Results of Endovascular Management for Mid-Basilar Artery Aneurysms

J. ZHANG¹, R. ZHANG¹, Z. WU², X. LV², B. LIU¹

¹ Suqian People's Hospital Drum Tower Hospital Group; Nanjing, China

² Interventional Neuroradiology Department, Beijing Neurosurgical Institute and Beijing Tiantan Hospital, Capital Medical University; Beijing, China

Key words: mid-basilar artery, cerebral aneurysm, endovascular embolization

Abstract

We evaluated the results of endovascular management of patients with mid-basilar artery aneurysm (mBAA).

During a seven year period, 14 patients (mean age 39.6 years, male/female ratio 1:1) with mBAA were treated with endovascular techniques at our institute. Pretreatment clinical grades were determined using the Hunt-Hess scale. Outcome was evaluated using the Glasgow Outcome Scale scores (GOS) during a mean follow-up period of 15.6 months (range, three to 70 months).

Fourteen patients with 15 mBAAs were treated endovascularly. Four (28.6%) patients died of rebleeding within one day after embolization. In ten mBAAs, immediate postprocedural angiograms showed that complete occlusion was achieved, subtotal occlusion in one, and incomplete occlusion in four. Follow-up angiographic results in ten patients confirmed complete occlusion of 11 aneurysms. Long-term outcome was good (GOS Score 4 or 5) in ten patients (71.4%) and fatal (GOS Score 1) in four (28.6%).

Favorable overall long-term outcome can be achieved in 78.6% patients with mBAAs. Endovascular management of mBAAs is an effective treatment in the long-term. In our experience, the natural history of mBAAs is dismal.

Introduction

Aneurysms of the mid-basilar artery (mBA) are rare and these aneurysms have a poorer prognosis¹⁻⁵. Higa et al. documented a five year

incidence of severe morbidity and mortality of 80%². Anatomically, the basilar artery (BA) is located in the depth of the valley surrounded by the bilateral petrous bones. Surgical access to this area is hampered by a dense collection of vital cranial nerves and perforating arteries to the brain stem^{6,7}. Challenges include difficulty with the surgical approach; the frequent occurrence of broad-necked, fusiform or giant aneurysms; and the incorporation of the branches of BA. As a result, the rarity and unique morphological features of mBAAs make it difficult to individually tailor the treatment strategy^{2,5}. However, an endovascular approach to this area is comparatively easy because of the simple access to the BA^{4,8-16}. The aim of this retrospective analysis was evaluation of endovascular management for mBAAs.

Clinical Material and Methods

Sixty-two patients with basilar artery aneurysms underwent endovascular treatment at our institute between 2000 and 2007. Fourteen patients (22.6%) had mid-basilar artery aneurysms, which were included in this study. There were seven women (50%) and seven men (50%), ranging from 18 to 68 years with a mean age of 39.6 years. Ten patients (71.4%) presented with SAH and four patients (28.6%) presenting without SAH had headaches. Based on the Hunt and Hess grading scale, six patients (60%) were Grade I, one (10%) was Grade II and three (30%) were Grade III.

All procedures were performed or supervised by the senior author (ZW). All endovas-

cular procedures were performed via the transfemoral arterial route. All endovascular surgeries were performed under general anesthesia. All the procedures were performed under full systemic heparinization to maintain the activated clotting time around twice the base value. In this series, Guglielmi detachable coils (GDC, Boston Scientific, Fremont, CA, USA/Orbit, Cordis, CA, USA/Microvention, Microvention, Aliso Vajo, USA) were mainly used to fill the aneurysm. The detachable coils were delivered under road-mapping guidance, and the aneurysm was packed as densely as possible. One patient underwent endovascular parent vessel occlusions without bypass procedure. If a stent was placed, the patient was medicated with 300 mg/d aspirin and 75 mg/d clopidogrel three days before the procedure and with 300 mg/d aspirin for a month afterwards.

Postoperative angiography was classified as follows: complete occlusion, subtotal, or incomplete. Results of follow-up angiography were also classified in the same way, and clinical outcomes were evaluated according to Glasgow Outcome Scale scores.

Results

The aneurysms were small in seven (diameter <10 mm), large in five (10 to 25 mm), and giant in three (>25 mm). Four (26.7%) aneurysms were saccular, nine (60%) were acute dissecting aneurysms and two (13.3%) were arteriosclerotic aneurysms. One case was associated with two aneurysms. All cases are shown in Table 1. Nine stents (two Driver stents, one Neuroform stent, five Leo stents and one Enterprise stent) were used in nine cases. In ten (66.7%) of the 15 mBAAs, complete occlusion was achieved, while subtotal occlusion was found in one (6.7%), and incomplete occlusion in four (26.6%). Neurological status worsened in one (7.1%) out of 14 cases, resulting in left limb weakness after treatment. Follow-up angiography was obtained in ten surviving cases at 6.8 months (range, three to 12 months) after treatment and there was complete occlusion in all aneurysms.

After a mean follow-up duration of 15.6 months (range, three to 70 months), outcome in ten patients (71.4%) was reflected by a GOS

Table 1 Data of 14 patients with mid-basilar aneurysms

Patient No.	Age/Sex	HH Grade	Sizes of aneurysms (mm)	Type	Treatment	Angiographic outcome	Follow-up	Outcome (GOS)
1	51/F	0	10×10	Saccular	Coil	Co	70-mo	5
2	33/M	I	3×5	Saccular	Coil	Co	6-mo	5
			3×5	Saccular				
3	31/F	III	20×30	Arteriosclerotic	BA occlusion	Co	30-mo	4
4	50/M	III	7×8	Saccular	Coil	Co	5-mo	5
5	68/F	III	7×12	Dissecting	Stent-coil	Co	8-mo	5
6	30/M	0	9.7×7.7	Dissecting	Stent alone	In	6-mo	5
7	48/M	0	11×10	Arteriosclerotic	Stent alone	In	11-m	5
8	28/F	I	3×4	Dissecting	Stent-coil	Co	11-mo	5
9	18/M	0	9×10	Dissecting	Stent-coil	Co	6-mo	5
10	66/F	I	13.8×10.7	Dissecting	Stent-coil	Co	3-mo	5
11	18/F	I	50×60	Dissecting	Stent alone	In	18 days	1
12	10/M	II	34×45	Dissecting	Stent alone	In	21 days	1
13	52/F	I	6×7	Dissecting	Coil	Co	15-h	1
14	51/M	I	4×6	Dissecting	Stent-coil	Sub	1 day	1

F, female; M, male; HH Grade, Hunt-Hess Grade, BA, basilar artery; Co, complete; In, incomplete; Sub, subtotal; mo, months; GOS, glasgow outcome scale.

Figure 1 Case 6. A 30-year-old man who presented with headaches and was found to harbor an acute dissecting aneurysm at the mid-BA with proximal narrowing as shown on left VA angiogram (A). The aneurysm was wide-necked with small caliber of the BA. B) Left vertebral artery injection after a 3.5×25 Leo stent placement showing the aneurysm was filling incompletely. At 6-month follow-up, right VA and left VA angiograms showing occlusion of the basilar artery and disappearance of the aneurysm.

score of 4 or 5, in four (28.6%) by a score of 1. Recurrent SAH was confirmed to be the cause of death in four patients (occurring after endovascular treatment), two were stented only, one was partially coiled and one was completely coiled.

Discussion

Mid-basilar artery aneurysms comprise 22.6% of basilar artery aneurysms. These aneurysms have a poorer prognosis than aneurysms at other locations because of their dis-

Figure 2 Case 9. An 18-year-old man presented with headaches and cerebral angiography revealed an acute dissecting aneurysm at the mid-basilar artery with proximal narrowing. A) Frontal view from a left vertebral artery angiogram, shows the aneurysm originating from the basilar artery trunk at the origin of the anteroinferior cerebellar artery. B) 3-D reconstruction of left vertebral artery injection after embolization. C) T2-weighted MR imaging shows an extensive signal abnormality involving the right inferior pons, which was thought to be consistent with edema and/or ischemic changes.

secting nature, as in our cases⁵. The most common finding in our series was a pseudoaneurysm with irregular vessel lumen narrowing proximally.

Patients with lesions involving the basilar artery trunk without adequate collateral circu-

lation from the posterior communicating arteries are at highest risk¹⁰. Higa et al. documented a five year incidence of severe morbidity and a mortality of 80%². Several neurosurgical approaches have been used to access the basilar artery as described by many au-

thors, but these approaches have been successful only in the hands of a limited number of skilled neurosurgeons^{6,7}. On the other hand, endovascular access to the BA is not difficult in general^{4,8-17}. Since then, we have selected endovascular surgery as the first choice of treatment for mBAAs with anticipated surgical difficulties.

Three cases of basilar trunk endovascular occlusion have been reported in cases of giant and fusiform aneurysms of the BA with good outcome¹⁶. We present one patient with an upper BA fusiform aneurysm treated successfully with endovascular occlusion of the aneurysm and basilar trunk. In determining the safety of BA occlusion, the most important factor to be taken into account is the presence and size of the PCoAs^{16,18,19}. Therefore, before occlusion of the BA during therapy is considered, documentation of the presence and size of the PCoAs is essential. The presence of an adequate caliber of posterior communicating artery allowed retrograde filling of the BA. In a series of vertebrobasilar aneurysms treated by parent vessel occlusion, delayed neurological complications were reported in 45% of the cases and the majority of these complications were found to be fatal^{10,16,18}. The immediate risk of endovascular treatment needs to be weighted against the predicted annual likelihood of morbidity and mortality from this disease, in patients with risk factors commonly seen in the stroke population.

Typically acute dissecting aneurysms are associated with proximal and distal narrowing of the lumen representing evidence of extension of the dissecting process along the wall. Arteriosclerotic, saccular aneurysms do not have this up and downstream luminal narrowing and the widening represents the diseased segment of the vessel. This is a very important differentiation point and the reason why dissecting aneurysms treated by luminal coiling tend to rebleed because the dissecting process spreads along the wall and may be responsible for rerupture, hence parent vessel occlusion or reconstruction with stent placement along the entire length of the involved vessel segment is needed for protection. Stent placement has the advantage of allowing the maintenance of the parent arterial

lumen²⁰⁻²⁸. Endovascular stenting without coiling has been used successfully for the treatment of atherosclerotic lesions, pseudo-aneurysms, fusiform aneurysms, arterial dissections and thrombosis of the cerebral vasculature as reported by multiple authors¹⁴. Park et al. described patients with fusiform and dissecting aneurysms in whom endovascular stenting alone, without coiling, lead to aneurysm thrombosis¹⁴. However, our our patients with giant BA trunk aneurysms treated with stenting alone died of rebleeding within one month after the procedure.

Although detachable coils have provided an alternative approach to treatment, they have their own difficulties in the treatment of giant and fusiform aneurysms of the BA^{1,10,16,18}. Clot formation in the sac does not mean the aneurysm is completely cured. Subsequent bleeding was observed in four patients, two giant aneurysms were treated with stenting without coiling and two was coiled completely on angiogram. The rebleeding rate of coil embolization in this series was 28.6%.

Reported results for BA and VBJ aneurysms were less favorable with a good outcome (GOS 4-5) in 39% and death in 44%^{1,7,10,14,16}. Yoshimoto et al. reported favorable outcomes in four (40%) out of ten patients with BA fusiform aneurysms, of whom four presented with SAH⁵. Two of the four patients who presented with SAH underwent endovascular treatment. One of the two patients died and the other had a good recovery. In our present series, ten fared well at long-term follow up, and four deaths were caused by SAH within one day after endovascular treatment. It seems that giant size and stent treatment alone present a likelihood of post-embolization rebleeding.

Conclusions

The natural history of mBAAs is dismal. Technical advances and growing experience with endovascular techniques have resulted in an increased percentage of patients undergoing endovascular therapies. Favorable overall long-term outcome can be achieved in 71.4% patients with mBAAs.

References

- 1 Buckle C, Rabadi MH. Bilateral pontine infarction secondary to basilar trunk saccular aneurysm. *Arch Neurol.* 2006; 63(10): 1498-1499.
- 2 Higa T, Ujiie H, Kato K, et al. Basilar artery trunk saccular aneurysms: morphological characteristics and management. *Neurosurg Rev* DOI: 10.1007/s10143-008-0163-3.
- 3 Jabbour R, Khalifeh R, Al Kutoubi A, et al. Dissecting aneurysm of the basilar trunk in a young man. *Arch Neurol.* 2003; 60(7): 1016-1018.
- 4 Lawton MT, Daspi C, Phillip MD, et al. Technical aspects and recent trends in the management of large and giant midbasilar artery aneurysms. *Neurosurgery.* 1997; 41(3): 513-552.
- 5 Yoshimoto Y, Hoya K, Tanaka Y, et al. Basilar artery dissection. *J Neurosurg.* 2005; 102: 476-481.
- 6 Cantore G, Santoro A, Guidetti G, et al. Surgical treatment of giant intracranial aneurysms: current viewpoint. *Neurosurgery.* 2008; 63[ONS Suppl 2]: ONS279-ONS290.
- 7 Mack WJ, Ducruet AF, Angevine PD, et al. Deep hypothermic circulatory arrest for complex cerebral aneurysms: lessons learned. *Neurosurgery.* 2008; 62(6 Suppl 3): 1311-1323.
- 8 Fiorella D, Kelly ME, Albuquerque FC, et al. Curative reconstruction of a giant midbasilar trunk aneurysm with the pipeline embolization device. *Neurosurgery.* 2009; 64: 212-217.
- 9 Hassan T, Ezura M, Takahashi A. Treatment of giant fusiform aneurysms of the basilar trunk with intra-aneurysmal and basilar artery coil embolization. *Surg Neurol.* 2004; 62(5): 455-462.
- 10 Henkes H, Liebig T, Reinartz J, et al. Endovascular occlusion of the basilar artery for the treatment of dissecting and dysplastic fusiform aneurysms. *Nervenarzt.* 2006; 77(2): 192-196.
- 11 Jin SC, Kwon DH, Choi CG, et al. Endovascular strategies for vertebrobasilar dissecting aneurysms. *Am J Neuroradiol.* 2009; 30: 1518-1523.
- 12 Jones BV, Tomsick TA, Franz DN. Guglielmi detachable coil embolization of a giant midbasilar aneurysm in a 19-month-old patient. *Am J Neuroradiol.* 2002; 23: 1145-1148.
- 13 Leibowitz R, Do HM, Marcellus ML, et al. Parent vessel occlusion for vertebrobasilar fusiform and dissecting aneurysms. *Am J Neuroradiol.* 2003; 24: 902-907.
- 14 Park SI, Kim BM, Kim DI, et al. Clinical and angiographic follow-up of stent-only therapy for acute intracranial vertebrobasilar dissecting aneurysms. *Am J Neuroradiol.* DOI 10.3174/ajnr.A1561
- 15 Rabinov JD, Hellinger FR, Morris PP, et al. Endovascular management of vertebrobasilar dissecting aneurysms. *Am J Neuroradiol.* 2003; 24: 1421-1428.
- 16 Wenderoth JD, Khangure MS, Phatouros CC, et al. Basilar trunk occlusion during endovascular treatment of giant and fusiform aneurysms of the basilar artery. *Am J Neuroradiol.* 2003; 24: 1226-1229.
- 17 Lv X, Li Y, Liu A, et al. Endovascular management of multiple cerebral aneurysms in acute subarachnoid hemorrhage associated with fenestrated basilar artery: a case report and review of the literature. *Neuroradiol J.* 2008; 21: 137-142.
- 18 Omahen DA, Findlay JM. A giant fusiform basilar aneurysm treated by bilateral vertebral artery occlusion. *J Clin Neurosci.* 2004; 11(3): 324-328.
- 19 Redekop GJ, Durity FA, Woodhurst WB. Management-related morbidity in unselected aneurysms of the upper basilar artery. *J Neurosurg.* 1997; 87(6): 836-842.
- 20 Lv M, Lv X, Li Y, et al. Vertebral dissecting aneurysm treated with the Wingspan stent deployment and detachable coils: Technical note. *Interventional Neuroradiology* 2009; 15: 113-116.
- 21 Lv X, Jiang C, Li Y, et al. Endovascular treatment for pediatric intracranial aneurysms. *Neuroradiology.* 2009; 51: 749-754.
- 22 Lv X, Li Y, Jiang C, et al. Endovascular treatment using stents for vertebral artery fusiform aneurysms. *Neurol Res.* 2010 May 4. [Epub ahead of print].
- 23 Lv X, Jiang C, Li Y, et al. Clinical outcomes of ruptured and unruptured vertebral artery-posterior inferior cerebellar artery complex dissecting aneurysms after endovascular embolization. *Am J Neuroradiol.* 2010 Apr 15. [Epub ahead of print].
- 24 Lv X, Jiang C, Li Y, et al. Intracranial pseudoaneurysms, dissections and carotid-cavernous fistulas: repair with percutaneous implantation of endovascular covered stents. *Interventional Neuroradiology* 2008; 14: 435-440.
- 25 Lv X, Jiang C, Li Y, et al. Treatment of giant intracranial aneurysms. *Interv Neuroradiol* 2009; 15: 135-144.
- 26 Lv X, Li Y, Wu Z. Endovascular management for bilateral ophthalmic segment "kissing aneurysms" presenting with nasal bleeding: case report. *Neuroradiol J.* 2008; 21: 266-269.
- 27 Wu Z, Lv X, Yang X, et al. Ruptured vertebro-infero-posterior cerebellar artery dissecting aneurysm treated with the Neuroform stent deployment and vertebral artery occlusion. *Eur J Radiol Extra.* 2009; 70: e100-e103.
- 28 Zhang J, Lv X, Jiang C, et al. Endovascular treatment of cerebral aneurysms with the use of stents in small cerebral vessels. *Neurol Res.* 2010; 32(2): 119-122.

Zhongxue Wu, MD
 Beijing Neurosurgical Institute
 Beijing Tiantan Hospital
 Capital Medical University
 No.6, Tiantan Xili
 Chongwen, Beijing, 100050
 P.R.China
 Tel.: 86-10-67098850
 Fax: 86-10-67018349
 E-mail: tyyzjb@sina.com