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MRA EVALUATION OF CIRCLE OF WILLIS : A MORPHOLOGIC STUDY IN POPULATION OF WESTERN UTTAR PRADESH.

Anatomy

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ABSTRACT

Introduction : The circle of Willis is a polygonal structure of blood vessels present at the base of brain which distributes oxygen-rich arterial blood to the cerebral mass. A complete circle of willis not only important for vascularisation , it also plays crucial role in the outcome of neurosurgeries as well. **Material and Method :** 400 patients were retrospectively evaluated, MR examination was performed with 1.5 T MR machine (GE OPTIMA). **Result:** 400 MRA were reviewed and in 42 cases (10.5%) normal pattern of circle of Willis was observed.**Conclusion:** Analysis and establishing the pattern of circle of Willis is one of the most important prerequisites of various diagnostic & therapeutic neurovascular procedures.

KEYWORDS

MRA, complete Circle of willis, neurovascular procedures .

INTRODUCTION :

The circle of Willis is a polygonal structure of blood vessels present at the base of brain which distributes oxygen-rich arterial blood to the cerebral mass (1), also referred as "Circulus Arteriosus cerebri" (fig 1.1). The pattern of arterial arrangement & communication forms a unique arterial network connecting the principle arteries supplying the brain (2).The circle of Willis and its branches are subjected to numerous variations. The variations not only differ from person to person but also on the two sides of the same individual. Various dissection and angiographic studies by several workers have shown that variations occur in a very high proportion of cases. Inspite of numerous studies conducted over several decades in several countries employing various methods across different geographical and racial background, there is no clarity as to how and why the variations occur. Different studies have quoted different facts and figures which have led to a spectrum of findings. A complete circle of willis not only important for vascularisation , it also plays crucial role in the outcome of neurosurgeries as well.

MATERIAL AND METHOD :

400 patients were retrospectively evaluated who were considered as healthy subjects with regard to the anatomy of the circle of Willis.. All patients were examined with 3D TOF MR angiography. MR angiography has a high sensitivity and specificity for depicting the anatomy of the circle of Willis. Vessels with a diameter of at least 1 mm on the source image are almost always present and patent. MR examination was performed with 1.5 T MR machine (GE OPTIMA). The MR angiography examination was performed with standard head coil. The MR angiography protocol consisted of non-contrast 3DTOF transaxial acquisition which was used for examination of all patients with the following parameters (Table 1.1):

Table 1.1 Parameters of 3D TOF MR angiography	
3DTOF	
TR	30-40 msc
TE	6-10 msc
FA	20-25mm
Slice thickness	0.8mm
Number of partitions	96

RESULT :

In the present study, 400 MRA were reviewed and in 42 cases (10.5%) normal pattern of circle of Willis was observed (fig 1.2.1) (fig 1.2.2) . Incidence of normal pattern reported by various authors has been tabulated in Table 1.2. Complete circle of willis was present in (24/400) 6% females and (18/400) 4.5% males .

DISCUSSION :

The findings of present study are approximately similar to that of Blackburn (5), Puchades et al. (12) and Qui et al (30) with repect to normal pattern of circle of Willis. The lowest incidence (7.89%) has been reported by Parthapratim et al (8). Hina et al (28) has reported the highest ever (72.5%). Cerebral arteries structurally differ from the other systemic arteries; have scarce elastin fibers in medial layer and thin adventitia, lack external elastic lamina (between medial layer and adventitia), and have well-developed internal elastic lamina instead (between intimal and medial layer) (31).Smooth muscle fibers of the cerebral arteries are arranged circularly, perpendicularly oriented to the blood flow, while other systemic arteries have smooth muscle fibers arranged spirally around the long axis of the artery. Perpendicular orientation of smooth muscles may be an adaptation to the high wall tension present in cerebral arteries, where such structural property might have a preventive role against the arterial wall bursting. The association between anomalies of circle of Willis and cerebral aneurysms has been well documented (32).

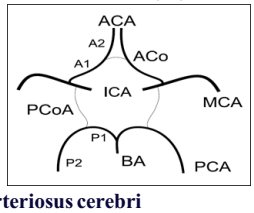

Fig 1.1 Circulus Arteriosus cerebri

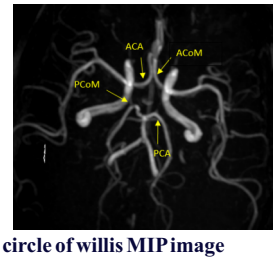

Fig 1.2 Complete circle of willis MIP image

Table 1.2: Incidence Of Complete Circle Of Willis In Different Studies.

S NO	AUTHOR	PERCENTAGE (%)
1.	Windle et al (1888) [130]	38%
2.	Fawcett and blachford (1905)[66]	19 - 96.1%
3.	Blackburn (1907) [40]	9 - 29.5%
4.	Van mitterwallner et al (1955) [131]	27.2%
5.	Alpers et al. (1959) [7]	25 - 52.3%
6.	Riggs (1963)[10]	28 - 19%
7.	Fischer et al (1965) [132]	30%
8.	Vare A M and Bansal P C (1970)[77]	29 - 26.86%
9.	Raja Reddy et al. (1972)[78]	34 - 53.3%
10.	Puchades et al (1975) [129]	13%
11.	N Jayasree and G Sadasivan (1981)[81]	18%
12.	Kamath S (1981)[82]	38 - 56%
13.	P N Jain and V Kumar (1990)[88]	45 - 19.45%

14.	Stephen and John (1991)[90]	47 - 52%
15.	Macchi et al. (1996)[9]	50 - 41%
16.	Hartkamp et al. (1998)[98]	52 - 42%
17.	Hussain et al (2001) [96]	20%
18.	Chen et al (2004) [133]	21%
19.	Kapoor et al (2008) [12]	20.4%
20.	Parthapratim et al (2009)[105]	7.89%
21.	Haripriya et al 2010[134]	32%
22.	Maaly et al (2011) [111]	46.7%
23.	Li Q et al (2011)[135]	27%
24.	Raghvendra k (2012) [136]	55%
25.	Hashemi et al (2013)[120]	34.5%
26.	Hina et al (2013) [121]	72.5%
27.	Saika et al (2014)[137]	22.1%
28.	Qiu et al (2015)[138]	12.24%
29.	Present study	10.5%

CONCLUSION

Cerebral circulation is exposed to cardiac-generated pulsatility ,:arterial pressure pulsation and flow pulsation. These circulation components input energy into the skull which has to be dissipated to protect microcirculation and BBB from damage. Analysis and establishing the pattern of circle of Willis is one of the most important prerequisites of various diagnostic & therapeutic neurovascular procedures .This finding is of potential significance for neurologists and neurosurgeons since it may manifest as higher incidence in disorders like migraine, schizophrenia and cerebrovascular disorders due to compromised collateral circulation and poor shunt capability. Variations in configuration of circle of Willis can remain asymptomatic or present with symptoms like sudden onset of headache, blurring of vision and transient ischemic attacks. It may also predispose to cerebral ischemia in young adults (33).

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