Original Research Article

A STUDY OF ANATOMICAL VARIATIONS IN THE EXTERNAL CAROTID ARTERY IN CADAVERS

Kachhave Sanjay Kishanrao [1]

[1] Associate Professor, Department of Anatomy, Prathima Institute of Medical Sciences, Naganur, Karimnagar

Corresponding Author: Dr. Kachhave Sanjay Kishanrao

Abstract

Background: The External Carotid Artery primarily supplies blood to the scalp, neck, and facial regions of the body. A comprehensive understanding of the vasculature and nerves in these areas is invaluable for various therapeutic and diagnostic procedures, including surgical resections for head, neck, facial, and oral cancers, radical neck dissections, as well as plastic and reconstructive surgeries in this critical region. Cerebrovascular strokes resulting from conditions such as atherosclerosis, hemorrhage, or embolism necessitate radiological investigations like carotid angiograms, while surgical interventions such as carotid endarterectomy also demand a thorough knowledge of the anatomy of the external carotid artery and its branches.

Methods: This study utilized 50 cadavers preserved with 10% formalin, yielding a total of 100 neck halves for analysis. Among these cadavers, 42 were male, and 8 were female, obtained from the Department of Anatomy at Prathima Institute of Medical Sciences, Naganur Karimnagar, Telangana State. Anomalous branching patterns of the carotid arteries and variations in the relative positions of the internal and external carotid arteries can potentially damage the cranial nerves associated with them. Consequently, a morphometric study of the external carotid artery through meticulous cadaver dissections was undertaken.

Results: the most common variation observed is the Linguofacial Trunk, with frequencies of 15 (30%) on the right side and 16 (32%) on the left side. The Direct origin from STA and Thyrolingual Trunk variations have lower frequencies compared to other variations. Thyrolinguofacial Trunk and Terminal trifurcation of ECA are relatively rare occurrences. Accessory branches of ECA and SLA direct branch of ECA are observed at similar frequencies on both sides. APA at a higher level is more frequently observed on the left side compared to the right side. The sternocleidomastoid branch from CCA is a rare occurrence, with only one instance observed on the left side.

Conclusion: The branching pattern of the ECA in the neck exhibits significant variability. A comprehensive understanding of its angioarchitecture is essential for enhancing procedural outcomes and averting life-threatening complications. Preoperative angiographic evaluation to determine the carotid bifurcation level and arterial branching pattern can be invaluable in preventing injury to critical structures like the hypoglossal nerve and minimizing hemorrhage during surgical exploration of the head and neck region.

Keywords: Anatomy, Carotid artery Variations, Branching pattern, External carotid artery.

Introduction

The external carotid artery (ECA) and its branches are crucial vascular conduits in the head and neck region. Originating in the carotid triangle alongside the internal carotid artery (ICA) from the common carotid artery (CCA), it serves as the primary supplier of blood to tissues in the head and neck through its eight branches: superior thyroid artery (STA), ascending pharyngeal artery (APA), lingual artery (LA), facial artery (FA), occipital artery, posterior auricular artery (PAA), superficial temporal artery, and maxillary artery. Additionally, ECAs contribute significantly to the collateral blood supply to the brain via numerous connections between their branches and the cranial branches of the ICA and vertebral arteries [1]. A comprehensive understanding of the blood vessels and nerves in the regions of the head, neck, and face is highly beneficial for various therapeutic and diagnostic procedures. These include surgical interventions for cancers of the head, neck, face, and oral cavity; radical neck dissection; and plastic and reconstructive surgeries pertinent to this critical area. Moreover, cerebrovascular events such as strokes resulting from conditions such as atherosclerosis, hemorrhage, or embolism necessitate radiological investigations such as carotid angiograms. Surgical procedures such as carotid endarterectomy require in-depth knowledge of the anatomy of the external carotid artery and its branches. Furthermore, anomalous branching patterns of the carotid arteries and variations in the relative positions of the internal and external carotid arteries have the potential to damage associated cranial nerves. In cases of neck trauma, injuries to the carotid arteries can lead to inaccessible, life-threatening hemorrhage, necessitating emergency surgical intervention [2, 3]. Pseudoaneurysms resulting from blunt carotid injuries frequently affect branches of the ECA rather than the main ECA itself [4]. The clinical importance of the ECA and its branches is underscored by their utility in various radiological and surgical procedures, including intra-arterial infusion chemotherapy [5], carotid stenting, endarterectomy [6, 7], and various head and neck surgeries [8]. Thus, a thorough comprehension of both normal and variant ECA anatomy is essential for radiologists and surgeons alike to ensure successful procedural outcomes and minimize vascular complications in the head and neck region. This study aimed to investigate variations in the trajectory, associations, and branching arrangements of the External Carotid Artery.

Material and Methods

In this investigation, a total of 100 neck halves from embalmed cadavers were dissected, comprising 50 on the right side and 50 on the left side. Of these, 84 neck halves originated from 42 male cadavers and 16 from 8 female cadavers, procured from the Department of Anatomy at Prathima Institute of Medical Sciences, Naganur, Karimnagar, Telangana State. The cadaver's neck was adequately supported on a wooden block in an extended position. Following this, skin incisions were made: the first incision extended from the chin to the sternum along the midline, and the second incision traversed the inferior border and angle of the mandible, with the subsequent reflection of the skin flap inferolaterally. The platysma was then reflected upward, and the sternocleidomastoid muscle was incised at the midpoint and reflected superolaterally. Further dissection involved cutting and reflecting the anterior belly of the digastric muscle and the infrahyoid muscles, with displacement of the submandibular gland. The ansa cervicalis loop was identified and removed. Opening the carotid sheath exposed the contents of the carotid triangle, facilitating tracing of the external carotid artery upward. Its trajectory was noted, and all associated branches were dissected and exposed. Subsequent dissection involved the removal of the parotid gland in a piecemeal fashion to expose the terminal branches of the external carotid artery, namely the superficial temporal artery and maxillary artery. Variations observed in the branches and course of the external carotid artery were meticulously recorded. Statistical analysis of the data was performed for comparison and correlation by calculating the mean, standard deviation, and range.

Results

A total of 50 cadavers embalmed with 10% formalin were used involving 100 sides were studied in this study. It involved 42(84%) males and 8(16%) female cadavers. A critical analysis of Table 1 shows the most common variation observed is the Linguofacial Trunk, with frequencies of 15 (30%) on the right side and 16 (32%) on the left side. The Direct origin from STA and Thyrolingual Trunk variations have lower frequencies compared to other variations. Thyrolinguofacial Trunk and Terminal trifurcation of ECA are relatively rare occurrences. Accessory branches of ECA and SLA direct branch of ECA are observed at similar frequencies on both sides. APA at a higher level is more frequently observed on the left side compared to the right side. The sternocleidomastoid branch from CCA is a rare occurrence, with only one instance observed on the left side.

Table 1: Showing the Variations in branching pattern of ECA in 50 Human cadavers

Variation of ECA	*Right*	*Percentage*	*Left*	*Percentage*
Direct origin from STA	1	2	4	8
Thyrolingual Trunk	2	4	2	4
Linguofacial trunk	15	30	16	32
Thyrolinguofacial trunk	0	0	1	2
Occipitoauricular trunk	2	4	0	0
Accessory branches of ECA	5	10	4	8
SLA direct branch of ECA	4	8	4	8
Terminal trifurcation of ECA	0	0	1	2
APA at a higher level	1	2	3	6
Sternocleidomastoid branch from CCA	0	0	1	2

Table 2 shows that the majority of cases (33) exhibit a normal level of bifurcation of the CCA, with no observed variations. These cases are all bilateral. Among the variations, the most common is a high bifurcation at the level of the greater cornua of the hyoid bone (2b), with a total of 10 occurrences. Among these, 4 cases are unilateral, and 6 cases are bilateral. The high bifurcation between the upper border of the thyroid cartilage and the greater cornua of the hyoid bone (2a) is observed in 6 cases, all of which are bilateral. There is only one instance of a high bifurcation above the level of the greater cornua of the hyoid bone (2c), and it is classified as unilateral. No cases of low bifurcation are observed in this study.

Table 2: Variations in the level of bifurcation of common carotid artery

Level of Origin	Number	Unilateral	Bilateral
Normal	33	0	33
High (2a) between the upper border of the thyroid cartilage and greater cornua of the hyoid bone	6	0	6
High (2b) at the level of greater cornua of the hyoid bone	10	4	6
High (2c) above the level of greater cornua of the hyoid bone	1	1	0
Low	0	0	0

Discussion

Significant anatomical variations were observed in the level of origin, termination, and branching patterns of the external carotid arteries. Previous studies have extensively documented various variations, including unilateral or bilateral absence of the ECA, as well as differences in the position and branching pattern of the ECA. Sanjeev et al. [9] found that the Superior Thyroid Artery (STA) arose directly from the common carotid artery in 35.14% of cases. According to Al-Rafiah et al. [10] the STA branches directly from the common carotid artery in 18.3% of cases. In a study conducted by Natsis et al. [11] the superior thyroid artery originated from the external carotid artery in 39% of cases and from the common carotid artery in 61% of cases. The anterior branches originated separately from the external carotid artery in 76% of the cases, while common trunks were found in 24% of the specimens. In the current study, it was observed that the STA directly originated from the common carotid artery in 1 (2%) case on the right side and in 4 (8%) cases on the left side. Al-Rafiah et al. [10] observed that the Superior Thyroid Artery (STA) originated from a thyrolingual trunk in 1.7% of cases and from a common thyrolinguofacial trunk in another 1.7% of cases. Ozgur et al. [12] in their investigation, noted that the STA, LA, and FA arose separately in 90% of cases, as a linguofacial trunk in 7.5% of cases, and as a thyrolingual trunk in 2.5% of cases. Sanjeev et al. [9] identified the linguofacial trunk in 18.92% of cases and the thyrolingual trunk in 2.7%. In the current study, the thyrolingual trunk was observed in 4% of cases on the right side and in 4% of cases on the left side. The linguofacial trunk was present in 30% of cases on the right side and in 32% of cases on the left side, whereas the thyrolinguofacial trunk was detected in 2% of cases only on the left side. Sanjeev et al. [9] identified a combined trunk of the occipital and posterior auricular arteries in 2.7% of cases.

Marques et al. [13] documented a rare variation in two cases where the occipital artery branched off very near the carotid bifurcation, resembling the trifurcation of the Common Carotid Artery. A comparable variation, wherein the occipital artery originated approximately 5 mm from the origin of the ECA, was observed in our current study. Sanjeev et al. [9] discussed the presence of accessory branches originating from the External Carotid Artery (ECA). They identified the superior laryngeal artery as a direct branch from the external carotid artery in two cases, the sternocleidomastoid muscular branch in two cases, and the tonsillar artery in one case. In the current investigation, numerous accessory branches of the ECA were observed, accounting for 10% (5 cases) on the right side and 8% (4 cases) on the left side. These include the infrahyoid artery, pharyngeal muscular branches, branches to the submandibular gland, and branches to the parotid gland and tonsillar branches. Mohandas et al. [14] observed that while the left common carotid artery typically bifurcates at the superior border of the lamina of the thyroid cartilage, the superior thyroid artery (STA) originates directly from the common carotid artery (CCA) approximately 1 cm proximal to the bifurcation. In addition, they noted that the superior laryngeal artery (SLA) arose directly from the external carotid artery (ECA), which is typically a branch of the STA. Soubhagya et al. [15] detailed various patterns of SLA in their dissection study, highlighting its significance in partial laryngectomy and laryngeal reconstruction surgery. They also observed a case of SLA duplication, emphasizing the importance of ligating both arteries to minimize bleeding during the procedure. Furthermore, they stressed the consideration of SLA variations by clinicians during intra-arterial chemotherapy for laryngeal cancers given its role as the principal artery to the larynx.

A similar variation was noted in our study, in which the superior laryngeal artery (SLA) directly originated from the ECA instead of from the superior thyroid artery in 8% (4 cases) on the right side and in 8% (4 cases) on the left side, consistent with previously reported cases in the literature. In one instance on the left side, two SLAs were observed, one arising from the STA and the other directly from the ECA, both piercing the thyrohyoid membrane alongside the superior laryngeal nerve. Sanjeev et al. [9] documented a case in which the external carotid artery terminated in the posterior auricular, superficial temporal, and maxillary arteries. In our current investigation, we observed a variation in which the ECA terminated into the posterior auricular, maxillary, and transverse facial arteries on the left side in one male cadaver. Hima et al. [16] reported a common linguofacial trunk with a higher origin of the ascending pharyngeal artery in two cadavers. In our study, the ascending pharyngeal artery originated at a higher level than usual in one case (1.67% (1 case) and 6.67% (4 cases) on the left side. Additionally, we observed that the ECA branched directly into the superior thyroid, lingual, facial, and occipital arteries, resembling a tree-like pattern. Al-Rafiah et al. [10] found the ascending pharyngeal artery arising from the ECA bifurcation in 1.7% of cases and from the ICA in 1.7% of cases. Similarly, in our study, APA originated from the CCA bifurcation in one case. Anomalous branches originating from the common carotid artery include the occipital artery arising alongside the sternocleidomastoid muscular branch. In our study, we observed a sternocleidomastoid branch originating from the CCA on the left side of the male cadaver. Additionally, Chitra et al. [17] reported trifurcation of the right common carotid artery, highlighting its relevance in intra-arterial chemotherapy for head and neck cancer. Vinaitha et al. [18] found bilateral higher bifurcation of the common carotid artery and looping of the external carotid artery on the left side, with the superior thyroid artery branching directly from the common carotid artery. In our study, bifurcation of the CCA above the angle of the mandible and looping of the ECA were not observed.

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Conclusion

The branching pattern of the ECA in the neck exhibits significant variability. A comprehensive understanding of its angioarchitecture is essential for enhancing procedural outcomes and averting life-threatening complications. Preoperative angiographic evaluation to determine the carotid bifurcation level and arterial branching pattern can be invaluable in preventing injury to critical structures like the hypoglossal nerve and minimizing hemorrhage during surgical exploration of the head and neck region.

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