

## Case Report

# Embolization of a spinal dural arteriovenous fistula with ethylene-vinyl alcohol copolymer (Onyx) using a dual-lumen microballoon catheter and buddy wire technique

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## Abstract

**Background:** *N*-butyl 2-cyanoacrylate (NBCA) remains the standard embolic agent for spinal dural arteriovenous fistula (SDAVF) treatment. Treatment of SDAVF with ethylene-vinyl alcohol copolymer (Onyx, ev3-Covidien, Irvine CA, USA) is currently not well established. Although several cases have reported the use of Onyx to embolize an intracranial dural arteriovenous fistula using a dual-lumen microballoon catheter, Onyx embolization of an SDAVF using a dual-lumen microballoon catheter has not been reported.

**Case Description:** We treated a 57-year-old man with an SDAVF using a dual-lumen microballoon catheter and buddy wire technique to perform transarterial Onyx embolization via the left sixth intercostal artery.

**Conclusions:** Onyx embolization using a dual-lumen microballoon catheter was effective. Furthermore, the buddy wire technique was useful for providing rigid support of the microcatheter in a narrow and tortuous intercostal artery.

**Key Words:** Balloon catheter, buddy wire technique, ethylene-vinyl alcohol copolymer, Onyx, spinal dural arteriovenous fistula

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## INTRODUCTION

Endovascular embolization has become an accepted alternative to surgical management of spinal dural arteriovenous fistula (SDAVF).<sup>[9,12]</sup> While the successful use of *N*-butyl 2-cyanoacrylate (NBCA) for endovascular treatment has been reported in a number of cases,<sup>[6,10]</sup> the use of an ethylene-vinyl alcohol copolymer (Onyx, ev3-Covidien, Irvine, CA, USA) to treat SDAVF is currently not well established. We describe a case of SDAVF treated with transarterial Onyx embolization using a dual-lumen microballoon catheter and buddy wire technique.

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## CASE PRESENTATION

### History and examination

A 57-year-old male, with an 18-month history of urinary incontinence and 15 months of progressive lower extremity numbness, presented with a 10 days of increased lower extremity weakness. The patient had no history of trauma. The neurological examination documented a bilateral paraparesis (manual muscle testing 2/5) accompanied by mild hyporeflexia and dysesthesia relative T9 sensory level. The spinal magnetic resonance imaging (MRI) study revealed spinal cord edema T3 to the conus medullaris and enlarged perimedullary thoracic veins; these findings were consistent with a SDAVF [Figure 1]. Spinal angiography was performed using a 4 Fr catheter (Michaelson, Cook, Bloomington, IN, USA). Selective injection of the left sixth intercostal artery revealed a SDAVF that was supplied by a radiculomeningeal artery and drained through the perimedullary veins [Figure 2]. The orifice of the left sixth intercostal artery was narrow and the vessel was tortuous.

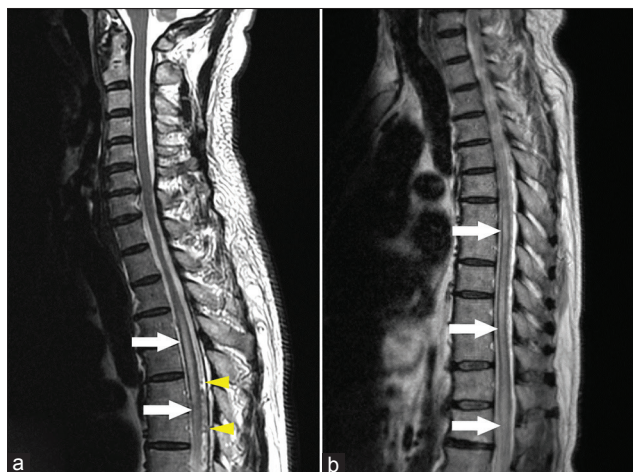
### Selective embolization procedure

Five days after admission, we performed a super selective embolization. Under general anesthesia, a 6 Fr introducer sheath was inserted into the right femoral artery. Following arterial access, 4000 U of heparin was injected and an activated clotting time of 275 s was achieved. Our attempts to catheterize the left sixth intercostal artery orifice using a 5 Fr guiding catheter (CX catheter-A II Michaelson type, Gadelius Medical, Tokyo, Japan) over a 0.035-inch outer diameter guidewire (Radifocus, Terumo, Tokyo, Japan) were unsuccessful; we could not advance both a guidewire and guiding catheter. However, we were able to navigate a 0.0165-inch inner diameter microcatheter (Excelsior

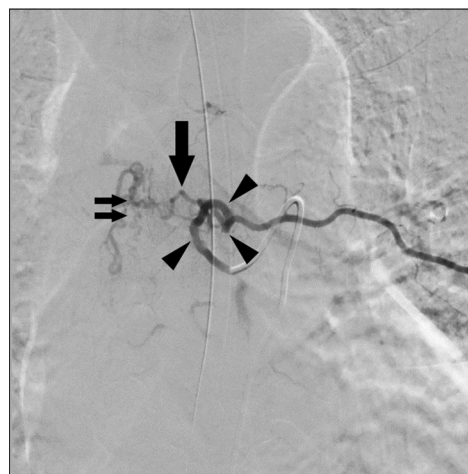
SL-10, Stryker, Fremont, CA, USA) into the distal left sixth intercostal artery over a 0.014-inch outer diameter, 200 cm microguidewire (CHIKAI, Asahi Intecc, Nagoya, Japan). We exchanged the microguidewire for a 0.014-inch outer diameter, 300 cm microguidewire (Aguru, Boston Scientific, Marlborough, MA, USA), and the guiding catheter and microcatheter for a 5 Fr multipurpose guiding catheter (Envoy, Codman and Shurtleff, Raynham, MA, USA). Insertion of the microguidewire into the distal left sixth intercostal artery as a buddy wire stabilized the guiding catheter in the artery orifice [Figure 3]. A 0.0165-inch inner diameter dual-lumen microballoon catheter (Scepter XC 4 × 11 mm, Microvention/Terumo, Tustin, CA, USA) was inserted into the dorsal spinal artery over a 0.014-inch outer diameter microguidewire (CHIKAI, Asahi Intecc, Nagoya, Japan) [Figure 3] and the balloon was inflated. Onyx 18 was injected through the dual-lumen microballoon catheter. A total of 0.35 cc of Onyx was injected over a period of 6 min and 55 s, after which the SDAVF was completely occluded. The syringe suction easily deflated the balloon and the subsequent removal of the microballoon catheter was completed without any observable adherence to the Onyx cast. A postprocedure selective injection of the left sixth intercostal artery revealed the Onyx cast and occlusion of the SDAVF [Figure 4]. Postprocedure multiplanar reconstructed dyna-computed tomography imaging showed the dense deposition of Onyx from the radiculomeningeal artery to the proximal perimedullary veins [Figure 5]. No complications associated with the procedure were evident.

### Postoperative course

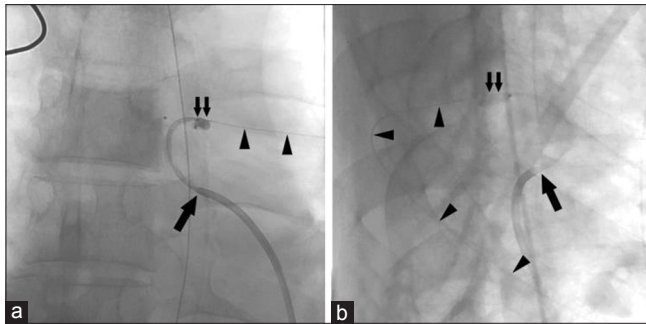
Lower extremity weakness markedly improved within three postprocedure weeks, and his urinary and sensory symptoms partially resolved at 6 months. The thoracic



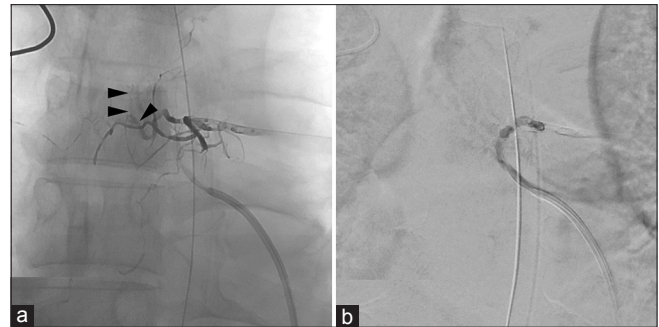
**Figure 1:** (a) MRI on admission. T2-weighted images reveal spinal cord edema from T3 extending inferiorly (arrows), with associated enlarged perimedullary veins in the thoracic cord (arrowheads). (b) Spinal cord edema is shown to extend to the conus medullaris (arrows)



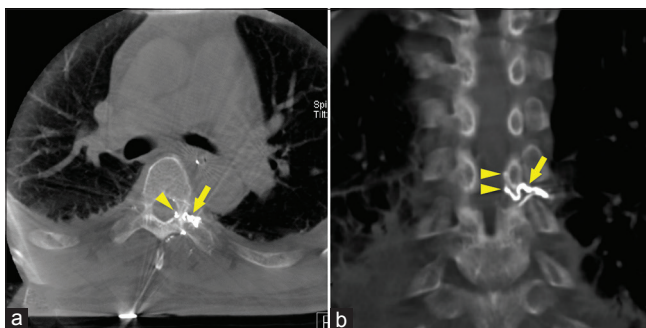
**Figure 2:** Anterior view of selective injection of the left sixth intercostal artery via a 4 Fr catheter demonstrates a spinal dural arteriovenous fistula supplied by a radiculomeningeal artery (large arrow) and drained through enlarged perimedullary veins (small double arrows). The course of the left sixth intercostal artery was tortuous and its orifice was narrow (arrowheads)



**Figure 3:** Anterior (a) and lateral views (b). A 5 Fr guiding catheter is inserted into the left sixth intercostal artery orifice (large arrow). A buddy wire is shown in the left sixth intercostal artery (arrowheads) and a dual-lumen microballoon catheter is shown in the dorsal spinal artery (small double arrows) during balloon inflation



**Figure 4:** (a) Unsubtracted fluoroscopic image obtained postprocedure shows the Onyx cast. Note the dense penetration of Onyx into the proximal perimedullary veins (arrowheads). (b) Anterior view of selective injection of the left sixth intercostal artery postprocedure demonstrates occlusion of the spinal dural arteriovenous fistula



**Figure 5:** Axial (a) and coronal (b) views from multiplanar reconstructed dyna-computed tomography obtained postprocedure reveal the dense penetration of Onyx from the radiculomeningeal artery (arrow) to the proximal perimedullary vein (arrowheads)

MRI 3 months postprocedure revealed the spinal cord edema had resolved, and the enlarged perimedullary veins were no longer visible [Figure 6]. The MRI at 12 months postprocedure showed no evidence of SDAVF recurrence.

## DISCUSSION

The goal of surgical and endovascular SDAVF treatment is to permanently obliterate the fistula and its draining vein.<sup>[8]</sup> Endovascular embolization for SDAVF has become an accepted alternative to surgical management because of its lower invasiveness.<sup>[9,12]</sup>

NBCA is currently the standard embolic agent for SDAVF; however, the permanent cure rates are not high. Niimi *et al.*<sup>[6]</sup> reported that out of 49 SDAVF patients treated primarily with NBCA, adequate embolization was achieved in 39 (80%) patients, with angiographic recurrence occurring in eight of the 35 (23%) patients for whom follow-up data were obtained. A meta-analysis of the outcomes of SDAVF treatment revealed that surgery achieves complete obliteration in 96.6% of patients. In contrast, endovascular treatment results in complete obliteration of an SDAVF in only 72.2% of cases.<sup>[2]</sup> Jellema *et al.*<sup>[5]</sup> reviewed their experience with



**Figure 6:** MRI obtained 3 months postprocedure reveals the resolution of spinal cord edema, and enlarged perimedullary veins were no longer visible

butyl-2-cyanoacrylate (Histoacryl, Tissuaseal, Ann Arbor, MI, USA) embolization of SDAVF in 24 patients over a 10-year period. In 12 of 24 cases, the draining vein was occluded and there was no recurrence or persistent fistula observed during the follow-up period. In the remaining 12 patients, the Histoacryl did not reach the draining vein, with recurrence of the fistula occurring in eight of these patients, who required additional treatment. They concluded that it is essential for the embolic agent to occlude the proximal draining vein to achieve permanent occlusion of an SDAVF.

### Viscosity of Onyx

The viscosity of Onyx, a liquid embolic agent, makes it useful for the endovascular treatment of intracranial dural arteriovenous fistula; however, Onyx has only been used to treat SDAVF in 10 patients.<sup>[3,8,13]</sup> Onyx is advantageous over NBCA because Onyx injection is easier to control and the procedure does not require rapid withdrawal of the catheter immediately after embolization.<sup>[13]</sup> These characteristics of Onyx facilitate the venous penetration

required to achieve obliteration of the proximal draining vein.

### Disadvantages of Onyx

However, some disadvantages of Onyx should be noted.<sup>[1]</sup> For example, it takes time for Onyx to create a proximal plug, which can result in undesirably long fluoroscopy times and radiation exposure. However, use of a dual-lumen microballoon catheter for Onyx embolization to treat intracranial dural arteriovenous fistula enhances penetration without the need for the long plug process used in the common “plug and push” technique.<sup>[4,11]</sup> Further, a “plug” is formed upon inflating the proximal balloon, which allows for continued flow of Onyx and increases feeder resistance proximally for better control of reflux and improved distal penetration. To our knowledge, this is the first case report of Onyx embolization for an SDAVF using a dual-lumen microballoon catheter. Our results indicate that Onyx increases the likelihood of densely filling the proximal draining vein, compared to using NBCA, because the dual-lumen microballoon catheter allows for greater control and improved penetration.

### Super selective embolization of SDAVF

To perform super selective embolization of SDAVF safely, the guiding catheter must be inserted into the intercostal artery for rigid support of the microcatheter. However, this can be difficult to achieve because the caliber of the orifice of the intercostal arteries is often small, and their course can be looped or elongated. Nishino *et al.*<sup>[7]</sup> reported the cases of three patients with a posterior circulation aneurysm who were treated by coil embolization with the aid of a buddy wire technique. The guiding catheter was stabilized in the subclavian artery by advancing the stiff wire into the brachial artery, which allowed for firm support of the microcatheter. As a result, coil embolization was safely performed in all patients. Similarly, we inserted a buddy wire into the guiding catheter parallel to the microcatheter, but the wire was not introduced into the access vessel after exiting the guiding catheter. This technique may allow for endovascular SDAVF treatment in patients with narrow or tortuous intercostal arteries.

### CONCLUSION

This case highlights two points. First, Onyx can be used to successfully treat SDAVF via a dual-lumen microballoon catheter. Second, the buddy wire technique is effective for providing rigid support of the microcatheter in narrow and tortuous intercostal arteries. Our initial experience

indicates that Onyx embolization using a dual-lumen microballoon catheter is effective for the treatment of SDAVF, as it facilitates controlled penetration of the embolic agent into the draining vein.

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### Conflicts of interest

There are no conflicts of interest.

### REFERENCES

- Adamczyk P, Amar AP, Mack WJ, Larsen DW. Recurrence of “cured” dural arteriovenous fistulas after Onyx embolization. *Neurosurg Focus* 2012;32:E12.
- Bakker NA, Uyttenboogaart M, Luijckx GJ, Eshghi OS, Mazuri A, Metzemaekers JD, *et al.* Recurrence rates after surgical or endovascular treatment of spinal dural arteriovenous fistulas: A meta-analysis. *Neurosurgery* 2015;77:137-44; discussion 144.
- Gokhale S, Khan SA, McDonagh DL, Britz G. Comparison of surgical and endovascular approach in management of spinal dural arteriovenous fistulas: A single center experience of 27 patients. *Surg Neurol Int* 2014;5:7.
- Jagadeesan BD, Grigoryan M, Hassan AE, Grande AW, Tummala RP. Endovascular balloon-assisted embolization of intracranial and cervical arteriovenous malformations using dual-lumen coaxial balloon microcatheters and Onyx: Initial experience. *Neurosurgery* 2013;73(2 Suppl Operative):ons238-43; discussion ons243.
- Jellema K, Sluzewski M, van Rooij WJ, Tijssen CC, Beute GN. Embolization of spinal dural arteriovenous fistulas: Importance of occlusion of the draining vein. *J Neurosurg Spine* 2005;2:580-3.
- Niimi Y, Berenstein A, Setton A, Neophytides A. Embolization of spinal dural arteriovenous fistulae: Results and follow-up. *Neurosurgery* 1997;40:675-82; discussion 682-73.
- Nishino K, Ito Y, Hasegawa H, Kikuchi B, Fujii Y, Tanaka R. Modified buddy wire technique for coil embolization of posterior circulation aneurysms. *Neuroradiology* 2007;49:49-55.
- Nogueira RG, Dabus G, Rabinov JD, Ogilvy CS, Hirsch JA, Pryor JC. Onyx embolization for the treatment of spinal dural arteriovenous fistulae: Initial experience with long-term follow-up. Technical case report. *Neurosurgery* 2009;64:E197-8; discussion E198.
- Sivakumar W, Zada G, Yashar P, Giannotta SL, Teitelbaum G, Larsen DW. Endovascular management of spinal dural arteriovenous fistulas. A review. *Neurosurg Focus* 2009;26:E15.
- Song JK, Gobin YP, Duckwiler GR, Murayama Y, Frazee JG, Martin NA, *et al.* N-butyl 2-cyanoacrylate embolization of spinal dural arteriovenous fistulae. *AJNR Am J Neuroradiol* 2001;22:40-7.
- Spiotta AM, James RF, Lowe SR, Vargas J, Turk AS, Chaudry MI, *et al.* Balloon-augmented Onyx embolization of cerebral arteriovenous malformations using a dual-lumen balloon: A multicenter experience. *J Neurointerv Surg* 2015;7:721-7.
- Steinmetz MP, Chow MM, Krishnaney AA, Andrews-Hinders D, Benzel EC, Masaryk TJ, *et al.* Outcome after the treatment of spinal dural arteriovenous fistulae: A contemporary single-institution series and meta-analysis. *Neurosurgery* 2004;55:77-87; discussion 87-78.
- Warakaulle DR, Aviv RI, Niemann D, Molyneux AJ, Byrne JV, Teddy P. Embolisation of spinal dural arteriovenous fistulae with Onyx. *Neuroradiology* 2003;45:110-2.