DOI: http://doi.org/10.4038/jmj.v34i1.148

Review Article

Anatomical variations in the origin of the superior thyroid artery

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Abstract

Superior thyroid artery (STA) is first and lowest branch of external carotid artery (ECA) and it supplies thyroid, parathyroid, upper larynx and neck region. The STA origins either from ECA, common carotid artery (CCA) or its bifurcation level. Various researchers have reported differences in its origin. The STA commencing from the ECA is comparatively more in Indian and Ethiopian but its derivation from CCA bifurcation point is more in Turkey and Korean. Origin of STA in relative to upper border of thyroid cartilage is used as a landmark. The CCA bifurcates into external and internal carotid arteries at same level and occasionally bifurcates at a higher or lower level than its usual site. Origin of STA from CCA is associated with high bifurcation and its origin from the ECA is related with the low CCA division. Comparatively STA origin from CCA or its bifurcation level is more on right side. The CCA developed from third aortic arch and any alteration in development of aortic arches might also contribute to these variations. The STA is an artery of abundant clinical significance and it is recommended to do detailed study of its origin, course, branches, size, and positional relation with the external laryngeal nerve, hyoid bone and thyroid cartilage. Understanding of these variations is immense importance in academic and clinical arena for planning and performing surgical procedures in neck region.

Keywords

Superior thyroid artery variation, carotid bifurcation, upper border of thyroid cartilage

Introduction

The Superior thyroid artery (STA) is the first branch of the external carotid artery (ECA) in the neck. The STA provides branches to sternocleidomastoid, infrahyoid, cricothyroid, superior laryngeal and glandular/terminal branches to both thyroid and parathyroid glands (1,2). Thus it supplies the anterior part of neck region. Most of the Medical standard textbooks state that the STA origins as an anterior or front branch from the ECA (2,3,4).

The variability in the place of origin and level of origin of STA were reported by different authors. The STA may origin either from the common carotid artery (CCA), or ECA or at the level of CCA bifurcation site (4,5).

The variant STA is Detected by accidental injury during surgical procedures like total bilateral lobectomy, total unilateral with partial contralateral lobectomy of thyroid pathological conditions. The incidental damage or accidental injury of the STA or its branches or any malignant attack of its vessel wall may results in death by bleeding (2).

Anatomical study of superior thyroid artery:

Anatomically the STA was exposed by a skin incision made from the jaw to sternum in the midline and the fold of skin reflected inferolaterally and platysma muscle was taken upward. The fat and fascia were detached from the borders of the sternocleidomastoid. Then the sternocleidomastoid muscle withdrawn and the deep fascia removed from the anterior belly of digastric muscle to expose the infrahyoid muscles. The fat and fascia between the posterior belly of digastric and superior belly of omohyoid were removed to expose the carotid triangle. Thus exposed the major vessels of carotid triangle including CCA, ECA, the part of internal carotid artery (ICA) and branches of the ECA. The STA was the first and lowest branch of ECA in the carotid triangle (5).

Origin of superior thyroid artery from different source of vessels:

The previous reported studies pointed out the three major types of variants in the origin of STA (table 1) and other variations were in lesser percentage.

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Table-1 Differences in the origin of STA by different authors:

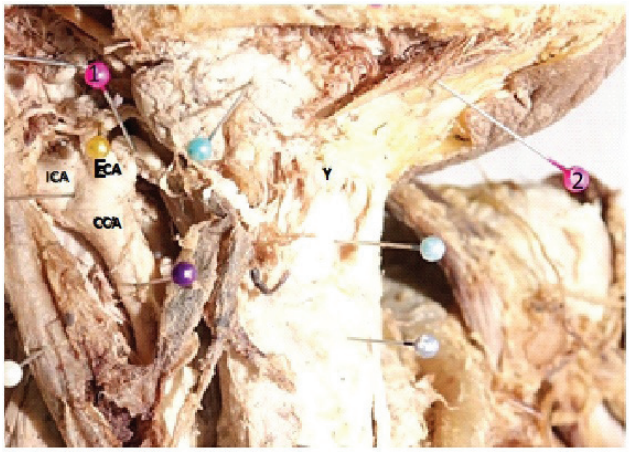
Author	Year/ Country	Origin of superior thyroid artery			
		Major three types of variations			Others
		ECA (in %)	CCA bifurcation level (in %)	CCA (in %)	
Joshi A et al.,	2014, India	66.6%	31.81%	1.51%	Nil
Dessie MA	2018, Ethiopia	44.2%,	27.9%	26.7%	1.2 % (lingual artery)
Ozgur Z et al.,	2009, Turkey	25% (above CCA)	40%	35%	Nil
SY Won	2016, Korea	20%	40%	40%	Nil

It was noted that the origin of STA from the ECA was comparatively more in the Indian and Ethiopian population (Fig 1) but its derivation from the CCA bifurcation point (Fig 2) was comparatively more in Turkey and Korean population. It was suggested by Natis K et al *in* 2011, development of a novel classification scheme on the origin of the STA and they commented that its origin in majority of the cases is considered at the level of the CCA bifurcation and not from the ECA (6). The origin of STA from CCA was found 45 % in the Americans but only 5% in the Swiss population (7). Ozgur Z et al. noted that greater incidence of origin of STA from the CCA was present in the East Asians (2).

Fig 1. STA originates at the level of bifurcation of right CCA at its anterior surface

1. CCA 2.IJV 3. Vagus nerve 4.Thyroid gland 5.Sternothyroid 6. Thyrohyoid 7. Cricothyroid 8. Superior thyroid artery 9. Facial artery 10. Hypoglossal nerve 11. Inferior alveolar nerve 12. Phrenic nerve 13.Scalene anterior muscle 14. Trunk of brachial plexus 15. Submandibular gland 16. External carotid artery 17. Internal carotid artery.

Fig 2. STA originates from the posteromedial surface of the right ECA.



STA 2. Mylohyoid muscle and Y denotes level of the hyoid bone

The CCA commonly provides no branch prior to its split into external and internal carotid arteries in the neck but a reported studies stated CCA may give rise to the superior thyroid, vertebral, laryngeal or ascending pharyngeal arteries (7).

Munjamkar P. et al. in 2017 compared the origin of STA on both sides of the neck and they commented STA most frequently arose from the ECA on the left side compared to right but majority of STA origin either from the CCA or at its bifurcation level on the right side (8). Thus comparatively right side of the neck has more chance for its origin from the CCA or its bifurcation level.

Burlakoti and Massy-Westropp, reported a case of common arterial trunk (thyrolinguofacial trunk) for three arteries namely lingual, superior thyroid and facial arteries in their studies (9). The study by Joshi A et al. observed that the STA might arise from the subclavian artery or shared trunk with the lingual artery in lesser percentage (5).

Various scholars have conveyed the cases of thyrolingual trunk originating from the CCA (2). Ghosh et al. reported an extremely rare variation where STA originated from the internal carotid artery near the CCA bifurcation level (10). Thwin S et al. noticed a common linguofacial stem in their studies (11). The linguofacial stem was the commonest detected deviation with the thyrolinguofacial trunk happening only in less number (12). The STA originated from lingual artery in 1.2 % of Ethiopian population (4).

Origin of superior thyroid artery in relation with the midline cartilages in the neck region:

It was observed that STA commonly arose as an anterior branch from the ECA immediately above the CCA bifurcation

level (5), which was usually just above the upper margin of thyroid cartilage. Another study stated that the STA origin just at the lower margin of greater cornu of hyoid bone (8).

Apart from these studies of dissimilarities in the origin of the STA from different sources of vessels, the study of the origin of STA in comparative to the midline structures in the neck were desirable for successful surgeries (13). Thus the level of the beginning of STA in relation to the upper border of thyroid cartilage was selected and used as an important landmark (Fig 1).

Table-2 Differences in the origin of the STA in level with the upper border of thyroid cartilage by different authors

Author	Year/ Country	Origin of superior thyroid artery from		
		Above the upper border of thyroid cartilage	At the level of upper border of thyroid cartilage	Below the level of upper border of thyroid cartilage
Sreedharan R et al.,	2018, India	96.66%	1.66%	1.66%
Dessie MA	2018, Ethiopia	51.2%	44.7%	44.7%
Joshi A et al	2014, India	86.36%	13.64% is at the same level and below it	

It was noted from the above studies that the STA originated above the level of upper margin of thyroid cartilage was more in number than the other types. (Table 2)

The CCA normally divided into ECA and ICA at the level of upper margin of thyroid cartilage and the STA which was the first branch from the ECA must be located slightly above the level of the thyroid cartilage. Al-Rafiah A et al. identified the CCA may bifurcate either at a superior or inferior than its usual site and they commented higher bifurcation of CCA was more common (12, 14). Thus bifurcation level of CCA may also influence the source of origin of the STA (12). (Figur 2)

The derivation of STA from CCA was connected with high CCA bifurcation and its derivation from the ECA was connected with the low carotid bifurcation (4). SY Won, (2016) reported the suggestion that these variations might be due to the ethnic differences (13).

The CCA and the part of the internal carotid artery were developed from the third aortic arch. The ECA buds cranially as a novel vessel from the third aortic arch (15). Any little changes or alteration in the development of the aortic arches might also be contributed to these variations. The origin of the ECA from the uppermost part of the 3rd aortic arch or straight from the dorsal aorta and the derivation of the ICA from the 2nd aortic arch associated with the ECA establishment from small canals are the anticipated embryological explanation for the high bifurcation of CCA (16).

Preoperative ultrasound examination is necessary to predict these types of variation of STA (9). Former angiographic valuation to determine the level of carotid division and the branch off pattern of the carotid arterial system may provide esteemed information to escape the damage of vital neck structures (12).

Clinical significance of superior thyroid artery:

Studies indicated that in 20-45% of superior parathyroid glands received the major vascular supply from the STA (17). The anterior glandular branches (AGB) of STA typically course along the medial border of the upper pole of thyroid lobe to supply largely the frontal surface as anteromedial and anterolateral glandular branches (2, 18). The AGB traversed above the isthmus to communicate with its corresponding branch of the opposite side while its posterior glandular branch (PGB) inclines on the posterior border to supply the corresponding medial and lateral surfaces (2).

The STA crossed the external laryngeal nerve before it reached the upper pole of thyroid lobe (5). The nerve is likely at risk when ligating the STA stem. The rate of injury to this nerve is variable but it can be as high as 58% and its dysfunction results in inability to achieve high frequency sound (18). External laryngeal nerve is the sole motor nerve to the cricothyroid muscle, which maintains the tension of the vocal cord.

The study of the course of the STA and its distance from the thyroid gland should be clearly defined to minimize the bleeding during the removal of tumors from thyroid and parathyroid glands (13).

The STA is clinically essential for embolization of thyroid and parathyroid masses. The STA can be used as a source of repairing material succeeding carotid endarterectomy. It is the nourishing channel for almost 80% of thyroid growths (19,13). There is a correlation between the STA blood flow and the thyroid gland mass, micro vessels density and histopathological pattern in Grave's disease (19). During radical neck surgery, the chief dreaded problem is the break of the superior thyroid artery and its branches (5).

Conclusion:

The superior thyroid artery is a blood vessel of abundant clinical significance and it is recommended to do the detailed study of its origin, course, branches, size, relationship with the

external laryngeal nerve, hyoid bone and thyroid cartilage are needed. These important values are necessary for a harmless effort in appropriate location for catheterization, preparation and implementation of any surgical procedures in neck region. Understanding of these arterial variations is immense importance in academic and clinical arena.

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