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Original Research Article

Significance of level of bifurcation of common carotid artery and variant branches of external carotid artery in cervicofacial surgeries with ontological explanation: a cadaveric study

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ABSTRACT

Background: External carotid artery is the main artery supplying the structures of neck and face. Variability in the branching pattern of external carotid artery is important surgically and radiologically from the point of view of procedures carried out in that region. Purpose of the present study was to study the branching pattern of external carotid artery.
Methods: Carotid triangle of the neck and the infratemporal fossa was dissected for studying the external carotid artery.
Results: Generally the common carotid artery bifurcates at the level of upper border of lamina of thyroid cartilage. Level of bifurcation of common carotid artery may vary; it may arise at a lower level or at a higher level than its normal level of origin, which was observed in this study. Amongst the branches of external carotid artery like the superior thyroid artery, the facial artery, the lingual artery usually shows variations in their origin. These include origin of superior thyroid artery from common carotid artery, common trunk for facial and lingual arteries and many other different types of variations were seen in this study.
Conclusions: Variant origins of the branches of external carotid artery are of significance in surgeries of thyroid, parotid gland, tongue as well as important in diagnostic procedures of head, neck, face region.

Keywords: Common carotid artery, Common trunk, External carotid artery, Facial artery, Lingual artery, Superior thyroid artery

INTRODUCTION

External carotid artery is the main artery supplying the structures in the neck. It is the branch of common carotid artery arising lateral to the upper border of thyroid cartilage.[1]

After its origin in the carotid triangle, anteromedial to the internal carotid, the external carotid artery ascends deep to the posterior belly of digastric and the stylohyoid muscle, crosses the styloglossus and stylopharyngeus muscle on their lateral side, approximately parallels the ramus of mandible and passes into the deep portion of parotid gland.

As it ascends it gives out branches in the neck as well as on the face, in neck the branches are superior thyroid artery, lingual artery, facial artery, ascending pharyngeal artery. While on the face it gives out occipital artery, and posterior auricular artery along with its terminal branches, the superficial temporal and maxillary artery.

Superior thyroid artery

The superior thyroid artery is typically the first branch from the external carotid, arising usually from its anterior surface. Its origin may be from the common carotid rather than the external; Daseler and Anson found similar origin, from the common carotid artery.[2] The artery runs downwards and forwards to supply the adjacent muscles, the larynx, and the thyroid gland.

Ascending pharyngeal artery

The smallest branch of external carotid arises from the posterior surface of it, often close to its origin, and ascends vertically anteromedial to the internal carotid artery and on the side of pharynx; it gives numerous branches to the pharynx, palate, tonsil and several meningeal branches. It may arise from occipital artery.

Lingual artery

Lingual artery arises from the anterior surface of external carotid above the superior thyroid artery, usually opposite to the tip of the greater cornu of hyoid bone. It run upwards, and then curve downward and forwards passing deep to the digastric and stylohyoid muscle and then disappears medial to the hyoglossus muscle in the substance of tongue to supply it.

Facial artery

It arises from the anterior surface of external carotid artery above the level of tip of greater cornu of hyoid bone. Then it runs forwards and upwards deep to the digastric and stylohyoid muscle, arching above the latter, to come in contact with submandibular salivary gland, finally winding around the lower border of mandible to run on the face and giving out its further branches. This artery may arise from common stem with the lingual or very rarely with the maxillary artery.

Occipital artery

It arises from the posterior surface of external carotid artery, opposite to the level of facial artery. It runs backwards to cross the internal carotid artery and internal jugular vein superficially, thereafter pierces deep cervical fascia and ascends tortuously towards the scalp giving out its various further branches.

Posterior auricular artery

It arises from the posterior surface of external carotid artery, but above the level of origin of occipital artery where it is crossed by the digastric and stylohyoid muscle. It may arise as a branch of the occipital rather than as an independent branch from the external carotid. It gives of a twig to the adjacent muscles of scalp and to the parotid gland.

Superficial temporal and maxillary

These are the terminal branches of external carotid artery, both of them arise within the substance of parotid gland; the superficial temporal continues upward towards temporal region while the maxillary runs deep to the ramus of mandible and enters the infratemporal fossa.[3]

Purpose of the present study was to observe the level of bifurcation of common carotid artery as well as variations in the origin of different branches of external carotid artery, which are important in surgical procedures done on thyroid gland, tongue, face as well as neck surgeries along with diagnostic procedures.

METHODS

The study was a cross-sectional observational study. Complete study was carried out from October 2018 to April 2019. 30 cadavers 26 males and 4 females, ranging in the age group of 40 to 60 years, embalmed with 10 per cent formalin were procured from the department of Anatomy of Dr. D. Y. Patil Medical College, Pune; these cadavers were labelled from 1-30. Dissection was carried out according to Cunningham's manual of practical anatomy volume 3.[4]

The steps of dissection were as follows. Midline incision of the neck was taken and skin flap was reflected on the lateral side. Superficial fascia along with platysma was reflected laterally. Investing layer of the deep cervical fascia was reflected to expose the carotid triangle. Anterior layer of carotid sheath was cut to expose the carotid arteries. Level of bifurcation of common carotid artery into internal and external carotid arteries was observed. Ramus of the mandible was cut to expose external carotid artery and all its branches. All the branches of external carotid were dissected and traced. Variations in the origin of these branches were noted down and photographed.

Statistical analysis

Percentages were calculated according to statistical method by multiplying the decimal by the factor of 100.

RESULTS

In the study conducted on external carotid artery, the level of origin of external carotid artery was studied, and also the variable origins of all the branches of external carotid were noted. Most of the branches showed the variations in their origin except terminal branches. Variations found in the study were as follows.

Level of bifurcation of common carotid artery

Level of bifurcation of common carotid artery was variable; sometimes it was originating at high level and sometimes at low level than normal.

Superior thyroid artery

A common variation found in the origin of superior thyroid artery was its origin from the common carotid artery.

Facial artery

Facial artery was seen arising as a common trunk with lingual artery.

Posterior auricular artery

It was seen arising from occipital artery in two cases.

Other variations

- Superior laryngeal artery in one case was arising from lingual artery.
- Superior laryngeal artery arising directly from external carotid artery in one case.
- In one case there was a common trunk for superior thyroid artery and lingual artery.

Table 1: Variations found in the level of bifurcation of common carotid artery and branches of external carotid artery.

Variations	Right side	Left side	%
High level of origin of external carotid artery			
7 cm above the level of upper lamina of thyroid cartilage	√	-	
Above the level of hyoid bone	√	-	8.3
At the level of hyoid bone	√	√	
	√	√	
	-	√	
Low level of origin of external carotid artery			
Between the lower border and upper border of lamina of thyroid cartilage	√	√	5
Below the lower border of lamina of thyroid cartilage	√	-	
	√	-	
Variation in the origin of superior thyroid artery			13.3
From common carotid artery	√	√	
	√	√	
	√	√	
	√	√	
	-	√	
	-	√	
	-	√	
	-	√	
Variation in the origin of facial artery			
Common trunk with lingual artery	√	√	
	√	√	6.7
	-	√	
	-	√	
Posterior auricular artery was arising from occipital artery in two cases.	√	-	3.3
	√	-	
Other variations			
Superior laryngeal artery in one case was arising from lingual artery.	-	√	1.6
Superior laryngeal artery arising directly from external carotid artery in one case.	-	√	1.6
In one case there was a common trunk for superior thyroid artery and lingual artery.	√	-	1.6

√ indicates the presence of variation on that side.

DISCUSSION

Common carotid artery most frequently shows lower or higher bifurcation into external and internal carotid arteries. Though common carotid does not give any branches, sometimes superior thyroid, superior laryngeal, occipital arteries may arise from it.

Thwin et al reported the bifurcation of common carotid artery at the level of the second cervical vertebra (hyoid bone). In the present study similar variation was observed in three cases (Table 1).[5]

Figure 1: Level of bifurcation of common carotid artery above the level of hyoid bone.
1- Common carotid artery, 2- External carotid artery, 3- Internal carotid artery, 4- Upper lamina of thyroid cartilage, 5- Hyoid bone.

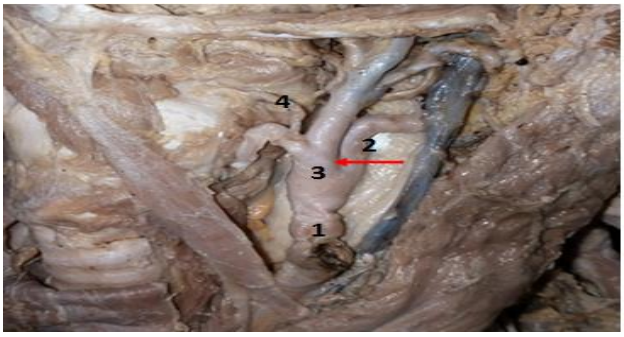

Figure 2: Level of bifurcation of common carotid artery below the level of upper lamina of thyroid cartilage.
1- Common carotid artery, 2- Internal carotid artery, 3- External carotid artery, 4- Upper lamina of thyroid cartilage.

Esakkiammal found superior thyroid artery (STA) originating from the common carotid artery at the level of carotid bifurcation. In present study superior thyroid artery arose from common carotid artery in eight cases (Table 1).[6]

Rao et al found the origin of superior laryngeal artery from the external carotid artery instead of the superior thyroid artery. In the present study superior laryngeal artery was arising from external carotid artery in one case (Figure 6) while from lingual artery in another case (Figure 5).[7]

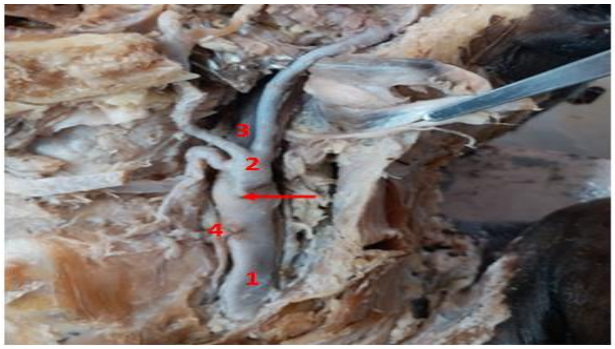

Figure 3: Origin of superior thyroid artery from common carotid artery.
1- Common carotid artery, 2- External carotid artery, 3- Internal carotid artery, 4-Superior thyroid artery.

Figure 4: Common trunk for lingual and facial artery.
1- Common carotid artery, 2- Common trunk, 3- Facial artery, 4- Lingual artery.

Kishve reported high division of common carotid artery on both sides 1cm above the greater cornu of hyoid bone. The superior thyroid artery originated from common carotid artery on both sides just above the level of greater cornu of hyoid bone. The linguofacial trunk was originating from the anterior aspect of common carotid artery and coursed towards the mandible for 1cm and divided into lingual and facial arteries. Present study also showed bifurcation of common carotid artery at higher level i.e., at the level of hyoid bone and linguofacial trunk was also seen in four cases (Table 1).[8]

Zumre and colleagues in their study on human foetuses found a linguofacial trunk in 20% cases, a thyro-lingual trunk in 2.5% cases, and a thyro-linguo-facial trunk in 2.5% of the human foetuses. Present study showed thyro-lingual trunk in one case.[9]

Ali in their study on external carotid artery found the common stem for ascending pharyngeal, lingual and facial artery and linguofacial trunk.[10]

Khanal reported bifurcation of the common carotid artery at the level of upper border of thyroid cartilage on both sides. Superior thyroid artery was originating from the common carotid artery directly 7 mm below the

bifurcation on both sides. On the right side ascending pharyngeal artery was found to be arising from the medial aspect of external carotid artery above the lingual artery and below the facial artery, 2.2 cm from the point of bifurcation. Posterior auricular artery was also found to be arising unusually high, above the angle of mandible, 6.4 cm from the point of bifurcation. In the present study we also found high level of bifurcation of common carotid artery and high level of origin of posterior auricular artery.[11]

Figure 5: Superior laryngeal artery in one case was arising from lingual artery.
1- Lingual artery, 2- Superior laryngeal artery.

Figure 6: Superior laryngeal artery arising directly from external carotid artery in one case.
1-External carotid artery, 2- Superior laryngeal artery.

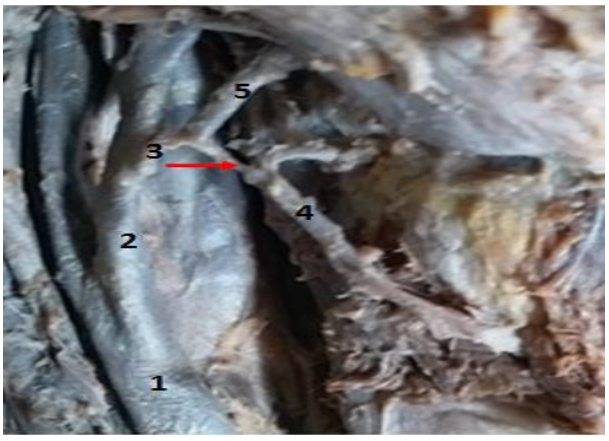

Figure 7: In one case there was a common trunk for superior thyroid artery and lingual artery.
1- Common carotid artery, 2- External carotid artery, 3- Common trunk, 4- Superior laryngeal artery, 5- Lingual artery.

Mamatha noted the bifurcation of the common carotid artery 2.2 cm above the superior border of the lamina of the thyroid cartilage. Both superior thyroid artery and the lingual artery were arising from a common trunk at the level of bifurcation of common carotid. This thyro-lingual trunk was also reported in the present study in one case (Figure 7).[12]

Rao mentiones that profound knowledge of the anatomical variations of the external carotid artery, such as its branching pattern and position is essential to avoid complications with catheter insertion in carotid arteries in various procedures. Variations in the origin of superior thyroid artery and superior laryngeal artery from the carotid arterial tree and the similarity of their diameters would lead to a significant possibility of wrong identification during surgery.[13]

The angle of mandible is an important landmark for surgical access to the carotid body. A vascular surgeon operating in head and neck region close to angle of mandible must be aware of high bifurcation of common carotid artery as seen in the present study, so as to avoid any vascular catastrophy or damage to hypoglossal nerve which may lead to paralysis of the tongue. Radiologists also should be aware of this kind of level of bifurcation of common carotid artery so as to interpret the carotid angiograms.[6]

Knowledge of the surgical anatomy of the branches of external carotid artery ensures maintaining a bloodless surgical field during major radical neck dissection surgeries to minimize postoperative complications. It is evident that there is a possibility of wide range of variations in the superior thyroid artery, superior laryngeal artery and other branches of external carotid artery. Abnormalities observed in our case, adds to the long list of known variations of these arteries and could help avoid serious implications during radiological examinations, interventions, ultrasound examination, and exploration of the neck, thyroid and parathyroid surgery, tracheotomy, surgery of the larynx, pharynx and upper esophagus and microvascular surgeries.[12]

Embryological explanation

The development of the external carotid arterial system is a complicated process of angiogenesis which includes formation and regression of vessels. The formation of hyostapedial artery plays an important role in the development of external carotid arterial system.

Initially at 9 mm stage of the embryo the dorsal remnant of the second aortic arch gives rise to hyoid artery. Later at 16 mm stage of the embryo, the hyoid artery gives of an ascending branch running into the future tympanic cavity called as stapedial artery. At this stage the various ventral vestiges of the first and second aortic arch arteries along with ventral aorta form ventral pharyngeal artery

which later gives rise to the main stem off the external carotid system.

A simple view is that when the primary arterial channels are formed, the most appropriate channels enlarge and persist while the others regress, which may result in the final arterial pattern. Unusual selection of some of these vascular channels from the primary capillaries as well as incomplete regression is thought to account for the anomalies affecting the different arterial patterns.[13]

CONCLUSION

Thus in order to carry out procedures like radical neck dissection, external carotid embolization, reconstruction of aneurysm and carotid endarterectomy, it is mandatory to keep in mind maximum possible variations in the origin, courses, branching pattern and distribution of the external carotid artery along with its branches, as lack of awareness or prior knowledge may lead to fatal errors if one blood vessel is mistaken for another.

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