

# The Effect of Posterior Communicating Artery and Fetal Posterior Cerebral Artery Anomalies on Prognosis in Endovascular and Thrombolytic Therapy Patients

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## Abstract

**Objective:** Acute reperfusion therapy is a critical intervention for stroke patients with the aim of restoring blood flow. The presence of anatomical anomalies, such as fetal posterior cerebral artery (fPCA) and posterior communicating artery (PCOM) variations, can impact treatment outcomes and patient prognosis. This study aimed to assess the potential influence of these anomalies on patients undergoing acute reperfusion therapy.

**Materials and Methods:** Demographic characteristics of patients who underwent acute reperfusion therapy for stroke were considered among three distinct groups: the PCOM group, fPCA group, and control group. The demographic attributes examined for each group included gender distribution, mean age, presence of comorbidities, thrombolysis in cerebral infarction, national institutes of health stroke scale (NIHSS), and European cooperative acute stroke study II (ECASS II) scores. The significance of differences in these attributes among the groups was assessed.

**Results:** The study included a total of 106 patients: 42 patients in the PCOM group, 31 patients in the fPCA group, and 33 patients in the control group. No significant differences in demographic data were observed among the groups. The greatest decrease in NIHSS at the 24<sup>th</sup> hour was observed in the PCOM group, whereas the least decrease on day 7 was observed in the fPCA group. No differences were detected in the NIHSS values on the 24<sup>th</sup> hour and 7<sup>th</sup> day among the groups. When the 24<sup>th</sup> hour computed tomography scans of the groups were evaluated according to the ECASS II criteria, no significant differences were observed among the groups. Hemorrhage was not observed in 52.4% of patients in the PCOM group and 66.7% of patients in the control group.

**Conclusion:** The impact of fPCA and PCOM anomalies on patients undergoing acute reperfusion therapy for stroke was evaluated. Although no significant demographic differences were found among the groups, the study highlights the importance of further research to better understand their potential impact on treatment outcomes.

**Keywords:** Fetal PCA, acute stroke, PCOM

## Introduction

Cerebrovascular disorders continue to represent a significant and increasing global health concern, necessitating the ongoing refinement of diagnostic and therapeutic approaches. Among the advancements in this field, acute reperfusion therapy has emerged as a transformative intervention with unprecedented potential for salvaging ischemic brain tissue and mitigating the

devastating consequences of cerebrovascular events. As the landscape of acute reperfusion therapies evolves, it becomes increasingly critical to deepen our understanding of the intricate vascular anatomy that underlies these interventions.

Fetal posterior cerebral artery (fPCA) is a common cerebral circulation variety. Complete fPCA (cfPCA) and partial fPCA (pfPCA) are two different types of fPCA definitions. cfPCA is the



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artery that originates from the internal carotid artery and has no relationship with the basilar artery. The PCA originating from the internal carotid artery with a minor or atretic relationship with the basilar artery is referred to as pfPCA. Using autopsy or imaging techniques, such as magnetic resonance angiography, the prevalence of fPCA varies among individuals who are healthy (15-32%) and those with a history of cerebral infarction (5-36%) [1]. The posterior communicating artery (PCOM) emerges from the internal carotid artery and interacts with PCA. The vessel provides 5 to 12 branches to the thalamus, reticular nucleus, mammillothalamic tract, diencephalon, and caudate nucleus. The vessel appears unilaterally in 33% of cases, and abnormalities, such as aplasia, hypoplasia, or duplication, are visible in more than 50% of cases [2]. fPCA and PCOM are pivotal components of cerebral circulation and contribute to the intricate network that ensures optimal blood supply to the brain [3,4]. Anomalies or variations in these arterial structures can significantly impact the outcomes of acute reperfusion procedures, influencing both the safety and efficacy of these therapeutic interventions [5].

This study is positioned at the intersection of acute reperfusion therapy and cerebral vascular anatomy to investigate the potential impact of fPCA and PCOM anomalies on patients undergoing this critical intervention. By systematically assessing the presence and characteristics of these anatomical variations, we aim to contribute valuable insights into the intricate dynamics that may influence the success of acute reperfusion therapy and, consequently, the trajectory of stroke patients on their road to recovery.

## Materials and Methods

### Study Design

This retrospective observational study was designed to investigate the demographic characteristics of patients undergoing acute reperfusion therapy for stroke, with a specific focus on anatomical anomalies within the PCOM and fPCA. The study included three distinct groups: PCOM, fPCA, and control.

### Participant Selection

Patient records from 2018-2023 were reviewed, and individuals who underwent acute reperfusion therapy for stroke were identified. Computed tomography (CT) angiography was performed for all patients. Thus, the variations in cases were determined through CT angiography. These patients were then categorized into three groups based on the presence of vascular anomalies: the PCOM group, comprising patients with PCOM anomalies; the fPCA group, comprising patients with fetal PCA anomalies; and the control group, which included patients without observed vascular anomalies.

### Demographic Characteristics

Demographic attributes were systematically evaluated for each group. Gender distribution, mean age, and presence

of comorbidities were assessed as baseline characteristics. Additionally, the thrombolysis in cerebral infarction (TICI) score, national institutes of health stroke scale (NIHSS), and European cooperative acute stroke study II (ECASS II) scores were recorded for each participant. The ECASS II includes hemorrhagic infarction type 1 (HI1), which is characterized by small petechiae along the infarcted margins; hemorrhagic infarction type 2 (HI2), which is characterized by confluent petechiae within the infarcted area but without a space-occupying effect; parenchymal hematoma type 1 (PH1), which involves a blood clot covering less than 30% of the infarcted area with some slight space-occupying effect; and parenchymal hematoma type 2 (PH2), which involves a blood clot covering more than 30% of the infarcted area with a significant space-occupying effect [6].

### Ethical Considerations

This study adhered to the ethical guidelines and was approved by the Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (decision number: 2021-06-10, date: 15.03.2021). Patient confidentiality was strictly maintained throughout the research process. Informed consent was obtained from all individual participants included in the study.

### Statistical Analysis

Statistical analysis was performed to determine the significance of differences in demographic attributes among the three groups. Descriptive statistics were used to present the baseline characteristics of each group. Continuous variables are expressed as means with standard deviations, and categorical variables are presented as percentages. To assess the significance of observed differences, appropriate statistical tests, such as t-tests or ANOVA, were employed for continuous variables, whereas chi-square tests were utilized for categorical variables.

## Results

In this comprehensive examination of the dataset, comprising 106 patients distributed among three distinctive groups the PCOM group, fPCA group, and control group, detailed demographic and clinical characteristics were meticulously assessed. The PCOM, fPCA, and control groups consisted of 42, 31, and 33 patients, respectively. The initial analyses explored variables such as gender distribution, age, comorbidities, and clinical outcomes (Table 1).

### Demographic Characteristics

Gender distribution exhibited minor variations among the groups, with 33.3% females in the PCOM group, 48.3% in the fPCA group, and 51.5% in the control group. Conversely, male representation was higher in the PCOM group (66.7%) than in the fPCA (51.7%) and control (48.5%) groups. The mean age,

although not statistically significant, demonstrated a slight disparity, with the fPCA group having the highest mean age (74.6 years), followed by the control (68.3 years) and PCOM (69.2 years) groups (Table 1).

The presented results compare three groups (PCOM, fPCA, and control) in the context of acute ischemic stroke. Admission NIHSS scores did not differ significantly between the groups (p=0.55). The distribution of treatment modalities (tPA, thrombectomy, tPA + thrombectomy) displayed no significant variation among the groups, with p-values of 0.83, 0.36, and 0.83, respectively. These findings provide insights into the baseline characteristics and treatment patterns of the studied groups (Table 2).

**Multivariate Analysis**

The multivariate analysis, considering the estimates and

confidence intervals, further elucidated the influence of various factors on the study outcomes. Time exhibited a significant negative impact on NIHSS scores, emphasizing the temporal effectiveness of acute reperfusion therapy across all groups (Figure 1). Additionally, NIHSS scores at admission were positively associated with treatment effectiveness, suggesting a correlation between the severity of initial neurological impairment and the subsequent response to therapy. The group variable, which included the PCOM and fPCA groups in comparison to the control group, did not reach statistical significance, but the confidence intervals suggested a potentially greater reduction in NIHSS scores in the PCOM group (Table 3).

**Clinical Outcomes and Radiological Evaluations**

Detailed examination of clinical outcomes revealed intriguing patterns. TICl scores, which reflect the effectiveness of

Table 1. Demographic features of the groups				
	PCOM n=42	fPCA n=31	Control n=33	p
<b>Gender</b>				
Female	14 (33.3%)	15 (48.3%)	17 (51.5%)	0.24
Male	28 (66.7%)	16 (51.7%)	16 (48.5%)	
<b>Age</b>	69.2 (13.9)	74.6 (12.7)	68.3 (13.4)	0.15
<b>Comorbidities</b>				
Absent	5 (11.9%)	7 (20.7%)	7 (21.2%)	0.49
Present	37 (88.1%)	24 (79.3%)	26 (78.8%)	
<b>DM</b>				
Absent	24 (57.1%)	22 (72.4%)	21 (63.6%)	0.42
Present	18 (42.9%)	9 (27.6%)	12 (36.4%)	
<b>HT</b>				
Absent	18 (42.9%)	14 (44.8%)	14 (42.4%)	0.98
Present	24 (57.1%)	17 (55.2%)	19 (57.6%)	
<b>HL</b>				
Absent	37 (88.1%)	30 (99,1%)	29 (87.9%)	0.13
Present	5 (11.9%)	1 (0.90%)	4 (12.1%)	
<b>CAD</b>				
Absent	26 (61.9%)	25 (82.8%)	25 (75.8%)	0.13
Present	16 (38.1%)	6 (17.2%)	8 (24.2%)	

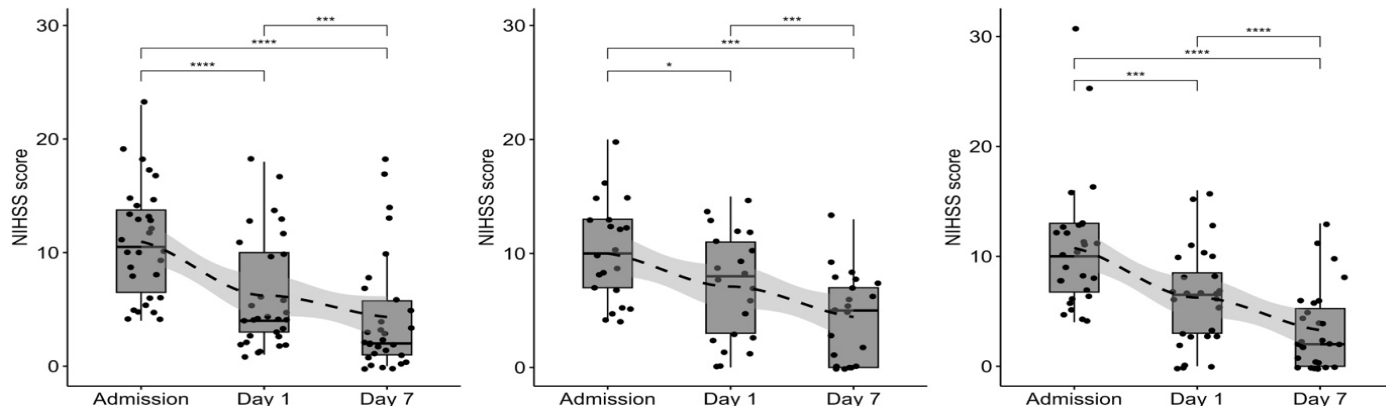
DM: Diabetes mellitus, HT: Hypertension, HL: Hyperlipidemia, CAD: Coronary artery disease, PCOM: Posterior communicating artery, fPCA: Fetal posterior cerebral artery

Table 2. The distribution of treatment modalities				
	PCOM n=42	fPCA n=31	Control n=33	p
Admission NIHSS	12.5 [8.00; 17.0]	12.0 [8.00; 15.0]	11.0 [8.00; 13.0]	0.55
<b>Treatment</b>				
tPA	22 (52.4%)	13 (41.9%)	17 (51.5%)	0.83
Thrombectomy	13 (31.0%)	12 (38.7%)	12 (36.4%)	
tPA + thrombectomy	7 (16.7%)	6 (19.3%)	4 (12.1%)	

tPA: Tissue plasminogen activator, NIHSS: National institutes of health stroke scale, PCOM: Posterior communicating artery, fPCA: Fetal posterior cerebral artery

thrombectomy, did not differ significantly among the groups. The PCOM group had a higher proportion of TIC1 scores (15.8%), whereas the fPCA group had a higher proportion of TIC2A-2B scores (73.7%). At the 24<sup>th</sup> hour, NIHSS scores exhibited variability, with no significant differences between

the groups. Similarly, 24<sup>th</sup> hour CT scans based on the ECASS II criteria did not reveal significant disparities. The incidence of hemorrhage varied among the groups, with 52.4% in the PCOM group and 66.7% in the control group exhibiting no hemorrhage (Table 4).



**Figure 1.** Relationship between NIHSS score and time (admission, day 1 and day 7)

NIHSS: National institutes of health stroke scale

Table 3. Confidence intervals and relationship between groups according to NIHSS scores			
	Estimate (%95 CI)	Standard error	T value
Intercept	0.78 (-1.90, 3.47)	1.36	0.58
Time	-0.43 (-0.52, -0.33)	0.05	-9.03
Admission NIHSS	0.55 (0.36-0.73)	0.10	5.71
Group			
Control	Reference	-	-
PCOM	1.30 (-0.98, 3.57)	1.15	1.12
fPCA	1.74 (-0.80, 4.27)	1.26	1.36

CI: Confidence interval, NIHSS: National institutes of health stroke scale, PCOM: Posterior communicating artery, fPCA: Fetal posterior cerebral artery

Table 4. Clinical outcomes of the groups				
	PCOM n=42	fPCA n=31	Control n=33	p
TICI score				
TIC1	3 (15.8%)	5 (26.3%)	6 (35.3%)	0.44
TIC2A-2B	16 (84.2%)	14 (73.7%)	11 (64.7%)	
24 <sup>th</sup> hour NIHSS	4.00 [3.00; 11.5]	8.50 [3.00; 12.0]	7.00 [3.00; 10.0]	0.73
24 <sup>th</sup> hour CT				
HI1-2	12 (28.6%)	7 (22.5%)	8 (24.2%)	0.38
PH1-2	8 (19.0%)	8 (25.8%)	3 (9.09%)	
No hemorrhage	22 (52.4%)	16 (51.6%)	22 (66.7%)	
7 <sup>th</sup> day NIHSS	2.00 [1.00; 5.75]	5.50 [0.00; 7.00]	2.00 [0.00; 5.25]	0.55
7 <sup>th</sup> day CT				
HI1-2	12 (30.8%)	10 (32.2%)	14 (43.8%)	0.12
PH1-2	7 (17.9%)	3 (9.6%)	0 (0.00%)	
No hemorrhage	20 (51.3%)	16 (51.6%)	18 (56.2%)	

TICI: Thrombolysis in cerebral infarction, PCOM: Posterior communicating artery, fPCA: Fetal posterior cerebral artery, NIHSS: National institutes of health stroke scale, HI: Hemorrhagic infarction, PH: Parenchymal hematoma, CT: Computed tomography

## 7<sup>th</sup> Day Clinical and Radiological Outcomes

On the 7<sup>th</sup> day, NIHSS scores exhibited a significant decrease across all groups, affirming the efficacy of acute reperfusion therapy. Radiological evaluations on the 7<sup>th</sup> day mirrored those at the 24<sup>th</sup> hour, with no significant differences in H11-2 and PH1-2 and no hemorrhage observed among the groups (Table 4).

## Discussion

Our investigation into the interplay of anatomical anomalies, particularly those within the PCOM and fPCA, in the context of acute reperfusion therapy for stroke has revealed intriguing patterns. The observed outcomes suggest that the treatment is effective in patients with both PCOM and fPCA; however, there appears to be a notable trend indicating potentially superior effectiveness in the PCOM group. It was observed in an article that patients with bilateral PCOM tend to have milder strokes at admission compared with those with absent/unilateral PCOM (median NIHSS score 18 versus 27 points). Additionally, these patients demonstrated better neurological improvements during discharge (quantified by the median decrease in NIHSS score) and higher rates of 3-month functional independence compared to those without good collaterals [7,8]. In support of this study, our findings indicated that individuals with PCOM had a better admission NIHSS score and more favorable neurological improvement compared to those with fPCA.

The disparity in treatment response between the PCOM and fPCA groups may be attributed to distinct characteristics inherent in these anatomical anomalies. The greater reduction in NIHSS scores within the PCOM group raises compelling considerations. One plausible explanation aligns with the anatomical location of PCOM anomalies, which may predominantly reside in the distal segments of cerebral arteries. This spatial orientation likely enhances collateral flow and provides an auxiliary blood supply route during instances of arterial blockage [9-11]. The fact that this does not result in a difference when evaluated in terms of hemorrhage status can be considered a questionable outcome in our study. Consequently, the augmented collateral flow may serve a protective role by mitigating potential brain damage and contributing to the more favorable treatment outcomes observed in the PCOM group.

Conversely, the fPCA group exhibited positive treatment responses, albeit with a lesser reduction in NIHSS scores, compared with the PCOM group. This may indicate variations in collateral capacities or regional blood supply dynamics associated with fPCA anomalies [12-14]. However, further exploration is warranted to elucidate the specific mechanisms contributing to the observed differences in treatment efficacy between the anatomical subgroups. There was no significant

difference in procedural success (TICI scores) between the fPCA, PCOM, and control groups, indicating that these variations did not pose significant challenges for the interventional radiologist performing the procedure. Vascular variations did not significantly alter the procedural success of interventional radiologists. This result suggests that outcomes were more likely influenced by hemodynamic changes than procedural aspects.

## Study Limitations

PCOM is the second most common aneurysm (25% of all aneurysms) and accounts for 50% of all internal carotid artery aneurysms [15,16]. Our study did not report any instances of aneurysm rupture in either the PCOM or fPCA groups, thereby limiting our ability to conclusively attribute treatment outcomes to this factor. Nevertheless, this absence underscores the importance of considering alternative explanations for observed trends. It is crucial to acknowledge the limitations of our study and the need for more extensive investigations involving larger patient cohorts and extended follow-up periods to validate and generalize our preliminary findings.

## Conclusion

In conclusion, acute reperfusion is effective and safe for patients with fPCA or PCOM anomalies. These anatomical variations may not only pose minimal impediments to the therapeutic procedure but also act as potential collateral pathways. The observed trends suggest a reduced risk of bleeding during the procedure and propose a positive prognosis for patients with such anomalies. However, the generalizability of these findings requires validation in more comprehensive studies with larger sample sizes and longer follow-up durations.

## Ethics

**Ethics Committee Approval:** This study adhered to the ethical guidelines and was approved by the Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (decision number: 2021-06-10, date: 15.03.2021).

**Informed Consent:** Informed consent was obtained from all individual participants included in the study.

## Authorship Contributions

Surgical and Medical Practices: H.A.E., Ö.Y., Concept: İ.A., V.Y., Design: H.A.E., İ.A., Z.E.K., Data Collection or Processing: H.A.E., İ.A., Analysis or Interpretation: H.A.E., Ö.Y., Literature Search: H.A.E., İ.A., Ö.Y., Writing: H.A.E., İ.A.

**Conflict of Interest:** No conflicts of interest were declared by the authors.

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