Section: Gross Anatomy

Original Research Article

STUDY OF ORIGIN, COURSE, TERMINATION AND BRANCHES COMMON CAROTID ARTERIES AND ITS VARIATIONS-A CADAVERIC STUDY

***Premakumari C R*[1]**

[1]*Assistant Professor, Department of Anatomy, Karwar Institute of Medical Sciences, Karwar, Karnataka, India.*

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Corresponding Author:
Dr. Premakumari C R,
Assistant Professor, Department of Anatomy, Karwar Institute of Medical Sciences, Karwar, Karnataka India.
Email: drpremaaims@gmail.com.

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ABSTRACT

Background: The common carotid arteries with their terminal branches provide the major source of arterial blood to the head, neck and brain. Among the arterial branches in the human body, the carotid bifurcation is particularly important to avoid fatal mix-up with internal carotid artery which supplies blood to the brain. A profound knowledge of variations of the common carotid artery such as its branching pattern is essential during catheter insertion to carotid arteries, carotid endarterectomy, intraarterial chemotherapy for head and neck cancers and in radical neck surgeries to avoid fatal complications. **Objectives**: i) To study the origin of right and left common carotid artery. ii)To study the level of termination of right and left common carotid arteries with reference to the upper border of thyroid cartilage. Iii)To study the branching pattern of right and left common carotid arteries. Iv) To observe the variations.

Materials and Methods: A comprehensive cadaveric study of origin and termination of common carotid arteries was carried out in the Department of Anatomy, J.J.M. Medial College, Davangere: The study included a total number of 54 common carotid artery specimens (46 males, 8 females) in total of 27 embalmed cadavers in the Department of Anatomy, J.J.M. Medical College. Bilateral head and neck regions and thoracic regions were dissected in these cadavers following the methodology given in Cunningham's manual for the dissection of common carotid arteries. A detailed study was done regarding the origin of right and left common carotid arteries, their length, level of origin, level of termination, pattern of termination and any additional branches apart from terminal branches. Measurements and photographs were taken after dissection. **Results:** In the present study, 18.5% left common carotid arteries showed variations in origin. Out of these, 11.1% originated as a branch of brachiocephalic trunk, 3.7% showed bicarotid trunk originating from arch of aorta, which divided into right and left common carotid arteries. 1.9% of common carotid artery specimens showed trifurcation with the origin of ascending pharyngeal artery at the termination. 44.4% specimens terminated above the level of upper border of thyroid cartilage. 51.9% specimens showed additional branches, superior thyroid artery being the commonest (40.7%).

Conclusion: The present study, showed that left common carotid artery variations (81%) were more compared to right common carotid artery variations (59.2%). The present study adds new information regarding the frequency of occurrence of different variations of the common carotid arteries. This will be useful during head and neck surgeries, angiographies and other surgeries involving common carotid arteries and in thyroid surgeries to avoid fatal complications.

Keywords: Common carotid arteries, brachiocephalic trunk, higher bifurcation, additional branches.

INTRODUCTION

Arteries are the thick walled tubes which convey blood from the heart to the capillaries in various tissues.

The word artery is derived from the ancient Greek word 'arteria', literally means air tube and was first used by Aristotle. Because they were empty in cadavers, early anatomists believed that they all carried air.

The word 'carotid' is derived from Greek word 'karotides' which referred to the main arteries going to the head. Another equivalent word for karotides is katotiko's meaning stupefying and karo's meaning deep sleep. It was known from antiquity that compression of common carotid arteries induce heavy sleep.

The common carotid arteries with their terminal branches internal carotid and external carotid arteries provide the major source of blood to the head and neck. External carotid supplies the exterior of head, face and most of the neck and internal carotid supplies cranial and orbital contents.

A variant of origin, course and termination of common carotid artery is of great clinical value during head and neck surgeries, angiographies, to avoid a fatal mix-up with the internal carotid artery which supplies brain.

The level of bifurcation of the common carotid artery will be useful to surgeons when ligating the vessels in the head neck regions during surgery and to avoid unnecessary complications during carotid endarterectomy. Intra thoracic carotid bifurcation ca rry a high risk of unintentional catheterization above the carotid bifurcation during conventional cerebral angiography, in particular if they are associated with short common carotid artery.

Variation in bifurcation of common carotid artery in carotid artery stenosis due to atheromatous plaques would render carotid endarterectomy challenging obliging the consideration of an alternative therapeutic strategy such as angioplasty and stenting. A thorough knowledge of common carotid artery anatomy is essential as it is used to intra arterial chemotherapy for various head and neck cancers.

The origin and course of superior thyroid and inferior thyroid arteries originating as variations from the common carotid artery could be of interest in thyroid surgeries. Carotid pulse is felt during cardio-pulmonary resuscitation (CPR) in cardiac arrest to access the recovery. Hence the present was conducted to study of origin and termination of common carotid arteries in humans.

MATERIAL AND METHODS

The study was carried out in a total of 54 common carotid artery specimens from 27 embalmed and formalin fixed cadavers (23 males, 4 females) in the Department of Anatomy, J.J.M. Medical College, Davangere, Karnataka, India. The age of cadavers of both sexes were approximately 60 to 75 years of age. The cadavers were allotted for routine undergraduates dissection.

Method of collection of data

The study was carried out by conventional dissection method in dissection room. Ethical clearance obtained from the institution for study. The methodology prescribed by Cunningham's manual for the dissection of common carotid arteries was followed.

As the upper limbs were dissected and the clavicles divided by that time, to expose the arch of aorta, a cut was done through the first rib immediately anterior to the subclavian veins. Manubrium of the sternum was turned upwards to expose the arch of aorta with its branches in the superior mediastinum. Brachiocephalic veins, and its tributaries crossing the arch were divided and turned to one side. Connective tissue, fat, remains of the thymus were cleared over the aortic arch. Other veins displaced to expose the remainder of the aortic arch and the branches which arise from its convex surface. Origin of left common carotid artery and other branches coming from the arch of aorta were traced upwards. Any variations in the origin of right and left common carotid artery were observed and photographs were taken. Length of the left common

carotid artery from its origin to sternoclavicular joint was measured with a measuring tape. If the brachiocephalic trunk and left common carotid artery were arising from the common trunk from aortic arch, the length of the common trunk was measured.

The dissection of the front of the neck was started by incising the skin from chin to sternum in the midline. Skin flaps and platysma were reflected inferolaterally. Fat and fascia over the sternocleidomastoid, superior belly of omohyoid and posterior belly of digastric were cleared. Fat and fascia from the area between the posterior belly of digastric and the superior belly of omohyoid was removed to expose the carotid triangle and its contents. Superficial part of the fascial carotid sheath surrounding the internal jugular vein, the carotid arteries, and the vagus nerve was removed. The upper border of thyroid cartilage was cleared. The common carotid arteries were traced both sides upto their termination. On the right side, origin of the CCA from the brachiocephalic trunk at sternoclavicular joint was traced. On the left side, the origin of the CCA from arch of aorta was traced. Photographs were taken from their origin to termination. Any variation regarding level of termination with respect to thyroid cartilage's upper border noted. Branching pattern at the termination was noted. Length of the arteries from their origin till termination taken. Length of other branches coming from the artery apart from the terminal branches were measured with the measuring tape. Photographs were taken.

Inclusion Criteria

Total of 54 embalmed and formalin fixed cadavers with approximate age group of 60-75 years allotted for dissection to undergraduate medical and dental

students were included for the study. Both male and female cadavers with intact and properly embalmed head, neck and thoracic regions were included.

Exclusion Criteria

Improperly embalmed cadavers, decapitated, damaged and very old cadavers were excluded from the study.

Parameters like side, sex, origin, level of origin and termination with reference to standard points, branching pattern at termination were studied.

Statistical Analysis

The results of the present study were expressed as mean, range, standard deviation values, number and percentage. Unpaired 't' tests were used to compare between two groups. 'p' value of 0.05 and less was considered for statistical significance. Analysis was done using SPSS (statistical presentation system software) package – version 16.

RESULTS

In the present study, 96.3% of right common carotid arteries and 81.5% of left common carotid arteries had their normal origin. 11.1% of left common carotid artery originated as a branch of brachiocephalic trunk from its left proximal portion and 3.7% originated along with the brachiocephalic trunk from a common trunk, the common trunk originated from arch of aorta. Another 3.7% of left common carotid artery originated along with the right common carotid artery from Bicarotid trunk. The bicarotid trunk originated from arch of aorta.

30.8% of right common carotid artery originated from brachiocephalic trunk above the level of sternoclavicular joint.

Table 1: Origin of Right & Left Common Carotid Arteries

Side	Total No.	BCT		From AOA		CT with LCCA/RCCA		CT with BCT	
		No	%	No	%	No	%	No	%
Right	27	26	96.3	-	-	1	3.7	-	-
Left	27	3	11.1	22	81.5	1	3.7	1	3.7

The average length of right common carotid artery in the present study in males was 9.9±1.4 cm and in females was 10.3±3.0 cm with no significant differences between the two sexes. The average length of left common carotid artery was 13.8±1.7 cm in males and in females was 12.8±1.3 cm. However the length of left common carotid artery was significantly higher than the right side due to their variant origins. Normal values of length of right and left comm carotid arteries is 9.5 cm and 14 cm respectively.

Table 2: Level of origin of Right common Carotid Artery

		Number of specimens	Percentage
From BCT (n=26)	At SCJ	18	69.2
	Above SCJ (within 2.5 cm)	8	30.8

Normally the common carotid artery bifurcates into external and internal carotid arteries. In the present study, 1 specimen (1.9%) on left side showed trifurcation with additional ascending pharyngeal artery arising at its bifurcation into terminal branches. 98.1% showed normal bifurcation.

The normal termination of common carotid artery at the level of superior border of thyroid cartilage occurred in 55.6% (30 specimens), 22.2% (12 specimens) showed termination upto 2 cm above the level of superior border of thyroid cartilage, 18.5% (10 specimens) showed termination between 2.1 cm to 3.5 cm (level of tip of greater cornu of hyoid) above the level of upper border of thyroid cartilage, 3.7% (2 specimens) showed slight low bifurcation within 1 cm below the level of superior border of thyroid cartilage.

Left common carotid artery showed 81% of variations among the total specimens while right common carotid artery showed 59.2% of variations.

The patterns of variability in the branches of the common carotid artery are of paramount importance not only in clinical practice but also in theoretical considerations. Among the arterial branches in the human body, the common carotid bifurcation is particularly important because the internal carotid artery supplies blood to the brain. Lack of experience regarding the possible variations could lead to fatal errors if one blood vessels is mistaken for another. A profound knowledge of the anatomical characteristics and variations of the common carotid artery such as its branching pattern and its position is essential to avoid complications with catheter insertion of carotid arteries in various procedures.

Table 3: Pattern of Variations of Origin of Left Common Carotid Artery

	No. of specimens (n=27)	Percentage
From BCT	3	11.1
CT with RCCA	1	3.7
CT with BCT (CT from AOA)	1	3.7

Table 4: Length of Common carotid Arteries from origin to superior border of Thyroid Cartilage

Sex	Right	Left	Rt v/s Lt	
			t	p
Male	9.9±1.4 cm (7.7-14.0)	13.8±1.7 cm (10.0-16.5)	8.54	<0.001, HS
Female	10.3± 3.0 cm (7.5-14.5)	12.8±1.3 cm (10.9-13.6)	1.54	0.19, NS
M v/s F	T=0.21 P=0.85, NS	T=1.48 P=0.20, NS		

Table 5: Pattern of Termination of Common Carotid arteries

	No. of specimens	Percentage
ICA+ECA (Bifurcation)	53	98.1
ICA + ECA + APA (Trifurcation)	1	1.9
Total	54	100.0

Table 6: Level of termination of common carotid arteries

Level of termination	No. of specimens	Percentage
At TC's upper border	30	55.6
Upto 2 cm above TC's upper border	12	22.2
2.1 – 3.5 cm above TC's upper border	10	18.5
Within 1cm below TC's upper border	2	3.7
Total	54	100

Table 7: Additional Branches of Common Carotid arteries

Additional branches of CCA	No. of specimens (n=54)	Percentage
STA	22	40.7
ITA	2	3.7
SLA	1	1.9
LA	2	3.7
APA	1	1.9
Total	28	100

Table 8: Total Variations of Right & Left Common Carotid Arteries

Side	Total No. of specimens	No. of variations	Percentage
Right	27	16	59.2
Left	27	20	74.1

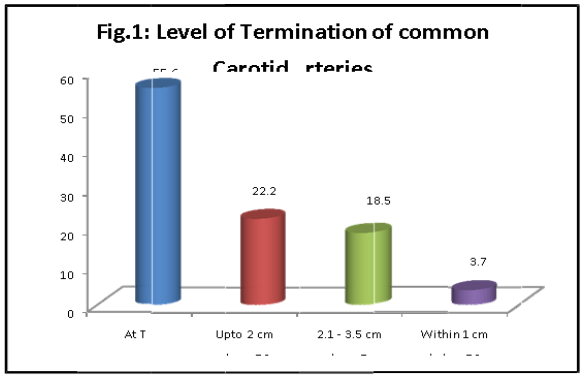

Figure 1: Level of Termination of common

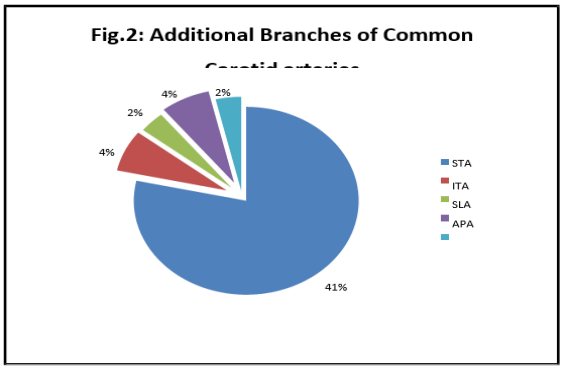

Figure 2: Additional Branches of Common

DISCUSSIONS

In the present study, out of 27 specimens of right common carotid arteries studied, 26 specimens (96.3%) were found to have normal origin i.e., from brachiocephalic trunk. 1 specimen (3.7%) originated along with the left common carotid artery forming a bicarotid trunk. The bicarotid trunk originated from the arch of aorta.

Bergman RA, mentions that the left common carotid artery varies in origin more than the right. The left common carotid may arise from brachiocephalic or from a common stem with right common carotid artery.[1]

Nayak SR studied 62 cadavers regarding the variations in branching pattern of aortic arch. Among these, variation in aortic arch branching pattern were found in 6 cadavers (9.6%). Among these 6 cases, 3 cases (4.8%)

presented a left common carotid artery as a branch of brachiocephalic trunk with different degrees of branches.[2]

Indumathi S. studied 75 aortic arch specimens for their variations. Among these, 4 specimens (5.48%) had a common origin of both the brachiocephalic trunk and left common carotid artery.

C. Bhattarai and PP Poudel found the similar above variation in 11 specimens (12.9%) out of 85 cadavers.[3]

Out of 193 aortic arches studied by Nelson ML, 2 specimens (1%) had a common trunk uniting the brachiocephalic trunk and left common carotid arteries.[4]

In a study by II Young Shin in a total of 25 Korean adult cadavers, in 2 cadavers (8%) the brachiocephalic trunk and left common carotid artery originated together from the arch of aorta.[5]

A total of 633 digital subtraction angiographies of Caucasian Greek patients were studied by Natsis KI. Eight types of aortic arch were found. The classification from I to VIII was made according to the incidences recorded, with type I being the most common and type VIII being the least frequent. Type II i.e., common origin of brachiocephalic trunk and left common carotid artery was found in 96 cases (15%).[6]

Liechty et al., reported a bicarotid trunk associated with retroesophageal right subclavian artery in 10.7% of cases based on a study of 1000 cadavers.[7]

In the present study, out of total 27 right common carotid artery specimens studied, 26 specimens arose from brachiocephalic trunk. Out of 26 specimens, 18 specimens (69.2%) originated at the level of sternoclavicular joint and 8 specimens (30.8%), originated above the level of sternoclavicular joint.

Gray's text book of Anatomy mentions about 12% right common carotid arteries may arise above the level of sternoclavicular joint.[8]

The present study shows length of the right common carotid artery was 9.9±1.4 cm (range 7.7-14.0 cm) in males and 10.3±3.0 cm (range 7.5 - 14.5 cm) in females. The difference in length between males and females was not significant. The length of left common carotid in males was 13.8±1.7 cm (range 10.0-16.5 cm) and in females was 12.8±1.3 cm (range 10.9-13.6 cm), with no significant difference between males and females. There was a significant difference between the length of right and left common carotid arteries due to specimen was dependent on the various factors pertaining to the corresponding cadaver.

In a study conducted by Riberio RA in 46 male cadavers, the average length of the right common carotid artery was 9.6±0.1 cm while the left common carotid was 12.1±0.2 cm with a significant difference between the sides.[9]

In the present study out of 54 specimens, 53 specimens i.e., 98.1% showed the usual bifurcation of common carotid artery dividing into external and internal carotid arteries. In 1 specimen (1.9%) there is a trifurcation with the origin of ascending pharyngeal artery from common carotid along with external and internal carotid arteries.

In a study of carotid system of arteries by R. Chitra in 25 cadavers, 1 right common carotid artery (4%) showed trifurcation with occipital artery at termination along with external and internal carotid arteries. In a larger study by Adachi et al., out of 298 subjects studied, 2 cases (0.67%) showed carotid trifurcation with the left occipital artery as the third branch. Morquis et al observed the occipital artery at the carotid bifurcation in 2 cases (1.8%) out of 110 cases studied.[10]

Gurbuz J. has reported trifurcation of the left common carotid artery into three terminal branches; external carotid, internal carotid and occipital arteries during routine dissection as a case report.[11]

In the present study, out of total 54 specimens, termination of common carotid artery occurred at the level of superior border of thyroid cartilage in 30 specimens (55.6%), 12 specimens (22.2%) showed termination upto 2 cm above the level of superior border of thyroid cartilage, 10 specimens (18.5%) showed termination between 2.1 cm to 3.5 cm (maximum level; upto tip of greater cornu of hyoid) above the level of upper border of thyroid cartilage, 2 specimens (3.7%) showed slight low bifurcation within 1 cm below the level of upper border of thyroid cartilage.

In a study by Ribeiro RA in 46 male cadavers, the distance of common carotid artery bifurcation from the superior border of thyroid cartilage varied from 0.8 (below the level) to 1.9 cm (above the level) with an average of 0.9 ±

0.1 cm on the right side, with no differences between the sides.[9]

In a study by Lo A, in a total of 67 carotid specimens common carotid artery bifurcation occurred at the level of superior border of thyroid cartilage in 39% and at the body of the hyoid bone in 40% of specimens.[12]

Ito and associates reported a high common carotid artery bifurcation in 25 cases (31.2%), standard bifurcation in 46 cases (57.5%) and low bifurcation in 9 cases (11.3%) in a total of 80 cases.[13]

Rafiah AA reported that carotid bifurcation level was at the level of superior border of thyroid cartilage in 48.3% of cases, 25% were opposite the body of hyoid bone, and 18.3% were at the level between the thyroid cartilage and hyoid bone out of 60 common carotid artery specimens studied in 30 cadavers. The bifurcation appeared at a lower level than the superior border of thyroid cartilage in 5% cases, while in 3.3% of cases the bifurcation level was seen higher than the hyoid bone.[14]

A case is reported by Gailloud P. showing the intrathoracic bifurcation of common carotid arteries bilaterally between T1 and T3.[15]

A study by Natsis K in 100 common carotid artery specimens showed that the superior thyroid artery originated from common carotid artery in 61% of cases.

Lo A studied 67 common carotid artery specimens out of which superior thyroid artery originated from common carotid artery in 52.3% and 46.2% originated from external carotid artery.

Jadhav SD reports a case of origin of lingual artery from the right common carotid artery. Unusual case of origin of the superior thyroid, lingual artery and facial artery from the common carotid artery by a common trunk was described by Arthur Thomson. Babu, Budhiraj and Rastogi reported origin of thyrolingual trunk from the right and left common carotid artery respectively.10 Gluncic V23 and Menezes FO49., reported the ascending pharyngeal artery and inferior thyroid artery originating from the common carotid artery respectively. 116 in the present study, out of 27 left common carotid arteries studied,[20] Jadhav SD reports a case of origin of lingual artery from the right common carotid artery. Unusual case of origin of the superior thyroid, lingual artery and facial artery from the common carotid artery by a common trunk was described by Arthur Thomson. Babu, Budhiraj and Rastogi reported origin of thyrolingual trunk from the right and left common carotid artery respectively.[10]

Gluncic V23 and Menezes FO49., reported the ascending pharyngeal artery and inferior thyroid artery originating from the common carotid artery respectively.

In the present study, additional branches of common carotid arteries were found in 28 specimens out of 54 specimens. Superior thyroid artery originated from common carotid artery in 22 specimens (40.7%). Inferior thyroid artery originated from common carotid artery in 2 specimens (3.7%). Superior laryngeal artery originated from common carotid artery in 1 specimen (1.9%). Lingual artery in 2 specimens (3.7%) and ascending pharyngeal artery in 1 specimen (1.9%) originated from common carotid artery.

In the present study, out of 27 left common carotid arteries studied, 20 specimens showed variations (81%). Out of 27 right common carotid arteries studied 16 specimens showed variations (59.2%). It was observed that left common carotid artery showed more variations compared to the right common carotid artery.

CONCLUSION

It was concluded that Origin of left common carotid artery varied more than the right side in the present study. The most frequent variation was the origin of left common carotid artery from brachiocephalic trunk at different degrees of branching. In one specimen bicarotid trunk was originated from arch of aorta giving rise to both the right and left common carotid arteries. Significant number of right common carotid arteries originated above the level of sternoclavicular joint. In the present study there was a trifurcation with ascending pharyngeal artery as the additional branch in one specimen. In the present study 44.4% of the common carotid artery specimens terminated at a level higher than the superior border of thyroid cartilage. The highest level was at the tip of greater cornu of hyoid bone. The present study revealed that left common carotid artery variations were more compared tthe right common carotid artery.In the present study the frequent origin of superior thyroid artery from common carotid artery at different levels was found. Superior thyroid artery was the commonest additional branch from common carotid artery in the present study, the incidence was higher in the present study compared to other studies. Origin of inferior thyroid artery from the common carotid artery is a rarest possibility. 10. 11. 12. In the present study 2 specimens (3.7%) showed the origin of inferior thyroid artery from common carotid artery. The incidence is significantly higher in the present study compared to other studies. Lingual artery originated from common carotid artery in 2 specimens (3.7%) which is also of the rare variations. The present study revealed that left common carotid artery variations were more compared to the right common carotid artery.

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