

Configuration of Circle of Willis in Bangladeshi Population: An Observational Study

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Abstract:-

Background: The Circle of Willis serves as an important potential collateral pathway at the base of the brain. The size and patency of the components of the Circle of Willis are known to be variable. The objective of the study was to explore the configuration of the Circle of Willis among Bangladeshi population.

Methods: It was a cross-sectional observational study on 42 patients who were undergoing Digital Subtraction Angiography (DSA) for different reasons. Data regarding the morphology of Circle of Willis (CoW) was obtained from DSA. Then the data were compared with available literature.

Results: A total of 42 patients were enrolled. Among them, 47.6% (20 patients) had complete CoW and it was incomplete in the rest of 52.4% (22 patients). Among 22 patients who had Incomplete Circle of Willis, the most common anomaly was absent Anterior Communicating Artery (40.90%) followed by absent A1 segment of Anterior Cerebral Artery (31.82%). Absent Posterior Communicating Artery and absent P1 segment of PCA was found in 27.23% and 9.09% respectively. 4.7% (2 patients) had abnormality in more than one vessel.

Conclusion: Circle of Willis was found to be incomplete in majority of the patients (52.4%) while the commonest anomaly was absent Anterior Communicating Artery (40.90%) among the study population.

I. INTRODUCTION

Circle of Willis was first described by Sir Thomas Willis (1964) in his 'Cerebri Anatome' and it was officially named as the 'Circulus Arteriosus Cerebri Willisii'¹. It is constituted by two internal carotid arteries and basilar artery anastomosing at the base of the brain. Cerebral blood flow is supplied through the left and right internal carotid arteries (ICA) and the basilar artery to the arterial circle of Willis, and thence to the brain.

Circle of Willis serves as a potential collateral pathway, which maintains adequate cerebral perfusion in the case of diminished afferent blood supply through the internal carotid and basilar arteries. Its function depends on the continuity of its circular configuration, referred to as morphological completeness which is known to be variable in normal population². The collateral potential of the Circle of Willis would be impaired if any component of this cycle is absent or hypoplastic³.

Complete Circle of Willis (Figure 1) consists of anteriorly, pre-communicating segments of right and left anterior cerebral arteries (A1 segments), joined by the anterior communicating artery (ACom); posteriorly, pre-communicating segments of right and left posterior cerebral arteries (P2 segments) which are connected to the corresponding internal carotid arteries by posterior communicating arteries (PCom). The Circle of Willis is considered typical if all the component vessels are present; they are not duplicated or triplicated; origin of the contributing vessels is from its typical source and the external diameter is not less than 1 mm⁴. The anterior segment of CoW is taken as incomplete if the anterior communicating artery or pre-communicating segments (A1 segments) is hypoplastic or absent. The posterior CoW is incomplete if one of the posterior communicating arteries or pre-communicating segments (P1 segments) is hypoplastic or absent in either hemisphere. As a whole the Circle of Willis is taken as incomplete if either of anterior or posterior segment is incomplete⁵.

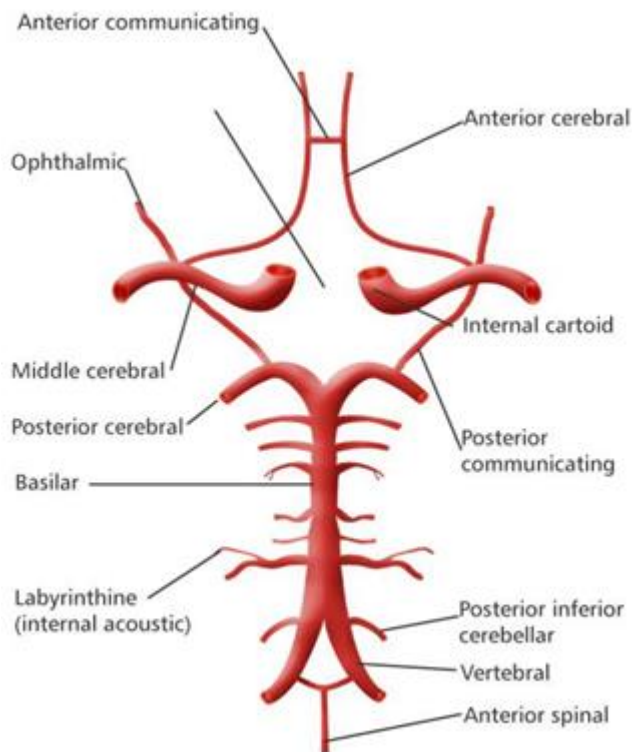


Figure 1: Configuration of a Complete Circle of Willis

The main types of anatomical variations of the circle of Willis consist of hypoplasia of any of its component vessels, accessory vessels (represented as duplications or triplications), anomalous origin (persistence of the embryonic derivation of the posterior cerebral artery from the internal carotid) or absence of any vessel⁶. In this study the focus was to identify absent or hypoplasia of the circle which are actually determinants of completeness of Circle of Willis.

Digital Subtraction Angiography (DSA) is a relatively new technique which integrates digital data collection and computer processing to produce a medical image. DSA is well accepted as the gold standard method to describe the anatomy of cerebral blood vessels. Other non-invasive methods like CT Angiogram and MR Angiogram are also available. But still, DSA remains even more sensitive in comparison to them⁷. The patients undergoing DSA for different clinical reasons were included for the study. Thus, most accurate information about the anatomy of CoW was obtained.

II. MATERIALS AND METHODS

This Cross-sectional Observational Study was conducted in Bangbandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh from March, 2015 to August, 2017. Proper ethical approval was taken from the Institutional Review Board. 42 adult patients were selected by purposive sampling method. Only those patients were

enrolled who were undergoing DSA for different clinical reasons after written informed consent to get the most accurate data about CoW. The results were expressed as means (\pm SD) for continuous variables and as percentages for categorical variables.

III. RESULTS

A total of 42 patients were enrolled. Among them, 15 (35.7%) patients were female and 27 (64.3%) were male. The mean age (\pm SD) of the study population was 50 (\pm 15.5) years with a range from 25 to 80 (Table I).

Age group (years)	Frequency (n)	Percentage (%)
≤ 40	15	35.7
41-50	5	11.9
51-60	9	21.4
61-70	12	28.6
≥ 71	1	2.4
Mean \pm SD (year)	50 \pm 15.5	
Range (min-max) in year	25-80	

Table I: Distribution of the study population by age groups (n=42)

Out of total 42 patients, a majority of 52.4% (22 patients) of them had Incomplete Circle of Willis and the rest 47.6% (20 patients) had it in Complete form.

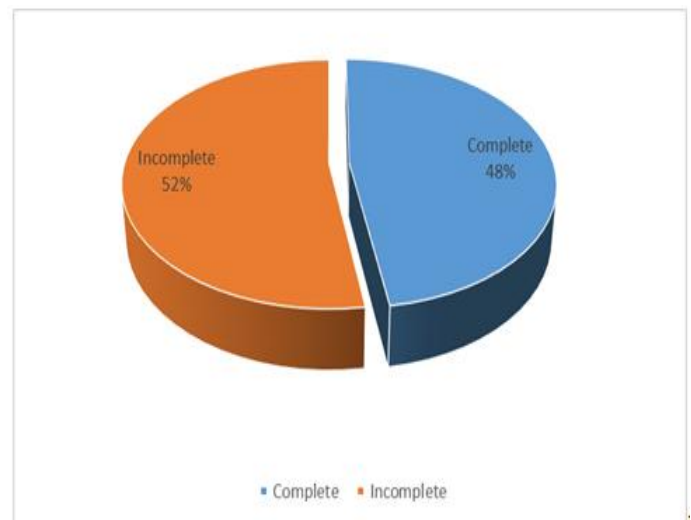


Figure 2: Distribution of study population by completeness of Circle of Willis (n=42)

Table II shows distribution of patients by absence of vessels in patients of Incomplete Circle of Willis. Among 22 patients who had Incomplete Circle of Willis, 2 patients had abnormality in two different vessels. The table shows most patients had absent Anterior Communicating Artery (40.90%) followed by A1 segment of ACA (31.82%).

Absence of vessel		Frequency (n)	Percentage (%)	
Anterior Communicating Artery		9	40.90	
A1 segment of ACA	Left	4	18.18	31.82
	Right	3	13.63	
	Both	0	0	
Posterior Communicating Artery	Left	4	18.18	27.23
	Right	0	0	
	Both	2	9.09	
P1 segment of PCA	Left	1	4.54	9.09
	Right	1	4.54	
	Both	0	0	

Table II: Distribution of patients by absence of vessels in patients of Incomplete Circle of Willis (n=22)

IV. DISCUSSION

This study was carried out with an aim to explore the configuration of the Circle of Willis among Bangladeshi population. The findings of this study were compared with the results of some other published articles elsewhere in the world.

A total of 42 patients were enrolled in this study. The mean (\pm SD) age of the study population was found to be 50 (\pm 15.5) years ranging from 25-80years. The most frequent age group was \leq 40 years representing 35.7% of total patients followed by 28.6% in 61-70 years group. Male:female ratio was 1.8:1

Circle of Willis was found to be incomplete in 52% patients and complete in the rest 48%. Among the persons with incomplete Circle of Willis, 40.90% had incomplete Anterior Communicating Artery (AComA) followed by incomplete A1 segment of Anterior Cerebral Artery (ACA) in 31.82% and Posterior Communicating Artery (PCA) in 27.23%. A similar study done in a similar population by Iqbal (2013) in Kerala, India showed the majority (52%) of the Circle of Willis were anomalous⁸. In another study in Pakistani population, Siddiqi et al. (2013) found the Circle of Willis was incomplete in 33.5% of individuals. In this study, the most common abnormality was in Posterior Communicating Artery followed by Anterior Communicating Artery whereas in this study, the most patients with incomplete Circle of Willis had absent Anterior Communicating Artery (40.90%) followed by A1 segment of ACA (31.82%)⁹.

V. CONCLUSION

Circle of Willis was found to be incomplete in majority of the patients (52.4%) while the commonest anomaly was absent Anterior Communicating Artery (40.90%) in Bangladeshi Adult population. Anomalies in Circle of Willis is very common in almost all the studies but the location of the anomalies varies.

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