Original Research Paper

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CT ANGIOGRAPHIC ANALYSIS OF CIRCLE OF WILLIS AND ITS VARIANTS

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ABSTRACT **Aim and Methods:** The objective of this study was to assess the role of CT Angiography in the evaluation of Circle of Willis (CoW) and its anatomical variants and to determine their relation with associated vascular pathologies. **Background:** The Circle of Willis is a crucial arterial polygon at the base of the brain that bridges the carotid and vertebra-basilar systems. Anatomical variations in the Circle of Willis are common and most of them are incidentally discovered during imaging. Multi Detector CT Angiography is an excellent tool which offers in depth analysis on the anatomy of the Circle of Willis and its variants. **Results:** The predominant type of variation observed was hypoplastic vessel (40%) of which PCom (27%) was the most common vessel involved. 15% of the subjects exhibited findings of aneurysm with ACom being the most frequent site. No remarkable association was revealed between Circle of Willis configuration and the occurrence of aneurysms/AVMs in the current study. **Conclusion:** In our study we found no concrete association between CoW configuration and the incidence of aneurysms/AVMs. Incomplete or balanced variants were predominant over classical CoW. CT Angiography is an excellent tool for the analysis of CoW. An in depth understanding of its variants can help radiologist in executing thorough and complete reports to aid clinicians and interventional radiologists.

KEYWORDS : Willis, circle, angiography, vascular

INTRODUCTION

The Circle of Willis, named after the famous English physician Thomas Willis (1621-1675), is a crucial arterial anastomotic polygon at the base of the brain that bridges the carotid and vertebro-basilar systems. The ring shaped arrangement of the vessels acts as a contingency by redistributing blood in the event of compromised arterial flow. This collateral capability of the CoW provides for a surplus blood supply to the brain. Structurally, the CoW consists of bilateral Internal Carotid Arteries (ICA) in conjunction with the Posterior Communicating Arteries (PCom) of either side, symmetrical proximal Posterior Cerebral Arteries (PCA) the proximal portion of bilateral Anterior Cerebral Arteries (ACA), and the Anterior Communicating Artery(ACom). The Middle Cerebral Arteries (MCA) are not direct contributions of the circle. Anatomical variations in the Circle of Willis are common, majority of which are incidentally discovered during routine imaging. The variants include - absent or hypoplastic vessels, accessory vessels, persistent primitive vessels, and anomalous origins.

Aims and Methods

Our aim was to assess the role of CT Angiography in the evaluation of Circle of Willis and its anatomical variants and to determine their relation with associated vascular pathologies.

This hospital based cross sectional study was carried out over 4 months duration from May 2023 to August 2023. The sample included 25 patients aged between 19-80 years, irrespective of gender, who were referred to our Radiology department for cerebral angiography. Pregnant women and patients below 18 years of age were excluded from the study.

Image acquisition was done using GE Revolution 32 Serial Slice CT scanner. Non- enhanced scans were acquired initially to demonstrate haemorrhage or calcification. 80 - 100 ml of Low Osmolar Contrast Medium (LOCM) was administered via pressure injector at a rate of 5ml /sec through an antecubital vein cannula with 20 seconds delay time. All the vessels imaged were assessed for normal formation and calibre. The Circle of Willis was evaluated for absent/hypoplastic vessels, accessory vessels, attenuation, duplication/triplication, abnormal origin, and persistent fetal origin, in concordance with the morphological classification proposed by Arsany Hakim et al.. Additionally, the association of these variants with vascular pathologies like aneurysms was also assessed.

Images from the Study

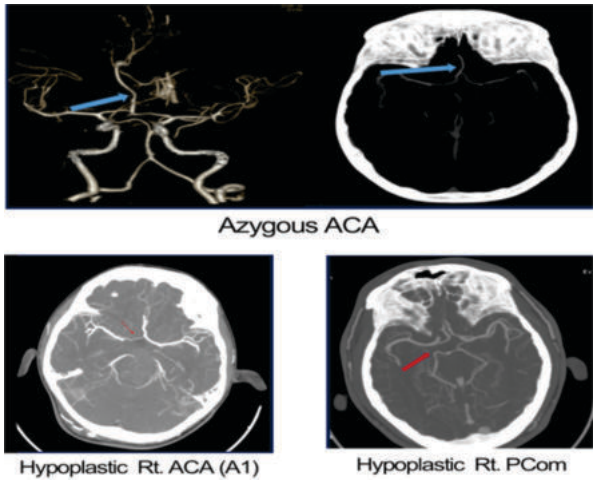

Figure 1. MPR and MIP CT Angio showing Azygous ACA (top). CT Angio showing Hypoplastic Rt.A1 and Rt.PCom (bottom)

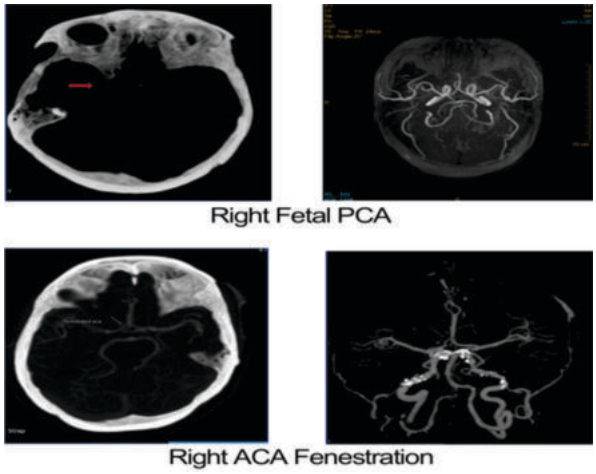

Figure 2. Angiographic images showing Right Fetal PCA (top) and Right ACA fenestration (bottom).

Results and Inference

In our study we observed some form of variation of Circle of Willis in more than half of the cases. The predominant type of variation observed was hypoplastic vessel (40%), of which PCom (27%) was the most common vessel involved followed by A1 segment of ACA (13%). Unilateral hypoplasia was noted to be more frequent than bilateral. Fetal origin of PCA was observed in 16% of the cases. From the study sample, 15% of subjects exhibited findings of aneurysm with ACom being the most frequent site of involvement. Our study also had two cases of fenestrated ACA and one case of Azygous ACA. One case of infundibular origin of PCom was also noted. No remarkable association was revealed between Circle of Willis configuration and the occurrence of aneurysms/AVMs in the current study.

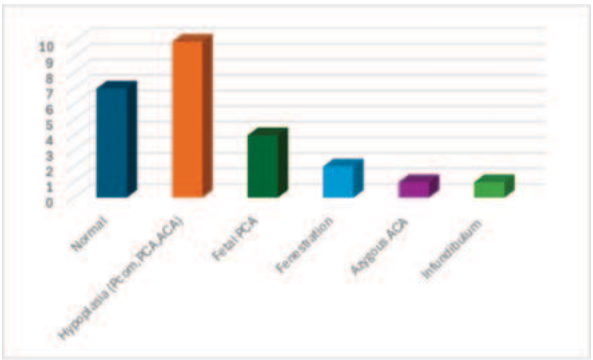

Figure 3. Frequency of Circle of Willis variants.

CONCLUSION

This study followed the morphological criteria proposed by Arsany Hakim et al. for cerebral arterial variants which included, variation in vessel origin (common origin, infundibulum, anomalous origin due to persistent embryological circulation), variation in the number of vessels (increased or decreased number of vessels), variation in morphology (hypoplasia, hyperplasia, early bifurcation, Fenestration) and variation in the pathway (persistent carotid- vertebrobasilar and internal - external carotid anastomoses).

The Circle of Willis is considered complete when no component is hypoplastic or absent. In our analysis, variations in morphology were customary, present in more than half the volunteers with hypoplastic vessels being the most predominant encounter. This study in its current form showed no concrete association between CoW configuration and the incidence of aneurysms/AVMs, but an alternative outcome in a large scale study cannot be ruled out.

Most of the variations in CoW can be identified using CT Angiography. This study aims to further our understanding of cerebral angiographic anatomy and associated pathologies which hopefully will help radiologists in executing thorough and complete reports to aid clinicians and interventional radiologists.

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