Original Article

The different recanalization rates of posterior communicating artery aneurysms with a fetal posterior communicating artery and anterior communicating artery aneurysms with a variation of the unilateral A1 segment

Yang Zhang[#], Yi Gu[#], Yu He, Chaojie Tang, Binxian Gu, Yongdong Li, Wu Wang

Institute of Diagnostic and Interventional Radiology, Shanghai Jiao Tong University Affiliated Sixth People's Hospital, Shanghai, China

Contributions: (I) Conception and design: Y Zhang, Y Gu, W Wang; (II) Administrative support: W Wang; (III) Provision of study materials or patients: Y Gu, B Gu, W Wang; (IV) Collection and assembly of data: Y Zhang, Y Gu, Y He, C Tang; (V) Data analysis and interpretation: Y Zhang, Y Li, W Wang; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work.

Correspondence to: Wu Wang, MD, PhD. Institute of Diagnostic and Interventional Radiology, Shanghai Jiao Tong University Affiliated Sixth People's Hospital, Shanghai 200233, China. Email: wangwangwuwu@hotmail.com.

Background: Posterior communicating artery (PcomA) aneurysms are more likely to recanalize than anterior communicating artery (AcomA) aneurysms. However, it is still unclear whether the recanalization rate of these aneurysms is a result of involvement from the fetal posterior cerebral artery (fPCA) in PcomA aneurysms and variation of the unilateral A1 segment in AcomA aneurysms. The purpose of this study is to retrospectively evaluate the different recanalization rates between PcomA aneurysms with fPCA and AcomA aneurysms with a variation of the unilateral A1 segment.

Methods: We retrospectively collected information regarding 214 patients, each with communicating segment aneurysms between January 2013 and January 2020. Follow-up documentation on clinical and imaging data was comparatively analyzed between variant types, and recanalization rates of the variant and normal types were analyzed by stratification.

Results: Of the 84 variant-type aneurysms (PcomA with fPCA and AcomA with a variation of the unilateral A1 segment, 41/43), complete recanalization occurred in 23 patients (27.4%), and it was significantly more likely to occur in PcomA aneurysms with fPCA (39.1%) than in AcomA aneurysms with a variation of the unilateral A1 segment (16.3%). Stent-assisted coil embolization (SACE) has been shown to reduce recanalization (OR =0.092, 95% CI: 0.011 to 0.790, P=0.03). Additionally, variant types and the normal type (non-fetal, 106, and bilateral A1 symmetry, 24) have different odds ratios (OR) of recanalization (P=0.04), and the OR of the variant subtypes was significant, unlike the normal type (P=0.49).

Conclusions: This study suggests that PcomA aneurysms with fPCA are more likely to recanalize than AcomA aneurysms with a variation of the unilateral A1 segment.

Keywords: Posterior communicating artery (PcomA) aneurysms; anterior communicating artery aneurysms (AcomA aneurysms); recanalization; variation; stent

Submitted Jan 06, 2021. Accepted for publication Jun 18, 2021.
doi: 10.21037/qims-21-17
View this article at: https://dx.doi.org/10.21037/qims-21-17

Introduction

Posterior communicating artery (PcomA) aneurysms account for 15–20% of all intracranial aneurysms, while anterior communicating artery (AcomA) aneurysms occupy a close proportion, with approximately 20% (1). Although the similar incidence rate was assumed to be related to similar hemodynamics, the recanalization rate of PcomA aneurysms was almost twice that of AcomA aneurysms (23.0% *vs.* 12.2%) (2). Despite this, previous studies on the subject seem to have taken no account of vascular variations, altering hemodynamics and affecting aneurysm recanalization.

The fetal posterior cerebral artery (fPCA) is a common variant seen in the circle of Willis, and 30–40% of PcomA aneurysms are associated with fPCA variants (3,4). However, the prevalence of unilateral A1 segment variation in AcomA aneurysms (>60%) (5,6) is much greater than fPCA in PcomA aneurysms. The two variants could lead to different hemodynamics and even affect the recanalization rate of some related aneurysms.

In this study, data on patients from our center relating to PcomA aneurysms with fPCA and AcomA aneurysms with a variation of the unilateral A1 segment were retrospectively collected to demonstrate whether PcomA aneurysms with fPCA are more likely to recanalize than AcomA aneurysms with a variation of the unilateral A1 segment.

Methods

Patients and data

Endovascular treatment (EVT) is the first therapeutic option for intracranial aneurysms at our center, the Institute of Diagnostic and Interventional Radiology, Shanghai Jiao Tong University Affiliated Sixth People's Hospital, in Shanghai, which has carried out EVT on cerebral aneurysms since 1998 (7). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by our hospital's ethics committee, and individual consent of patients for this retrospective analysis was waived.

From January 2013 to January 2020, patients with either PcomA aneurysms or AcomA aneurysms at our center were included in this study. fPCA can be divided into 2 types: partial fPCA and full fPCA (8), and variation of the A1 segment can likewise be divided into 2 types: Al segment hypoplasia and unilateral absent A1 segment (2).

The following information was collected on each patient: gender, age, hypertension, diabetes mellitus, smoking history, alcohol intake, the clinical presentation of a ruptured or unruptured intracranial aneurysm, and evidence of stent-assisted coil embolization (SACE) and retreatment procedures (*Figure 1*). Angiographic features including size and neck width of the aneurysm, dome-to-neck (D/N) ratio, the presence of wide neck, and initial embolization results were obtained. Maximum diameter and neck dimensions were measured by working projection angiography. Aneurysms with a diameter ≥4 mm or a D/N ratio <2 were defined as wide neck aneurysms (9).

EVT procedure

To determine an aneurysm's properties and make preliminary EVT plans, cerebrovascular computed tomography angiography (CTA) was performed on patients with ruptured cerebral aneurysms, and magnetic resonance angiography (MRA) was performed on patients with unruptured cerebral aneurysms (10). Generally, the first EVT was stand-alone coil embolization for acute ruptured cerebral aneurysms. However, if complete embolization could not be achieved, second-stage embolization (*Figure 2*) would be carried out within 1 month of the first procedure.

All EVTs were performed by experienced interventionalists using a biplane neuroangiographic system [digital subtraction angiography (DSA), AXIOM Artis dBA; Siemens Medical Solutions, Germany] with general anesthesia. A 6F/7F femoral sheath was used as standard, and a 6F/7F guiding catheter was selectively placed into the corresponding internal carotid artery (ICA).

All patients received systemic heparinization to maintain an activated clotting time of 2–3 times the baseline value throughout their procedure. All patients also underwent full four-vessel cerebral angiography and rotational angiography with three-dimensional (3D) image reconstruction to evaluate the aneurysm, including the neck, width, and height, and obtain working projections that demonstrate both neck and dome of the aneurysms.

Patients with unruptured aneurysms who had been allocated for stent placement were started on dual antiplatelet drugs (aspirin 100 mg/day and clopidogrel 75 mg/day) for at least 3 days before the procedure, with the dosage maintained for 4 weeks postoperatively, followed by only aspirin for 2–5 months. If SACE was performed on patients with ruptured aneurysms, they were administered 300 mg of aspirin and 300 mg of clopidogrel via gastric tube 2 hours before stent implantation. However, in the last

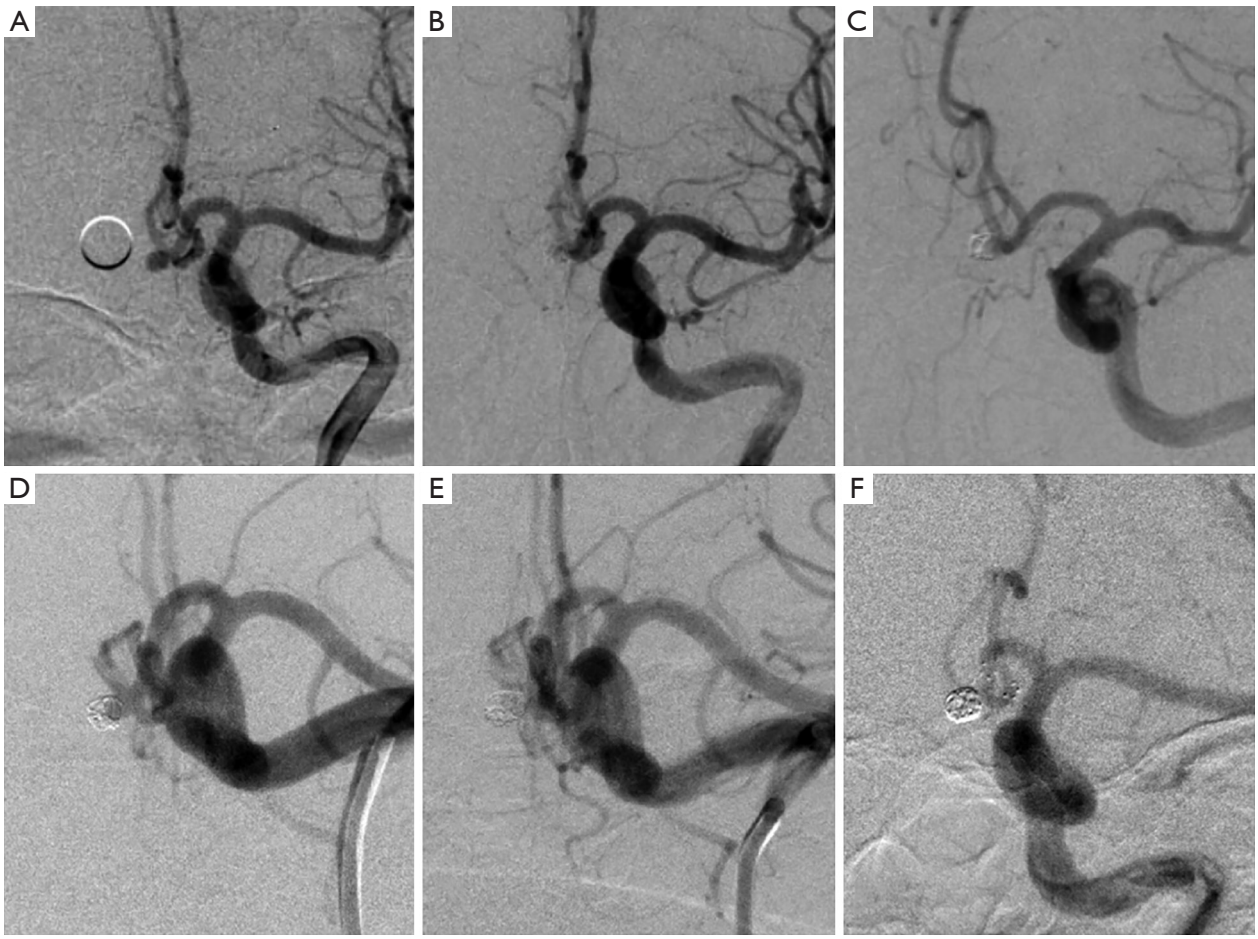

Figure 1 A 50-year-old male with SAH. (A) Working projection angiogram of the left ICA shows a small AcomA aneurysm. (B) Immediate angiogram post-EVT demonstrated adequate occlusion of the MRRC Grade II aneurysm. (C,D) Serial working projection angiograms at 3 and 6 months post-EVT demonstrated progressive recanalization of the AcomA aneurysm. (E) Immediate angiogram post-EVT treatment with SACE demonstrated complete occlusion of the aneurysm. (F) Follow-up angiogram 24 months after retreatment demonstrated complete occlusion of the aneurysm and AcomA patency. SAH, subarachnoid hemorrhage; ICA, internal carotid artery; AcomA, anterior communicating artery; EVT, endovascular treatment; MRRC, Modified Raymond-Roy Classification; SACE, stent-assisted coil embolization.

3 years, this method has changed to intravenous injection of Tirofiban during EVT.

Patients with ruptured aneurysms were given the same dose of aspirin and clopidogrel following surgery for the same length of time as patients with unruptured aneurysms.

It should be noted that except for 2 patients being treated with an Enterprise stent, all other patients were treated with a Neuroform™ stent.

Follow-up methods

The Modified Raymond-Roy Classification (MRRC) was used to determine each aneurysm's immediate and follow-up EVT results (11,12). MRRC I and II collectively refer to instances of adequate occlusion, and Class IIIa and IIIb to instances of incomplete occlusion.

The principles of imaging follow-up relate to our previous study where patients with ruptured aneurysms required their first DSA follow-up observation within 1–3 months of the initial procedure. If a patient was asymptomatic, the first follow-up DSA was to be carried out within 6 months of the initial procedure for a fully embolized aneurysm and within 3 months for an incomplete embolized aneurysm. Should an aneurysm remain stable and be MRRC Grade I or II, the

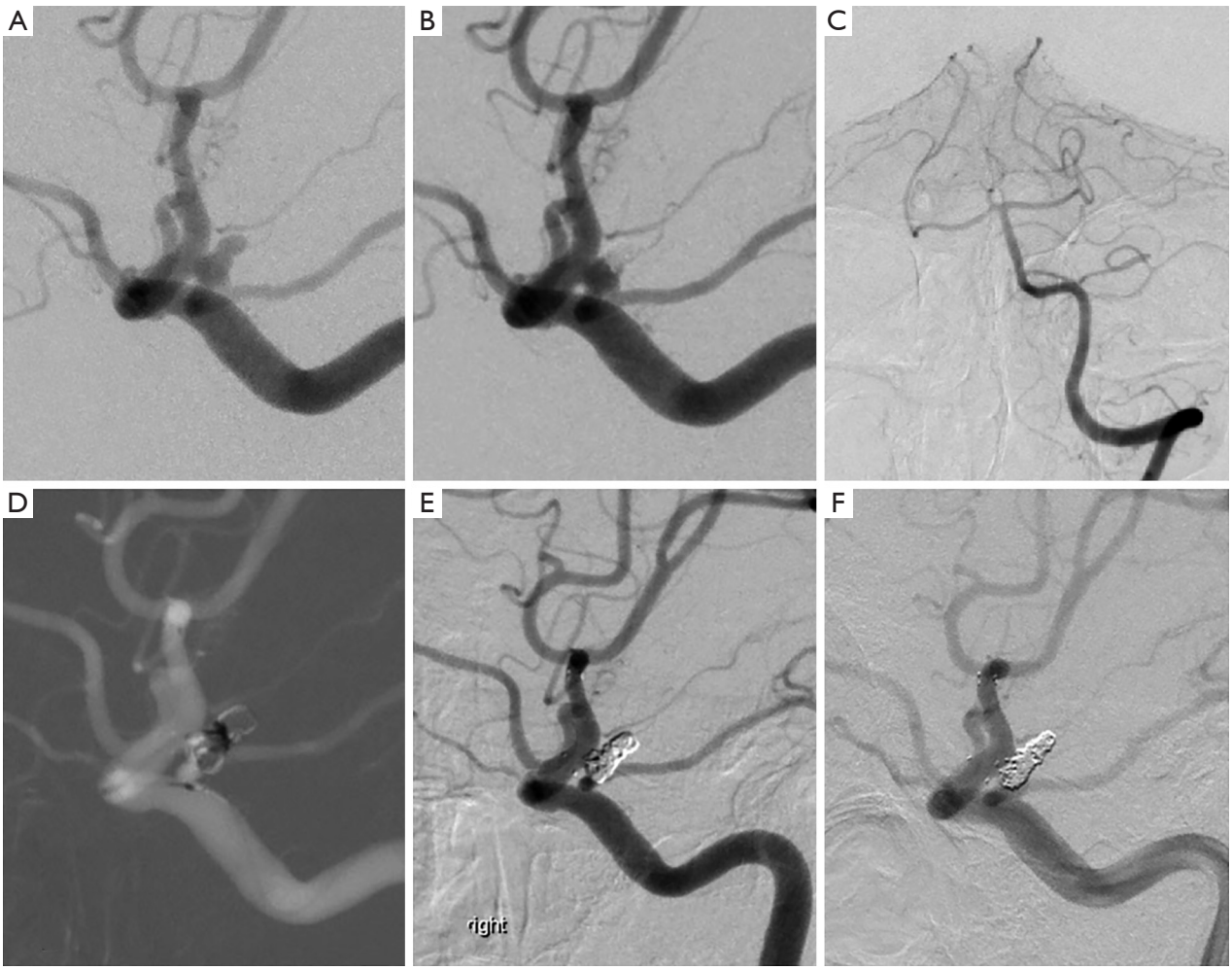

Figure 2 A 58-year-old female with SAH. (A) Working projection angiogram of the right ICA demonstrated a PcomA aneurysm (fPCA type) with daughter sac. (B) Immediate angiogram post-EVT demonstrated the daughter sac achieved a complete occlusion. (C) One month later, repeated left vertebral artery angiogram after right carotid artery compression indicated that bilateral PCAs were not visible. (D) Under the roadmap, the second-staged EVT was performed by SACE, with the proximal end of the stent being used to protect the PcomA's origin to keep the patency of the fPCA. (E,F) Serial follow-up angiograms of the right ICA 12 and 60 months after the second EVT demonstrated complete occlusion of the PcomA aneurysm with patency of the fPCA. SAH, subarachnoid hemorrhage; ICA, internal carotid artery; PcomA, posterior communicating artery; fPCA, fetal posterior cerebral artery; EVT, endovascular treatment; SACE, stent-assisted coil embolization.

follow-up time could be extended to 1–2 years (7).

The long-term follow-up results were divided into stable, progressive occlusion, minor recanalization, and major recanalization (13). The angiographic occlusion image was initially evaluated by two experienced neurointerventional specialists (with a combined 25 years of experience), and a third specialist (with 20 years of experience) assisted in forming a consensus for areas of disagreement.

Clinical evaluation included the recording of perioperative complications (within 30 days). The clinical follow-up endpoint was obtained 3 months after EVT and was assessed by the modified Rankin Scale (mRS), with an mRS of 0–2 points representing a good prognosis and 3–6 points being considered a poor prognosis.

Statistical analysis

Ordered categorical variables and non-ordinal categorical

variables were examined using a Mann-Whitney U test and Chi-squared and Fisher's exact tests, respectively, and continuous variables were tested by an unpaired *t*-test or Mann-Whitney U test. Categorical data were expressed as frequencies and group percentages, and continuous variables were displayed as mean ± SD or median (range).

The univariate analysis examined factors affecting recanalization during follow-up observations—the multivariate analysis comprised variables with P values <0.05 in the univariate analysis.

A binary logistic regression model was used to calculate the odds ratios (OR) with a 95% confidence interval (CI) and P value.

The Kaplan-Meier product-limit method and log-rank test estimated the cumulative recanalization-free survival. The Cox proportional hazards regression model (Cox model) played a role in calculating the OR with 95% CI of factors affecting the cumulative recanalization-free survival rate in the R environment.

Stratified analysis checked the homogeneity of the OR and calculated the OR with a 95% CI in each group and P value. Statistical significance was two-tailed P<0.05, and SAS V.9.4 (SAS Institute, Cary, NC, USA) and R software V.4.02 (Foundation for Statistical Computing, Vienna, Austria) were used for all calculations.

Results

General characteristics

Of the 275 patients with 295 PcomA or AcomA aneurysms admitted to our hospital between January 2013 and January 2020, 61 patients were excluded because of a lack of DSA follow-up or having variations not covered in this study, such as a persistent trigeminal artery or fenestrated variation. Therefore, 147 PcomA and 67 AcomA aneurysm patients, including 41 (27.9%) patients with fPCA (partial fPCA, 27, and full fPCA, 14) and 43 (64.2%) patients with a variation of the unilateral A1 (Al segment hypoplasia, 21, and absent A1 segment, 22) who had been tracked for over 3 months were eligible for this analysis. General patient characteristics are shown in *Table 1*.

The mean age of patients with PcomA aneurysms with fPCA and AcomA aneurysms with a variation of the unilateral A1 segment was 53.8±11.9 years (range, 27–77 years), with a greater number of women than men (52/84, 61.9%). Medical subsets of hypertension (n=55), diabetes mellitus (n=6), smoking (n=15) and alcohol intake (n=14) were identified.

The mean maximum diameter of the aneurysms was 5.0±2.1 mm (median 4.5 mm; range, 2.0–10.1 mm), the mean neck width was 3.2±1.3 mm (median 2.9 mm; range, 1.3–9.1 mm), and the mean D/N ratio was 1.7±0.6. SACE and retreatment were required in 17 (20.2%) and 15 (17.9%) patients, respectively.

Comparative analysis of the general characteristics and EVT results in PcomA aneurysms with fPCA and AcomA aneurysms with a variation of the unilateral A1 segment

The general characteristics and EVT results of the aneurysm subtypes are compared in *Table 1*. Women accounted for the majority (P<0.01) of patients with PcomA aneurysms with fPCA (as opposed to AcomA aneurysms with a variation of the unilateral A1 segment patients), and the ages of the PcomA with fPCA patients patients were significantly older (P<0.01).

The smoking history and alcohol intake of patients

Table 1 General characteristics and comparative analysis of the EVT outcomes of PcomA aneurysms with fPCA and AcomA aneurysms with a variation of the unilateral A1 segment

Variables	Total (n=84)	PcomA with fPCA (n=41)	AcomA with variation* (n=43)	P value
Women, n (%)	52 (61.9)	37 (90.2)	15 (34.9)	<0.01
Age (years) (mean ± SD)	53.8±11.9	57.6±11.3	50.2±11.6	<0.01
Hypertension, n (%)	55 (65.5)	30 (73.2)	25 (58.1)	0.15
Diabetes mellitus, n (%)	6 (7.1)	3 (7.3)	3 (7.0)	1.00
Smoking, n (%)	15 (17.9)	2 (4.9)	13 (30.2)	<0.01
Alcohol intake, n (%)	14 (16.7)	2 (4.9)	12 (27.9)	<0.01

Table 1 (*continued*)

Table 1 (*continued*)

Variables	Total (n=84)	PcomA with fPCA (n=41)	AcomA with variation* (n=43)	P value
Presentation, n (%)				1.00
Unruptured	6 (7.1)	3 (7.3)	3 (7.0)	
SAH	78 (92.9)	38 (92.7)	40 (93.0)	
Hunt & Hess grade, n (%)				0.83
I	12 (14.3)	6 (14.6)	6 (14.0)	
II	48 (57.1)	22 (60.50	26 (60.5)	
III	10 (11.9)	7 (17.1)	3 (7.0)	
IV	6 (7.1)	2 (4.9)	4 (9.3)	
V	2 (2.4)	1 (2.4)	1 (2.3)	
Stent-assisted, n (%)	17 (20.2)	9 (22.0)	8 (18.6)	0.70
Retreatment, n (%)	15 (17.9)	6 (14.6)	9 (20.9)	0.45
Maximum aneurysm size (mm) (mean ± SD)	5.0±2.1	5.4±2.4	4.7±1.8	0.13
Neck width (mm) (mean ± SD)	3.2±1.3	3.4±1.4	3.0±1.2	0.16
D/N ratio (mean ± SD)	1.7±0.6	0.7±0.6	1.7±0.6	0.99
Wide neck, n (%)	66 (78.6)	33 (80.5)	33 (76.7)	0.68
Initial embolization result (MRRC), n (%)				0.56
I	47 (56.0)	22 (53.7)	25 (58.1)	
II	22 (26.2)	10 (24.4)	12 (27.9)	
IIIa	9 (10.7)	6 (14.6)	3 (7.0)	
IIIb	6 (7.1)	3 (7.3)	3 (7.0)	
DSA follow-up duration (months) [median (range)]	11.5 [3–79.5]	12 [3–79.5]	9 [3–66]	0.37
DSA follow-up outcome, n (%)				0.03
I	37 (44.0)	14 (34.1)	23 (53.5)	
II	35 (41.7)	18 (43.9)	17 (39.5)	
IIIa	0 (0.0)	0 (0.0)	0 (0.0)	
IIIb	12 (14.3)	9 (22.0)	3 (7.0)	
Recanalization, n (%)				0.03
Stable or improvement	61 (72.6)	25 (61.0)	36 (83.7)	
Minor recanalization	9 (10.7)	7 (17.1)	2 (4.7)	
Major recanalization	14 (16.7)	9 (22.0)	5 (11.6)	
Clinical follow-up outcome, n (%)				0.74
Good prognosis	82 (97.6)	40 (97.6)	42 (97.7)	
Poor prognosis	2 (2.4)	1 (2.4)	1 (2.3)	

*, anterior communicating artery with a variation of the unilateral A1 segment. EVT, endovascular treatment; PcomA, posterior communicating artery; fPCA, fetal posterior cerebral artery; AcomA, anterior communicating artery; SAH, stent-assisted coil embolization; D/N, dome-to-neck; MRRC, Modified Raymond-Roy Classification; DSA, digital subtraction angiography.

Table 2 Univariate and multivariate analysis of risk factors for recanalization during follow-up observation

Variables	Recanalization, n (%)		Univariate analysis (P value)	Multivariate analysis (P value)	OR (95% CI)
	Yes (n=23)	No (n=61)			
Women	16 (69.6)	36 (59.0)	0.38		
Age >60 (years)	7 (30.4)	18 (29.5)	0.93		
Hypertension	19 (82.6)	36 (59.0)	0.04	0.15	
Diabetes mellitus	1 (4.3)	5 (8.2)	1.00		
Smoking	5 (21.7)	10 (16.4)	0.54		
Alcohol intake	4 (17.4)	10 (16.4)	1.00		
SAH presentation	1 (4.3)	5 (8.2)	1.00		
Maximum size (>7 mm)	4 (17.4)	10 (16.4)	1.00		
Wide neck	16 (69.6)	50 (82.0)	0.24		
Stent-assisted	1 (4.3)	16 (26.2)	0.03	0.05	0.121 (0.014 to 1.000)
PcomA with fPCA*	16 (69.6)	25 (41.0)	0.02	0.03	3.359 (1.139 to 9.900)

*, PcomA with fPCA *vs.* anterior communicating artery with a variation of the unilateral A1 segment. SAH, subarachnoid hemorrhage; PcomA, posterior communicating artery; fPCA, fetal posterior cerebral artery.

with PcomA aneurysms with fPCA was seen as much less significant (both P<0.01). There were no noteworthy differences in the other recorded factors, which included: hypertension (P=0.15), diabetes mellitus (P=1.00), presentation (ruptured versus unruptured) (P=1.00), Hunt & Hess grade (P=0.83), stent protection (P=0.70), retreatment (P=0.45), maximum aneurysm size (P=0.13), neck width (P=0.16), D/N ratio (P=0.99), wide neck (P=0.68), and initial EVT results (MRRC) (P=0.56).

Comparative analysis of follow-up outcomes in PcomA aneurysms with fPCA and AcomA aneurysms with a variation of the unilateral A1 segment

All selected patients were followed up for more than 3 months. The median DSA follow-up time was 12.5 months (range, 3–79.5 months), and the variations in individual patient follow-up time had no significant impact on overall outcomes (P=0.37). In addition, almost all patients had good prognoses (mRS ≤2) after undergoing coiling without any complications, such as rebleeding or thromboembolism, and their clinical outcomes did not significantly differ (P=0.74).

One patient with a PcomA aneurysm with fPCA had a rupture and died of a hemorrhage (10 years after EVT), while one patient with an AcomA aneurysm with a variation of the unilateral A1 segment was unable to walk independently due to an initial subarachnoid hemorrhage (SAH).

DSA follow-up demonstrated adequate occlusion was achieved in 72 of 84 aneurysms (85.7%) and recanalization in 23 aneurysms (27.4%, minor 9, major 14). Moreover, PcomA aneurysms with fPCA had higher recanalization rates than AcomA aneurysms with a variation of the unilateral A1 segment (39.1% versus 16.3%, P=0.03). Comparative analysis of follow-up outcomes is shown in *Table 1*.

Univariate analysis revealed that recanalization might be associated with hypertension, having no stent protection, and PcomA with fPCA. Furthermore, multivariate analysis indicated that SACE could reduce the recanalization of these aneurysms (OR =0.121, 95% CI: 0.014 to 1.000, P=0.05) and that PcomA with fPCA patients were at risk of aneurysm recanalization (OR =3.359, 95% CI: 1.139 to 9.900, P=0.03) (*Table 2*).

Kaplan-Meier estimates of cumulative recanalization-free rates within 24 months after initial treatment are shown in *Figure 3*. Cumulative recanalization-free rates reach significance for PcomA with fPCA (versus AcomA with a variation of the unilateral A1 segment).

As with multivariate analysis, the Cox model also indicated that stent assistance could reduce the cumulative recanalization incidence (OR =0.12; 95% CI: 0.02 to 0.91, P=0.04), which may be elevated by PcomA with fPCA (OR =2.47, 95% CI: 1.02 to 6.02, P=0.05) (*Figure 4*).

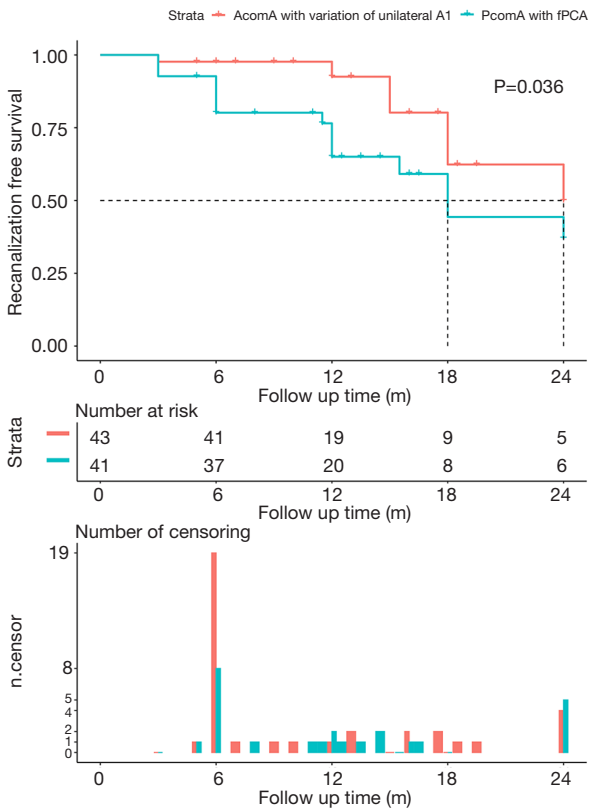

Figure 3 Kaplan-Meier estimates of cumulative recanalization-free survival in a cerebral communicating segment artery with variation (PcomA with fPCA versus AcomA with a variation of the unilateral A1). PcomA, posterior communicating artery; fPCA, fetal posterior cerebral artery; AcomA, anterior communicating artery.

Stratified analysis of the effect of a P1 or A1 variation on the differences of recanalization between PcomA and AcomA

We stratified PcomA and AcomA into 2 types, the normal type and the P1 or A1 variation type, respectively, to analyze the homogeneity of the OR between the 2 types and calculate the stratified OR of recanalization. Results are shown in *Table 3*.

A Breslow-Day test was conducted to record homogeneity of the OR, which suggested that stratified OR could not merge (P=0.04) and that PcomA with fPCA increased recanalization more than AcomA with a variation of the unilateral A1 segment (OR =2.3972, 95% CI: 1.1007–5.2208, P=0.02). At the same time, normal PcomA had a dissimilar effect on aneurysm recanalization (versus normal AcomA, P=0.49).

Procedural complications

There were no complications, such as vessel rupture, distal embolization, or any new neurologic deficits related to any of the procedures. In addition, after EVT, only 2 patients had slight in-stent restenosis (1 patient with PcomA with fPCA and 1 patient with AcomA with a variation of the unilateral A1 segment), which did not affect the distal blood supply.

Discussion

In this study, compared to AcomA aneurysms with a

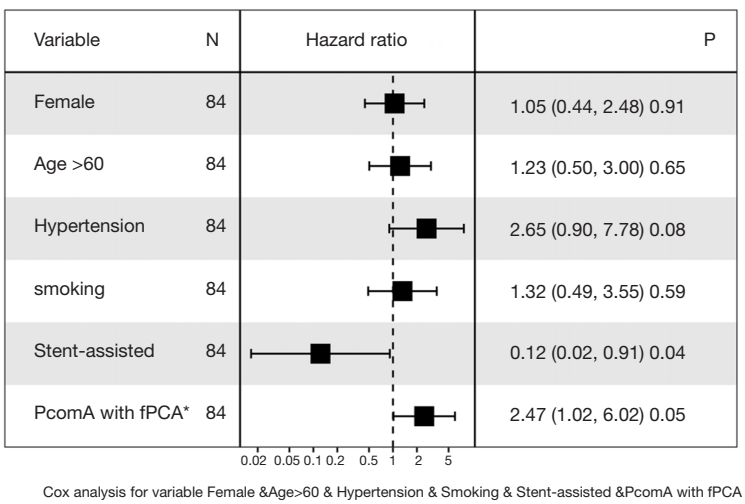

Figure 4 Cox analysis of variables effecting a cumulative aneurysm's recanalization-free survival. PcomA, posterior communicating artery; fPCA, fetal posterior cerebral artery. *, PcomA with fPCA *vs.* anterior communicating artery with a variation of the unilateral A1 segment.

Table 3 stratified analysis of the effect of P1 or A1 segment variation in differences in recanalization between PcomA and AcomA aneurysms

Stratification factor	Location	Recanalization, n (%)	Stable or improvement, n (%)	Homogeneity of the odds ratios (P value)	P value	OR (95% CI)
P1 or A1 variation	PcomA	16 (39.0)	25 (61.0)	0.04	0.02	2.3972 (1.1007–5.2208)
	AcomA	7 (16.3)	36 (83.7)			
Normal P1 or A1	PcomA	16 (15.1)	90 (84.9)		0.49	0.7245 (0.2942–1.7841)
	AcomA	5 (20.8)	19 (79.2)			

PcomA, posterior communicating artery; AcomA, anterior communicating artery.

variation of the unilateral A1 segment, PcomA aneurysms with fPCA had a greater likelihood of recanalization. However, regardless of the different recanalization rates, almost all patients with these 2 types of aneurysms had few complications and good clinical prognoses.

Interestingly, the proportion of male patients with AcomA aneurysms with a variation of the unilateral A1 segment was greater than that of male patients with PcomA aneurysms with fPCA (65.1% *vs.* 9.8%). This is potentially due to higher rates of smoking and drinking amongst males. Age was also a contributing factor, as patients with PcomA aneurysms with fPCA were older than patients with AcomA aneurysms with a variation of the unilateral A1 segment.

Univariate analysis indicated that SACE, hypertension, and PcomA with fPCA might be associated with an aneurysm's recanalization rate, but a multivariate analysis excluded hypertension, proved SACE to be a protective factor (P=0.05), and PcomA with fPCA to be a risk factor (P=0.03). Based on Cox regression analysis, these 2 factors were also observed to be related to the cumulative recanalization rate (P=0.04 and P=0.05). PcomA aneurysms with fPCA are shown to have more cumulative recanalization rates than AcomA aneurysms with a variation of the unilateral A1 segment (P=0.04).

Finally, we conducted a stratified analysis which demonstrated that the OR between the different variations in the PcomA and AcomA groups (normal and P1 or A1 segment variation) is inhomogeneous (P=0.04) and compared with the normal type, PcomA aneurysms with fPCA are shown to have more of an effect on recanalization than AcomA aneurysms with a variation of the unilateral A1 segment (P=0.02).

The incidence rates of fPCA and variation of the unilateral A1 segment in this study were 27.9% (41/147) and 64.2% (43/67), respectively, which are similar to those seen in other studies (30–40% and >60%) (3,6). Prior studies have suggested that PcomA aneurysms are more likely to recur than AcomA aneurysms (37.2% *vs.* 25.0%, P=0.259, and 23.0% *vs.* 12.2%, P<0.01) (2,12). However, these studies appeared to have neglected P1 or A1 segment variation factors that could increase these aneurysms' recanalization rates. Furthermore, recent, separate studies have focused on the relationships between fPCA and PcomA aneurysms and variation of the unilateral A1 segment and AcomA aneurysms (3,6). Choi *et al.* (4) reported that recanalization of PcomA aneurysms with fPCA surpassed the percentage associated with non-fetal PCAs (6 months: 22.4% *vs.* 15.4%, P=0.061 and 36 months: 37.8% *vs.* 26.9%, P=0.020). In addition, Tarulli *et al.* previously demonstrated that the A1-dominant AcomA aneurysm group showed significant changes in Raymond-Roy Occlusion Classification of a coiled aneurysm (P=0.03) and an increased proportion of patients with a filling of the aneurysmal sac (P=0.01) (6). However, this same test applied to the A1 codominant group showed nothing significant.

To date, there have been no large-scale studies comparing PcomA aneurysms with fPCA and AcomA aneurysms with a variation of the unilateral A1 segment in terms of the impact on recanalization after EVT. This study isolated variation groups to demonstrate that recanalization occurred more frequently in PcomA aneurysms with fPCA than AcomA aneurysms with a variation of the unilateral A1 segment (39.1% *vs.* 16.3%) and showed that the normal PcomA and AcomA aneurysm groups had the same recurrent risk (P=0.49). This indicates that both P1 and unilateral A1 segment variations could affect hemodynamics and increase the blood flow and shear stress in communicating arteries to promote both the frequency and hemorrhage rates and recanalization of aneurysms. However, the effect of these 2 variations may be different, which indicates the need for a long-term, large-sample cohort study to confirm this observation.

The use of stents has been confirmed to enhance coil embolization and reduce recanalization of aneurysms

(14-16). Chalouhi *et al.* (17) suggested that closed-cell stents were associated with significantly lower aneurysm recanalization rates (OR =0.4; 95% CI: 0.2–1; P=0.05). Cho *et al.* (15) used propensity score matching to balance the groups, and stents were viewed as beneficial in terms of reducing the overall risk of recanalization in coiled cerebral aneurysms compared to coiling alone (1.9% *vs.* 10.2%, P=0.004).

SACE was shown to reduce recanalization for these aneurysms in both our multivariate analysis and Cox regression model. In addition, based on the MRRC, we found that aneurysms with an initial embolization grade of IIIA were more likely to develop progressive embolization than deterioration.

During the follow-up period, a total of 9 aneurysms with an immediate embolization grade of IIIA were observed, only one of which deteriorated to a grade IIIB (PcomA with fPCA), with the others improving to a grade I or II (PcomA with fPCA, 2 grade I and 3 grade II aneurysms and AcomA with variation of unilateral the A1 segment, 1 grade I and 2 grade II aneurysms). This finding is also consistent with observations made by Mascitelli *et al.* (11), who hypothesized that Class IIIa aneurysms progress to occlusion more frequently than Class IIIb aneurysms.

P1 or A1 variations also showed a limited effect on flow diversion (FD). FD is a new technical device used to treat intracranial wide necks or giant aneurysms (18). It has also been recently proven that FD achieves good effects in the application out of clinical indications (19). However, many treatment centers have reported that the effect of simple FD treatment for a PcomA aneurysm with fPCA was subtherapeutic (20-22).

Among 50 fPCA aneurysms, only 17 cases (34.0%) achieved complete embolization, 9 cases (18.0%) showed neck residual, and the remaining 24 cases were sac residual.

Kan *et al.* reported a large blood pressure gradient in fPCA, so the concomitant aneurysm could therefore not be occluded (21). Furthermore, Tsang *et al.* posited that the backflow from the PCA area through to the fPCA might also lead to continuous aneurysm perfusion and impact (22), and the results of Pagiola *et al.* showed that FD treatment of AcomA aneurysms has certain risks, which may lead to thromboembolic complications (23).

Limitations

There were some limitations in the study. Firstly, our study represented observations from a single center and was not a randomized controlled trial. Secondly, using MRRC to evaluate EVT results for aneurysms may be affected by the clinician's level of experience. Finally, a pair of hemodynamics simulating fPCA and unilateral A1 segment variation should be established to verify hemodynamic effects.

Conclusions

The study indicated that PcomA aneurysms with fPCA are much more likely to recanalize than AcomA aneurysms with a variation of unilateral A1 segment, and this difference could not be reproduced between PcomA and AcomA aneurysms without variation. A long-term follow-up and large-scale study are required to confirm the long-term recanalization rates of PcomA aneurysms with fPCA and AcomA aneurysms with a variation of the unilateral A1 segment.

Acknowledgments

Funding: This study was partially supported by the National Natural Science Foundation of China (81771951) and the Shanghai Science and Technology Innovation Project (201409006000).

Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/qims-21-17). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of this work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by our hospital's ethics committee, and individual consent of patients for this retrospective analysis was waived.

References

1. Choi HH, Cho YD, Yoo DH, Lee SH, Yeon EK, Kang HS, Cho WS, Kim JE, Han MH. Safety and efficacy of anterior communicating artery compromise during endovascular coil embolization of adjoining aneurysms. J Neurosurg 2019;132:1068-76.
2. Choi HH, Cho YD, Yoo DH, Lee SH, Yeon EK, Kang HS, Cho WS, Kim JE, Han MH. Comparative analysis of coil embolization in posterior and anterior communicating artery aneurysms. J Neurointerv Surg 2019;11:790-5.
3. Thiarawat P, Jahromi BR, Kozyrev DA, Intarakhao P, Teo MK, Choque-Velasquez J, Niemelä M, Hernesniemi J. Are fetal-type posterior cerebral arteries associated with an increased risk of posterior communicating artery aneurysms? Neurosurgery 2019;84:1306-12.
4. Choi HH, Cho YD, Yoo DH, Lee HS, Kim SH, Jang D, Lee SH, Cho WS, Kang HS, Kim JE. Impact of fetal-type posterior cerebral artery on recanalization of posterior communicating artery aneurysms after coil embolization: matched-pair case-control study. J Neurointerv Surg 2020;12:783-7.
5. Krasny A, Nensa F, Sandalcioglu IE, Göricke SL, Wanke I, Gramsch C, Sirin S, Oezkan N, Sure U, Schlamann M. Association of aneurysms and variation of the A1 segment. J Neurointerv Surg 2014;6:178-83.
6. Tarulli E, Sneade M, Clarke A, Molyneux AJ, Fox AJ. Effects of circle of Willis anatomic variations on angiographic and clinical outcomes of coiled anterior communicating artery aneurysms. AJNR Am J Neuroradiol 2014;35:1551-5.
7. Li MH, Gao BL, Fang C, Gu BX, Cheng YS, Wang W, Scotti G. Angiographic follow-up of cerebral aneurysms treated with Guglielmi detachable coils: an analysis of 162 cases with 173 aneurysms. AJNR Am J Neuroradiol 2006;27:1107-12.
8. van Raamt AF, Mali WP, van Laar PJ, van der Graaf Y. The fetal variant of the circle of Willis and its influence on the cerebral collateral circulation. Cerebrovasc Dis 2006;22:217-24.
9. Hendricks BK, Yoon JS, Yaeger K, Kellner CP, Mocco J, De Leacy RA, Ducruet AF, Lawton MT, Mascitelli JR. Wide-neck aneurysms: systematic review of the neurosurgical literature with a focus on definition and clinical implications. J Neurosurg 2019;14:1-7.
10. Li MH, Li YD, Tan HQ, Gu BX, Chen YC, Wang W, Chen SW, Hu DJ. Contrast-free MRA at 3.0 T for the detection of intracranial aneurysms. Neurology 2011;77:667-76.
11. Mascitelli JR, Moyle H, Oermann EK, Polykarpou MF, Patel AA, Doshi AH, Gologorsky Y, Bederson JB, Patel AB. An update to the Raymond–Roy Occlusion Classification of intracranial aneurysms treated with coil embolization. J Neurointerv Surg 2015;7:496-502.
12. Raymond J, Guilbert F, Weill A, Georganos SA, Juravsky L, Lambert A, Lamoureux J, Chagnon M, Roy D. Long-term angiographic recurrences after selective endovascular treatment of aneurysms with detachable coils. Stroke 2003;34:1398-403.
13. Jeon JP, Cho YD, Rhim JK, Yoo DH, Cho WS, Kang HS, Kim JE, Han MH. Fate of coiled aneurysms with minor recanalization at 6 Months: rate of progression to further recanalization and related risk factors. AJNR Am J Neuroradiol 2016;37:1490-5.
14. Piotin M, Blanc R, Spelle L, Mounayer C, Piantino R, Schmidt PJ, Moret J. Stent-assisted coiling of intracranial aneurysms: clinical and angiographic results in 216 consecutive aneurysms. Stroke 2010;41:110-5.
15. Cho YD, Lee JY, Seo JH, Lee SJ, Kang HS, Kim JE, Son YJ, Jung KH, Kwon OK, Han MH. Does stent implantation improve the result of repeat embolization in recanalized aneurysms? Neurosurgery 2012;71:ons253-9.
16. Hwang G, Park H, Bang JS, Jin SC, Kim BC, Oh CW, Kang HS, Han MH, Kwon OK. Comparison of 2-year angiographic outcomes of stent- and nonstent-assisted coil embolization in unruptured aneurysms with an unfavorable configuration for coiling. AJNR Am J Neuroradiol 2011;32:1707-10.
17. Chalouhi N, Jabbour P, Singhal S, Drueding R, Starke RM, Dalyai RT, Tjoumakaris S, Gonzalez LF, Dumont AS, Rosenwasser R, Randazzo CG. Stent-assisted coiling of intracranial aneurysms: predictors of complications, recanalization, and outcome in 508 cases. Stroke 2013;44:1348-53.
18. Walcott BP, Stapleton CJ, Choudhri O, Patel AB. Flow diversion for the treatment of intracranial aneurysms. JAMA Neurol 2016;73:1002-8.
19. Yu SC, Kwok CK, Cheng PW, Chan KY, Lau SS, Lui WM, Leung KM, Lee R, Cheng HK, Cheung YL, Chan CM, Wong GK, Hui JW, Wong YC, Tan CB, Poon WL, Pang KY, Wong AK, Fung KH. Intracranial aneurysms: midterm outcome of pipeline embolization device--a

prospective study in 143 patients with 178 aneurysms. Radiology 2012;265:893-901.
20. Rinaldo L, Brinjikji W, Cloft H, Lanzino G, Gonzalez LF, Kan P, Castilla LR. Effect of fetal posterior circulation on efficacy of flow diversion for treatment of posterior communicating artery aneurysms: a multi-institutional study. World Neurosurg 2019;127:e1232-6.
21. Kan P, Duckworth E, Puri A, Velat G, Wakhloo A. Treatment failure of fetal posterior communicating artery aneurysms with the pipeline embolization device. J Neurointerv Surg 2016;8:945-8.
22. Tsang AC, Fung AM, Tsang FC, Leung GK, Lee R, Lui WM. Failure of flow diverter treatment of intracranial aneurysms related to the fetal-type posterior communicating artery. Neurointervention 2015;10:60-6.
23. Pagiola I, Mihalea C, Caroff J, Ikka L, Chalumeau V, Yasuda T, Marenco de la Torre J, Iacobucci M, Ozanne A, Gallas S, Marques MC, Carrete H, Frudit ME, Moret J, Spelle L. Flow diversion treatment of aneurysms of the complex region of the anterior communicating artery: which stent placement strategy should 'I' use? A single center experience. J Neurointerv Surg 2019;11:1118-22.

Cite this article as: Zhang Y, Gu Y, He Y, Tang C, Gu B, Li Y, Wang W. The different recanalization rates of posterior communicating artery aneurysms with a fetal posterior communicating artery and anterior communicating artery aneurysms with a variation of the unilateral A1 segment. Quant Imaging Med Surg 2022;12(1):354-365. doi: 10.21037/qims-21-17

