

Endovascular intervention of intradural hemorrhage from ruptured spontaneous vertebral artery dissection

Rui Xu, MD, PhD, Wei Liu, MD, MS, Jian-Long Li, MD, MS, Xin Liu, MD, MS, Da-Peng Hao, MD, PhD, Tong Zhang, MD.

ABSTRACT

الأهداف: دراسة أثر الشفاء العلاج داخل الشرايين للنزف داخل الجافية من تشريح شريان فقري تلقائي متمزق وذلك باستخدام لفائف جوجليمي القابلة للفصل ولفائف ميكانيكية.

الطريقة: أجريت هذه الدراسة الاسترجاعية في قسم الأشعة العلاجية، مستشفى ريزهاو، الصين، خلال الفترة من يناير 2008م إلى ديسمبر 2011م. ضمت الدراسة 12 مريض مصابين بالنزف داخل الجافية من تشريح (شريان فقري تلقائي متمزق) خضعوا لانصمام داخل الشرايين الداخلية الأوعية بعد التصوير ونتائج الفحص السريري. تم علاج لمعة أم الدم والشريان الأم عولجوا بالانصمام ولفائف الجوجليمي القابلة للفصل ولفائف الميكانيكية. وقد استخدمت لفائف الجوجليمي القابلة للفصل لانصمام لمعة أم الدم والشريان الأم المحادي لأم الدم. كما استخدمت اللفائف الكيميائية لانصمام الشريان الأم.

النتائج: أظهرت النتائج أن جميع الآفات كانت قريبة من منشأ الشريان المخيخي السفلي. جميع المرضى كانت نتائجهم ناجحة بدون أي مضاعفات. يتم تصوير الأوعية مباشرة بعد أن يوضح الانصمام أطباق تام. لم تسجل أي حالة وفاة أثناء عمل الدراسة. جميع نتائج الحالات كان أطباقها تام، وايضاً لم يكن هناك نزف من جديد ولا يحدث أي اقفار خلال الفترة من 6-36 شهر التي تبعت هذا الإجراء.

خاتمة: يعد التدخل بالعلاج داخل الشرايين بلفائف الجوجليمي ولفائف الكيميائية آمن وطريقة فعالة لعلاج النزف داخل الجافية من تشريح شريان فقري تلقائي ممزق.

Objective: To study the therapeutic effect of endovascular treatment for intradural hemorrhage from ruptured spontaneous vertebral artery dissections (SVAD) using Guglielmi detachable coils and mechanical coils.

Methods: The retrospective study was carried out in the Department of Interventional Radiology, Rizhao People's Hospital, Rizhao, China from January 2008 to December 2011. Twelve patients with intradural

hemorrhage from ruptured SVAD underwent endovascular embolization treatment after imaging and clinical evaluation. The aneurysm lumen and the parent artery were embolized with Guglielmi detachable coils and mechanical coils. Guglielmi detachable coils were used to embolize the aneurysm lumen and the parent artery adjacent to the aneurysm. Mechanical coils were used to embolize the parent artery.

Results: All lesions were proximal to the posterior inferior cerebellar artery origin. All patients had successful outcomes without any other complications. Angiograms immediately after embolization demonstrated complete occlusions. There were no patient deaths during the study. All cases resulted in complete occlusions, and no rebleeding or ischemia occurred during the 6-36 month follow-up period.

Conclusion: Endovascular intervention with Guglielmi detachable coils and mechanical coils is a safe and efficacious method for treating intradural hemorrhage from ruptured SVAD.

Neurosciences 2013; Vol. 18 (1): 46-51

From the Department of Intervention Radiology (Xu, Li, Liu X), and Department of ICU (Liu W), Rizhao People's Hospital, Rizhao, the Department of Radiology (Hao), The Affiliated Hospital of Medical College, Qingdao University, and the Department of Radiology (Zhang), Qingdao Municipal Hospital, Qingdao, Shandong, China.

Received 30th April 2012. Accepted 16th September 2012.

Address correspondence and reprint request to: Dr. Da-Peng Hao, Department of Radiology, The Affiliated Hospital of Medical College, Qingdao University, 16 Jiangsu Road, Qingdao, Shandong, China. Tel. +86 1866 1802582. Fax. +86 0633 3365366. E-mail: haodapeng2011@gmail.com

Disclosure. The authors declare no conflicting interests, support or funding from any drug company.

There are 3 well-defined layers in the wall of the vertebral arteries. These layers include the intima with internal elastic membrane, the media with external elastic membrane, and the adventitia.¹ Spontaneous vertebral artery dissections (SVAD) occur most commonly between the media and internal elastic layers.¹ The extradural vertebral artery has a thicker media and adventitia with more elastic fibers. Extradural SVAD most likely proceed through the internal elastic lamina to the subintima. This results in vertebrobasilar insufficiency or posterior circulation infarction attributable to arterial narrowing and thromboembolism.² The intradural vertebral artery has a thinner media and adventitia with fewer elastic fibers. Intradural SVAD most likely proceed through the media to the subadventitial layer, and results in subarachnoid hemorrhage (SAH) attributable to arterial dilatation and subsequent rupture.^{1,3,4}

Although SVAD rarely occur in the intradural vertebral artery, the mortality in these patients is higher.^{1,3} Endovascular intervention has been recommended as the standard and first choice for treatment. To date, no reports demonstrate the efficacy of Guglielmi detachable coils combining mechanical coils for the endovascular treatment in patients with SVAD. The aim of this retrospective study is to present our experience with Guglielmi detachable coils and mechanical coils for the endovascular treatment of 12 patients who had intradural hemorrhage from ruptured SVAD.

Methods. Between January 2008 and December 2011, a total of 12 patients with intradural hemorrhage from ruptured SVAD underwent endovascular treatment in the Department of Interventional Radiology, Rizhao People's Hospital, Rizhao, China. All patients were treated after informed consent was obtained from their relatives. The Institution's ethics review committee approved the research.

All patients were confirmed by CT (Figure 1a). The inclusion criterion was a lesion proximal to the posterior inferior cerebellar artery (PICA) origin in digital subtraction angiography (DSA). The 12 patients were treated with endovascular intervention. The aneurysm lumen and the parent artery were embolized by internal trapping. Guglielmi detachable coils (MicroPlex and HyperSoft, MicroVention Inc., Tustin, CA, USA) and mechanical coils (Cook, Bloomington, MA, USA) were used in the study. Guglielmi detachable coils were used to embolize the aneurysm lumen (MicroPlex) and the

parent artery adjacent to the aneurysm (HyperSoft). Mechanical coils were used to embolize the parent artery. All patients were treated within 3-7 days after the onset of symptoms. Heparin (4000 units) followed by an intravenous drip rate of 2000 units/hour was administered prior to the procedure to prevent clotting. After the procedure, all patients were sent to the neurosurgical intensive care unit for close neurological monitoring. Lumbar punctures were performed soon after the procedure to drain small amounts of post-surgical hemorrhage from the CSF. Nimodipine (50 ml, every 12 hours for 7 days by intravenous drip) was administered to prevent angiospasm.

Digital subtraction angiography (DSA) was performed during the endovascular intervention in all cases (Figures 1B-1H). The DSA or CT angiography (CTA) binding MRI was performed from 6 to 36 months post-operatively in all patients to ensure successful occlusion. The efficacy of the treatment was determined by the presence or absence of complete occlusions of the dissecting aneurysm and proximal artery.

Results. Eight male and 4 female patients with a mean age of 49 years (age range, 39-58 years) were studied. Sudden severe headache and vomiting were present in 10 patients. One patient described symptoms of cephalagra, which were present 5 days prior to experiencing a severe headache. Another patient presented initially with sudden dizziness, headache, and seizure disorder lasting for one day before experiencing an agonizing headache with vomiting. No patients had any definite cervical trauma or family history (Table 1). All lesions were proximal to the PICA origin and demonstrated the "pearl and string sign (local arterial dilatation with proximal or distal stenosis)" on DSA (Figures 1B-1D). The collateral circulation filled adequately. All patients had successful outcomes without rebleeding or any other complications during endovascular treatment. Angiograms immediately after embolization demonstrated complete occlusions of the dissecting aneurysms (Figure 1E) and proximal parent vertebral arteries (Figure 1F). After treatment, one patient reported auricle pain on the ipsilateral side to the procedure, and another reported double vision. Both of these symptoms resolved after symptomatic treatment.

All dissecting aneurysms and parent arterial segments remained occluded on follow-up imaging studies with conventional DSA or CTA (Figures 1G & 1H). Follow-up

Table 1 - Demographic details and clinical manifestations of patients with intradural hemorrhage from ruptured SVAD.

Patient	Gender, age	Lesion site	Hunt-Hess grade	Clinical manifestations
1	M, 39	Right	3	Sudden severe headache, vomiting, disturbed consciousness
2	M, 46	Right	1	Agonizing headache, vomiting
3	F, 48	Left	2	Cephalagra prior to severe headache
4	M, 50	Right	3	Sudden severe headache, vomiting, disturbed consciousness
5	M, 53	Left	3	Sudden severe headache, vomiting
6	F, 58	Right	2	Sudden severe headache, vomiting
7	M, 44	Left	3	Seizure disorder before headache
8	M, 49	Left	4	Sudden severe headache, vomiting, disturbed consciousness
9	F, 55	Right	3	Headache, vomiting
10	F, 40	Left	2	Sudden severe headache
11	M, 54	Right	3	Severe headache, vomiting
12	M, 52	Right	2	Sudden severe headache, vomiting

SVAD - spontaneous vertebral artery dissection, M - male, F - female

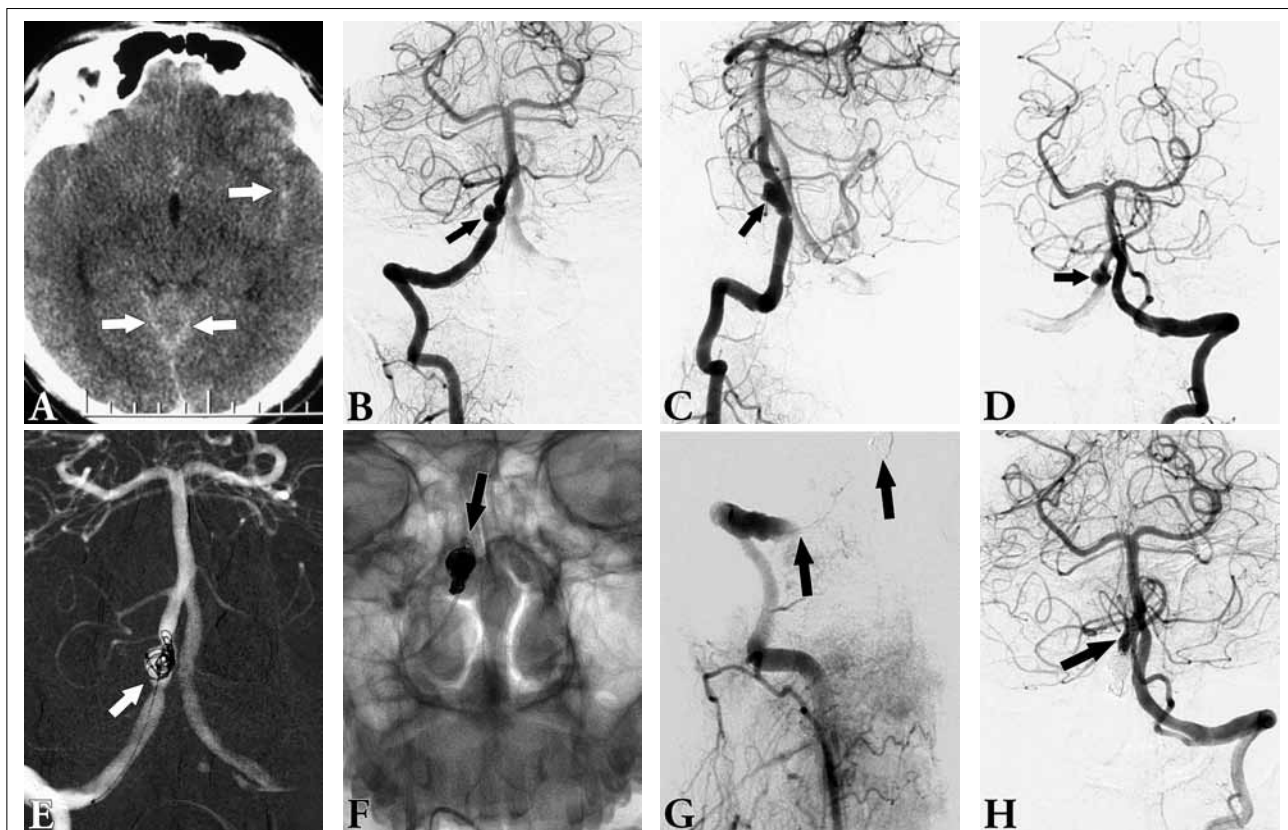


Figure 1 - Acutely ruptured right vertebral dissecting aneurysm proximal to the PICA origin in a 39-year-old man showing: A) Plain CT shows SAH. B & C) Right vertebral angiogram shows large aneurysmal dilation with string sign located proximal to the PICA origin (arrows). D) Left vertebral angiogram shows nourishment of posterior circulation originating from the left vertebral artery and filling of the right SVAD (arrow). E) Right vertebral angiogram demonstrates the dissecting aneurysm is embolized by the Guglielmi detachable coil (arrow). F) Right vertebral angiogram demonstrates the parent artery proximal to SVAD is embolized by the mechanical coil (arrow). G) Right vertebral angiogram obtained after embolization demonstrates both SVAD and parent artery are completely occluded. H) Left vertebral angiogram obtained after embolization demonstrates retrograde filling of the right distal vertebral artery and PICA. PICA - posterior inferior cerebellar artery, SAH - subarachnoid hemorrhage, SVAD - spontaneous vertebral artery dissection

MRI demonstrated no infarction in the medulla or the posterior inferior cerebellar artery territory in all patients. No recurrent hemorrhage was demonstrated on follow-up MRI.

Discussion. Spontaneous vertebral artery dissection is an uncommon but potentially disabling and fatal disease. Its annual incidence is 1 to 1.5 per 100,000.^{4,5} The SVAD typically occur in the V2 or V3 segment of the vertebral artery. The SVAD rarely occur in the V4 segment with subarachnoid hemorrhage (SAH).^{1,5} In Peluso et al's study,¹ only 13 SVAD occurred in the intradural V4 segment with SAH in a total of 756 endovascular treated aneurysms (incidence, 1.7%).

It is important to ensure accurate imaging diagnosis to allow for proper treatment. Both CTA and DSA are the most useful methods for diagnosing SVAD. The DSA has been recognized as the "gold standard" in diagnosing arterial dissections since it can clearly demonstrate the aneurysm lumen and the parent vertebral arteries. The CTA is a minimally invasive technique that can demonstrate the arterial lumen, parietal thrombus, calcification, and the relationship between the lesion(s) and the skull. In our study, CTA was used for follow-up imaging in some patients. The DSA combined with CTA can provide accurate imaging details. Angiogram appearances of SVAD are varied according to the location and the degree of the involved vessel wall. "Pearl and string sign" is the most common sign, especially for ruptured SVAD and all lesions in our study demonstrated this radiologic finding.^{6,7}

Deciding to proceed with endovascular treatment for SVAD and the effect it has on the lesion is both dependent upon the location of the SVAD and the condition of the collateral and posterior circulation. To date, endovascular treatment of SVAD has taken the place of surgical treatment.^{1,8} Sufficient analysis based on imaging and clinical data is helpful to make the best endovascular therapeutic strategy and gain the best effect. For lesions proximal to the PICA origin, the dissecting aneurysm and parent arterial segments are occluded with coils as long as the collateral circulation fills adequately via the contralateral vertebral artery or posterior communicating arteries. If collateral flow is insufficient, the parent artery is preserved. For lesions distal to the PICA origin, determining involvement of the anterior and posterior spinal artery is crucial. The perforation must also be localized to determine if it arises between 14 mm proximal and 16 mm distal to the union of the vertebrobasilar artery.⁶ Jin et al⁹ reported 3 patients with symptomatic PICA infarctions after endovascular occlusion with PICA preservation.

These 3 SVAD lesions were distal to the PICA origin. The authors suggested that the infarctions were related to the occlusion of critical perforating arteries. The decision to preserve or to embolize the PICA is critical in treating lesions involving the PICA origin. Kitanaka et al¹⁰ suggested that sacrificing the PICA was not always dangerous because of the rich pial anastomoses. Peluso et al¹ suggested that immediate internal coil trapping of the PICA was the preferred therapy in SVAD with SAH. This prevents recurrent SAH, which outweighs the risk of ischemia in the tissue being perfused by the PICA. In the present study, all lesions were proximal to the PICA origin, and the aneurysm lumen and the parent artery were all occluded.

When the dissection involves the dominant vertebral artery, evaluation of the collateral circulation via the contralateral vertebral artery or posterior communicating arteries should be considered first. For patients with lesions involving the contralateral vertebral artery or in patients with a single vertebral artery and insufficient posterior communicating arteries, reconstructive strategies should be considered. The indication and timing of treatment for SVAD still remain controversial.^{9,11} Most studies suggest that either unruptured or ruptured SVAD should be treated as early as possible. Early endovascular treatment has been considered standard and first choice especially in ruptured SVAD, which has a poor clinical outcome.^{1,6,9,11}

Approaches to endovascular strategies of SVAD could be divided into deconstructive (sacrificing the parent artery) and reconstructive (preserving blood flow through the parent artery).⁸ Deconstructive strategies can be performed when important branch vessels are not incorporated in the dissected segment of the artery and collateral blood flow could adequately supply the posterior circulation. Proximal occlusion of the parent artery has been widely used for treating ruptured SVAD. It is easily performed, but is not able to completely prevent subsequent ruptures of the same lesion. Proximally occluding the parent artery alone should only be considered when patients cannot be safely treated with other endovascular techniques.¹²⁻¹⁴ Internal coil trapping of the affected segment is the most thorough treatment method for ruptured SVAD. It efficaciously prevents rebleeding, but increases the risk of occlusion of side branches. This can lead to further injury to the vessel wall, and potential dislodging of emboli.^{1,8,9}

Reconstructive techniques include the double stent method and stent-assisted coil embolization. Reconstructive techniques have the ability to preserve

parent arteries, making this technique useful in cases of inadequate collateral flow or major branch vessel SVAD. In theory, reconstructive techniques are more reasonable than deconstructive ones. However, the double stent method usually takes a longer period of time to completely obliterate the dissection and cannot totally prevent the ruptured SVAD from rebleeding.⁸ Stent-assisted coil embolization is associated with a higher risk of rebleeding because ruptured SVAD are more friable than an intracranial aneurysm. Some studies suggest that preserving the parent vessel is not necessary in most patients. The techniques aimed at preservation of the parent artery are used only in cases of bilateral SVAD or vertebral artery dysplasia.^{1,8}

The present study indicates that there is a considerable pitfall associated with endovascular treatment modalities of ruptured SVAD. Radiologic complete occlusion is nearly impossible, and therefore rebleeding is always a possibility. Even if complete occlusion were obtained, there is still risk of recanalization.¹⁵⁻¹⁸ To solve this problem, we applied 2 types of coils - Guglielmi detachable coils and mechanical coils. Guglielmi detachable coils have high steerability and compliance, and were used to embolize the aneurysm lumen and the parent artery adjacent to the aneurysm. This method can reduce the risk of rupture. Mechanical coils have high intensity and were used to embolize the parent artery. This method can increase the complete occlusion rate and decrease the risk of recanalization.

However, in many cases, the dissection of the vessel walls is also found in the parent artery just adjacent to the aneurysm. As a result, the affected parent artery is very fragile as well as the aneurysm in such cases, which may be damaged by the hard mechanical coils and rupture. To avoid this problem, DSA was performed during treatment to evaluate the extent of the aneurysm. The parent artery adjacent to the aneurysm was embolized by Guglielmi detachable coils before placing the mechanical coils.

In the present study, the chance of complete occlusion increases and the risk of recanalization decreases. There was no rebleeding or any other procedure-related complications. The DSA was performed immediately after embolization and demonstrated 100% occlusion of the dissecting aneurysms and proximal vertebral arteries. Only one patient had short-term double vision, which may have been caused by temporary vertebrobasilar insufficiency. There was no rebleeding or ischemic complication during the duration of follow-up.

There are some limitations associated with endovascular treatment of ruptured SVAD with Guglielmi detachable coils and mechanical coils. Risk of

thrombosis in the distal parent artery after embolization is a concern. If a thrombus affected any important structure, such as the basilar artery, this could result in severe infarction of the posterior circulation territory. Another concern would be the possibility of mistakenly embolizing another branch of the affected artery or another artery altogether, leading to inadvertent ischemia of that vessels perfusion territory. The cases in our study are limited, and the follow-up duration is not long enough. The long-term efficacy of this treatment method remains to be determined in a large series.

In conclusion, endovascular treatment is a minimally invasive, safe, and feasible method for treating SVAD. Endovascular treatment with Guglielmi detachable coils combining machinery coils has a satisfactory efficacy and can decrease the ratio of rebleeding.

References

1. Peluso JP, van Rooij WJ, Sluzewski M, Beute GN, Majoie CB. Endovascular treatment of symptomatic intradural vertebral dissecting aneurysms. *AJNR Am J Neuroradiol* 2008; 29: 102-106.
2. Luo CX, Chi LX, Fan WH, Chen KN. Successful treatment of severe stenosis of the posterior cerebral artery with percutaneous transluminal angioplasty and stenting. *Neurosciences (Riyadh)* 2010; 15: 272-274.
3. Chiche L, Praquin B, Koskas F, Kieffer E. Spontaneous dissection of the extracranial vertebral artery: indications and long-term outcome of surgical treatment. *Ann Vasc Surg* 2005; 19: 5-10.
4. Schievink WI. Spontaneous dissection of the carotid and vertebral arteries. *N Engl J Med* 2001; 344: 898-906.
5. Arnold M, Bousser MG, Fahrni G, Fischer U, Georgiadis D, Gandjour J, et al. Vertebral artery dissection: presenting findings and predictors of outcome. *Stroke* 2006; 37: 2499-2503.
6. Taha MM, Sakaida H, Asakura F, Maeda M, Toma N, Yamamoto A, et al. Endovascular management of vertebral artery dissecting aneurysms: review of 25 patients. *Turk Neurosurg* 2010; 20: 126-135.
7. Naito I, Iwai T, Sasaki T. Management of intracranial vertebral artery dissections initially presenting without subarachnoid hemorrhage. *Neurosurgery* 2002; 51: 930-937; discussion 937-938.
8. Ahn JY, Han IB, Kim TG, Yoon PH, Lee YJ, Lee BH, et al. Endovascular treatment of intracranial vertebral artery dissections with stent placement or stent-assisted coiling. *AJNR Am J Neuroradiol* 2006; 27: 1514-1520.
9. Jin SC, Kwon DH, Choi CG, Ahn JS, Kwun BD. Endovascular strategies for vertebrobasilar dissecting aneurysms. *AJNR Am J Neuroradiol* 2009; 30: 1518-1523.
10. Kitanaka C, Sasaki T, Eguchi T, Teraoka A, Nakane M, Hoya K. Intracranial vertebral artery dissections: clinical, radiological features, and surgical considerations. *Neurosurgery* 1994; 34: 620-626; discussion 626-627.

11. Lee JW, Jung JY, Kim YB, Huh SK, Kim DI, Lee KC. Spontaneous dissecting aneurysm of the intracranial vertebral artery: management strategies. *Yonsei Med J* 2007; 48: 425-432.
12. Kim TK, Seo SI, Seol HY, Kwon BJ, Han MH. Mechanically-induced proximal arterial occlusion and stent-within-a-stent technique for the treatment of bilateral vertebral artery dissecting aneurysms. *Br J Radiol* 2006; 79: e166-e170.
13. Mehta B, Burke T, Kole M, Bydon A, Seyfried D, Malik G. Stent-within-a-stent technique for the treatment of dissecting vertebral artery aneurysms. *AJNR Am J Neuroradiol* 2003; 24: 1814-1818.
14. Rabinov JD, Hellinger FR, Morris PP, Ogilvy CS, Putman CM. Endovascular management of vertebrobasilar dissecting aneurysms. *AJNR Am J Neuroradiol* 2003; 24: 1421-1428.
15. Araki S, Oda K, Fujita T, Kawakami M. Internal trapping of a ruptured vertebral artery dissecting aneurysm followed by recanalization of the trapped vertebral artery without aneurysm recurrence: case report. *Neurol Med Chir (Tokyo)* 2010; 50: 914-917.
16. Kojima A, Okui S, Onozuka S. Long-term follow up of antegrade recanalization of vertebral artery dissecting aneurysm after internal trapping: case report. *Neurol Med Chir (Tokyo)* 2010; 50: 910-913.
17. Leibowitz R, Do HM, Marcellus ML, Chang SD, Steinberg GK, Marks MP. Parent vessel occlusion for vertebrobasilar fusiform and dissecting aneurysms. *AJNR Am J Neuroradiol* 2003; 24: 902-907.
18. Park KW, Park JS, Hwang SC, Im SB, Shin WH, Kim BT. Vertebral artery dissection: natural history, clinical features and therapeutic considerations. *J Korean Neurosurg Soc* 2008; 44: 109-115.

Related articles

Chen Z, Yang Y, Miao H, Chen J, Luo C, Feng H, et al. Endovascular treatment of ruptured peripheral intracranial aneurysms. *Neurosciences* 2012; 17: 133-138.

Yu JL, Wang HL, Xu K, Wang B, Luo Q. Endovascular treatment of an intracranial aneurysm with a ruptured bleb. *Neurosciences* 2012; 17: 127-132.

Luo CX, Chi LX, Fan WH, Chen KN. Successful treatment of severe stenosis of the posterior cerebral artery with percutaneous transluminal angioplasty and stenting. *Neurosciences* 2010; 15: 272-274.