Journal of the Anatomical Society of India 67 (2018) 162–165

Contents lists available at ScienceDirect

Journal of the Anatomical Society of India

journal homepage: www.elsevier.com/locate/jasi

Original Article

A Morphological Study of Branches of External Carotid Artery in Adult Human Cadavers

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ARTICLE INFO

Article history:
Received 3 May 2018
Accepted 6 November 2018
Available online 17 November 2018

Keywords:
Variations
Carotid
Vascular
Branches

ABSTRACT

IIntroduction: External carotid artery has eight named branches distributing to head and neck. The rich vascularity of most parts of head and neck (except brain and eye) is mainly maintained by external carotid artery through its branches. The detailed knowledge of external carotid artery and its branches is important for procedures like catheterization, radical neck dissection, reconstruction of aneurysms and carotid endarterectomy to prevent vascular accidents.
Material and methods: Twenty formalin fixed adult human cadavers, obtained from the Department of Anatomy were dissected.
Results: Mean distances of origin of eight branches of external carotid artery from carotid bifurcation were measured. The most common variation found was linguo-facial trunk in fourteen specimens (35%). The other variations found were common trunk for ascending pharyngeal artery and occipital artery in five specimens (12.82%) and thyrolingual trunk in one specimen (2.56%).There was appearance of two roots of ascending pharyngeal artery in one case.
Discussion: Knowledge about the variations of origin of branches of external carotid artery is important for surgeons performing head and neck surgeries. It is also helpful for radiologists for diagnostic imaging of vascular lesions and for interventional procedures.

1. Introduction

The common carotid, internal carotid and external carotid arteries provide major source of blood to head and neck region. The common carotid artery bifurcates into internal and external carotid arteries at the level of upper border of thyroid cartilage (at C_3-C_4 junction).[1]

External carotid artery has its eight named branches distributing to head and neck region. The superior thyroid, lingual and facial arteries arises from its anterior surface. The occipital and posterior auricular arteries arise from its posterior surface and ascending pharyngeal arteries arises from its medial surface. Maxillary and superficial temporal arteries are its terminal branches.[1] The rich vascularity of most parts of head and neck (except brain and eye) is mainly maintained by external carotid artery through its branches.[1]

The knowledge of variation of external carotid artery and its branches and their recognition during diagnostic imaging are useful for vascular procedures like carotid endarterectomy, extracranial or intracranial arterial bypass in occlusive cerebrovascular diseases, skull base tumors and aneurysms.[2] It is important for surgeries like thyroidectomy and laryngectomy. It also helps radiologists in reading angiograms of head and neck region and in accurate ultrasound image correlation.[3]

2. Material and methods

Twenty formalin fixed adult human cadavers of undetermined age and gender (forty sides of neck) were dissected for this study. One specimen was excluded as it was having carotid tumor. Exclusion criterias for this study were cadavers with any traumatic lesions on neck, evidence of any surgical procedure on neck and any tumour in neck region. This study was done with due permission of Institutional Ethics Committee. The distance of

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https://doi.org/10.1016/j.jasi.2018.11.011
0003-2778/

origin of each branch of external carotid artery from common carotid artery bifurcation was measured with a divider, thread and a ruler.

Descriptive statistical methods like mean, standard deviation and percentage was used for depicting and analysing data.

Normal branching pattern of external carotid artery is shown below in Fig. 1.

3. Results

In this study, the distance of origin of each branch of external carotid artery was measured from common carotid artery bifurcation. The branching pattern and the site of origin of each branch of external carotid artery were observed along with different variations related to it. All head neck surgeons should be aware about these variations while doing radical neck dissections to avoid iatrogenic complications.

The average distances of origin of all branches are mentioned in below Table 1.

The superior thyroid artery originated as separate branch in 38 cases, while it shared a common trunk with lingual artery as thyrolingual trunk in one case. The site of origin of superior thyroid artery varied as it arose from external carotid artery in seven cases (17. 94%) and from common carotid artery bifurcation in thirty cases (76.92%). While in two cases (5.12%), it arose from common carotid artery; out of which one was a separate branch and other shared a common trunk with lingual artery.

Lingual artery is one of the branches arising from anterior surface of external carotid artery. It originated as separate branch in twenty four cases (61.54%) in our study. Facial artery arose as separate branch from external carotid artery in twenty five cases (64.10%). Number of common trunk between lingual artery and facial artery were found in fourteen cases (35.9%) while number of common trunk between lingual artery and superior thyroid artery was in one case (2.56%).

Table 1
Showing average distance of origin of each branch of External Carotid Artery.

Branches of External Carotid Artery	Average distance of origin of branches of ECA from common carotid bifurcation (mm)
Superior Thyroid Artery	1.46
Lingual Artery	16.33
Facial Artery	20.95
Ascending Pharyngeal Artery	14.76
Occipital Artery	21
Posterior Auricular Artery	48.33
Maxillary Artery	68.69
Superficial Temporal Artery	68.69

(ECA –External Carotid Artery, mm - millimeter).

Ascending pharyngeal artery is a branch arising from medial surface of external carotid artery. Ascending pharyngeal artery originated at bifurcation of common carotid artery in eleven cases (28.21%) while it took origin from external carotid artery as separate branch in twenty three cases (58.97%). It showed a common trunk with occipital artery in five cases (12.82%). In one case, there was appearance of two roots of ascending pharyngeal arteries.

The branches arising from posterior surface of external carotid artery are occipital artery and posterior auricular artery. In present study, there were no variations observed in site of origin of posterior auricular artery; it arose as separate branch from external carotid artery in all cases. Occipital artery arose from external carotid artery as separate branch in thirty four cases (87.18%) and as a common trunk with ascending pharyngeal artery in five cases (12.82%).

The terminal branches of external carotid artery are superficial temporal artery and maxillary artery. No variations were found about their site of origin in the present study.

The different variations related to site of origin of External Carotid Artery are shown below in Figs. 2–5.

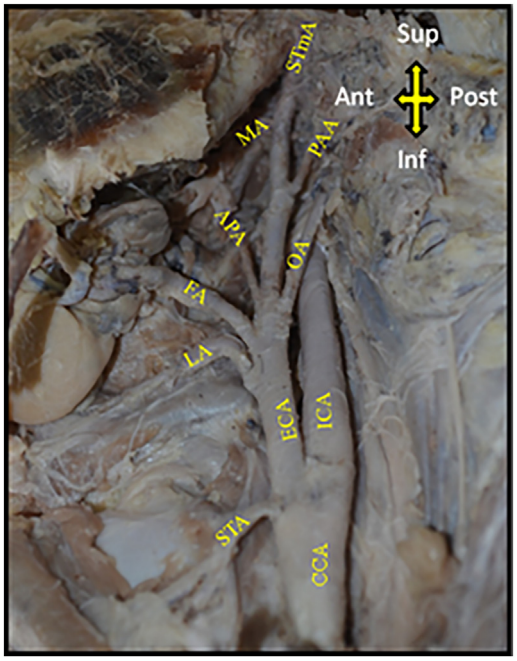

Fig. 1. Normal branching pattern of External Carotid Artery.
[CCA - Common Carotid Artery, **ICA -** Internal Carotid Artery, **ECA -** External Carotid Artery, **STA -** Superior Thyroid Artery, **LA -** Lingual Artery, **FA –** Facial Artery, **APA –** Ascending Pharyngeal Artery, **MA –** Maxillary Artery, **STmA –** Superficial Temporal Artery, **PAA -** Posterior Auricular Artery, **OA -** Occipital Artery**]**

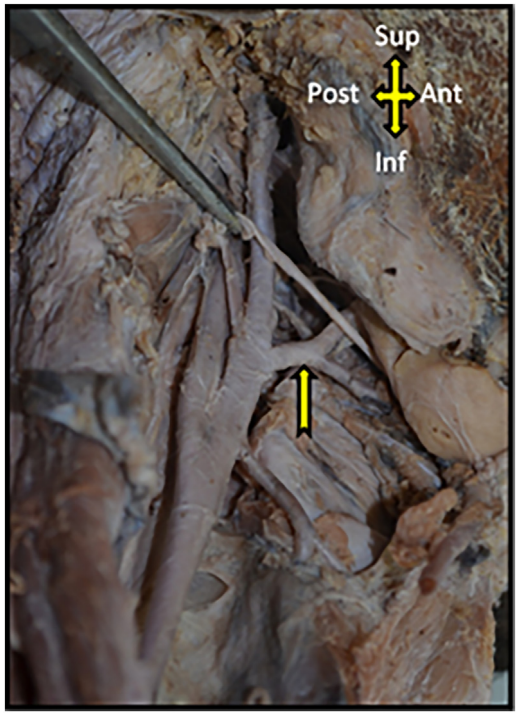

Fig. 2. Common Trunk for Lingual and Facial Artery (Linguofacial Trunk/LFT).

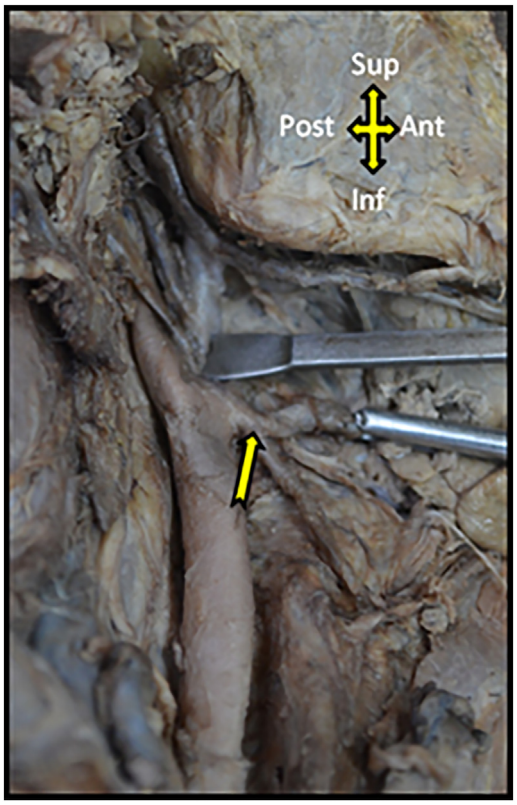

Fig. 3. Common Trunk for Superior Thyroid Artery and Lingual Artery (Thyrolingual trunk).

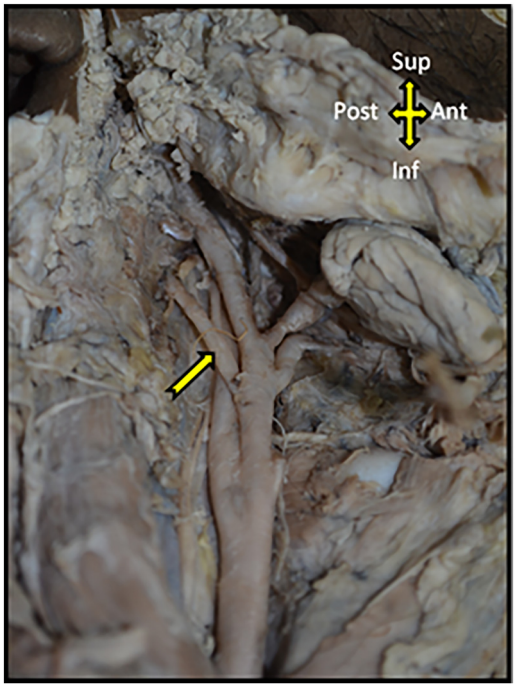

Fig. 4. Common Trunk for Occipital Artery and Ascending Pharyngeal Artery.

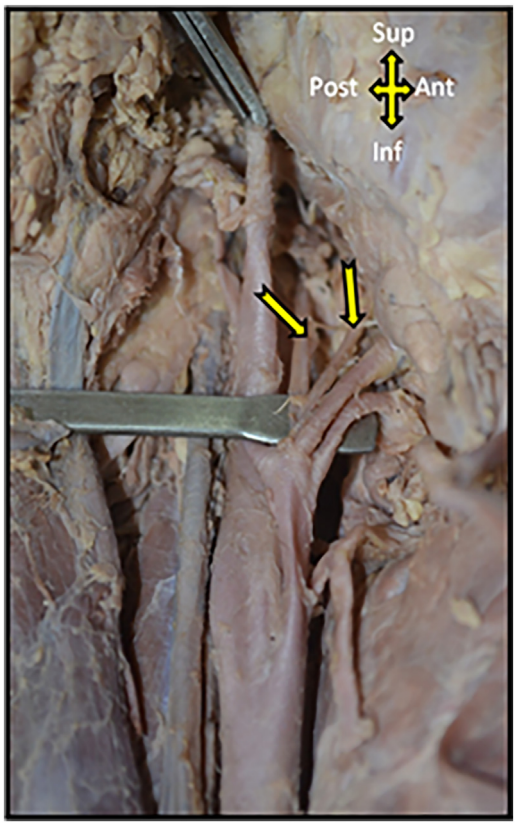

Fig. 5. Appearance of two Ascending Pharyngeal Arteries.

4. Discussion

The knowledge about the various branching patterns of external carotid artery is important during laryngectomy, thyroidectomy and glossectomy. It helps to avoid complications during plastic and reconstructive surgeries of head and neck region. It is also necessary to know these variations during preoperative selective arterial angiograms in case of head, neck tumors, arterial embolisation and intra arterial chemotherapy.[4]

In the present study, there was significant number of variations found about the origin of branches of external carotid artery. The embryological basis for these variations is as follows. The development of the external carotid arterial system is a complicated process of angiogenesis and remodeling which includes annexation and regression of the vessels. The development of hypostapedial artery which links the neural crest arterial system to the ventral pharyngeal artery marks an important event in the development of external carotid artery system. The various ventral vestiges of the first and second aortic arch arteries and ventral aorta form ventral pharyngeal artery which later forms the stem of external carotid system. The signals involved in this annexation and regression are not always synchronized and as a result the vascularization varies.[5]

Branches of external carotid artery develop centripetally starting from the arterial network of that territory and the preferred routes are formed in accordance with the local hemodynamic need. This hemodynamic need may results in various types of variation in branching pattern of external carotid artery (Table 2). [6]

The most common site of origin of superior thyroid artery in the present study was from common carotid artery bifurcation which is same as observed by Al Rafiah et al,[7] Lo et al. [9] and Ozgur [11] In the present study, superior thyroid artery arose from common carotid artery in two cases (5.12%). It is mentioned in 37th edition of Gray's Anatomy that the common carotid artery has no significant branches, but sometimes it may give rise to the superior thyroid artery and ascending pharyngeal artery.[1] During ligation of external carotid artery during hemorrhage from cancers of head

Table 2
Comparison of prevalence of site of origin of Superior Thyroid Artery.

Study	Prevalence of site of origin of STA		
	Above CCA bifurcation	At CCA bifurcation	Below CCA bifurcation
Al- Rafiah (2011)[7]	3.3	76.7	18.3
Mata J (2012)[8]	51.2	45.3	3.5
Lo A (2006)[9]	46.2	52	1.5
Acar M (2013)[10]	51	31	18
Ozgur Z (2009)[11]	25	40	35
Present Study	17.94%	76.92%	5.12%

Table 3
Comparison of Prevalence of Linguofacial Trunk & Thyrolingual Trunk in various other studies.

Study	Prevalence (%)	
	Linguofacial Trunk	Thyrolingual Trunk
Sanjeev et al. (2010) [4]	18.92%	2.7%
Mata J R et al. (2012)[8]	19.4%	2.8%
Hayashi et al. (2005) [13]	18%	1%
Ito H et al. (2006)[14]	17.5%	5%
Present Study (2015)	35.9%	2.56%

and neck region and surgeries like tonsillectomy or vascular tumours, it is necessary to identify branches and ligate above the origin of superior thyroid artery (Table 3).[12]

Linguofacial trunk is most common variation found in the present study. The prevalence of linguofacial trunk in the present study was higher than previous studies. This may be due to racial differences or due to difference in number of samples.

In the present study, one case of thyrolingual trunk arose from common carotid artery (4 mm below common carotid bifurcation). Similar cases of thyrolingual trunk arising from common carotid artery were also observed by Buddhiraja[15] and Heltzel.[16] The percentage of thyrolingual trunk in the present study was comparable with Sanjeev et al.[4] and Mata et al. (Table 4). [8]

The second most common variation found in the present study was common trunk for ascending pharyngeal artery and occipital artery.

In the present study, in one case there were two roots of ascending pharyngeal artery which took origin from external carotid artery; 15 mm above carotid bifurcation. The same variation was also observed by Al Rafiah et al. [7] in 6.7% of cases.

Lasjaunias et al. described a pharyngo-occipital system located at the craniocervical junction. It consists of the ascending pharyngeal and occipital arteries as they together supply the three cervical somites C1, C2, C3 and the third branchial arch. The pharyngo-occipital system explains the variability in the origin of the ascending pharyngeal and occipital arteries as well as their common origin.[17]

5. Conclusion

The different variations found in the present study will be useful for vascular surgeons to avoid iatrogenic complications during radical dissection in head, neck surgeries and it is also important for plastic surgeons during reconstructive surgeries on head and neck region. The knowledge of various branching patterns observed in the present study will also be helpful to radiologist during diagnostic as well as interventional procedures on head and neck.

Table 4
Comparison of Prevalence of Common Trunk for Ascending Pharyngeal Artery and Occipital Artery in various studies.

Study	Prevalence(%) of Common trunk for Ascending Pharyngeal Artery and Occipital Artery
Sanjeev et al. [4]	24.32%
Hayashi N et al. [13]	19%
Present Study (2015)	12.82%

Conflict of interest

None

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