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Original Article

Radiology Section

Influence of Foetal Origin of Posterior Cerebral Artery on Ischaemic Stroke

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ABSTRACT

Introduction: Foetal origin of posterior cerebral artery is one among the common variants in the circle of willis. In case of cerebral injury due to thromboembolic stroke, the presence of foetal type of PCA may modify its severity and the territory involved. The purpose of this study is to review and to evaluate the potential clinical significance of foetal type PCA in ischaemic stroke.

Aim: To analyse whether foetal PCA and its types are associated with ischaemic stroke.

Materials and Methods: This is an analytical cross-sectional study conducted from January 2019 to January 2020 to assess the PCA in the 174 patients referred to Magnetic Resonance Imaging (MRI) Brain and diagnosed as ischaemic stroke. Data was entered using Excel sheet and analysed using R v.3. 5.1. Descriptive analysis was performed followed by bivariate analysis.

Results: There is no statistically significant relationship between the presence of foetal PCA and ischaemic stroke and the p-value is 0.936.

Conclusion: There is no significant association of presence or absence of partial or complete type of foetal PCA with ischaemic stroke. No significant association was also found between the presence of foetal PCA and vascular territory of infarct and laterality of ischaemic stroke.

Keywords: Anatomical variants, Circle of willis, Infarct, Magnetic resonance imaging

INTRODUCTION

The circle of willis has many variants, one of the common variants being foetal origin of the Posterior Cerebral Artery (PCA) from the Internal Carotid Artery (ICA) [1]. Angiographic studies reveal that 11-46% of adults will have foetal type of PCA either unilaterally or bilaterally [2]. Foetal type PCA is defined as a PCA that originates from the ICA with or without a small connection with the Basilar Artery (BA). In this condition, instead of the BA, the ICA supplies blood to the PCA [3]. Collateral circulation in the brain is important for maintaining a sufficient cerebral blood flow in case of ischaemic stroke [1].

In case of cerebral injury due to thromboembolic stroke, the presence of foetal type of PCA may modify its severity and the territory involved [3].

MATERIALS AND METHODS

The present analytical cross-sectional study was conducted at Sri Manakula Vinayagar Medical College and Hospital, Puducherry, which is a multidisciplinary, 900 bedded hospital with fully equipped Radiodiagnosis Department. The study was conducted during the period of January 2019 to January 2020, to assess the posterior cerebral arteries in the 174 patients referred to MRI Brain. The inclusion criteria used in this study were those patients with diagnosis of ischaemic stroke on MRI. Patients with history of head trauma, cerebral surgery, vascular malformations, vasculitis and bilateral foetal PCA were excluded. The MRI images were acquired in the axial, coronal and sagittal planes using 1.5 Tesla PHILIPS whole body MR systems with standard imaging head coil with standard stroke protocol. Magnetic Resonance Angiography (MRA) was also done to assess the presence and type of foetal PCA. The primary outcome of this study was to evaluate the potential clinical significance of foetal type PCA in ischaemic stroke by comparing with normal type PCA.

STATISTICAL ANALYSIS

Data was entered using Excel and analysed using R v.3. 5.1. Descriptive analysis was performed followed by bivariate analysis. The p-value was calculated using single proportion test, Chi-square test or Fisher-exact test as appropriate. The p-value less than 0.05 was considered statistically significant.

RESULTS

Among the 174 cases studied, 32 (18.4%) patients were below 40 years of age, 74 (42.5 %) patients were above the age of 60 years and 68 (39.1 %) patients were between the age of 41 to 60. Of the 174 MRI studies reviewed, it was found that 68 (39.1%) patients were having foetal PCA compared to the remaining 106 (60.9%) who had normal posterior circulation. In this study, male patients were more (66.7%) when compared to female patients. Among the 116 males, 48 (41.3%) were found to have foetal PCA and among 58 females, 20 (34.4%) were found to have foetal PCA. Among the patients with foetal PCA, 38 (55.9%) patients had partial type of foetal PCA and 30 (44%) patients had complete type of foetal PCA.

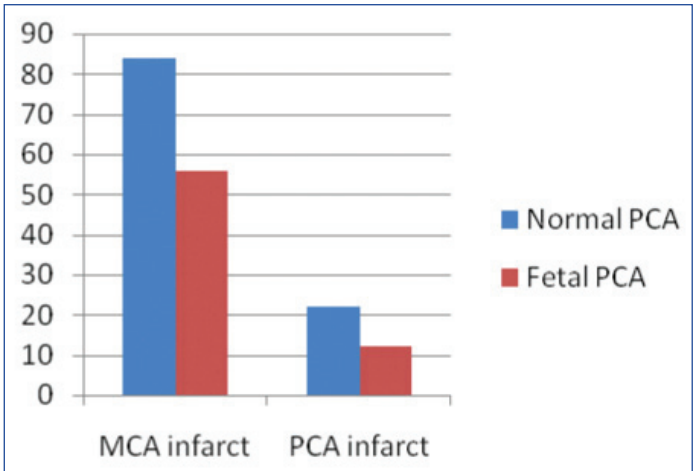
In this study, when comparing the side of foetal type of PCA, the right side foetal PCA is seen in 40 (58.8%) patients, which was more common than the left side foetal PCA which is seen in 28 (41.2%) patients.

Of the 174 patients, 140 (80.5%) patients had Middle Cerebral Artery (MCA) territory infarct and 34 (19.5%) patients had PCA territory infarct.

The distribution of type of PCA with respect to vascular territory of the infarct is given in [Table/Fig-1]. There was no significant association between the presence of foetal PCA and vascular territory of infarct (p-value is 0.936).

Among the patients with foetal PCA, ipsilateral infarcts were seen in 42 (61.8%) patients and contralateral infarcts were seen in 26 (38.2%) patients. There was no significant association between the presence of foetal PCA with ipsilateral or contralateral ischaemic stroke (p-value is 0.229).

The distribution of the type of foetal PCA with respect to the laterality of infarct is shown in [Table/Fig-2]. There was no statistically



[Table/Fig-1]: Distribution of type of PCA with respect to vascular territory of the infarct (p-value is 0.936).
PCA: Posterior cerebral artery; MCA: Middle cerebral artery

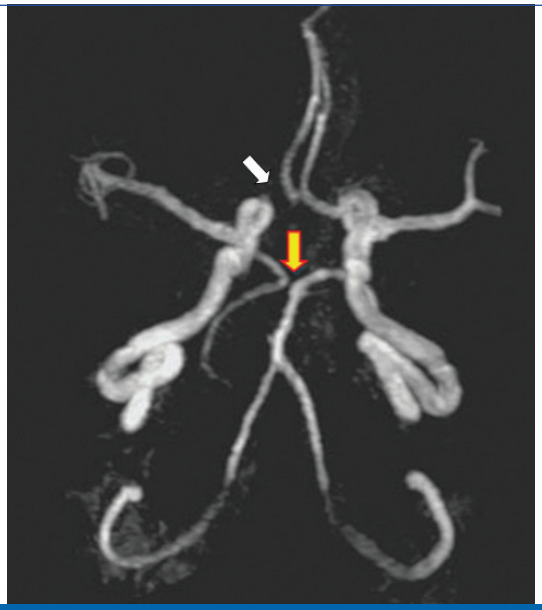
	Ipsilateral side	Contralateral side	p-value
Partial type	22	16	0.867
Complete type	20	10	

[Table/Fig-2]: Distribution of the type of foetal PCA in accordance with laterality of infarct.
Chi-square test applied

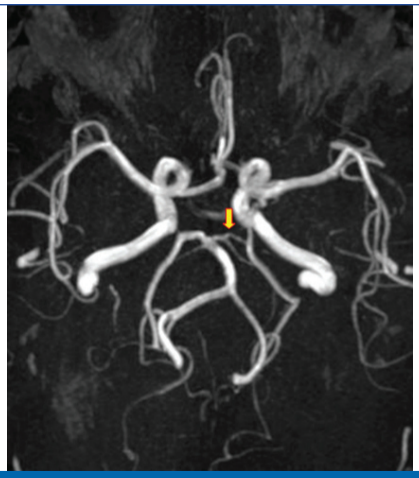
significant relationship between the type of foetal PCA and laterality of infarct and the p-value is 0.867.

DISCUSSION

The cerebral blood flow can be divided into two circulations: the anterior and the posterior circulation [4]. The posterior circulation comprises of vertebral arteries and its branches and BA which bifurcates into PCAs on each side. The PCA has three segments, named as P1, P2 and P3. P1 segment lies between the basilar bifurcation and the posterior communicating artery. The P2 segment lies between the posterior communicating artery and the posterior aspect of the midbrain and P3 segment of PCA starts from the pulvinar to the anterior limit of the calcarine fissure [5,6]. The term complete foetal type PCA is defined as the total absence of P1 segment of PCA, as shown in [Table/Fig-3]. Whereas, the term partial type foetal PCA is defined as hypoplastic P1 segment, as shown in [Table/Fig-4]. This P1 segment is the segment between basilar bifurcation and post communicating part of PCA [7,8].



[Table/Fig-3]: MR angiogram Maximum Intensity Projection (MIP) image shows right complete type of foetal PCA (yellow arrow). Another anatomical variation seen in this case is hypoplastic right A1 segment (white arrow).

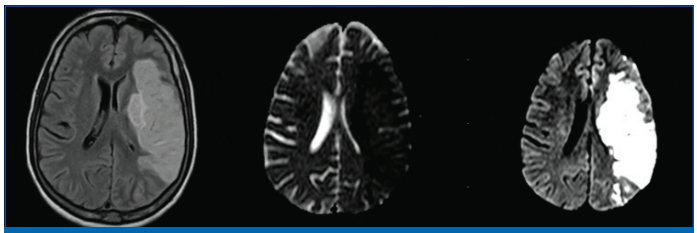


[Table/Fig-4]: MR angiogram Maximum Intensity Projection (MIP) image shows left hypoplastic P1 segment (arrow) with prominent posterior communicating artery-Suggestive of left partial foetal PCA.

In case of foetal PCA, the leptomeningeal vessels fail to develop between anterior and posterior circulation, hence there is more risk of developing ischaemic stroke. In partial foetal PCA, there is lack of development of leptomeningeal vessels as both the anterior and the posterior circulations are derived from the ICA, and collaterals could not be formed due to tentorium which prevents it. But a complete type foetal PCA can adapt to altered haemodynamics efficiently by developing collaterals [1]. Complete type of foetal PCA can impact the anatomy of the cerebral circulation by forming collaterals. Thus, in complete type PCA more area is perfused by the anterior circulation as PCA is completely supplied by ICA through collaterals [2]. Van Raamt AF et al., found lack of development of leptomeningeal collaterals in the foetal configuration of circle of willis, however their study did not show any association of full FTP with ischaemic strokes [7].

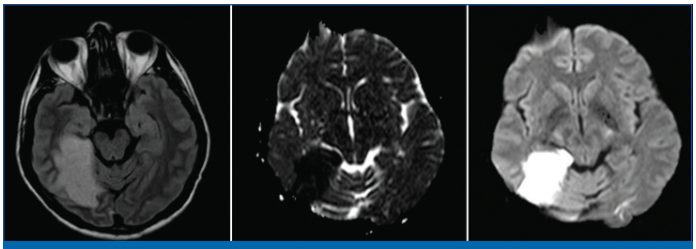
In this study, the male patients were about 66.7% when compared to study done by Roshan KA et al., in which 60.3% patients were male which is close to present observations [9]. A 26% of patients had foetal type PCA in Roshan KA et al., study while this study shows 39.1% of foetal PCA, which is higher [9]. In a study done by Roopashree R, 20% percent of patients had foetal type of PCA while this study shows a higher percentage [10]. A 21% of foetal PCA patients in this study have partial type of PCA while Roshan KA et al., study shows 10% which is less [9].

When compared to normal PCA, there is no statistical significant association between the presence of foetal type PCA and MCA territory ischaemic stroke in this study [Table/Fig-5].



[Table/Fig-5]: MRI axial sections of FLAIR, ADC and DWI sequences showing acute left MCA territory infarct.

Brandt T et al., study shows that incidence of PCA infarct is about 5% to 10% in general population [11]. This study shows 19% of ischaemic infarcts involving the PCA territory as shown in [Table/Fig-6] which is higher in the population of this study. Commonly, the atherosclerotic diseases of posterior circulation will lead to PCA territory infarct, while in case of presence of foetal PCA, atherosclerotic plaque or embolisation of common carotid artery causes occipital infarct [12]. Argyro M et al., in their study also concluded that in the presence of foetal PCA anatomical variant, since ICA is the dominant blood supplier, thrombosis or embolism of the ICA may cause infarction of the occipital lobe [13].



[Table/Fig-6]: MRI axial sections of FLAIR, ADC and DWI sequences showing acute right PCA territory infarct.

No significant association between presence of foetal PCA and ischaemic stroke was noted in this study which is similar to the study done by Amre N et al., [14]. Roshan KA et al., also states that there is no significant association of partial or complete type of foetal PCA with ischaemic stroke and the results are similar to the present study. van Raamt AF et al., found lack of development of leptomeningeal collaterals in the foetal configuration of circle of willis, however did not show any association of complete foetal type PCA with ischaemic strokes [7]. Lima FO et al., detected no clinical influence of the presence of foetal PCA on the outcome of ischaemic stroke [15]. Shaban A et al., studied the frequency and implication of stroke ipsilateral to foetal type PCA [16]. It also suggested that the presence of foetal type PCA does not increase the risk of ischaemic stroke. Various studies have been done on impact of foetal type PCA on ischaemic stroke. Among these studies van Raamt AF et al., and Shaban A et al., found no association of presence of foetal PCA and ischaemic stroke [7,16]. This study shows similar results. No association could be found between stroke and presence of foetal type PCA.

Limitation(s)

This study was done using 1.5T MRI which was available in the institution. 3T MRI/CT angiogram/Digital subtraction angiography may give more spatial resolution, information and better outcome.

CONCLUSION(S)

There was no significant association found between presence of foetal PCA and ischaemic stroke, and also no significant association found between the presence of foetal PCA or its types with ipsilateral or contralateral ischaemic stroke.

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