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The natural history of "contrast stasis" within aneurysm after embolization

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Abstract

Objective: Contrast stasis within residual aneurysm sac is sometimes seen after embolization of intracranial aneurysms and is thought to represent sluggish flow prone to thrombosis. We report the short- and intermediate-term angiographic outcomes of intra-aneurysmal contrast stasis following predominantly bioactive coil embolization procedures.

Design/Methods: Contrast stasis was identified by retrospective review of 153 consecutive patients treated at two centers with endovascular embolizations for intracranial aneurysms. Contrast stasis was defined by persistent opacification despite clearance of contrast from parent artery assessed during angiography at 3–5 frames/second. The contrast stasis were classified based on relative area and location visualized on dynamic angiographic images as small (5–15% of the total aneurysm), large (> 15%), or occurring only in the aneurysm neck by an independent reviewer.

Results: There were 44 patients (23 women: mean age 54.3±12.5 years) who had contrast stasis; 36 patients had small and 8 had contrast stasis in the neck of the aneurysm. There were no patients with large contrast stasis. Of these 44 patients, 33 patients had a mean follow up angiogram in 269.5 days; 10 patients had no follow up. In 21 patients, (18 were small and 3 were in the neck) the area of contrast stasis had spontaneously thrombosed while in 7 patients there was no change in the contrast stasis. The remaining 5 patients had increase in area of contrast stasis and required re-embolization. Size of the contrast stasis (p= 0.02) was the only statistically significant factor although there was a trend dome to neck ratio > 2 (p= 0.16) and washout on the initial angiogram (p= 0.16) affecting the thrombosis of contrast stasis.

Conclusions: Most small contrast stasis following coil embolization procedures spontaneously thrombose and do not require further treatment. A small proportion of patients had increase in the area of intra-aneurysmal contrast stasis and required further treatment.

MRA	magnetic resonance angiography
DSA	digital subtraction angiography

Introduction:

Embolization of intracranial aneurysms has become an accepted alternative to surgical treatment for certain aneurysms[1]. Contrast stasis within residual aneurysm sac is sometimes seen after coil embolization of intracranial aneurysms and is thought to represent sluggish flow prone to thrombosis. Aneurysm size and the percent of initial volumetric aneurysm occlusion are thought to be the most significant factors affecting the rate of recanalization[2] with limited information regarding the prognostic significance of contrast stasis. One study found that most contrast stasis resolve and are not a risk factor for recanalization in unruptured aneurysms using bare platinum coils[11]. However, it remains unclear in what proportion of contrast stasis in ruptured aneurysms using predominantly bioactive coils results in spontaneous obliteration and whether the magnitude of contrast stasis affects the chance of spontaneous obliteration. The information has direct implications regarding the decision to pursue areas of contrast stasis with further embolization. In this study, we report the short- and intermediate-term angiographic results of embolized aneurysms with contrast stasis following the procedure.

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Methods:

Patients

We retrospectively reviewed the angiographic images of all patients who underwent endovascular procedures for intracranial aneurysms at two institutions. The patients were identified using prospective local registry maintained by the cerebrovascular/endovascular programs that track all patients who undergo endovascular treatment for any indication. The patients reviewed were treated at Hennepin County Medical Center or University of Minnesota Medical Center from September 2006 through December 2009. The protocol for collecting data was reviewed and approved by the Institutional Review Boards.

Protocol for coil embolization

The endovascular procedures were performed under predominantly under general anesthesia and systemic heparinization. Infrequently, the procedures were performed under awake conditions. Using standard percutaneous approach, a 6-French introducer sheaths was placed in the common femoral artery and infrequently in the radial arteries. A 5 or 6 French guidecatheter, most frequently Envoy guide catheter (Envoy, Cordis Endovascular, Maimi Lakes, FL.), was advanced over guidewire under fluoroscopic guidance and road-mapping techniques into the internal carotid or vertebral artery. Intravenous heparin bolus (30 to 50 U/kg) was administered either at the time of guide catheter placement or immediately after placement of first detachable coil to achieve an activated coagulation time above 250 seconds. DSA images were acquired to identify best projections that allowed visualization of parent artery and aneurysm junction, and measure pertinent dimensions of the aneurysms prior to coil placement. Microcatheters (Excelsior SL 10 or Excelsior 1018; Boston Scientific, Natick, MA) were advanced over a microwire (Synchro 0.014" or Transcend 0.014"; Boston Scientific, Natick, MA) into the aneurysmal sac. Detachable coils were delivered into the aneurysmal sac and deployed using standard techniques. In addition to Guglielmi Detachable Coils (GDC, Boston Scientific Corporation, Natick, MA), several other detachable coils with unique attributes including Matrix (Boston Scientific Corporation, Natick, MA), Trufill DCS Orbit (Codman Neurovascular, Raynham, MA), HydroCoil (MicroVention Terumo, Aliso Viejo, CA), and Micrus Endovascular Microcoil (Micrus Endovascular Corporation, San Jose, CA) were used as deemed necessary. The procedure was continued until angiographic obliteration was complete, no further coils could be placed, or the risk of complications with continued embolization was judged to be high.

In some aneurysms with unfavorable neck to dome ratio, various techniques were used by the operators including stent or balloon assisted coil embolization. When the decision was made to place a self expanding stent, a self- expandable intracranial stent (Enterprise; Cordis, Miami Lakes, FL, Neuroform; Boston Scientific, Natick, MA or Xpert; Abbott Vascular, Abbott Park, IL) was deployed across the aneurysm neck either through the microcatheter or through the delivery catheter after exchange over a microwire.

Data collection

The following information was collected from the medical records of the patients with intra-aneurysmal contrast stasis: presenting symptoms (subarachnoid hemorrhage, asymptomatic, or others) and procedural details. Additional procedural aspects recorded include aneurysm location, and number and type of coils used. The type of antiplatelet therapy, dose and duration were documented as well. Following discharge, the follow up angiograms and clinic notes were reviewed and the change in contrast stasis and any re treatments were recorded.

Image analysis

The immediate post-treatment angiograms of all patients who underwent embolization were reviewed by one of the investigators (MA) who was not involved in any aspect of patient care. The pretreatment aneurysm size was determined by biplane angiography. The dynamic sequences of the angiographic images were used to identify intra-aneurysmal contrast stasis. Contrast stasis was defined by persistent opacification of the aneurysm despite clearance of contrast from parent artery assessed during angiographic images obtained at 3-5 frames/second. The contrast stasis were classified based on relative area and location visualized on dynamic angiographic images as small (5-15% of the total aneurysm), large (> 15%), or occurring in the aneurysm neck by independent review. Washout of contrast was defined as the clearance of contrast from the aneurysm after clearing the parent artery but before the completion of venous phase. Aneurysms were classified as small (< 6mm), medium (6-10mm) and large (> 10mm) based on the greatest dimension. The same investigator reviewed the follow up angiograms. Contrast stasis was classified as resolved, unchanged or increased in comparison with immediate post-procedure angiogram.

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Statistical Analysis

Statistical analysis was performed using SAS 9.1 software (SAS Institute Inc., Cary, NC). Descriptive statistics were expressed as means with standard deviation and frequency (percentages). Continuous and categorical variables were compared using ANOVA and chi-square tests, respectively. Statistical significance was accepted for p values < 0.05.

Results:

Patient population

A total of 153 patients underwent 165 endovascular procedures for intracranial aneurysms in our institutions during the study period. Based on the review of angiographic images of 165 procedures, 44 (26.7%) procedures in 44 patients were found to have intra-aneurysmal contrast stasis. The mean age (±standard deviation) of patients with intra-aneurysmal contrast stasis was 54.3 ± 12.5 years; range 25 to 77 years; 23 of the 44 patients were women. The indications for the coil embolizations were ruptured and unruptured intracranial aneurysms in 36 (81.8%) and 8(18.2%) of the patients, respectively. The demographic and clinical data including the patient's age, gender, aneurysm location, and size, and procedural data including the number and type of coils and other interventions used are summarized in Table 1.

Angiographic analysis

The aneurysms were located in the paraophthalmic segment (n=2), supraclinoid segment (n=7), paraclinoid segment (n=4), or bifurcation (n=2) of the internal carotid artery; anterior communicating artery (n=11), middle cerebral artery (n=3), anterior cerebral artery (n=1), vertebral artery (n=3), basilar artery (n=3), posterior inferior cerebellar artery (n=2) and posterior communicating arteries (n=6). Of the 44 patients with intra-aneurysmal contrast stasis, 36(81.8%) had small contrast stasis and 8(18.2%) had contrast stasis in the neck of the aneurysm only. There were no patients with large contrast stasis. Of the 44 patients, 43 were alive at the time of hospital discharge. One patient died 4 days later after hemorrhagic transformation of the basilar infarct. Of these 43 patients, 33 (77%) patients had a follow up angiogram at a mean interval (±standard deviation) of 269.5± 189.6 days. The area of contrast stasis spontaneously thrombosed in 21(63.6%) patients (18 were small and 3 in the neck), 7 patients had no change in the contrast stasis while 5(15.2%) patients had increased in area of contrast stasis and required further embolization. Figures 1–3 present representative cases of various grades of contrast stasis.

Antiplatelet therapy

All patients were given aspirin 325mg orally or rectally after the coil embolization procedure. The aspirin was continued for 30 to 60 days for those with only coil embolization. Those with stent assisted coil embolization (n= 5) were placed on aspirin 325mg indefinitely and clopidogrel 75mg for 30-90 days. Two patients with balloon assisted coil embolization were given clopidogrel 75mg for 5 or 30 days.

Factors associated with thrombosis of intra-aneurysmal stasis

Eighteen of the 33 patients (54.5%) had a dome-to-neck ratio of less than 2. The rate of thrombosis appeared to be higher in aneurysm with dome-to-neck ratio greater than 2 as compared to dome-to-neck ratio of less than 2 (73% vs 56%); 13 of the 21 patients with thrombosis of the contrast stasis on the follow-up angiogram had washout of contrast on the initial angiogram. Whereas 2 of the 7 patients with no change in contrast stasis and 4 of the 5 patients with increased contrast stasis had washout on the initial angiogram. All 7 of the patients with contrast stasis in the neck had thrombosis or no change on follow up angiogram. Size of the intra-aneurysmal contrast stasis was the only statistically significant factor ($p = 0.02$) although there was a trend towards association between dome-to-neck ratio greater than 2 ($p=0.16$) and washout of contrast on the initial angiogram ($p=0.16$) with spontaneous thrombosis (Table 2).

Discussion:

Contrast stasis is presumed to be due to sluggish flow within the aneurysm sac. Wang et al. found that contrast settling was strongly related to local flow dynamics. They found that aneurysms with larger vessel curvature experienced higher flow, which resulted in less gravitational settling[10]. Our review suggests that most small areas of intra-aneurysmal contrast stasis after coil embolization undergo spontaneous thrombosis despite concomitant use of antiplatelet agents and do not require further treatment. In our study, 63.6% of the contrast stasis spontaneously resolved, while another 21% had no change in the contrast stasis and did not require further interventions. In a small proportion of patients (15%), the intra-aneurysmal stasis increased and required further treatment. This study is mostly a reflection of bioactive coils. These findings confirm Hwang et al. who

Table 1.

Demographic, clinical and angiographic characteristics of patients with immediate post-procedure contrast stasis

Demo-graphics	Aneur-ysm location	Size in mm	Rup-tured	Residual dome or neck	Washout	Coils	Stent	Antiplatelet therapy
73/F	Pcom	3.8 × 7.8	No	dome	Yes	3 (2 Matrix, 1 GDC)	None	Aspirin 325mg × 1, Aspirin 81mg × 30 days
55/M	Acom	18 × 9	Yes	dome	Yes	6 (5 Matrix, 1 GDC)	None	Aspirin 325mg × 30 days
47/F	Acom	8 × 6	No	dome	Yes	4 Matrix	None	Aspirin 325 mg × 30 days
46/M	R MCA	5 × 4	Yes	dome	Yes	3 Matrix	None	Aspirin 325mg × 30 days
47/M	L choroidal	5.5 × 3	Yes	dome	Yes	1 Matrix	None	Aspirin 325mg × 1, Aspirin 81mg × 30 days
70/F	L PICA	4.5 × 5.5	Yes	neck	No	4 GDC	None	Aspirin 325mg × 30 days
54/M	Acom	4.5 × 2.5	Yes	neck	Yes	2 GDC	None	Aspirin × 81mg × 30 days
63/M	Acom	9 × 12	Yes	dome	Yes	14 coils (5 GDC, 6 Matrix, 3 Hydrocoils)	None	Aspirin 325mg × 30 days
68/M	L Acom	4.7 × 3.5	Yes	dome	No	3 Cerecyte	None	Aspirin 325mg × 1, Aspirin 81mg × 30 days
58/F	L ICA caver-nous	6 × 4	No	dome	No	5 (4 Ultipaq, 1 Cerecyte)	Xpert stent 4 × 60mm	Aspirin 325 indefinitely, Clo-pidogrel 75mg × 30 days
48/M	L ICA terminus	9.3 × 6	Yes	dome	No	6 coils (2 Micrus Cash-mere, 1 Presidio, 1 Cash-mere, 2 Ultipaque)	None	Aspirin 325mg × 30 days
25/M	L paracli-noid ICA	4.5 × 4.2	No	dome	No	4 GDC	None	Aspirin 325mg × 30 days
51/F	L ACA	9.8 × 9.1	Yes	neck	No	7 (3 Cashmere, 3 Micru-sphere, 1 Ultipaq)	None	Aspirin 325mg × 30 days
53/F	Basilar	6.2 × 5.5	Yes	dome	Yes	6 (2 Cerecyte, 2 Cash-mere, 2 Ultipaq)	None	Asprin 325mg × 60 days
39/M	Acom	8.5 × 10.5	No	dome	Yes	18 (3 Cashmere 4 Micru-sphere Cerecyte, 8 Ulti-paq, 1 Presidio, 1 Hydro-coil, 1 Hydrosoft)	None	Aspirin 325mg × 30 days
28/F	R Pcom	5.4 × 6.3	No	neck	Yes	5(2 Presidio 2 Ultipaq 2 Cashmere).	None	Aspirin 325mg x1, Asprin 81mg × 60 days
50/M	Basilar	4.5 × 4.2	No	neck	No	4 (1 Cashmere, 3 Ultipaq)	None	Aspirin 325mg × 1, Aspirin 81mg × 30 days
51/F	Acom	9.8 × 8.2	No	dome	No	6 (2 Cashmere, 2 Delta-paq, 2 Ultipaq	None	Aspirin 325mg × 30 days
54/F	R vertebral	3 × 4.2	Yes	dome	Yes	7 (1 Helipaq,6 Ultipaq).	None	Aspirin 325mg × 60 days
50/F	L Pcom	9 × 5.1	No	neck	No	8(1 GDC, 7 Matrix)	None	Aspirin 325mg x1, Aspirin 81mg × 60 days
67/F	L supracli-noid ICA	12 × 11	No	neck	No	12(3 Microplex, 4 Hydro-Coil, 5 Matrix)	None	Aspirin 325mg × 30 days
57/F	R ICA paracli-noid	8 × 4	No	neck	No	7 mini complex fill coils	None	Aspirin 325mg × 1, Aspirin 81mg × 60 days
51/M	L MCA	3.1 × 2.7	No	dome	No	6 (2 Micruspher, 1 Cash-mere, 1 Presidio 2 Ulti-paq)	None	Aspirin 325mg ×1, Aspirin 81mg × 30 days
64/M	Acom	9 × 12	No	dome	Yes	4 (1 Presidio, 1 Cashmere, 2 Ultipack)	None	Aspirin 325mg × 60 days
42/F	L choroidal	3.7 × 3.4	No	dome	No	3(1 Micrusphere, 2 Ulti-paq)	None	Aspirin 325mg × 30 days
42/F	L terminal ICA	4.5 × 6	No	dome	No	3(2 GDC, 1 Ultipaq)	None	Aspirin 325mg × 30 days
69/F	R Pcom	15.8 × 12	No	dome	No	17 Matrix	None	Aspirin 325mg × 1, Aspirin 81mg × 30 days
68/M	L paraophthal-mic ICA	5.2 × 3.5	No	dome	Yes	1 Cashmere	None	Aspirin 325mg × 1, Aspirin 81mg × 30 days
48/F	R supracli-noid ICA	4 × 3	Yes	dome	Yes	2 Matrix	None	Aspirin 325mg × 45 days
77/F	R Pcom	6.4 x7	Yes	dome	No	10 (8 Matrix, 2 GDC)	None	Aspirin 325mg × 1, Aspirin 81mg × 30 days
51/M	Acom	5 × 4.3mm	No	dome	Yes	9 GDC	None	Aspirin 325mg × 30 days
76/M	R PICA	6 × 4	No	dome	Yes	4 GDC	None	Aspirin 325g × 60 days
56/M	R Pcom	18 × 14	Yes	dome	No	14 (2 Presidio, 4 Micru-sphere, 3 Cashmere, 4 GDC, 1 Cashmere)	None	Aspirin 325mg × 60 days
55/M	Basilar	10 × 7	Yes	dome	No	17 Matrix	None	Aspirin 325mg × 4 days
52/M	R MCA	13 × 16	No	dome	Yes	48 matrix	NOne	Aspirin 325mg × 30 days
38/M	L caver-nous ICA	13 × 5	No	dome	Yes	25 Matrix	Hypergide 4 × 10mm Balloon assisted	Aspirin 325mg × 30 days, Clopidogrel 75mg × 5 day

Note- L, left; R, Right; ICA, internal carotid artery; ACA, anterior cerebral artery; Acom, anterior communicating artery; Pcom, posterior communicating artery. MCA, middle cerebral artery; PICA, posterior inferior cerebellar artery; H/H, Hunt and Hess scale; GDC, Guglielmi Detachable Coil;

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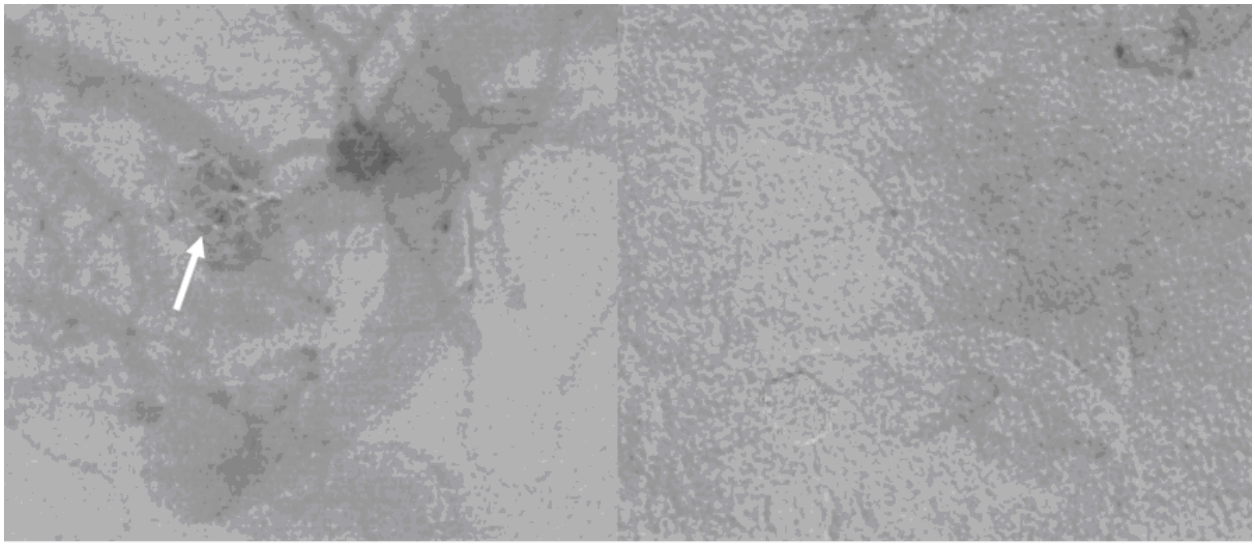
Table 1.

Demographic, clinical and angiographic characteristics of patients with immediate post-procedure contrast stasis

Demo-graphics	Aneur-ysm location	Size in mm	Rup-tured	Residual dome or neck	Wash-out	Coils	Stent	Antiplatelet therapy
61/F	R paracli-noid ICA	8.5 × 6.5	No	dome	Yes	10 Matrix	None	Aspirin 325mg × 7 days, Aspirin 81mg × 30 days
61/F	L caver-nous ICA	14 × 11	No	dome	No	5 (3 Matrix, 2 GDC)	None	Aspirin 325mg indefinitely, Clopidogrel 75mg × 30 days
43/F	L paracli-noid ICA	8 × 6	No	dome	Yes	5 (4 Hydrocoils, 1 Microplex)	Neuroform stent 4.5 × 20mm	Aspirin 325mg indefinitely, Clopidogrel 75mg × 90 days
46/F	R vertebral	7 × 6	No	dome	No	9 (6 Matrix, 3 GDC)	Neuroform stent 3.5 × 30mm	Aspirin 325mg indefinitely, Clopidogrel 75mg × 90 days
61/F	R vertebral	7 × 13	No	dome	Yes	2 Hydrocoils	None	Aspirin 325mg × 60 days
54/F	Basilar	3.5 × 3	No	dome	Yes	5 (3 Ultipaq, 2 Micrusphere)	Enterprise 4.5 × 22mm stent	Aspirin 325mg indefinitely, Clopidogrel 75mg × 30 days
74/M	L paraophthal-mic ICA	10 × 6	No	dome	Yes	7 GDC	Hyperform 4 × 7mm balloon assisted	Aspirin 325mg indefinitely, Clopidogrel 75mg × 30 days
31/M	Acom	11 × 8	No	dome	Yes	14 GDC	Enterprise 22mm stent	Aspirin 325mg indefinitely, Clopidogrel 75mg × 90 days
72/M	Acom	7 × 5	No	dome	No	4 Orbit mini complex	None	Aspirin 325mg × 1, Aspirin 81mg indefinitely

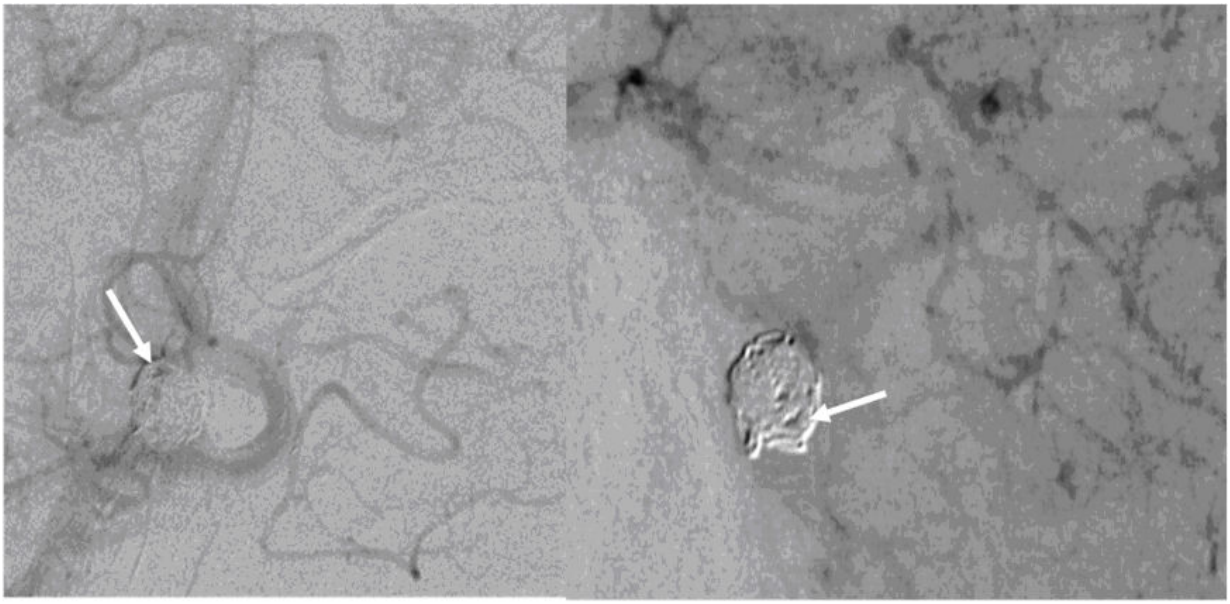
Note- L, left; R, Right; ICA, internal carotid artery; ACA, anterior cerebral artery; Acom, anterior communicating artery; Pcom, posterior communicating artery. MCA, middle cerebral artery; PICA, posterior inferior cerebellar artery; H/H, Hunt and Hess scale; GDC, Guglielmi Detachable Coil;



A B

Figure 1. Serial angiographic images of 51 year old man who underwent endovascular treatment for a ruptured intracranial anterior communicating artery aneurysm: A. Immediate post-procedure angiographic image demonstrating a small area (<10%) of contrast stasis within the aneurysm in the lateral projection. Notice that contrast is still visible in the aneurysmal sac despite washout of the contrast from the arteries. B. Angiographic image in the lateral projection obtained nine months after the procedure demonstrating that the contrast stasis has resolved.

used bare platinum coils for unruptured aneurysms[11]. In their study, 89 out of 104 (85.6%) unruptured aneurysms with contrast stasis resolved at 6 months follow up with MRA and remained unchanged without recanalization at



A B

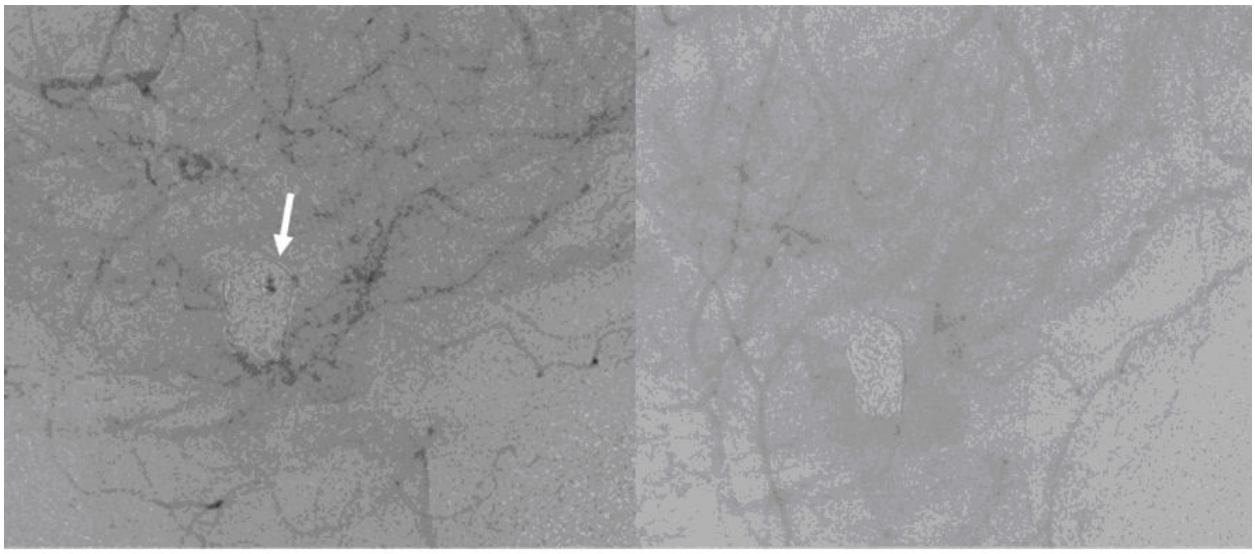
Figure 2. Serial angiographic images of 46 year old woman who underwent endovascular treatment for an unruptured intracranial vertebral artery aneurysm: A. Immediate post-procedure angiographic image demonstrating a small area (<10%) of contrast stasis within the aneurysm in the anterior posterior projection. Notice that contrast is still visible in the aneurysmal sac despite washout of the contrast from the arteries. B. Angiographic image in the anterior posterior projection obtained three months after the procedure demonstrating that the contrast stasis is unchanged.

2 years follow up with DSA. The remaining 15 patients in their study had recanalization on follow up. They found that contrast stasis was not a risk factor for recanalization.

Geyik et al. compared 80 patients treated with Cerecyte bioactive coils with matched group treated with bare platinum coils[8]. They found the initial treatment results were similar in both groups. However, a subgroup analysis showed that the rate of thrombosis was higher with Cerecyte coils compared with bare platinum coils on follow up studies[8]. The rates of recanalization in patients with completely and incompletely occluded aneurysms were found rates ranging from 19.5-25.7%[2–3]. Cognard et al. found that 6 out of 18 (30%) patients treated with bare platinum coils with initial subtotal occlusion (95-99% occluded) had regrowth at intermediate term follow up with 3 cases requiring retreatment[4]. In another study, the rates of recanalization were associated with incompletely occluded aneurysms, large aneurysms, aneurysms with necks greater than 4mm and ruptured aneurysms[5]. Our study suggests that intra-aneurysmal contrast stasis may assist in prognostication of long-term risk of recanaliztion.

In this study, there was no increased risk of thromboembolism associated with contrast stasis. The resolution of the contrast stasis on follow-up angiograms are thought to be subsequent to subacute thrombosis within the residual secondary to the interaction of the coil mass and blood flow. When blood first contacts a foreign surface like coils, a thin layer of platelets and fibrinogen covers the surface of the coils. Subsequent thrombosis depends on the surface charge, chemical properties, topographic features of the coils, and the pattern of blood flow in the vicinity[9]. Using a glass model of cerebral aneurysms, Shimano et al. examined the changes in intra-aneurysmal hemodynamics following coil embolizations[12]. They found that half life of the dye in the aneurysm reflected stagnation of intra-aneurysmal hemodynamics, suggesting that the prolongation of the contrast clearance within the aneurysm sac enhances thrombus formation.

This was a small study with only intermediate angiographic follow up; Follow-up angiography was not per-



A B

Figure 3. Serial angiographic images of 74 year old man who underwent endovascular treatment for an unruptured intracranial left paraophthalmic artery aneurysm: A. Immediate post-procedure angiographic image demonstrating a small area (<10%) of contrast stasis within the aneurysm in the anterior posterior projection. Notice that contrast is still visible in the aneurysmal sac despite washout of the contrast from the arteries. B. Angiographic image in the anterior posterior projection obtained eight months after the procedure demonstrating that the contrast stasis has resolved.

Table 2.

Intermediate term angiographic outcome according to strata defined by initial clinical and immediate post-procedure characteristics

	Contrast stasis at post-procedural angiogram (n=33)			
	No Change	**Thrombosed**	**Increased**	**P value**
	7	21	5	
Dome to neck ratio				0.167
Less than 2	6 (33.3%)	10 (55.6%)	2 (11.1%)	
More than or equal to 2	1 (6.7%)	11 (73.3%)	3 (20.0%)	
Washout				0.165
No	5 (35.7 %)	8 (57.1%)	1 (7.1%)	
Yes	2 (10.5%)	13 (68.4%)	4 (21.1%)	
Size of contrast stasis				0.025
Small (>15%)	3 (11.5%)	18 (69.2%)	5 (19.2%)	
Neck	4 (57.1%)	3 (42.9%)	0	
Presenting symptoms				0.918
Un-ruptured	5 (22.7%)	14 (63.6%)	3 (13.6%)	
Ruptured	2 (18.2%)	7 (63.6%)	2 (18.2%)	
Aneursym size				0.083
Small ((10mm)	1 (8.3%)	10 (83.3%)	1 (8.3%)	
Medium (11- 24mm)	6 (35.3%)	9 (52.9%)	2 (11.8%)	
Large ((25mm)	0	2 (50.0%)	2 (50.0%)	

Note: Washout was defined as: the clearance of contrast from the aneurysm after clearing the parent artery but before the completion of venous phase.

formed in 10 patients due to variety of reasons. Although this study was predominantly a reflection of bioactive coils, there were some bare platinum coils used. Therefore, the effect of each type of coil was not

separated because of the small total number of patients. Since all the patients were placed on aspirin, and aspirin and clopidogrel for those with stent assisted coil embolization, the affect of antiplatelet therapy on the contrast stasis could not be determined.

Conclusion:

Most contrast stasis following embolization using predominantly bioactive coils of ruptured and unruptured aneurysms results in thrombosis. Size of the contrast stasis was the only statistically significant factor in determining outcome. There is no increased risk of thromboembolism associated with contrast stasis. Few cases of contrast stasis will increase and require re treatment.

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