

Variation in Anterior Cerebral Circulation - A Prospective CT Angiographic Study.

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ABSTRACT

Background: Though variations of the Circle of Willis (CW) is quite common. not much CT angiographic study has been done to identify the anatomic anomalies. Variations of anterior cerebral artery, one of the small terminal branch of internal carotid artery, can be an incidental finding during routine radiological investigation or can be presented with aneurysm formation, ischemic or hemorrhagic manifestation. **Methods:** We have conducted a prospective study with retrospective analysis on all CT angiograms of the circle of Willis in 350 cases presented with symptoms of TIA or ischemic cerebral stroke using 128 slice MDCT. **Results:** We found Classical type of CW in 285 cases (81.42%) and variation in anterior cerebral circulation in 65 patients (18.57%). Among the variations we observed hypoplasia of A1 segment in 37 cases (10.5%), aplasia of A1 segment in 24 cases (6.8%), triple A2 segment in one case (0.2%), azygous artery in one case (0.2%) and fenestration in 2 cases (0.5%). Among 37 cases of hypoplasia of A1 segment 21(6%) cases have right sided hypoplasia and 16(4.5%) cases have left sided hypoplasia. Among 24 cases of aplasia of A1 segment 16 (4.5%) have right sided aplasia and 8 (2.2%) have left sided aplasia. Azygous variant of ACA was seen in one (0.2%) case & Fenestrations observed in 2 (0.5%) cases. **Conclusions:** Most of our results are in accordance with previous studies.

Keywords: Aplasia , Circle of Willis , Fenestration , Hypoplasia.

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INTRODUCTION

The anastomotic arterial circle "Circle of Willis" present in the interpenduncular cistern consisting of anterior circulation derived from internal carotid artery and posterior circulation derived from vertebral artery are connected by posterior communicating artery. Anterior circulation consists of internal carotid arteries, anterior cerebral arteries (ACA) and anterior communicating artery (ACoA) whereas posterior circulation consists of vertebral arteries, basilar artery (BA) and Posterior cerebral arteries (PCA).^[1]

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The anterior cerebral artery is major vessels responsible for the blood supply of the interhemispheric region. A1 is the segment of anterior cerebral artery from internal carotid to anterior communicating artery. A2 is the segment of anterior cerebral artery after anterior communicating artery. Cerebral artery occlusion leads to infarction in brain tissue.^[2] The occlusion is caused by stenosis, embolism or rupture of arteries. Intracranial aneurysms, more common in anterior circulation, are

the major cause of spontaneous subarachnoid hemorrhage.^[3]

MATERIALS & METHODS

We have done a prospective study with retrospective analysis on all CT angiograms of the circle of Willis (350 cases) obtained between 01.01. 2015 to 31. 12. 2015, on patients presented with symptoms of TIA or ischemic cerebral stroke at the Ashwini Hospital a neuroscience centre, Cuttack, Odisha, India. All images were obtained with CT angiogram by 128 slice MDCT. Illegible angiographies due to technical reasons had not been taken into account for statistical analysis. The examination of CT angiogram was performed by experienced radiologists. The formation and branches of Circle of Willis (CW) were examined. The anterior portion of CW, A1 and A2 segments of ACA, their anatomical variations and their association with other anomalies were examined. The presence of hypoplasia and aplasia of A1, impaired A2 (azygos variant), triple A2 (median artery of corpus callosum), fenestrations and bihemispheric ACA were evaluated.

RESULTS

In the present study we have studied randomly the angiographic finding of anterior cerebral circulation in 350 cases of which 180 were males and 170 were females. Among the cases studied anatomical variation in anterior cerebral circulation was detected in 64 patients (18.3%) and normal classical pattern in rest 286 cases (81.7%). [Table 2]

In the present study we found hypoplasia of A1 segment [Figure 5] in 37 cases (10.5%), aplasia of A1 segment [Figure 1] in 24 cases (6.8%), triple A2 segment [Figure 4] in one case (0.2%), azygous artery [Figure 3] in one (0.2%) and fenestration [Figure 2] in 2 cases (0.5%). Among 37 cases of hypoplasia of A1 segment 21(6%) cases have right sided hypoplasia and 16(4.5%) cases have left sided hypoplasia. Among 24 cases of aplasia of A1 segment 16 (4.5%) have right sided aplasia and 8 (2.2%) have left sided aplasia. Azygous variant of ACA [Figure 3] was seen in one (0.2%) case & Fenestrations observed in 2 (0.5%) cases.



Figure 1: Aplasia of A1 segment right ACA.

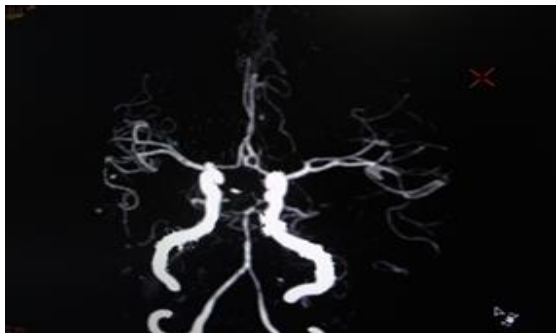


Figure 2: Fenestration of left ACA.

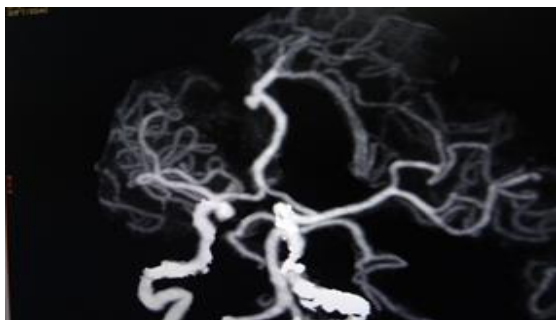


Figure 3: Single a2 (azygous) with aneurysm.

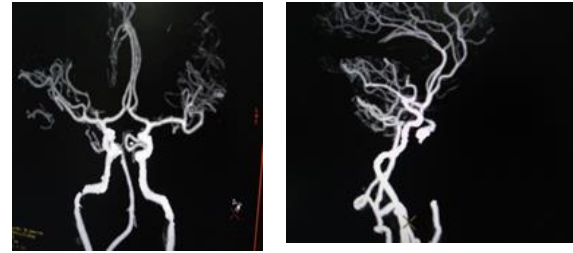


Figure 4: Triple A2.

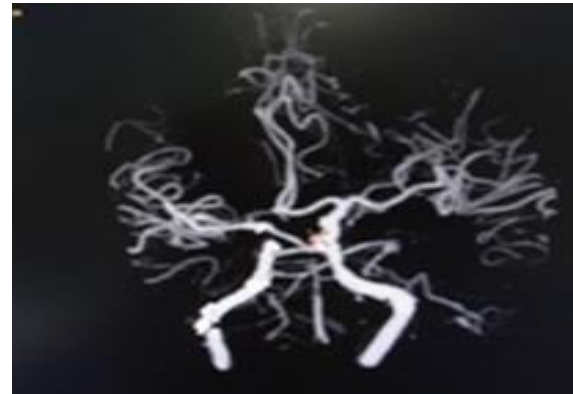


Figure 5: Hypoplasia of A1 segment of right ACA.

Table 1: Distribution of cases of variation of anterior circulation.

No of cases studied	n = 350
Hypoplasia of A1 segment	37 (10.5%)
Aplasia of A1 segment	24 (6.8%)
Azygous artery	1 (0.2%)
Fenestration	2 (0.5%)
Triple A2 segment	1 (0.2%)

Table 2: Incidence of variation of anterior circulation.

Total number of study group	n = 350
Presence of variation	65 (18.57%)
Normal angiography	285 (81.42%)

Table 3: Distribution of aplasia of A1 segment.

Aplasia of A1 segment	n = 24
Left side	8(30%)
Right side	16 (70%)

Table 4: Distribution of hypoplasia of A1 segment.

Hypoplasia of A1 segment	n = 37
Right side	21(56.7%)
Right side	21(56.7%)

DISCUSSION

Anatomical variations of the origin and distribution of branches of Circle of Willis in the interpeduncular at the base of brain are very common incidental finding on CT angiographic studies and are usually asymptomatic due to the presence of collateral circulation but their recognition is important for surgical and endovascular treatment planning. Though most of

them are clinically insignificant, some may predispose the patient to development of aneurysms or ischemic events.

In this study we found variation of anterior circulation in 65 cases (18.57%) and normal classical pattern of circle of willis in 285 cases (81.42 %) which is in accordance with Nodon DG et

al who have also observed variation in anterior circulation in 22.2% of cases.^[5] Gunnal S. A. et al in his study on anatomical Variations of the Circulus Arteriosus in cadaveric human brains has observed normal and Complete Circulus Arteriosus without any gross variation in 60% of cases.^[13]

Table 5: Variations.

Variation	Number and percentage (n=350)	Mean age in yr	Male	Female	Right side	Right side		Left side	Left side	
						Male	Female		Male	Female
Normal classic Circle of Willis	285 (81.42 %)	54.6	122	164	----	----	----	----	----	----
Hypoplasia of A1 segment	37 (10.5%)	60.1	13	24	21 (6%)	10 (2.8%)	11 (3.1%)	16 (4.5%)	3 (0.8%)	13 (8.6%)
Aplasia of A1 segment	24 (6.8%)	60.8	14	10	16 (4.5%)	9 (2.5%)	7 (2%)	8 (2.2%)	5 (1.4%)	3 (0.8%)
Azygous artery	1 (0.2%)	52.4	1	0	----	----	----	----	----	----
Fenestration	2 (0.5%)	48.7	1	1	1 (0.25%)	1 (0.25%)	----	1 (0.25%)	----	1 (0.25%)
Triple A2 segment	1 (0.2%)	54.2	1		-----	-----	-----	-----	-----	-----

Hypoplasia of A1 segment is the most common type of variation of anterior circulation observed in this study. It is seen in 37 cases (10.5%). Similar to our study Perlmutter D et al in his Microsurgical Anatomical study of the distal anterior cerebral artery observed hypoplastic A1 segment in 10% of cases.^[10] Similarly, Dimmick SJ et al in his multidetector CT angiographic study on normal variants of the cerebral circulation has also found hypoplasia of A1 segment in 10% of cases.^[6] In contrast to our study, Aleksandar Ješić et al has observed hypoplastic A1 segment in 2% of cases,^[6] Stefani MA et al has observed in 36% of cases.^[11] While Uchino A et al in his MR angiographic study on Anterior cerebral artery variations have demonstrated hypoplasia of A1 segment in 3% of cases,^[8] and Gunnal S. A. et al found hypoplasia of A1 segment in 5.33% of cases.^[13] We found hypoplasia of A1 segment is more common on right side 21(56.7%) than left side 16(43.2%). Similarly Aleksandar Ješić et al has observed hypoplastic A1 segment more common on right side (62.5%).^[2] In this study we found aplasia of A1 segment.in 24 cases (6.8%). In accordance with our study Uchino A et al have found unilateral A1 segment aplasia in 5.6% of cases in their MR angiographic study on Anterior cerebral artery variations^[8] and Krabbe-Hartkamp MJ et al have observed aplasia of A1 segment in 6.7% of cases in their morphologic study in variation on three-dimensional time-of-flight MR angiograms.^[12] In contrast to our study, Aleksandar Ješić et al has found aplasia of A1 segment.in 2.9% of cases,^[2] Dimmick SJ et al have found aplasia of A1 segment.in 1-2% of cases.^[6] We found aplasia of A1 segment is more common on right side 16(70%) than left side 8(30%). Similar to our study

Aleksandar Ješić et al has also observed aplastic A1 segment more common on right side (58%).^[2]

We found Azygous artery in one case (0.2%). Similar to our study Nodon DG et al has observed azygos anterior cerebral artery in 0.3% of study group.^[5] In contrast to our study Aleksandar Ješić et al has observed azygos variant in 2.8% of cases.^[2] Auguste KI has observed its prevalence to be around 0.3–2% on the basis of post-mortem and angiography studies.^[7]

We observed fenestration in 2 cases (0.5%). In accordance with our study Aleksandar Ješić et al has observed fenestration of A1 segment in 0.5% of cases.^[2] The prevalence of fenestration in A1 region is 0–4% as described in anatomical studies, 0.058% as described in angiographic studies,^[6,9] and 0.8%,^[9] 1.2% in MR vascular sequences. A2 fenestration was found in 2% of fetal post-mortem examinations.^[6,8]

In this study we observed triple A2 segment in one case (0.2%). Similar to our study E.Niederberger et al has observed triple or accessory ACA with a frequency 0.2-13%.^[12]

CONCLUSION

In this study we found classic variant of Circle of Willis in 81.71 % of the general population, which is in line with other previous studies. Hypoplastic A1segment found in around 10.5% of cases was more common on right side & in female patients. Aplasia of A1 segment seen in 6.8% of cases was more common on right side & in male patients. Azygos variant of ACA has been reported in 0.2% of cases & fenestration in anterior circulation was observed in 0.5% of cases. Variations of anterior

cerebral circulation may be asymptomatic and may not produce complications, although some of them increase the risk of aneurysm formation and acute intracranial hemorrhages, play an important role in planning of neurosurgical procedures or may be mistaken for serious pathologies.

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