

DIAMETER OF ANTERIOR CEREBRAL ARTERY ON MRI ANGIOGRAMS

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ABSTRACT

Background: Magnetic Resonance Imaging, by far, has been found to be the most sensitive and non-invasive method for detecting angiographic images on the circle of Willis. Arteries forming parts of circle of Willis frequently vary in size. The haemodynamics of the circle of Willis is influenced by variations in the caliber of the segments of the anterior and posterior cerebral arteries and their communicating arteries, thus affecting the major role of the circulus arteriosus as an anastomotic channel.

Materials and Methods: In the present study the diameter of A1 segment of anterior cerebral artery, forming the anterior part of the circle of Willis, is measured in the brains on MRI angiograms at two points 'A' and 'B' respectively.

Results: The left anterior cerebral artery at point 'A' has a larger diameter than the right, being 3.20mm and 2.72mm respectively. In males and females both the left anterior cerebral artery at point 'A' has a larger diameter than the right anterior cerebral artery, being 3.19mm and 2.86mm respectively in males and 3.21mm and 2.57mm respectively in females. The diameter of anterior cerebral artery on MRI angiograms at point 'B' is also larger on left side as compared to right side being 2.50mm and 2.31mm respectively. In males and females both it is larger on left side than on right side being 2.70mm and 2.42mm respectively in males and 2.30mm and 2.20mm respectively in females.

Discussion: The diameter was found to be higher on the left side than on right side and in males than in females. In view of this, the diameter which is presented here may provide reference values which will be specific to the three dimensional time of flight MRI angiography.

KEY WORDS: MRI angiograms, Diameter, Anterior cerebral artery.

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INTRODUCTION

The Anterior Cerebral Artery (ACA), a branch of the internal carotid artery on both right and left

sides, complete the circle of Willis anteriorly through an anastomosis between them -the anterior communicating artery (A Com A.). The

surgical nomenclature divides the anterior cerebral artery into three parts; A1 – from the termination of the internal carotid artery to the junction with the anterior communicating artery; A2-from the junction with the anterior communicating artery to the origin of the callosomarginal artery; and A3 – distal to the origin of the callosomarginal artery. The A1 segment is also known as the pre-communicating part of the anterior cerebral artery [1].

It is well known that MRI angiography is a sensitive and non-invasive modality which is suitable for detecting the anatomy of the circle of Willis. MRI angiography is said to have 100% sensitivity and 100% specificity for the anterior, middle and the posterior cerebral arteries. This modality is useful for finding a standard of reference for research on the anterior cerebral artery - the focus of the present study. The aim of the present study was to find out the diameter of the anterior cerebral artery in the living, on MRI angiograms.

MATERIALS AND METHODS

Fig. 1: Measurements of the diameter of the Anterior Cerebral Artery being taken on the right side on MRI angiograms.

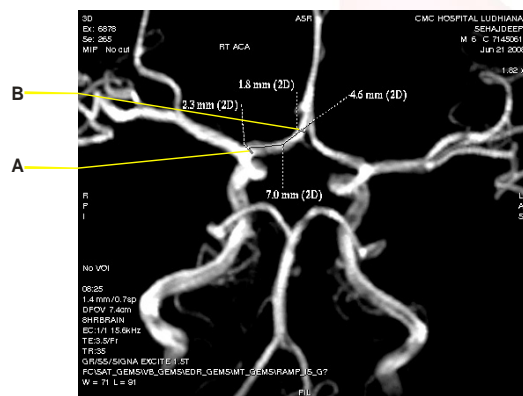
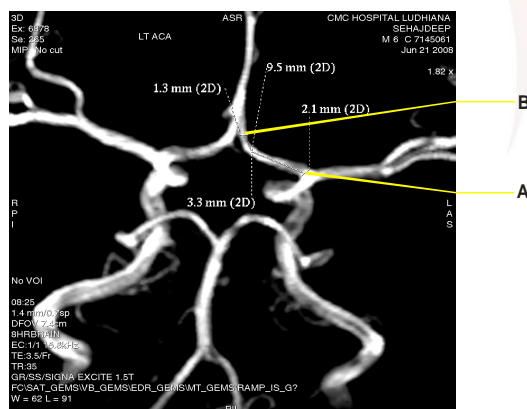


Fig. 2: Measurements of the diameter of the Anterior Cerebral Artery being taken on the left side on MRI angiograms.



This study was conducted on 50 normal angiograms of adult patients who underwent the three dimensional time of flight Magnetic Resonance Angiography of the circle of Willis at 1.5 Tesla field strength scanners in the Department of Radiodiagnosis and Imaging at Christian Medical College, Ludhiana, Punjab, India .All the angiograms were evaluated at the Radiology Department's workstation, on its maximum intensity projections as well as its source images. The A1 segment of the anterior cerebral artery, which is one of the components of the circle of Willis, was studied for its diameter.

The diameter of A1 segment of anterior cerebral artery forming the part of circle of Willis was measured separately at following two points: One is at its origin from the internal carotid artery (taken as point 'A'), another point at the proximal part of its junction with the anterior communicating artery (taken as point 'B').

RESULTS

Measurements of anterior cerebral artery at point 'A' COMPARISONS OF RIGHT AND LEFT SEGMENTS

Table 1: Diameter of anterior cerebral artery - A1 segment at its origin (at point 'A') in millimeters on MRI angiograms in Males.

| Right | | | | Left | | | | p-value | t-value |
|-------|------|------|------|------|------|------|------|---------|---------|
| Mean | SD | SEM | CV | Mean | SD | SEM | CV | | |
| 2.86 | 0.91 | 0.18 | 31.8 | 3.19 | 0.88 | 0.18 | 27.6 | 0.19 | 1.33 |

Table 2: Diameter of anterior cerebral artery- A1 segment at its origin (at point 'A') in millimeters on MRI angiograms in Females.

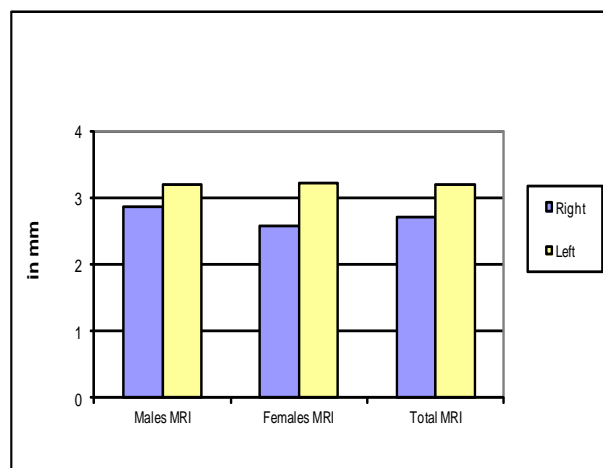
| Right | | | | Left | | | | p-value | t-value |
|-------|------|------|------|------|------|------|------|---------|---------|
| Mean | SD | SEM | CV | Mean | SD | SEM | CV | | |
| 2.57 | 0.53 | 0.11 | 20.6 | 3.21 | 0.88 | 0.18 | 27.4 | 0.003 | 3.12* |

Table 3: Diameter of anterior cerebral artery - A1 segment at its origin (at point 'A') in millimeters on MRI angiograms (in males and females total).

| Right | | | | Left | | | | p-value | t-value |
|-------|------|------|------|------|------|------|------|---------|---------|
| Mean | SD | SEM | CV | Mean | SD | SEM | CV | | |
| 2.72 | 0.75 | 0.11 | 27.6 | 3.2 | 0.87 | 0.12 | 27.2 | 0.003 | 3.00* |

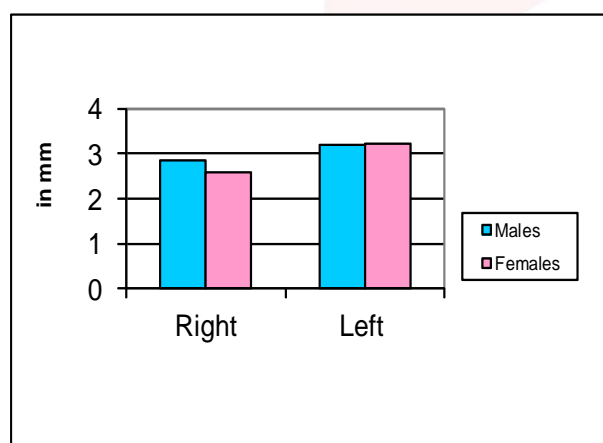
COMPARISON WITH REGARDS TO SIDE

Graph 1: Comparison of diameter of anterior cerebral artery – A1 segment at its origin (point 'A').



COMPARISON WITH REGARDS TO SEX

Graph 2: Comparison of diameter of anterior cerebral artery – A1 segment at its origin (point 'A').



Measurements of anterior cerebral artery at point 'B'

COMPARISON OF RIGHT AND LEFT SEGMENTS

Table 4: Diameter of anterior cerebral artery - A1 segment at proximal part of its junction with anterior communicating artery (at point 'B') in millimeters on MRI angiograms in Males.

| Right | | | | Left | | | | p-value | t-value |
|-------|------|------|------|------|------|------|------|---------|---------|
| Mean | SD | SEM | CV | Mean | SD | SEM | CV | | |
| 2.42 | 0.85 | 0.17 | 35.1 | 2.7 | 0.95 | 0.19 | 35.2 | 0.28 | 1.08 |

Table 5: Diameter of anterior cerebral artery- A1 segment at proximal part of its junction with anterior communicating artery (at point 'B') in millimeters on MRI angiograms in Females.

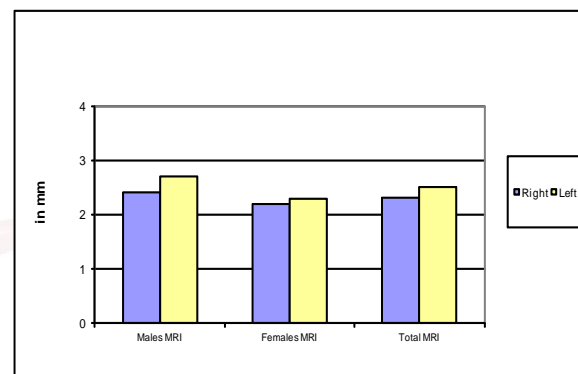
| Right | | | | Left | | | | p-value | t-value |
|-------|------|------|----|------|------|------|------|---------|---------|
| Mean | SD | SEM | CV | Mean | SD | SEM | CV | | |
| 2.2 | 0.55 | 0.11 | 25 | 2.3 | 0.82 | 0.16 | 35.7 | 0.62 | 0.49 |

Table 6: Diameter of anterior cerebral artery- A1 segment at proximal part of its junction with anterior communicating artery (at point 'B') in millimeters on MRI angiograms (in males and females total).

| Right | | | | Left | | | | p-value | t-value |
|-------|------|-----|------|------|------|------|------|---------|---------|
| Mean | SD | SEM | CV | Mean | SD | SEM | CV | | |
| 2.31 | 0.72 | 0.1 | 31.2 | 2.5 | 0.82 | 0.12 | 32.8 | 0.25 | 1.15 |

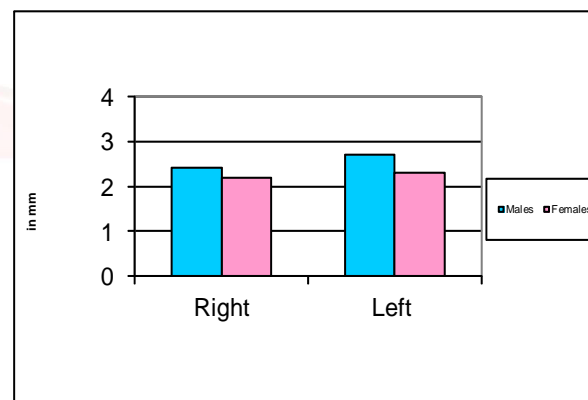
Comparison with regards to side

Graph 3: Comparison of diameter of anterior cerebral artery - A1 segment at proximal part of its junction with anterior communicating artery (point 'B').



COMPARISON WITH REGARDS TO SEX

Graph 4: Comparison of diameter of anterior cerebral artery-A1 segment at proximal part of its junction with anterior communicating artery (point 'B').



DISCUSSION

On MRI angiograms the left anterior cerebral artery at point 'A' has a larger diameter than the right anterior cerebral artery at point 'A', 3.20mm and 2.72mm respectively, the difference being 0.48mm. The left is significantly larger than the right and the difference has a highly significant p-value. In males the left anterior cerebral artery at point 'A' has a larger diameter than the right anterior cerebral artery at point 'A', 3.19mm and 2.86mm respectively, the difference being 0.33mm, which is non-significant. In the females the left anterior cerebral artery at point 'A' has

a larger diameter than the right anterior cerebral artery at point 'A', 3.21mm and 2.57mm respectively, the difference being 0.64mm. The left being larger in diameter is a significant difference from right with a significant p-value. The diameter of anterior cerebral artery on MRI angiograms at point 'B' (in all the cases taken together) is larger on left side as compared to right side being 2.50mm and 2.31mm respectively. The difference of diameter on left and right side is 0.19mm, which is non-significant. The diameter of anterior cerebral artery at point 'B' in the males is larger on left side than on right side. Diameter on left is 2.70mm whereas that on right side it is 2.42mm. The diameter of anterior cerebral artery at point 'B' in the female is larger on left side than on right side. Diameter on left is 2.30mm whereas that on right side it is 2.20mm.

According to Vohra et al (2006) [2] the diameter of anterior cerebral artery on MRI angiograms was found to range from 1.0 - 2.5mm and the mean diameter being 1.72 ± 0.45 mm. The value is less as compared to that in present study.

Hartkamp et al (1998) [3] made following observations for the mean vessel diameter (in mm) according to age and sex:

Table 7: Hartkamp et al (1998) [3] observations for the mean vessel diameter (in mm) according to age and sex:

| | Subjects aged 20-25 years | | Subjects aged 60-85 years | |
|-------|---------------------------|--------|---------------------------|--------|
| | Male | Female | Male | Female |
| Right | 2.3 | 2.3 | 1.9 | 1.8 |
| Left | 2.2 | 2.2 | 1.8 | 1.7 |

The values observed by him are less on both right and left sides as compared to those in the present study.

The diameter of ACA has been measured by many others but on cadaveric specimens of brain with intact ACA.

In the present study it has been observed that the diameters on left side are slightly larger both at point 'A' and 'B' than that on the right side. The difference of diameter on right and left side has shown a significant p-value at point 'A'. This finding is in accordance with findings by:

Orlandini et al (1985) [11] according to them

the diameter on left side is larger than the right side and that a statistically significant p-value exists for the difference in diameter on the two sides.

Pai et al (2005), Mandiola et al (2007), Kamath (1981) observed that diameters on left are greater than right but they could not find a significant difference between the two sides.

Khade et al. (2008) [12] noted a statistically significant difference of diameter of anterior cerebral artery on right and left side in females.

According to Kapoor et al (2008) [13] diameter and length of anterior cerebral artery do not show any differences on right and left side.

According to Murray (1964) right side has larger diameters than left side which is contrary to the findings in the present study.

It has been observed in the present study that the males have higher values for diameter as compared to females in general, but the difference is insignificant.

This observation in present study is accordance with observation by Orlandini et al (1985) and Kapoor et al (2008) in cadaveric brains. Hartkamp et al (1998) who measured diameter of anterior cerebral artery on MRI angiograms also found that males have larger diameters than females, but the difference is insignificant.

Table 8: Diameters of A1 segment given by various authors on cadaveric specimens of brain.

| Author | Year | Diameter On Right Side | Diameter On Left Side |
|--------------------------|------|-----------------------------------|-----------------------------------|
| Murray [4] | 1964 | 1.475mm | 1.425mm |
| Perlmutter and Rhoton[5] | 1976 | 2.6mm | 2.6mm |
| Kamath[6] | 1981 | $2.2\text{mm} \pm 0.6\text{mm}$ | $2.4\text{mm} \pm 0.05\text{mm}$ |
| Gomes et al[7] | 1986 | $2.3\text{mm} \pm 1.0\text{mm}$ | $2.5\text{mm} \pm 1.0\text{mm}$ |
| Stefani et al[8] | 2000 | $2.61\text{mm} \pm 0.34\text{mm}$ | $2.61\text{mm} \pm 0.34\text{mm}$ |
| Pai et al[9] | 2005 | 2.8mm | 2.9mm |
| Vohra et al[2] | 2006 | $1.44\text{mm} \pm 0.42\text{mm}$ | $1.44\text{mm} \pm 0.42\text{mm}$ |
| Mandiola et al[10] | 2007 | $2.37\text{mm} \pm 0.68\text{mm}$ | $2.42\text{mm} \pm 0.75\text{mm}$ |

Among the studies reviewed for this present work, the diameter of anterior cerebral artery-A1 segment at proximal of its junction with anterior communicating artery that is at point B was not quoted by any of the authors. It has been measured in the present study because this site of anterior cerebral artery, that is the

anterior communicating artery-anterior cerebral artery complex, is the commonest site for occurrence of aneurysms. Therefore it is a new addition in the present work for studies on anterior cerebral artery.

The range of diameter at point 'B' on right side is 0.85mm – 4.52mm, the mean diameter being $2.31\text{mm} \pm 0.72\text{mm}$ whereas, on the left side the range is 1 mm - 5.13mm and the mean diameter is $2.50\text{mm} \pm 0.82\text{m}$.

CONCLUSION

From all the published work it has been concluded that the circle of Willis is essential for the maintenance of a stable and a constant blood flow to the brain. Any changes in its morphology may condition the appearance and the severity of syndromes of vascular insufficiency [14]. It must be emphasized that a wider range of information on the size of the considered artery may be useful for a better interpretation of angiographic images and for deeper understanding of cerebral pathology [11].

Data obtained can provide precise microanatomic information for surgical treatment of aneurysm or vascular reconstructive procedures in circle of Willis. Also the anatomic parameters of anterior cerebral artery may be used to plan and design devices such as angiographic microcatheters and guides used in endovascular procedures [8].

Abnormal narrowing of vessels was a common occurrence on the right side than on the left in this study. This may be related to the need for a better blood supply to the left hemisphere. This is because of dominance of left cerebral hemisphere in most of the population [3] related to the handedness of the person.

The present study gives diameters of anterior cerebral artery and their difference according to side and sex. In view of this, the morphologic variation and diameters presented here may provide reference values specific to three dimensional time of flight MRI angiography, as well as be of value in studies in which three-dimensional time of flight MRI angiography is used to investigate other pathologic features of the circle of Willis.

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Conflicts of Interests: None

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