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Assessment of anatomical variations in the branches of external carotid artery

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Abstract

Introduction: Profound comprehension of the spatial orientation and intricacies of the external carotid artery and its ramifications is indispensable for faciomaxillary interventions and procedures involving the neck. A nuanced understanding of the divergences in the vascular branching pattern is particularly critical to circumvent complications arising from catheter insertions into carotid arteries during diverse medical interventions and pre-operative angiography. The external carotid artery serves as a pivotal conduit for the delivery of anticancer pharmaceuticals in the treatment of head and neck cancer. Thus, a clinical mastery over the anatomical intricacies and branching configurations of the external carotid artery is of paramount importance.

Materials and Methods: A total of 30 external carotid arteries were encompassed in the current investigation. The dissection of the external carotid artery transpired within the dissecting domain of the Anatomy Department at Krishna Institute of Medical Sciences, karad. Upon the revelation of the entire network of branches and the course of the external carotid artery, any discerned variations were meticulously documented. The length of the artery was gauged employing thread, scale, and vernier caliper. Subsequently, all acquired data underwent meticulous analysis using Microsoft Excel 2007 software, with representation in terms of mean and standard deviation.

Results: In routine cadaver dissection, an unusual external carotid artery branching pattern was observed, along with significant variations in branch origins on both sides. The average length of the external carotid artery, from its common carotid artery bifurcation to termination, measured 7.9 cm on the right and 7.8 cm on the left. Summary: External carotid artery exhibited atypical branching; notable variations in branch origins on both sides; average length—7.9 cm (right), 7.8 cm (left).

Conclusion: The mean length of the external carotid artery demonstrated a discernable distinction between the right and left sides. The proclivity for variations in the branching pattern of the external carotid artery was more conspicuous on the left side in comparison to the right side. These variances in the vascular architecture of the external carotid artery bear significant implications for vascular surgeons and radiologists, serving as a pivotal determinant in averting diagnostic inaccuracies and mitigating complications during surgical interventions in the craniofacial region.

Introduction

The external carotid artery serves as the principal arterial supply for the regions encompassing the head, face, and neck. Originating bilaterally from the common carotid artery, it initiates its course lateral to the upper border of the lamina of the thyroid cartilage, aligning with the intervertebral disc between the third and fourth cervical vertebrae [1,2]. Its trajectory is marked by the emission of substantial branches, accompanied by a swift reduction in caliber. Initially situated in the carotid triangle, it assumes an anteromedial position in relation to the internal carotid artery, later transitioning to an anterior and then lateral alignment as it ascends. While in children, the external carotid is comparatively smaller than the internal carotid, in adults, the two arteries attain nearly equal dimensions. A palpable arterial pulsation in the carotid triangle signifies the culmination of the common carotid and the commencement of the external and internal carotids [3].

The external carotid artery (ECA) boasts eight designated branches, dispersed across the head, neck, and face. The superior thyroid artery (STA), lingual artery (LA), and facial artery (FA) emerge from its ventral aspect, while the occipital artery (OA) and posterior auricular artery (PAA) originate dorsally. [4] The ascending pharyngeal artery (APA) takes its origin from the medial aspect. Upon reaching the neck of the mandible and within the parotid gland, the ECA bifurcates into the superficial temporal artery (STA) and the maxillary artery (MA), constituting its terminal ramifications [5,6].

The facial artery typically arises from the external carotid artery, just above the lingual artery, at the level of the greater cornu of the hyoid bone within the carotid triangle. Noteworthy variations include an intraparotid origin of the facial artery and its emergence as a common trunk with the lingual artery, forming the linguofacial trunk [7,8]. Additional variations involve the lingual artery forming a common trunk with the facial artery (lingofacial trunk) in 10-20% of cases, and a rare combination branch known as the thyrolinguofacial trunk [7]. Studies have also reported the presence of the linguofacial trunk, thyrolingual trunk, and thyrolingualfacial trunk in human fetuses [9,10].

A comprehensive understanding of the variations in the external carotid artery and its branches holds pivotal significance for faciomaxillary and neck surgeries. Precise knowledge of the branching pattern and origin of the external carotid artery is crucial to avert complications during catheter insertion in various procedures [11]. Variations in the origin of the external carotid artery pose a substantial risk of misidentification during surgery. A detailed comprehension of the gross and radiologic anatomy of the external carotid artery, along with its branching, is indispensable for the application of angiography in diagnosing lesions affecting the neck, face, and scalp. Common abnormalities readily diagnosed include tumors, vascular malformations, or bony disorders. Therefore, a profound understanding of the anatomy of this vessel is imperative for executing surgeries in a bloodless field and minimizing postoperative complications [12,13].

Given the plethora of variations observed in the branches of the external carotid artery, many of which remain undiscovered, the present study endeavours to unveil further anatomical intricacies in its course, branching, and distribution pattern, seeking correlation with existing findings.

Materials and Methods

Following the acquisition of ethical approval, the investigation encompassed the examination of 30 external carotid arteries. This study involved 15 embalmed cadavers, without restriction to age or gender, within the dissection hall of the Anatomy Department at Krishna Institute of Medical Sciences, karad. [14]

Conducting the dissection adhering to the guidelines outlined in "Cunningham's Manual of Practical Anatomy 15th edition" [15], a vertical midline incision was executed from the chin to the upper border of the sternum. Additionally, a horizontal incision initiated from the lateral side of the eye, traversing above the tragus and auricle, extending posteriorly up to the mastoid process. An oblique incision from the angle of the mouth to the posterior border of the ramus of the mandible was meticulously made. Another oblique incision along the anterior border of the sternocleidomastoid extended from the upper border of the sternum to the mastoid process. [16] The careful reflection of the skin, lateral to the auricles, towards the base of the mandible, and inferolaterally at the neck region, ensued. Following skin reflection, the platysma muscle was elevated, meticulously removing fat and fascia while safeguarding vessels and nerves. The sternocleidomastoid was then lifted to unveil underlying structures. The carotid triangle was exposed through fat clearance over the posterior belly of the digastrics and the superior belly of the omohyoid muscle.[17,18]

Tracking the common carotid artery within the carotid sheath until its bifurcation, the external carotid artery was pinpointed anteromedial to the internal carotid artery at the level of the upper border of the thyroid cartilage. Further dissection of the external carotid artery took place in the carotid and diagastric triangle. Variations in the origin and course of all branches of the external carotid artery were meticulously noted when visible. The length of the artery was manually measured using thread, a measuring scale, and vernier caliper for both the right and left sides. Subsequently, data analysis transpired using Microsoft Excel 2007 software, with results presented as mean ± standard deviation (SD).

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Results

During the routine dissection of cadavers, an atypical branching pattern of the external carotid artery was discerned. Noteworthy variations in the origin of branches of the external carotid artery on both sides were also identified and duly recorded. The average length of the external carotid artery, extending from its inception at the bifurcation of the common carotid artery to its conclusion, measured 7.9 cm on the right side and 7.8 cm on the left side. A comprehensive summary of the mean results and standard deviation (SD) pertaining to the length of various branches of external carotid arteries on both sides is presented in Table 1.

Table 1: Variations in the length of branches of ECA in cm.

Name & Branches of External Carotid artery	No. of specimen	Right side		Left side	
		Mean length	SD	Mean length	SD
Superior Thyroid Artery	10	0.4	0.002	0.5	0.02
Lingual Artery	10	1.2	0.05	0.7	0.04
Facial Artery	10	0.3	0.04	1.9	0.06
Ascending Pharyngeal Artery	10	0.5	0.02	2.3	0.02
Occipital Artery	10	2.8	0.06	3.8	0.04
Posterior Auricular Artery	10	3.9	0.04	4.0	0.05
Superficial Temporal Artery	10	1.7	0.02	7.3	0.06
Maxillary Artery	10	7.2	0.04	8.1	0.03

Variation in the Level of Carotid Bifurcation

In the majority of cases (21, 70%), the External Carotid Artery (ECA) originated at the level of the upper border of the thyroid cartilage. A higher level of origin, above the upper border of the thyroid cartilage, was noted in a minority of cases (9, 30%). The ECA consistently positioned itself anteromedial to the Internal Carotid Artery (ICA) at the level of the carotid bifurcation across all cases.

Variations in the Branching Pattern of ECA

In the present study, on the right side, 9 external carotid arteries exhibited the normal branching pattern, constituting 50% of the cases, which includes the absence of any trunk or trifurcation. Thyrolingual trunk was observed in one case (5.6% of the total), Linguo-facial trunk in 3 cases (20% of the total), and Occipito-auricular trunk in 1 case (5.6% of the total). Trifurcation of the common carotid artery was observed in only one case (5.6% of the total). On the left side, 7 external carotid arteries showed a normal branching pattern, accounting for 47.7% of the cases. Additionally, Linguo-facial trunk was present in 6 cases (27.7% of the total), Occipito-auricular trunk in 2 cases (12.24% of the total), and trifurcation of the common carotid artery in 2 cases (16.43% of the total). The facio-lingual trunk, running medially and upwards, was crossed by the hypoglossal nerve. Notably, the thyrolinguofacial and faciomaxillary trunks were not observed in any of the cases in the present study. Comparatively, the left side exhibited a higher prevalence of variations than the right side in the present study.

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Table 2: Showing the number and percentage of various trunks present in the specimens

Name of the Trunk Present	No. of Right-Side Specimen	Percentage (%)	No. of Left Side Specimen	Percentage (%)
Normal Branching Pattern	9	50	7	47.7
Thyrolingual Trunk	1	5.6	-	-
Linguo-facial Trunk	3	20	6	27.7
Occipito-auricular Trunk	1	5.6	2	12.24
Trifurcation of Common Carotid	1	5.6	2	16.43

Discussion

The findings of the present study shed light on notable variations in the origin and branching patterns of the External Carotid Artery (ECA), providing valuable insights into the anatomical intricacies of this crucial vascular structure.

One intriguing observation was the variation in the level of carotid bifurcation. The majority of cases (70%) displayed the ECA originating at the level of the upper border of the thyroid cartilage. However, a noteworthy minority (30%) exhibited a higher level of origin above the upper border of the thyroid cartilage. This variation underscores the inherent anatomical diversity in the origins of the ECA, which may have implications for surgical procedures and interventions in the carotid region.

Examining the branching patterns of the ECA, the study identified a range of variations, particularly on the right side. Sixty percent of cases demonstrated a normal branching pattern, characterized by the absence of trunks or trifurcation. Notable variations included the presence of the Thyrolingual trunk in 6.6% of cases, Linguo-facial trunk in 20% of cases, and Occipito-auricular trunk in 6.6% of cases. Trifurcation of the common carotid artery was an uncommon finding, occurring in 6.6% of cases. On the left side, the normal branching pattern was observed in 46.6% of cases. Additional variations included the presence of the Linguo-facial trunk in 26.6% of cases, Occipito-auricular trunk in 13.33% of cases, and trifurcation of the common carotid artery in 13.33% of cases. Intriguingly, certain trunks such as the facio-lingual, thyrolinguofacial, and faciomaxillary trunks were not observed in any cases.

The identification of these variations is of paramount importance in the context of surgical planning and interventions involving the external carotid artery. The presence of atypical branching patterns may pose challenges during procedures, necessitating a thorough understanding of the possible variations. For instance, the presence of rare trunks or trifurcation may require meticulous attention to avoid inadvertent complications.

The higher prevalence of variations on the left side, as observed in this study, emphasizes the need for individualized assessments and heightened awareness during clinical procedures. Clinicians and surgeons should be attuned to the potential diversity in the vascular anatomy, especially when dealing with the external carotid artery.

Conclusion

The findings of this study on the variations of the external carotid artery and its branches align with and substantiate prior research, further contributing to the collective understanding of this intricate vascular structure. Notably, the study has unveiled new variations, expanding the existing body of knowledge in the field.

The identified variations in the branching pattern of the external carotid artery hold significant clinical implications, particularly for head and neck surgeons. A nuanced comprehension of these variations is crucial for planning and executing surgical interventions in the complex anatomy of the head and neck region.

A noteworthy observation from this study is the higher prevalence of variations on the left side in comparison to the right side. This asymmetry underscores the importance of individualized assessments and heightened vigilance during procedures, especially considering the intricate network of vessels in the region. The subtle discrepancy in the mean length of the external carotid artery between the right and left sides adds an additional layer of anatomical insight. While the difference is minor, such details are essential for surgical precision and may influence procedural approaches.

The detailed insight and awareness gained from the study regarding the anatomical variations of the external carotid artery are of paramount importance. This knowledge serves as a valuable resource for vascular surgeons and radiologists, acting as a preventive measure against diagnostic errors and complications during surgical interventions in the head and neck region.

In conclusion, the study contributes substantively to the existing body of knowledge on the external carotid artery, emphasizing the importance of continual exploration and understanding of anatomical variations. This knowledge not only advances academic understanding but also directly informs clinical practices, ultimately enhancing the efficacy and safety of procedures in the critical domain of head and neck surgery.

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