Treatment of Intracranial Aneurysm with Bare Stent only

MICHAEL MU HUO TENG [1,2], CHAO-BAO LUO [1,2], FENG-CHI CHANG [1,2], HARSAN HARSAN [3]

[1] *Department of Radiology (MMHT, CBL, FCC), Taipei Veterans General Hospital, Taipei, Taiwan*
[2] *National Yang Ming University (MMHT, CBL, FCC), Taipei, Taiwan*
[3] *Neurosurgery Department (HH), Siloam Hospital, Lippo Karawaci. Medical Faculty, Pelita Harapan University, Tangerang, Indonesia*

Key words: aneurysms, treatment, stent, dissecting aneurysms, fusiform aneurysms

Summary

Typical treatment of intracranial aneurysm includes: surgical clipping, intrasacular packing, and parent artery occlusion. The treatment of a fusiform aneurysm is often parent artery occlusion, and keeping patency of the parent artery is difficult. We report our experience in the treatment of 3 cases of intracranial fusiform aneurysm with stent placement inside the parent artery only, without coil packing of the aneurysm lumen. All 3 patients had a non-hemorrhagic dissecting aneurysm in the vertebral artery. They were treated with 2 Helistents, 3 Neuroform stents, and 2 Neuroform stents, respectively. These aneurysms disappeared after treatment at their follow-up angiograms. Treatment with a bare stent may induce obliteration or reduction in the size of some aneurysms. This technique is useful in the treatment of non-hemorrhagic fusiform-shaped aneurysms or non-hemorrhagic dissecting aneurysms to preserve the patency of these parent arteries.

Introduction

Typical treatment of an intracranial aneurysm includes surgical clipping, wrapping, ligation of the parent artery, intraluminal coiling, and trapping of the parent artery with the aneurysm.

A fusiform dissecting aneurysm is difficult to treat, and usually it needs parent artery occlusion. Occlusion of the parent artery can be done with an endovascular procedure or by surgery. If the patient cannot tolerate occlusion of the parent artery, then an extracranial – intracranial artery bypass has to be considered [1]. In a vertebral artery aneurysm, the bypass surgery is difficult. Another choice is to perform 'flow re-direction," to avoid the flow in an aneurysm but still fill important branches or perforators [2]. A bare stent has been used to facilitate coiling in a wide neck aneurysm, large aneurysm, or giant aneurysm and to protect patency of the parent artery [3-5].

We report the application of bare stents in the treatment of fusiform intracranial aneurysm without coiling.

Patients and Results

We report the treatment of three consecutive intracranial aneurysm patients with a bare stent.

The first patient is a 41-year-old female patient with hypertension. She had sudden onset of explosive headache, right side hemiplegia and left face numbness, compatible with right lateral medullary syndrome. MRI showed acute infarct in the right lateral medulla. MRA showed an aneurysm. Vertebral angiogram showed a fusiform that was 5.7 mm in diameter dissecting the aneurysm in the distal right vertebral artery (Figure 1). She was referred to us for intravascular intervention five months after the previous episode. The patient refused to undertake right

* Supported partly by Taipei Veterans General Hospital, VGH-93-260, V97C1 B1-096

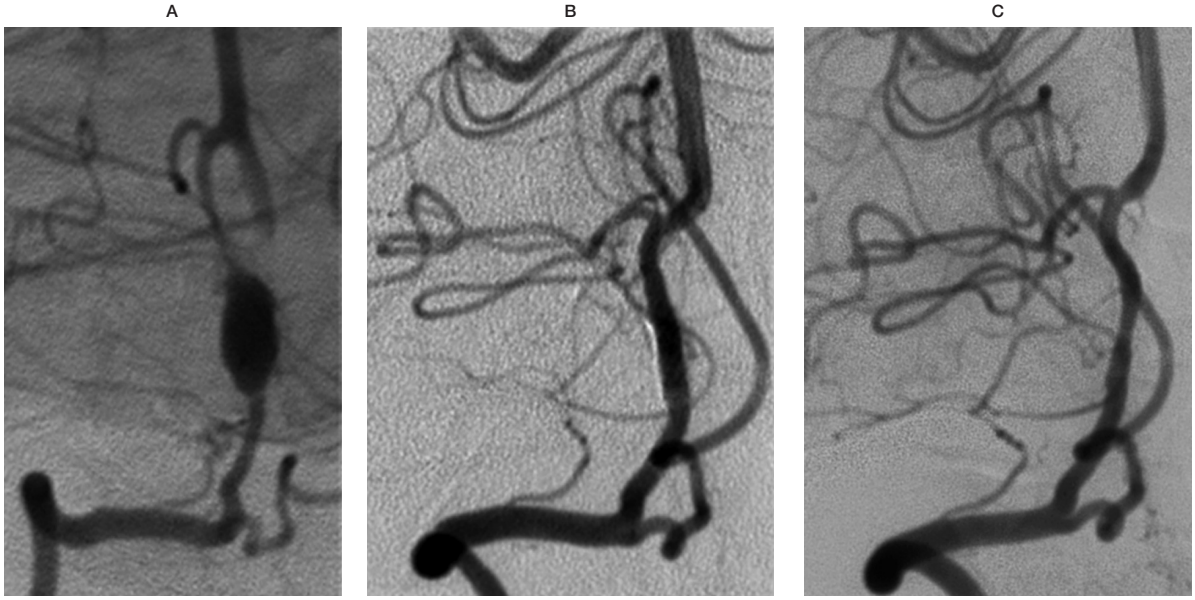

Figure 1 A) Right vertebral angiogram before treatment shows a 5.7 mm in diameter fusiform dissecting aneurysm in distal right vertebral artery, distal to the origin of the right posterior inferior cerebellar artery B). Vertebral angiogram immediately after placement of two Helistents inside showed disappearance of the aneurysm and patency of the right vertebral artery C). Vertebral angiogram 7 months after treatment showed no recurrence of aneurysm. The vertebral artery remains patency with slight narrowing of its lumen.

vertebral artery trapping. There was slight narrowing in the parent artery immediate and distal to the aneurysm. Two overlapping stents (balloon-expandable, Helistents: 2.5 mm x 13 mm and 2.5 mm x 16 mm) were placed in the arterial segment. A vertebral angiogram performed seven months and a CT angiogram performed three years and four months after intravascular intervention showed disappearance of the aneurysm and patency of the right vertebral artery. No subarachnoid hemorrhage was found during the clinical follow-up of 4.5 years.

The second patient is a 62-year-old male. He presented with headache twice in one month with no consciousness loss or neurological deficit. MRI showed an aneurysm. An angiogram showed a fusiform aneurysm about 8 mm in diameter and 14 mm in length at the dominant left distal vertebral artery, about 2 mm distal to the origin of the left posterior inferior cerebellar artery (Figure 2). We were consulted to treat this patient three months after the angiogram was taken. Three Neuroform stents (two stents of 4.5 mm x 20 mm, and one stent of 4.5 mm x 15 mm) were placed in the left distal vertebral artery to treat the aneurysm. To preserve the posterior inferior cerebellar artery, we managed to cover this artery with only one layer of stent. A follow-up angiogram three months and a CT angiogram 17 months after intervention showed disappearance of the aneurysm. Clinical follow-up 17 months after the intervention showed no subarachnoid hemorrhage.

The third patient is a 54-year-old female with two recurrent episodes of severe headache after swimming. MRI a half-month after the second episode showed suspected vertebral artery dissection. A vertebral angiogram one month after the previous episode showed a focal dissecting aneurysm in the distal left vertebral artery, with involvement of the origin of the posterior inferior cerebellar artery. Intravascular intervention was performed 35 days after the last episode by placement of two overlapping Neuroform stents (3 mm x 20 mm and 2.5 mm x 20 mm) inside the distal left vertebral artery. An angiogram 12 months after treatment showed small caliber and a smooth border of the artery previously affected with aneurysm. Clinical follow-up 12 months after the procedure showed no recurrent headache or evidence of subarachnoid hemorrhage.

Discussion

Mechanism of the bare stent

The effect and impact of bare stent placement in an aneurysm orifice has been studied in a canine model *in vitro*[6]. Stents can change the blood flow pattern in an aneurysm sac, disrupt the flow pattern, increase flow stagnancy,

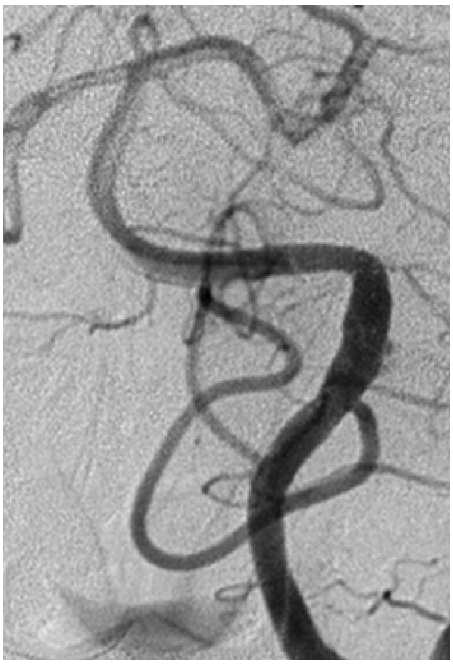

Figure 2 A) Left vertebral angiogram showed a fusiform aneurysm about 8 mm in diameter at the dominant left vertebral artery about 2 mm distal to the origin of the left posterior inferior cerebellar artery. B) Follow-up angiogram three months after placement of three Neuroform stents showed disappearance of the aneurysm. Only slight dilatation is noted at the previous aneurysm segment.

reduce inflow momentum, and reduce the impact zone under high flow [6]. Mechanical study has shown reduction of flow movement inside the aneurysm sac to less than 5% by the placement of a stent across the aneurysm neck [7]. Stent placement on the aneurysm neck will increase the chance of a blood clot formation in the aneurysm sac and also reduce the chance of growth and rupture of the aneurysm. After placement of the stent, the thrombus in the luminal surface of the stent will be covered by a layer of neointima [8]. The incidence of intimal thickening detected on angiogram at six months follow-up after placement of single layer of a Neuroform stent was found to be 18.8% [9].

What kind of stent to use

Brassel et al. cured a true fusiform aneurysm involving the P1 segment with a single balloon-expanding stent [10]. Fiorella et Al treated 10 small intradural pseudoaneurysms associated with subarachnoid hemorrhage using Neuroform stent placement as monotherapy [11]. These cases were not amenable to coil placement. Complete or near complete resolution was observed in nine cases. Therefore, both balloon-expanding and self-extending stents can be used. In selecting the type of stent to use, we have to consider stent flexibility, available size of the stent, and the stability of the stent after implantation. Slight stenosis proximal or distal to the aneurysm may increase a balloon-expanding stents' stability and help it to avoid migration distally or into the aneurysm. In this report, we used a balloon-expanding stent in the first case because of the presence of stenosis proximal and distal to the aneurysm.

How many layers of bare stent are needed

A single layer of stent placed inside the arterial segment with aneurysm may or may not be effective to close an aneurysm. The overlapping stent technique / stent-in-a-stent technique has been described to reduce the porosity of the stent wall and decrease flow to the aneurysm sac, and thus enhance rapid thrombosis and neointimal formation [12]. This will thereby prevent re-bleeding from the aneurysm. Because of individual variability, we do not know how many layers of stent are ideal. One of our cases used three layers of Neuroform stent.

Patency of perforating arteries

From animal studies, it has been shown that the stent will maintain patency of the parent artery, produce blood stasis between the stent and the vessel wall, but without obstructing the perforating artery [13,14]. Histologic study showed the presence of fibrotic reactive scar tissue in the space between the stent and the vessel wall. If multiple layers of bare stent are to be used,

the telescoping technique can reduce the layers of stent covering the arterial segment with perforators. Staged placement of layers of stent by a separation of about one month or more may also reduce the possibility of perforator occlusion.

Indications of stent-only treatment

Vanninen et Al. reported stent-only treatment in 12 cases of true saccular aneurysm, with only 3 cured [15,16]. Therefore, stent-only treatment is not an ideal treatment for true saccular aneurysm. The bare stent cannot achieve immediate obliteration of the aneurysm and therefore, is not an ideal treatment for a ruptured aneurysm.

The imaging studies did not show any subarachnoid hemorrhage in these patients, although it is suspected that in their past clinical history, they experienced a subarachnoid hemorrhage. We choose to use stent-only treatment because the patients were asymptomatic for some time when we were consulted for intravascular intervention.

Covered stents

Covered stents can obliterate the lumen immediately to prevent recurrent hemorrhage. The disadvantages of covered stents are relative rigidity for intracranial use and possible obliteration of perforator branches. However, covered stents have been successfully applied in a ruptured fusiform dissecting aneurysm 17, and a giant aneurysm in the middle cerebral artery 18. These stents were deployed after confirmation that no perforating artery was blocked by the placement of the stents.

Conclusions

Stent-only treatment without coiling can be used in a non-hemorrhagic intracranial fusiform aneurysm.

References

1 Boulos AS, Levy EI et Al: Evolution of neuroendovascular intervention: a review of advancement in device technology. Neurosurgery 54: 438-453, 2004.
2 Boardman P, Byrne JV: Giant fusiform basilar artery aneurysm: Endovascular treatment by flow reversal in the basilar artery. Brit J Radiol 71: 332-335, 1998.
3 Turjman F, Massoud TF et Al: Combined stent implantation and endosaccular coil placement for treatment of experimental wide-necked aneurysms: a feasibility study in swine. Am J Neuroradiol 15: 1087-1090, 1994.
4 Luo CB, Wei CJ et Al: Stent-assisted embolization of internal carotid artery aneurysms. Chin Med J (Taipei). 66: 460-466, 2003.
5 Szikora I, Guterman LR et Al: Combined use of stents and coils to treat experimental wide-necked carotid aneurysms: preliminary results. Am J Neuroradiol 15: 1091-1102, 1994.
6 Meng H, Wang Z et Al: Saccular aneurysms on straight and curved vessels are subject to different hemodynamics. Implication of intravascular stenting. Am J Neuroradiol 27: 1861-1865, 2006.
7 Yu SCM, Zhao JB: A steady flow analysis on the stented and non-stented side wall aneurysm models. Med Engineering Physics 21: 133-141, 1999.
8 Wakhloo AK, Lanzino G et Al: Stents for intracranial aneurysms : the beginning of a new endovascular era. Neurosurgery 43: 377-379, 1998.
9 Lee DH, Arat A et A: Intimal thickening after placement of a Neuroform stent. Interventional Neuroradiology 13: 239-246, 2007.
10 Brassel F, Rademaker J et Al: Intravascular stent placement for a fusiform aneurysm of the posterior cerebral artery. Eur Radiol 11: 1250-1253, 2001.
11 Fiorella D, Albuquerque F et Al: Endovascular reconstruction with the Neuroform stent as monotherapy for the treatment of uncoilable intradural pseudoaneurysms. Neurosurgery 59: 291-300, 2006.
12 Benndorf G, Herbon U et Al: Treatment of a ruptured vertebral artery aneurysm with double stent placement: Case report. Am J Neuroradiol 22: 1844-1848, 2001.
13 Masuo O, Terada T et Al: Study of the patency of small arterial branches after stent placement with an experimental in vivo model. Am J Neuroradiol 23: 706-710, 2002.
14 Massoud TF, Turjman F et Al: Endovascular treatment of fusiform aneurysms with stents and coils: technical feasibility in a swine model. Am J Neuroradiol 16: 1953-1963, 1995.
15 Vanninen R, Manninen H, Ronkainen A: Broad-based intracranial aneurysms: thrombosis induced by stent placement. Am J Neuroradiol 24: 263-266, 2003.
16 Mehta B, Burke T et Al: Stent-within-a-stent technique for the treatment of dissecting vertebral artery aneurysms. Am J Neuroradiol 24: 1814-1818, 2003.
17 Chiaradio JC, Guzman L et Al: Intravascular graft stent treatment of a ruptured fusiform dissecting aneurysm of the intracranial vertebral artery: Technical case report. Neurosurgery 50: 213-217, 2002.
18 Pero G, Denegri F et Al: Treatment of a middle cerebral artery giant aneurysm using a covered sten. J Neurosurg 104: 965-968, 2006.

Michael Mu Huo Teng
Department of Radiology
Taipei Veterans General Hospital
Taipei, Taiwan
National Yang Ming University
Taipei, Taiwan
E-mail: mmhteng@vghtpe.gov.tw