Original Research Paper

Volume - 10 | Issue - 10 | October - 2020 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Anatomy

ANATOMICAL VARIATIONS IN THE BRANCHES OF EXTERNAL CAROTID ARTERY IN CADAVERS

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ABSTRACT

Background: External carotid artery (ECA) is the main artery of head and neck region. It has eight named branches to maintain a rich vascularity of most of the structures of head and neck. The present study was undertaken to assess external diameter of ECA at origin and branching pattern of ECA.

Methods: A total of 100 carotid specimens of 50 human cadavers (24 males and 26 females) were dissected in the Department of Anatomy at medical colleges and diameter and branching pattern of ECA were noted.

Results: The diameter of ECA at its origin was in the ranged between 4.5 to 8 mm with mean of 6.676±0.8053 mm. 77% cases showed normal branching pattern of ECA, the commonest variation was the occurrence of linguofacial trunk (18%) and occipitiauricular trunk (4%). STA and lingual artery (LA) arose commonly from ECA in 71(71%) and 94 cases (94%) respectively. The origin of STA from ECA was statistically significant on left side (56.3%) compare to right (43.7%). Facial artery (FA), occipital artery (OA) and posterior auricular artery (PAA) arises as single branch and common trunk on right and left side. The accessory branches was observed to be present in total 3(3%) cases including 1(33.33%) on right and 2(66.66%) on left side.

Conclusion: The present study revealed that the number of branches and branching pattern of ECA is variable and this variations do have a significant role in the various applications of anatomy of ECA for example in embolization, chemotherapy, cervical discectomy, thyroid surgeries etc.

KEYWORDS : External carotid artery, Specimens, Cadavers, Anatomy, Branches

INTRODUCTION

The arterial pattern of the human body is one of the systems that show a large number of variations. A variation in the course and branching pattern of an artery is both interesting and significant for both clinicians and anatomists [1].

The external carotid artery, feeds the structures of the face, the scalp, upper part of the thyroid gland and some part of the dura mater, is main artery of the head and neck region [2, 3]. ECA arises in the carotid triangle from the common carotid artery (CCA) along with the internal carotid artery (ICA). In addition, ECA system is a complex vascular system providing the nourishment to the territorial area of the head and neck. Branches of ECA 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 ECA [2].

However, ECA has eight named branches distributed to the head, neck and face, namely the superior thyroid artery (STA), it is the main arterial supply of the thyroid gland, the upper part of the larynx, muscles and overlying skin of the neck region [4-6]. It is branched from the anterior surface of the ECA as a first branch, just below the level of greater cornu of the hyoid bone [4, 5, 7], lingual artery (LA) and facial artery (FA) arise from its ventral aspect, the occipital artery (OA) and posterior auricular artery (PAA) arises from dorsal aspect and the ascending pharyngeal artery (APA) arises from medial aspect. Behind the neck of the mandible, within the substance of the parotid gland, it divides into superficial temporal artery (STA) and maxillary artery (MA) as its terminal branches [8].

ECA and its branches have numerous variations and their exploration is significant for anatomist and clinicians. So the anatomical knowledge of the origin, course, and branching pattern of the ECA, as well as STA will be useful to surgeons when ligating the vessels in the head and neck regions during surgery and to avoid the unnecessary complications during carotid endarterectomy [9]. In spite of its surgical importance there are few studies on the branching pattern of ECA in India. Most of the literatures available are case reports. The present study was undertaken to know the anatomy and branching pattern of ECA and STA.

MATERIAL AND METHOD

This observational study was carried out on 100 carotid specimens obtained from the formalin embalmed cadavers of 50 human of different age groups and both sexes allotted to the undergraduate students for dissection in the Department of Anatomy at medical colleges. The hemisectioned head and neck specimens which were allotted to students of previous year were also included. Any injuries in the region of the neck which have injured the external carotid artery and anomalous tortuosities, dilatations, aneurysms or atheromatous/ occlusive disease specimens were not included in the study.

The external carotid artery and its branches were studied by dissection method which involved exposure of the artery in the anterior triangle, opening the carotid sheath, tracing it and its branches in the parotid gland and infratemporal fossa.

An incision was made from the chin to the sternum in the midline and a second incision along the base of the mandible from chin to the tip of mastoid process. The skin was reflected inferolaterally. The superficial fascia containing platysma with nerves and the deep fascia were reflected. The anterior margin of sternocleidomastoid was pushed laterally; the carotid sheath and its contents were exposed. The anterior layer of carotid sheath was incised exposing the common carotid artery and its bifurcation into internal and external carotid arteries. The levels of bifurcation of CCA, the diameter of ECA at its origin using sliding calipers were taken and the relation between ECA and ICA were noted.

The ECA was traced in the digastric triangle and then it was followed till the parotid gland by removing the posterior belly of digastric and stylohyoid muscles and hypoglossal nerve for better exposure of the artery. In the parotid gland the ECA was traced by removing the gland piecemeal. The zygomatic arch was divided, anterior and posterior to the attachment of masseter with a bone cutter, and was pulled down with the muscle. The masseter was stripped from the surface of the mandible as far as the angle. The coronoid process from mandible was cut by an oblique cut from the mandibular notch to point where the anterior margin of ramus meets the body of mandible. The coronoid process and attached temporalis were pulled upwards. One horizontal cut through the neck of the mandible and another immediately above the mandibular foramen were made. The pieces of bones were removed and underlying muscles, vessels, and nerves were exposed, the parts of the pterygoid plexus of veins which obscure our view were removed. External carotid artery which was followed from parotid gland was found to divide medial to the neck of mandible into terminal branches, superficial temporal artery and maxillary artery. The pterygoid muscles were sacrificed for better vision. The number of branches and the branching pattern of ECA were noted.

Statistical Analysis

Various data obtained from dissection of human cadavers and

variations were noted and analyzed using STATA VERSION-10 statistical software. The baseline characteristics were summarized in percentage, Mean and Standard deviation. Chi square test, Chi square test for trend, Fisher's exact test was used to analyze data.

OBSERVATIONS AND RESULTS

A total of 100 carotid specimens of 50 human cadavers (24 male and 26 female) were studied in the medical colleges. There were 50(50%) carotid specimen on right side and 50 (50%) carotid specimen on left side. The maximum numbers of cases were in age groups of 41-50 years (28%) followed by 61-70 years (26%). Table 1 shows the distribution of cases according to age and gender, (P value - 0.8390).

Table 1: Age And Sex-wise Distribution Among The Study Group

Age Group	Number of Cases		Total
	Male	Female	
41-50	14	14	28
51-60	10	12	22
61-70	14	12	26
71-80	10	14	24
Total	48	52	100

The diameter of external carotid artery at its origin was in the ranged between 4.5 to 8 mm with mean ± standard deviation of 6.676± 0.8053 mm. The maximum number of cases have diameter from 6.1 to 7 mm. The external diameter of ECA was non-significant among the male and female, (P value- 0.2077) as shown in figure 1.

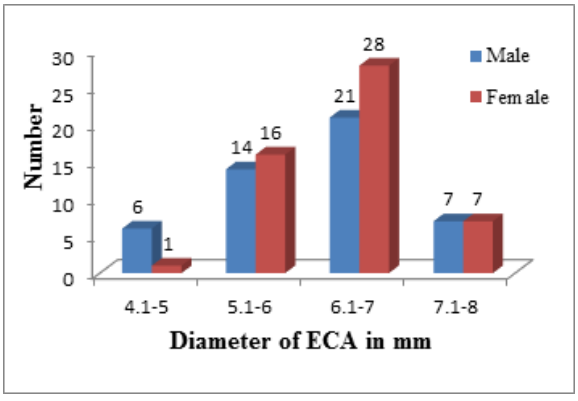

Figure 1: External Diameter (mm) Of ECA In Male And Female

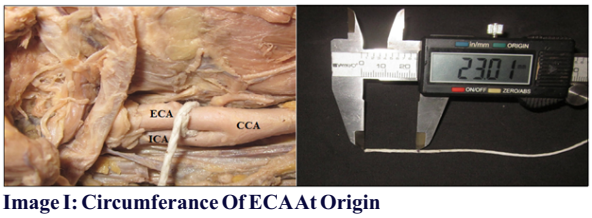

Image I: Circumferance Of ECA At Origin

In present study, 77(77%) cases showed normal branching pattern of ECA, The maximum number of cases (18%) have linguofacial trunk, 1(1%) case have common trunk for lingual and superior laryngeal artery and 4(4%) cases have occipitoauricular trunk.

The superior thyroid artery and lingual artery arose commonly from ECA in 71 (71%) and 94 cases (94%) respectively. From the table 2 it is observed that the origin of superior thyroid artery from ECA was statistically significant on left side compare to right, (P value - 0.021) whereas we found no significant difference in the site of origin of lingual artery on right and left side, (P-Value - 0.092).

Table 2: Site Of Origin Of Superior Thyroid (ST) Artery And Lingual Artery (LA) From ECA

Side	Superior thyroid artery	
	No. of cases	P value
Right	31 (43.7%)	0.021
Left	40 (56.3%)	
	Lingual artery	
Right	45(47.87%)	0.092
Left	49(52.12%)	

The lingual artery arose most commonly as a separate branch in 81 cases (81%), on right it was 38(46.34%) and on left it was 43(52.43%), as a common trunk with facial artery - linguofacial trunk in 18 cases (18%). 11(61.11%) on right and 7(38.88%) on left side (Image IIa), and with superior laryngeal artery in 1 case (1%) on right side (Image IIb).

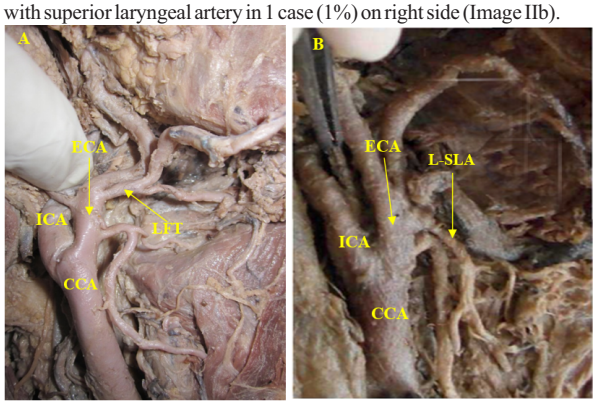

Image II: A) Linguofacial Trunk on Right side and B) L-SLA on right side

Table 3 shows the distribution of facial artery (FA), occipital artery (OA) and posterior auricular artery (PAA) arises as single branch and common trunk on right and left side. The accessory branches was observed to be present in total 3(3%) cases including 1(33.33%) on right side and 2(66.66%) on left side, this distribution was non-significant, (P-value - 0.558). External carotid artery terminates by dividing into maxillary and superficial temporal arteries in the parotid gland behind the neck of mandiblein all cases.

Table 3: Distribution of FA, OA and PAA Arises As Single Branch And Common Trunk On Right And Left Side

Side	Type of origin of FA		P value
	Single	CT	
Right	39 (47.56%)	11(61.11%)	0.298
Left	43(52.43%)	7(38.88%)	
Total	82	18	
	Type of origin of OA		
Right	46(47.91%)	4(100%)	0.1175
Left	50(52.08%)	0	
Total	96	4	
	Type of origin of PAA		
Right	46(47.91%)	4(100%)	0.1175
Left	50(52.08%)	0	
Total	96	4	

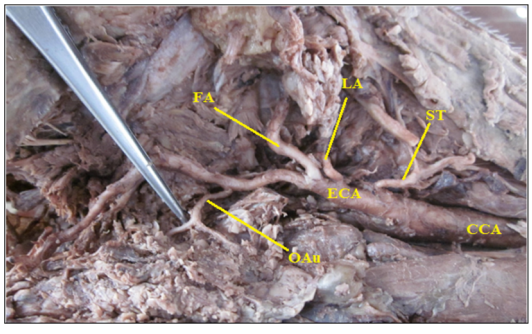

Image III: Occipitoauricular Right Side

DISCUSSION

The arterial diameter is an indicator of blood flow and is therefore relevant in ensuring good reperfusion of local structures during reconstructive surgeries. Information on normal arterial diameters is also important in relation to changes in response to drugs or alterations in diseases, such as hypertension, atherosclerosis and diabetes [10]. The diameter of carotid arteries is of importance due to its vascular access site for intravascular intervention, catheterization. The knowledge of the diameter of the CCA, ICA & ECA are important to determine the pathological changes [12]. In present study, the diameter of ECA at its origin was measured using digital vernier calipers. The diameter of ECA at its origin ranged between 4.5 to 8 mm with mean ± standard deviation of 6.676± 0.8053 which is compared with previous studies [10, 12].

The current study has revealed that the number of branches and branching pattern is variable. Normally ascending pharyngeal artery arises as a slender artery from the medial surface of ECA near its origin [13]. No variations were seen in the origin of ascending pharyngeal artery in our study. Superior thyroid artery arises from the front of ECA just below the level of greater cornu of hyoid bone [13]. The commonest variation in the origin of STA encountered was its origin from CCA. A meta-analysis of variations of the STA revealed racial differences in the origin. Higher frequency of its origin from ECA was observed in Caucasoid than in East Asians [14]. In present study, STA arose commonly from ECA in 71 (71%) cases; most frequently on left side compare to right which is coincide with the findings reported by Nakamasa et al [15]. It is necessary to understand the surgical anatomy of the STA to carry out successful radical neck dissection and to minimize the postoperative complication in a bloodless surgical field, during thyroidectomy operations the STA must be ligated and this somewhat frequent variation must be kept in mind by the surgeon [16]. Lingual artery arises from the antero-medial aspect of external carotid artery opposite the tip of greater cornu of hyoid bone, above superior thyroid artery [13]. In existing study, 94(94%) cases of LA were arising from ECA. On right side LA was originated from ECA in 45(47.87%) and on left side it was 49(52.12%). The linguofacial trunk was seen in 11(61.11) cases on right side and in 7(38.88%) cases on left side, this was comparable with the previous studies [15, 17, and 18]. On right side we observed only 1(100%) case showing common trunk of LA with superior laryngeal artery and on left side there was no such pattern was seen. A thyrolingual, thyrolinguofacial trunk was not observed in the present study. Normally facial artery is branch arising from antero-medial surface of external carotid artery above the level of lingual artery [13]. The facial artery most often was a separate branch from ECA and in few cases it arose in common with lingual artery-linguofacial trunk.

Classically occipital artery arises from posterior surface of ECA opposite the facial artery [13]. In present study, occipitoauricular trunk reported in 4(4%) cases, this variation was seen on right side while on left side no such variation was observed (0%). Posterior auricular artery arises as a small branch from the posterior surface of ECA above digastric and stylohyoid muscles [13]. In 96 cases (96%) the posterior auricular artery arises as single branch from ECA, 46 cases (47.91%) on right side and 50 cases (52.08%) on left side. Normally ECA terminates by dividing into maxillary and superficial temporal arteries in the parotid gland behind the neck of mandible [19]. No variations were seen in the origin of superficial temporal and maxillary arteries. A few accessory branches arising directly from ECA were observed.

CONCLUSION

The branching pattern of external carotid artery is variable. ECA classically have eight branches. However the present study has revealed that the number of branches and branching pattern of ECA is variable and linguofacial trunk and occipitiauricular trunk is common as compare to other branching pattern of ECA. This variations do have a significant role in the various applications of anatomy of ECA for example in embolization, chemotherapy, cervical discectomy, thyroid surgeries etc.

Acknowledgement

The authors sincerely thank the Department of Anatomy and administration of Government Medical College and Hospital, Nagpur, Maharashtra, for permission to study and providing facility to carry out the work.

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