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Treatment of tiny intracranial aneurysms with guidewire manipulation

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Abstract

Background: Tiny false intracranial rupture aneurysms are particularly rare. It is challenged both to neurosurgery and endovascular treatment.

Methods: We present here five rare cases of perforator tiny aneurysms that were diagnosed based on DSA. These patients were found due to SAH, and they decided to treat these aneurysms with endovascular therapy. After numerous attempts, the coiling microcatheter failed to access the aneurysms. As a result, the aneurysms finally were treated with guidewire manipulation.

Results: *Mean follow-up time was about 10.4 months. The* outcomes of the 5 cases were all surprisingly excellent. The patients were followed up with angiography and telephone till now. No revascularization of aneurysm was found.

Conclusions: This paper demonstrated for the first time to our knowledge that tiny false intracranial aneurysm may be treated with guidewire manipulation. While larger studies with long-term follow-up are required to validate these promising results, guidewire manipulation is a new approach worth considering when microcatheter cannot enter aneurysm.

Keywords: Intracranial aneurysm, Rupture, Guidewire manipulation, Endovascular intervention, Tiny aneurysm

Background

Tiny false intracranial rupture aneurysms are particularly rare, representing approximately 1% of all intracranial aneurysms, and 0.5–2% of all ruptured aneurysms [1]. Patients typically present with acute subarachnoid hemorrhage, and the affected population is younger than patients with saccular aneurysms [2]. Tiny intracranial aneurysms exhibit more aggressive behavior compared to saccular aneurysms and more intra-operative complications occur with tiny false intracranial rupture aneurysms, independent of the treatment types offered [3]. They are also significantly more likely to relapse and rebleed after treatment [4]. Endovascular treatment offers a lower morbidity–mortality rate compared with surgical approaches. The authors describe five rare cases of tiny false intracranial rupture aneurysms. Based on our experience, we suggest a new approach for the treatment of tiny false intracranial rupture aneurysms of artery perforators.

Methods

We present here five rare cases of perforator tiny aneurysms that were diagnosed based on DSA. These patients were found due to SAH. After they all deny of craniotomy, we decided to treat these aneurysms with endovascular therapy. During procedure numerous attempts try, the coiling microcatheter failed to access the aneurysms. As a result, the aneurysms finally were treated with guidewire manipulation. Case 4 and 5 are very similar to case 3 and 2. So we describe in detail three typical cases below.

Case 1

This was a 49-year-old female experiencing sudden headache, nausea and vomiting on August 3rd, 2012. Head CT (Fig. 1a) and initial angiography taken in local hospital on the same day revealed perimesencephalic SAH without presentation of aneurysm. After being treated conservatively as perimesencephalic non-aneurysm SAH for about 2 months, review of 3D cerebrovascular angiography (Fig. 1b) on September 21st in local hospital presented a tiny aneurysm (0.8 mm*0.8 mm)of basilar perforating artery. So, she came to our department for

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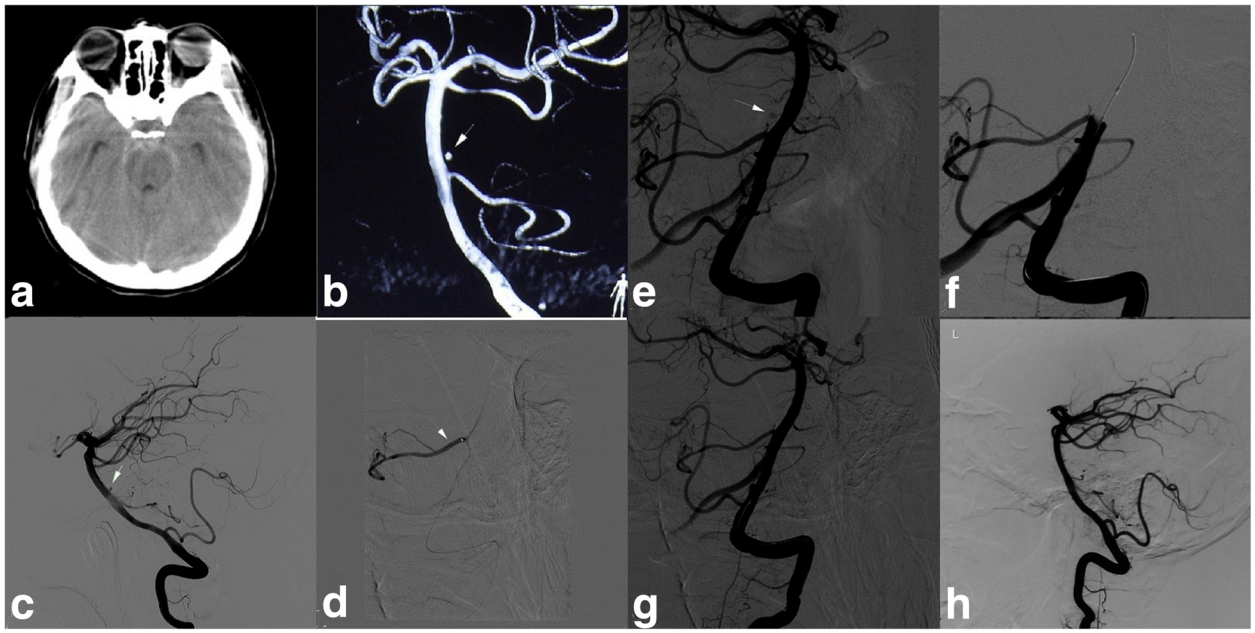

Fig. 1 a-h. Case 1: a 49-year old female experiencing sudden headache, nausea and vomiting. Computed Tomography (**a**) revealed small amount of SAH and some clotting that were restricted to perimesencephalic cisterns. Conventional Computed Tomography Angiography (**b**) and initial DSA of lateral projection (**c**) showed a tiny aneurysm (arrow) from the basilar trunk. AICA angiography (**d**) (arrow) illustrated that the aneurysm was not from anterior inferior cerebellar artery or its branches. **e** Intraoperative oblique projections of basilar artery showed contrast stagnation. Endovascular balloon (**f**) was used to occlude parent artery by compressing the origin of the perforator for about 5 min. Complete disappearance of the aneurysm was presented in (**g**) and in the 2-year follow-up image (**h**) of basilar angiogram

treatment on October 12th. Review of angiography in local hospital showed a tiny aneurysm with a diameter less than 1 mm. Angiography taken in our hospital (Fig. 1c) on October 12th confirmed the existence of the perforator aneurysm. In order to illustrate that the aneurysm was not originated from anterior inferior cerebellar artery (AICA) or its branches that was close (Fig. 1d) to the aneurysm, AICA angiography was taken. It was evident that AICA was visible while the aneurysm was invisible.

After serious discussion, surgeons decided to perform endovascular treatment. On October 16th, the patient was prepared with oral acetylsalicylic acid (ASA 300 mg) and Plavix (300 mg). The intracranial intervention surgery was operated under general anesthesia, and also under systemic heparinization to prevent arterial thromboses. Operator performed right femoral artery Seldinger puncture and put into a 6F artery sheath, making vertebral artery angiography through left vertebral artery at the level of C2. Marathon microcatheter (ev3 Neurovascular, Irvine, USA) failed to enter the cavity of aneurysm after several attempts. The operator expected electrocoagulation would take effect. We put the Traxcess 14 guidewire (Microvention, Columbia Aliso Viejo, USA.) into the aneurysm, and advanced the microcatheter close to the pedicle, then treated the guidewire as if a stent guidewire, connected it to the Solitaire stent detachment system (ev3 Neurovascular, Irvine, USA) at about 1.0 mA electronic current, and passed current through it for 4 min (Figs 2 and 3). Immediately angiography after charging showed weakened aneurysm image (Fig. 1e). Operator decided to reinforced with a 4 × 7 mm Hyperform Balloon (ev3 Neurovascular, Irvine, USA) at the exact place where the parent artery of the aneurysm was originated and inflated it for about 5 min (Fig. 1f). In both lateral and frontal projections of later angiography after inflation, the aneurysm completely disappeared (Fig. 1g). The patient suffered no complications from this procedure The patient was followed up with angiography(Fig. 1h). 1 year later and with telephone till now. No revascularization of aneurysm was found.

Case 2

A 51 year-old female patient presented with sudden severe headache and vomit. She was found to have a subarachnoid hemorrhage (Fig. 4a) with extension into the fourth ventricle.

CT angiography (Fig. 4b) and Digital Subtraction Angiography (Fig. 4c) performed 8 and 10 days after the ictus, showed a small (0.8*1.4 mm) aneurysm arising from the proximal portion of a perforating vessel on the rostral basilar artery. After a multidisciplinary discussion of the case, it was decided to pursue endovascular treatment. The patient was pre-medicated with acetylsalicylic

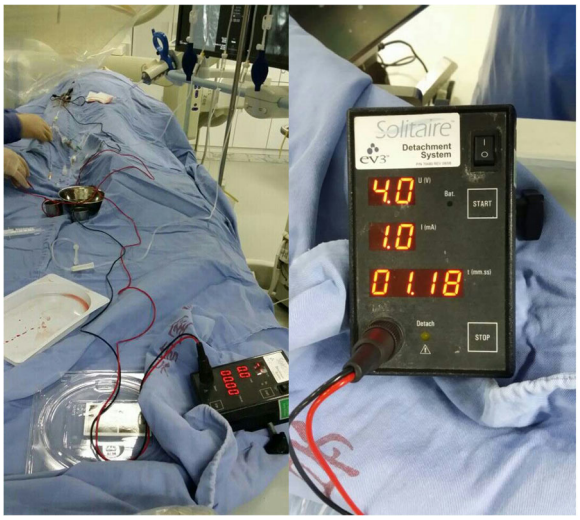

Fig. 2 **a**-**b** Intraoperative imaging **a** of Solitaire detachment system. **b** shows electric current of Solitaire detachment system at 1.0 mA, and detached for about 4 min

acid (ASA 300 mg) and Plavix (300 mg). Under general anesthesia and after administration of an intravenous bolus of 3000 IU of heparin, a 6 F Envoy guiding catheter (Cordis Neurovascular) was placed in the left vertebral artery. An Enchelon-10 microcatheter (Micro Therapeutics ev3 Neurovascular, Toledo Way, Irvine, CA USA) was then navigated over a Traxcess-14 (Microvention, Columbia Aliso Viejo, USA.) to the basilar artery. Echelon-10 failed to enter the aneurysm (Fig. 4d). The manipulation of electrocoagulation was performed in the same way as with Case 1. When the guidewire was withdrawn from the aneurysm, immediate control DSA showed no persistent filling of the aneurysm (Fig. 4e). The immediate postoperative course was uneventful and dual antiplatelet therapy was stopped. Repeat DSA 36 days later showed no persistent filling of the aneurysm and no parent artery compromise (Fig. 4f). The patient remains asymptomatic at Follow-up 6 months later.

Case 3

A male patient in his sixteen presented with severe sudden headache 2 months after head trauma. Head CT scan showed SAH. Consecutive DSA recordings (Fig. 5a and b) did reveal an aneurysmal source, a very small (1.2 mm*1.2 mm) left-sided tiny false intracranial rupture aneurysm arising from the proximal portion of left internal carotid artery perforator, and another aneurysm at the cavernous portion of left internal carotid artery.

It was decided to treat the aneurysms with endovascular therapy. After premedication with ASA (300 mg) and Plavix (300 mg), the patient was placed under general anesthesia. A bolus of 3000 IU of heparin was administered intravenously, and a 6 F Envoy guiding catheter (Cordis Neurovascular) was placed in the left carotid artery. We decided to treat the distal aneurysm first, but the microcatheter (enchelon-10) failed to get into the aneurysm assisted by the Traxcess-14 guidewire. The alternative plan was to treat the proximal aneurysm next. After embolization of the proximal cavernous portion aneurysm (Fig. 5c), operators all agreed to use two long stents to cover both the distal and proximal aneurysm. Two Enterprise stents (Codman 4.5 mm*37 cm) were deployed

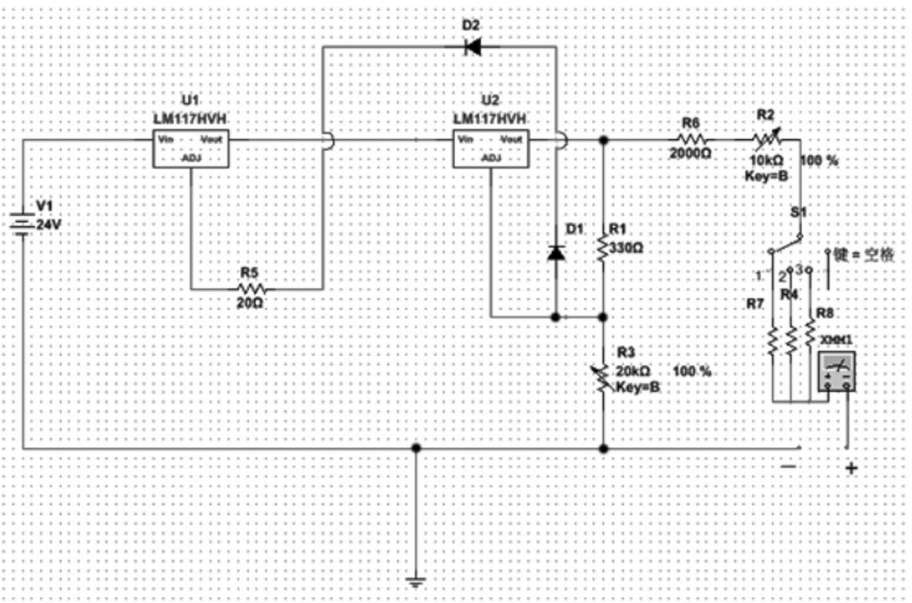

Fig. 3 Circuit diagram of Solitaire detachment system

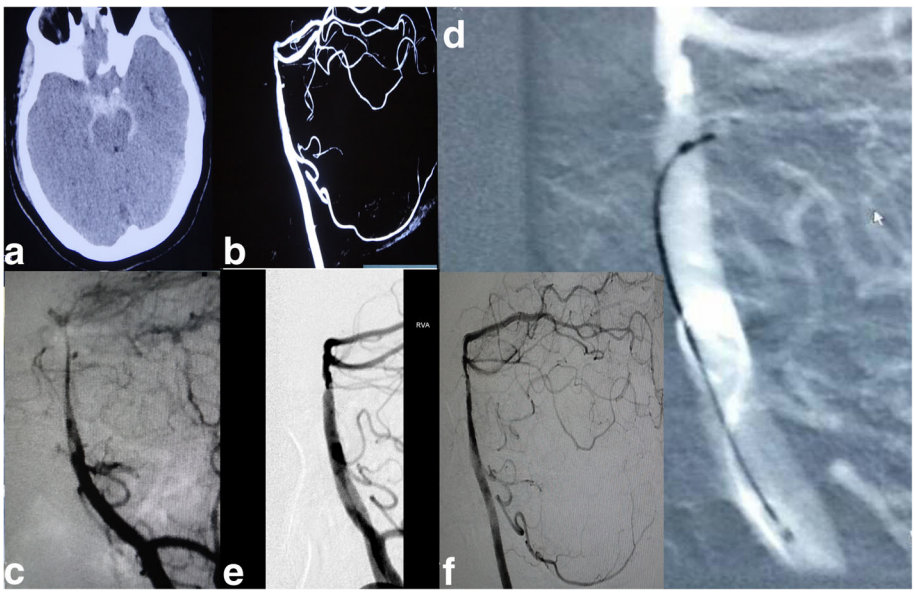

Fig. 4 a-f. Case 2: A 51 year-old female patient presented with sudden severe headache and vomiting. CT scan (**a**) showed diffused subarachnoid haemorrhage. CT angiography (**b**) and Digital Subtraction Angiography (**c**) performed 8 and 10 days after the ictus, showed a small aneurysm arising from the proximal portion of a perforating vessel of the rostral basilar artery. Lateral projection of left vertebral artery (**d**) showed Echelon-10 failed to enter the aneurysm. Immediate DSA (**e**) showed no persistent filling of the aneurysm. Repeat DSA 36 days later (**f**) showed no persistent filling of the aneurysm and no parent artery compromise

through a Prower Plus microcatheter (Codman) in the internal carotid artery. As the distal aneurysm continued to fill after deployment of 2 stents, the microcatheter was navigated again to the pedicle of the aneurysm assisted by the Traxess-14 guidewire (Fig. 5d–f). The same electrocoagulation procedure was performed just as the first cases above. Immediate disappearance of the aneurysm was noted (Fig. 5g). Follow-up DSA was performed 6 month later (Fig. 5h), confirming no residual aneurysm filling. At 7 months, the patient had no neurologic deficits and was able to return to her normal life as a student.

Result

We describe five rare cases of tiny false intracranial rupture aneurysms (Table 1). Three of aneurysms located at basilar artery, another aneurysm located in internal carotid artery and the other one located at posterior cerebral artery. These patients were all treated with guidewire manipulation. *Mean follow-up time was about 10.4 months. The* outcomes of the 5 cases were all surprisingly excellent. The patients were followed up with angiography and telephone till now. No revascularization of aneurysm was found.

Discussion

The management of intracranial aneurysms in our center consists of a multidisciplinary evaluation by the neurosurgical and endovascular teams. All patients are evaluated after their presentation to our hospital, and treatment is performed when the patient is stable for the procedure, usually within a timeframe of less than 72 h after admission. With consensus, the treatment choice for tiny false intracranial rupture aneurysm at our institution is primarily endovascular approach.

Tiny false intracranial rupture aneurysm still is challenging to us all. Clinical manifestations and signs of this type of patients were milder than typical aneurysmal SAH. Additional salient features of these aneurysms include the usual occurrence on low flow arteries and the fact that they are frequently partially thrombosed upon discovery. These features underscore a potentially more benign natural history, and we tend to underestimate that these aneurysms are likely dissecting in nature. Nevertheless, re-rupture occurred in one of seven cases in our review that was not treated early [5]. Oft-seen proximal clip occlusion or trapping approach was employed in treating these aneurysms [5, 6], but the vessel was small, diseased, and often less collateralized by frequently seen anastomoses. In addition, given the extremely fragile wall of aneurysm, the surgical management can be complicated and risky; these aneurysms are candidates for endovascular therapy.

Reports of tiny false aneurysm treatment were seldom, especially cases treated with endovascular therapy. Hamel et al. reported failure of advancement of microcatheter into aneurysm, followed by surgical clipping via a suboccipital craniotomy, which was then complicated by tension pneumocephalus [7]. Sukh Que. Park, et al. reported

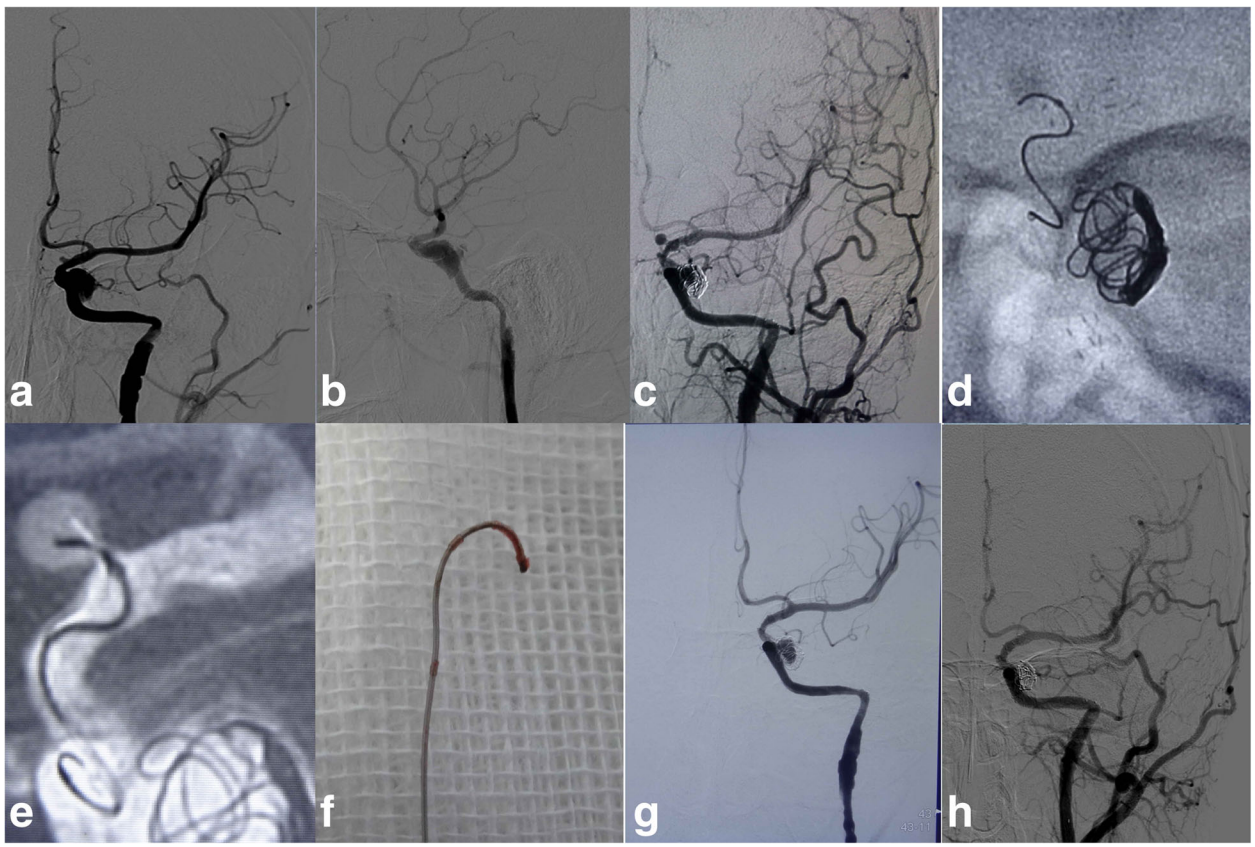

Fig. 5 a-**h** Case 3: A patient in his sixteen presented with severe sudden headache 2 months after head trauma. Frontal (**a**) and Lateral (**b**) projection of left internal carotid artery showed a very small blister-like aneurysm arising from the proximal portion of internal carotid artery perforator, and another aneurysm at the cavernous portion of internal carotid artery. After embolization of the cavernous aneurysm, the distal blister-like aneurysm continued to fill after deployment of 2 stents (**c**). Frontal projection of left internal carotid artery without subtraction (**d**) and Roadmap (**e**) showed microcatheter was navigated again to the pedicle of the aneurysm assisted by the Traxess-14 guidewire (**f**). Immediate disappearance of the aneurysm (**g**) was noted. Follow-up DSA was performed 6 month later (**h**), confirming no residual aneurysm filling

3 cases of tiny perforator aneurysms (diameter less than 1 mm) and all were treated with conservative treatment successfully. They defined this kind of aneurysms as premesencephalic SAH, but not universally acknowledged yet [8]. Lukui Chen, et al. reported two circumferential branch aneurysms of the basilar artery and treated with intravascular coiling and the result was excellent [9].

Recently, multilayer flow-diverting stents appear to be a promising strategy. Peschillo performed three cases using flow-diverting stents based on previous successful experience with their use in intracranial dissections [10].

Table 1 Detail of all five aneurysm

Age	location	Aneurysm size	result	Follow-up
49	Basilar artery	0.8 mm*0.8 mm	good	12 month
51	Basilar artery	0.8 mm*1.4 mm	good	6 month
16	Internal carotid artery	1.2 mm*1.2 mm	good	7 month
59	Posterior Cerebral Artery	1.0 mm*3 mm	good	14 month
54	Basilar artery	0.7 mm*0.6 mm	good	13 month

Directly (two thromboembolic events) or indirectly (one hemorrhage at the external ventricular drain site, probably caused by the dual antiplatelet therapy) complications occurred in all three patients and one case resulted in permanent morbidity. Kuhn reported a serial of four cases of tiny false intracranial rupture aneurysms [11]. All aneurysms were arisen from the proximal section of perforator artery. No periprocedural or postprocedural complications occurred, but mild intimal hyperplasia was observed on follow-up. We cannot overlook the effect of stent.

In our case series, the pedicles of these aneurysms were so thin that microcatheter could not reach the designated position after several attempts. Then, electrocoagulating the aneurysm with guidewire was tried, and immediate result was excellent. In Case 3, 2 stents were successes to cover the aneurysm, but none contrast agents retention was observe, indecated intimal hyperplasia would be more possibly. So we try our method, the aneurysm was opaque till then. The exact mechanism is unknown. Pure electrocoagulation can be one of explanation, This is the

initial trial to use guidewire manipulation for tiny false intracranial rupture aneurysm. Even though the number of cases is few, it is undoubtedly a new thought. These cases deserve further investigation. The patients have no rebleeding up to now and still at follow-up with phone.

However, the main concern about this endovascular technique is its durability. But 10.4 months mean follow-up times and systemic heparinization can exclude the effect of vessel spasm and thrombus formation to some extent. Guidewire manipulation provides a new thought when microcatheter could not be navigated into the aneurysm. The exact mechanism needs further investigation. Whether it can be applied to other vascular disease, like arteriovenous malformation, dural arteriovenous fistulas or other small vascular disease, need further exploration.

Conclusion

Endovascular guidewire manipulation represents a new thought in the technique of neurointerventional aneurysm treatment. We showed that the treatment of tiny false intracranial rupture aneurysms with guidewire manipulation can be effective and safe through short-term observation. Larger studies with long-term follow-up are required to validate these promising results.

Abbreviations

AICA: Anterior Inferior Cerebella Artery; ASA: Acetylsalicylic Acid; CT: Computed Tomography; DSA: Digital Subtraction Angiography; SAH: Subarachnoid Hemorrhage

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Each author stated that this work contains no libelous or unlawful statements and does not infringe any other personal or proprietary right of others, nor contains any fraudulent, plagiarized or incorrectly attributed material.

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Availability of data and materials

Yes

Authors' contributions

YJ make substantial contributions to conception and design, and acquisition of data, and analysis and interpretation of data; YJ participate in drafting the article; and YL give final approval of the version to be submitted and any revised version.

Ethics approval

The protocol of this study was carried out according to the principles of the Declaration of Helsinki and approved by the Medical Ethics Committee of Beijing Tiantan Hospital. Written informed consent was obtained from all of the participants.

Consent for publication

Written informed consent was obtained from patient's parents or patient for publication of this case report and accompanying images.

Competing interests

Each author identified no financial interests or affiliations with institutions, organizations, or companies relevant to the manuscript. None competing financial interests exist.

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