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A detailed study of arterial variations in circle of Willis among migraine and non migrainous patients in Western Uttar Pradesh

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Abstract---Background: The human brain represents 2% of human body weight. It is supplied by two major arteries, paired internal carotid arteries and vertebral arteries. The arterial circle of Willis forms a polygonal anastomotic channel between two internal carotid artery and two vertebral arteries. The arterial circle is situated at the base of the brain in the interpeduncular fossa. Dr. Thomas Willis who first described the function of arterial anastomosis in 1966. Aim: To study the incidence of arterial variations in circle of willis among migraine patients of Western U.P. Methodology: Present study was conducted in the Department of Anatomy, Santosh Medical College Ghaziabad in collaboration with the Department of Radiodiagnosis, Rama Medical College & Hospital, Ghaziabad and from Dr. O.P Gupta Imaging Centre, Meerut. A total of 132 patients were scanned and 3D TOF sequence has been taken for MRA (BRAIN) examination.3D angiogram was reviewed for variation in brain. Results: The complete circle of Willis was absent among16.7% Migraine patients and 12.2%

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in non migrainous patients. The anterior communicating artery (A.com.) was absent in 26.7% migrainespatients and Anterior communicating artery were present in 73.3% in migrainous patients. In non migrainous patients A. com. was absent in 12.2% patients and present in 87.8% patients. Right posterior communicating (P.com) artery was absent in 1.3% migraine patients. There was 1.35% variation found in left posterior communicating artery in migraine patients. Conclusion: Study reveals that the circle of Willis of migraine patients is more incomplete than the non migrainous patients. The frequency of absence of A.com is more common in migraine patients.

Keywords---Magnetic resonance angiography (MRA), complete circle of Willis (COW), (3D-TOF) – 3D - time of flight, (A.com.) anterior communicating artery, P.com. (Posterior communicating artery), n = number of patients.

Introduction

The human brain represents 2% of human body weight the human brain represents 2% of body weight. It is supplied by two major arteries, paired internal carotid arteries and vertebral arteries[1]. The arterial circle of willis forms a polygonal anastomotic channel between two internal carotid artery and two vertebral arteries. The arterial circle is situated at the base of the brain in the interpeducular fossa [2]. Dr. Thomas Willis who first described the function of arterial anastomosis in 1966. The arterial circle of willis (also referred as "Circulus Arteriosus cerebrii) forms a polygonal anastomotic channel between two internal carotid artery and two vertebral arteries. The arterial circle is situated at the base of the brain in the interpeduncular fossa[3]. Based on recent anatomical [4,5,6] and radiological studies[7,8,9] it has been proved that normal variations in Circle of Willis are more common in healthy individuals. Knowledge of the presence of normal variants such as fenestrations, duplications, and persistent fetal arteries plays an important role in the diagnosis of arterial malformations and helps in surgical planning. The anatomical structure of Circle of Willis (COW), an important source of collateral blood flow in the brain, may contribute to the pathos mechanism of migraine[10,11]. Migraine is a common, illness whose mechanism of pathogenesis remains to be discovered. Studies have shown that migraines are associated with increased risk of both ischemic[12] and hemorrhagic stroke[13,] suggesting a potential vascular (Arterial) role in the etiology of this condition. The variation of circle of willis may be alert brain hemodynamics, resulting in various cerebrovascular diseases, the formation of cerebral aneurysm has correlation with morphology of circle of willis[4]. MRI angiography imaging is used to assessment of patient with hypertension, stroke and hemorrhage. MRA procedure may be done with contrast or without contrast medium (Gadolinium), this is a non-invasive technique.

Material and Methods

This cross-sectional study was conducted in the department of radiodiagnosis, Santosh Medical College & Hospital, Ghaziabad and Dr. O.P Gupta Imaging

Centre, Meerut. Non contrast-Magnetic resonance angiography imaging of brain. Before the examination of MRA Prior written consent was taken from all the patients who were going under the study. Angiography of brain Scanning protocol consisted of (3D TOF) 3- dimensional time of flight axial acquisition. MRI Angiography of brain was performed on GE 1.5 TESLA Optima MRI machine (figure.1). MRA Brain angiography images were viewed for normal pattern of arterial anatomy and their variation study from June 2019 to NOV 2021. This study included 132 patients after meeting the requirements of inclusion criteria. After getting approval from institutional ethics committee and written informed consent from the patients, all the patients scanning had done under 3D time of flight (TOF) MR angiograms. Out of 132 patients 58 was suffering from migraine and 74 were non migranious patients considered for the study. They were aged between 18 and 60 years. Below 18 and above 60 year patient were excluded in this study.

MRA (brain) protocol scan technique

A head surface coil was used for brain angiography. The Magnetic resonance angiography protocol consisted of non-contrast 3-dimensional time of flight trans axial acquisition which was used for examination of all patients with the following parameters-rectangular field of view (FOV) 200 -220 mm, matrix size 520 -560 with slice thickness of 0.6 -8 mm and 150 partitions with the total imaged volume (effective slab thickness) 70-75 mm. Time Reptation – 22-25/Time Echo -6.50ms. For best resolution in imaging, slice thickness was used using matrix size 192 x 256. (MIP).

Figure 1. MRIMachine1.5 TESLA GE Optima

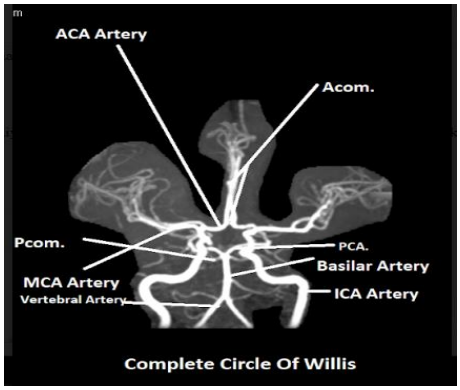

Figure 2. MRA Images of complete circle of Willis

(ICA- Internal Carotid Artery), (ACA- Anterior Cerebral Artery), (PCA -Posterior Cerebral artery), (MCA- Middle Cerebral Artery), (A.com. -Anterior Communicating Artery), (P.com. - Posterior Communicating Artery)

Result

In this study we have studied angiographic findings of circle of willis in 132 patients, out of which 58 were migraine patients and 74 were non migrainous patients. The variations of circle of Willis in migraine patients was detected in 19 (32.8%) cases and normal classical pattern in circle of Willis in migraine patients were found in 39 (67.2%). In non migrainous patient variation in circle of Willis was detected 24.3% (35) and complete circle of Willis found in 75.7% non-migraines patient. Incomplete circle of Willis was found to be higher in migrainous patients in comparison to non migrainous patients. The Anterior part (Anterior communicating artery) of circle of Willis were absent 26.7% (n=16) in migraine patients (total 58 (100%) while it is present in 73.3% (n=42) patients). In non migrainous patients n=74 (100%) the A.com was absent in 12.2% (n=9) patients where as it was present in 87.8% (n=65). Posterior part of circle of Willis, right communicating artery was absent in 1.3% migraine patients. There was 1.35% variation found in left posterior communicating artery in migraine patients. Anterior communicating artery is the parameter that is the commonest variant parameter noted in this study. Significant difference was noted with regard to Non migranious and migraine patient. Table 1,2 & 3 shows the percentage of variations in migraine and Non migranious patients.

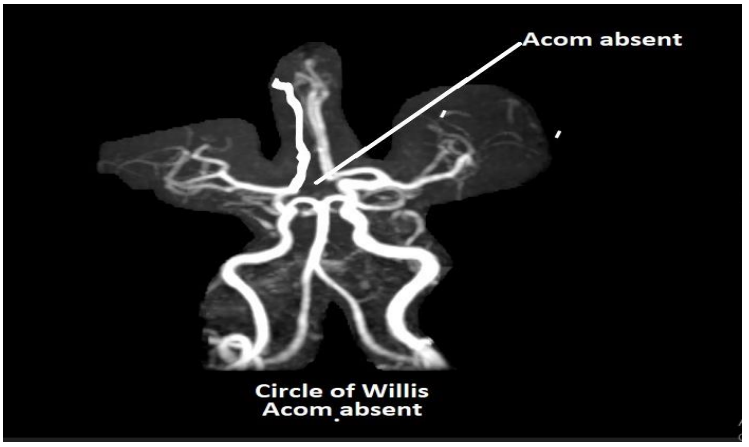

Figure 3. Incomplete Circle of Willis (Absent Anterior communicating artery in migraine patient)

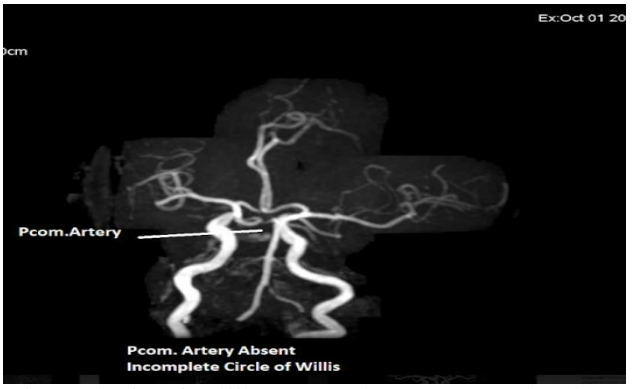

Figure 4. Incomplete Circle of Willis (Posterior Communicating artery absent in migraine patient)

Table 1
Mean and standard Deviation

NO. OF PATIENTS	132
MEAN	12.37
STD. DEVIATION	4.223

Table 2
Frequency of Circle of Willis in Non migranious and migraine patients

CIRCLE OF WILLIS			
	COMPLETE	INCOMPLETE	TOTAL
Migraine Patient	39 (62.2%)	19(32.8)	58(100%)
Non-Migranious Patient	39 (75.7%)	35(24.3%)	74 (100%)

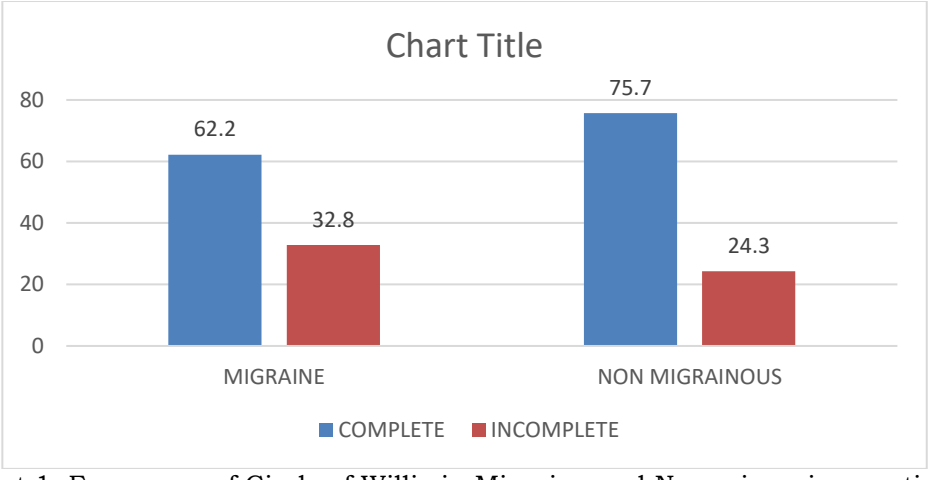

Chart 1. Frequency of Circle of Willis in Migraine and Non migranious patients

Table 3
Frequency of present and absent of anterior communicating artery

A.COM			
	ABSENT	PRESENT	TOTAL
MIGRAINE PATIENT	16(26.7)	42(73.3%)	58 (100%)
NON MIGRANIOUS	9(12.2%)	65(87.8%)	74(100%)

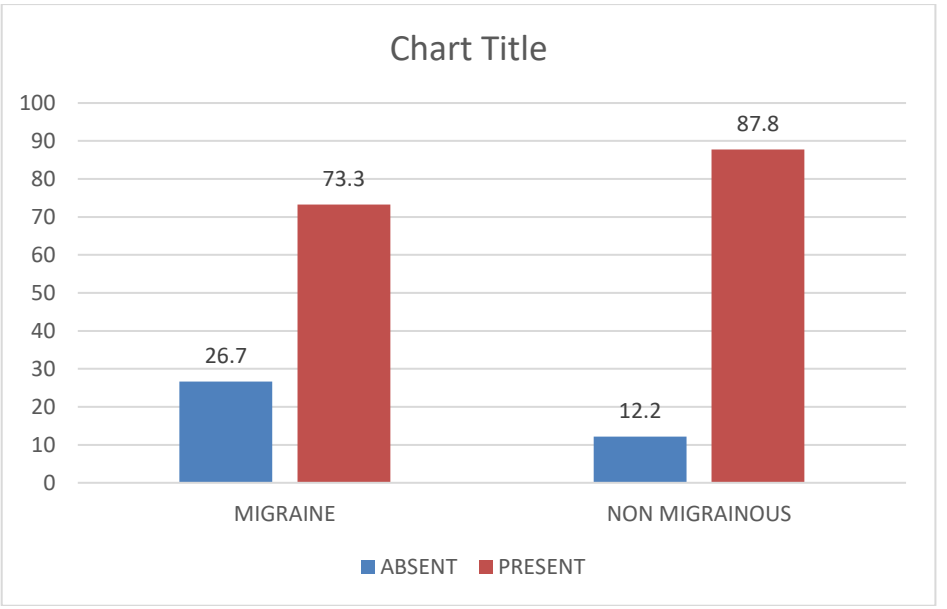

Chart 1. Frequency of Circle of Willis in Migraine and Non migranious patients

The data is evaluated by software SPSS**,** chi square test was applied and the value of Pearson's correlation coefficient was found 0.003. The test shows that the value of correlation coefficient is significant.

Discussion

In this study the variations in the COW are more incomplete in migraine patients. Incomplete anterior part of circle of Willis was found to be associated with migraine. While Posterior part of circle of Willis less absent compare to anterior part of circle of Willis. This may not be surprising, as many of the brain regions suspected to be involved in the pathogenesis of migraine, might be more likely to be affected by changes in Anterior and posterior circulation of brain. An incomplete posterior circle was also more common in Migraine patient, supporting the hypothesis proposed by Cucchiara[10] that it may contribute to the cortical spreading depression common in these patients, although the role that such variations may play in the pathogenesis of migraine requires further study.

These anatomical variations in the vasculature of the brain may account for the reported increased risk of both ischemic[12] and hemorrhagic[13] stroke in migraineurs. In our study, we have evaluated all studies available in the present literature, in addition we studies a control group. The data was analyzed. In the

study by Ezzatian[14] only Migraine was studied and findings are suggestive of no significant differences in the prevalence of anatomical variations in patients versus controls. Cavestro[15] used similar criteria to the above-mentioned studies also included a slightly broader definition of variations, including variations such as displacement of the vessels, leading to potential over-counting of relevant anatomical variations.

Bugnicourt[16] did not consider vessel diameter as a factor in determining the presence of a complete or incomplete COW, counting only the presence or absence of a vessel. In our study the variations of circle of Willis in migraine patients was detected more in compare to non migrainous patients. While anterior part of the circle of Willis is more significant in migraine patients. Anterior communicating artery was more absent in migraine patient then the non migrainous patients. 19 (32.8%) cases and normal classical pattern in circle of Willis in migraine patients were found in 39 (67.2%). In non-migraines patient variation in circle of Willis was deducted 24.3% (35) and complete circle of Willis found in 75.7% non-migraines patient. Incomplete circle of Willis higher in migraine patients compare with the non migranious. Cucchiara et al[10] reported that variations were less common in women, for both migraineurs and healthy controls, while Klimek-Piotrowska et al[17] found variations in the general population to be more common in women than in men. In this study Posterior part of circle of Willis, right posterior communicating artery was less absent in migraine patients. Left posterior communicating artery was also less absent in migraine patients. In comparison of posterior communicating artery (Right and left) in migraine and normal patients was approximately or slightly higher in migraine patients. Result of this study was undercounting of variations as compared to other studies. We considered these differences in the definition of variations to be minimal, and an incomplete circle was defined as any changes potentially affecting cerebral hemodynamics Bugnicourt**[16]**. Our study is in favor of Henry B M[18].

Conclusion

The present study has shown that anatomical variants of the circle of Willis through MRI angiography in migraine patients are a frequent finding among the Western U.P. Population. This Study reveals that the circle of Willis of migraine patients is more incomplete than the non migranious patients. The association of migraine with Anterior communicating artery (anterior part of circle of Willis) was significant in this study. Those patients whose suffering from migraine (A. com is more absent patients) in compare to non migranious patients. While posterior communicating were also more absent in migraine patients. The associations of migraines patients have higher risk of stroke. This study suggests that migraine patients have a higher rate of anatomical variations in the COW. Knowledge of Variation of circle of Willis in migraine patients is very helpful for neuro-physician for treatment. While most important for neurosurgeons for planning and performing the open neurosurgery and laparoscopic neuro surgery.

Conflicts of Interests: None

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