



Morphometric Analysis of V2 Segment of Vertebral Artery in Patients with Symptomatic Neck Pain in South Indian Population – A CT Angiography Based Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Objectives: The morphometric changes in the vertebral artery are essential for various interventions. Inadequate details about it can lead to risk of vertebral artery injury and other complications. This study explains the normal anatomical course of V2 segment of vertebral artery which is more prone for iatrogenic injury.

Materials and Method: 25 adult patients with symptomatic neck pain were involved in the study. Various measurements were made from seventh cervical vertebra (C7) to the third cervical vertebra (C3) that included Distance from midline to VA, Distance from medial margin of Longus Colli to VA, Perpendicular distance from anterior margin of transverse process to center of VA, Horizontal distance from anterior tubercle to VA, sagittal and coronal diameter of the transverse foramen and vertebral artery.

Result: Distance from midline, Distance from medial margin of Longus Colli, Perpendicular distance from anterior margin of transverse process to center of VA and Horizontal distance from

anterior tubercle were increased towards right compared to left side. The sagittal and coronal diameter of the transverse foramen and vertebral artery decreased from C6 to C3 vertebra. Vertebral artery dominance was seen on left side in all cases.

Conclusion: Preoperative assessment by computed tomography angiography helps to know the course of the vertebral artery, understand its patterns and assess various abnormalities thereby aids in preventing complications in future surgeries.

Keywords: Vertebral artery; transverse foramen; V2 segment; CT angiography; cervical vertebra.

1. INTRODUCTION

Morphometric variations of the vertebral artery are significant for diagnostic and surgical interventions [1]. The vertebral artery comprises of 4 segments. The first of the 4 segments (V1) arise from the subclavian artery to the transverse process of sixth cervical vertebra (C6). The second segment of the vertebral artery (V2) arises superiorly through the transverse foramen of the sixth cervical vertebra (C6) until it reaches the transverse process of the axis vertebra (C2). The third segment (V3) starts from axis vertebra (C2) to the foramen magnum and the fourth segment (V4) begins from the foramen magnum, passes through dura mater and merge with its counterpart from opposite side to form basilar artery [2,3,4].

The incidence of anatomical variation of V2 segment of vertebral artery is high [5]. Anomalous V2 segment of vertebral artery have also been reported in few publications. It states that about 10% of study population has abnormalities [3,4,5,6].

The anatomical variation in the vertebral artery and inadequate information about its variation can cause increased risk of vertebral artery injury during cervical spine surgery [7,8]. Hence this study aims to describe the morphometric variation of the V2 segment of vertebral artery to prevent iatrogenic vertebral artery injury.

2. MATERIALS AND METHODS

This was an observational study carried out in a tertiary care center. Complete enumerative sampling was done. 25 adult patients with symptomatic neck pain were involved in the study after obtaining consent. The patients who underwent CT angiography had their renal function tests within normal limits. Measurements were made from seventh cervical vertebra (C7) up to the third cervical vertebra (C3).

The parameters measured were distance from the midline to the center of the vertebral artery,

distance from the medial margin of the Longus Colli muscle to the center of vertebral artery, perpendicular distance from the anterior margin of the transverse foramen to the center of vertebral artery, horizontal distance from the anterior tubercle (or the tip of C7 transverse process) to the center of vertebral artery, diameter of transverse foramen, sagittal diameter of transverse foramen, coronal diameter of transverse foramen, sagittal diameter of vertebral artery and coronal diameter of vertebral artery.

All details regarding the patients were kept confidential. Statistical analysis was done using Statistical Package for Social Science (SPSS version 17) for Microsoft Windows. Descriptive statistics were presented as numbers.

3. RESULTS

Vertebral artery entered the transverse foramen of sixth cervical vertebra (C6) in all 25 adults involved in the study. There weren't any abnormal entrance observed.

Mean distance from the midline to the center of the vertebral artery (20.45 ± 0.73 mm and 20.38 ± 1 mm in right and left side respectively) and from the medial margin of the Longus Colli muscle to the center of vertebral artery (6.86 ± 2.41 mm and 6.23 ± 3.39 mm in right and left side respectively) were increased towards the right side at the level of seventh cervical vertebra (C7). Perpendicular distance from anterior margin of transverse process to center of vertebral artery was increased in the right side (5.76 ± 0.87 mm) when compared to the left side (4.79 ± 0.81 mm). Horizontal distance from the anterior tubercle (or the tip of C7 transverse process) to the center of vertebral artery was 13.37 ± 3.34 mm and 13.41 ± 2.59 mm in the right and left side respectively. The diameter of the transverse foramen before the entry of vertebral artery at the level of seventh cervical vertebra (C7) was 6.99 ± 0.5 mm and 6.98 ± 0.54 mm in the right and left side respectively (Table 1).

Table 1. Diameter of the transverse foramen

Parameters measured	Right (Mean ± SD mm)	Left (Mean ± SD mm)
Distance from midline	20.45 ± 0.73	20.38 ± 1
Distance from medial margin of longus colli	6.86 ± 2.41	6.23 ± 3.39
Perpendicular distance from anterior margin of transverse process to center of va	5.76 ± 0.87	4.79 ± 0.81
Horizontal distance from anterior tubercle	13.37 ± 3.34	13.41 ± 2.59
Diameter of transverse foramen	6.99 ± 0.5	6.98 ± 0.54

Table 2. Mean values of sagittal and coronal diameter

	Sagittal diameter of TF (Mean ± SD mm)		Coronal diameter of TF (Mean ± SD mm)		Sagittal diameter of VA (Mean ± SD mm)		Coronal diameter of VA (Mean ± SD mm)	
	Right	Left	Right	Left	Right	Left	Right	Left
C6	7.01 ± 0.56	7.02 ± 0.58	6.14 ± 0.61	6.89 ± 1.26	3.28 ± 0.42	3.97 ± 0.58	3.32 ± 0.54	3.3 ± 0.55
C5	5.8 ± 0.85	6.40 ± 0.98	5.68 ± 0.55	6.36 ± 0.57	3.07 ± 0.52	3.38 ± 0.75	3.18 ± 0.68	3.34 ± 0.61
C4	5.53 ± 0.74	6.01 ± 0.69	5.83 ± 0.52	6.25 ± 0.60	2.88 ± 0.6	3.13 ± 0.44	2.88 ± 0.44	3.3 ± 0.41
C3	5.64 ± 0.8	6.06 ± 0.78	5.74 ± 0.68	6.40 ± 0.81	2.7 ± 0.54	3.07 ± 0.39	2.84 ± 0.46	3.24 ± 0.46

Table 3. Sagittal and the coronal diameter of the vertebral artery

	Right (mm)	Left (mm)
sagittal diameter of VA	2.989	3.393
coronal diameter of VA	3.06	3.299

The sagittal and coronal diameter of the transverse foramen and vertebral artery decreases from C6 to C3 vertebra. The mean values were tabulated in Table 2.

The mean sagittal and the coronal diameter of the vertebral artery is greater on the left side which is enumerated in Table 3.

4. DISCUSSION

The incidence of iatrogenic vertebral artery injury in cervical spine surgeries was found to be 0.07%-1.4% [9]. The incidence was low because the vertebral artery was protected by the transverse process in V2 segment [10]. However if there was an anomalous vertebral artery or if the artery was at the level of C7 vertebra where it lies outside the transverse foramen, the risk for iatrogenic injury would have been high [5]. Excessive lateral dissection due to loss of midline orientation during surgeries like corpectomy [11] and anatomic delineation of midline structures in severe spondylosis [12] may cause iatrogenic vertebral artery injury. Hence preoperative assessment of vertebral artery anatomy can prevent iatrogenic vertebral artery injury and its complications [13].

Vertebral artery entered the transverse foramen of sixth cervical vertebra (C6) in all 25 patients

involved in the study. This was similar to the study done by Hong JT et al where the vertebral artery entered the transverse foramen of C6 vertebra in 94.9% of the study population [3]. Mean distance from the midline to the center of the vertebral artery at the level of C7 vertebra in the right side was 20.45 ± 0.73 mm and on the left side was 20.38 ± 1 mm. The mean distance did not differ much on the right and left side which was similar to the study done by Zhao L et al. [14].

The mean distance from the medial margin of the Longus Colli muscle to the center of the vertebral artery at the level of seventh cervical vertebra was 6.86 ± 2.41 mm on the right side and 6.23 ± 3.39 mm on the left side. The mean distance was increased towards the right side at the level of seventh cervical vertebra (C7). The average perpendicular distance from anterior margin of transverse process to the center of the vertebral artery on the right side was 5.76 ± 0.87 mm and on the left side was 4.79 ± 0.81 mm. This distance also increased towards the right side when compared to the left side. Horizontal distance from the anterior tubercle (or the tip of C7 transverse process) to the center of the vertebral artery was 13.37 ± 3.34 mm and 13.41 ± 2.59 mm in the right and left side respectively. The diameter of the transverse foramen before the entry of the vertebral artery at the level of

seventh cervical vertebra (C7) was 6.99 ± 0.5 mm on the right and 6.98 ± 0.54 mm on the left side. This shows that there was no significant difference found between right and left side which was similar to other studies [14].

Decrease in the sagittal diameter and the coronal diameter of the transverse foramen from sixth cervical vertebra (C6) to third cervical vertebra (C3) was noted and this showed similarity with other studies [14,15]. The sagittal and the coronal diameter of the vertebral artery decreased from C6 to C3 vertebra and the least diameter was found at the level of third cervical vertebra (C3). Similar findings were observed in the study done by Zhao L et al. [14].

It was found that the risk of vertebral artery injury was more in lower cervical spine (more at C3 followed by C4 and C5) as the diameter of the transverse foramen and vertebral artery decreased from C6 to C3. But according to the study by Sureka B et al the highest risk of vertebral artery injury was found at the level of C5 followed by C4 and C3 [16]. This study also reveals vertebral artery dominance on the left side; that is, the vertebral artery was larger on the left side that was similar to other studies done in China and India [14,16].

5. CONCLUSION

This study briefly describes the morphometric analysis of V2 segment of vertebral artery in a small group of south Indian population. It helps to understand the anatomical features and anomalies of the vertebral artery. Thus preoperative imaging and assessment is essential to prevent iatrogenic vertebral artery injury. Better understanding of the vertebral artery anatomy can prevent complications in surgeries.

CONSENT

Consent was obtained from patients and those with renal function test within normal limits underwent CT angiography.

ETHICAL APPROVAL

The study began after obtaining ethical clearance from institutional ethical committee.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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