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## RESEARCH ARTICLE

## Variant topography of the Carotid Arteries -A Clinicoanatomical Appraisal.

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## Abstract

Apart from being the chief arteries of head, neck and brain, the carotids serve as an important landmark in defining the plane of dissection during radical neck surgeries. This report presents unique bilateral variations of the carotid arterial system in the neck explored during cadaveric dissection of a male cadaver. Common carotid arteries bilaterally terminated at a higher vertebral level and displayed abnormal branching patterns. Surgico-anatomical basis of undocumented branches such as accessory lingual artery and accessory pharyngeal artery revealed in this case report have been discussed in detail. A sound knowledge of such variations is important for radiologists performing carotid angiography, for anaesthesiologists and for surgeons performing vascular surgeries like carotid endarterectomy, catheterization and carotid aneurysm.

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## INTRODUCTION

The carotid arteries nourish the areas of head, neck and brain. The common carotid artery (CCA) can display varying patterns in termination. It may divide at the level of hyoid bone, at a lower level along the larynx or may not divide at all [1]. Precise knowledge of variations in the CCA bifurcation become imperative as iatrogenic bradycardia and arrhythmia are commonly encountered during neck surgeries involving carotid sinus. Furthermore, variability in the carotid bifurcation anatomy considerably influences systemic risk factors and can affect plaque formation at CCA termination [2, 3]. External anatomical landmarks and non invasive radiological techniques of neck like ultrasonography, Doppler, CT and skiagrams should become the gold standard for evaluating carotid bifurcation level pre-operatively. Paradoxical and inconsistent positional relationship of External carotid artery (ECA) and Internal carotid artery (ICA) should be borne in mind during facio-maxillary surgeries to ensure the ligation of ECA. Anomalous branches of ECA may play a crucial role in neck surgeries. While performing carotid endarterectomy, these branches act as important landmarks for adequate revelation of the surgical field so that proper cross clamping can be done [4].

## Case report:

During routine dissection hall teaching programme of medical undergraduates, bilateral variations of carotid arterial system were observed bilaterally in an Indian adult male cadaver.

On right side:

The common carotid artery bifurcated 2.5cms above the upper border of the thyroid cartilage into right external carotid artery (rECA) and right internal carotid artery (rICA). On this side the rECA was paradoxically positioned posterolateral to the rICA. The superior thyroid artery (STA) branched from the anterior surface of CCA 1.5 cm

above the upper border of thyroid cartilage. Thus on the right side the CCA gave three branches namely 1) Superior thyroid artery 2) External carotid artery 3) Internal carotid artery. The STA then descended along the lateral border of thyrohyoid to reach the apex of the thyroid gland where it terminated by supplying the gland, superior belly of omohyoid and thyrohyoid muscles. Immediately after the bifurcation of CCA, the ECA divided into a handful of branches in the carotid triangle. The level of origin as measured from the upper border of thyroid cartilage was as follows: The lingual artery at 3cms, facial artery at 3.4cms and occipital artery at 3.8 cms. Apart from these branches, the rECA conspicuously gave rise to two accessory branches of which we could not find a reference in accessible literature. The accessory lingual artery (ALA) took origin from the medial surface of the ECA at the level of facial artery. This accessory branch coursed along with the lingual artery and traversed between the middle constrictor and the hyoglossus muscles supplying both of them. The lingual, accessory lingual and facial artery traversed in front of the ICA to reach their destination. Notably, the ascending pharyngeal artery displayed a higher level of origin and was the sixth branch (inspite of the usual first) of the rECA. It was accompanied by another unnamed branch, an accessory pharyngeal artery (APA) which took origin from the medial aspect of the ECA at the level of facial artery. This accessory pharyngeal artery terminated by supplying the superior constrictor muscle. The rECA then entered the anteromedial surface of the parotid gland and terminated within the substance of the gland. Strikingly at the termination, apart from dividing into superficial temporal artery and maxillary artery, the rECA also gave twin posterior branches traversing towards the mastoid process. Thus at termination, the r ECA quadrifurcated into these branches in the parotid parenchyma 2.8cms from the tragus .To summarize, the sequential origin of the branches of rECA caudo-cranially are:1)Lingual artery 2)Accessory lingual artery 3)Facial artery 4)Accessory pharyngeal artery 5)Occipital artery 6) Ascending pharyngeal artery 7)posterior auricular artery 8)Twin Mastoid arteries 9)superficial temporal artery and 10)maxillary artery.

On left side:

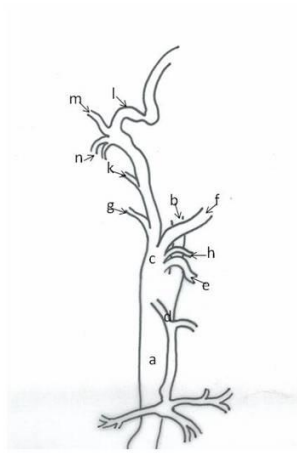
The CCA divided into ICA and ECA 2.0 cm above the upper border of thyroid cartilage. The ICA and ECA were normal in disposition in contrast to the presentation on the right side. The first branch given by the left CCA was superior thyroid artery given off 1cm above the upper border of thyroid cartilage as an anterior branch .The superior laryngeal artery (SLA) branched off from the CCA just distal to the origin of the STA. Thus STA and SLA were both the branches of CCA given off from the anterior aspect just before its bifurcation into ECA and ICA. At the termination the ECA apart from dividing into the superficial temporal artery and maxillary artery gave an unnamed posterior branch just proximal to the superficial temporal artery. This unnamed artery which we refer to as mastoid branch took a tortuous course towards the mastoid area.

The remaining branches of ECA exhibited normal course and distribution pattern. Other neurovascular structures of the neck displayed normal anatomy.

Fig1: Branching pattern of right common carotid artery showing a-common carotid artery, b-internal carotid artery, c-external carotid artery, d-superior thyroid artery, e-lingual artery, f-facial artery, g-occipital artery, h-accessory lingual artery, k-posterior auricular artery, l-maxillary artery, m-superficial temporal artery, n-mastoid arteries, o-external auditory meatus, p-submandibular gland, q-thyroid cartilage, r-thyroid gland, s-superior belly of omohyoid



Fig1: Right side neck and face region showing the carotid arterial system

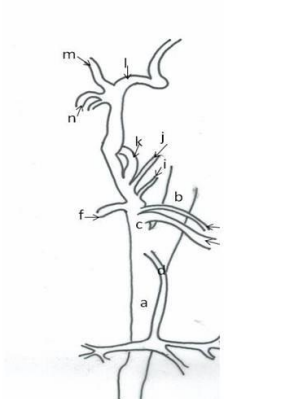


Schematic line diagram of the arteries in Fig1

Fig2: Branching pattern of right common carotid artery showing a-common carotid artery, b-internal carotid artery, c-external carotid artery, d-superior thyroid artery, e-lingual artery, f-facial artery, g-occipital artery, h-accessory lingual artery, i-accessory pharyngeal artery, j-ascending pharyngeal artery, k-posterior auricular artery, l-maxillary artery, m-superficial temporal artery, n-mastoid arteries, o-external auditory meatus, p-submandibular gland, q-thyroid cartilage, r-thyroid gland, s-superior belly of omohyoid, t-mylohyoid, u-hyoglossus



Fig2 : Right side neck and face region showing the carotid arterial system after reflection of the submandibular gland and the facial artery.

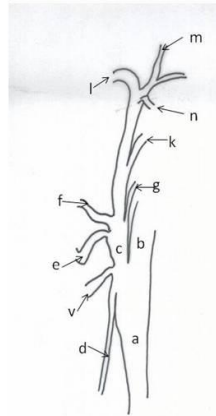


Schematic line diagram of the arteries in Fig 2

Fig3: Branching pattern of left common carotid artery showing a-common carotid artery, b-internal carotid artery, c-external carotid artery, d-superior thyroid artery, e-lingual artery, f-facial artery, g-occipital artery, k-posterior auricular artery, l-maxillary artery, m-superficial temporal artery, n-mastoid arteries, o-external auditory meatus, p-submandibular gland, q-thyroid cartilage, r-thyroid gland, v-superior laryngeal artery.



Fig 3: Right side neck and face region showing the carotid arterial system



Schematic line diagram of the arteries in Fig 3

### Discussion:

By the 32<sup>nd</sup> day of intrauterine life, six pairs of aortic arches course along the five branchial arches. Each primitive aorta divides into ventral and dorsal segments. The common carotid arteries develop from an elongation of the adjacent part of the aortic sac whereas the ECA develops from the ventral aorta. As the neck elongates, longitudinal anastomoses takes place between the arch arteries that links the intersegmental arteries and their branches. Normally the communication between the first and the second arch disappears. Persistence of the proximal segment of these arches may lead to the development of these aberrant vessels. [5]

There has been varying opinion regarding the level of bifurcation of CCA. Several standard textbook cites the upper border of thyroid cartilage to be the level of bifurcation. According to Ilic, 58% cases displayed same level of origin whereas Espalieu found it to be true in 65% and Golth and Poisel in 67% of cases [6]. Zumre et al have related the bifurcation of CCA to vertebral levels. They have documented the bifurcation of CCA to be 55% at C3 level, 35% at C4 level, 10% at C5 level on the right side and 60% at C3 level, 40% at the C4 level on left side. [7] Few authors differed in opinion. In one of the studies conducted by Lucev et al, he concluded that CCA bifurcated at the inferior border of hyoid bone in 25% cases, at superior border of hyoid bone and at inferior border of thyroid cartilage in 12.5% cases [6]. Our finding is consistent with that of Lucev et al. as the right CCA bifurcated at the level of upper border of hyoid bone whereas the left CCA bifurcated at lower border of the hyoid bone. This higher bifurcation level was accompanied by origin of superior thyroid artery from the anterior surface of CCA bilaterally.

In head and neck surgeries performed for microvascular free tissue transfer, the STA is used as a recipient vessel. The STA also plays an important role in selective embolization of thyroid gland and in identifying the superior laryngeal nerve [8]. Lo et al. have reported that an inverse relationship exist between the level of CCA bifurcation and the site of origin of STA from either CCA or ECA [9]. Hollinshead has described that in only 16% of cases STA took origin from CCA [10]. Murlimanju et al reported the STA to be a branch of the CCA but the SLA arose directly from the ECA. [11] This is applicable to our finding too but it differed in that the superior laryngeal artery (SLA) which usually arises from STA was found to originate directly from the CCA. According to a Meta analysis done by Toni et al., presence, site of origin and numerical variations of STA varies with ethnic origin and gender. They found that the STA arises more often from ECA in Caucasians than East Asians. [12] Ozgur et al observed the origin of the STA according to the carotid bifurcation and evaluated it as above (25%), below (35%) and at the same level (40%). [13]

In contrast to the SLA arising from the common carotid artery in our study Murlimanju et al observed that it arose from the external carotid artery instead of the superior thyroid artery. [11]

The knowledge of relative positions of ECA and ICA is also important for the clinicians. As in our case where ECA is placed postero-lateral to ICA, the anterior branches coursing in front of the ICA may compress on the artery

resulting in decreased blood supply to the brain. This finding belongs to the 1.7% of cases as reported by Al-Rafiah et al. [14]. Rusu et al have also documented this rare finding with the ECA situated postero-lateral to the ICA and the anterior branches of ECA crossing the ICA. [15]

After its origin, the ECA emanated two accessory branches- accessory lingual artery and the accessory pharyngeal artery.

This report also presents arterial variations such as ALA and accessory pharyngeal arteries which have never been described in the existing literature to the best of our knowledge. Anatomy of such aberrant vessels needs special mention as they can be occult causes of intra- operative haemorrhage especially during mandibular molar extractions. We also report a rare variation in the termination of ECA bilaterally. The ECA trifurcated bilaterally in the substance of parotid gland into maxillary, superficial temporal and an anomalous branch. This anomalous branch coursed towards the post-auricular region and terminated by supplying the soft tissue in the region of the mastoid and hence was named the mastoid arteries. This mastoid branch could be used to raise myofascial pedicle for reconstructive surgeries. It could also become the site of profuse bleeding during head injuries.

## Conclusion

Proper understanding of the variant level of origin, course, and branching pattern of ECA and ICA and their relationship with each other is essential for successful removal of plaque. Pre-operative appreciation of such variations can help maintain a bloodless surgical field during emergency cricothyroidotomy, carotid catheterization, aneurysm reconstruction and radical neck dissection [11].

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