

# SUCCESSFUL STENTING BY COMBINATION TECHNIQUE OF REVERSE FLOW AND DOWNSTREAM FILTERING FOR LONG CHRONIC TOTAL OCCLUSION OF THE CERVICAL VERTEBRAL ARTERY: TECHNICAL CASE REPORT

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Received, October 6, 2008.

Accepted, March 12, 2009.

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**OBJECTIVE:** To report a case of successful recanalization using the combination technique of reverse flow and downstream filtering in chronic total occlusion of the bilateral vertebral artery (VA).

**CLINICAL PRESENTATION:** A 59-year-old man had experienced attacks consisting of vertigo and/or dysarthria more than 1 year before presentation. He experienced symptoms despite the administration of antiplatelet drugs and presented to our institution. Diagnostic cerebral angiography demonstrated that the right VA was not occluded at the ostium but, rather, along its midcervical portion and that the left VA ended in the left posterior inferior cerebellar artery.

**INTERVENTION:** Long chronic total occlusion of the right cervical VA was recanalized successfully and safely by reverse flow and downstream filtering with proximal flow blockade and a distal filter device positioned in the right brachial artery. Follow-up angiography at 1 year demonstrated no re-occlusion. The patient's symptoms disappeared after recanalization and did not recur. To our knowledge, there are no reports describing successful angioplasty and/or stenting for long chronic total occlusion of the cervical VA.

**CONCLUSION:** Stenting using the combination technique of reverse flow and downstream filtering can safely open even long chronic cervical VA occlusion and may be effective in the treatment of patients experiencing vertebrobasilar insufficiency due to bilateral chronic VA occlusion.

**KEY WORDS:** Angioplasty, Chronic total occlusion, Filtering, Reverse flow, Stenting, Vertebral artery

*Neurosurgery* 65:E378–E379, 2009

DOI: 10.1227/01.NEU.0000348293.01482.0F

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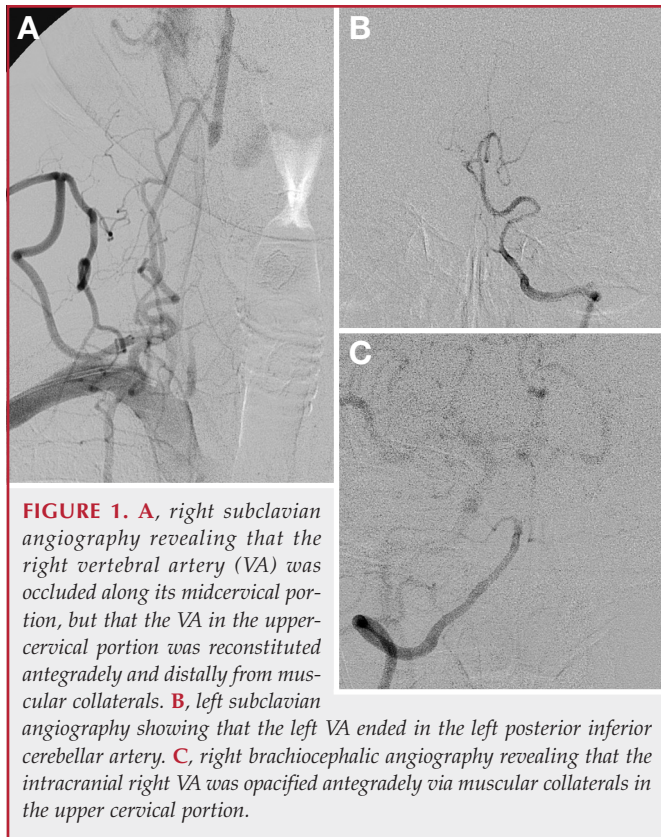
Chronic total occlusion (CTO) of the bilateral vertebral artery (VA) may cause vertebrobasilar insufficiency. However, there are few reports regarding whether or not long CTO of the cervical VA can be opened. We report a case of successful recanalization by stenting using the combination technique of making a reverse flow and downstream filtering for CTO of the cervical VA longer than 5 cm.

## CASE REPORT

A 59-year-old man had experienced transient attacks of vertigo and/or dysarthria for more than 1

**ABBREVIATIONS:** BA, basilar artery; CTO, chronic total occlusion; PFB, proximal flow blockade; SA, subclavian artery; VA, vertebral artery

year before presentation. His symptoms always occurred when he stood up and began to walk. He experienced right cerebellar infarction in 1999 and right parietal hemorrhage in 2004, respectively. Other than right hearing disturbance, his neurological examination was within normal limits. Magnetic resonance imaging demonstrated an old right cerebellar infarction and an old right parietal hemorrhage. Magnetic resonance angiography suggested high-grade stenosis in the basilar artery (BA). The patient experienced symptoms despite administration of antiplatelet drugs (100 mg/d of aspirin and 75 mg/d of clopidogrel) and presented to our institution. Diagnostic cerebral angiography performed in 2006 demonstrated that the right VA was not occluded at the ostium but, rather, along its midcervical portion. The length of the occlusive lesion was approximately 8 cm, the distal segment of the right VA was opacified via collateral arteries (Fig. 1A), and the left VA ended in the left posterior inferior cere-

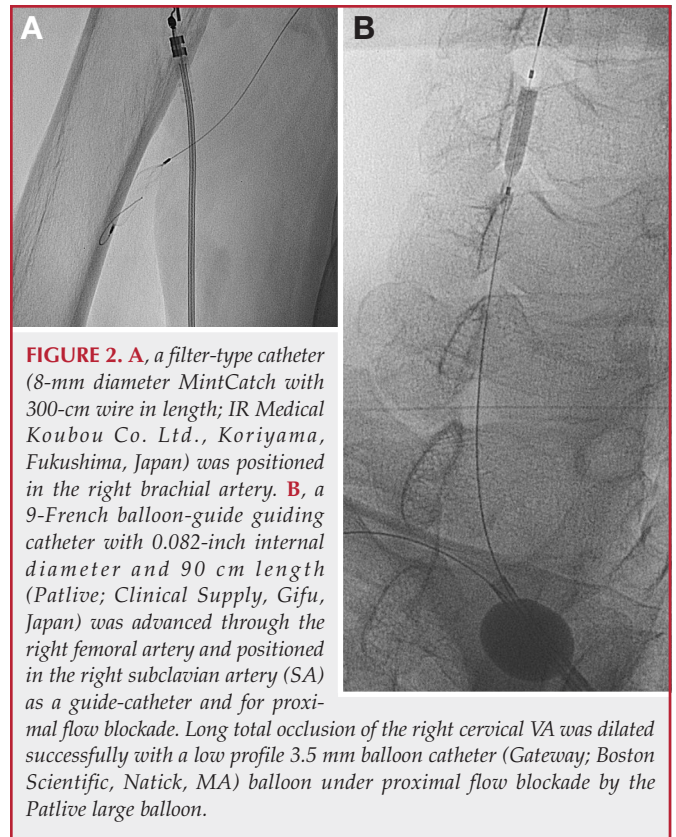


**FIGURE 1.** **A**, right subclavian angiography revealing that the right vertebral artery (VA) was occluded along its midcervical portion, but that the VA in the upper-cervical portion was reconstituted antegradely and distally from muscular collaterals. **B**, left subclavian angiography showing that the left VA ended in the left posterior inferior cerebellar artery. **C**, right brachiocephalic angiography revealing that the intracranial right VA was opacified antegradely via muscular collaterals in the upper cervical portion.

bellar artery (Fig. 1B). The BA was not opacified by the right subclavian angiography (Fig. 1C). The distal segment of the BA was opacified by carotid angiography through the posterior communicating artery. The patient's symptoms probably occurred due to vertebrobasilar insufficiency after standing to walk. After the patient's written informed consent was given, endovascular recanalization was performed 3 months after diagnostic angiography under local anesthesia and systemic heparinization (5000 units intravenously). He continued on the 2 kinds of antiplatelet agents for 1 month after endovascular treatment and remained on aspirin thereafter.

A 9-French sheath was inserted in the right femoral artery and a 5-French sheath in the left femoral artery. A 9-French balloon-guide guiding catheter with a 0.082-inch internal diameter and measuring 90 cm in length (Patlive; Clinical Supply, Gifu, Japan) was advanced through the right femoral artery and positioned in the right subclavian artery (SA) as a guide-catheter and for proximal flow blockade (PFB). A filter-type catheter (8-mm diameter MintCatch with 300-cm wire in length; IR Medical Koubou Co. Ltd., Koriyama, Japan) (6) was inserted through the Patlive and positioned in the right brachial artery (Fig. 2A) to capture the probable debris or thrombi migrating downstream by reverse flow from the cervical VA after recanalization of long CTO. A 5-French catheter (125 cm-JB3; Medikit Co. Ltd., Tokyo, Japan) was advanced through the left femoral artery and positioned in the right brachiocephalic artery to visualize retrograde flow along the BA to the right cervical VA via the posterior communicating artery during the procedures.

The balloon of the guide-catheter was inflated with contrast medium and saline at the proximal end of the SA and blocked proximal flow. The Right Away SuperHard wire (0.014 inch, 300 cm length; Piolax;



**FIGURE 2.** **A**, a filter-type catheter (8-mm diameter MintCatch with 300-cm wire in length; IR Medical Koubou Co. Ltd., Koriyama, Fukushima, Japan) was positioned in the right brachial artery. **B**, a 9-French balloon-guide guiding catheter with 0.082-inch internal diameter and 90 cm length (Patlive; Clinical Supply, Gifu, Japan) was advanced through the right femoral artery and positioned in the right subclavian artery (SA) as a guide-catheter and for proximal flow blockade. Long total occlusion of the right cervical VA was dilated successfully with a low profile 3.5 mm balloon catheter (Gateway; Boston Scientific, Natick, MA) balloon under proximal flow blockade by the Patlive large balloon.

Kanagawa, Japan) coupled with a low profile 3.5 mm balloon catheter (Gateway; Boston Scientific, Natick, MA) was able to penetrate the long CTO successfully. The balloon catheter was inflated over approximately 8 cm in length, from the distal end to the proximal end of the long VA occlusion (Fig. 2B). Right brachiocephalic angiography under PFB of the right SA showed that retrograde reverse flow from the BA to the right VA and SA appeared (Fig. 3), indicating that the long CTO was opened. Thereafter, the balloon catheter was replaced by a stent catheter (Genesis; Cordis Endovascular, Miami, FL) over the SuperHard wire, and 4 Genesis stents (1 measuring  $4.0 \times 24$  mm; 3 measuring  $4.0 \times 18$  mm) were placed in the cervical VA of the 8-cm-long lesion. Right brachiocephalic angiography under PFB showed that there was retrograde reverse flow from the BA to the right SA. Final angiography after the deflation of the guide-catheter balloon demonstrated that the long chronic VA occlusion was recanalized successfully and that the BA was opacified well antegradely. We did not discover any emboli in the distal filter positioned in the right brachial artery. The patient's symptoms were improved immediately after recanalization and did not recur during the 1-year follow-up period. Follow-up arteriography performed at 1 year demonstrated no restenosis or reocclusion (Fig. 4).

## DISCUSSION

Previous studies have reported that acute or subacute total occlusion of the VA and/or BA can be recanalized (5, 11). A study published in 1994 reported that total occlusion of the intracranial VA can be opened even in the chronic stage (3). Another study

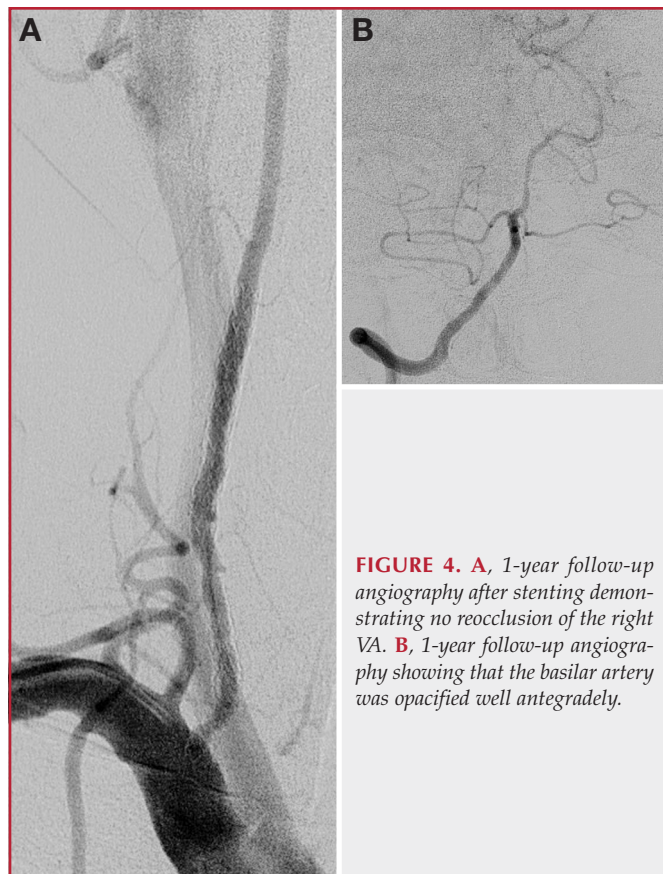


published in 1997 reported that CTO of the middle cerebral artery can be opened (12). Intracranial stenting for ischemic stroke was first reported in 1999 for emergency (11) and elective (10) cases. To the best of our knowledge, there are no reports regarding successful angioplasty and/or stenting for long CTO of the cervical VA.

There are 3 probable risks in angioplasty and/or stenting for CTO of the cervical VA. The first is the risk of intracranial embolization of clots or debris into the intracranial arteries. The second risk is vascular rupture or perforation by guidewires or balloon catheters. Finally, downstream embolization of clots or debris into the peripheral branches in the upper extremity may occur. To prevent intracranial embolism during elective cervical carotid



**FIGURE 3.** Right brachiocephalic angiography showing that the right SA was blocked and the right VA and SA were opacified retrogradely by the reverse flow.



**FIGURE 4.** A, 1-year follow-up angiography after stenting demonstrating no reocclusion of the right VA. B, 1-year follow-up angiography showing that the basilar artery was opacified well antegradely.

artery stenting, several techniques for protection have been reported (1, 9, 13). The most effective or rational way of protection is to develop a reverse flow from the intracranial to the cervical artery by occluding the large artery proximal to the lesion. We therefore applied the new combination technique of reverse flow and downstream filtering to prevent embolization. A balloon-guide catheter with 10 mm or more of the maximal inflation diameter is required for PFB, because the diameter of the SA is 10 mm or more. Unless the maximal inflation diameter is enough for PFB, the strategy fails and other strategies must be planned. If the right VA originates from the proximal portion in the right SA and very near the brachiocephalic artery, a balloon-guide catheter cannot be positioned at the suitable site for PFB. We considered using a filter device distally in the right VA to further protect against intracranial emboli after successful recanalization by producing an angiographic retrograde flow from the BA to the right SA because there were possible thrombi which remained in the revascularized right VA without flowing into the right brachial artery. However, it seemed difficult and dangerous to navigate a filter device through the right VA immediately after balloon dilatation, and we did not insert a filter device into the distal VA. Unless angiographic retrograde flow could not be found, we inserted a filter device distally in the right VA immediately after balloon dilatation.

Although extracranial-intracranial artery bypass surgery or vertebral endarterectomy was considered as one of the therapeutic options in the posterior cerebral circulation, it is associated with high risks of serious complications and mortality (2, 4). Previous studies reported good outcome after treatment with external carotid to distal vertebral (C1–C2) level bypass with saphenous vein or radial artery (7, 8). However, the bypass surgery is not common.

Stenting using the combination technique of reverse flow and downstream filtering under PFB can safely open even long chronic cervical VA occlusion and may be effective in the treatment of patients experiencing vertebrobasilar insufficiency due to bilateral chronic VA occlusion.

## Disclosure

Takahisa Mori, M.D., Ph.D., serves as an advisor for IR Co. Ltd. The other authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in this article.

## REFERENCES

- Adami CA, Scuro A, Spinamano L, Galvagni E, Antonucci D, Farello GA, Maglione F, Manfrini S, Mangialardi N, Mansueto GC, Mascoli F, Nardelli E, Tealdi D: Use of the Parodi anti-embolism system in carotid stenting: Italian trial results. *J Endovasc Ther* 9:147–154, 2002.
- Ausman JI, Diaz FG, Sadasivan B, Dujovny M: Intracranial vertebral endarterectomy. *Neurosurgery* 26:465–471, 1990.
- Honda S, Mori T, Fukuoka M, Kajita K, Arisawa M, Nishimura T, Mori K: Successful percutaneous transluminal angioplasty of the intracranial vertebral artery 1 month after total occlusion—Case report. *Neurol Med Chir (Tokyo)* 34:551–554, 1994.
- Hopkins LN, Budny JL: Complications of intracranial bypass for vertebrobasilar insufficiency. *J Neurosurg* 70:207–211, 1989.

5. Imai K, Mori T, Izumoto H, Kunieda T, Takabatake N, Yamamoto S, Watanabe M: Transluminal angioplasty and stenting for intracranial vertebrobasilar occlusive lesions in acute stroke patients. *AJNR Am J Neuroradiol* 29:773–780, 2008.
6. Iwata T, Mori T, Tajiri H: Successful staged endovascular treatment of a symptomatic cervical carotid bifurcation stenosis coupled with a coincidental unruptured cerebral aneurysm in the carotid distal segment. *AJNR Am J Neuroradiol* 29:1948–1950, 2008.
7. Kakino S, Ogasawara K, Kubo Y, Kobayashi M, Kashimura H, Ogawa A: Symptomatic occlusion at the origin of the vertebral artery treated using external carotid artery–cervical vertebral artery bypass with interposed saphenous vein graft. *Surg Neurol* 69:164–168, 2008.
8. Kieffer E, Praquin B, Chiche L, Koskas F, Bahnini A: Distal vertebral artery reconstruction: Long-term outcome. *J Vasc Surg* 36:549–554, 2002.
9. Milosevic ZV, Kocijancic JJ, Bunc M, Bajrovi FF, Zvan B: Dual cerebral protection technique during carotid stenting. *J Endovasc Ther* 14:86–90, 2007.
10. Mori T, Kazita K, Mori K: Cerebral angioplasty and stenting for intracranial vertebral atherosclerotic stenosis. *AJNR Am J Neuroradiol* 20:787–789, 1999.
11. Mori T, Kazita K, Seike M, Nojima Y, Mori K: Successful cerebral artery stent placement for total occlusion of the vertebrobasilar artery in a patient suffering from acute stroke. *J Neurosurg* 90:955–958, 1999.
12. Mori T, Mori K, Fukuoka M, Honda S: Percutaneous transluminal angioplasty for total occlusion of middle cerebral arteries. *Neuroradiology* 39:71–74, 1997.
13. Mori T, Tajiri H, Iwata T: Emergency carotid artery stenting for total or near occlusion with or without proximal flow control in acute stroke stage. International Stroke Conference Poster: International Stroke Conference, New Orleans, Feb 19–22, 2008.

## Acknowledgments

We thank Nozomi Chiba, B.A., for secretarial assistance and the nurses and radiological technicians in our neuroendovascular catheterization room for specialized assistance.

## COMMENTS

Iwata et al. describe an interesting case in which they essentially created a subclavian steal syndrome to recanalize a chronically occluded vertebral artery. By inflating a balloon in the proximal right subclavian artery and passing a protection device into the distal right brachial artery, they were able to protect simultaneously the intracranial and brachial circulations from thromboembolic propagation. This article supports the growing body of literature that documents the feasibility of reopening chronically occluded vessels. As the authors themselves demonstrated, innovative techniques are often required to perform these procedures.

**Felipe C. Albuquerque**  
*Phoenix, Arizona*

Iwata et al. describe a novel technique for endovascular revascularization of a long chronic occlusion of the right vertebral artery. The authors' method is elegant and innovative, involving concepts of proximal flow arrest and embolic protection for retrograde flow.

Extracranial vertebral artery occlusive disease is an important and serious condition, particularly in symptomatic, medically refractory patients. Traditional surgical treatment options are associated with serious morbidity risks. The authors exercise creative use of endovascular devices and techniques to treat this complex disease with successful

results angiographically and clinically for the patient. Their method of protecting against intracranial emboli was proximal flow arrest with an inflated balloon in the right subclavian artery. Potentially, a protection device in the right vertebral artery distally could have been used in combination for further intracranial protection.

More patients treated with this technique and angiographic follow-up to assess the incidence of restenosis, as well as clinical follow-up to assess long-term symptom-free and stroke-free duration will be necessary to more critically evaluate this treatment technique. The authors' sharing of this novel and elegant technique and their creative use of endovascular devices and techniques to treat complex diseases, such as this, are what will advance our field.

**Brian L. Hoh**  
*Gainesville, Florida*

The authors describe the technique of revascularization of the cervical vertebral artery. Obviously, one does not know how long this artery was occluded, but the occlusion perhaps was not as long as the authors allude to, in that one can see the takeoff of the vertebral from the subclavian with reconstitution owing to the muscular branch.

Nevertheless, the concept of reversal of flow in the vertebral artery with downstream filtering is a unique way to potentially deal with embolic debris, and I think that this is useful to put into the catalog of tricks. Unfortunately, as is known with anterior circulation disease, posterior circulation revascularization has not been studied as well to determine whether revascularization reduces the risk of stroke or posterior circulation disease when it is extracranial in origin. Be that as it may, on the basis of this case, the authors have provided suggestions regarding this type of revascularization.

**Robert H. Rosenwasser**  
*Philadelphia, Pennsylvania*

Iwata et al. present a brief technical report describing the successful recanalization of a chronically occluded cervical vertebral artery by performing an antegrade approach to the occlusion and proximal subclavian temporary balloon occlusion to allow retrograde flow of blood via the posterior communicating artery with consequent protection of the intracranial circulation. This reversal of flow during the reperfusion phase of the procedure along with the placement of the distal filter in the brachial artery provided protection against intracranial embolic events. The authors achieved technical success, no complications, and long-term patency for this patient presenting in a state of vascular insufficiency.

The authors describe a very elegant approach to the recanalization of a vessel in a patient with clear vascular insufficiency. This represents an excellent technical case report with a good, innovative technique and an excellent result. Although likely to be used in very few cases, this report provides the readership an excellent technical description with some interesting well-thought-out nuances that helped achieve success.

**Charles J. Prestigiacomo**  
*Newark, New Jersey*