Original Article

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Morphological Variations of the Thyroid Gland in the North Indians: A Cadaveric Study with its Clinical Relevance

Apurba Patra[1], Arun Sharma[2], Vishal Malhotra[3], Vimal Gupta[4]

[1]Assistant professor, Anatomy Department, Dr. Radhakrishnan Govt Medial College, Hamirpur (H.P.), [2]Senior Demonstrator, Anatomy Department, Govt Medial College, Chandigarh-32, [3]Senior Resident, Department of SPM, GMC, Patiala, [4]Tutor, Anatomy Department, Dr. Radhakrishnan Govt Medial College, Hamirpur (H.P.).

Abstract

Introduction: The morphological variations of the thyroid gland are not an uncommon phenomenon and may due to embryological remnant or non-specific development of different parts of it. Prior anatomical knowledge of these variations is of immense importance to prevent catastrophies during or after thyroid surgeries. Therefore, in this study we aimed to investigate the prevalence of morphological variations of the thyroid glands in north Indian cadavers. **Subjects and Methods**: This study was conducted on 50 formalin embalmed adult human cadavers aging between 40–65 years, of which 40 were males and 10 were females. Thyroid glands were dissected and examined properly for the presence of pyramidal lobe, levator glandulae thyroidae, accessory thyroid tissue and complete absence of isthmus. **Results:** The pyramidal lobe was present in 9 (18%) and frequently arising from the right side of the isthmus. LGT was found in 7 (14%) and almost in all cases it was extending from the apex of the pyramidal lobe to the hyoid bone. Only 2 (4%) cadavers did not show an isthmus while accessory thyroid tissue was found only in one case. Morphological variations were more common in females than in males and the difference was statistically significant (p value<0.05). The means of all measured parameters were higher in female than in male but these gender differences were not significant (p>0.05). **Conclusion:** Morphological variation of the thyroid gland is a common phenomenon, particularly in female. Hence it requires proper detection and documentation prior to any thyroid surgery, so that iatrogenic catastrophies can be avoided.

Keywords: Morphological Variation, Pyramidal Lobe, Levator Glandulae Thyroidae, Isthmus, Accessory Thyroid Tissue

Corresponding Author: Arun Sharma, Senior Demonstrator, Anatomy Department, Govt Medial College, Chandigarh-32.

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Introduction

The thyroid gland is a highly vascular and placed anteriorly in the lower part of the neck.[1] It consists of two symmetrical lateral lobes united by an isthmus, lies in front of the second, third and fourth tracheal ring.[2,3] The size of the thyroid gland varies considerably with age, sex, physiological state, race and geographical location. It is observed that the size is larger in female than in male.[4] Developmentally, thyroid gland appears as an epithelial proliferation in the floor of the pharynx between the tuberculum impar and the copula in the form of bi-lobed diverticulum, called the thyroglossal duct. The lower part of the duct develops into median isthmus and two lateral lobes. The upper connection of the duct with the floor of pharynx later disappears.[5] The embryological remnant of the caudal end of the thyroglossal duct is commonly known as pyramidal lobe (PL). PL occurs frequently and widely varies in size. When present, it extends upward from the isthmus or from the junction of the isthmus and one of the lateral lobes, usually the left lobe and connected to the thyroid cartilage or hyoid bone.[5,6] The upper end of the PL may continue as a fibro-muscular strand known as levator glandulae thyroidae (LGT) which is usually attached to the hyoid bone. When the PL is absent, LGT may extend from the upper part of the isthmus.[7] Accessory thyroid tissues (ATT) are usually found at embryonic site of origin of thyroid gland or anywhere along the pathway of descent of thyroglossal duct.[8] It may present as a separate mass containing normal thyroid follicle and supplied by Agenesis of the thyroid isthmus (AI) is defined as the complete and congenital absence of the isthmus.[9] A high division of the thyroglossal duct generates two independent thyroid lobes with the absence of isthmus.[10] Thyroid diseases are among the most common endocrine disorders in India.[11] Most of the diseases, affecting it require medical and surgical intervention. The surgeons plan for thyroidectomy for different stages of thyroid carcinoma must be aware about the morphological variations of the gland. Otherwise it can result in incomplete resection of the thyroid gland resulting in serious complications in diseases like carcinoma & Grave's disease where complete removal of thyroid gland is indicated.

The aim of the study was to emphasize various morphological variations of the human thyroid gland and forming a foundation for safe and more effective thyroid surgery.

Subjects and Methods

This study was conducted in anatomy department on 50 formalin embalmed adult human cadavers aging between 40–65 years of which 40 were males and 10 were females. Cadavers with known history of thyroid diseases or crushing injury to the neck were excluded from the study.

A vertical midline skin incision was given starting from the chin up to the suprasternal notch. The subcutaneous fat and deep fascia was exposed, the infrahyoid muscles were identified and reflected laterally. The pretracheal fascia was removed and the right and the left lobe of the gland were identified. The thyroid gland was examined carefully for the presence of PL, LGT, accessory thyroid tissue and complete absence of isthmus. During dissection, the existence of the PL, LGT and ATT were noted. Photographs were taken for each specimen. PL if present, its position was noted. Three linear parameters

of the PL were measured: the length (from the base to the apex), the width (transverse diameter of the base) and thickness (anteroposterior diameter of the base).and its length from base to apex, the breadth at the base and thickness was measured (cm) with the help of digital vernier callipers (with least count of 0.01). LGT if present, its nature (fibrous, muscular or fibromuscular), relation with the PL, extension, length and breadth were observed. The measurements of the PL and LGT were taken directly, with the help of a Mitutoya (Japan) vernier caliper (accuracy 0.01 mm).

Statistical analyses were performed using Microsoft office Excel software version 16.0 for windows 10. Differences in the incidence of morphological variations between genders were tested using a Pearson chi-square test. The comparison of morphometric data of PL, LGT was done between male and female by using un paired 't' test. The p-value of < 0.05 was considered as statistically significant.

Result

Total 50 thyroid glands were studied from 40 male and 10 female cadavers. Presence of PL, LGT, absence of isthmus and accessory thyroid tissue were the morphological variations observed in the gland. 18 glands showed morphological variations, while rest had normal anatomy [Table 1]. Morphological variations were more common in females than in males and the difference was statistically significant (chi square value=9.36, df=1, p value=0.002). All the major morphological variations observed in the study were summarized [Table 2].

Pyramidal lobe: It was found that 9 (37.04%) out of 50 thyroid gland has PL. The incidence was being 5 (37.21%) in male and 4 (36.36%) in female. It was also observed that this lobe was situated more on the right side than on the left. Its base was mostly attached to the right half of upper border of the isthmus with or without encroachment on the adjacent part of the left lobe [Figure 1]. According to the origin and location of PL, Milojevic et al,[12] classified it into five types. On the basis of that classification, we have found two cases of type I (4%), three of type II (6%), two of type III (4%), one case each of type IV (2%) and type V (2%) with the right sided being predominant [Table 3]. The length (base to apex), breadth and anteroposterior thickness at the base of this lobe varied from 0.6 to 3.8 cm, 0.4 to 1.3 cm and 0.2 to 0.5 cm respectively. The mean length, breadth and anteroposterior thickness of this lobe were 2.11 ± 1.12, 1.08 ± 0.43 and 0.45 ± 0.21 cm respectively.

Table 1: Morphological variations in either sex

Sex	Morphological variations	Normal anatomy
Male	11	29
Female	8	2
Total	19	31

Table 2: Different types of morphological variations and sex distribution of the patients studied.

Morphological variations	Male	Female	Total	Percentage (%)
PL	5	4	9	18
LGT	4	3	7	14
ATT	1	-	1	2
AT	1	1	2	4

Note: more than one variations were seen in few specimens (PL: pyramidal lobe; LGT: levator glandulae thyroidae; ATT: accessory thyroid tissue; AI: Absent Isthmus)

Table 3: Classification of the pyramidal lobe on the basis of its attachment to the thyroid gland

Sex	Central part of the isthmus (Type I)	Junction of the right lobe with the isthmus (Type II)	Junction of the left lobe with the isthmus (Type III)	Left lobe (Type IV)	Right Lobe (Type V)	Total
Male	1	2	2	-	-	5
Female	1	1	-	1	1	4
Total	2	3	2	1	1	9

Table 4: Comparison of Incidence of Pyramidal Lobe, Levator Glanduleae Thyroideae, absent isthmus and accessory thyroid tissue

Authors	Year	Sample size	P L (%)	LGT (%)	AI (%)	ATT (%)
Harjeet et al.[13]	2004	410	28.9	33.5	7.9	-
Ranade et.al,[14]	2008	105	58	49.5	33	0.95
Nurunnabi ASM et al,[15]	2008	60	41	20	-	-
Joshi SD,[16]	2010	90	37.77	30	16.7	-
Veerahanumaiah S et al,[17]	2014	89	46	41	9	2.24
Milojevic et al,[11]	2013	58	55.2	59.4	-	-
Rajkonwar AM et al,[18]	2016	80	38.75	18.75	21.25	-
Present Study	2018	50	18	14	4	2

(PL:Pyramidal Lobe; LGT: Levator Glanduleae Thyroideae; ATT: Accessory thyroid tissue AI: Absent Isthmus)

LGT: LGT was found in 7 (14%) cases of which 4 (8%) were male and 3 (6%) female. In male, the lower end of LGT was associated the apex of PL [Figure 1] in three cases while one case, where the PL was absent, the lower attachment was with isthmus of thyroid gland. In female, the lower end of LGT was associated the apex of PL in all the three cases. Almost in all cases the upper end of LGT was attached to the body of hyoid bone, except in one where LGT failed to reach hyoid bone and was attached to the thyroid cartilage. On the basis of Mori's,[13] classification, we found 5 cases of hyopyramidalis, one each of thyrepyramidalis and hyglandularis. In one case the lower end of LGT was bifurcated, right end attached to the right lobe of the thyroid gland through PL and left end attached to the left lobe directly [Figure 2]. It was observed that in 4 cases, the nature of the LGT was fibro muscular and in 3 cases, it was fibrous on gross visualization. The length and breadth (midway of its length) of LGT varied from 1.3 to 5.8 cm and 0.4 to 0.6 cm respectively. The mean of length and breadth were 3.16 ± 1.21 and 0.6±0.32 cm respectively.

The means of all these measured parameters were higher in female than in male but these gender differences were not statistically significant ($p>0.05$).

Accessory thyroid lobe: In one case, accessory thyroid lobe was found below and lateral to the right lobe as a separate mass. The accessory lobe was larger in size than the main lobe and both of them were supplied by the branch of right superior thyroid artery [Figure 3].

Absence of Isthmus: The isthmus was absent in two (4%) cases; of which one of each sex [Figure 4].

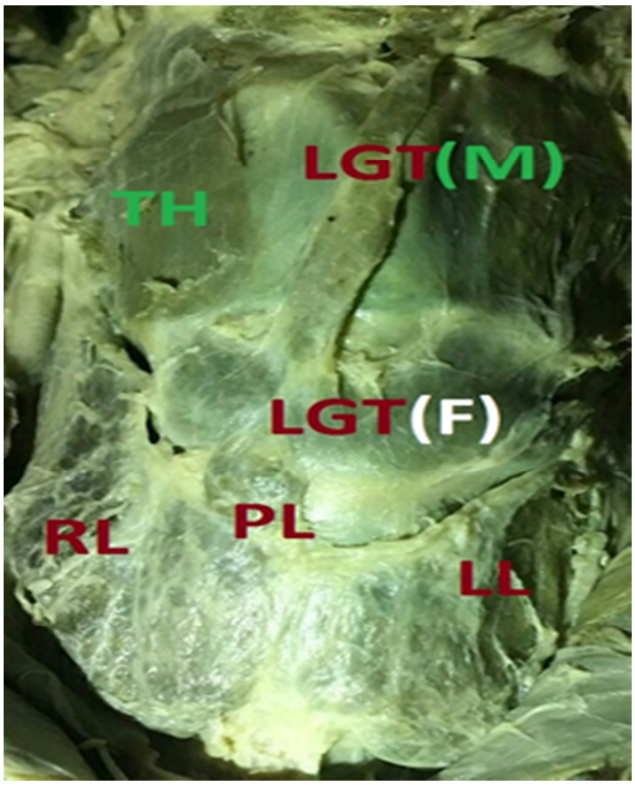

Figure 1: showing PL attached to the right half of upper border of the isthmus with or without encroachment on the adjacent part of the left lobe and its apex associated with the lower end of LGT. (RL: Right lobe; LL: Left lobe; PL: Pyramidal lobe; LGT (F): Levator glandulae thyroidae (fibrous); LGT (M): Levator glandulae thyroidae (muscular).

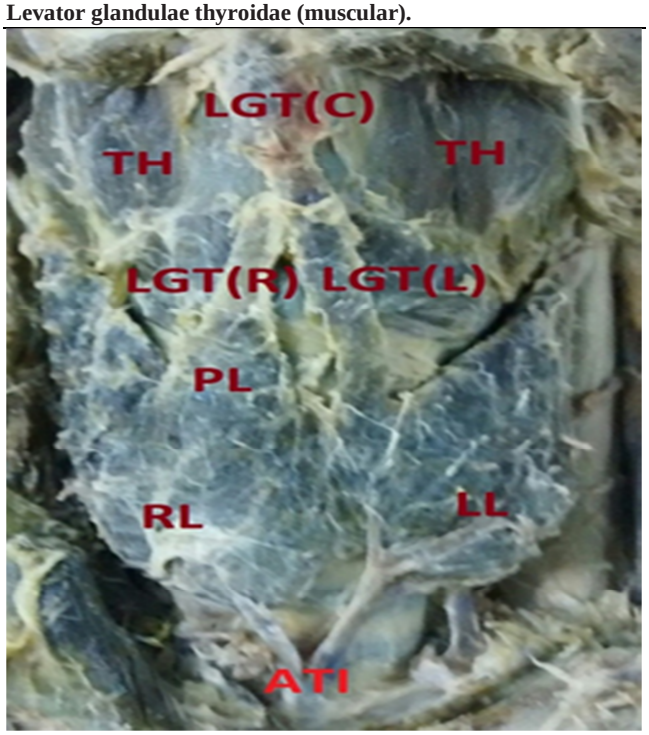

Figure 2: showing bifurcation of end of LGT, right end attached to the right lobe of the thyroid gland through PL and left end attached to the left lobe directly. RL: Right lobe; LL: Left lobe; PL: Pyramidal lobe; LGT(R): Levator glandulae thyroidae (right end); LGT (L): Levator glandulae thyroidae (left end); LGT (C): Levator glandulae thyroidae (Common); TH: Thyrohyoid muscle; ATI: Arteria thyroidae ima.

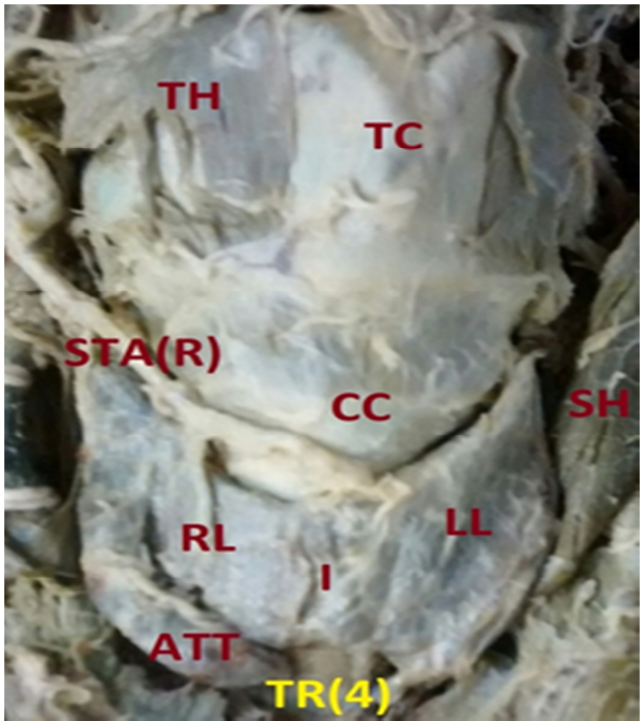

Figure 3: showing accessory thyroid tissue in the form of accessory lobe. RL: Right lobe; LL: Left lobe; ATT: Accessory

thyroid tissue; I: Isthmus; CC: Cricoid cartilage; TC: Thyroid cartilage; TH: Thyrohyoid muscle; SH: Sternohyoid muscle(reflected); TR (4): Fourth tracheal ring; STA(R): Right superior thyroid artery supplying the ATT, RL and LL.

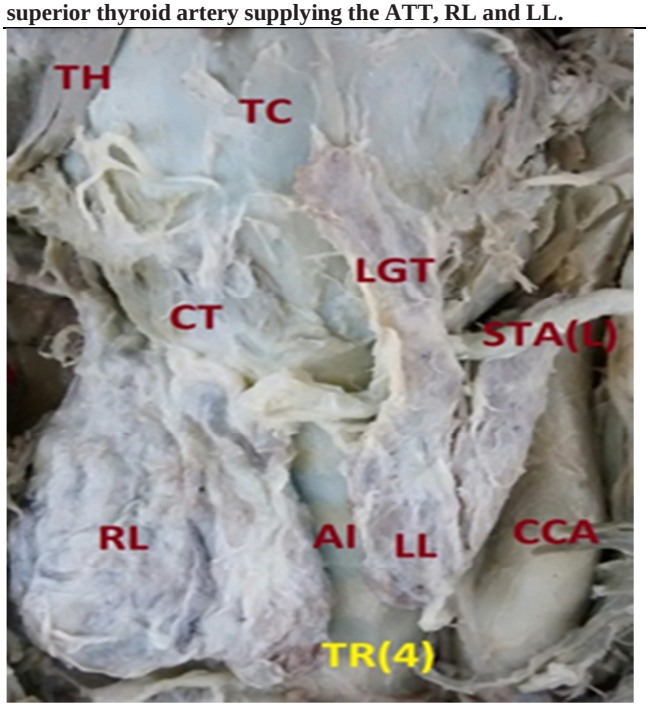

Figure 4: showing absent isthmus RL: Right lobe; LL: Left lobe; TH: Thyrohyoid muscle; CT: Cricothyroid muscle; TC: Thyroid cartilage; AI: Absent isthmus; LGT: Levator glandulae thyroidae; CCA: Common carotid artery; STA (L): Left superior thyroid artery also supplying the upper pole of right lobe. TR (4): Fourth tracheal ring.

Discussion

The morphological variations of the thyroid gland found in present study were compared with previous similar studies [Table 4].[14-19]

Pyramidal Lobe was found to be the most commonly occurring morphological variation of the thyroid gland with 18% incidence. As evident from the [Table 4], the incidence of the presence of the PL varies from 18% to 58%. This large variation in occurrence of PL may be because of difference in ethnicity and dietary habits (iodine content) of the population studied. As far as Indian subcontinent is concerned, coastal area of southern India (Ranade et al),[15] showed highest incidence (58%), followed by North east region (Rajkonwar et al),[19] showing 38.75% followed closely by western part (Joshi et al),[17] showing 37.77% incidence. Our study, comprising of cadavers of north Indian origin showed the lowest incidence (18%) of PL amongst all. Harjeet et al,[14] who also studied the incidence of PL on cadavers of Northwest Indian origin found it to be 28.9%, much less than the other parts of Indian subcontinent. So we can conclude that incidence of PL may have a relation with dietary iodine content. Incidence is highest in coastal area of southern India and lowest in northen India (Himalayan goitre endemic belt of northern India), located far away from the coastline where availability of seafood is very limited.

In the present study PL was arising more commonly from the junction of the right lobe with the isthmus (Milojevic type II) which is in contrary with the findings of the previous studies.[12,17,19] Most authors have described the origin of PL from the upper border of the isthmus, slightly from the left of mid-sagittal plane. The presence of double PL has also been described by Joshi et al.[17] This rare anomaly of double pyramidal process is generally explained by assuming a high bifurcation of the thyroid anlage, the growing thyroglossal duct split at its apex, and each branch giving origin to a lobe of the gland.[20] Embryologically PL represents partial persistence of glandular tissue from the caudal end of the thyroglossal duct.[21] Its presence could be a potential source of increased risk in thyroidectomy, due to its unreliable preoperative diagnosis on scintigraphic images.[22]

Total, subtotal & partial thyroidectomy performed for different stages of thyroid carcinoma require precise and accurate knowledge of variations associated with the gland. PL, also known as Lolouett's lobe - should be looked for & removed otherwise it can result in incomplete resection of the thyroid gland. Residual thyroid tissue in the PL can lead to serious complications in diseases like carcinoma & Grave's disease where complete removal of thyroid gland is indicated.[16]

LGT was found to be the 2nd most commonly occurring morphological variations of the thyroid gland with 14% incidence. The incidence of the presence of the LGT varies from 14% to 59.4% [Table 4].

According to Standring, the LGT extends from the PL or the upper border of the isthmus usually on the left side, to the body of hyoid bone above.[1] Various authors have studied the extension of LGT in detail. According to Joshi et al.[17] LGT was attached to hyoid bone in 66.66% cases, to the upper border of thyroid cartilage in 14.81% and to the lower border of the thyroid cartilage in 18.51% cases. Harjeet et al,[14] described it as extending caudally from the body of the hyoid in 53.2% of males and in 52.9% of females, in 10.8% from the median thyroid ligament, and from the lower border of the lamina of the thyroid in 34.04%. Marshall,[23] found LGT attached to the hyoid bone in 28.3% cases and in 14.98% cases it merged with the fascia covering the thyroid cartilage. Faysal et al,[24] observed an unusual case in which LGT extended from the apex of the mastoid process up to the body of hyoid bone. In our study, the upper end of LGT was attached to the body of hyoid bone in all cases, except in one where LGT failed to reach hyoid bone and was attached to the thyroid cartilage. Regarding its association with PL, Rajkonwar et al,[19] found that in all cases LGT was extending from the apex of the PL. Current study showed that the lower end of LGT was associated the apex of PL in all cases except in one where the PL was absent and the lower attachment was with isthmus of thyroid gland.

Based on the observations of 210 LGTs, Mori,[13] classified it into five types; a) Hyopyramidalis, b) Thyreopyramidalis, c) Thyreoglandularis, d) Hyoglandularis, and e) Tracheoglandularis. In the present study we found 5 cases of hyopyramidalis (came from apex of PL went up to hyoid bone), one each of thyreopyramidalis (extending from PL to thyroid cartilage) and hyoglandularis (directly came from upper border of isthmus and went upto hyoid bone) type of LGT. Though many earlier workers have studied the

morphology of LGT but were of different opinions, so this remains a matter of debate and further investigation. According to Gregory and Guse,[25] Soemmerring's LGT 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. Allan,[26] reported LGT, a band of connective tissue, which extended from the apex of right or left lobe or isthmus of the thyroid gland to the hyoid bone. Chaudhary et al,[27] carried out microscopic examination, which revealed that LGT was mainly made up of glandular, muscular and fibrous tissue. Our study showed that in 4 cases, the nature of the LGT was fibro muscular while in 3 it was fibrous on gross visualization. So, it is obvious from above discussion, that its fibromusculogandular nature was not simultaneously reported by any of the authors as in the present study. We further suggest histological examination of the tissue of LGT to confirm its nature.

We found an accessory gland located below and lateral to the right lobe at the level of 3rd to 4th tracheal ring and was lying on the common carotid artery. Braun et al,[22] studied 58 cadavers and found one specimen with an accessory thyroid gland. This may be present at the carotid bifurcation and may resemble carotid body tumour.[28] Sometimes this ectopic tissue could be the patient's only properly functioning thyroid tissue and removal of tumor could cause severe hypothyroidism.[29] Mysorekar et al,[29] reported an ectopic thyroid tissue in the parotid gland. According to him, this could be due to a common evolution of the thyroid and parathyroid glands.

In the present study, absence of isthmus was found to be the least commonly occurring morphological variations of the thyroid gland with 4% incidence. According to various authors its occurrence varies from 4% to 33% [Table 4]. The absence of an isthmus can be associated with other types of dysorganogenesis, such as the absence of a lobe or the presence of ectopic thyroid tissue.[30] When absence of isthmus is observed, a differential diagnosis against the following pathologies should be carried out: (a) autonomous thyroid nodule; (b) thyroiditis; (c) primary carcinoma; (d) neoplastic metastases; and (e) infiltrative diseases such as amyloidosis.[6]

Conclusion

PL was found to be the most commonly occurring morphological variation of the thyroid gland with 18% incidence and frequently arising from the right side of the isthmus. Large variation in the occurrence of PL may be because of difference in ethnicity and dietary habits (food iodine content) of the population studied. LGT was found in 14% and almost in all cases it was extending from the apex of the pyramidal lobe to the hyoid bone. Only 4% cadavers did not show an isthmus while accessory thyroid tissue was found only in one case. Morphological variations were more common in females than in males and the gender difference was statistically significant (p value<0.05). The means of all measured parameters were higher in female than in male but these gender differences were not significant (p>0.05).Morphological variation of the thyroid gland is a common phenomenon, particularly in female. Hence it requires proper detection and documentation prior to any surgery on the thyroid gland so that iatrogenic catastrophies can be avoided.

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