

Tortuous Vertebral Arteries-Incidence and Clinical Implications

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ABSTRACT

Aim: The present study was aimed at investigating the incidence of the tortuosity of the vertebral artery in adult cadavers in order to offer useful data to anatomists, radiologists, endovascular interventionalists and surgeons. In addition, the literature was reviewed so as to enable a comparison of our results with those of previous studies and an analysis of the clinical implications which are related to these variations.

Methods: Seventy cadavers were dissected to study the pathway which was carried by the prevertebral segment of 140 vertebral arteries.

Result: A total of 31 vertebral arteries (22.1%) were showing the tortuous pathway in 25 cadavers (bilateral in six and unilateral in 19 cadavers single coil tortuosity in 26 and double coil in five vertebral arteries).

Conclusions: The described variations in the pathway of the V₁ segment of the vertebral artery have clinical implications in a wide field of pathologies in that region. Careful preoperative planning is essential in cases with tortuous vertebral arteries to avoid potentially life threatening complications.

Key Words: Prevertebral segment, Arterial tortuosity, Scalenovertbral trigone

INTRODUCTION

The vertebral artery (VA), after taking its origin from the 1st part of the subclavian artery, runs straight upwards in a scalenovertbral trigone and usually reaches the transverse foramen of the C6 vertebra, which is also known as the prevertebral (V₁) segment. Between its origin and its entrance into the transverse foramen, the segment of the vertebral artery may show some tortuosity which can take a variety of forms and occupy several orientations [1].

Before undertaking any surgeries in the cervical region, the knowledge of the variant pathway of the V₁ segment is mandatory to avoid a potentially catastrophic injury to the vertebral artery [2] and to take decisions on the appropriate corrective surgery options [3].

METHODS

Dissection was carried out in 70 formalin fixed cadavers (sixty two males and eight females) who were aged between 35-80 years, in the scalenovertbral region (between the scalenus anterior and the longus colli) on both the sides, so a total of 140 vertebral arteries were exposed. The path which was taken by the prevertebral segment of the vertebral artery was studied in detail. Any form of tortuosity, either having a single coil or a double coil, was noted. The plane of the tortuous vertebral arteries along with the direction of the convexity with respect to its plane was examined.

RESULTS

Thirty one (22.1%) vertebral arteries showed the tortuous pathway [Table/Fig-1], [Table/Fig-2], and [Table/Fig-3]). Bilateral tortuosity was encountered in six cadavers and unilateral tortuosity in 19 (13 on the left and six on the right). Twenty six (18.6%) vertebral arteries had a single coil tortuosity, while in the rest (3.5%), a double coil was encountered. The maximum number of single coil tortuosities

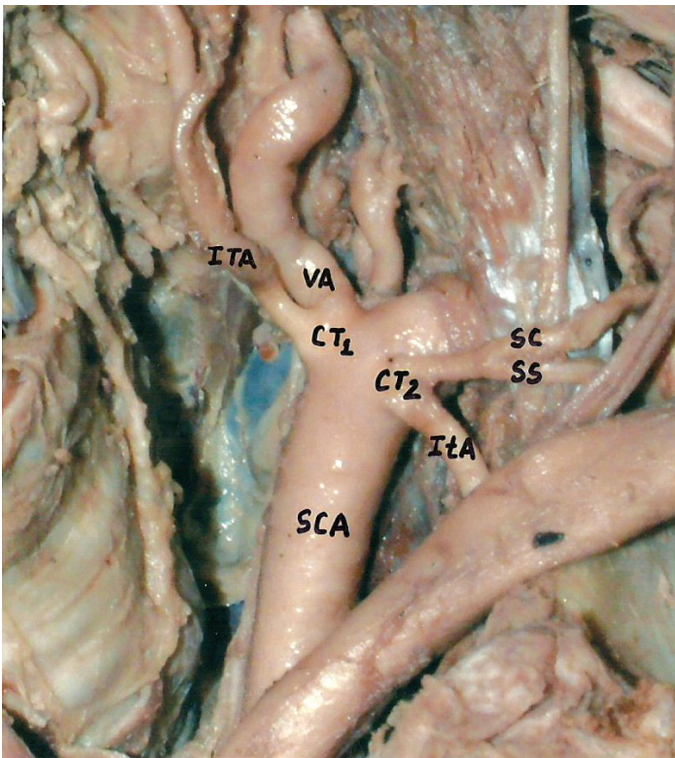
were observed in the transverse plane (medial convexity in 15 cadavers and lateral convexity in four), followed by tortuosity in the sagittal plane (ventral convexity in four and dorsal in three cadavers). Among the double coil tortuosities, two in the transverse plane, two in the sagittal plane and one in the transverse-sagittal plane were reported.

DISCUSSION

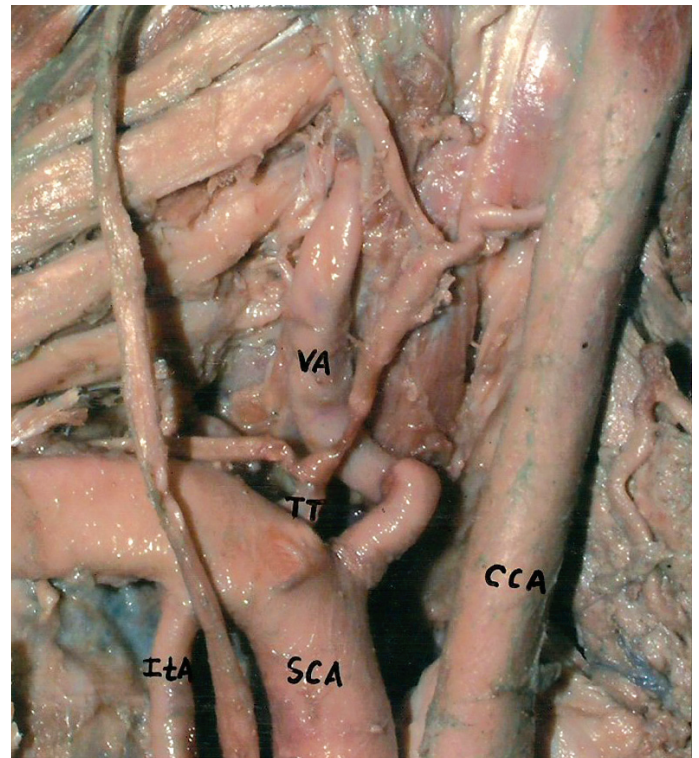
Developmentally, the vertebral artery is formed between the 32nd and the 40th gestational day (7-18mm embryo) from the fusion of the secondary persistent segments of the cervical arteries and the primitive dorsal aortic arch. It is a firm belief that whereas an abnormal arrangement of this fusion process is definitely responsible for any abnormal origins, the possibility of these abnormalities in fusion contributing to some tortuosities of the vessel also cannot be ruled out [1].



[Table/Fig-1]: Tortuous right vertebral artery (VA) with medial convexity arising from right subclavian artery (RSA)



[Table/Fig-2]: Left vertebral artery (VA) in common (CT₁) with inferior thyroid artery (ITA) arising from left subclavian artery (SCA) showing tortuosity in sagittal plane with proximal dorsal and distal ventral convexity



[Table/Fig-3]: Tortuous right vertebral artery (VA) in transverse sagittal plane with proximal medial and distal dorsal convexity taking origin from right subclavian artery (RSA) entering into C7 transverse foramen

S. No.	Author (Study)	Incidence (%)
1	Tschabitscher et al ⁷ (1991)	47.2
2	Matula et al ¹ (1997)	39.1
3	Curylo et al ⁸ (2000)	27
4	Ranganatha and Manjunath ⁹ (2006)	23.7
5	Present Study	22.1

[Table\Fig-4]: Comparative incidence of tortuous vertebral arteries

Type of Tortuosity	Plane	Direction of convexity	Percentage (n)
Single coil	Transverse	Medial	48.38% (15)
		Lateral	12.90% (4)
	Sagittal	Ventral	12.90% (4)
		Dorsal	9.67% (3)
Double coil	Transverse	Proximal medial Distal lateral	6.45% (2)
	Sagittal	Proximal dorsal Distal ventral	6.45% (2)
	Transverse sagittal	Proximal medial Distal dorsal	3.22% (1)

[Table\Fig-5]: Morphological analysis of tortuosity

The tortuosity in the VA was not recognized until 1958, when Hadler described four cases in 21 subjects who were aged between 45 and 91 years and were examined post mortem [4].

Clinically, the tortuosity of the V₁ segment does not have a haemodynamically significant consequence. However, the loops can cause radiculopathy via nerve root compression [5]. Cervical spinal fractures have been reported to be secondary to the bony erosion from a V₁ loop which is in contact. Also, a vertebral loop which is caused by the displacement from a mass lesion in the scalenovertebral trigone may be compressed and it may lead to

vertebro-basilar insufficiency. These asymptomatic loops may be corrected by a bypass procedure [1]. The intervertebral foramen is often widened and its appearance may be confused with the congenital absence of the pedicle or the presence of a neurofibroma, which is the most common cause of this lesion [6].

The reported incidences of tortuous vertebral arteries by earlier authors are shown in [Table/Fig-1]. Earlier, Tschabitscher et al [7] and Matula et al [1] encountered tortuous vertebral arteries in 47.2% and 39.1% of their dissections respectively [Table\Fig-4]. The incidence which was noted by them is much more than the 22.1% incidence which was encountered with this anomaly in the present study. A possible explanation which has been given for such a high incidence in their study is the larger age group (59–82 years) of their study material, which might have been responsible for the atherosclerotic changes in the carotid and the subclavian arteries and also the extension into their branches as well resulting in the lengthening and dilatation of the same (8) (9). But, other authors have suggested that the deflection of the VA may result from cervical osteophytosis [10] and yet others have suggested that this condition may be congenital [11].

Most of the tortuosities (48.3%) which were encountered in our study were found in the transverse plane, with the direction of their convexities towards the medial side. The details of the tortuosities with their planes and the direction of their convexities which were encountered in our studies have been described in [Table/Fig 5]. Curylo et al suggests that during the anterior decompression surgery of the cervical spine, the medially located vertebral artery carries the risk of VA injury [8].

The operative indications for surgery in the cervical region include spondylosis, a herniated inter-vertebral disc, tumour, infection and trauma. Although the lateral position of the VA does not hinder the anterior approach to the cervical vertebra, the presence of an abnormally tortuous VA, by using anatomic landmarks to guide

decompression may not prevent iatrogenic injury to the VA. The failure to recognize this anomaly during the preoperative planning can lead to the laceration of the vessel [8].

The laceration of the VA is the most challenging surgical dilemma which is faced during anterior cervical spinal surgery [12]. Such an injury may cause catastrophic consequences, especially in those patients who present with an inappropriate blood deficit by the contralateral artery (e.g. by atherosclerotic occlusion) [13], which may cause brain stem infarction [14] and central respiratory dysfunction [15].

In a nutshell, apart from understanding the clinical implications, the data which is derived from the gross anatomical dissections of cadavers can be a useful guideline to the surgeons for careful pre-operative planning in cases with an unusual course of VA and can help them in avoiding potentially life threatening complications.

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