

## Anatomical Variations of the Thyroid Gland

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**Abstract: Objectives:** The present work aimed at studying the variations of the thyroid gland. **Methods:** 9 Formalin fixed and 8 plastinated specimens were studied for any variations and developmental anomalies. The length and width of each lobe, length of the isthmus, the distance between the bases of the two lobes and distance between the upper poles were measured. **Results:** The pyramidal lobe was associated with the levatorglandulaethyroidae in 2 specimens (11.76%). The levatorglandulaethyroidae was not associated with the pyramidal lobe in 3 specimens (17.64%). The isthmus was bifid in 1 specimen (5.88%) and has an upper extension in 1 specimen (5.88%) and a lower extension in 2 specimens (11.76%) but it was absent in 1 specimen (5.88%). **Conclusion:** Good knowledge of variations in the thyroid gland would be helpful for surgeons in performing tracheostomies and in the evaluation of scintigraphy.

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**Keyword:** anatomical variations, accessory thyroid tissue, levatorglandulaethyroidae, pyramidal lobe.

### 1. Introduction

The thyroid gland is the most notable gland that varies greatly in its size and structure (Kelly *et al.*, 1984).

The thyroid gland is located anteriorly in the neck at the level of C5–T1 vertebrae (Moor and Dalley, 2006). It usually consists of two lateral lobes and an interconnecting isthmus. The lobes lie against the lateral sides of the lower part of the larynx and the upper part of the trachea. The isthmus connects the lower parts of the two lobes and is usually anterior to the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> tracheal cartilages. Quite often the pyramidal lobe exists and ascends from the isthmus and may reach the upper part of the lamina of the thyroid cartilage. Sometimes, the levatorglandulae thyroideae muscle extends from the body of the hyoid bone caudally towards the gland (Harjeet *et al.*, 2004).

The thyroid gland appears in the floor of the pharynx between the tuberculum impar and the copula. Subsequently the thyroid descends in front of the pharyngeal gut as a bilobed diverticulum. During this migration, the thyroid remains connected to the tongue by the thyroglossal duct. This duct later disappears. With further development, the thyroid gland descends in front of the hyoid bone and the laryngeal cartilages. It reaches its final position in front of the trachea in the seventh week. By then it has acquired a small median isthmus and two lateral lobes (Sadler, 2012).

The thyroid gland is well known for its anomalies, which distort the morphology of the gland causing various thyroid illnesses (Arriaga and Myers, 1988).

Persistence of the pyramidal lobe and the thyroglossal cyst are the commonest anomalies of thyroid gland (Sankar *et al.*, 2009). The rare anomalies are agenesis of the thyroid gland either partial or total, aberrant thyroid glands and agenesis of the isthmus (Sankar *et al.*, 2009).

If accessory thyroid tissue and pyramidal lobe are missed at surgery it is likely to be noted on scan and may be the site of recurrent or persistent thyroid cancer (Braun *et al.*, 2007).

Thyroid gland surgery is one of the more common surgical interventions in the head and neck region. Risk of damage to the parathyroid glands, external branch of the superior laryngeal nerves, inferior laryngeal nerves and hematoma due to vascular damage can be minimized by keeping in mind all the anatomical variations and developmental anomalies of the thyroid gland (Prakash *et al.*, 2012).

So the aim of the present work is to study the anatomical variations and developmental anomalies of the thyroid gland in order to reduce complications and have safe surgery.

### 2. Material and Methods

The present study was carried on 8 plastinated and 9 formalin fixed human cadaveric thyroid gland. They were selected with no macroscopic evidence of disease. They were obtained from the dissection room at Anatomy Department, Faculty of Medicine. The sex and age of the cadavers were not assessed in this study.

### Morphological Study

In formalin fixed specimens, the skin, platysma and the subcutaneous tissue were removed from the anterior cervical region and the infrahyoid muscles were clearly exposed. The strap muscles were separated from the thyroid gland by blunt dissection. Then the thyroid gland was exposed.

Plastinated and formalin fixed specimens were studied for any variations and developmental anomalies.

After examination, the selected specimens were photographed using digital camera. The length and width of each lobe, length of the isthmus, the distance between the bases of the two lobes and distance between the upper poles were measured. Digital calipers sensitive to 0.01mm were used. Protractor and flexible metric instruments were used when needed. The data obtained, was tabulated and statistically analyzed.

### 3.Results

In the formalin fixed specimens, the length of the right lobe of the thyroid gland ranged between 2.3 cm and 7 cm with an average length of  $4.1 \pm 1.6$  cm. The length of the left lobe ranged between 2 cm and 5 cm with an average of  $3.6 \pm 1.0$  cm. The width of the right lobe of the thyroid gland ranged between 1 cm and 2.5 cm with an average of  $1.7 \pm 0.5$  cm. The width of the left lobe of the thyroid gland ranged between 1 cm and 2.5 cm with an average of  $1.9 \pm 0.6$  cm. The length between upper poles of the thyroid gland ranged between 2.5 cm and 4.7 cm with an average of  $3.7 \pm 0.9$  cm. The length between the bases of the 2 lobes of the thyroid gland ranged between 0.5 cm and 3.5 cm with an average of  $1.8 \pm 1.3$  cm. The length of the isthmus of the thyroid gland ranged between 1.4 cm and 4.5 cm with an average of  $2.7 \pm 1.1$  cm (Table 1).

In the plastinated specimens, the length of the right lobe of the thyroid gland ranged between 4 cm and 6.5 cm with an average length of  $5.1 \pm 0.8$  cm. The length of the left lobe ranged between 3 cm and 5 cm with an average length of  $4.6 \pm 0.4$  cm. The width of the right lobe of the thyroid gland ranged between 2 cm and 3 cm with an average of  $2.4 \pm 0.3$  cm. The width of the left lobe ranged between 2 cm and 3 cm with an average of  $2.3 \pm 0.4$  cm. The length between upper poles of the thyroid gland ranged between 4 cm and 5.5 cm with an average of  $4.9 \pm 0.5$  cm. The length between the bases of the 2 lobes of the thyroid gland ranged between 2 cm and 3.5 cm with an average of  $2.7 \pm 0.5$  cm. The length of the isthmus of the thyroid gland ranged between 1.5 cm and 3 cm with an average of  $2.0 \pm 0.6$  cm (Table 2).

In the current study, the pyramidal lobe was present in 4 specimens (23.53%). It was associated with the levatorglandulaethyroidae in 2 specimen (11.76%) (Fig. 1,2) (Table 3). In one of them the levatorglandulaethyroidae arose from the apex of the pyramidal lobe (Fig. 2).

The pyramidal lobe was not associated with the levatorglandulaethyroidae in 2 specimens (11.76%). It either arose from the right part (5.88%) (Fig. 3) or from the left part of the isthmus (5.88%) (Fig. 4).

The levatorglandulaethyroidae was present in 5 specimens (29.41%). It was not associated with the pyramidal lobe in 3 specimens (17.64%) (Table 3). It arose from the left lobe in one specimen (5.88%) (Fig. 6) and from the isthmus in 2 specimens (11.76%).

The isthmus was bifid in 1 specimen (5.88%) (Fig. 4). It had an upper extension in 1 specimen (5.88%) and a lower extension in 2 specimen (11.76%) (Figs. 5, 7), but it was absent in 1 specimen (5.88%) (Fig.8).

**Table 1: Showing different measurements of the formalin fixed thyroid gland**

No. of specimen	Right lobe		Left lobe		isthmus	Length between upper poles	Length between bases of the 2 lobes
	Length	Width	Length	Width			
1	3.6	1.3	4.5	1.7	1.4	4.3	3
2	2.3	1	2	1	----	4.7	3.5
3	3	1.5	4	2	2	----	----
4	7	2.5	----	----	4.5	----	----
5	5.5	2	4.5	2.5	3	3	1.3
6	4.5	2.5	5	2.5	3	4	1
7	----	----	2.5	2	----	----	----
8	----	----	3	2.5	----	----	----
9	3	1.5	3.5	1	----	2.5	0.5
<b>Mean</b>	4.12	1.75	3.62	1.9	2.78	3.7	1.86
<b>±SD</b>	1.65	0.58	1.06	0.62	1.17	0.91	1.31

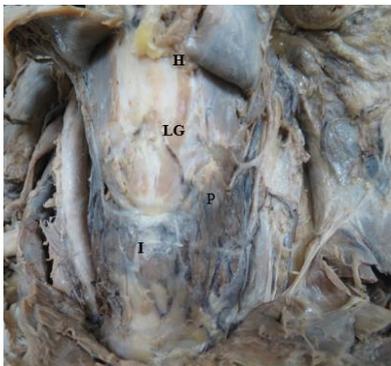
**Table 2: Showing different measurements of the plastinated thyroid gland**

No. of specimen	Right lobe		Left lobe		isthmus	Length between upper poles	Length between bases of the 2 lobes
	Length	Width	Length	Width	Length		
1	5.5	2.5	4.5	3	----	5.5	3.5
2	4	2	3	2	----	5.5	2
3	----	----	5	2	----	----	----
4	4.8	2	3.7	2	2	4.5	2.6
5	4	2	4.6	2	1.7	4	2.3
6	5.2	2.7	4.5	2.5	----	5.5	3.3
7	6.5	2.4	5	2	3	5	2.5
8	5	3	5	3	1.5	5	3
<b>Mean</b>	5.16	2.43	4.61	2.35	2.05	4.91	2.74
<b>±SD</b>	0.82	0.39	0.46	0.47	0.66	0.58	0.54

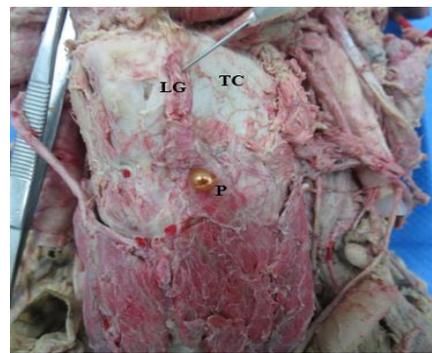
**Table 3: Showing the percentages of occurrence of the PL and LGT and their association with each other**

	Total no.	%	PL Assoc. with LGT	%	LGT not Assoc. with PL	%
<b>PL</b>	4	23.53%	2	11.76%	---	---
<b>LGT</b>	5	29.41%	---	---	3	17.64%

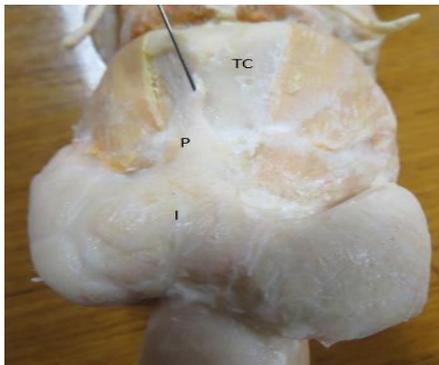
**PL:** Pyramidal lobe; **LGT:** levatorglandulaethyroideae.



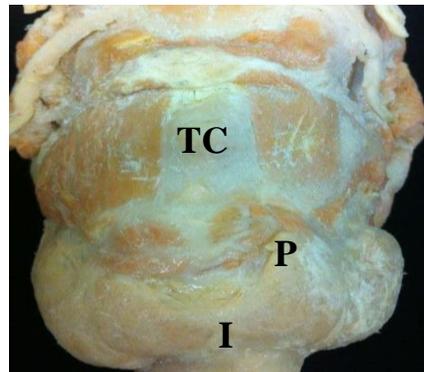
**Fig. 1:** A photograph of the front of the neck showing levatorglandulaethyroideae (LG) arising from the isthmus (I) of the thyroid gland and attached to the hyoid bone (H). P: pyramidal lobe



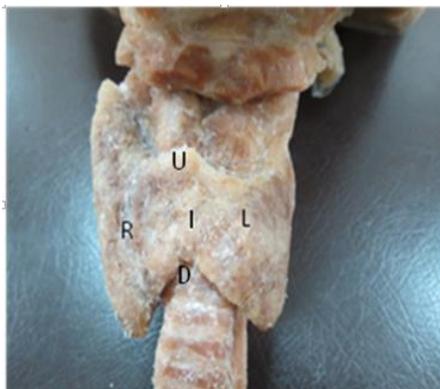
**Fig. 2:** A photograph of the front of the neck showing the pyramidal lobe (P). The levatorglandulaethyroideae (LG) arises from the apex of the pyramidal lobe (P) reaching to the upper third of thyroid cartilage (TC).



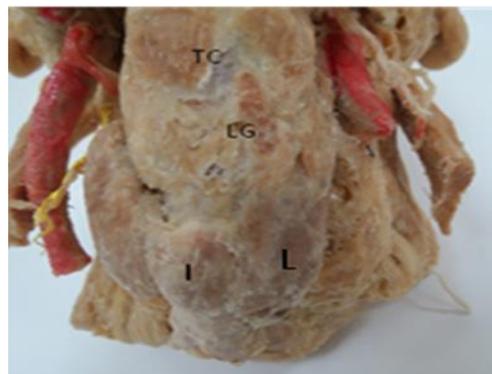
**Fig. 3:** A photograph of a part of the front of the neck showing the pyramidal lobe (P) arising from the right part of the isthmus (I) of the thyroid gland. The pyramidal lobe (P) reaches to the middle of thyroid cartilage (TC).



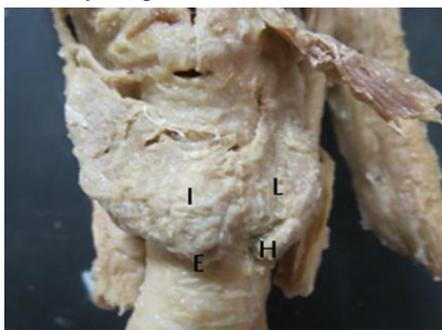
**Fig. 4:** A photograph of a part of the front of the neck showing the pyramidal lobe (P) arising from the left portion of the isthmus (I). The pyramidal lobe (P) does not reach the thyroid cartilage (TC). The isthmus of the thyroid gland is bifid.



**Fig. 5:** A photograph of a part of the front of the neck showing an upward extension (U) & downward notch (D) of the isthmus (I). The left lobe (L) is smaller than the right lobe (R) of the thyroid gland.



**Fig. 6:** A photograph of a part of the front of the neck showing the levator glandulae thyroideae (LG) arising from left lobe (L) of the thyroid gland and reaches to thyroid cartilage (TC). The isthmus (I) is nodular in shape.



**Fig. 7:** A photograph of a part of the front of the neck showing the left lobe (L) which gives an inferior horn (H). The isthmus (I) shows an inferior extension (E).



**Fig. 8:** A photograph of a part of the front of the neck showing the thyroid gland without an isthmus.

#### 4. Discussion

In this study, a number of variations of the thyroid gland were observed. Failure of the development of the entire gland, or part of the gland, results in agenesis or hemigenesis, which may be unilateral or isthmic (Braun *et al.*, 2007).

The mean length of the lateral lobes of the thyroid gland is described as 5 cm in most of the anatomical texts [Du Plessis (1975); Hollinshead and Rosse (1985); Standring (2005)]. In the present work the mean length of the right and left lobes of the formalin fixed thyroid glands was 4.1 and 3.6 cm respectively. The mean length of the right and left lobes of the plastinated thyroid glands was 5.1 and 4.6 cm respectively. In both the formalin fixed and plastinated specimens the left lobe was smaller than the right lobe. This is in agreement with Joshi *et al.* (2010) where the mean length of the right lobe was 4.32 cm and the left lobe was 4.22 cm.

In the current study, the pyramidal lobe was present in 23.53% of specimens. The pyramidal lobe was associated with the levator glandulae thyroideae in 11.76% of specimen. It either arose from the right part (5.88%) or from the left part of the isthmus (5.88%). In

5.88% the levator glandulae thyroideae arose from the apex of the pyramidal lobe. This is in accordance with the study of Joshi *et al.* (2010) who found the pyramidal lobe in 37.77%. It was attached either to the isthmus or the lateral lobes. On the contrary, Braun *et al.* (2007) found a pyramidal lobe in 55% of the cadavers.

According to Gregory and Guse, Soemmerring's (2007) the levator glandulae thyroideae is an accessory muscle which runs from the hyoid bone to insert partly on the thyroid cartilage and partly on the isthmus of the thyroid gland. In the current study, the levator glandulae thyroideae was present in 29.41% of specimens. It arose from the left lobe in 5.88% of specimens and from the isthmus in 11.76% of specimens. This is in agreement with Joshi *et al.* (2010) where the levator glandulae thyroideae was present in 30% of specimens.

In the present work the isthmus was absent in 5.88% of specimens. This is in disagreement with the study of (Joshi *et al.*, 2010) where the isthmus was absent in 16.66%. According to Pastor Vazquez (2006), the agenesis of isthmus can be associated with dysorganogenesis related to anomalies of thyroid

gland, such as the absence of a lobe or the presence of ectopic thyroid tissue.

The isthmus was bifid in 5.88% of specimens. It had an upper extension in 5.88% of specimens and a lower extension in 11.76% of specimens. This is in accordance with the study done by (Harjeet *et al.* (2004) where the two lobes were separate in 7.9% of thyroids. Failure of the isthmus fusion in the midline may be the principal cause of an isolate isthmus agenesis (Karaby, 2003).

Therefore, the thyroid gland variations should be taken into consideration in order to reduce complications and have safe surgery.

### Conclusion

Good knowledge of variations in the thyroid gland would be helpful for surgeons in performing tracheostomies and in the evaluation of scintigraphy.

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