

Variations of Bifurcation of the Common Carotid Artery, and Origin of Superior Thyroid Artery, in Sudanese: A Cadaveric Study

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Abstract: Background: Knowledge of the bifurcation level of the common carotid artery (CCA) is important during surgery, mummification, and radiological studies. This study aim to evaluate the anatomical variations in the bifurcation level of CCA, and the origin of the superior thyroid artery (STA), in Sudanese populations. Their knowledge reduces risk during surgery and helps in arterial ligation. **Materials and Methods:** 30 neck cadaveric specimens were evaluated on sides, using natural anatomical tools and methods for the anatomical studies. **Results:** The bifurcation of CCA was found at 36.7% at the level of the upper border of thyroid cartilage (TC), 61.7% above, and 1.6% below. No big differences were found in carotid bifurcation on both sides. The right side showed 30% were normal, 66.7 % high, and 3.3% were low-level bifurcation, left showed 43.3% were normal, 56.7% high, and no low level of bifurcation was observed. Origin of STA either from external 50% or bifurcation 46.7% was nearly about the same, with a few incidences 3.3% from the common carotid. Significance differences were observed in origin STA between both sides, on the right the artery commonly originates from external, and on the left commonly from the bifurcation. **Conclusion:** CCA bifurcates at a higher level in Sudanese, with no big difference in carotid bifurcation on both sides. Statistically, a significant difference was found in the origin of STA on both sides. **Recommendation:** higher bifurcation of CCA, and side variations in origin of STA, should be put into consideration during surgery and radiology.

Keywords: Bifurcation level common carotid artery & origin of superior artery, cadaveric study.

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1. INTRODUCTION

The common carotid arteries (CCA) are the main vessels that supply the structures of the head and neck, within the thoracic cavity right and left CCA are originated from the brachiocephalic and arch of the aorta successively, then ascend to the neck without giving off any branches [1, 2]. In the upper part of the neck, each one is divided into external carotid (ECA) and internal carotid (ICA), these usually occur at the level of the upper border of the thyroid cartilage (TC), rarely they course up without subdivision [3, 4, 5]. After division, the ICA enters the skull directly to supply the structures within it, while the ECA divides into many branches to head and neck structures [2]. In most cases, the first branch of the external carotid is the superior thyroid artery (STA) for the thyroid gland [6]. At the level of the carotid bifurcation, there are

important physiological centers containing receptors for detecting changes in the composition of arterial blood flow and pressure changes [7]. The carotid bifurcation is one of the most common sites of atherosclerotic plaque; the possible explanation for this is the anatomical variations in the level of bifurcation [8, 9, 10, 11, 12, 13].

The anatomical Knowledge of carotid bifurcation level is important during surgery, mummification, and radiological studies. Many studies were done to describe the bifurcation level of CCA, and their results showed many variations. Studies by Preeti Sonje *et al*, 2019 [14]; K. Radha, 2014 [15]; Vatsala A R *et al.*, 2014 [16]; Ribeiro R. A *et al.*, 2006 [17], found that the most common level of carotid bifurcation was at the level of the upper border of TC, and superior

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border of the TC was the most stable anatomical level for carotid bifurcation, while the study of Albert lo *et al.*, 2006 [18], showed, the bifurcation level of CCA at the hyoid bone more than the superior border of the TC, and the work of Anasuya Ghosh *et al.*, 2019 [19]; Manisha B Sinha *et al.*, 2019 [20]; Ambali Manoj and Jadhav Surekha, 2012 [21], showed, bifurcation of CCA at the level of the hyoid bone, and upper border of TC was about the same. Moreover, the studies of K. Radha, 2014 [15]; Ambali Manoj and Jadhav Surekha, 2012 [21]; Vatsala A R *et al.*, 2014 [16], found low incidences of carotid bifurcation below the lower border of TC. While no lower bifurcation was mentioned in the study of Anasuya Ghosh *et al.*, 2019 [19]. In most common cases, the STA was found to originate from the external carotid artery, Ranjith Sreedharan *et al.*, 2018 [6]; Keith L Moore, 2011 [2]; Harold Ellis, 2006 [1], in the results of Preeti Sonje *et al.*, 2019 [14] the STA was found commonly originated from the CCA, and results of Albert lo *et al.*, 2006 [18] found the origin of STA from CCA in 52.3%, and ECA in 46.2% of the cases. The aim of this work was to study the variations in a bifurcation of CCA, and the origin of superior thyroid artery, in Sudanese, their knowledge, can help in surgery, mummification, and arterial ligation.

2. MATERIALS AND METHODS

This is a descriptive, retrospective, cross-sectional study, carried out in Khartoum State, Sudan, between Augusts to December 2021. In these study 30 cadaveric necks specimens were dissected in booth sides, 22 males and 8 females, using natural anatomical tools and methods that use for the medical students' studies. The specimens were selected from dissection rooms in different medical colleges in Khartoum State. Inclusion criteria: formaldehyde-fixed necks cadaver specimens from the dissection rooms of the medical colleges. Exclusion criteria: Cadavers that were macerated or damaged by students before data collection. The dissection was evaluated for bifurcation of CCA in relation to the upper border of TC, and origin of the STA, or to be from CCA, ICA, or ECA. This

study relied on the following: any bifurcation found above the upper border of the TC, is classified as higher bifurcation, if found at the level of the upper border of TC, it is classified as a normal bifurcation level, and if found below the upper border of the TC, classified as lower bifurcation. Same photos were taken from the dissected specimens using digital camera. Ethical approval: the ethical approval was obtained verbally from the head of the departments in each medical college, in which the study was carried out. Data analysis: The data were analyzed using SSPS16 software, and frequencies and percentages were taken.

3. RESULTS

30 neck cadaveric specimens were evaluated on both sides, a total of 60, 22 (73.3%) were males and 8 (26.7%) were females. in 22 (36.7%) of the cases the level of bifurcation of the CCA was found at the level of the upper border of TC, (Figure 2, 6), in 37 (61.7%) were found above the upper border of TC, (Figure 1, 4, 5) and in one (1.6) of the cases were found below the upper border of TC, (Figure 2), (Table 1). Concerning the level of bifurcation of CCA on both sides; the right side showed 9(30%) of the cases the bifurcation was found at the level of upper border TC, 20 (66.7%) of the cases the bifurcation was above upper border TC, and in 1 (3.3%) of the cases was below upper border TC, left side showed, 13 (43.3%) of the cases the bifurcation was at the level of the upper limit of TC, 17 (56.7%) of the cases the bifurcation was above the upper border the CT, and no one was below the upper border of TC, (Table 1).

Out of all cases, the origin of STA was found, 30 (50%) from ECA, (Figure 2), 28 (46.7%) from the bifurcation, (Figure 1, 4, 6), and (3.3%) from the CCA, (Figure 5), (Table 2). Concerning the origin of the STA between both sides; the left side showed; that 9 (30%) were from ECA, 20 (66.6%) were from bifurcation, and one (3.3%) was from CCA, and the right side showed, 21(70%) from ECA, 8 (26.6%) from bifurcation, and one (3.3%), from CCA, (Table 2)

Table 1: Shows the Bifurcation Level of the Common Carotid Artery, among Sudanese Subjects

Bifurcation Level of Common Carotid Artery	Right Side (n=30)		Left Side (n=30)		All (n=60)	
	Frequencies	Percentages	Frequencies	Percentages	Frequencies	Percentages
Higher Bifurcation: Above the upper border of thyroid cartilage	20	66.7%	17	56.7%	37	61.7%
Normal Bifurcation: At the level of the upper border of thyroid cartilage	9	30%	13	43.3%	22	36.7%
Lower Bifurcation: Below the upper border of thyroid cartilage	1	3.3%	00	0.0%	1	1.6%
Total	30	100%	30	100%	60	100%

Table 2: Shows the Origin of the Superior Thyroid Artery among Sudanese Subjects

Origin of Superior Thyroid Artery	Right Side (n=30)		Left Side (n=30)		All (n=60)	
	Frequencies	Percentages	Frequencies	Percentages	Frequencies	Percentages
From common carotid artery	1	3.3%	1	3.3%	2	3.3%
From the external carotid artery	21	70 %	9	30.0%	30	50%
From bifurcation of common carotid artery	8	26.6%	20	66.6%	28	46.7%
Total	30	100%	30	100%	60	100%

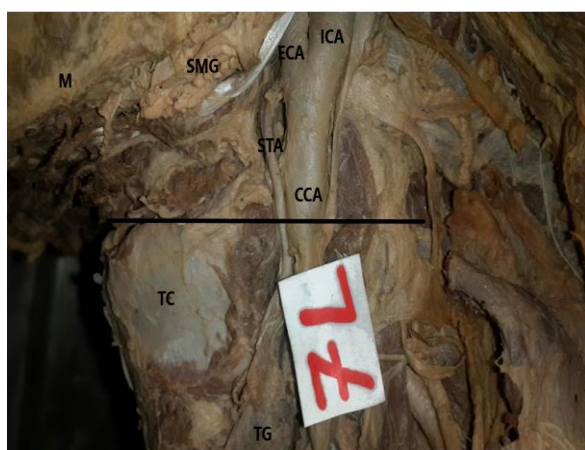


Figure 1: dissected neck, left side shows, bifurcation of the common carotid artery above to upper border of thyroid cartilage, and origin of superior thyroid artery from bifurcation. (TG, thyroid gland), (TC, thyroid cartilage), (CCA, common carotid artery), (STA, superior thyroid artery), (ICA, internal carotid artery), (ECA, external carotid artery), (SMG, submandibular gland), and (M, mandible). a raw shows level the upper border of thyroid cartilage

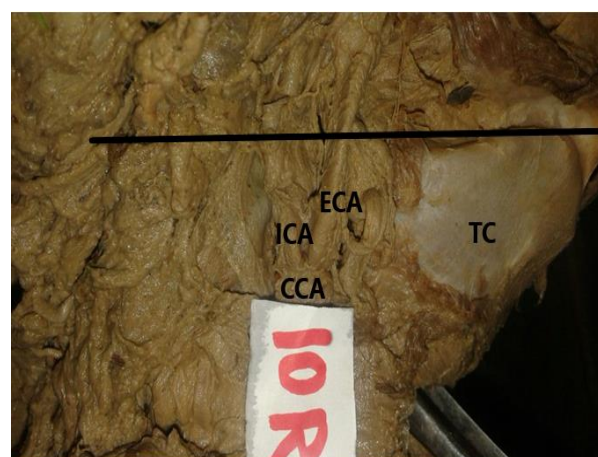


Figure 3: dissected neck, the right side shows bifurcation of the common carotid artery below to upper border of the thyroid cartilage. (TC, thyroid cartilage), (CCA, common carotid artery), (ICA, internal carotid artery), and a raw shows level the upper border of the thyroid cartilage.

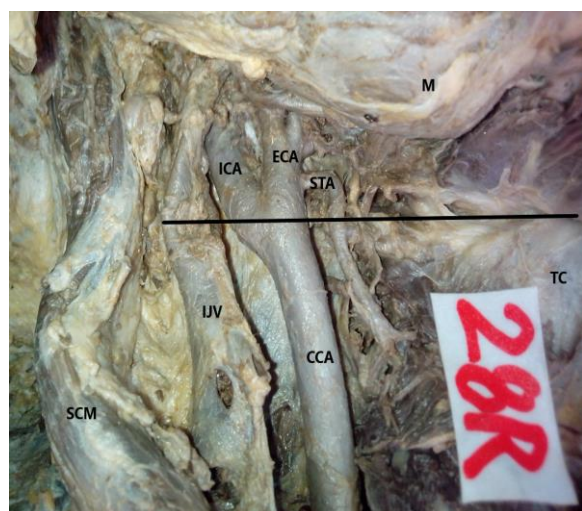


Figure 2: dissected neck, the right side shows bifurcation of the common carotid artery at the level of the border of the thyroid cartilage and origin of superior thyroid artery from external carotid. (TC, thyroid cartilage), (TG, thyroid gland), (CCA, common carotid artery), (STA, superior thyroid artery), (ICA, internal carotid artery), (ECA, external carotid artery), (IJV, internal jugular vein), (SCM, sternocleidomastoid muscle) and (M, mandible). a raw show level of the upper border of the thyroid cartilage

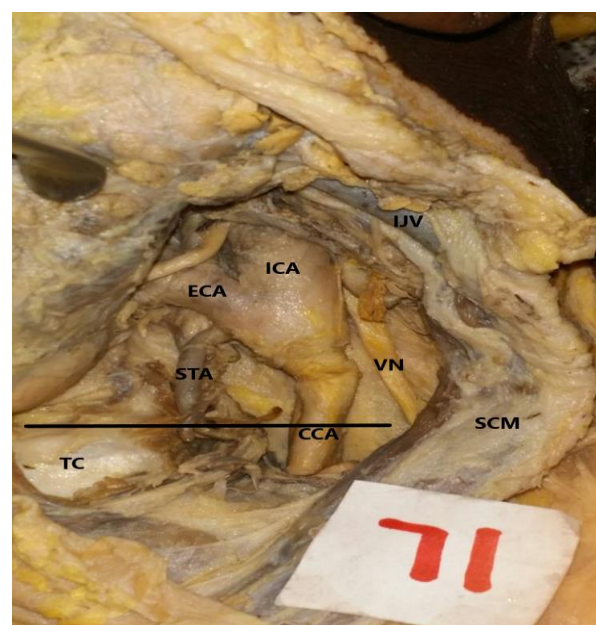


Figure 4: dissected neck, left side shows bifurcation of the common carotid artery above to upper border of thyroid cartilage, and origin of superior thyroid artery from bifurcation. (TC, thyroid cartilage), (CCA, common carotid artery), (STA, superior thyroid artery), (ICA, internal carotid artery), (ECA, external carotid artery), (VN, vagus nerve), and (SCM, sternocleidomastoid muscle). A raw shows level the upper border of thyroid cartilage.

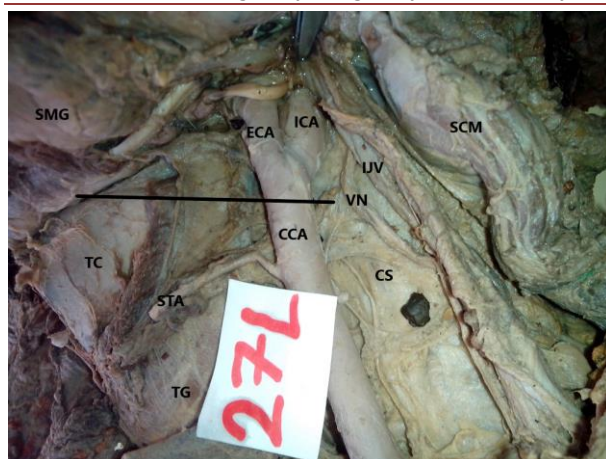


Figure 5: dissected neck, left side shows bifurcation of the common carotid artery above to upper border of thyroid cartilage, and origin of superior thyroid artery from common carotid. (TC, thyroid cartilage), (TG, thyroid gland), (CCA, common carotid artery), (STA, superior thyroid artery), (ICA, internal carotid artery), (ECA, external carotid artery), (SMG, submandibular gland), (CS) carotid sheath), and (SCM, sternocleidomastoid muscle). a raw shows level the upper border of thyroid cartilage

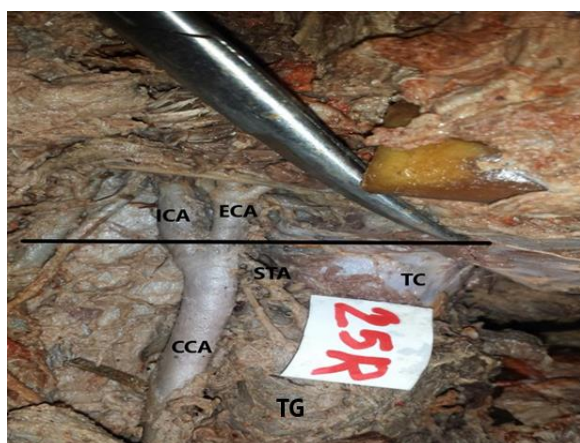


Figure 6: dissected neck, left side shows bifurcation of the common carotid artery at the level upper border of the thyroid cartilage, and origin of superior thyroid artery from the bifurcation. (TC, thyroid cartilage), (TG, thyroid gland), (CCA, common carotid artery), (STA, superior thyroid artery), (ICA, internal carotid artery), (ECA, external carotid artery). a raw shows level the upper border of the thyroid cartilage

4. DISCUSSION

In most common cases the CCA bifurcates into external and internal at the upper border of the TC, really this occurs above or low to the upper cartilage. The reports of Manisha B Sinha *et al.*, 2019 [20]; Vatsala A R *et al.*, 2014 [16]; Albert lo *et al.*, 2006 [18], showed that carotid bifurcation commonly occurs above the upper border of TC, this is a consider as higher bifurcation, while the results of Anasuya Ghosh *et al.*, 2019 [19]; Deepa Devadas *et al.*, 2018 [22]; K. Radha, 2014 [12]; Ambali Manoj and Jadhav Surekha, 2012 [21], showed the commonest level of carotid bifurcation was at the level of the upper border of TC, this is considered as normal bifurcation. Moreover, no

bifurcation was found at the level of the superior border of TC in the result of Manisha B Sinha *et al.*, 2019 [20]. The results of this study found the commonest level of carotid bifurcation is above the upper border of the TC. Results of this work were in accordance with the results of Manisha B Sinha *et al.*, 2019 [20]; Vatsala A R *et al.*, 2014 [16]; Albert lo *et al.*, 2006 [18], who stated that higher bifurcation when the division occurs at the level of the body of C 3, and normal if occur at the body of C 4 vertebrae. lower bifurcation is rare compared to higher or normal ones, the result of Manisha B Sinha *et al.*, 2019 [20]; Anasuya Ghosh *et al.*, 2019 [19]; Deepa Devadas *et al.*, 2018 [20]; Vatsala A. R *et al.*, 2014 [16], showed no incidence of lower bifurcation, while the results of this study and of the K. Radha, 2014 [15]; Ambali Manoj and Jadhav Surekha, 2012 [21], showed a few incidences of lower bifurcation. Lower bifurcation may refer to the thoracic bifurcation of the CCA which occur in very rear cases in case of vascular anomalies. Ampali M *et al.*, 2012 [21], described, no difference in carotid bifurcation on both sides, the present study found a statistically significant difference in carotid bifurcation on both sides. This is in accordance with the result of Vatsala A R *et al.*, 2014 [16], who described the same finding, and not with the result of Ampali M *et al.*, 2012 [21]. Despite the difference in length in right and left of CCA, this does not affect the level of the bifurcation.

Found that, the STA was found commonly originated from CCA in the result of Preeti Sonje *et al.*, 2019 [14], while the result of Ranjith Sreedharan *et al.*, 2018 [6], found STA commonly originated from ECA, Moreover, Albert lo *et al.*, 2006 [18], found no more differences in the origin of this artery either from CCA or ECA. The present study found the origin of STA either from ECA or carotid bifurcation was nearly about the same, this is in accordance with the results of Albert lo *et al.*, 2006 [18]. Significance differences were found in this work in the origin of the STA on both sides of the neck, (Table 2). These differences may refer to minor variations in bifurcation between both sides.

CONCLUSION AND RECOMMENDATION

In Sudanese, the CCA was bifurcate at a higher level and had no big difference in bifurcation between the right and left sides. Significant difference was found in the origin of STA on both sides of the neck. Higher bifurcation of CCA, and side variations in the origin of the STA, should be put into consideration during surgery and radiology studies.

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ABBREVIATIONS

CCA; common carotid artery, ECA; External carotid artery, ICA; Internal carotid artery, TC; Thyroid cartilage, STA; Superior thyroid artery.

ETHICS APPROVAL AND CONSENT

The ethical approval for the study was obtained from the Ethics Committee of the Faculty of Medicine, OIU. Sudan. The consent was taken verbal from the head of the departments of medical colleges.

AUTHORS' CONTRIBUTIONS

FathElrahman, conducted data collection, and literature review, and conceptualized. Elghazaly conducted results, discussion, and review of the final design. All authors contributed to review and revision to final approval and version.

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