Original Research Article

Anatomical variations of thyroid gland - A cadaveric study

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Abstract

Background: Thyroid gland is situated in anterior lower neck region close to vital structures surrounding the trachea. Many anatomical variations are noted in the morphology and arterial supply of thyroid gland. Without prior knowledge, these variations can lead to damage of the surrounding structures as well as incomplete removal of gland in thyroidectomy. **Materials and methods**: The study was done on 52 adult human cadavers of either sex during educational dissections in the departments of Anatomy, Siddhartha Medical College, Vijayawada and N.R.I. Medical College, Chinakakani, for a period of four years from 2014 to 2018. **Results:** Various anatomical variations observed in this study are pyramidal lobe, levator glandulae thyroideae and absence of isthmus along with variations in the origins of superior and inferior thyroid arteries. **Conclusion**: Thorough and clear knowledge of anatomical variations prior to treatment of thyroid and anterior neck surgeries lead to significant reduction in the morbidity and mortality.
Key Word: Common carotid artery, External carotid artery, Hyoid bone, Levator glandulae thyroideae, Pyramidal lobe, Thyroid cartilage.

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INTRODUCTION

Thyroid is an endocrine gland of rich vascularity which is situated anteriorly in lower part of neck. It extends from 5th cervical to 1st thoracic vertebra. It has two symmetrical lobes bridged by isthmus, which lies against 2nd, 3rd and 4th tracheal rings. The arteries supplying the thyroid gland are superior and inferior thyroid arteries and thyroid eaima artery, which is inconstant and unpaired. Superior thyroid artery arises from external carotid artery as its first branch. The inferior thyroid artery arises from the thyrocervical trunk. Thyroid gland develops from thyroglossal duct with contribution from 4th pharyngeal pouch and ultimobronchial body during embryological period. Disturbance in the thyroglossal duct descent or regression can result in various thyroid anomalies. These include pyramidal lobe, levator glandulae thyroideae, absence of isthmus or lobes, lingual thyroid and accessory thyroid tissue. Thorough knowledge of anatomical variations of thyroid gland is of utmost importance to prevent damage to parathyroid glands and laryngeal nerves. The identification of pyramidal lobe and its removal is of paramount importance during total thyroidectomy and post-operative radiotherapy for carcinoma of thyroid. Because of intimate relationship of thyroid arteries with laryngeal nerves, there is a risk of damage to these nerves during ligation of arteries thereby causing paralysis of laryngeal muscles. The present scenario of surgical management of thyroid diseases is more dependent on the embryology and anatomical variations of the thyroid gland and other vital structures in the neck, which helps the surgeon to perform successful neck surgeries and decrease the patient morbidity and mortality.

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MATERIALS AND METHODS

This study was done on 52 adult human cadavers of either sex (Male: 40 and Female: 12) allotted for educational dissections in the Departments of Anatomy, Siddhartha Medical College (Govt.), Vijayawada and N.R.I. Medical College, Chinakakani, Guntur (Dt.) over a period of four years (from 2014 to 2018). All the cadavers were properly embalmed and fixed in formalin. Dissection of anterior neck region was done carefully following standard procedure to expose the thyroid gland and its arteries, with particular significance to the presence of levator glandulae thyroideae, pyramidal lobe and their attachments. Origins of arterial supply were noted. Proper ethical clearance was obtained from the ethical committee of this institution for the present study.

RESULTS

The following anatomical variations were observed in the present study.

1. Levator glandulae thyroideae
2. Pyramidal lobe
3. Pyramidal lobe with levator glandulae thyroideae.
4. Absence of isthmus
5. Origin of superior and inferior thyroid arteries.

Presence of levator glanduale thyroideae was the most common anatomical variation, whereas the absence of isthmus was the least common. Absence of isthmus is more common in females compared with males. In the present study, levator glandulae thyroideae is seen in 18 out of 52 cadavers (34.6%). It is more common in male cadavers (14) than in female (4). Out of the 18 cadavers showing levator glandulae thyroideae, inferior attachment was to the pyramidal lobe in 4 cadavers (7.7%), to the left side of the isthmus in 9 cadavers (17.3%), to the right side of isthmus in 2 cadavers (3.8%) and to the midline of isthmus in 3 cadavers (5.8%).

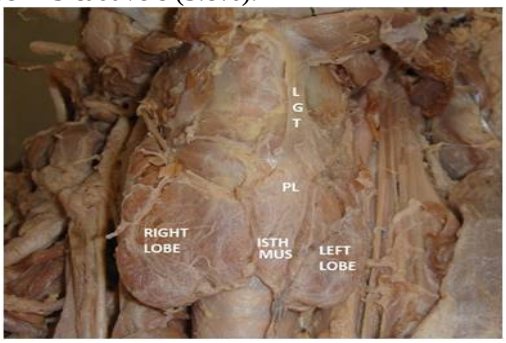


Figure 1: Pyramidal lobe with levator glandulae thyroideae. Pyramidal lobe is noted to left of the midline and levator glandulae thyroideae shows inferior attachment to the pyramidal lobe and superior attachment to the hyoid bone. PL – Pyramidal lobe. LGT - Levator glandulae thyoideae.

Out of the 18 cadavers showing levator glandulae thyroideae, superior attachment is to hyoid bone in 15 cadavers (28.8%) and to thyroid cartilage in 3 cadavers (5.8%). The pyramidal lobe is seen in 7 out of 52 cadavers (13.4 %) in present study.

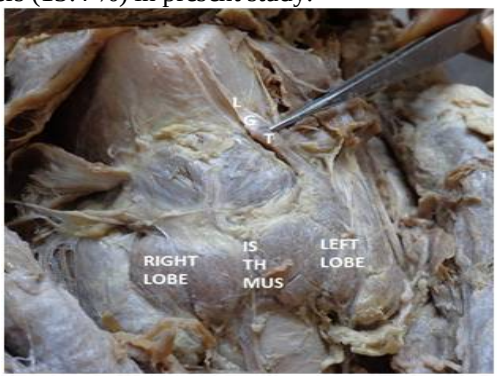


Figure 2: Levator glandulae thyroideae shows superior attachment to the thyroid cartilage and inferior attachment to the left of isthmus. LGT– Levator glandulae thyroideae.

Table 1: Variations of the thyroid gland noted in the present study

S.No	Variation	Total number
1	Levator glandulae thyroideae	18 (34.6%)
2	Pyramidal lobe	7 (13.4%)
3	Absence of isthmus	3 (5.8%)

Table 2: Variations of thyroid gland in the present study with gender significance

S No	Variation	Gender	
		Male	Female
1	Levator glandulae thyroideae	14(26.9%)	4(7.7%)
2	Pyramidal lobe	5 (9.6%)	2 (3.9%)
3	Absence of isthmus	1 (1.9%)	2 (3.8%)

Absence of isthmus was noted in 3 cadavers (5.8%) in present study. No cadaver shows aberrant thyroid tissue.

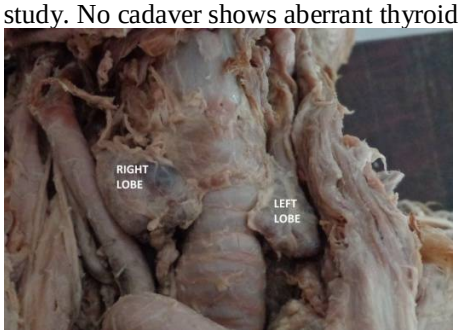


Figure 3: Absence of isthmus of thyroid gland.

In the present study, superior thyroid artery is noted arising at common carotid artery bifurcation in 3 cadavers, out of which 2 are on left side and 1 on right side (2.9%) and from common carotid artery in 2 cadavers, one on each side (1.9%). Rest of the cadavers show normal superior thyroid artery origin from external carotid artery.

Figure 4: Superior thyroid artery arising at common carotid artery bifurcation on left side. STA - Superior thyroid artery. CCA - Common carotid artery

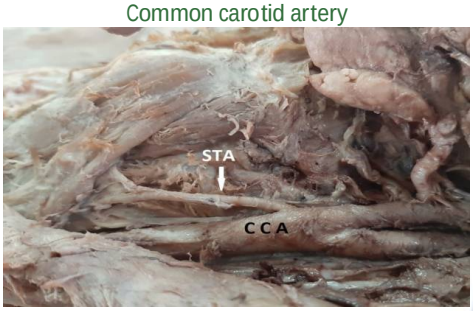
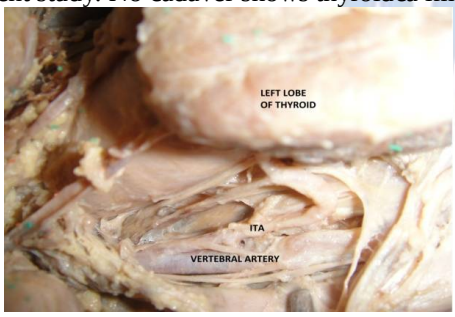


Figure 5: Superior thyroid artery arising from the common carotid artery on left side. STA -Superior thyroid artery. CCA - Common carotid artery

In one cadaver (0.96%), the inferior thyroid artery is noted arising from the vertebral artery on the left side in the present study. No cadaver shows thyroidea ima artery.



DISCUSSION

Levator Glandulae Thyroideae: According to Stranding[1] (2006) it is a fibromuscular band that extends from the pyramidal lobe or upper border of the isthmus of thyroid gland to the body of hyoid bone. According to Gregory and Guse[2], Sommerrings levator glandulae thyroideae is an accessory muscle which extends from hyoid bone partly to the thyroid cartilage and partly to the isthmus of thyroid gland. Mori classified levator glandulae thyroideae into five types in 1964. It is based on its origin and insertion.

Type 1: Hyopyramidalis
Type 2: Thyreopyramidalis
Type 3: Thyreoglandularis
Type 4: Hyoglandularis
Type 5: Tracheoglandularis.

As per the study done by A. Harjeet *et al*[3] (2004) levator glandulae thyroideae is present in 19.8% cadavers, of which 53% show superior attachment to hyoid bone and 10% show attachment to thyrohyoid ligament. Levator glandulae thyroideae is present in 43% cadavers according to Marshall[4] (1895), in 49.5% cadavers by Ranade A V *et al*[5] (2008), in 7.3% cadavers according to Daksha Dixit *et al*[6] (2009) and in 43.3% cadavers by Sultana S Z *et al*[7] (2009). In Sultana *et al*[7] study, the levator glandulae thyroideae shows inferior attachment to the apex of pyramidal lobe in 22 cadavers (out of 26) and superior attachment to hyoid bone, while remaining 4 cadavers show inferior attachment to isthmus extending cranially to thyroid cartilage or hyoid bone. In the study done by Joshi S D *et al*[8] (2010), levator glandulae thyroideae was seen in 30% cadavers, with superior attachment to body of hyoid bone in most of the cases Kafeel Hussain *et al*[9] (2015) noted levator glandulae thyroideae in 25% of cadavers in their study out of which 4 were noted extending from pyramidal lobe and 3 from the right lobe of thyroid gland. According to Shobha Gaikwad[10] (2016) study levator glandulae thyroideae is noted in 30.85% cadavers. Levator glandulae thyroideae was noted in 5% of cadavers in study done by Venkata Vinay Kumar M *et al*[11] (2018), in 36.6% cadavers in study done by Hemalatha[12] (2018) and in 18.75% cadavers in study done by Anjan Jyoti Rajkonwar[13] (2016). Prevalence of levator glanduale thyroideae is 41% in study done by Veerahanumaiah S[14] (2015) and 34.61% in study done by Abhijeet Yadav[15] (2014). Devi Sankar K[16] (2009) noted a rare case of agenesis of isthmus of thyroid gland which is associated with bilateral levator glandulae thyroideae. In the present study, levator glandulae thyroideae is seen in 18 out of 52 cadavers (34.6%). Out of the 18 cadavers showing levator glandulae thyroideae, inferior attachment is to the pyramidal lobe in 4 cadavers (7.7%), to the left side of isthmus in 9 cadavers (17.3%), to the right side of isthmus in 2 cadavers (3.8%) and to the isthmus at midline in 3 cadavers (5.8%). Out of the 18 cadavers showing levator glandulae thyroideae, superior attachment is to the hyoid bone in 15 cadavers (28.8%) and to the thyroid cartilage in 3 cadavers (5.8%). The presence of Levator glandulae thyroideae in the present study is comparable with studies done by Hemalatha[12] (2018) and Abhijeet Yadav[15] (2014).

Pyramidal Lobe: Incidence of pyramidal lobe which is an embryological remnant of thyroglossal duct vary between 15 to 75% in anatomy literature according to Thews[17] (1999). It is also called as Laloutte's lobe. Prevalence of pyramidal lobe is noted in 50% cadavers in Bhatnagar *et al*[18] (1997) study, in 28.9% cadavers in Harjeet A *et al*[3] (2004) study, in 58% cadavers in Ranade

A V *et al*[5] (2008) study. Its incidence is 7.31% according to study by Daksha Dixit *et al*[6] (2009) and 57.8% as per O Tanriover *et al*[19] (2011) study. Pyramidal lobe was noted in 37.77% of cadavers in Joshi SD *et al*[8] (2010) study, in 50% cadavers in study by Sultana S *et al*[20] (2009), and in 55% of cadavers according to Braun *et al*[21] (2007). Pyramidal lobe was observed in 40.6% of cadavers according to Kafeel Hussain[9] (2015) study and in 26.59% by Shobha Gaikwad[10] (2016) study. Pyramidal lobe was observed in 13.3% of cadavers according to Venkata Vinay Kumar M *et al*[11] (2018), in 43.3% cadavers according to Hemalatha[12] (2018) study, in 38.75% cadavers according to Anjan Jyoti Rajkonwar[13] (2016) study, in 46% cadavers according to Veerahanumaiah S[14] (2015) study and 30.76% cadavers according to Abhijeet Yadav[15] (2014) study. The pyramidal lobe was noted in 7 cadavers (13.4%) in the present study. The presence of pyramidal lobe in the present study is comparable with study done by Venkata Vinay Kumar M *et al*[11] (2018).

Absence of isthmus of Thyroid Gland: Absence of isthmus is due to embryological or developmental defect in which high division of thyroglossal duct will result in the formation of two independent thyroid lobes devoid of isthmus. According to Marshall[4] (1895) study, prevalence of absence of isthmus was about 10%. Isthmus of thyroid gland is absent in 6.9% cadavers by Braun *et al*[21] (2007) study, in 33% cadavers by Ranade A V *et al*[5] (2008) study, in 14.6% cadavers according to Daksha Dixit *et al*[6] (2009) study and in 16.6% cadavers by Joshi D *et al*[8] (2010) study In their study Kafeel Hussain[9] (2015) found absence of isthmus in 6.20% of cadavers and in 29.78% cadavers in study by Shoba Gaikwad[10] (2016). Absence of isthmus was observed in 8.3% of cadavers in study by Venkata Vinay Kumar M *et al*[11] (2018), in 6.66% of cadavers by Hemalatha[12] (2018) study and in 21.25% cadavers by Anjan Jyoti Rajkonwar[13] (2016) study. Prevalence of absence of isthmus is 9% in study done by Veerahanumaiah S[14] (2015). Absence of isthmus was noted in 3 cadavers (5.8%) in the present study. The absence of isthmus in the present study is comparable with studies done by Braun *et al*[21] (2007), Kafeel Hussain[9] (2015) and Hemalatha[12] (2018)

Superior thyroid artery origin: The superior thyroid artery commonly takes its origin from the external carotid artery as its first branch. Less frequently it may take its origin either from the common carotid artery or at its bifurcation. Rarely it arises from subclavian artery. Vazquez *et al*[22] (2009) in his study noted that superior thyroid artery is having four different origins, of which the most common being from common carotid bifurcation in 49% and from thyrolingual trunk in 0.6% cadavers. In Kevin W Ongeti *et al*[23] (2012) study, in 80.4% cadavers the superior thyroid artery is arising from external carotid artery, in 2.2% it is arising at common carotid bifurcation and in 10.9% cadavers it is from common carotid artery. According to Abhijeet Joshi *et al*[24] (2014) the superior thyroid artery is taking its origin from external carotid artery in 66.67% cadavers, from common carotid artery in 1.51% and at common carotid bifurcation in 31.81%. Lucev *et al*[25] (2000) in their study reported that superior thyroid artery is arising from common carotid bifurcation in about 22.5% cadavers, from common carotid artery in 47.5% and from external carotid artery in 30%. According to Anitha T *et al*[26] (2011) study superior thyroid artery most commonly arises from external carotid artery in 59% cases, at common carotid artery bifurcation in 19% cases and from common carotid artery in 21% cases. According to Hollinstead[27] (1966) superior thyroid artery is noted arising from common carotid artery bifurcation in 16% cases. Sanjeev *et al*[28] (2010) noted that superior thyroid artery is arising from common carotid artery bifurcation in 35.14% cadavers. According to Meselech A D[29] (2018) study superior thyroid artery is noted arising from external carotid artery in 44.2% cadavers, at common carotid bifurcation in 27.9% cadavers and from the common carotid artery in about 26.7% cadavers. In the present study, superior thyroid artery is noted arising at common carotid artery bifurcation in 3 cadavers (2.9%) and from common carotid artery in 2 cadavers (1.9%). Rest of the cadavers show normal origin from the external carotid artery. The origin of superior thyroid artery from the common carotid artery in the present study is comparable with study done by Abhijeet Joshi *et al*[24] (2014) and the origin at the common carotid artery bifurcation is comparable with study done by Kevin W Ongeti *et al*[23] (2012).

Inferior thyroid artery origin: The inferior thyroid artery commonly takes its origin from thyrocervical trunk. Less frequently it may arise from subclavian artery, and very rarely from vertebral artery, internal thoracic artery, aortic arch, brachiocephalic trunk, common carotid artery, dorsal scapular and supra scapular arteries. In a case report by Konstantinos Natsis *et al*[30] (2009) left inferior thyroid artery is noted arising from left vertebral artery. The inferior thyroid artery arises from vertebral artery in 0.7% of cases according to Adachi B[31] (1928). In the present study one cadaver shows origin of inferior thyroid artery from the vertebral artery on left side (0.96%). The origin of inferior thyroid artery from vertebral artery in this study is comparable with study done by Konstantinos Natsis *et al*[30] (2009) and Adachi B[31] (1928).

CONCLUSION

Thorough knowledge of normal anatomy of thyroid gland and its variations are essential to accurately diagnose the disease and to perform effective and safe surgery. During surgery identification of pyramidal lobe is essential so that total removal of pathology is possible without leaving any residual disease in pyramidal lobe. Identification of pyramidal lobe is also essential in the treatment planning of radio iodine therapy for carcinoma of thyroid cases and for follow up. Absence of isthmus of thyroid gland is also associated with other anomalies of thyroglossal duct descent and regression like absence of lobe, ectopic thyroid tissue etc. Hence during thyroidectomy, one should look for absence of isthmus. During ligation of thyroid arteries in thyroid surgeries, inadvertent damage to the laryngeal nerves leading to intrinsic laryngeal muscle paralysis can occur due to close association between arteries and nerves near the thyroid gland. Hence prior knowledge of arterial variations is essential to prevent these complications.

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