Endovascular Treatment of Unruptured A1 Segment Aneurysms

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Summary

Aneurysms of the A1 segment of the anterior cerebral artery (A1A) are rare and challenging to treat. Less information is available regarding their management by endovascular approach. We evaluated our experience of endovascular treatment in 15 patients with unruptured A1As.

We retrospectively reviewed unruptured A1As treated by embolization at our hospital. The clinical data and angiographic results were reviewed. A special technique involving shaping microcatheter tips was used for catheterization.

From September 2009 to December 2012, 15 patients presenting with unruptured A1As were identified. All the patients were treated by selective embolization including five patients with balloon-assisted coiling (BAC) or stent-assisted coiling (SAC). These adjunctive techniques were used to catheterize the sac safely or to protect a branch at the neck. According to the location and direction of the aneurysm, "Z-shaped", "S-Shaped" or "U-Shaped" microcatheter tip shaping was used for microcatheter positioning and stabilization. All patients showed an excellent clinical outcome. A complete aneurysm occlusion was obtained in all the patients.

Endovascular treatment of A1As is feasible and associated with good results. Because of their location and close relationship with perforators, endovascular treatment of A1As sometimes requires the use of BAC or SAC. The microcatheter tip shaping technique is very important for coiling. Our results suggest that en-

dovascular treatment is a suitable therapeutic option for unruptured A1As when the aneurysm size is optimal for embolization.

Introduction

Aneurysms of the proximal segment of the anterior cerebral artery (A1As) are rare, accounting for 0.8%-3.4% of intracranial aneurysms. They are challenging to treat because of their close relationship with perforators¹. A1As are also an important cause of non-traumatic subarachnoid hemorrhage (SAH). Most of these aneurysms are treated by either surgical or endovascular treatment when associated with a high risk of bleeding. There are limited data in the literature concerning the endovascular treatment of unruptured A1As. The aim of this study was to report our experience with endovascular treatment and imaging follow-up of 15 patients with unruptured A1As.

Materials and Methods

Population

We studied all patients with aneurysms included in our database and treated by endovascular methods between December 2009 and December 2012: 1435 patients with 1516 aneurysms were embolized by our team; 15 (1.05%) of them had unruptured A1As (Table 1). All the aneurysms were in compatible shape for

Table 1 Characteristics of fifteen patients with A1As.

Patient no.	Age/sex	Aneurysm size (mm)	Aneurysm neck (mm)	Branch at the neck	Location on parent artery	Treatment	Angiographic outcome	Follow-up (month)	Outcome (GOS)
1	53/M	3.5×5.6 saccular	3.0	YES	Superior	Coiling, no shaped tip	Co	4	5
2	49/M	3.4×4.3 saccular	3.3	NO	Superior	SAC, no shaped tip	Co	10	5
3	57/F	3.3×4.2 saccular	2.9	NO	Superior	Coiling, S-shaped tip	Co	4	5
4	62/F	3.4×3.5 saccular	2.8	NO	Superior	Coiling, Z-shaped tip	Co	10	5
5	55/F	4.2×6.1 saccular	3.3	NO	Superior	Coiling, S-shaped tip	Co	11	5
6	62/F	2.6×3.1 saccular	2.5	Yes	Superior	BAC, no shaped tip	Co	35	5
7	77/F	4.5×4.7 saccular	3.4	NO	Superior	Coiling, S-shaped tip	Co	23	5
8	49/F	4.9×5.5 saccular	3.7	NO	Superior	Coiling, Z-shaped tip	Co	18	5
9	49/F	2.7×2.9 saccular	2.3	NO	Superior	BAC, S-shaped tip	Co	14	5
10	39/F	4.2×4.4 saccular	3.2	NO	Superior	Coiling, S-shaped tip	Co	15	5
11	47/F	15×17 saccular	6.2	Yes	Superior	SAC, no shaped tip	Co	16	5
12	58/F	2.2×3.0 saccular	2.1	NO	Superior	BAC, U-shaped tip	Co	31	5
13	37/F	3.0×3.5 saccular	2.8	NO	Superior	Coiling, S-shaped tip	Co	12	5
14	42/F	3.8×4.5 saccular	3.1	NO	Superior	Coiling, S-shaped tip	Co	13	5
15	73/F	3.5×4.6 saccular	3.2	NO	Superior	Coiling, U-shaped tip	Co	24	5

BAC balloon-assisted coiling; SAC Stent-assisted coiling; Co Complete occlusion; GOS Glasgow outcome scale

coiling. The indications for treatment included a de novo aneurysm (n=2), a cerebral arteriovenous malformation (hemodynamic aneurysms, n=1) and a relatively young age (<65 years, n=12).

Aneurysm characteristics

The maximum dimension of the sac ranged from 2.9 to 17 mm (mean 5.12 mm) and aneurysm neck size ranged from 2.1 to 6.2 mm (mean 3.2 mm). Three aneurysms had branches at the neck. All aneurysms were superiorly located, a few millimeters after the internal carotid artery (ICA) bifurcation. Endovascular treatment was performed in all patients (Table 1).

Endovascular procedure

All patients were treated by endosaccular coiling. An Echelon-10 microcatheter (M.T.I-ev3, CA, USA) or Headway 17 microcatheter (MicroVention, Aliso Viejo, CA, USA) was used for catheterization. Microcatheter tip were steam shaped into "S", "Z" or "U" shape according to the configuration of A1As and their parent arteries. If balloon-assisted coiling (BAC) was required, a HyperForm balloon (Micro Therapeutics, Irvine, CA, USA) was always used. If stent-assisted coiling was required, NeuroForm (Boston Scientific, CA, USA) stents was always used and patients were put on 75 mg clopidogrel and 100 mg aspirin for at least three days before the endovascular procedure and were maintained on the same dosage for at least six weeks. Aspirin was continued for six months.

Immediate outcome

Aneurysm obliteration was evaluated by angiography and classified as complete occlusion, neck remnant, or incomplete occlusion. Clinical outcome was graded according to a modified Glasgow Outcome Scale (GOS).

Figure 1 Embolization of A1A with branches at the neck. A) 3D reconstruction of the left ICA injection showed an A1 aneurysm at the medium part of the A1 fenestration (arrow). A branch artery (FOA) perforated from the neck of the aneurysm (double arrow) and a Heubner artery arose from the FOA trunk (arrowhead). B) The angle formed by the aneurysm and the proximal parent artery was blunt and the microcatheter easily navigated into the sac without shaping the tip. C) A stent microcatheter was prepared during embolization in case of unstable coiling (arrow). D) Final angiographic control showed a complete aneurysm occlusion without stent-assisted coiling and the branch artery was not influenced. E) Follow up angiography (4 months) showed no recurrence of the aneurysm.

Patient follow-up

Angiography was performed at three to six months. Further examinations were obtained yearly if needed.

Illustrative cases

Case 1: A 53-year-old man (Patient 1) presented with a de novo aneurysm detected at CT angiography. Angiography showed a 3.45 mm

Figure 2 Embolization of A1A with an “S-shaped” microcatheter tip. A) Angiography showed an A1A with a small neck (arrow). The acute angle formed by the aneurysm and the proximal parent artery made catheterization difficult. B) A retrograde approach was attempted, but compression test showed there was no anterior communicating artery. C) The microcatheter tip was shaped into an “S” shape (arrows) and the shaped tip allowed successful coil delivery into the sac without significant kick-backs. D) Final angiography showed a complete aneurysm occlusion. E) Follow-up angiography (4 months) showed no recurrence of the aneurysm.

×5.6 mm A1A with a wide neck (Figure 1A). A branch artery (fronto-orbital artery, FOA) perforated from the neck of the aneurysm and a Heubner artery arose from the FOA trunk. Although the aneurysm was superiorly located, the angle formed by the aneurysm and the proximal parent artery was blunt. So the micro-

angiography showed no recurrence of the aneurysm (Figure 1E).

Case 2

A 57-year-old woman (Patient 3) presented with a right A1A detected by DSA. Previous attempt of endovascular treatment in another institution failed because aneurysm catheterization was unfeasible. Angiography showed a 3.32 mm × 4.24 mm A1A with a small neck (Figure 2A). The acute angle formed by aneurysm and proximal parent artery made catheterization more suitable by retrograde approach, but compression test showed there was no anterior communicating artery. So we shaped the catheter tip into “S” shape and the shaped tip was successful at coil delivery into the sac without significant kick-backs (Figure 2B). Final angiographic showed a complete aneurysm occlusion (Figure 2C) and the patient woke up with a normal neurological examination. Follow up angiography showed no recurrence of the aneurysm (Figure 1E).

Case 3

A 55-year-old woman (Patient 5) presented with a right A1A detected by digital subtraction angiography (DSA). Angiography showed a 4.2 mm × 6.1 mm A1A located on the superior posterior wall of the parent artery (Figure 3A). An “S-shaped” technique was used and the catheter tip was successfully positioned into the aneurysm sac (Figures 2B and 3C). Final angiography showed a complete aneurysm occlusion (Figure 3D). Follow-up angiography showed no recurrence of the aneurysm (Figure 3E).

Results

Fifteen patients with A1As were embolized during the study period, and the results are shown in Table 1. There were two men and 13 women; the mean age was 53.9 years (range 37-77). The maximum dimension of the sac ranged from 2.9 mm to 17 mm (mean 5.12 mm) and aneurysm neck size ranged from 2.1 mm to 6.2 mm (mean 3.2 mm). The perforating artery was incorporated into the neck in three cases. Endovascular treatment was successful in all patients. The catheterization of A1As were challenging in 12 patients because of their superior

location and aneurysm sac direction. “Z-shaped”, “S-Shaped” or “U-Shaped” microcatheter tips helped catheterization in these cases. In five cases, the microcatheter could not be safely placed or stabilized. Therefore, embolization required the use of a balloon or stent. The balloon was used to protect a perforator at the neck in two patients and to fix the microcatheter tip in one patient. The stent was used to protect the parent artery in two patients. All patients showed an excellent clinical outcome (GOS=5). Immediate angiographic control showed a complete occlusion in all cases. Follow-up angiography showed complete occlusion.

Discussion

Our study shows that endovascular treatment of A1As is feasible and associated with good clinical and anatomical results. A1As have been diagnosed with increasing frequency probably because of increasing awareness. Aneurysms of the proximal anterior cerebral artery have three characteristics that differ from intracranial aneurysms in general: 1) they are usually small; 2) they can arise at the origin of perforators; and 3) they rupture at a smaller size. Because of these specific features, A1 aneurysms are technically challenging to treat and there are limited data on their neurosurgical and endovascular treatment.

The treatment of unruptured intracranial aneurysms (UIAs) remains complex and not clearly defined. While for ruptured intracranial aneurysms the management and the treatment option (surgery or endovascular treatment) are well defined by several trials, for asymptomatic UIAs the best management is still uncertain. The rationale to treat an UIA is to prevent its rupture and consequent SAH and all complications derived from hemorrhage or reduce/eliminate neurological palsy. The patient's clinical history, aneurysm characteristics, and strategy management influence the natural history of UIAs and treatment outcomes.

According to the International Study of Unruptured Intracranial Aneurysms (ISUIA), patient age over 60 is associated with a statistically significant increased risk of rupture. However, even if the aneurysm is discovered at an early age, the choice of treatment could be considered during the follow-up time according to the five-year cumulative rupture risk rate in or

Figure 4 Catheter tip shaping techniques for different kinds of A1As. A) No shaped catheter tip is suitable for aneurysms located in the superior wall of the A1 segment and pointing distally. B) Nor can any shaped catheter tip be used by a retrograde approach for aneurysms located in the superior wall of the A1 segment and pointing proximally. C) An "S-shaped" catheter tip is suitable for aneurysms located in the superior wall of the A1 segment and pointing proximally, especially for when the aneurysm is away from the ICA bifurcation. D) A "Z-shaped" catheter tip is suitable for aneurysms located in the superior wall of the A1 segment, pointing proximally, close to the ICA bifurcation. The "Z-shaped" catheter tip ignored the angle between the terminal portion of the ICA and the proximal portion of the A1 segment. E) A "U-shaped" catheter tip is especially suitable for aneurysms located in the inferior wall of the A1 segment. It is also suitable when the aneurysm is located in the anterior or posterior wall.

der to prevent rupture. In our group, most of the patients were chosen for embolization because of a relatively young age (n=12). Other indications for treatment included de novo aneurysm (n=2) and cerebral arteriovenous malformation (n=1).

The guidelines for the management of ruptured aneurysm point out that in patients with ruptured aneurysms judged to be technically amenable to both endovascular coiling and

neurosurgical clipping, endovascular coiling should be considered. But unlike ruptured aneurysms, Kunz et al.² pointed out that treatment of UIAs can be conducted with an equivalent low rate of permanent morbidity for clipping, and coiling treatment of symptomatic aneurysms elevates the procedural risk. However, the majority of unruptured aneurysms in the USA are now treated with endovascular coiling. Although surgical clipping is used for treat-

ment of most ruptured aneurysms, its use is decreasing over time. Dissemination of endovascular procedures appears widespread across patient and hospital subgroups. In addition, the advantages of coiling over clipping would be better realized if the cost of coils could be comparably reduced to that of clips.

Mitchell et al.³ claimed that aneurysm size 4 mm or smaller is a risk factor for intraoperative rupture in ruptured but not unruptured aneurysms. In our group, ten aneurysm diameters were less than 4 mm but this adds no risk factor for embolization for they are unruptured.

Thromboembolic events are the most common complication following coiling of UIA. However, Kang et al.⁴ found no statistically significant relationship between the presence and the number of clinically silent ischemic lesions on diffusion-weighted imaging and cognitive changes after the procedure.

In our series, most unruptured A1As suitable for coiling were treated by endovascular approach. The challenging part of endovascular treatment is aneurysm catheterization because they are small and superiorly located, a few millimeters after the ICA bifurcation: in this situation, the microcatheter guidewire is inferiorly directed to enter the A1 origin and, then, it must immediately be turned in the opposite direction to enter the aneurysm. In most cases, the microcatheter could not be easily placed or stabilized. So special tip-shaping techniques are needed for microcatheter positioning and stabilization.

Our clinical outcomes in coiling unruptured A1As are encouraging even though the maneuver is stressful, risky, and sometimes seems impossible. The shaping of the microcatheter is of great importance for catheterization and it is the key point for an optimal embolization. In order to safely catheterize A1 aneurysms, the microcatheter tip should be "Z-Shaped", "S-Shaped" or "U-Shaped" depending on the parent artery (Figure 4). These shapes matched the anatomical structure of the ICA bifurcation and A1 segment and facilitated aneurysm catheterization, stabilizing the microcatheter, and decreasing the risks in case of perforation. For

some aneurysms with a sharp angle to the parent artery, the retrograde approach from the opposite side is very helpful if the anterior communicating artery is feasible.

In order to catheterize A1As safely, BAC can be used. The balloon can assist aneurysm catheterization, stabilize the microcatheter, and decrease the risks in case of perforation. Moreover, the balloon can be overinflated to protect a perforator at the neck. If the aneurysm is wide-necked, a stent is needed. The stent can stabilize the microcatheter, eliminate protrusion of coils, and protect perforators at the neck. By stent-assisted coiling, some small ruptured A1As (1.5 mm - 2.0 mm) were also embolized at our institute (unpublished material). However, for very small ruptured aneurysms, material limitation and tendency to perforate make most of these A1As better clipped by surgery. In our experience, these adjunctive techniques were mandatory to treat some of the unruptured A1 aneurysms.

Despite the frequent use of these techniques, our patients maintained a normal neurological examination highlighting the safety of endovascular treatment. Moreover, anatomical results were satisfactory and stable in all followed-up cases. Indeed, A1As are less prone to recanalization because they are small and sidewall aneurysms. Therefore, our series suggests that with optimal shaping of the microcatheter tip and suitable catheterization, endovascular treatment is an effective therapeutic option for the management of A1As.

Conclusions

Our study reported a series of unruptured A1As treated by selective embolization, showing that endovascular treatment is feasible and safe. Suitable catheter tip shaping, a retrograde approach and balloon or stent-assisted coiling are very helpful to assist the endovascular procedure. When A1A size is suitable for selective endovascular treatment, it should be an effective therapeutic option.

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