Endovascular therapy for posterior communicating artery-infundibular dilatation aneurysms

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Abstract

Objective: The purpose of this study was to explore the effect of endovascular therapy on posterior communicating artery-infundibular dilatation aneurysms.

Methods: A total of 15 patients with ruptured aneurysms caused by posterior communicating artery-infundibular dilatation who were treated in our neurosurgical center from January 2015 to December 2018were included in this study. They were performed with bilateral internal carotid angiography and vertebral angiography and treated with endovascular method. The modified Rankin Scale (mRS) was used for clinical follow-up for 18 months.

Results: There were 10 patients in the posterior communicating artery-infundibular dilatation aneurysms with non-fetal posterior cerebral artery. Among them, 8 patients were treated with coil-alone embolization. Immediate imaging showed infundibular dilation residual in 6 cases and no contrast filling in either infundibular dilation or aneurysm in 2 case. Another 2 were treated with stent-assisted coiling embolization, and immediate imaging showed no contrast filling. Of the 5 patients in posterior communicating artery-infundibular dilatation aneurysms with fetal posterior cerebral artery, 4 were only coiled in the aneurysm sack with contrast filling in infundibular cones, and 2 were treated with stent assisted coiling. Among the 10 patients with non-fetal posterior cerebral artery, 3 showed recurrence, 4 showed stable images, 2 were also stable with no contrast filling in infundibular dilation or aneurysm and 1 was

lost to follow-up. Among the 5 patients with fetal posterior cerebral artery, 1 showed stable images,3 showed recurrence and 1 was lost to follow-up.

Conclusions: For posterior communicating artery-infundibular dilatation aneurysms with non-fetal posterior cerebral artery, stent-assisted coiling of aneurysm embolization combined with occlusion of cones is effective to prevent or reduce recurrence.

Key words: posterior communicating artery-infundibular dilatation aneurysms; endovascular treatment; fetal posterior cerebral artery; stent-assisted coiling of aneurysm embolization; occlusion of cones.

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Introduction

Spontaneous subarachnoid hemorrhage (SAH) is a common acute and severe disease in neurology [1]. Intracranial aneurysms are the most common cause of spontaneous subarachnoid hemorrhage, and the posterior communicating conus is one of the most common sites of aneurysms [2]. The aneurysms growing in the conus posterior communicating artery are a special type of posterior communicating artery aneurysms. Therefore, the choice of treatment for these aneurysms is different from other posterior communicating aneurysms. Because of the special growth site of posterior communicating artery-infundibular dilatation aneurysms, it is necessary to distinguish them from common intracranial aneurysms [3].

Currently, there is no final conclusion yet about whether the posterior communicating artery infundibular cone is a normal structural variation or a pre-aneurysmal lesion. There is little information available for this controversy. Clinically, there are cases of fetal rupture and hemorrhage which were directly caused by the posterior communicating cone without any morphological change [4]. However, there are also cases of enlarged cone and aneurismal saccular changes dilated from the posterior communicating infundibulum found during follow-up [5]. Most of the aneurysms located in the posterior communicating artery are formed by infundibular conical structure combined with local dilation. In this study, we aimed to explore the effect of endovascular therapy on posterior communicating artery-infundibular dilatation aneurysms.

Subjects and Methods

Subjects

A total of 15 patients with posterior communicating artery-infundibular dilatation aneurysms were recruited from the Department of Neurosurgery, the First Affiliated Hospital of Wannan Medical College between January 2015 and December 2018. All participants provided written informed consent. The present study was approved by the Ethics Committee of Wannan Medical College. We retrospectively analyzed the imaging features and clinical data of

patients with ruptured aneurysms at the infundibular conical origin of the posterior communicating artery. Among the patients, 4 were male and 11 were female. All patients with Hunt-Hess Grade of I to III.

Imaging examination

Brain computed tomography (CT) showed subarachnoid hemorrhage primarily accumulated in suprasellar cistern. There were 10 patients with a modified Fisher grade of I-II and 5 with a modified Fisher grade of III-IV. All patients received cerebral angiography, including bilateral internal carotid angiography and vertebral angiography. The results of angiography showed that the origin of the posterior communicating artery was in conical or triangular shape, with posterior communicating artery stemming out from its top. Carotid compression test of internal carotid artery (ICA) was performed at the conical lesion side to determine whether it was fetal posterior cerebral artery. Specific descriptions rather than Raymond grade were utilized for both immediate post-procedure and follow-up digital subtraction angiography (DSA) angiography images.

Treatment

The patients were treated under general anesthesia with heparinization during the operation. Starting from angiogram, heparin was given by intravenous injection at a dose of 80 U/kg. The dose was increased by half-dose every 30 min until it reached 1000 U and then maintained. The arterial channel was kept unobstructed for drip transfusion. Heparin was only used for patients treated with coil-alone embolization. For emergency cases that required stent-assisted embolization, after angiography was completed with a definitive diagnosis, 300 mg of plavix and 300 mg of aspirin were given through anus or stomach tube. If intra-stent thrombosis and slower forward flow were found on imaging, 10-minute infusion of Tirofiban (5 mg/100 ml) through arterial catheter was given at a low dose of 4-5 ml based on body weight. This procedure could be done repeatedly. The Enterprise stent (Codman) was used for treatment, and the stent delivery catheter was Headway 21 (MicroVention) or Prowler Select Plus microcatheter (Codman). The stenting was either half deployment or post (coiling) deployment. The coiling microcatheter for aneurysm was Enchelon 10 (EV3). Patients who underwent re-treatment with stent-assisted embolization received conventional 75 mg of plavix and 100 mg of aspirin by oral for 3 to 5 days prior to procedure, and the medications were adjusted based on the thrombelastogram. Other treatments included lumbar puncture, vessel spasm prevention, fluid infusion and nutrition support, dehydration, intracranial pressure control, and other management needed according to clinical symptoms.

Follow-up

The patients received DSA, computed tomography angiography (CTA) or magnetic resonance angiography (MRA) were follow-up for 3-6 months or 12-18 months after procedure. Specific description rather than Raymond Scale was utilized for the DSA follow-up images. The modified Rankin Scale (mRS) scores were used for clinical follow-up of the patients, and the patients with poor outcome were rated with mRS score ≥3.

Statistical analysis

All experiments were repeated three times with the same sample. Statistical analysis was made by software SPSS24.0 (International Business Machines, corp., Armonk, NY, USA). Counting data were expressed as means ± standard deviation (SD). Measurement data are expressed as a percentage.

Results

Imaging characteristics

Ten of the 15 patients had non-fetal posterior cerebral artery. Among them, 8 patients received coil-alone embolization, of which 6 showed residual aneurysmal neck, and 2 had no contrast filling in aneurysm or cone. Another 2 patients received stent-assisted coiling embolization, and both infundibular cone and aneurysm were occluded together, with no contrast filling in either the cone or the aneurysm (Figurer 1a-1e). Five of the 15 patients were confirmed through the carotid compression test on the involved side, and it suggested that their posterior communicating artery was the origin of fetal posterior cerebral artery (Figurer 2a-2f). Among them, 1 patient received stent-assisted embolization, 4 received coiling embolization only in the bulged bleb, and all of them had contrast filling in infundibular cones.

Follow-up

Two patients were lost to follow-up. The follow-up period was 20.5 ± 4.1 months. Among the 9 patients with non-fetal posterior cerebral artery, 8 were available for follow-up. Among the 7 patients treated with coil-alone embolization, 3 showed obvious recurrence, and then they received stent-assisted embolization, and the infundibular conical origin was also occluded together. Both aneurysm and cone showed no contrast filling. Imaging of another 4 patients indicated they were in stable condition and continued to be followed up. Two patients who received stent-assisted embolization showed no contrast filling in aneurysm or infundibular cone during follow-up (Figurer 1f-1h). Among the 5 patients with fetal posterior cerebral artery, 4 were available for follow-up, of whom 3 received retreatment with stent-assisted embolization, and 1 was in stable condition and continued to be followed up (Figurer 2g-2h), and 1 old-aged patient was lost to follow-up due to other reasons after 3 months.

Postoperative Hunt-Hess grades and MRS scores

All 15 patients successfully completed operation without any intra-procedure aneurysm rupture or intra-stent thrombosis. Among the 15 patients, 12 had preoperative Hunt-Hess grades of I to II, and 3 had a preoperative Hunt-Hess grade of III. All of the 15 patients showed clinical improvements after treatment without any new neurological deficit. During follow-up, 13 of the 15 patients had mRS scores of ≤ 2.

Discussion

The posterior communicating artery connects the internal carotid artery system and vertebral artery system. After originating from the internal carotid artery, it may show dilation at the base. If the dilation is obvious, it shows an apparent conical or triangular shape on the image,

which is usually known as posterior communicating cone (or called "infundibular dilation). The study of Vlajković about infundibular dilatation of the posterior communicating artery in a defined population showed a 2.2% incidence rate of posterior communicating infundibular dilation in autopsy reports [6]. In addition, Vlajković performed autopsy on 190 fetuses and found there was no posterior communicating dilation. Therefore, he believed that the dilation was acquired after birth. Although it is an indisputable fact that aneurysm does occur at the dilation cone, it has been controversial whether the posterior communicating cone represents a normal vascular variant or pre-aneurysm lesion. Generally, the posterior communicating cone is considered to be less than 3 mm. Some scholars studied a group of cases and found that a larger-than-3mm posterior communicating cone was not necessarily pathological [7]. The posterior communicating aneurysm at the conical origin was found to be the main type of aneurysm that caused spontaneous subarachnoid hemorrhage after rupture, and the local morphology of the cone showed obvious change in most cases [8]. In our study, all of 15 patients had obvious morphological changes. We believed that if the cone had obvious irregular morphological change, it should be regarded as pre-aneurysmal lesion, and close attention was needed to pay. If the change further enlarged, treatment of the cone can be considered.

For open surgery clipping, it is difficult to distinguish between the ruptured aneurysm evolved from the cone and the conventional ruptured posterior communicating aneurysms. It is unreliable to determine the fetal-type posterior cerebral artery through CTA [9-11]. With the development of endovascular therapy, more patients choose intervention treatment. Carotid compression test under DSA is still the gold standard to determine whether a vessel is a fetal posterior cerebral artery. During treatment, it is needed to determine whether there is fetal-type posterior cerebral artery. Treatment of ruptured aneurysms evolved from conical dilation is not different from the treatment of the conventional ruptured posterior communicating aneurysms [12-14]. Endovascular strategy for treating posterior communicating artery aneurysm according to angiographic architecture is reservation or sacrifice of posterior communication artery.

In the present study, 10 patients with aneurysms combined with non-fetal posterior cerebral artery were treated by endovascular therapy, and we found that recurrence likely to occur if only the rupture point was embolized with coiling alone. Finally, 5 of the 10 patients, including the recurrent patients, received stent-assisted embolization with the cone occluded together, and there were no new clinical symptoms after operation. However, in case of ruptured aneurysms evolved from the cone with fetal type posterior cerebral artery, treatment and vascular reconstruction were difficult [13, 15]. Sometimes, we could only pack the bleb at the rupture point initially and embolize the residual sac that can be observed on the imaging at a later stage. If the stent-assisted embolization is used at the first stage, the concern is that use of the antiplatelet medication could increase the risk of re-bleeding. Moreover, complex intervention techniques were required to embolize the aneurysm while still maintaining the patency of parent artery. In this study, the treatment plan for 4 patients was to embolize the rupture points only. During follow-up, 3 aneurysms still showed recurred sacs with contrast filling on the images, and they were treated with stent-assisted embolization without

occluding the conical origin.

Conclusion

In conclusion, we found that it was difficult to select the stent type and pin-point the proximal deployment location when stent-assisted embolization was performed. Our experience suggested that procedures should be performed in stages. Pack the rupture points first, and then perform stent-assisted embolization after follow-up to improve safety. Moreover, the Raymond Scale is unsuitable to evaluate the treatment results, due to the fact that it is hard to determine whether the conical dilation is part of aneurysm or not. Further studies are needed for this type of posterior communicating aneurysms.

Acknowledgments

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Conflicts of interest

None.

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Figure legends

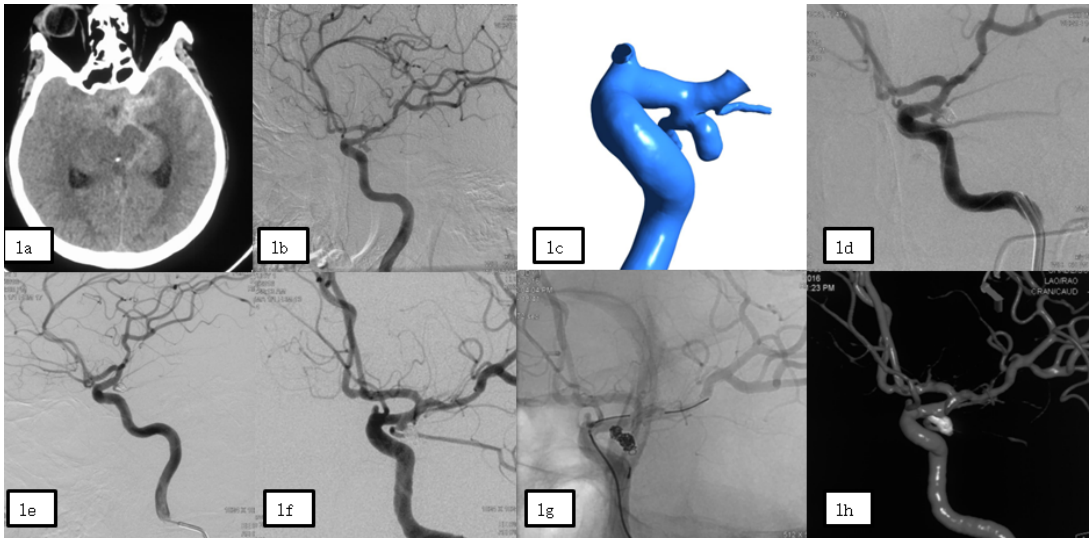

Figure 1. Posterior communicating aneurysm at the conical dilation with non-fetal posterior cerebral artery. (a) Hemorrhage accumulated in left suprasellar cistern; (b) Angiography of left posterior communicating conical aneurysm; (c) 3D image of morphology of the aneurysm; (d) Coiling alone embolization of the sac; (e)Angiography of left posterior communicating conical aneurysm immediately after procedure; (f) Recurred aneurysm at 6-month follow-up; (g) Stent-assisted embolization, with posterior communicating cone being occluded together; (h)Post-procedure 3D image.

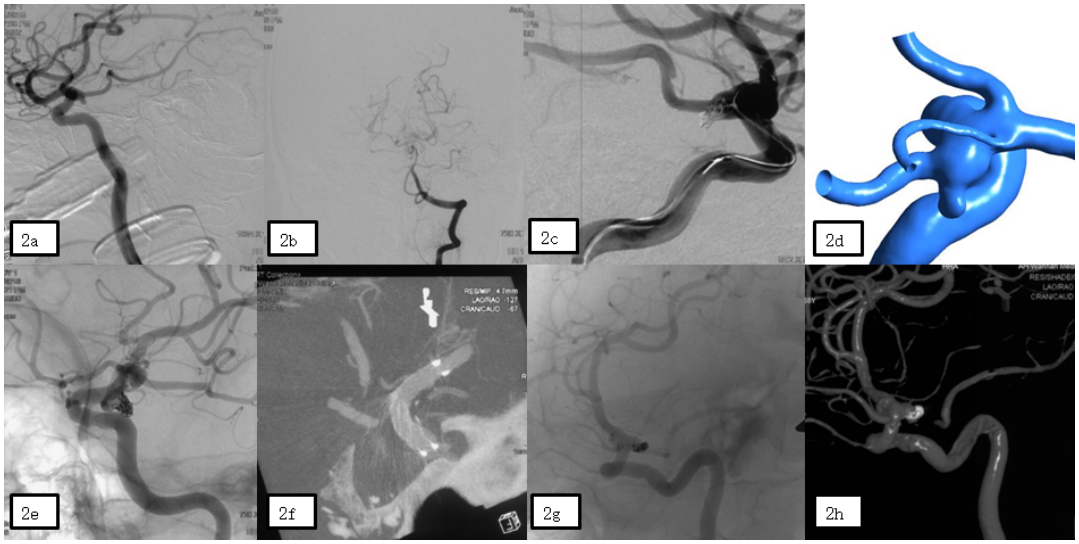

Figure 2. Posterior communicating aneurysm at the conical dilation with fetal-type posterior cerebral artery. (a) Right posterior communicating aneurysm at the conical origin; (b) Angiography of vertebral artery, no blood supply from vertebral artery to posterior cerebral artery when compressing the right internal carotid artery; (c) Stent-assisted embolization; (d) 3D image of the aneurysm; (e) Stent implanted in the cone, immediate angiograph right after procedure; (f) Dyna CT showing good stent deployment in the posterior communicating artery and internal carotid artery; (g) Partial contrast filling of sac, and partial coil displacement at 18-month follow-up; (h) 3D image during follow-up.