clinically oriented embryology*. 6th ed. Philadelphia: WB. Saunders, 1998, 222-32.
15. Tanriover O, Comunoglu N, Eren B, *et al.* Morphometric Features of the Thyroid Gland: A Cadaveric Study of Turkish People; *Folia Morphology*. 2011;70(2):103-108.
16. Pankow BG, Michalak J, McGee MK. Adult Human Thyroid Weight, *Health Physc*. 1985 Dec;49(6):1097-103.
17. Feind CR. *Surgical Anatomy*. In: Ingbar SH, Braverman LE, editors. *The Thyroid-A Fundamental and Clinical Text*. Fifth edition. Philadelphia: J.B. Lippincott Company, 1986, 607-617.
18. Ranade AV, Rai R, Pai MM. Anatomical Variations of the Thyroid Gland: possible surgical implications. *Singapore Med J*. 2008;49(10):831-4.
19. Anderson L. editor. *Embryonic Origin and Development of Thyroid Progenitor Cells. An Experimental study focused on endoderm, Eph A4 and Foxa 2*. 1st edition. London: Institute of Biomedicine. Department of Medical Biochemistry and Cell Biology, 2010.
20. Kaur SH, Kumar U, Bajwa SJS, *et al.*, Absent Thyroid Isthmus: Embryological and Clinical Implications of a Rare Variation of Thyroid Gland Revisited. *Thyroid*. 2013;10(2):80-82.