Neurology Asia 2023; 28(1) : 113 – 119

Mechanical thrombectomy for treatment of thromboembolic complication before coiling of the ruptured intracranial aneurysms

[1]Ruo-Chen Hu *MD*, [1]Bing Zhou *MD*, [1]Ming-Zhao Zhang *MD*, [1]Bo Li *MD*, [1]Rong-Qing Qin *MD*, [1]Yu-Bo Zhang *MD*, [1]Chen-Yu Wan *MD*, [2]Jun Cheng *MD*

[1]Department of Interventional and Vascular Surgery, [2]Department of Neurosurgery, The Affiliated Hospital of Hangzhou Normal University, Hangzhou City, Zhejiang Province, China.

Abstract

Background & Objective: During aneurysm embolization procedure, the occurrence of arterial embolism before the coil packing is rare and less reported. This study aimed to evaluate the safety and efficiency of mechanical thrombectomy in the treatment of thromboembolic complication before aneurysm coiling in the ruptured aneurysm embolization procedure. *Methods:* Between January 2010 and December 2021, 426 patients with ruptured intracranial aneurysms were treated with endovascular embolization in our hospital. Out of them, 5 patients were found to have thromboembolic event at the ipsilateral arteries of the aneurysm before coiling of the aneurysms. We used mechanical thrombectomy to recanalize the occluded arteries, followed by coiling of the aneurysms. We retrospectively analyzed the clinical and imaging data of the patients, and the safety and efficiency of the therapeutic regime was evaluated. *Results:* The occluded arteries were successfully recanalized with mechanical thrombectomy and the ruptured aneurysms were successfully treated by simple coiling or stent-assisted coiling. No severe operation-correlated complications occurred during the procedures. Postoperative imaging showed 1 case of cerebral infarction in thromboembolic area. One patients had motor aphasia, and the other 4 cases had no significant neurologic deficits compared to before operation. At the time of discharge, the mRS score was 2 in 1 patient, 1 in 1 and 0 in 3; and at 3 months after operation, the mRS score was 2 in 1 patient and 0 in 4.
Conclusions: For patients with ruptured aneurysm, thromboembolic event before aneurysm coiling is rare. Mechanical thrombectomy followed by coiling of the aneurysms is a safe and reasonable treatment regime, which may improve the prognosis of patients.

Keywords: Mechanical thrombectomy, thromboembolic complication, coiling, aneurysm, modified Rankin Scale, follow-up

INTRODUCTION

In the recent 30 years, with the development of endovascular technologies, the treatment regimes of intracranial aneurysms have changed dramatically. The interventional embolization has become the first-line treatment for ruptured aneurysms.[1] In the aneurysmal endovascular treatment, thromboembolic event (TE) is one of the most common complications, and the incidence of TE is reported between 3% and 51% in different studies.[2-5] According to the process of an aneurysmal endovascular treatment, TE may happen in the stage of pre-coiling, intra-coiling or post-coiling of the aneurysm. There were many studies on the treatments of TE which happened in the intra-coiling or post-coiling stage[3,4,6-10], but there were few studies dedicated to the TE that happened in the pre-coiling stage. In the past 12 years, 5 patients developed TE before the coiling of the ruptured intracranial aneurysms in our hospital. In this study, we summarize and report our experience in the treatment of pre-coiling TE which happened in the process of aneurysmal endovascular treatment.

METHODS

With the approval of the hospital institutional review board, we reviewed the clinical data of

Address correspondence to: Jun Cheng, Department of Neurosurgery, The Affiliated Hospital of Hangzhou Normal University. No. 126, Wenzhou Road, Hangzhou City, Zhejiang Province, 310015, China. Tel: +86 571-88358068, E-mail: z18668138116b@163.com

Date of Submission: 10 January 2023; Date of Acceptance: 26 January 2023

https://doi.org/10.54029/2023cmx

patients with ruptured intracranial aneurysms treated in our hospital from January 2010 to December 2021. During this period, 426 patients with ruptured intracranial aneurysms underwent endovascular embolization in our hospital. Among these patients, 42 patients with TE occurred, including 5 with pre-coiling TE and 37 of intra-coiling or post-coiling TE. A retrospective study was carried out on the 5 patients with pre-coiling TE.

Of the 426 patients with ruptured aneurysm, pre-coiling TE occurred in 5 patients in the aneurysm embolization procedures. Among the 5 patients, 4 were female and 1 were male, aged from 57 to 86 years. Before the embolization procedure, physical examination showed somnolence in 1 patient, moderate or severe headache in 3, meningeal irritation sign - positive in 4 and motor paralysis in 0. Pre-operative emergency brain CTA was performed to determine the aneurysmal size, shape and location. Of them, 2 aneurysms located at the anterior communicating artery, 1 in segment 6 of the internal carotid artery, 1 in segment 7 of the internal carotid artery, and 1 in top of the basic artery. The pre-operative Hunt-Hess grade was 2 in 4 cases and 5 in 1 case; and the pre-operative modified Fisher score was 0 in 1 case, 1 in 3 cases and 2 in 1 case.

Once the diagnosis was confirmed, the neurosurgeons and the neurointerventionalists discussed the treatment plan and reached an agreement before endovascular procedure. Emergency endovascular treatment (within 24 hours after the onset) was performed in the patients after the signed informed consent forms were obtained from the patient or their families. Under general anesthesia, all procedures were performed with the transfemoral arterial approach. Cerebral angiographies were performed to further definite the size, shape and neck of aneurysms, and to find the best working projection. The ipsilateral cerebral arterial embolism was found before coiling the aneurysms in 5 patients. After consultation occurred between the two neuro-interventionalists, consensus was reached and it was decided that mechanical thrombectomy (ME) should be performed before aneurysm coiling. A standard procedure of ME was performed with a thrombus removal device (ev3/Covidien, Irvine, CA, USA) in the 5 patients. In the process of pulling thrombus, the stent passed through the aneurysm should be as slow as possible to avoid the aneurysm from rupturing. Systemic heparinization was not given until the occluded artery was recanalized and the aneurysm was properly protected by coils. The aneurysms were treated with simple coiling or stent-assisted coiling, and the packing of the aneurysms was as attenuated as possible to avoid aneurysmal re-rupture or recurrence. Before the stent implantation, tirofiban was administered intravenously with a loading dose. Head CT examination was performed immediately after the embolization procedure to determine whether there was intraoperative bleeding. To patients with stent-assisted coiling, tirofiban was continued for 12 hours, and aspirin and/or plavix were bridged at the 8th hour after the operation.

The clinical data were acquired from the medical-record department and the imaging data from the Picture Archiving and Communication Systems (PACS). The primary endpoints of the study were the patients' mRS scores at the time of discharge and 6 months after the operation, and the combined endpoints were the recanalization rate, complications related to the thrombectomies, the incidence of cerebral infarction in the embolic area, the results of aneurysm filling. Due to the small sample size of this study, the data were analyzed mainly with descriptive statistics.

RESULTS

Of the 5 patients, the aneurysms were located in the anterior communicating artery in 2 patients, in the internal carotid artery in 2 and in the top of the basic artery in 1. The diameter of the aneurysms was 3 mm~8 mm, including 3 cases of wide-necked aneurysm. There were 1 cases of pre-coiling TE at the left middle cerebral artery, 2 at the right middle cerebral artery, and 1 at the trunk of basilar artery. The TE was founded before the aneurysm started to be coiled, which were ipsilateral to the aneurysms (Table 1).

ME was performed with solitaire FR stent in the 5 patients. Of the 5 patients, pulling embolus was done 1 time in 3 patients and 2 times in 2 (Figure 1). According to the modified Thrombolysis In Cerebral Infarction (mTICI) scale, all the patients attained a 2b/3 recanalization, with a recanalization rate of 100%. Distal migration of the thrombus and occlusion of the distal artery occurred in 1 case (Figure 2), and arterial spasm occurred in 3 cases including a severe spasm of the basilar artery in 1. There were no bleeding events or irreversible vascular occlusion events such as intimal dissection. The aneurysmal embolization was successfully performed in the 5 patients after thrombectomy, with 3 simple coilings and 2 stent-assisted coilings (Figure 1). According to

Table 1: The baseline data of the patients and their aneurysms

No	Sex/ age	Hunt-hess grade	modified Fisher score	Characteristics of the aneurysms			Embolic site	Revasculari-zation time
				Location	Size	Shape		
1	F/57	5	3	C6 segment of right ICA	5*6mm	Saccular/ wide-necked	M1 segment of the right MCA	36min
2	M/37	2	3	Top of BA	3.5*2.5mm	Saccular/ wide-necked	Trunk of BA	24min
3	M/74	2	3	ACOMA	8*8mm	Saccular/ narrow-necked	M1 segment of the left MCA	33min
4	F/72	2	3	ACOMA	3.5*5mm	Saccular/ narrow-necked	A2 segment of the left ACA	20min
5	F/86	2	2	C7 segment of right ICA	3*3mm	Irregular/ wide-necked	M1 segment of the right MCA	15min

ACOMA: anterior communicating artery; ICA: internal carotid artery; ACA: anterior cerebral artery; MCA: middle cerebral artery; BA: basilar artery.

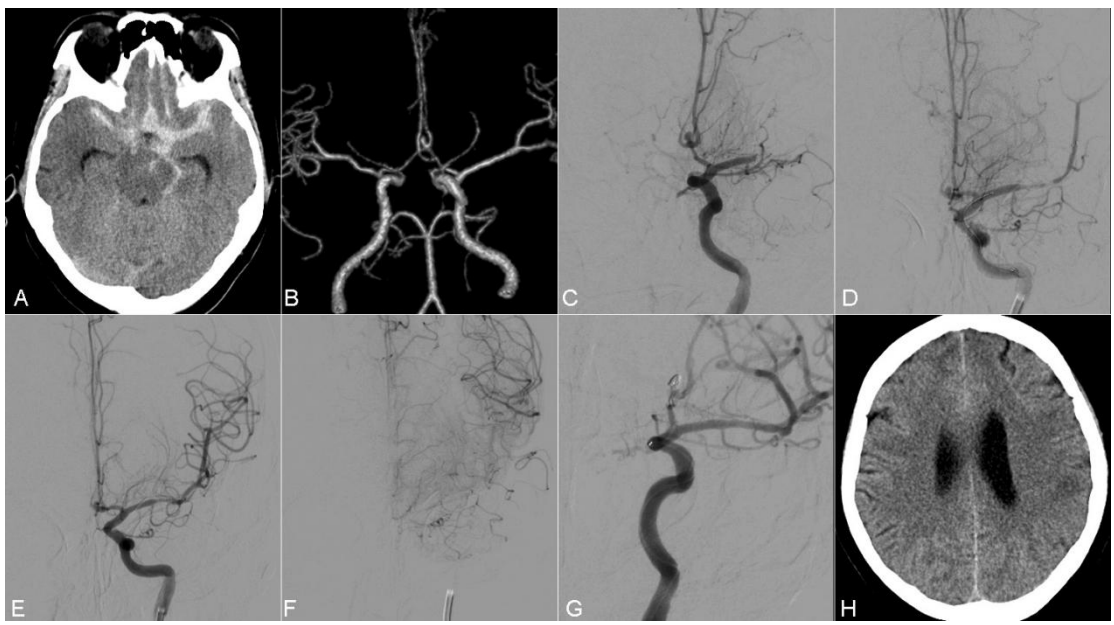

Fig 1. Images of case3. A: The emergency head CT scaning showed subarachnoid hemorrhage in the suprasellar cistern with a modified Fisher score of 3. B: The CT angiography displayed a anterior communicating aneurysm about 3mm*2mm in size. C and D: Thromboembolic occlusiondeveloped in the M1 segment of the left MCA before coiling of the aneurysm, and was recanalized by mechnical thrombectomy. E: The angiography revealed recanalization and local vasospasm of the M1 segment of left MCA. F: Delayed development of the distal arteries of the MCA suggested distal migration of the thrombus. G: The aneurysm was successfully treated with simple coiling. H: Local cerebral infarction was found in the left parietal lobe on the postoperative head CT scan.

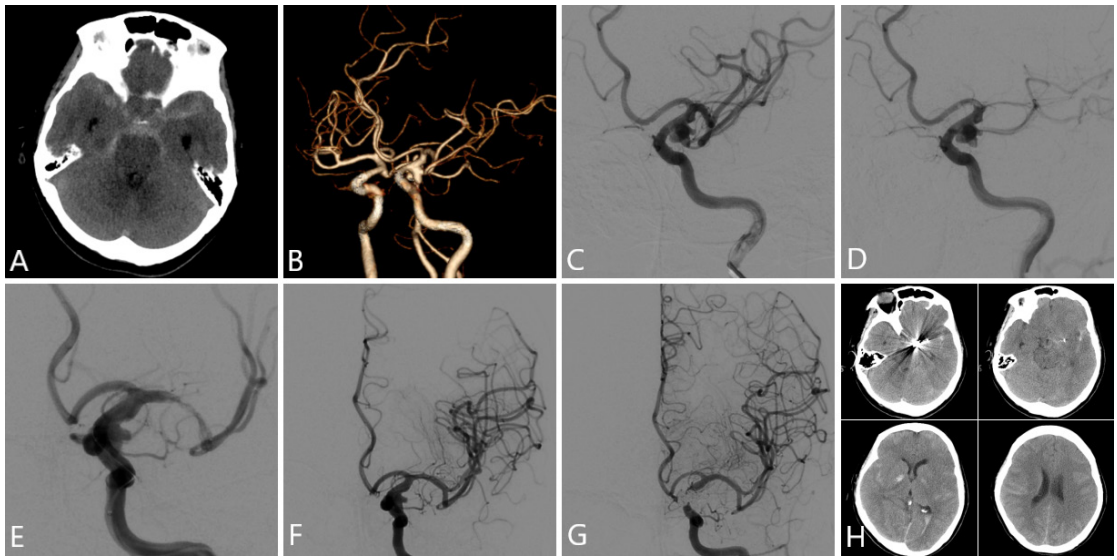

Fig 2. Images of case1. A: The emergency head CT scaning showed subarachnoid hemorrhage in the suprasellar cistern with a modified Fisher score of 3. B: The CT angiography displayed a anterior communicating aneurysm about 5mm*6mm in size. C: Cerebral angiography revealed a aneurysm at the C6 segment of right ICA. D and E: During positioning of the guiding catheter, the middle cerebral artery was not visualized anymore, mechanical thrombectomy was performed with solitaire FR stent. F: After mechanical thrombectomy, the middle cerebral artery was completely recanalized. G: The aneurysm was successfully treated with simple coiling. H: No obvious cerebral infarction was found in the head CT 5 days after the endovascular treatment.

the 3-point Raymond scale (RS), all the aneurysms obtained a complete obliteration (Table 2).

One of the 5 patients, one demonstrated motor aphasia after the operation, postoperative CT showed left cerebral infarction which was consistent with the pre-coiling embolic artery (Figure 1). Asymptomatic cerebral infarction in the right frontal lobe was found on the postoperative CT in another patient. The other 3 patients did not demonstrate a significant difference between the preoperative and postoperative clinical and imaging data. At discharge, the mRs score was 2 points in 1 patient and 0 in 4. At 3 months after the operation, the mRs score was 2 points in 1 patient and 0 in 4, and the patient's aphasia did not improve significantly.

Table 2: The results of MT, coiling of aneurysms and follow-up

No	TICI score of recanalization	Complications related to MT	Cerebral infarction in imaging	Coiling		New neurological deficit	mRS of follow-up	
				Method	RS		At discharge	3 months
1	2b	Thrombus migration, Arterial spasm	yes	Simple coiling	3	motor aphasia	2	2
2	3	Arterial spasm	yes	Stent+coiling	3	No	0	0
3	3	Arterial spasm	No	Stent+coiling	3	No	0	0
4	3	No	No	Simple coiling	3	No	0	0
5	3	No	no	Simple coiling	3	No	0	0

TICI: thrombolysis in cerebral infarction; MT: mechanical thrombectomy; RS: Raymond scale; mRS: modified Rankin Scale.

DISCUSSION

Intraoperative TE is still the most common complication in aneurysm endovascular procedure. Due to the different diagnostic methods, inclusion criteria and study time in different studies, the reported incidences of TE were different, with a range from 3% to 61%.[2-5] The incidence of TE assessed by postoperative MR was higher, and the incidence of cerebral infarction was found to be as high as 49% to 51% by postoperative MR examination, although the TE displayed in MR imaging were mostly asymptomatic.[2] The antiplatelet regimens were not the same, some studies showed the preoperative use of antiplatelet drugs can significantly reduce the incidence of intraoperative TE[11,12], and clopidogrel has a better effect than aspirin in this aspect.[13] Compared with unruptured aneurysms, the incidence of TE was higher in the ruptured aneurysmal endovascular procedure.[2,14] Besides, the patients who were treated with assistant technique and diverting devices were more likely to have intraoperative TE than those who were treated with simple coiling.[15,16]

According to the process of an aneurysmal embolization procedure, the TE may happen in the stage of pre-coiling, intra-coiling or post-coiling of the aneurysm. Pre-coiling TE is defined as the event that occurs during the period from the insertion of the arterial sheath to the beginning of coil embolization. Pre-coiling TE is considered to be different from intra- and post-coiling in pathogenesis. There may be two main causes of pre-coiling TE: first, the catheter operation induces the plaque falling from the vessel wall; second, the thrombus formed in the catheter falls and occludes the distal artery along with blood flow. There may be three main causes of intra- and post-coiling TE: first, the artery is occluded by the thrombus induced by the coil, stent or other assistant devices; second, the artery is occluded by overpacking of the coils or the incomplete stent deployment; third, the displacement of thrombi in aneurysms leads to distal arterial embolism. The differences in pathogenesis between pre-coiling TE and intra- or post-coiling TE may lead to different treatment options.

There are many reports on the study of TE during the endovascular treatment of cerebral aneurysms, which focused on the safety and efficacy of intraoperative use of the new antiplatelet drug such as abciximab, eptifibatide, and tirofiban.[3,4,17-18] Many clinical studies have shown that tirofiban has a positive effect on recanalization of the occluded arteries than fibrinolytic agents, and tirofiban shows better safety than other antiplatelets such as abciximab and eptifibatide;[18,19,22] and intra-arterial use of 2B/3A receptor antagonist is also safer and more effective than that of fibrinolytic such as urokinase.[20-22] Many studies have shown that intraoperative TE can be reduced by enhancing the preoperative antiplatelet regimen, for example, a combination of three antiplatelet drugs or an increase in the dosage of antiplatelet drugs.[11,12]

However, as far as we know there is very few study dedicated to the treatment of TE before aneurysm coiling. In our opinion, there are some deficiencies in the use of new antiplatelet drugs and thrombolytic drugs before the ruptured aneurysm is dissolved. First, because the wall of the ruptured aneurysm is very fragile, the use of antiplatelet or thrombolytic drugs in arteries or veins is associated with a greater risk of rebleeding before the aneurysm has not been necessarily protected; second, the old embolus or atherosclerotic plaque may be the main cause of pre-coiling TE, and in these cases, the efficacy of the drugs is very poor. Therefore, we chose MT as the preferred treatment in this situation.

Another problem worth discussing is coiling the aneurysms first or recanalizing the occluded arteries first. We think that it may be more reasonable to recanalize the occluded arteries first. There are two reasons to be considered: First, the tolerance of brain tissue to ischemia is very poor, and delayed recanalization may lead to massive cerebral infarction; second, because of the influence of coils and stents, the risk and difficulty of MT after aneurysm embolization will increase. In this group, MT was successfully performed in the 5 patients without significant complications, and the recanalization of TICI 2B/3 was achieved in all the patients. The results of our patients indicated that MT followed with the coiling of an aneurysm may be a therapeutic schedule for the patients with ruptured aneurysm and pre-coiling TE.

There are several limitations in this study. First, this is a small-sample retrospective study with no control group, so it is impossible to give a certain answer to its safety and rationality. Also, we judge the nature of thrombus based on the timing of the thromboembolic events and the location and shape of the thrombus, but we did not have pathological examinations of the thrombus, so there may be a misjudgment. Besides, postoperative head MR examination was performed only in 1 patient but not in the other 4 patients, which may underestimate the incidence

and severity of the TEs after the operations.

In conclusion, pre-coiling TE is a rare complication in an aneurysmal endovascular procedure. In this situation, MT followed by the coiling of the aneurysms is a safe and reasonable procedure, which may be helpful for our reperfusion therapy and improve the patient's prognosis. Nevertheless, this conclusion needs to be confirmed by randomized controlled studies with larger samples.

REFERENCES

1. Connolly ES Jr, Rabinstein AA, Carhuapoma JR, *et al*. Guidelines for the management of aneurysmal subarachnoid hemorrhage: a guideline for healthcare professionals from the American Heart Association/ american Stroke Association. *Stroke* 2012; 43(6):1711-37. doi: 10.1161/STR.0b013e3182587839
2. Altay T, Kang HI, Woo HH, *et al*. Thromboembolic events associated with endovascular treatment of cerebral aneurysms. *J Neurointerv Surg* 2011; 3(2):147-50. doi: 10.1136/jnis.2010.003616
3. Cho YD, Lee JY, Seo JH, *et al*. Intra-arterial tirofiban infusion for thromboembolic complication during coil embolization of ruptured intracranial aneurysms. *Eur J Radiol* 2012; 81(10):2833-8. doi: 10.1016/j.ejrad.2011.11.023
4. Linfante I, Etezadi V, Andreone V, *et al*. Intra-arterial abciximab for the treatment of thrombus formation during coil embolization of intracranial aneurysms. *J Neurointerv Surg* 2010; 2(2):135-8. doi:10.1136/jnis.2009.001933
5. Brooks NP, Turk AS, Niemann DB, *et al*. Frequency of thromboembolic events associated with endovascular aneurysm treatment: retrospective case series. *J Neurosurg* 2008; 108(6):1095-100. doi:10.3171/JNS/2008/108/6/1095
6. Chung J, Lim YC, Suh SH, *et al*. Stent-assisted coil embolization of ruptured wide-necked aneurysms in the acute period: incidence of and risk factors for periprocedural complications. *J Neurosurg* 2014;121(1): 4-11. doi: 10.3171/2014.4.JNS131662
7. Martínez-Pérez R, Lownie SP, Pelz D. Intra-arterial use of abciximab in thromboembolic complications associated with cerebral aneurysm coiling: The London Ontario Experience. *World Neurosurg* 2017;100: 342-50. doi:10.1016/j.wneu.2017.01.023
8. Sedat J, Chau Y, Mondot L, *et al*. Is eptifibatide a safe and effective rescue therapy in thromboembolic events complicating cerebral aneurysm coil embolization? Single-center experience in 42 cases and review of the literature. *Neuroradiology* 2014; 56(2):145-53. doi:10.1007/s00234-013-1301-3
9. Nagahata M, Kondo R, Saito S, *et al*. Which factors increase procedural thromboembolic events in patients with unruptured paraclinoid internal carotid artery aneurysm treated by coil embolization? *Neuroradiol J* 2011; 24(5):712-4. doi:10.1177/197140091102400507
10. Edwards NJ, Jones WH, Sanzgiri A, *et al*. Antiplatelet therapy for the prevention of peri-coiling thromboembolism in high-risk patients with ruptured intracranial aneurysms. *J Neurosurg* 2017; 127(6):1326-32. doi:10.3171/2016.9.JNS161340
11. Hwang G, Huh W, Lee JS, *et al*. Standard vs modified antiplatelet preparation for preventing thromboembolic events in patients with high on-treatment platelet reactivity undergoing coil embolization for an unruptured intracranial aneurysm: A randomized clinical trial. *JAMA Neurol* 2015; 72(7):764-72. doi:10.1001/jamaneurol.2015.0654
12. Shimamura N, Naraoka M, Matsuda N, *et al*. Use of preprocedural, multiple antiplatelet medications for coil embolization of ruptured cerebral aneurysm in the acute stage improved clinical outcome and reduced thromboembolic complications without hemorrhagic complications. *World Neurosurg* 2020; 133:e751-e756. doi:10.1016/j.wneu.2019.09.149
13. Matsumoto Y, Kondo R, Matsumori Y, *et al*. Antiplatelet therapy for prevention of thromboembolic complications associated with coil embolization of unruptured cerebral aneurysms. *Drugs R D* 2012;12(1): 1-7. doi:10.2165/11599070-000000000-00000
14. Lessne ML, Shah P, Alexander MJ, *et al*. Thromboembolic complications after Neuroform stent-assisted treatment of cerebral aneurysms: the Duke Cerebrovascular Center experience in 235 patients with 274 stents. *Neurosurgery* 2011; 69(2):369-75. doi:10.1227/NEU.0b013e31821bc49c
15. Chalouhi N, Jabbour P, Singhal S, *et al*. Stent-assisted coiling of intracranial aneurysms predictors of complications, recanalization, and outcome in 508 cases. *Stroke* 2013; 44(5):1348-53. doi:10.1161/STROKEAHA.111.000641
16. Briganti F, Leone G, Cirillo L, *et al*. Postprocedural, midterm, and long-term results of cerebral aneurysms treated with flow-diverter devices: 7-year experience at a single center. *Neurosurg Focus* 2017; 42(6):E3. doi:10.3171/2017.3.FOCUS1732
17. Sedat J, Chau Y, Gaudard J, *et al*. Administration of eptifibatide during endovascular treatment of ruptured cerebral aneurysms reduces the rate of thromboembolic events. *Neuroradiology* 2015; 57(2):197-203. doi:10.1007/s00234-014-1452-x
18. Dornbos D 3rd, Katz JS, Youssef P, *et al*. Glycoprotein IIb/IIIa inhibitors in prevention and rescue treatment of thromboembolic complications during endovascular embolization of intracranial aneurysms. *Neurosurgery* 2018; 82(3):268-77. doi:10.1093/neuros/nyx170
19. Jeong HW, Jin SC. Intra-arterial infusion of a glycoprotein IIb/IIIa antagonist for the treatment of thromboembolism during coil embolization of intracranial aneurysm: a comparison of abciximab and tirofiban. *AJNR Am J Neuroradiol* 2013; 34(8):1621-5. doi:10.3174/ajnr.A3501
20. Brinjikji W, Morales-Valero SF, Murad MH, *et al*. Rescue treatment of thromboembolic complications during endovascular treatment of cerebral aneurysms: a meta-analysis. *AJNR Am J Neuroradiol* 2015; 36(1):121-5. doi:10.3174/ajnr.A4066
21. Brinjikji W, McDonald JS, Kallmes DF, Cloft HJ. Rescue treatment of thromboembolic complications

during endovascular treatment of cerebral aneurysms. *Stroke* 2013; 44(5):1343-7. doi:10.1161/STROKEAHA.111.000628

22. Dornbos D 3rd, Katz JS, Youssef P, Powers CJ, Nimjee SM. Glycoprotein IIb/IIIa inhibitors in prevention and rescue treatment of thromboembolic complications during endovascular embolization of intracranial aneurysms. *Neurosurgery* 2018;82(3):268-77. doi:10.1093/neuros/nyx170.