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Original Research Article

MORPHOLOGICAL VARIATIONS IN THE ARTERIAL & NERVE SUPPLY OF THYROID GLAND – A CADAVERIC STUDY

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ABSTRACT

Introduction: The arteries and nerves related to the thyroid gland are very important as they are the potential source of bleeding and palsy during thyroidectomies and other head and neck surgeries. Thus a thorough knowledge of relation between them is a prerequisite for the surgeons and other interventionists.

Materials and Methods: The study was done in the Department of Anatomy, Government Medical College, Patiala, Punjab among 30 adult human cadavers from May 2015 to Nov 2015. The origin, course, terminal branches and the relation of superior and inferior thyroid arteries to external and recurrent laryngeal nerves respectively were noted and the results were evaluated. The complete pattern of morphology of the thyroid gland in relation to the arterial and nerve supply was labelled as standard or variant. Bilateral symmetry of pattern was noted and details of the variations were enumerated. A detailed inference was obtained in the light of present observations and the findings of earlier workers.

Results: In 29 cases we found the superior and inferior thyroid arteries were originating from the external carotid artery and thyrocervical trunk respectively while in 1 case there was thyroidea ima artery originating from right common carotid artery with absent right inferior thyroid artery. The external and recurrent laryngeal nerves were related to superior and inferior thyroid arteries as described by most of the standard textbooks but the detail percentages of the relationship is given below.

Conclusion: The study is an attempt to establish a relation between the variations that we generally encounter in thyroid glands related to its arteries and nerves. Proper identification of thyroid gland vessels is very important in order to avoid major complications during and after neck surgeries. Thyroid anatomy and its associated anatomical variations are very essential to know for Endocrinologist and Surgeons, so that these anomalies are not overlooked while arriving at a diagnosis.

KEY WORDS: External laryngeal nerve, Recurrent laryngeal nerve, Superior thyroid artery, Inferior thyroid artery.

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INTRODUCTION

The thyroid gland is highly vascular endocrine gland situated anteriorly in the neck at the level of fifth cervical to first thoracic vertebra [1]. It is composed of two lateral lobes connected by a narrow median isthmus in front of the trachea in anterior lower neck [2]. Three arteries mainly supply the thyroid gland.

The superior thyroid artery - arises from the external carotid and passes to the upper pole; The inferior thyroid artery - arises from the thyrocervical trunk of the 1st part of the subclavian artery and passes behind the carotid sheath to the back of the gland; The thyroidea ima artery - is inconstant; when present, it arises from the aortic arch or the brachiocephalic artery; Apart from these named branches, numerous small vessels pass to the thyroid from the pharynx and trachea so that even when all the main vessels are tied, the gland still bleeds when cut across during a partial thyroidectomy [3].

The superior thyroid artery, the first branch from the anterior aspect of the external carotid, after giving off its sternocleidomastoid and superior laryngeal branches, pierces the pretracheal fascia as a single vessel to reach the summit of the upper pole .The external laryngeal nerve is immediately behind the artery as the vessel approach the upper pole. The artery divides on the gland into an anterior branch that runs down to the isthmus and a posterior branch that runs down the back of the lobe and anastomoses with an ascending branch of the inferior thyroid artery from the lower pole. In thyroidectomies the artery is ligated close to the upper pole or its anterior and posterior branches are ligated instead, to avoid the damage to external laryngeal nerve.

The inferior thyroid artery, from the thyrocervical trunk, arches upward and medially behind the carotid sheath and then loops downwards to the lower pole. It divides outside the pretracheal fascia into branches that pierces the fascia separately to reach the lower part of the gland. The recurrent laryngeal nerve has a variable relationship to the artery but always lies behind the pretracheal fascia. Ligating the inferior thyroid artery well lateral to the gland or carefully ligating its small branches on the surface of the gland, helps to safeguard the nerve. The inferior thyroid artery gives off the ascending cervical artery and small pharyngeal, esophageal, laryngeal and tracheal branches before its terminal distribution to the thyroid gland; the small inferior laryngeal artery ascends with the recurrent nerve.

The relationship of the recurrent laryngeal nerve to the thyroid lobes has importance in thyroid surgery. As they approach the medial surface of the gland from below, the nerve lies in or in front of the groove between the trachea and oesophagus. The left nerve, which recurves around the arch of aorta in the superior mediastinum, is more likely to have entered the groove and lies posterior (though occasionally anterior) to the inferior thyroid artery. The right nerve recurves around the right subclavian artery at the root of the neck and may be more lateral to the trachea, passing anterior or posterior to inferior thyroid artery or in between its branches. Each nerve is behind the pretracheal fascia, and runs medial or lateral or through a thickening of the fascia attached to the cricoid cartilage and upper tracheal rings (the suspensory ligament of Berry).The nerve runs behind the cricothyroid joint and passes upward under cover of the inferior constrictor. At the level of the upper border of the isthmus the nerve often divides into two. If so, the anterior (larger) branch is the motor branch to laryngeal muscles, and the posterior branch is sensory only. The rare non-recurrent right laryngeal nerve may be a hazard during thyroid surgery [4].

The risk of injury to the recurrent laryngeal nerves is ever present during neck surgery. Near the inferior pole of the thyroid gland, the right recurrent laryngeal nerve is intimately related to the inferior thyroid artery and its branches. The nerve may cross anterior or posterior to the branches of the artery, or it may pass between them. Because of this close relationship the inferior thyroid artery is ligated some distance lateral to thyroid gland, where it is not close to the nerve. Although the danger of injuring the left recurrent laryngeal nerve during surgery is not as great owing to its more vertical ascent from the superior mediastinum, the artery and nerve are also closely associated near the inferior pole of the thyroid gland. Hoarseness is the usual sign of unilateral recurrent nerve injury; however, temporary aphonia or disturbance of phonation (voice production) and laryngeal spasm may occur. These signs usually result from bruising the recurrent laryngeal nerves during surgery or from the pressure of accumulated blood and serous exudate after the operation [5].

Since there are an alarming number of table

deaths in patients of thyroid diseases due to deaths in patients of thyroid diseases due to excessive and uncontrollable bleeding during thyroid surgeries, a thorough knowledge of the arterial supply of the thyroid gland is very essential for the surgeons.

Aims and Objectives:

To study the arterial supply of thyroid glands and variations, if any, To study the relation of superior thyroid and inferior thyroid arteries, with external and recurrent laryngeal nerves respectively and their variations, if any.

MATERIALS AND METHODS

Thirty properly embalmed human cadavers of either sex procured from the Department of Anatomy, Government Medical College, Patiala formed the material for this study. The cadavers were labelled from 1-30 with suffix "M" for male and "F" for female. All embalmed cadavers available during the study period were included, whereas cadavers with gross abnormality in the neck such as any scar or any swelling were excluded from the study. The incisions on the neck for exposure of thyroid gland and its arterial pattern was given as shown in Cunningham's Manual of Practical Anatomy by ROMANES (Reprinted 2016) [6] taking care to preserve all nerves related to its arteries by sacrificing venae commitans. The fascia over the lobe of thyroid gland was cleaned carefully. The arterial supply and the relations of the arteries to respective nerves were studied in situ. The data obtained was noted down and the results were evaluated. The thyroid gland was dissected carefully and all the arteries supplying the thyroid gland on both sides were noted accordingly. The number, origin, course, number of terminal branches and relationship with the adjacent nerves at the superior and inferior pole of the thyroid gland i.e. the external laryngeal nerve and the recurrent laryngeal nerve, of the superior thyroid arteries and the inferior thyroid arteries were noted respectively. Presence or absence of thyroidea ima artery was noted in each case and any other variations pertaining to the arterial supply was also noted.

RESULTS

Right superior thyroid artery: In all the 30 cases, the right superior thyroid arteries were single in number and were originating from the right external carotid artery. Their course was towards the superior pole of the right side and as usual, all of them had two terminal branches i.e. anterior and posterior supplying the anterior, medial and the lateral surfaces. In all the cases, the right superior thyroid arteries were lying laterally and anteriorly to right external laryngeal nerves at the superior pole.

Left superior thyroid artery: In all the 30 cases, the left superior thyroid arteries were single in number and were originating from the left external carotid arteries. Their course was towards the superior pole of the left side and as usual, all of them had two terminal branches i.e. anterior and posterior supplying the anterior medial and lateral surfaces. In all the cases, the left superior thyroid arteries were lying laterally and anteriorly to left external laryngeal nerves at the superior pole.

Right inferior thyroid artery: The right inferior thyroid arteries were present in 29 out of 30 cases. In 1 case, the right inferior thyroid artery was absent and the right inferior pole of that gland was getting its blood supply from the lateral branch of thyroidea ima artery. The thyroidea ima artery was originating from the right common carotid artery and had two terminal branches, medial and lateral. The medial branch was supplying the isthmus of the thyroid gland whereas the lateral branch was supplying the lower pole of the right side of the gland. (Fig. 2)

In all other 29 cases, the right inferior thyroid arteries were single in number and were originating from the thyrocervical trunk of the right side. Their course was towards the lower pole of the right lobe after making a loop from the origin they were finally terminating with two branches, i.e. superior and inferior. The relationship of the right inferior thyroid artery with the right recurrent laryngeal nerve at lower pole was variable. In 9 cases out of 29, i.e. 31%, the right inferior thyroid artery was passing anterior to the right recurrent laryngeal nerve whereas in majority of the cases i.e. 15 out of 29 i.e. 51.7%, it was passing posterior to right recurrent laryngeal nerve. In the remaining 5 cases, i.e. 17.3%, the right recurrent laryngeal

nerve was passing between the branches of right inferior thyroid artery.

Left inferior thyroid artery: The left inferior thyroid arteries were present in all the 30 cases. They were single in number and were originating from the left thyrocervical trunk. Their course was towards the lower pole of the left lobe and after making a loop from the origin, they were terminating in the gland as superior and inferior branches. The relationship of the left inferior thyroid artery with left recurrent laryngeal nerve at the lower pole was variable. In majority of the cases, i.e.18 out of 30 cases i.e.in 60%, the left inferior thyroid artery was lying anterior to the left recurrent laryngeal nerve whereas in the rest 40% cases, it was lying posterior to the nerve.

Thyroidea ima artery: The thyroidea ima artery was present in only 1 case (3.33%).It was single in number, originating from the right common carotid artery. Its course was towards the isthmus of the thyroid gland and was terminating by giving two branches, medial and lateral. The medial branch was directly supplying the isthmus of the thyroid gland whereas the lateral branch was supplying the inferior pole of the right lobe. Interestingly, the right inferior thyroid artery was absent in this case and thus, the lateral branch of the thyroidea ima artery was the sole supply of the right lower pole of the gland behaving as the right inferior thyroid artery. In this case, the right recurrent laryngeal nerve was passing posterior to the lateral branch of the thyroidea ima artery at the right lower pole of the gland. (Fig. 2)

Fig. 1: Showing relation of Inferior Thyroid Artery(ITA) (Arrow) & Recurrent Laryngeal Nerve(RLN)(Double arrow).

Fig. 2: Showing Thyroidea ima artery (TIA) and its branch.

Fig.3: Showing Superior Thyroid Artery (STA)(Arrow) and External Laryngeal Nerve (ELN) (Double Arrow).

DISCUSSION

Bergman et al. reported that STA is generally considered to be present in 100% of cases and its absence has only been reported only once. An unusually large STA may replace the contralateral vessels or the inferior thyroid artery. The superior thyroid artery was more frequently present as compared to the inferior thyroid artery and the variability of the superior thyroid artery may be influenced by the anthropological factors. The lowest incidence of arterial variants of the thyroid gland has been recorded in the Swiss population with the highest in the Americans. However, there is paucity of literature with regard to unusual STAs in the Asian subcontinent especially in India. Variations in the origin of STA are important in preoperative selective arterial angiograms to map out the vascularity and the true extent of the tumors of the head, neck and face. It is also important in cases of selective arterial embolization to reduce the vascularity of the tumors of the head, neck and face and in selective intraarterial

chemotherapy. Head and neck surgeons must be familiar with anatomical variations of the STA in order to achieve a better surgical outcome [7].

The relationship of superior thyroid artery with the external laryngeal nerve was observed in all the cases. It was observed that in all the cases, the the STAs were lying anteriorly and laterally to the ELNs at superior pole of the thyroid gland.

Most of the anatomical textbooks have described the usual relation between the STAs to be as anterior and lateral to ELNs at the upper pole of the gland [4].

Table 1: Comparison of origin of STA between present study & earlier available studies.

Sl. No	Authors & Year	Origin
1	Mehta V 2010	Common carotid artery
2	Natsis K 2011	External carotid artery
3	Natsis K 2011	At the level of carotid bifurcation
4	Present Study 2015	External Carotid artery

In the present study, the inferior thyroid arteries were originating from the thyrocervical trunk in 29 cases. In 1 case, we observed that the inferior thyroid artery was absent. It was replaced by a lateral branch of thyroideae ima artery, which was arising from right common carotid artery.

Kulkarni V reported a case where the inferior thyroid artery on the left side was absent and on the right side it was arising from the thyrocervical trunk. On right side, the artery and its branches coursed in usual pattern. But on the left side, a lateral branch of the right inferior thyroid artery was supplying its whole lower pole [8].

Table 2: Comparison of origin of inferior thyroid artery with the present study and earlier available studies.

Sl No	Authors & year	Origin
1	B Pejkovik 2004	Internal thoracic artery
2	Natsis K 2010	Vertebral artery
3	Present Study 2015	Thyrocervical trunk

Campos BA et al. studied the anatomical relationship between the recurrent laryngeal nerve and the inferior thyroid artery in 76 embalmed corpses, 8 females and 68 males. In both sexes, the recurrent laryngeal nerve lay more frequently between branches of the inferior thyroid artery; it was found in this position in 47.3% of male corpses and 42.8% of female ones. On the right, recurrent laryngeal nerve was found between branches of the inferior thyroid artery in 49.3% of the cases, anterior to it in 38.04%, and posterior in 11.26%. On the left, the recurrent laryngeal nerve lay between branches of the inferior thyroid artery in 44.45%, posterior to the inferior thyroid artery in 37.05%, and anterior to it in 18.05% of the cases [9].

In the present study, we found that in 9 cases out of 29, i.e. 31%, the right inferior thyroid artery was passing anterior to the right recurrent laryngeal nerve whereas in majority of the cases i.e. 15 out of 29 i.e. 51.7%, it was passing posterior to right recurrent laryngeal nerve. In the remaining 5 cases, i.e. 17.3%, the right recurrent laryngeal nerve was passing between the branches of right inferior thyroid artery. On the left side, in 18 out of 30 cases i.e.in 60%, the left inferior thyroid artery was lying anterior to the left recurrent laryngeal nerve whereas in the rest 40% cases, it was lying posterior to the nerve.

Table 3: Comparison of the relationship of recurrent laryngeal nerve with inferior thyroid artery between the present study and earlier available studies.

Sl.No	Authors & Year	Relationship with RRLN	Relationship with LRLN
1	Ardito G 2005	23% anterior to it 35% posterior to it 40% in between its branches	45% anterior to it 35% posterior to it 30% in between its branches
2	Joshi A 2014	65% anterior to it 35% posterior to it 30% in between its branches	22% anterior to it 45% posterior to it 33% in between its branches
3	Present Study 2015	31% anterior to it 51.7% posterior to it 17.3% in between its branches	60% anterior to it 40% posterior to it

In the present study we found thyroidea ima artery in 1 case only. It was arising from right common carotid artery and was dividing into two branches, medial & lateral. The medial branch was supplying the isthmus of the thyroid gland whereas the lateral branch was supplying the inferior pole of the right lobe.

Many authors have observed different origins of thyroidea ima artery.

Surgeries of the thyroid gland demand a proper knowledge about the gross anatomy of the neck

region and the anatomical variations of the structures located within it.

Table 4: Comparison of origin of TIA between present study and earlier available studies.

Sl.No	Authors & Year	Origin.
1	Ranade et.al 2008	Arch of Aorta
2	J Prasad 2010	Brachiocephalic Trunk
3	Present Study 2015	Right common carotid artery

Consequently, it is important to have a clear knowledge regarding the branches and variations of all these arteries. Variations in the thyroid vasculature are frequently documented in classical anatomical, surgical and radiological textbooks. Most studies showed the anatomic variation of the inferior thyroid artery and the recurrent laryngeal nerve, and few have demonstrated variations of the superior thyroid artery (STA) and the external laryngeal nerve (ELN). Past studies have reported the incidence of origin of the superior thyroid artery from the common carotid artery in 5-45% cases.

An embryological explanation for the variation in all these cases could be the persistence or reappearance of vascular system in relation to the derivative of third aortic arch. These persisting or reappeared channels supplement or substitute the regular arteries, thereby securing blood supply to that side of thyroid gland, which had variant arterial supply [10].

Previous authors have reported that the superior thyroid artery is occasionally double and unilateral. An unusually large superior thyroid artery may replace the contralateral vessel or inferior thyroid artery of the same side. Morriggl et al14 reported a case of complete absence of left superior thyroid artery which was replaced by thyroid ima artery. It can be so small that it is represented only by the infrahyoid branches or by the superior laryngeal artery. In present study, no such case was observed [11].

CONCLUSION

Iatrogenic injury can be avoided with this knowledge as well as possible anatomic and pathological variation that may exist. All diagnosis and surgical procedures involving suprasternal fossa, tracheostomy in particular, require a careful approach because of possible existence of lowest thyroid artery or thyroid ima artery. Once cut or injured it can cause extensive and uncontrollable bleeding. Description of arterial and venous variations, especially if they are of rare occurrence is important for interpretation within the scope of modern imaging techniques.

Conflicts of Interests: **None**

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