Interdisciplinary Neurosurgery 16 (2019) 150–154

Contents lists available at ScienceDirect

Interdisciplinary Neurosurgery

journal homepage: www.elsevier.com/locate/inat

Technical Notes & Surgical Techniques

Reconstructive endovascular treatment of symptomatic large or giant unruptured vertebrobasilar fusiform aneurysm with LVIS stent-assisted partial coil embolization☆

Mustafa Najibullah (MD)[a], Geng Dangmurenjiafu (MD)[a], Taotao Dou[a], Sanawar Abbas[b], Xiaojiang Cheng (MD, PHD)[a], Maimaitili Aisha (MD)[a,*]

[a] Department of Neurosurgery, The First Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang, China
[b] Department of Radiology, The First Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang, China

ARTICLE INFO

Keywords:
Unruptured vertebrobasilar fusiform aneurysm
Large
Giant
LVIS stent
Stent-assisted coil
Stent-within-a-stent technique

ABSTRACT

Objectives: Large or giant vertebrobasilar fusiform aneurysms (VFAs) remain one of the most formidable lesions. The purpose of this study was to evaluate the technical feasibility, clinical and angiographic outcomes of LVIS SACP-SWS technique in patients with large or giant unruptured VFAs.

Patients and methods: Eleven patients with large or giant unruptured VFAs underwent LVIS SACP-SWS technique between Jun 2015 and May 2017. Thirty-eight (38) LVIS stents were completely deployed at desired position. Outcomes were evaluated based on the modified Rankin Scale (mRS) score and angiography.

Results: The LVIS SACP-SWS was successful without any treatment-related complications in all 11 patients. In regard to clinical outcome, mRS was 3.55 ± 1.29 at pre-operative stage that significantly ($p = 0.01$) decreased to 1.91 ± 1.92 at last follow-up. The mean decrease in mRS was 1.63 ± 1.69. Near-complete occlusion of dissecting aneurysmal sac (NO) was seen in 5 patients at DSA follow-up and complete occlusion of dissecting aneurysmal sac (CO) was in 4 patients, the remaining patient was re-treated by occluding the V4 segment of right verbal artery.

Conclusions: Our results provide an encouraging support for the LVIS stent-assisted coil partial embolization combined with stent-within-a-stent technique. Further studies of the technique as an alternative strategy for treatment of large or giant unruptured VFAs are warranted.

1. Introduction

Large or giant intracranial vertebrobasilar fusiform aneurysms (VFAs) are rare lesions with very poor prognosis [18]. Clinically, these aneurysms may present as subarachnoid hemorrhage (SAH), posterior circulation ischemic stroke or brain stem compression manifestations including headache, cranial nerve compression and ataxia [16–18,20]. Because of the morphological characteristics of VFAs and the complex anatomical structures in their vicinity, surgical treatment is usually technically difficult and associated with high rates of morbidity and mortality [4,7]. With the recent developments in the field of intracranial stents and devices, endovascular approaches are being used more frequently as a first-line treatment for these lesions [2,4,7,11,15,23]. However, available approaches have shown to be comprehensively ineffective [10,19,20,22]. Stent-assisted coil embolization combined with stent-within-a-stent technique (SAC-SWS) have been applied to ruptured blood blister-like aneurysms and ruptured dissecting aneurysms of the intracranial vertebrobasilar artery with observed excellent clinical and angiographic results [6,10,15,19].

The Low-Profile Visualized Intraluminal Support (LVIS) device (MicroVention, Tustin, California) is a new device. It has greater metal coverage and mesh density than other self-expandable stents. It

Abbreviations: BA, basilar artery; VFAs, vertebrobasilar fusiform aneurysms; LVIS, Low-Profile Visualized Intraluminal Support; PICA, posterior inferior cerebellar artery; SACP, stent-assisted coil partial embolization; SAH, subarachnoid hemorrhage; SWS, stent-within-a-stent; VA, vertebral artery; VBA, vertebrobasilar artery; DSA, digital subtraction angiography; MRA, magnetic resonance angiography; AICA, anterior inferior cerebellar artery; PCA, posterior cerebral artery; CT, computed tomography; CTA, computed tomography angiography; MRI, magnetic resonance imaging

☆ This paper has not been published in whole or in part and no funding contributes to it.

* Corresponding author at: Department of Neurosurgery, The First Affiliated Hospital of Xinjiang Medical University, Xinshi District, NO. 393, Urumqi, Xinjiang, China.

E-mail address: 1591467218@qq.com (Maimaitili Aisha).

https://doi.org/10.1016/j.inat.2019.02.001
Received 19 January 2019; Accepted 2 February 2019

represents a balanced option between conventional stents and flow diverters. It is designed for stent-assisted coil embolization of wide neck intracranial aneurysms [6,24]. Notably, prior research on the reconstructive endovascular treatment for large or giant VFAs with the LVIS stent-assisted coil partial embolization combined with stent-within-a-stent technique (SACP-SWS) is limited. The purpose of this study was to evaluate the technical feasibility, clinical and angiographic outcomes of LVIS SACP-SWS technique in patients with large or giant unruptured VFAs.

2. Material and methods

This study is a prospective observational study. Ethical approval was obtained from the Ethical Institutional Review Board. Written informed consent was obtained from patients or their family member before including in the study. Eleven patients with large or giant unruptured VFAs underwent SACP-SWS in our institution between June 2015 and May 2017. Every patient underwent preoperative neuroimaging examination, including computed tomography (CT) scanning, CT angiography (CTA), and magnetic resonance (MR) imaging. All patients underwent digital subtraction angiography (DSA) before the procedure. 3D DSA reconstruction was also conducted for all patients to measure the aneurysm size and precisely visualize the origin of PICA, AICA and other perforators.

The inclusion criteria were: (i) the aneurysm was large (defined as 20–25 mm in maximum affected segment) or giant (> 25 mm in maximum affected segment); (ii) the lesions that were treated with SAPC-SWS; (iii) clinical symptoms relevant to the intracranial VFAs, mainly including ischemic stroke and the mass effect of the lesions and (iv) imaging modalities examination shown intimal flap, intramural hematoma, double-lumen, pearl-and-string sign and retention of contrast medium in the involved segment of the parent vessel. Exclusion criteria included: (i) ruptured VBAs; (ii) the maximum affected segment of aneurysm is < 20 mm; (iii) incidentally found asymptomatic VFAs; (iv) previously treated aneurysms via another approach and (v) aneurysms clearly related to vasculitis or fibromuscular dysplasia.

2.1. Treatment protocol and SAPC-SWS technique

All procedures were performed under general anesthesia. In patients receiving the SACP-SWS treatment, dual antiplatelet therapy (100 mg/day of aspirin and 75 mg/day of clopidogrel) was routinely administered to the patients from 3 days until the time of the procedure. This therapy was maintained for 6 months and was changed to aspirin monotherapy (100 mg/day). Moreover, the response testing to aspirin and clopidogrel was performed to confirm therapeutic responses. A dosage of 5000 units of heparin was injected intravenously after the achievement of femoral artery puncture followed by continuous infusion (1000 units of heparin per hour during the procedure). Activated coagulation time was maintained between two or three times at the baseline value during the procedure and for 72 h after the procedure.

A 6-F guiding catheter was inserted into V2 segment of VA. Thereafter, Headway-21 (MicroVention) microcatheter assisted by Traxcess guidewire (MicroVention) was advanced into a branch of the posterior cerebral artery (PCA) and then after, Traxcess guidewire was retrieved. In the same way, the Echelon-10 microcatheter was inserted to aneurysm sac. The first LVIS stent was introduced into the distal affected segment passing through Headway-21 microcatheter and gently deployed to cover the distal affected artery. Also, in all cases, the first stent always was insufficient to completely cover the entire affected segment and altered the hemodynamic. More stent was implanted (placed end by end) using the SWS technique to completely cover the entire affected segment. Furthermore, stent device length (5 mm) on each side of the affected segment was expanded to ensure the entire lesion coverage. The aneurysmal sac was partially embolized, as much as possible in the condition that the significant artery or perforators which supply the brainstem and cerebella were not affected, by using Echelon-10 microcatheter with a jailing technique before completely releasing the last stent.

2.2. Clinical assessment and angiographic follow-up

DSA results were immediately obtained post-operatively and during follow-up. The extent of aneurysmal sac obliteration was assessed according to Raymond Scale: complete occlusion, near-complete occlusion and partial occlusion. Interventional neuroradiologist evaluated angiographic outcomes. Postoperative status and follow-up clinical results were acquired by means of outpatient visits or telephonic contact. Results were evaluated according to the modified Rankin Scale (mRS) score.

A total of 38 LVIS stents were deployed and an average of 3.45 stents (range 2–5 stents) used to treat each aneurysm. Stents were successfully implanted in all 11 patients and finally completely covered the affected segment. No operation-related complications occurred.

2.3. Statistical analysis

The results are presented in frequencies, percentages and mean ± SD. Wilcoxon rank sum test was used to compare the change in mRS scores from pre-operative to last follow-up. A p-value < 0.05 was considered significant. All the analysis was carried out on SPSS 16.0 version software (Chicago, Inc., USA).

3. Results

The mean age of patients was 57.27 (± 10.88) ranging from 37 to 73 years. The majority of patients were males (90.9%). In regard to clinical presentation, mass effect was present in all patients. Ischemia, dysphagia and dysarthria each constituted in 45.5% patients. Tinnitus and Hemiplegia each constituted in 36.4% patients. Basilar artery aneurysm location was present in all the patients. Left and right vertebral artery was present in 45.5% and 18.2% patients respectively. Aneurysm length was found to be 23.47 (± 2.91) mm and stent size was 136.82 (± 1.16) mm^2 (Table 1).

Table 2 presents the angiographic and clinical findings of patients with symptomatic large or giant unruptured VBA-DAs treated with SACP-SWS. At pre-operative, partial occlusion of dissecting was in all the patients on angiography. DSA follow-up was performed in 10

Table 1
Basic characteristics of patients.

Basic characteristics	n = 11
Age in years, mean ± SD (median), range	57.27 ± 10.88 (59.0), 37–73
Male gender, no. (%)	10 (90.9)
Clinical presentation[a], no. (%)	
Mass effect	11 (100.0)
Dizziness	3 (27.3)
Tinnitus	4 (36.4)
Ischemia	5 (45.5)
Dysphagia	5 (45.5)
Dysarthria	5 (45.5)
Hemiplegia	4 (36.4)
Ataxia	3 (27.3)
Visual field defect of left eye	1 (9.1)
Aneurysm location[a]	
Left vertebral artery	5 (45.5)
Basilar artery	11 (100.0)
Right vertebral artery	2 (18.2)
Aneurysm length (mm), mean ± SD (median), range	23.47 ± 2.91 (22.30), 20.20–28.30
Stent size (mm^2), mean ± SD (median), range	136.82 ± 1.16 (137.50), 135–138

[a] Multiple responses.

Table 2
Angiography findings and clinical symptoms of patients with symptomatic large or giant unruptured VBA-DAs treated with SACP-SWS.

	n = 10
Angiography findings	
At immediate post-operative	
Partial occlusion of dissecting	10 (100)
At follow-up (in months), mean ± SD	10.40 ± 3.77
Complete occlusion of dissecting aneurismal sac (CO)	4 (40.0)
Near-complete occlusion of dissecting aneurismal sac (NO)	5 (50.0)
Retreat (RT)	1 (10.0)
Clinical symptoms	
At discharge	
Dysarthria	1 (10.0)
Dysarthria and hemiplegia of right limbs	1 (10.0)
Mild dizziness	3 (30.0)
Mild tinnitus	1 (10.0)
Myasthenia of left limbs	1 (10.0)
Myasthenia of right limbs	1 (10.0)
Tinnitus	1 (10.0)
Visual field defect of left eye	1 (10.0)
At follow-up (in months), mean ± SD	11.82 ± 4.49
Dysarthria	1 (10.0)
Mild dizziness	1 (10.0)
Mild dysphagia and myasthenia of right limbs	1 (10.0)
Mild tinnitus	1 (10.0)
Myasthenia of left limbs	1 (10.0)
Myasthenia of left limbs and dysarthria	1 (10.0)
Myasthenia of right limbs	1 (10.0)

In 1 patient angiography and clinical symptom could not be assessed at follow-up and discharge.

patients and mean follow-up was 10.40 (± 3.77) months. Near-complete occlusion of dissecting aneurismal sac (NO) was seen in 50% patients at DSA follow-up and complete occlusion of dissecting aneurysmal sac (CO) was in 40% patients, one patient (Fig. 1) was retreated by occluding the V4 segment of right vertebral artery with coils (Fig. 2) because follow up DSA of the right VA revealed that aneurysmal sac slightly increased in size. Clinical findings at discharge showed mild dizziness in 30% of patients. The last mean follow-up was 12.40 (± 4.27) months. One patient mRS scores was 5 and bed-ridden for 5 days before procedure, finally died of pulmonary embolism and deep venous thrombosis (mortality rate = 9.1%).

In regard to clinical outcome, mRS was 3.55 ± 1.29 at pre-operative which significantly (p = 0.01) decreased to 1.91 ± 1.92 at last follow-up. The mean decrease in mRS was 1.63 ± 1.69 (Table 3).

4. Discussion

Large or giant VFAs are a well-known cause of acute SAH or the posterior circulation ischemic stroke and constitute a relatively small and uncommon subgroup of aneurysms [1,16,22]. VFAs remain one of the most formidable lesions due to their size, location and morphology. Previous endovascular treatments have not been proven effective as a definitive treatment [1,10,17].

Thirty-eight (38) LVIS stents were used for treating those lesions with no operation-related complications. We used double LVIS stents that were telescoping in 3 patients to assist coil partial embolization of the aneurismal sac, and multiple stents that were partially overlapping (placed end by end) in the rest of the patients. We decided to embolize the aneurysmal sac as much as possible so that the significant arteries

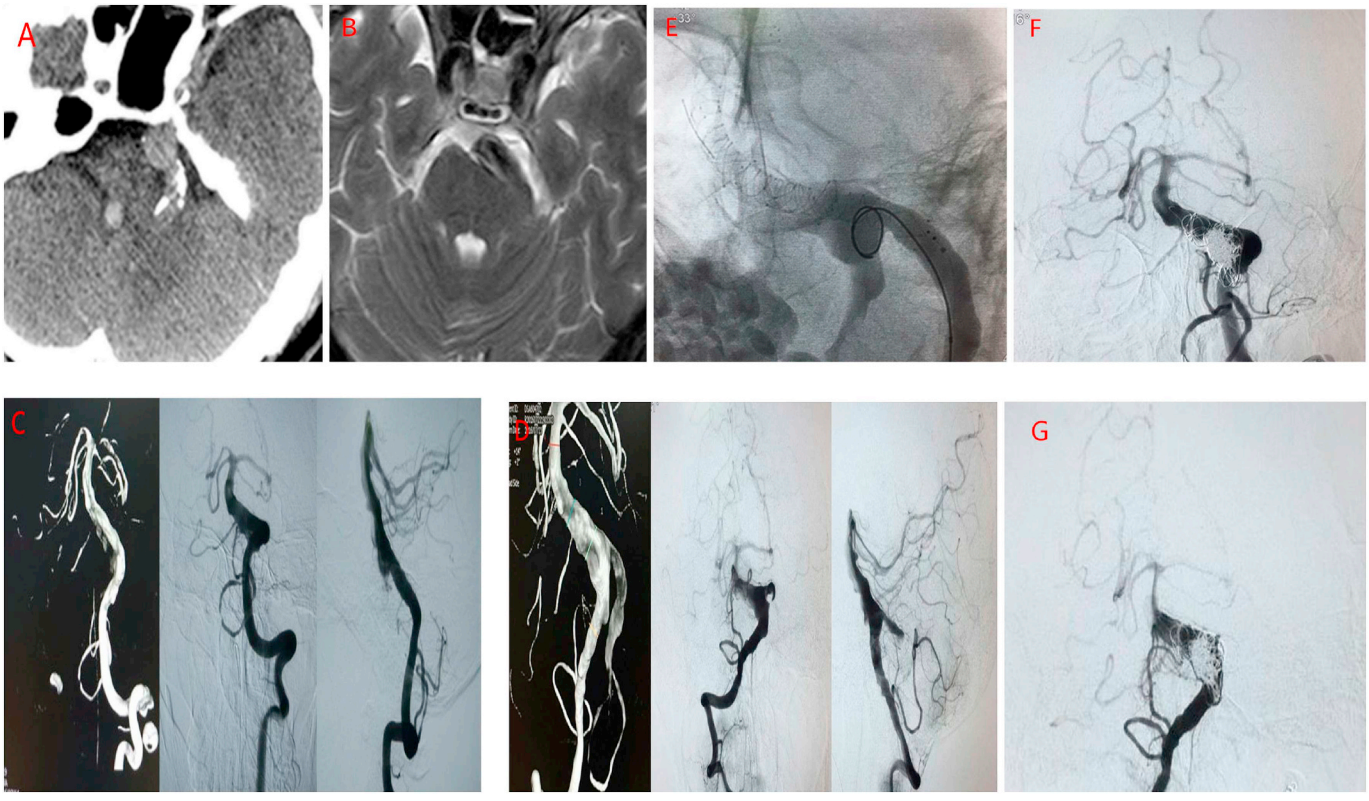

Fig. 1. Case 4. A 37-year-old man was admitted at our department with dysarthria, dysphagia and hemiplegia of right limb. The CT scan revealed no SAH (A) and MRI shown a giant VFA with brainstem compression (B). At preoperative angiograms, 3D reconstruction, anteroposterior and lateral angiogram of the left VA (C) and the right VA (D) acquired revealed a giant fusiform aneurysm in the vertebrobasilar arterial trunk. An unsubtracted DSA (E) showed the 4 LVIS stents completely deployed and the fifth LVIS stent incompletely deployed with SWS technique as well as the coil was implanted the aneurismal sac. After operation immediate anteroposterior angiograms of the left VA F (F) and the right VA (G) acquired shown the sac was embolized partially and the AICA remained patent.

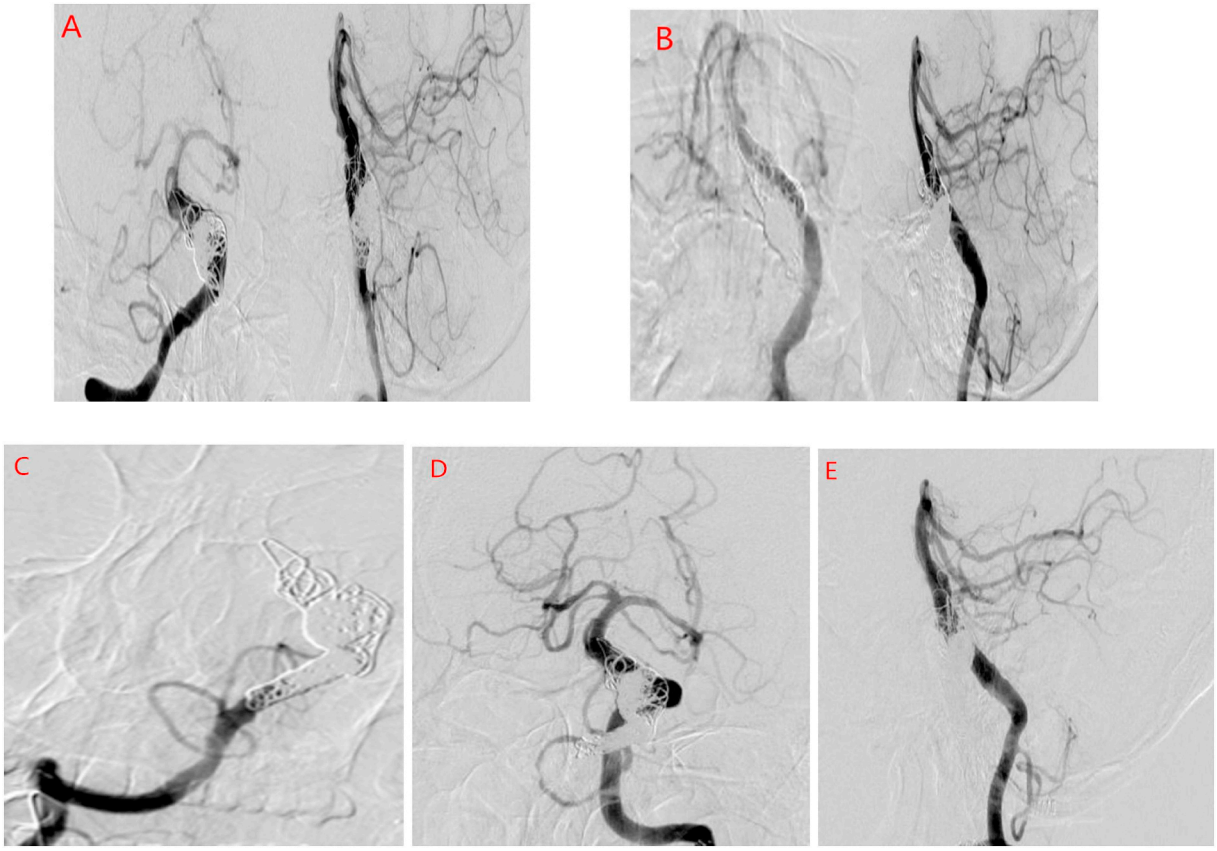

Fig. 2. Case 4. Follow-up angiograms of the VFA treated with SACP-SWS technique. Anteroposterior and lateral views of angiograms acquired from right VA (A) and left VA (B) 13 months after operation. DSA revealed from the right VA angiogram that the aneurismal sac had increased slightly in size, however, the left VA angiogram revealed the BA was reconstructive. The V4 segment of right VA was occluded (C). After operation, anteroposterior (D) and lateral (E) views of angiograms acquired from left VA showed the BA was reconstructive.

Table 3
Comparison of mRS score from pre-operative to follow-up.

Time period	mRS score (mean ± SD)
Pre-operative	3.55 ± 1.29
Follow-up	1.91 ± 1.92
Mean change	1.63 ± 1.69
p-Value[a]	0.01*

[a] Wilcoxon rank sum test.
* Significant.

and perforators were not affected. However, complete occlusion or near-complete occlusion was impossible because of the rich vital perforators' origin from the vertebrobasilar system. Hence, immediate post-procedural angiograms showed partial occlusion of fusiform aneurismal sac in all 11 patients.

In this study we report partial occlusion of large or giant vertebrobasilar fusiform aneurismal sac with SAC-SWS technique. Multiple LVIS stents were deployed with SWS technique in the treatment of all 11 aneurysms. The clinical outcomes showed that majority of the patients improved and obtained a relatively stable condition as reflected by the reduced mRS scores (the mean mRS score decreased from 3.55 ± 1.29 at pre-operative to 1.91 ± 1.92 at last follow-up, p = 0.01). DSA follow-up outcome showed complete occlusion of dissecting aneurysmal sac in 2 cases (20%) and near-complete occlusion of dissecting aneurysm sac in 5 (50%).

The surgical treatment of VBFs tends to be associated with unsatisfactory results and high risk [5,7]. Consequently, more endovascular treatment strategies are being used as the first line of treatment of VFAs [2,3,5,9,13,15]. However, the optimal endovascular treatment option of VBFs has not yet been well-established [5,12,17,18].

Stent-only therapy was reported by Wang et al. [22] to treat unruptured vertebrobasilar fusiform aneurysms, they implanted double or multiple stents with parallel (placed side by side) approaches with both methodologies achieving good outcomes. However, for large VFAs these stents cannot completely obliterate the dissecting aneurysm sac or cover the affected segment leading to inflow dispersal into the aneurysmal sac or bleeding.

Coils in large or giant aneurysms not only serve as a scaffold to organize thrombi but also provide a second layer of protection from hemorrhagic complications by altering intra-aneurysmal flow dynamics and allowing controlled intraaneurysmal thrombosis with eventual reorganization into a stable fibrous tissue [8,9,14,21]. Therefore, stent-assisted coil partial embolization combined with stent-within-a-stent technique was performed finally in all 11 patients in this study. The number of coils needed to provide this function is, however, unclear to. Natarajan et al. [11] believed that packing density needs to be less than with stent- or balloon-assisted or primary coiling but more than simply 1 or 2 coils. They used computational fluid dynamics and found the most effective coil mass by volume appears to be 11%. In our experience, 15% of packing density is enough to promote thrombosis in the large or giant VFAs.

For SACP-SWS technique, the possible technical trouble is implanting the second stent or the remaining stents due to unsupported large aneurysmal sac. Fortunately, the microwire of LVIS stent systems can direct the Headway-21 microcatheter into the previous stent lumen. Consequently, no procedure-related complications in this study were encountered. Also, this treatment is not ideal for ruptured VFAs due to

aneurysmal sac partially embolized. The possibility of the perforators becoming occluded is another major concern in SACP-SWS therapy. Unfortunately, one patient developed right AICA occlusion 12 months after procedure.

4.1. Limitations of the study

The main limitations of this study are the small number of cases and the short follow-up periods. In the future, multicenter clinical trials with larger sample size and longer follow-up are necessary to further evaluate the efficacy of this treatment modality.

5. Conclusions

Our results provide encouraging support for the LVIS stent-assisted coil partial embolization combined with stent-within-a-stent technique as an alternative strategy for large or giant unruptured VFAs. Further studies of the technique as an alternative strategy for treatment of large or giant unruptured VFAs are warranted.

Compliance with ethical standards

Funding

No funding was received for this research.

Conflict of interest

Mustafa Najibullah declares that he has no conflict of interest.
Geng Dangmurenjiafu declares that he has no conflict of interest.
Taotao Dou declares that he has no conflict of interest.
Sanawar Abbas declares that he has no conflict of interest.
Xiaojiang Cheng declares that he has no conflict of interest.
Maimaitili·Aisha declares that he has no conflict of interest.

This article does not contain any studies with animals performed by any of the authors.

Informed consent

Informed consent was obtained from all individual participants included in the study.

References

[1] O. Ahmed, C. Storey, P. Kalakoti, J.D. Thakur, S. Zhang, A. Nanda, et al., Treatment of vertebrobasilar fusiform aneurysms with Pipeline embolization device, Interv. Neuroradiol. 21 (2015) 434–440.
[2] Y. Chung, S.H. Lee, S.K. Choi, B.J. Kim, K.M. Lee, E.J. Kim, Triple stent therapy for the treatment of vertebral dissecting aneurysms: efficacy and safety, World Neurosurg. 99 (2017) 79–88.
[3] M. He, H. Zhang, D. Lei, B.-Y. Mao, C. You, X.-D. Xie, et al., Application of covered stent grafts for intracranial vertebral artery dissecting aneurysms, J. Neurosurg. 110 (2009) 418–426 (Clinical article).
[4] M.Y.S. Kalani, J.M. Zabramski, P. Nakaji, R.F. Spetzler, Bypass and flow reduction for complex basilar and vertebrobasilar junction aneurysms, Neurosurgery 72 (2013) 763–775.
[5] M. Kerolus, M.K. Kasliwal, D.K. Lopes, Persistent aneurysm growth following pipeline embolization device assisted coiling of a fusiform vertebral artery aneurysm: a word of caution, Neurointervention 10 (2015) 28–33.
[6] B.M. Kim, E.C. Chung, S. Il Park, C.S. Choi, Y.S. Won, Treatment of blood blister-like aneurysm of the internal carotid artery with stent-assisted coil embolization followed by stent-within-a-stent technique, J. Neurosurg. 107 (2007) 1211–1213.
[7] M.T. Lawton, A.A. Abla, W.C. Rutledge, A. Benet, Z. Zador, V.L. Rayz, et al., Bypass surgery for the treatment of dolichoectatic basilar trunk aneurysms: a work in progress, Neurosurgery 79 (2016) 83–99.
[8] N. Lin, A.M. Brouillard, C. Krishna, M. Mokin, S.K. Natarajan, A. Sonig, et al., Use of coils in conjunction with the pipeline embolization device for treatment of intracranial aneurysms, Neurosurgery 76 (2015) 142–149.
[9] B. Lubicz, L. Collignon, F. Lefranc, M. Bruneau, J. Brotchi, D. Baleriaux, et al., Circumferential and fusiform intracranial aneurysms: reconstructive endovascular treatment with self-expandable stents, Neuroradiology 50 (2008) 499–507.
[10] B. Mehta, T. Burke, M. Kole, A. Bydon, D. Seyfried, G. Malik, Stent-within-a-stent technique for the treatment of dissecting vertebral artery aneurysms, AJNR Am. J. Neuroradiol. 24 (2003) 1814–1818.
[11] S.K. Natarajan, N. Lin, A. Sonig, A.T. Rai, J.S. Carpenter, E.I. Levy, et al., The safety of Pipeline flow diversion in fusiform vertebrobasilar aneurysms: a consecutive case series with longer-term follow-up from a single US center, J. Neurosurg. 125 (2016) 111–119.
[12] S.I. Park, B.M. Kim, D.I. Kim, Y.S. Shin, S.H. Suh, E.C. Chung, et al., Clinical and angiographic follow-up of stent-only therapy for acute intracranial vertebrobasilar dissecting aneurysms, AJNR Am. J. Neuroradiol. 30 (2009) 1351–1356.
[13] T.J. Phillips, J.D. Wenderoth, C.C. Phatouros, H. Rice, T.P. Singh, L. Devilliers, et al., Safety of the pipeline embolization device in treatment of posterior circulation aneurysms, AJNR Am. J. Neuroradiol. 33 (2012) 1225–1231.
[14] M. Piotin, R. Blanc, L. Spelle, C. Mounayer, R. Piantino, P.J. Schmidt, et al., Stent-assisted coiling of intracranial aneurysms clinical and angiographic results in 216 consecutive aneurysms, Stroke 41 (2010) 110–115.
[15] M.H. Rho, H.J. Park, E.C. Chung, Y.J. Choi, S.Y. Lee, Y.S. Won, et al., Various techniques of stent-assisted coil embolization of wide-necked or fusiform atherosclerotic and dissecting unruptured vertebrobasilar artery aneurysms for reducing recanalization: mid-term results, Acta Neurochir. 155 (2013) 2009–2017.
[16] R.H. Sacho, G. Saliou, A. Kostynskyy, R. Menezes, M. Tymianski, T. Krings, et al., Natural history and outcome after treatment of unruptured intradural fusiform aneurysms, Stroke 45 (2014) 3251–3256.
[17] A.H. Siddiqui, A.A. Abla, P. Kan, T.M. Dumont, S. Jahshan, G.W. Britz, et al., Panacea or problem: flow diverters in the treatment of symptomatic large or giant fusiform vertebrobasilar aneurysms, J. Neurosurg. 116 (2012) 1258–1266.
[18] O. Soenmez, W. Brinjikji, M.H. Murad, G. Lanzino, Deconstructive and reconstructive techniques in treatment of vertebrobasilar dissecting aneurysms: a systematic review and meta-analysis, AJNR Am. J. Neuroradiol. 36 (2015) 1293–1298.
[19] S.H. Suh, B.M. Kim, S. Il Park, D.I. Kim, Y.S. Shin, E.J. Kim, et al., Stent-assisted coil embolization followed by a stent-within-a-stent technique for ruptured dissecting aneurysms of the intracranial vertebrobasilar artery, J. Neurosurg. 111 (2009) 48–52 (Clinical article).
[20] L.I. van Oel, W.J. van Rooij, M. Sluzewski, G.N. Beute, P.N.M. Lohle, J.P.P. Peluso, Reconstructive endovascular treatment of fusiform and dissecting basilar trunk aneurysms with flow diverters, stents, and coils, AJNR Am. J. Neuroradiol. 34 (2013) 589–595.
[21] A.K. Wakhloo, J. Mandell, M.J. Gounis, C. Brooks, I. Linfante, J. Winer, et al., Stent-assisted reconstructive endovascular repair of cranial fusiform atherosclerotic and dissecting aneurysms long-term clinical and angiographic follow-up, Stroke 39 (2008) 3288–3296.
[22] J. Wang, X.-F. Liu, B.-M. Li, S. Li, X.-Y. Cao, Y.-P. Liang, et al., Application of parallel stent placement in the treatment of unruptured vertebrobasilar fusiform aneurysms, J. Neurosurg. 126 (2017) 45–51.
[23] I. Yuki, Y. Murayama, F. Vinuela, Endovascular management of dissecting vertebrobasilar artery aneurysms in patients presenting with acute subarachnoid hemorrhage, J. Neurosurg. 103 (2005) 649–655.
[24] X.X. Zhang, W.S. Li, N. Lv, Q.Z. Zhang, Q.H. Huang, Endovascular management of ruptured basilar artery dissection with two overlapping Low-profile Visualized Intraluminal Support stents, Interv. Neuroradiol. 22 (2016) 659–661.