ORIGINAL ARTICLE

HISTOMORPHOMETRIC COMPARISON OF DIAMETER OF RIGHT AND LEFT VERTEBRAL ARTERIES

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ABSTRACT

Introduction: It is evident that slight changes in the diameter of a vessel cause tremendous changes in its ability to conduct blood when the blood flow is streamline. The conduction of vessel increases in proportion to the diameter. Asymmetry of the vertebral arteries, with a larger left than right vessels has been described, but only few authors has recorded the dimensions.

Aim: The present study was carried out to measure and compare Inner and Outer diameter of left and right vertebral artery.

Material and Methods: 300 transverse annuli (sections) of vertebral artery were studied from 30 embalmed cadavers. Transverse annuli were processed and stained with Haematoxylin & Eosin. Stained slides were studied under the trinocular research microscope using 40x magnifications and the images obtained under microscope were transferred to computer and histological parameters were taken on computer images using Image-proplus software version 5.1. Inner and Outer diameter of transverse annuli were measured. Comparisons of left and right vertebral artery diameters were made using paired t test by SPSS version 15 software.

Results: Inner diameter of left vertebral artery was 2.74 ± 0.46 mm and right vertebral artery was 2.64 ± 0.45 mm, the difference is statistically significant. Outer diameter of left vertebral artery was 3.16 ± 0.54 and right vertebral artery was 3.03 ± 0.51, hence the difference is statistically significant. **Conclusion:** The left sided vertebral artery was found to be dominant than the right side.

Key words: vertebral artery, Inner diameter, Outer diameter, left dominance

INTRODUCTION

The brain gets copious arterial supply from a pair of internal carotid and a pair of vertebral arteries. Vertebral arteries are arguably, the most important of the medium-sized arteries in the body, supplying the hind brain centers that control cardiac, and respiratory, as well as equilibrium functions. There are several congenital and structural factors that may contribute to a reduction in blood flow in the vertebral artery, causing ischemia and consequent neurological symptoms. Exostoses of the vertebrae may compress the vessel from outside, whereas atherosclerotic plaques in the vessel wall can be considered as an internal cause of compromised blood flow in the artery. Mechanical stretching of the artery, such as may occur on full range of cervical spine rotation, may also cause decrease in vertebral artery blood flow. Therefore the underlying cause of the reduction in blood flow is a decrease in the luminal diameter, thus crossectional area of the vessel. Furthermore, the relative magnitude will partly depend on the initial size of the artery. Asymmetry of the vertebral arteries, with a larger left than right has been described by many workers like *Cunningham*[1], Mitchell J, McKay A[2] and Machhi et al[3]. However, only few workers have recorded the dimensions of vertebral arteries, and particularly of its suboccipital and intracranial parts. Such effects will be more serious if the blood flow in the larger of the two vertebral arteries were compromised, leading to hypoxia of the hind brain. The present study was undertaken, therefore to measure these dimensions of the vertebral arteries in available cadaver material, in order to contribute to the little documented data and to inform future blood flow studies and for evidence based clinical practice.

MATERIALS & METHOD

Sixty vertebral arteries were dissected from 30 embalmed cadavers obtained from GMERS Medical college sola and other institutes. The study consisted of meticulous dissection of vertebral arteries and staining of the slices of vertebral artery obtained from the

dissection .For the staining purpose materials used were Automatic Tissue Processor, Manual Rotary Microtome and standard staining equipments. The stained slides were studied under Trinocular Research Microscope and images obtained from it were analyzed on computer with image proplus software version 5.1. taken on computer images using Image-proplus software version 5.1. Image-proplus software version 5.1 was calibrated before taking the measurements.

Following histological parameters were measured and recorded:-

- D1:- inner/internal lumen diameter of the vertebral artery. Measured from one end of luminal surface of endothelial cells of tunica intima to another end of luminal surface of endothelial cells .
- D2:- perpendicular to D1 measuring inner luminal diameter.
- D3:- tunica intima width/thickness measured from luminal endothelial surface to the internal elastic lamina
- D4:- tunica media width/thickness measured from internal elastic lamina to the external elastic lamina
- Di:- average of D1 and D2, average inner/internal diameter (D1+D2)/2.
- Do: - outer or external diameter = Di +2D3 +2D4.

The stained slides of vertebral arteries which were having disrupted walls showing only half circle were not included in the measurement of inner and outer diameter.

All these measurements were statistically analyzed by calculating the Mean and Standard Deviation (SD). The comparison of parameters between left and right side of the vertebral arteries was done by paired t-test using the software SPSS version 15.

Figure 1: Dissected Vertebral arteries on both sides

OBSERVATIONS

It is found that inner diameter of vertebral artery on left side is 2.74mm. ± 0.458 and on right side is 2.64mm. ± 0.448. Paired t-test shows that mean difference in inner diameter of right and left side of vertebral artery is 0.104, 95% confidence interval lower limit of which is 0.016 & upper limit is 0.192 and p value is 0.021 which is less than 0.05 and hence the difference is significant.

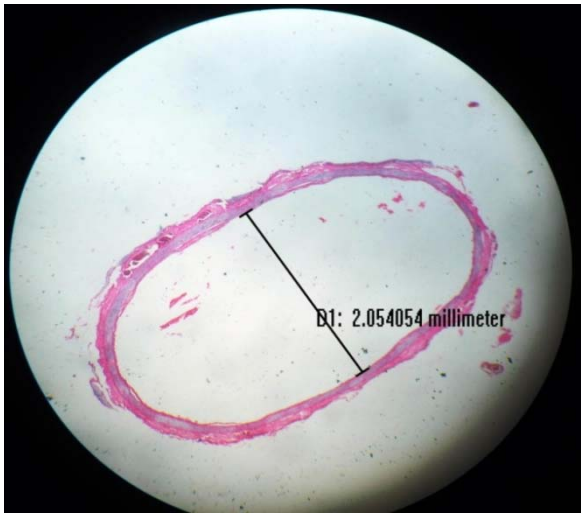

Figure 2: Vertebral artery 40x magnification measurement of D1 – Inner luminal Diameter

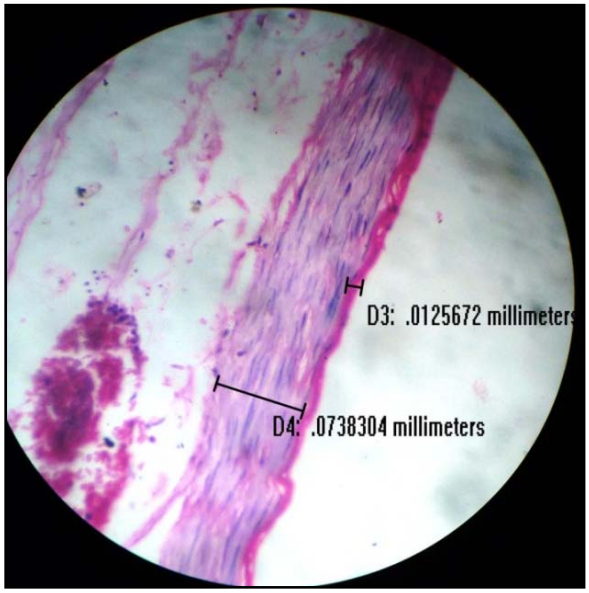

Figure 3: Vertebral artery 400x magnification D3 – Tunica intima width, D4 – Tunica media Width

Table 1: Comparison of Inner and Outer Diameter of Right and Left Side of Vertebral Arteries

	Vertebral Arteries	
	Left Side	Right Side
Average Inner diameter	3.16mm	3.06mm
Average Outer diameter	2.74mm	2.64mm

It is found that outer diameter of vertebral artery on left side is 23.16mm. ± 0.544 and on right side is

3.03mm. ± 0.507. Paired t-test shows that mean difference in inner diameter of right and left side of vertebral artery is 0.122, 95% confidence interval lower limit of which is 0.034 & upper limit is 0.211 and p value is 0.007 which is less than 0.05 and hence the difference is significant.

DISCUSSION

The flow of blood in the arterial circulation is governed by the fundamental laws of fluid dynamics. Knowledge of these principles permits a better understanding of physiologic abnormalities associated with arterial obstruction. The pressure within the arterial wall is related to the interaction between the elasticity of the vascular walls and volume of blood contained within. The circumferential stress applied to an arterial wall is a function of the transmural pressure, the inside radius of the artery and its wall thickness. So histomorphometric analysis of diameter of vertebral artery will help in the better understanding of fluid dynamics within the vertebral artery.[5]

Inner diameter and outer diameter of vertebral artery

The diameter of vertebral arteries is described in the range of 0.5mm to 5.5mm by *Andrew L Carney*.[4] Mitchell J [5] described inner and outer diameter of suboccipital and intracranial segment of the vertebral arteries of left and right side studied in 40 paired suboccipital and 54 paired intracranial vertebral arteries. In his study it was found between suboccipital and intracranial part, there was significant difference in diameter ($p \leq 0.001$) but between right and left side there was no significant difference was found.

Diameter of vertebral artery is also measured grossly in 57 human cadavers by Barbara Cagnie et al.[6] Diameter was determined by measuring width of the artery and dividing width by 3.14. In this study mean diameter of left vertebral artery was found to be 3.79 mm. ± 0.80, while right sided diameter was 3.06 mm. ± 1.25.

Vertebral artery diameters were also taken by real time ultra sound measurements and their dimensions described in different parts of vertebral artery are described by Mitchell J et al[7]. The measurement taken by real time ultrasound is closer to the measurement of outer diameter of an artery measured in this study.

In cadaveric study, due to tissue shrinkage the dimensions of vertebral artery are less than dimensions measured by real time ultrasound, and also age difference and ethnic difference leads to variations in the measurement of dimension from one study to another.

Comparison of inner and outer diameters of right and left side of the vertebral arteries

Asymmetry of the vertebral arteries, with a larger left than right vessel has been described in anatomical books by *Cunningham*[1] , Mitchell J, McKay A[2] and Machhi et al[3]etc.

Barbara cagnie et al[6] has studied vertebral arteries grossly and found that mean diameter of left vertebral artery 3.79mm. ± 0.80 was significantly greater than the mean diameter of right vertebral artery 3.06 mm.± 1.25. (p= 0.005). Mitchell J[8] studied suboccipital and intracranial parts of vertebral arteries and did not found significant difference between left and right side of the vertebral arteries in suboccipital and intracranial regions. In the present study, it was found that inner diameter on the left side of the vertebral artery was 2.74mm.± 0.458 and on right side was 2.64mm. ± 0.448 and when paired t-test was applied the difference was found to be significant as p=0.021 which is less than 0.05. Similarly, the outer diameter on the left side of the vertebral artery was 3.16mm. ± 0.544 and on right side was 3.03mm. ± 0.507 and when paired t-test was applied the difference was significant as p=0.007 which is less than 0.05.

Thus in present study left side vertebral artery was found to be dominant than the right side and the results are comparable with the study of Barbara cagnie et al[6] and description given by authors like *Cunningham*[1] , Mitchell J, McKay A[2] and Machhi et al[3]etc.

Further study required to measure differences in diameter in each part of vertebral artery and comparison of both sides.

CONCLUSION

Inner diameter of left vertebral artery was 2.74 ± 0.46 mm and right vertebral artery was 2.64 ± 0.45 mm, the difference is statistically significant. Outer diameter of left vertebral artery was 3.16 ± 0.54 and right vertebral artery was 3.03 ± 0.51, the difference is statistically significant. The left sided vertebral artery was found to be dominant than the right side. Despite of many differences in materials, methods and number of investigated specimens, some results of our study were quite similar to those reported earlier. The purpose of this study was to present detailed histomorphometric measurements of diameter of vertebral artery, which will help in understanding fluid dynamics within the vertebral artery. Our study would also provide specific data on the histomorphometry of diameter of vertebral artery in Indian subjects, which were lacking so far.

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