e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(2); 1180-1185

Original Research Article

A Morphological Study of the External Carotid Artery with Reference to Adjacent Anatomical Landmarks in Cadavers

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Received: 25-12-2022 / Revised: 20-01-2023 / Accepted: 08-02-2023
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Conflict of interest: Nil

Abstract

Aim: The aim of this observational study was to establish the relationship of External Carotid Artery with reference to Adjacent Anatomical landmarks in cadavers.

Methods: The present observational study was done in the Department of Anatomy, Netaji Subhas medical College and Hospital, Bihta, Patna, Bihar, India. 60 hemi-necks obtained from 30 formalin embalmed cadavers (20 male and 10 female) were dissected and the external carotid arteries were traced from the origin to termination.

Results: The ECA took origin at the level of upper border of thyroid cartilage (TC) in 40/60 cases (66.66%). Higher level of origin was noted in the remaining 20 of 60 cases (33.34%). Higher levels of carotid bifurcation were further categorized keeping the TC as anatomical landmark. No lower levels of origin were noted in this study. The anteromedial position of the ECA relative to the ICA at the level of the carotid bifurcation was noted in all the cases.

Conclusion: The exact anatomical knowledge of External Carotid Artery with reference to adjacent anatomical landmarks is helpful for surgeons to plan surgeries and prevent complications during various diagnostic and therapeutic procedures.

Keywords: External Carotid Artery, Anatomical Landmark, Cadaver, Carotid Tubercle.

Introduction

The arterial supply of head and neck region is mainly derived from the carotid system of arteries. Additional supply comes from the branches of the subclavian artery, most importantly the vertebral artery. The carotid system of arteries begins as the common carotid artery (CCA), which bifurcates into the external carotid artery (ECA) and the internal carotid artery (ICA). [1] The level of carotid bifurcation cannot be predicted by any known clinical sign. Most of the literature states that bifurcation of the common carotid artery occurs at the level of the superior border of the thyroid cartilage. [2]

The external carotid artery (ECA) and its branches serve as the major vascular channels of the head and neck region. The ECA arises in the carotid triangle from the common carotid artery (CCA) along with the internal carotid artery (ICA). The ECA is the main feeding vessel to the tissues of the head and neck region through its 8 branches, namely the 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. In addition, the ECAs also play an important role in providing collateral blood supply to the brain through the many connections between the branches of the ECA and cranial branches of the ICA and vertebral arteries. [3] Injuries to the carotid arteries in cases of neck trauma are the cause of inaccessible exsanguinating haemorrhage, requiring emergency surgical intervention. [4,5] Pseudoaneurysms occurring consequent to blunt carotid injury commonly affect branches of the ECA than the main ECA itself. [6] The clinical significance of the ECA and its branches is further reinforced by their application in a wide range of radiological and surgical procedures such as intra-arterial infusion chemotherapy [7,8] carotid stenting and endarterectomy [9,10] as well as various head and neck surgeries. [11-13]

A good knowledge of the normal anatomy and variations of ECA and its branches are of prime importance in both surgical and medical specialties. Both carotid endarterectomy and carotid stenting to prevent recurrence of stroke warrant a thorough knowledge of the carotid system. [14] Extracranial-intracranial bypass procedure for revascularization uses the ECA or one of its branches as donor vessels. [15]

The aim of this study was to establish the relationship of External Carotid Artery with reference to Adjacent Anatomical landmarks in cadavers.

Material and Methods

The present prospective study was done in the Department of Anatomy, Netaji Subhas medical College and Hospital, Bihta, Patna, Bihar, India. 60 hemi-necks obtained from 30 formalin embalmed cadavers (20 male and 10 female) were dissected and the external carotid arteries were traced from the origin to termination. Cadavers in which embalming had been done through CCA and those with injuries in the head and neck region were excluded from this study.

The cadavers were aged between 50 and 80 years. Variations encountered in the origin and branching pattern of the ECA were documented with digital photography. The data was tabulated and the percentage of cadavers with variations in the branching pattern of ECA as well as variations in the level of the carotid bifurcation were computed and analysed.

Results

Table 1: Variations in the level of bifurcation of common carotid artery

Level of origin	No. (%)	Laterality	
		Unilateral	Bilateral
Normal 60	40 (66.66%)	0	40
High (2a)	10 (16.66%)	0	10
High (2b)	8 (13.34%)	5	3
High (2c)	2 (3.34%)	2	0
Low	0	0	0

2a, between upper border of thyroid cartilage and greater cornua of hyoid bone; 2b, at the level of greater cornua of hyoid bone; 2c, above the level of greater cornua of hyoid bone

The ECA took origin at the level of upper border of thyroid cartilage (TC) in 40/60 cases (66.66%). Higher level of origin was noted in the remaining 20 of 60 cases (33.34%). Higher levels of carotid bifurcation were further categorized keeping the TC as anatomical landmark. No lower levels of origin were noted in this study. The anteromedial position of the ECA relative to the ICA at the level of the carotid bifurcation was noted in all the cases.

Table 2: Variations in the anterior branches of external carotid artery

Branching pattern	No. (%)
Separate origin	48 (80%)
Linguofacial trunk	10 (16.66%)
Thyrolinguofacial trunk	2 (3.34%)
Thyrolingual trunk	0

The anterior branches of the ECA include the STA, LA, and FA. Out of the 60 hemi-necks studied, separate origins for the anterior branches of the ECA were observed in 48 cases. In the remaining 12 cases, formation of common trunks was observed. The linguofacial trunk was the commonest observed variation with the thyrolinguofacial trunk (TLFT) occurring only in a single case. The TLFT was found to arise 6 mm above the carotid bifurcation and after a short length of 3 mm, divided into the STA and a common linguofacial trunk. No thyrolingual trunks were observed.

Table 3: Distribution of accessory branches of external carotid artery

Name of accessory branch	No. (%) (n=60)
Superior laryngeal artery	4 (6.66)
Double ascending pharyngeal artery	2 (3.33)
Masseteric branch	1 (1.66)
Branch to Internal jugular vein	1 (1.66)

Accessory branches were found to arise from the ECA in 8 of 60 cases (13.33%).

Discussion

Surgeries like thyroidectomy, laryngectomy, faciomaxillary surgeries, tonsillectomy, glossectomy and other neck surgeries involve areas supplied by or related to branches of the ECA. [16] Orofacial reconstruction surgeries, including scalp transplantation, depend on the superior thyroid, lingual and facial arteries for their technical applicability, feasibility, and flap survival. [17]

The carotid bifurcation is an important anatomical and surgical landmark requiring special mention in the pathogenesis of carotid atheromatous disease and its consequent management by carotid stenting and endarterectomy. [18] According to Al-Rafiah et al. [19] and Mompeo and Bajo [20], the commonest position of high carotid bifurcation was at the level of the hyoid bone in 25% and 36.85% cases respectively which correlates with our study. Lower levels of bifurcation have also been reported by the same authors with varying frequencies. Carotid bifurcations as low as intrathoracic bifurcations have also been reported in available literature. [21,22]

A low carotid bifurcation may be associated with Klippel-Feil anomaly [22] and may cause difficulties during surgeries like cervical discectomy. [23] With reference to previous similar studies, it may be noted that a higher level bifurcation is more common and lower bifurcations are less frequent. This correlates well with the present study also where no low level bifurcations were found. At the same time, a high carotid bifurcation (CB) should caution surgeons regarding the close proximity of hypoglossal nerve and superior cervical ganglion as well as possible STA origin from the CB. [2] The position of the CB depends on how low or high ECA originates from the third aortic arch. [24]

It can thus be concluded that the level of the carotid bifurcation exhibits a great degree of anatomical variability and cautious ascertaining of its position is mandatory to avoid complications during angiographic and surgical interventions. The occurrence of common trunks in the branching pattern of the ECA has frequently been described in the current literature. The linguofacial trunk, by far, appears to be the commonest variation with high incidence as per literature reports. The linguofacial trunk was observed in 16.66% cases in the present study.

A unilateral TLFT was observed in a single case in our study (3.34%). This coincides with findings of previous studies where a TLFT is a relatively rare occurrence with the incidence reported to be 1.7% by Al-Rafiah et al. [19] According to Baik et al. [25], common linguofacial trunks arising from the ECA may place the LA or FA in closer proximity to the tonsillar fossa, increasing the risk of iatrogenic vessel injury. The linguofacial trunk is also a common site of traumatic pseudoaneurysm after tonsillectomy. [26]

Mata et al. suggests that the embryology of the combined trunks would be in keeping with the angiogenesis theory, which suggests that confluence of the vessels and vessels with large diameter are more common in fetuses compared with adults as TLFTs are more common in fetuses and tend to disappear in adults. [1] Hayashi et al. [27] observed the origin of APA from the ECA with relation to the origin of LA and found high origin above LA in 66% cases and below LA in 9% cases. We found a high origin of APA at the level of the LA in our study.

The branches of the ECA are the key landmarks for adequate exposure and appropriate placement of cross-clamps to carry out successful removal of plaque and minimize postoperative complications in a bloodless surgical field.27 Caution must be paid with ligature of blood vessels of the carotid triangle, because if these blood vessels are not distinguished, this may have catastrophic consequences in cerebral circulation or it can cause bleeding in the region of the ECA. [28,29]

Conclusion

The anatomical knowledge of relationship of External Carotid Artery with reference to adjacent anatomical landmarks is helpful for vascular surgeons to plan surgeries and prevent complications during various diagnostic and therapeutic procedures. The branching pattern of the ECA in the neck shows considerable amount of variability and a clear anatomical understanding of the angioarchitecture will help to improve overall procedure outcome and prevent fatal complications. Prior angiographic assessment to ascertain the level of carotid bifurcation as well as the branching pattern of the carotid arterial system may prove valuable to avoid injury to vital structures such as hypoglossal nerve and minimise troublesome haemorrhage during surgical exploration of the head and neck region.

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