A cross sectional study of variations in the external carotid artery in cadavers

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Abstract

The External Carotid Artery supplies mostly the scalp, neck and face regions of the body. A detailed knowledge of blood vessels and nerves in this head, neck and face regions is very helpful in various therapeutic and diagnostic procedures such as surgical resection of head, neck, face and oral cancers, radical neck dissection, plastic and reconstructive surgeries related to this vital region. Cerebrovascular strokes due to atherosclerosis, haemorrhage or embolism require radiological investigation like carotid angiogram, surgical procedures like carotid endarterectomy also require a thourough knowledge of anatomy of external carotid artery and its branches. Anomalous branching pattern of the carotid arteries and variations in the relative position of internal and external carotid arteries can also damage cranial nerves related to them. Hence, it was decided to undertake a morphometric study of external carotid artery by meticulous dissection of cadavers. The aim was to study variations in the course, relations and branching pattern of External Carotid Artery. In this study, 60 cadavers embalmed with 10% formalin were used, and thus 120 neck-halves were studied. Of these cadavers 52 were male and 8 were female. These cadavers were obtained from the Department of Anatomy, Seth G.S. Medical College, Parel, Mumbai, Maharashtra. The present study was conducted over the period of two years. Linguofacial trunk was observed to be the commonest variation i.e. in 17 cases (28.33%) on the right side and in 18 cases (30%) on the left side. Thyrolinguofacial trunk was encountered in one case (1.67%) on the left side. Also Accessory branches of ECA such as branches to the parotid gland, submandibulargland, infrahyoid region and pharyngeal muscular branches were found in 6 cases (10%) on the right side and in 5 cases (8.33%) on the left side.

Keywords: Thyrolinguofacial trunk, External carotid artery, Endarterectomy, Cerebrovascular strokes, Cadavers

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Introduction

The common carotid artery bifurcates into External and Internal Carotid Arteries lateral to the upper border of the lamina of thyroid cartilage which corresponds with the intervertebral disc between the third and fourth cervical vertebrae. As it ascends, it takes a curved or spiral course slightly forwards, backwards and then little laterally and passes midway between the tip of the mastoid process and the angle of the mandible. Then it divides into its terminal branches, the superficial temporal and maxillary arteries in the substance of the parotid gland behind the neck of the mandible. The external carotid artery (ECA) has eight named branches distributed to the head, neck and face. The superior thyroid (STA), lingual (LA) and facial arteries (FA) arise from its anterior aspect, the occipital (OA) and posterior auricular arteries (PAA) from posterior aspect and the ascending pharyngeal artery (APA) is the only branch which arises medially. The maxillary and superficial temporal arteries are its terminal branches.[1]

A detailed knowledge blood vessels and nerves in this head, neck and face regions is very helpful in various therapeutic and diagnostic procedures such as surgical resection of head, neck, face and oral cancers, radical neck dissection, plastic and reconstructive surgeries related to this vital region. Cerebrovascular strokes due to atherosclerosis, haemorrhage or embolism require radiological investigation like carotid angiogram, surgical procedures like carotid endarterectomy also require a thorough knowledge of anatomy of external carotid artery and its branches. Anomalous branching pattern of the carotid arteries and variations in the relative position of internal and external carotid arteries can also damage cranial nerves related to them.

The aim was to study variations in the course, relations and branching pattern of External Carotid Artery. A morphometric study of external carotid artery was conducted over the period of two years by meticulous dissection of cadavers. In this study, 60 cadavers embalmed with 10% formalin were used, and thus 120 neck-halves were studied. Of these cadavers, 52 were male and 8 were female. These cadavers were obtained from the Department of Anatomy, Seth G.S. Medical College, Parel, Mumbai, Maharashtra.

Linguofacial trunk was observed to be the commonest variation i.e. in 17 cases (28.33%) on the right side and in 18 cases (30%) on the left side .Thyrolinguofacial trunk was encountered in one case (1.67%) on the left side. Also Accessory branches of ECA such as branches to the parotid gland, submandibular gland, infrahyoid region and pharyngeal muscular branches were found in 6 cases (10%) on the right side and in 5 cases (8.33%) on the left side.

Aims and Objectives

The aim was to study variations in the course, relations and branching pattern of External Carotid Artery.

The objectives were:

1. To study and note down variations in the course and relations of ECA
2. To study and note down variations in the branching pattern of ECA

Materials and Methods

In this study, 120 neck-halves of embalmed cadavers were dissected of which 60 belonged to right side and 60 were of left side. Of 120 neck-halves, 104 belonged to 52 male cadavers and 16 belonged to 8 female cadavers. These cadavers were obtained from the Department of Anatomy, Seth G.S. Medical College, Parel, Mumbai, Maharashtra.

The neck of the cadaver was properly supported on a wooden block in extended position. Skin incisions were taken. The first incision from the chin to the sternum in the midline and second across the inferior border and the angle of mandible and skin flap was reflected inferolaterally. Platysma was reflected upwards. The sternocleidomastoid muscle was cut in the middle and reflected superolaterally. The anterior belly of digastric and the infrahyoid muscles were cut and reflected. The submandibular gland was pushed aside. The ansa cervicalis loop which was seen is sacrificed. The contents of carotid triangle were exposed by opening the carotid sheath. The external carotid artery was traced upwards. Its course was noted and all its branches were dissected and exposed. The parotid gland was dissected and removed in piece meal to expose the terminal branches of the external carotid artery namely superficial temporal artery and maxillary artery. When all the branches and course of the external carotid artery were visible, variations noted down. The data were statistically analyzed for the purpose of comparison and correlation by calculating the Mean, Standard deviation and Range.

Results

In our research study 120 neck-halves of 52 male cadavers and 8 female cadavers were dissected (60 right sides and 60 left sides) and the external carotid artery and its branches were studied. Many variations were encountered in the formation, termination and branching pattern of the ECA. The following variations in branching pattern of ECA were found:

Table 1: Variations in the branching pattern of ECA

Sr. No.	Variations	Number of Specimens			
		Right	Percentage (%)	Left	Percentage (%)
1.	Direct origin of STA from CCA	2	3.33	5	8.33
2.	Thyrolingual trunk	2	3.33	3	5
3.	Linguofacial trunk	17	28.33	18	30
4.	Thyrolinguofacial trunk	0	0	1	1.67
5.	Occipitoauricular trunk	3	5	0	0
6.	Accessory branches of ECA	6	10	5	8.33
7.	SLA direct branch of ECA	6	10	5	8.33
8.	Terminal trifurcation of ECA	0	0	1	1.67
9.	APA at a higher level	1	1.67	4	6.67
10.	Sternocleidomastoid branch from CCA	0	0	1	1.67

Discussion

The level of origin, termination and the branching pattern of the external carotid arteries show considerable anatomical variations. A lot of variations such as unilateral or bilateral absence of ECA, variations in position and branching pattern of ECA were previously documented in the literature.

Superior thyroid artery as a direct branch of Common Carotid artery

Sanjeev et al found that Superior Thyroid Artery (STA) is a direct branch of the common carotid artery in 35.14% of the cases.[2] According to A. Al-Rafiah et al, superior thyroid artery branched from the common carotid artery in 18.3 % cases.[3] According to a study conducted by Natsis K, Raikos A, Foundos I et al, the superior thyroid artery was branched from the external carotid artery in 39% and from the common carotid artery in 61% of cases. The anterior branches were originating separately from the external carotid artery in 76% of cases and the common

trunks were found in 24% of the specimens.[4] In the present study, it was found that STA originated from common carotid artery directly in 2 (3.33%) cases on the right side and in 5 (8.33%) cases on the left side.(Fig. 1)

STA as a direct branch of CCA			
A. Al-Rafiah et al (2011)	**Natsis et al (2011)**	**Sanjeev et al (2010)**	**Present study**
18.3%	61%	35.14%	3.33% (Right) 8.33% (Left)

Thyrolingual trunk, Linguofacial trunk and Thyrolinguofacial trunk

Al-Rafiah et al found that STA branched from a thyrolingual trunk in 1.7% and from a common thyrolinguofacial trunk in 1.7% cases.[3] Ozgur Z, Govsa F, Ozgur T. in their study found that STA, LA, and FA arose separately in 90% of cases, as a linguofacial trunk in 7.5% cases, and as a thyrolingual trunk in 2.5% of cases.[5] Sanjeev et al in their study found the linguofacial trunk in 18.92% cases and thyrolingual trunk in 2.7% of cases.[2] In the present study, thyrolingual trunk was seen in 3.33% of cases on right side and in 5% of cases on the left side (Fig. 2A and Fig. 2B). Linguofacial trunk was seen in 28.33% cases on the right side and in 30 cases on the left side (Fig. 3) and thyrolinguofacial trunk was seen in 1.67 % cases (Fig. 4).

Thyrolingual trunk			
A. Al-Rafiah et al (2011)	**Sanjeev et al (2010)**	**Ozgur Z et al (2011)**	**Present study**
1.7%	2.7%	2.5%	3.33% (Right) 5% (Left)

Thyrolinguofacial trunk	
A. Al-Rafiah et al (2011)	**Present study**
1.7%	0.83%

Linguofacial trunk			
A. Al-Rafiah et al (2011)	**Sanjeev et al (2010)**	**Ozgur Z et al (2011)**	**Present study**
1.7%	18.92%	7.5%	28.33% (Right) 30% (Left)

Occipitoauricular trunk

Sanjeev et al found a common trunk of occipital and posterior auricular arteries (2.7%).[2] Afitap et al also found occipitoauricular trunk in 18.3%.[6]

Common trunk of Occipital artery and Posterior auricular artery		
A. Al-Rafiah et al (2011)	**Sanjeev et al (2011)**	**Present study**
18.3%	2.70%	5% (Right) 0% (Left)

In the present study, the occipitoauricular trunk was encountered in 5% of the cases on right side. (Fig. 5A and Fig. 5B) Marques S. R., Itezerote A. M. et al reported a rare variation in two cases in which the occipital artery was branching off very close to the carotid bifurcation looking like the trifurcation of Common Carotid Artery.[7]A similar variation in which the occipital artery was given off at a distance of 5 mms from the origin of the ECA was observed in the present study. (Fig. 6)

Accessory branches from External Carotid Artery

Sanjeev et al mentioned about the accessory branches of the ECA. They found superior laryngeal artery as a direct branch from the external carotid artery in two cases, sternocleidomastoid muscular branch in two cases and tonsillar artery in one case.[2] In the present study, many accessory branches of ECA were found in 10% (6 cases) on the right and in 8.33 % (5 cases) on the left side such as infrahyoid artery (IHA - Fig. 12), pharyngeal muscular branches (PM- Fig. 7 and Fig. 8), branches to submandibular gland (SMB Fig.8), parotid gland and tonsillar branches.

Superior laryngeal artery as a direct branch of ECA

Rao Mohandas K.G., and Rao Asutosh S. found that the left common carotid artery bifurcated at the superior border of lamina of thyroid cartilage normally but the superior thyroid artery (STA) was the direct branch of common carotid artery (CCA) 1cm proximal to the bifurcation. Also the superior laryngeal artery (SLA) was arising directly from the external carotid

artery (ECA) which is a branch of STA normally.[8] Soubhagya R. Nayak, Ashwin Krishnamurthy et al documented the variable patterns of SLA in their dissection study. According to them, the origin and morphology of SLA is important during partial laryngectomy and reconstruction surgery of the larynx. They also found duplication of SLA in one case. They said that, in case of duplication of the SLA, both the arteries should be ligated to minimize bleeding. According to them, as SLA is the principal artery to the larynx, variations of SLA should be considered by the clinicians in intra-arterial chemotherapy for laryngeal cancers.[9] A similar variation was found in this study, where the superior laryngeal artery (SLA) was directly arising from the ECA instead of from superior thyroid artery in 10% (6 cases) on the right and in 8.33% (5 cases) on the left side similar to the cases which were previously reported in the literature. (Fig. 9) In one case on the left side, it was found that there were two SLA, one arising from the STA whereas the other one arising from the ECA directly and both were piercing the thyrohyoid membrane along with the superior laryngeal nerve. (Fig. 11)

Trifurcation at the termination of the ECA into maxillary artery, posterior auricular artery and the transverse facial artery

Sanjeev et al encountered a case in which the external carotid artery was terminated into the posterior auricular, the superficial temporal and the maxillary arteries.[2] In the present study, a variation was observed in which ECA terminated into the posterior auricular artery, maxillary artery and the transverse facial arteries on the left side in one male cadaver.(Fig. 10A and Fig. 10B)

Ascending pharyngeal artery (APA) at a higher level

A.Hima Bindu and B. Narsinga Rao in their study on 20 cadavers reported a common linguofacial trunk (LFT) with higher origin of ascending pharyngeal artery in two cadavers.[10] In the present study, the ascending pharyngeal artery was found to be originating at a higher level than the normal in 1.67% (1 case) and 6.67% (4 cases) on the left side.(Fig. 11, Fig. 13) Thwin S S, Soe M M found simultaneous branching of the right ECA into the lingual artery, facial artery, occipito-auricular trunk and distal part of the ECA after the origin of superior thyroid artery. The APA was originating at a higher level on both sides. The APA was given off above the level of origin of lingual artery on the right side and at the level of the linguofacial trunk on the left side.[11] A similar variation in which ECA branched directly at its origin into the superior thyroid, lingual, facial and occipital arteries like branches of a tree was found in the present study. (Fig. 12). A. Al-Rafiah et al found that APA arose from the ECA from the bifurcation in 1.7% cases and from the ICA in 1.7% cases.[3] Similarly, APA was found to be originating from the bifurcation of the CCA in one case in the present study. (Fig. 14)

Sternocleidomastoid branch from Common carotid artery

Anomalous branches arising from the common carotid artery have been described in the literature previously. Koneko et al had reported that occipital artery arose along with the sternocleidomastoid muscular branch from the common carotid artery.[12] A sternocleidomastoid branch arising from CCA on the left side in a male cadaver was encountered in the present study. (Fig. 15) Chitra et al have reported the trifurcation of the right common carotid artery in a male cadaver aged about 55 years. The author mentioned the importance of this variable branching pattern of CCA in intra-arterial administration of chemotherapeutic drugs for head and neck cancers.[13] D. Vinaitha, K. Suba Anandhi et al during routine dissection of the anterior triangle of the neck found that the common carotid artery bifurcated at a higher level than normal bilaterally and external carotid artery looping on the left side. Also superior thyroid artery was found to be a direct branch of common carotid artery.[14] In this study, bifurcation of CCA above the level of angle of mandible or looping of ECA was not found.

Conclusions

A thorough knowledge of the normal anatomy and anomalous variations of the site of origin, course and branching pattern of the External Carotid Artery is not only of paramount surgical importance during vascular diagnostic interventional procedures and surgeries but also helps in reducing the chances of intra-operative secondary haemorrhage and post-operative complications.

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