IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 12 Ver. 8 (December. 2018), PP 58-66
www.iosrjournals.org

Anatomical Variation of Common Carotid Artery Bifurcation In Relation To Cervical Vertebra on CT Angiogram

Dr. Padma Badhe[1], Dr. Pratik Dabharde[2], Dr. Anuja S Kapadnis[3], Dr. Dasari Ravi Kiran[4]

[1](Associate professor, Department of Radiology, Seth G.S Medical college and KEM hospital, Mumbai, India)
[2](Senior Resident, Department of Radiology, Seth G.S Medical college and KEM hospital, Mumbai, India)
[3](Resident, Department of Radiology, Seth G.S Medical college and KEM hospital, Mumbai, India)
[4](Resident, Department of Radiology, Seth G.S Medical college and KEM hospital, Mumbai, India)
Corresponding author- Dr. Padma Badhe

Abstract:
Aims and objectives: *To see anatomical variation of common carotid artery bifurcation in relation to cervical vertebra on CT angiogram in Indian population.*
Materials and methods:*It was a hospital based, observational, descriptive, cross sectional study with a sample size of 200 cases during a period of 1.5yrs in the department of radiology of Seth G.S. medical college and KEM hospital Mumbai.Patients undergoing CT Angiogram covering neck vessels to brain were included in study.*
Results: *Out of 200 patients, level of bifurcation was at the same level bilaterally in 172 patients. While in 28 patients, the level of bifurcation was different on left and right side. Out of the 200 patients, level of CCA bifurcation on right side was at C2 in 3 patients, C2-C3 in 8 patients, C3 in 96 patients, C3-C4 in 32 patients, C4 in 52 patients, C4-C5 in 6 patients, C5 in 3 patients. Out of the 200 patients, the level of CCA bifurcation on left side was at C2 in 5 patients, C2-C3 in 8 patients, C3 in 103 patients, C3-C4 in 26 patients, C4 in 47 patients, C4-C5 in 8 patients, C5 in 3 patients. In 172 patients the level of bifurcation was same. In these, the bifurcation occurred at C2 in 2 patients (1.2%), C2-C3 in 5 patients (2.9%), C3 in 91 patients (53%), C3-C4 in 24 patients (13.9%), C4 in 43 patients (24.9%), C4-C5 in 6 patients (3.5%), C5 in 1 patient (0.6%).*
Conclusion:*The Common carotid artery and its branches are the most important vessels in the neck. These vessels are susceptible to injury during various surgical procedures, neck dissections, and orthopedic surgeries on cervical vertebra. A high common carotid artery bifurcation possesses a higher risk of being hit by intra-articular screws during orthopedic procedures on cervical vertebra.Various endovascular procedures are nowadays performed in neck masses to devascularize the tumor before complete excision .Knowledge of accurate location of carotid artery bifurcation can aid in surgical planning, in ligation of external carotid artery, intra-arterial administration of chemotherapeutic agents and radical neck dissection.*
Key words: *Common carotid artery bifurcation, CT angiogram, Cervical Vertebra, Anatomical variation.*

Date of Submission: 07-12-2018 Date of acceptance: 22-12-2018

I. Introduction

Common carotid arteries are the main arteries that supply the head and neck with oxygenated blood.They divide in the neck to form the external carotid artery and internal carotid artery. The common carotid arteries are seen bilaterally. These arteries originate from different arteries, but follow symmetrical courses. The right common carotid artery originates in the neck from the brachiocephalic trunk. The left common carotid artery originates from the arch of aorta in the thorax.

External carotid artery supplies blood to the face and neck. The external carotid artery usually begins at the upper border of thyroid cartilage at the level of C3 vertebral body and curves, passing forward and upward and then inclining backward to the space behind the neck of mandible where it divides into the superficial temporal and maxillary artery within the parotid gland. It rapidly diminishes in size as it travels up in the neck owing to the number and large size of its branches. At its origin, this artery is closer to the skin and more medial than the internal carotid, and is situated within the carotid triangle(1).

Internal carotid artery is the major supply of the brain. It arises from the common carotid artery usually at the level of C3 vertebral body(2).

Carotid artery injury is uncommon but not a rare complication of various diagnostic and therapeutic procedures. The consequence of inadvertent carotid artery injury may be quite devastating but its incident can be reduced by knowing the correct anatomy of the carotid arteries. A high common carotid bifurcation possesses a higher risk of being hit by intra articular screws during procedures on cervical vertebra. Thus knowledge on the

anatomical variations of the carotid bifurcation is necessary for the correct interpretation of results obtained by means of different radiological procedures and for vascular surgical procedures in the region mainly because of the significant rates of the occurrence of variations(3).

Various radiological procedures for the evaluation of the common carotid artery bifurcation include color Doppler, CT angiogram, MR angiogram, and Digital subtraction angiography (DSA).

CT angiogram is the most widely used modality due to its easy availability, low cost and noninvasive nature. 3D CT angiogram has made depiction and anatomical understanding easier for interpretation by surgeons and the interventional radiologist so that the procedure can be planned beforehand by visualizing the exact anatomy of the carotid bifurcation and its relation with the surrounding region minimizing complications

II. Aims And Objectives

To see anatomical variation of common carotid artery bifurcation in relation to cervical vertebra on CT angiogram in Indian population.

III. Materials And Methods

It was an observational cross sectional study done in the department of radiology of Seth G.S. medical college and KEM hospital Mumbai.200 cases were studied over a period of 18 months in patients undergoing CT Angiogram covering neck vessels to brain.

Inclusion criteria:

All adult patients undergoing CT angiogram covering neck vessels to brain as advised by the respective physician/surgeon and who gave informed consent for study and fulfilling the below mentioned criteria: Either male or female, age more than 18 years, patients having normal serum creatinine value (0.3-1.4 mg/dl), patients not allergic to contrast.

Exclusion criteria:

Any patient not willing for the study, any patient having increased serum creatinine levels (>1.4 mg/dl), any patient having history of contrast allergy reaction, any patient having age less than 18 years.

Study procedure:

All studies were performed on a PHILIPS 64 slice Brilliance Computed TomographyUnit. Proper informed consent was taken from patient after explaining to them about the risks and benefits of examination. Essential clinical history was obtained mainly regarding previous surgery or interventional procedure. All the study related datawas collected at the time of CT scan. The serum creatinine value of patient was checked.

CT data was obtained with following parameters:Field of view: 350 mm; Thickness: 2 mm; Pitch: 1 mm; Filter standard: B: Window width60; Window length: 360; Matrix: 512 x 512.Age based standard low dose [Kv-120Mas/slice-220] CT protocol was used.

Standard contrast enhanced CT angiogram scanning protocol including plain phase followed by arterial phase by bolus tracking method. An arterial phase was done by injecting 1.5 ml/kg non-ionic iodinated contrast material at the rate ranging from 3ml/sec to 4ml/sec using pressure injector. Plain scan included brain with upper part of neck. Arterial phase includedbrain with neck and covering arch of aorta.

All the image data was sent electronically to a workstation [Philips Tera-recon] for analysis.Data for study was mainly obtained from the arterial phase of the CT angiogram.

Scans were assessed for the presence of any variation in the common carotid artery bifurcation and recorded with respect to the cervical vertebra as described by Furukawa et al(4).

IV. Results

The Common carotid artery was identified as the largest branch of the neck arising from the brachiocephalic trunk on right side and arch of aorta on left side. Bifurcation of CCA was identified as the level at which the CCA is dividing into ICA and ECA. This level of division was noted with respect to the cervical vertebra.

CCA bifurcation was identified bilaterally in all 200 patients. Out of 200 patients, level of bifurcation was at the same level bilaterally in 172 patients (86%). While in 28 patients (14%), the level of bifurcation was different on left and right side.

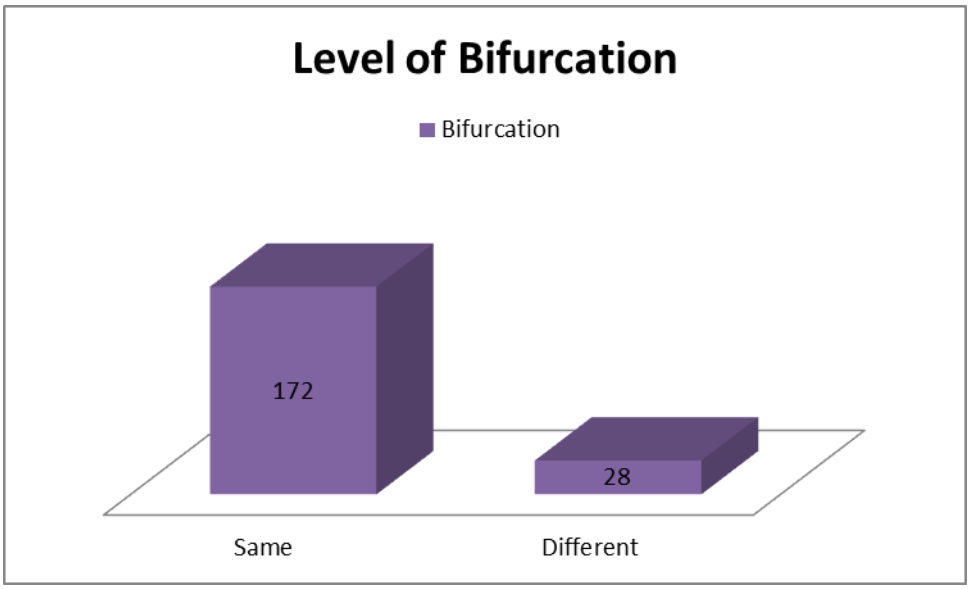

Fig 1. Bar diagram showing the level of CCA bifurcation at same or different level bilaterally in total number of patients.

Out of the 200 patients, level of CCA bifurcation on right side was at C2 in 3 patients (1.5%), C2-C3 in 8 patients (4%), C3 in 96 patients (48%), C3-C4 in 32 patients (16%), C4 in 52 patients (26%), C4-C5 in 6 patients (3%), C5 in 3 patients (1.5%).

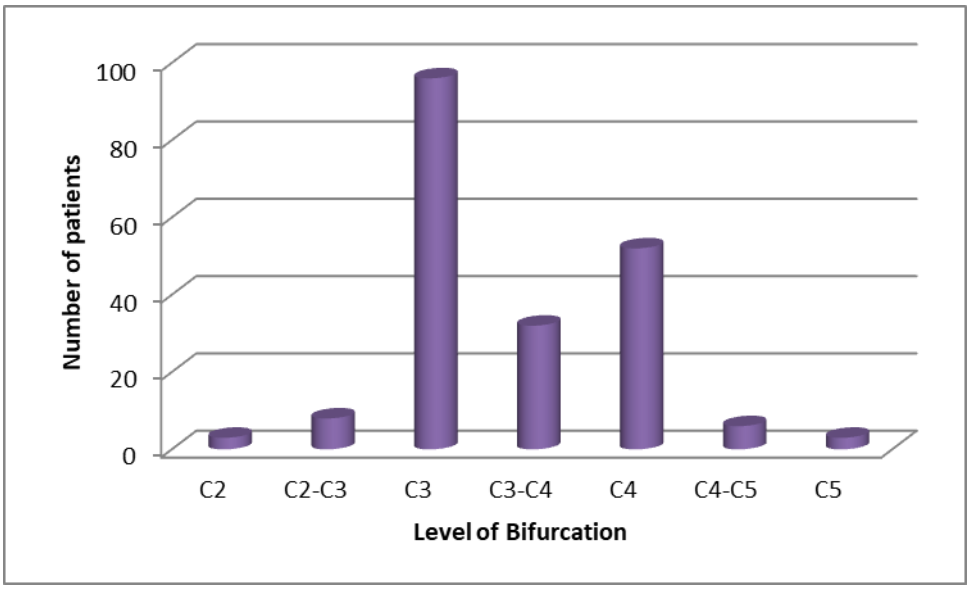

Fig 2. Bar diagram showing variation in the level of CCA bifurcation on right side.

Out of the 200 patients, the level of CCA bifurcation on left side was at C2 in 5 patients (2.5%), C2-C3 in 8 patients (4%), C3 in 103 patients (51.5%), C3-C4 in 26 patients (13%), C4 in 47 patients (23.5%), C4-C5 in 8 patients (4%), C5 in 3 patients (1.5%).

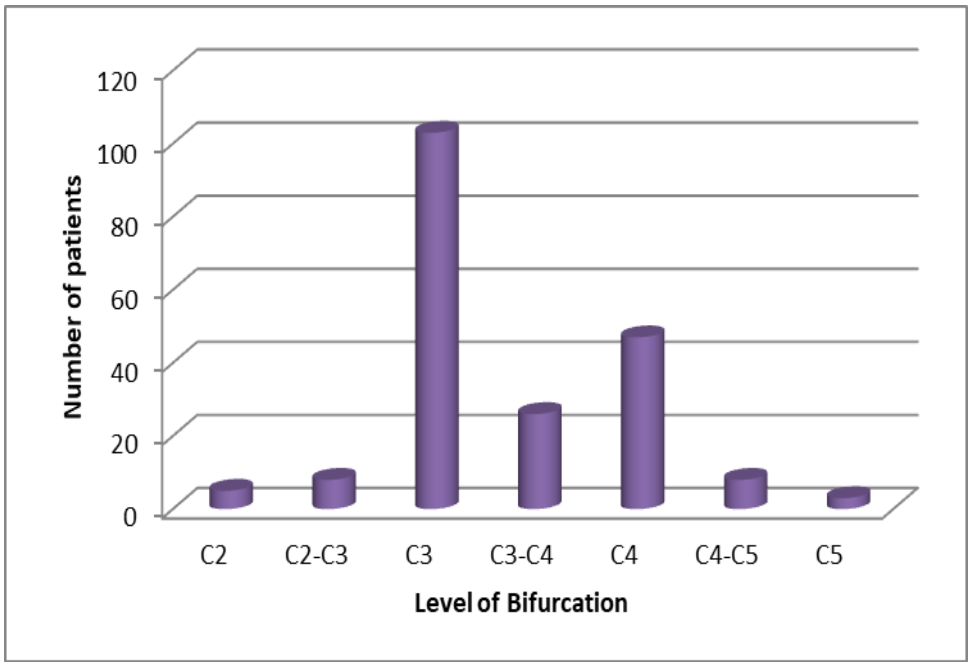

Fig 3. Bar diagram showing variation in the level of CCA bifurcation on left side.

In 172 patients the level of bifurcation was same. In these, the bifurcation occurred at C2 in 2 patients (1.2%), C2-C3 in 5 patients (2.9%), C3 in 91 patients (53%), C3-C4 in 24 patients (13.9%), C4 in 43 patients (24.9%), C4-C5 in 6 patients (3.5%), C5 in 1 patient (0.6%).

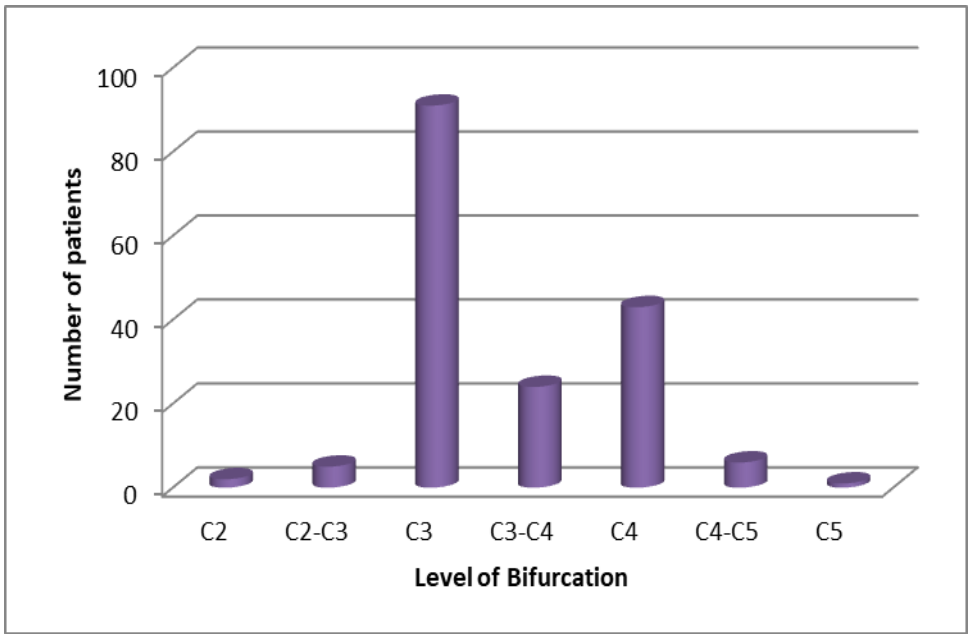

Fig 4. Bar diagram showing variation in the level of CCA bifurcation, where the level of bifurcation was at the same level bilaterally.

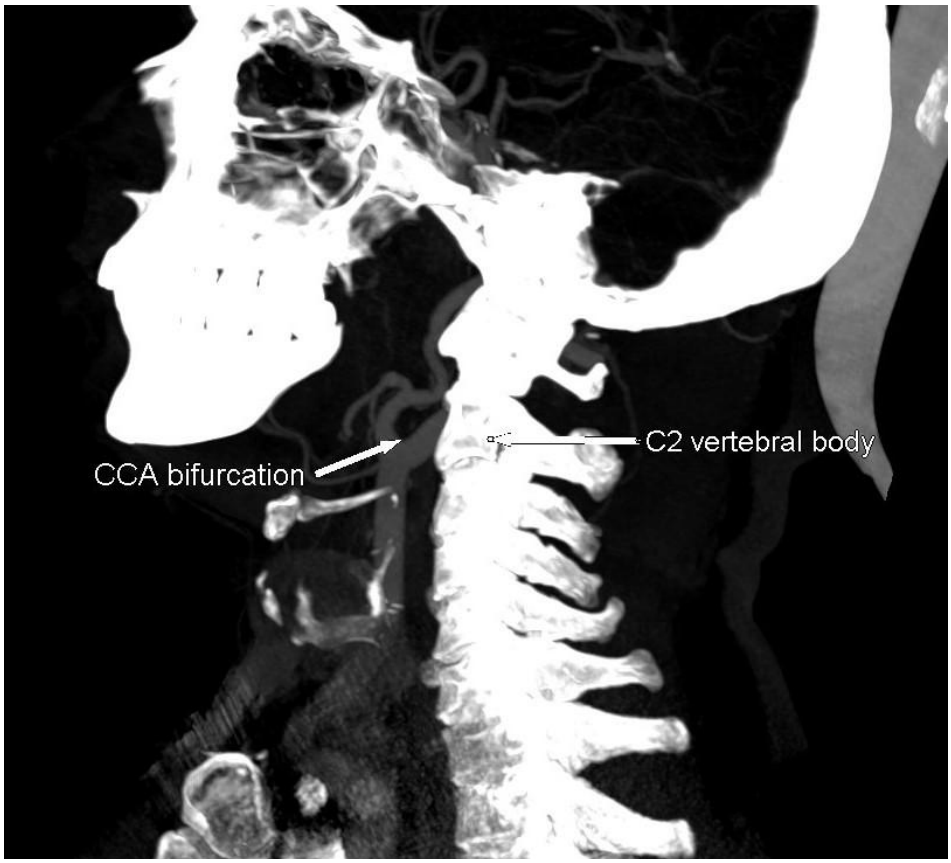

Fig 5. Sagittal MIP image of neck on CT angiogram showing Level of CCA bifurcation at C2 vertebral body (High bifurcation).

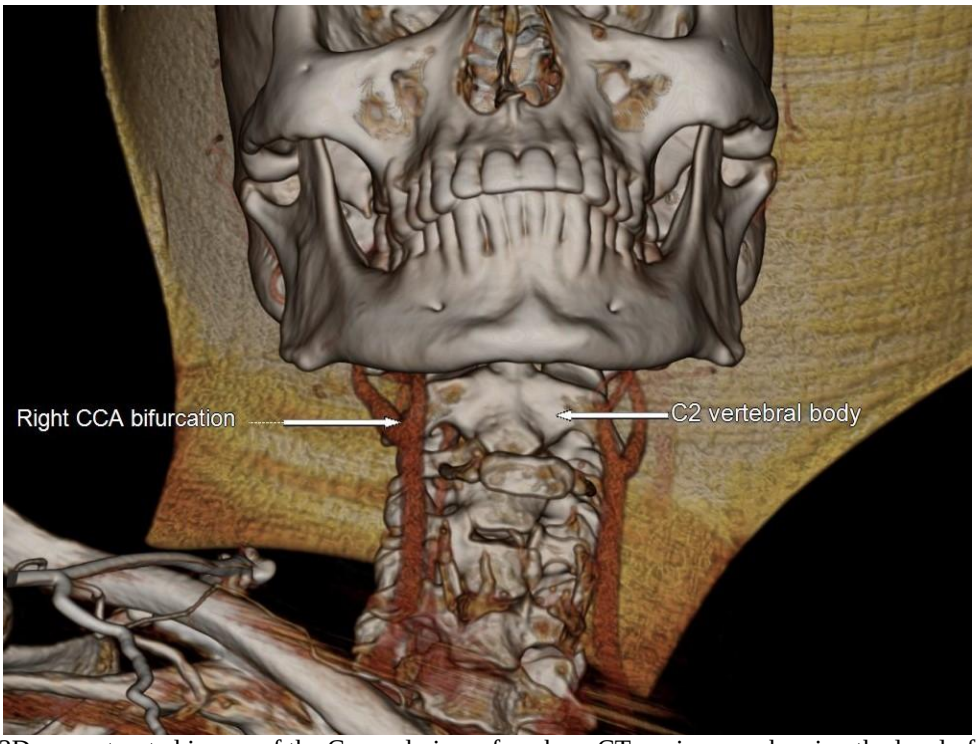

Fig 6.3D reconstructed image of the Coronal view of neck on CT angiogram showing the level of CCA bifurcation with respect to C2 vertebral body(high bifurcation)

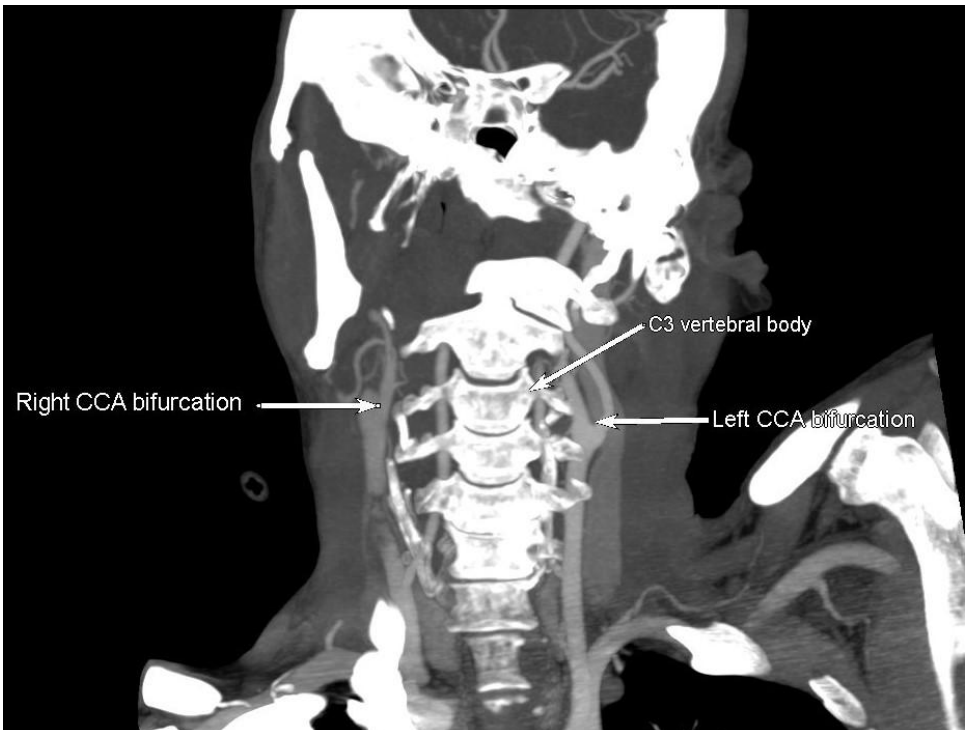

Fig 7.MIP Coronal image of neck vessels on CT angiogram showing left and right CCA bifurcation at the same level (C3 vertebral body).

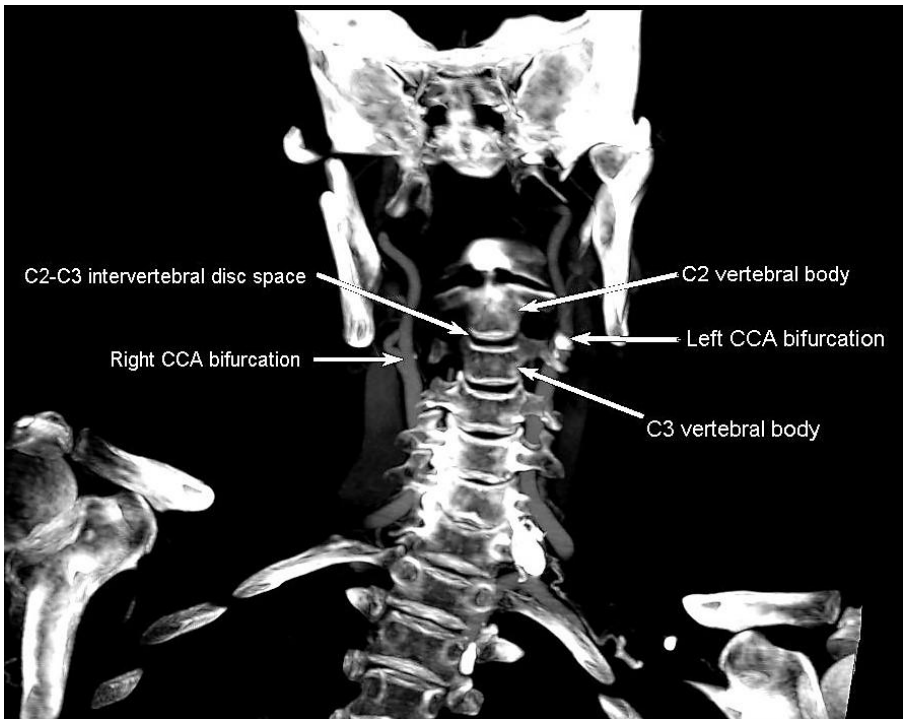

Fig 8.MIP Coronal image of neck vessels on CT angiogram showing different level of CCA bifurcation on left and right side (Right CCA bifurcation at C3 vertebral body, left CCA bifurcation at C2-C3 intervertebral disc space)

Fig 9.MIP coronal image of neck vessels on CT angiogram showing CCA bifurcation at C2 vertebral body on left and right side.

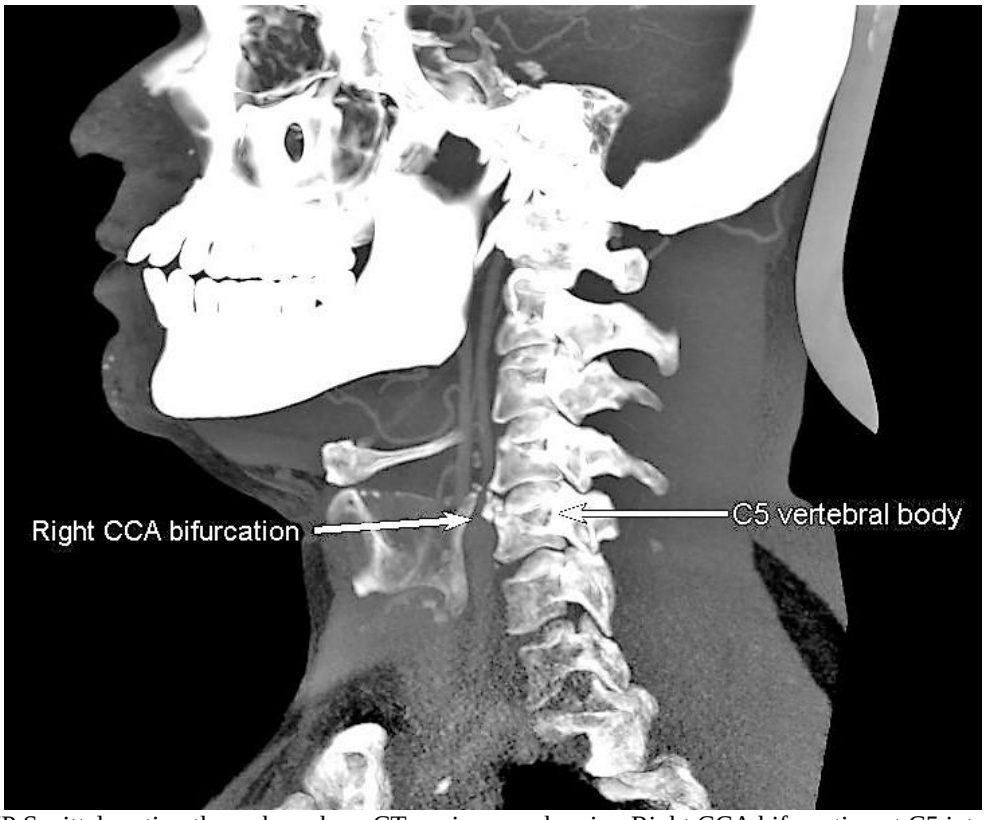

Fig 10.MIP Sagittal section through neck on CT angiogram showing Right CCA bifurcation at C5 intervertebral disc space (Low Bifurcation).

V. Discussion

The common carotid artery, external carotid artery and internal carotid artery are the main arterial supplies to the head and neck(5).In head and neck surgery, the common carotid arteries are important landmarks, defining the plane of the dissection during radical neck surgery(6).

Reported common causes for bradycardia include anesthetic agents, central neural blockage, and vagal reflex by surgical stimulus(7).

Compared to other causes, prediction of occurrence of the vagal reflex is difficult. Therefore, if procedures used during surgery involve the carotid sinus, innervated by the vagus nerve, the possibility of triggering arrhythmia or hypotension should be considered. Therefore accurate evaluation of the carotid bifurcation level with noninvasive techniques remains an important goal and external anatomical landmarks can be clinically useful in predicting the bifurcation level of the carotid artery(4).

A similar study was done by Woldeyes et al in the Ethiopian population in cadaveric patients.Furukawa et al performed study in Japanese population in 100 alive patients and the level of CCA bifurcation was determined on CT angiogram. Carotid Bifurcation (CB) was identified in 100% of the patient. In their study, the most common CB was at the level of C3 vertebral body. Second most common CB was at the level of C4 vertebral body. Third most common CB was at the level of C3-C4 intervertebral disc.Fourth most common CB was at the level of C2 vertebral body. Fifth most common CB was at the level of C2-C3 vertebral body. Rest of the CB (C4-C5, C5) were less commonly found.

In our study, we have classified the level of bifurcation with respect to cervical vertebra as described by Furukawa et al.200 patients were involved in the study. Carotid bifurcation (CB) was identified in 100% of the patient. In 172 patients (86%), the level of CCA bifurcation was same bilaterally. In 28 patients (14%), the level of CCA bifurcation was different bilaterally. In our study, the most common CB was at the level of C3 vertebral body. (48% on right and 51.5% on left) Second most common CB was at the level of C4 vertebral body. (26% on right and 23.5% on left) Third most common CB was at the level of C3-C4 intervertebral disc space. (16% on right and 13% on left)Fourth most common CB was at the level of C2-C3 intervertebral disc space. (4% on right and 4% on left) Fifth most common CB was at the level of C4-C5 intervertebral disc space. (3% on right and 4% on left)Bifurcation at the level of C2 and C5 was seen in very few patients.

In both the studies, the most common CB was at C3 level, second most common being C4 level, third most common being C3-C4 intervertebral disc space.

The difference in the result of study by Furukawa et al and our study was the fourth most common CB, which was C2 vertebral body in their study. In our study, it is C2-C3 intervertebral disc space. Very high bifurcation (Above C1 vertebral body level, C1 vertebral body level, C1-C2 intervertebral disc space level) was not found in our study. Also, a very low bifurcation (C5-C6 intervertebral disc space level, C6 vertebral bodylevel and beyond) was not found in our study.These differences may be due to the difference in the number of samples used in the studies.

VI. Conclusion

The Common carotid artery and its branches are the most important vessels in the neck. These vessels are susceptible to injury during various surgical procedures, neck dissections, and orthopedic surgeries on cervical vertebra. Knowing the exact level of bifurcation is very important, as low bifurcation or high bifurcation may cause complications. In our study, we studied the anatomical variation of common carotid artery bifurcation level in relation to cervical vertebra in 200 patients We have found variations in the level of CCA bifurcation. We have classified these variations as determined by Furukawa et al. Our results were comparable with the previous study with some differences. A high common carotid artery bifurcation possesses a higher risk of being hit by intra-articular screws during orthopedic procedures on cervical vertebra.

Various endovascular procedures are nowadays performed in neck masses to devascularize the tumor before complete excision. For devascularization, various embolising agents are used. Mostly either the branches of ECA supplying the tumor are embolised or ECA is embolised. In case of high bifurcation, the embolic material could extend into the common carotid artery instead of external carotid artery with subsequent stroke(8). Additionally, the exact bifurcation site and arterial variations of the CCA are clinically important in many other procedures, such as ligation of the external carotid artery, intra-arterial administration of chemotherapeutic agents, interpretation of digital subtraction angiography, and during radical neck dissection(9)(10). Investigations have observed that the ratio of mortality and morbidity of high level carotid bifurcation cases after carotid endarterectomy attempt are quite high(4).

To avoid these complications, the exact level of bifurcation needs to be known before surgery. Accordingly,surgery can be planned. We found that CT angiogram of the neck vessels is a valuable tool in determining the exact level of the bifurcation in relation to the cervical vertebra. Adequate knowledge of these variations is important for radiologists owing toincrease in the number of endovascular procedures and neck surgeries. Axial-oblique images with MPR and MIP reformations are particularlyimportant in delineating these

variations. Preoperative cross-sectional imaging workup can help identify variations in level of CCA bifurcation and reduce procedure-related morbidity and mortality.

VII. Acknowledgement

The authors express their gratitude and indebtedness to the Department of Radiology, Seth G.S Medical College and KEM Hospital for providing necessary infrastructure and resources to accomplish this research work. The authors also express respect and gratitude to Dr. Hemant.L.Deshmukh, Professor and Head, Department of Radiology, Seth G.S Medical College, KEM Hospital, Mumbai for providing valuable and resourceful inputs. The authors are truly indebted to their colleagues, seniors and juniors for their support, valuable guidance, encouragement and help through the duration of the study. Finally, the authors are thankful to patients whose help has made it possible to complete this study.

References

[1]. Ashrafian H. Anatomically specific clinical examination of the carotid arterial tree. Anat Sci Int. 2007;82(1):16–23.
[2]. Manbachi A, Hoi Y, Wasserman BA, Lakatta EG, Steinman DA. On the shape of the common carotid artery with implications for blood velocity profiles. Physiol Meas. 2011;32(12):1885–97.
[3]. DH W. Anatomical Variations of the Common Carotid Artery Bifurcations in Relation to the Cervical Vertebrae in Ethiopia. Anat Physiol [Internet]. 2013;4(3). Available from: https://www.omicsonline.org/open-access/anatomical-variations-of-the-common-carotid-artery-bifurcations-in-relation-to-the-cervical-vertebrae-in-ethiopia-2161-0940.1000143.php?aid=28419
[4]. Furukawa S, Wingenfeld L, Takaya A, Nakagawa T, Sakaguchi I, Nishi K. Morphological Variation of the Carotid Artery Bifurcation Level. 2012;1(1):1–2.
[5]. Lučev N, Bobinac D, Marić I, Drešćik I. Variations of the great arteries in the carotid triangle. Otolaryngol Neck Surg [Internet]. 2000;122(4):590–1. Available from: http://journals.sagepub.com/doi/10.1067/mhn.2000.97982
[6]. Elhammady MS, Wolfe SQ, Farhat H, Ali Aziz-Sultan M, Heros RC. Carotid artery sacrifice for unclippable and uncoilable aneurysms: Endovascular occlusion vs common carotid artery ligation. Neurosurgery. 2010;67(5):1431–6.
[7]. Kusumaphanyo C, Charuluxananan S, Sriramatr D, Pulnitiporn A, Sriraj W. The Thai Anesthesia Incident Monitoring Study (Thai AIMS) of anesthetic equipment failure/malfunction: An analysis of 1996 incident reports. J Med Assoc Thail. 2009;92(11):1442–9.
[8]. Trigaux JP, Delchambre F, Van Beers B. Anatomical variations of the carotid bifurcation: Implications for digital subtraction angiography and ultrasonography. Br J Radiol. 1990;63(747):181–5.
[9]. Gluncic V, Petanjek Z, Marusic A, Gluncic I. High bifurcation of common carotid artery, anomalous origin of ascending pharyngeal artery and anomalous branching pattern of external carotid artery. Surg Radiol Anat. 2001;23(2):123–5.
[10]. Riles TS, Berenstein A, Fisher FS, Persky MS, Madrid M. Reconstruction of the ligated external carotid artery for embolization of cervicofacial arteriovenous malformations. J Vasc Surg. 1993;17(3):491–8.

Dr. Padma Badhe. “Anatomical Variation of Common Carotid Artery Bifurcation In Relation To Cervical Vertebra on CT Angiogram”.” IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 17, no. 12, 2018, pp58-66.