Original Research Paper

Volume-7 | Issue-9 | September-2017 | ISSN - 2249-555X | IF : 4.894 | IC Value : 79.96

Pharmacology

ANATOMICAL VARIATIONS IN THE ORIGIN OF COMMON CAROTID ARTERY AND THE BRANCHING PATTERN OF THE EXTERNAL CAROTID ARTERY

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ABSTRACT

Introduction: The accurate anatomy of the common carotid and external carotid arteries are important in head and neck surgeries.

Aim: The present study is a cadaveric study of origin of common carotid artery and the branching pattern of external carotid artery.

Materials and methods: This study was conducted in 100 hemi-necks obtained from 50 cadavers.

Results: The origins of common carotid arteries were found to be normal. The lengths of right and left common carotid arteries were found to be variable. The levels of bifurcation of common carotid artery was found to be variable with 66.7% bifurcating at the level of superior border of thyroid cartilage, above the thyroid cartilage in 3.3% and below the thyroid cartilage in 30% in adults. In foetus, the common carotid artery bifurcates at the upper border of thyroid cartilage in 60%, above thyroid cartilage in 12.5% and below thyroid cartilage in 27.5%. The superior thyroid artery arose from the common carotid artery in 2% of cases, from external carotid artery in 37% cases and from the bifurcation in 61% cases. In one case superior laryngeal artery arose from the external carotid artery and in another case, it arose from the common carotid artery. In 3 cases of the total 60 hemi-necks of adult group, lingual artery took origin as a common trunk with the facial artery as linguofacial trunk.

Conclusion: These vessels show variability and a thorough anatomical knowledge about these vessels would be of help during head and neck surgeries and also during radiological examination.

KEYWORDS : .

INTRODUCTION

The common carotid artery, the external carotid artery and internal carotid artery are the major source of blood to the head and neck. In head and neck surgery, the common carotid arteries are important landmarks, defining the plane of dissection during radical neck surgeries. Clinical diagnosis and surgical procedures require a thorough knowledge of these arteries as well as their variations. Recent and continuing advances in surgical procedures have made the need for such detailed knowledge more important.

Accurate evaluation of the carotid bifurcation level with non-invasive techniques remains an important goal and external anatomical landmarks can be useful in predicting the bifurcation level of the carotid artery.

Anatomical knowledge of variations in the origin of common carotid artery and variations in the branching pattern of the external carotid artery will also be useful in situations like:-

1. Surgeries– thyroidectomy, laryngectomy, faciomaxillary surgeries, tonsillectomy, glossectomy and other neck surgeries.
2. Plastic and reconstructive surgeries of the head, neck and face which depend on the external carotid artery for their supply.
3. Preoperative selective arterial angiograms to map out the vascularity and the true extent of the tumours of the head, neck and face.
4. Selective arterial embolization to reduce the vascularity of the tumours of head, neck and face.
5. In embalming using common carotid artery.

MATERIALS AND METHODS

The material consisted of 100 hemi-necks (30 formalin fixed cadavers adult and 20 foetus) available in the department of Anatomy, GOVERNMENT MEDICAL COLLEGE, KOZHIKODE. This study was done as a cross – sectional study after getting clearance from the INSTITUTIONAL ETHICS COMMITTEE.

Methodology

The cadaver was placed in supine position and a block was placed under the back of the head to raise it to a convenient position. A median incision is made on the neck from the symphysis menti to the sternal notch. 3 more incisions

1. along the lower border of the mandible
2. anterior border of sternocleidomastoid muscle
3. sternal notch to the acromion of scapula

Fat and fascia were carefully cleared from the area of dissection. The carotid arteries were dissected out.

The relations of the veins with the carotid artery were observed. The branches of the ECA were traced in the carotid triangle.

The terminal branches superficial temporal and maxillary arteries were traced behind the angle of the mandible.

Further down the neck the common carotid artery is traced by cutting the medial half of the clavicle to see the origin. On the left side, the origin of common carotid was traced in the mediastinum at the arch of aorta. On the right side, the origin of the common carotid was traced in the lower part of neck coming from brachiocephalic trunk.

RESULTS

Each of the following parameters was observed in the 100 hemi-necks.

1. Origin of common carotid artery.
2. Length of right and left common carotid arteries.
3. Level of bifurcation of common carotid artery.
4. Variations in the branching pattern of external carotid artery.
5. Relation of external carotid artery to the internal carotid artery.

Origin of common carotid artery

In all cases, it was found that the common carotid artery originated normally both in the right and left.

Length of left and right common carotid artery

The common carotid arteries take similar courses through the neck. In the previous studies, the right common carotid had an average length 9.4cm, and the left had13.8 cm in adults. In previous literatures in foetus, the left common carotid artery is about 14.82 mm.

In adults, the length ranged between 7.5 cm and 11.5 cm with an average of 9.43 cm on the right. On the left, the length ranged between 10.5 cm and 13 cm with an average of 11.98 cm.

In foetus, the length ranged between 1 cm and 3.5 cm with an average of 2.27 cm on the right. On the left, the length ranged between 1.2 cm and 4.5 cm with an average of 3.34 cm.

Level of bifurcation of common carotid artery

In the present study in adults, the common carotid artery bifurcates at

the upper border of thyroid cartilage in 66.7%, above the thyroid cartilage in 3.3% and below the thyroid cartilage in 30%.

In foetus, the common carotid artery bifurcates at the upper border of thyroid cartilage in 60%, above thyroid cartilage in 12.5% and below thyroid cartilage in 27.5%.

Variations in branching pattern of external carotid artery
Anterior branches
Superior thyroid artery
In one case (both right and left), the superior thyroid took origin from common carotid artery (fig1). In another case it took origin from external carotid artery (fig2). No variations were noted in foetus group.

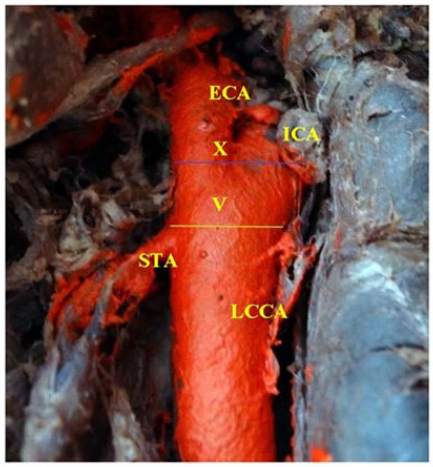

FIG 1 : Left side of neck showing the origin of superior thyroid artery from left common carotid artery

STA – superior thyroid artery, ICA – internal carotid artery, ECA – external carotid artery, LCCA – left common carotid artery, X – carotid bifurcation, V – origin of superior thyroid artery

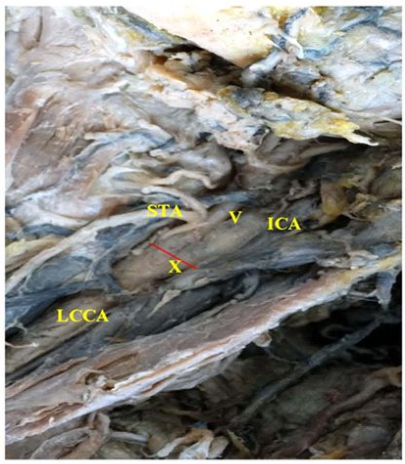

FIG 2 : Left side of neck showing origin of superior thyroid artery from external carotid artery

STA – Superior Thyroid Artery , LCCA – Left common carotid aartery, X – bifurcation of common carotid artery, V – origin of superior thyroid artery, ICA – Internal carotid artery

Lingual artery
In 3 cases of the total 60 hemi-necks of adult group, lingual artery took origin as a common trunk with the facial artery called as linguofacial trunk (fig3). No variations noted in the foetus group.

Facial artery
In 3 of the 60 hemi-necks of adult group, facial artery arises as a common trunk with lingual artery as linguofacial trunk as mentioned above (fig3). No variations in the foetus group.

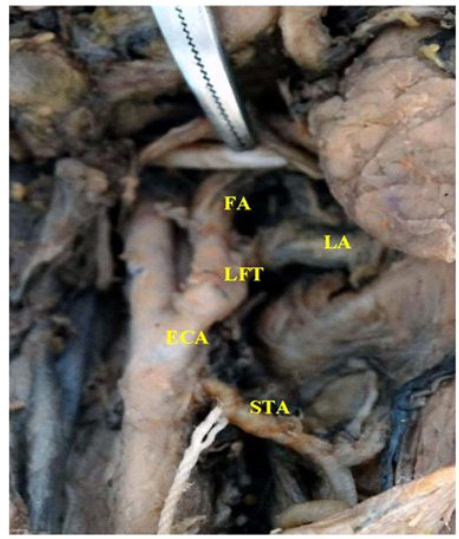

FIG 3: Right side of neck showing linguo-facial trunk
FA- Facial artery, LA- Lingual artery, LFT- Linguo facial trunk, ECA- External carotid artery, STA- Superior thyroid artery

Posterior branches (Occipital artery and Posterior auricular artery), Medial branch - Ascending pharyngeal artery and Terminal branches

(Maxillary artery and Superficial temporal artery)
Showed no variations both in adult and foetus groups.

Relation of external carotid artery to internal carotid artery
In adults and foetus, in 93% the external carotid artery was lying anteromedial to internal carotid artery and in 7% the external carotid artery was lying anterolateral to internal carotid artery.

DISCUSSION
Variations in the origin of common carotid artery
The developmental anomalies in the aortic arch's branching pattern and carotid systems arise from the unusual patterns of development of the embryonic aortic arch system of pharyngeal arches, so that there may be persistence of the aortic arches that normally disappear or disappearance of the parts that normally persist.

A study which was done by Nayak et al[2] in 2006 reported the classical branching pattern of the aortic arch in 91.4% cases and variations were found in six cadavers (9.6%); 4.8% presented common origin of the carotid arteries; 1.6% had bi-innominate sequence, and the same specimen had left coronary artery arising from arch of aorta directly; 1.6% presented right subclavian artery arising directly from the aorta; 1.6% had left vertebral artery a branch of aortic arch.

In the present study, the origins of right and left common arteries showed no variations both in adults and foetus.

Variations in the length of right and left common carotid artery
In the present study, the average length of the right common carotid artery in adults was 9.43 cm and that of left common carotid is 11.98 cm. The average length of the right and left common carotid artery falls within the normal range described (Ribeiro, 2006[3]).

In foetus, the average length of right common carotid was 2.27cm and that of left common carotid is 3.34cm. The average length of left common carotid artery falls under normal range (Spinzda, 2008[7]).

Variations in the bifurcation of common carotid artery

Authors	Population	Size	Thyroid cartilage			Hyoid bone		
			At the superior border	Body	Below thyroid	Body	Greater horn	Above
Lo[4] (2006)	New Zealand	36	39%			40%		

Ito[6] (2006)	Japanese	80	57.4%		11.3%	31.2%		
Klosek[9] (2008)	Thai	43	20.93 %		66.26 %		12.79 %	
Al-Rafiah[12] (2011)	Saudi Arabian	30	48.3%	5%		25%		3.3%
Present study	Indian	30	66.7%		30%	3.3%		

Observing the above table it is found that the present study is closely related to the study of Ito[5] (2006). Study of Ito had reported 57.4% of the bifurcation at the superior border of thyroid cartilage. The present study had 66.7% of the bifurcation at the superior border of thyroid cartilage.

In a study conducted by Zumre O et al[1] in 2005, in 40 foetus reported the levels of bifurcation of common carotid artery to be 55% at C3, 35% at C4 and 10% at C5 on the right side and 60% at C3, 40% at C4 on the left side. In the present study in foetus, bifurcation of common carotid artery is 15% at C3, 60% at C4 and 25% at C5 on the right side and 10% at C3, 60% at C4 and 30% at C5 on the left side.

Variations in the branching pattern of external carotid artery

Author	Population	Size	Origin of Superior thyroid artery			
				From ECA	From CCA	From bifurcation
Teresa[10] (2009)	English	165		29%	27%	49%
Ozgur[11] (2009)	Turkey	20		25%	35%	40%
Mata JR[14] (2012)	Indian	18		51.2%	3.5%	45.3%
Anagnostopoulou[15] (2014)	Athens	68	R	32.4%	36.8%	30.9%
			L	38.1%	42.6%	9.1%
Present study	Indian	50	R	38%	2%	60%
			L	36%	2%	62%

The present study and previous studies show the variable origin of STA which means that the STA is neither a reliable landmark for identification of ECA nor a safe point for its ligation.

Anangwe et al[8] (2008) reported that linguofacial trunk was the most common variation in the branching pattern of ECA.

Natsis K et al[13] (2011) reported that in 76% of cases branches of ECA were separate and in 24% ECA had common trunks.

In the present study, 3 cases (3/50) i.e. 6% of linguofacial trunk were found bilaterally. The present study is closely related to study of Ozgur[11] et al (2009). There were no incidences of thyrolinguofacial and thyrolingual trunks.

Variations in the relation between ECA and ICA

Ito H et al[5] (2006) reported reverse location of ECA and ICA in 6.3% of cases and Rusu MC et al[6] (2006) reported a case in which ECA lies posterolateral to ICA.

Al Rafiah[12] et al (2011) observed various position of ECA to ICA. In 51.7% ECA lies anteromedial to ICA, in 36.7% ECA lies medial to ICA, in 10% cases ECA lie anterior to ICA and in 1.7% cases ECA lies lateral to ICA.

Anangwe D[8] et al (2008) observed that the ECA lie anterolateral to ICA in 30% cases.

In the present study, in 93% cases ECA lie anteromedial to ICA which is also the most common relation between ECA and ICA. In 7% cases ECA lie anterolateral to ICA.

The knowledge of the variations in the relation between ECA and ICA is important to avoid damage to ICA during ligatures in the carotid triangle.

CONCLUSION

The present study is a cadaveric study of the origin of common carotid arteries and branching pattern of external carotid artery in 100 hemi-necks.

The findings observed in the present study can be summarized as follows:

1. The right common carotid originated from brachiocephalic trunk and left common carotid originated from the arch of aorta in all cases.
2. The right and left common carotid arteries showed variable lengths.
3. The common carotid artery bifurcation was observed in different levels, from upper border of thyroid cartilage, above and below the thyroid cartilage which means that the origin of external carotid artery was variable in many cases.
4. The superior thyroid artery had variable origin. 2% arose from the common carotid artery, 37% from the external carotid artery. Most commonly it arose from the common carotid artery bifurcation (61%).
5. In 92% of cases, the branching pattern of external carotid artery was normal. In 6% cases, linguofacial trunk was observed and in 2% cases the superior thyroid artery originated from the common carotid artery.

It can thus be concluded that these vessels show variability and a better anatomical knowledge about these vessels would be of help during head and neck surgeries and also during the interpretation of angiograms by radiologist.

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