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Dual-Lumen Balloon Catheter Technique for Onyx Embolization of Spinal Dural Arteriovenous Fistula

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Abstract

Spinal dural arteriovenous fistula (SDAVF) is the most common type of spinal vascular malformation. The main purpose of endovascular treatment is to occlude the fistula site and the proximal part of the draining vein. However, this is not always possible because of the difficulty of selective catheterization in patients with tortuous feeding arteries, as well as the risk of reflux of the liquid embolic agent. Herein, we present three cases in which a dual-lumen balloon catheter together with a liquid embolic agent was used to occlude the SDAVF. Complete and persistent occlusion was confirmed by magnetic resonance images taken at 6 months after the treatment. Using the dual-lumen balloon catheter technique in cases of long and tortuous feeder arteries supplying the SDAVF can result in safe and successful embolization.

Keywords

Dual lumen catheter; embolization; spinal dural arteriovenous fistula; Onxy

INTRODUCTION

Spinal dural arteriovenous fistula (SDAVF) represents a shunt between a radiculopial artery and a radicular vein with retrograde drainage to the perimedullary vessels leading to venous congestion of the spinal cord. Traditionally, surgery is considered the first-line treatment for SDAVFs, although endovascular embolization has also been used widely [1]. Recent studies in which n-butyl cyanoacrylate (NBCA) was used as an embolic agent, administered via traditional micro-catheters, reported success rates of 25%–75% [2]. Reports on the use of the Onyx (Medtronic, Minneapolis, MN, USA) as an embolic agent for treating spinal SDAVFs are scarce, but the success of the Onyx for intracranial dural arteriovenous fistula has aroused interest in its potential utility for their spinal counterparts [3]. The main reason for failed embolization in SDAVF is an inability to penetrate the nidus and proximal draining vein with the liquid embolizing agent. Herein, we present three cases in which a Scepter C (MicroVention, Inc., Aliso Viejo, CA, USA) dual-lumen balloon catheter was used in conjunction with the Onyx for successful embolization of the SDAVF.

TECHNIQUE

In this study, our embolization technique was used in male patients having angiographically diagnosed SDAVF. The patients were aged 62, 64, and 55 years, and presented with lower extremity weakness and progressive paraparesis. Their fistula sites were located in the left T7, right T8, and right T6 segmental arteries, respectively. Informed consent was obtained from all patients. Magnetic resonance images showed spinal cord edema and serpentine enhancing veins on the cord surface (Figure 1). On angiograms, the radiculomedullary artery did not arise from the same segmental artery that supplies the fistula in any patient. Additionally, due to their relatively tortuous and long feeding arteries, all patients were deemed unsuitable for standard embolization techniques. We needed to protect the anterior spinal artery for possible anastomoses. All procedures were performed under general anesthesia. The right common femoral artery was first accessed via a 6F long sheath because of difficult cannulation cases. After a standard exchange maneuver, a 5F guiding catheter (Simmons; Terumo Europe NV, Leuven, Belgium) with a soft tip was placed inside the segmental artery. The main arterial

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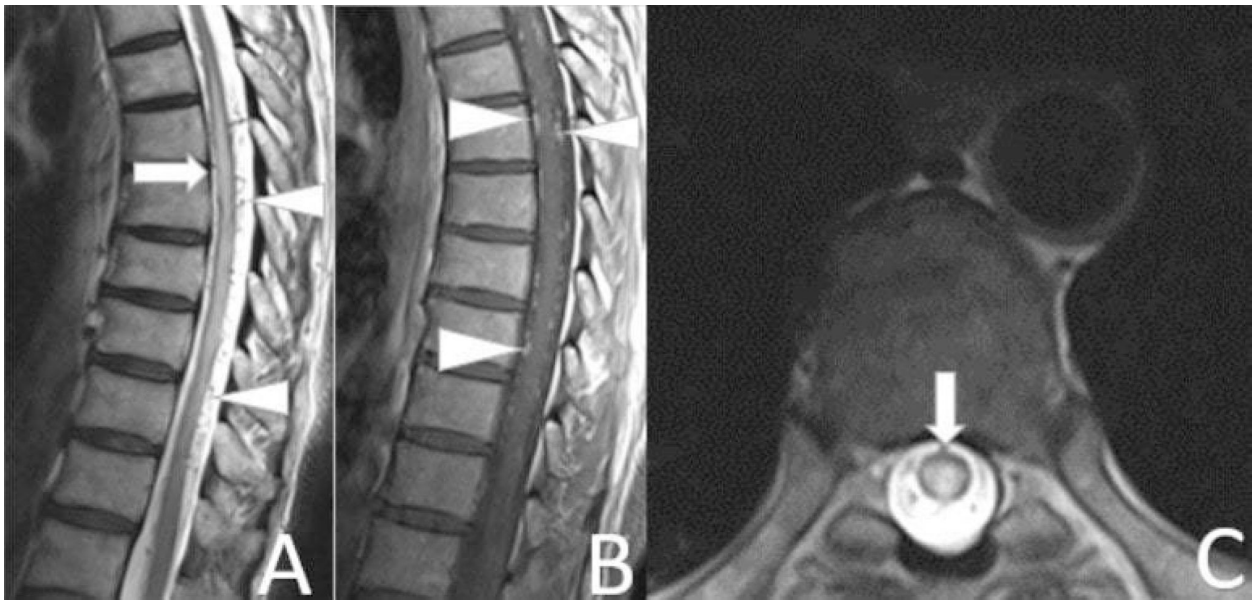

Figure 1. (A) T2-weighted coronal magnetic resonance image shows diffuse multilevel intramedullary hyperintensity (arrow) representing edema and serpentine flow voids (arrowhead), consistent with enlarged intradural vessels. (B) Contrast-enhanced T1-weighted coronal magnetic resonance image shows serpentine enhancing veins on the cord surface. (C) T2-weighted axial magnetic resonance image demonstrates intramedullary hyperintensity (arrow) depending on edema.

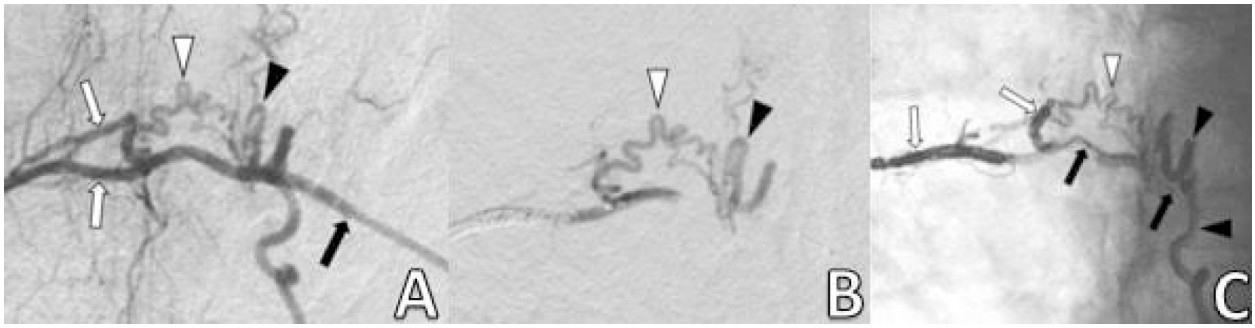

Figure 2. A 64-year-old male patient with newly developed urination dysfunction accompanied by progressive paraparesia for last 3 months. (A) Right T8 intercostal artery angiogram shows the segmental artery (black arrow), branches distal to the feeding artery that supply paraspinal soft tissues (white arrows), long and tortuous feeding artery of the fistula (white arrowhead), and draining vein (black arrowhead). (B) After coil embolization of the distal branches, angiogram obtained through the Scepter C balloon lumen reveals the precise anatomy of the feeding artery (white arrowhead) and proximal draining vein (black arrowhead). (C) The final roentgenogram obtained immediately after the Onyx injection shows the distal and proximal markers of the Scepter C catheter with an inflated balloon (black arrows), dens coil packing inside the distal branches (white arrows), Onyx cast inside the feeding artery (white arrowhead) and draining vein (black arrowheads).

branches supplying the paraspinal soft tissues distal to the fistula feeder were initially occluded by using detachable coils to avoid possible untoward effects of distal liquid embolization. A 4 mm × 10 mm Scepter C balloon was then advanced through the guide catheter just prior to the feeding artery. Under balloon inflation and road mapping, the catheter lumen was used for Onyx injection. The fistula and the proximal part of the draining vein were successfully penetrated with the Onyx (Figures 2 and 3).

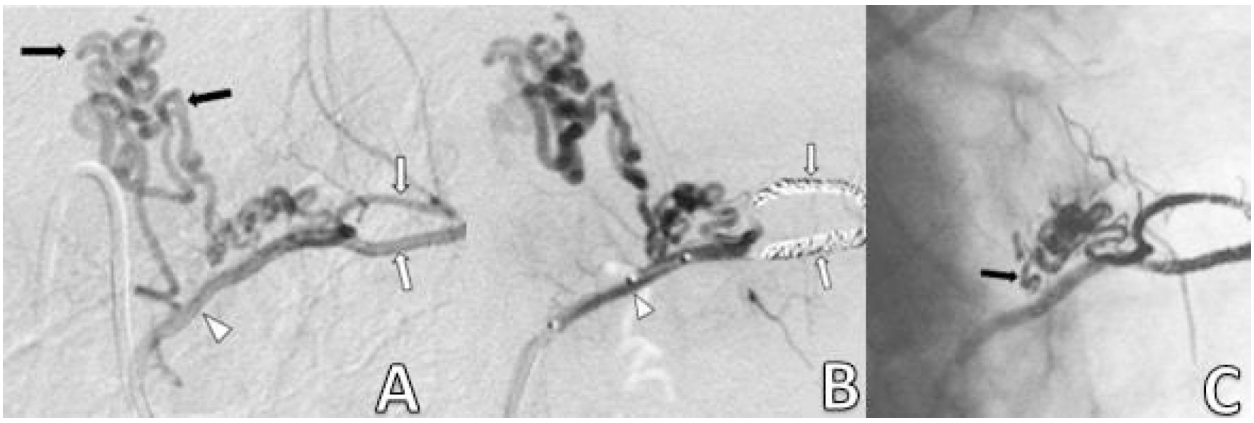

Figure 3. A 62-year-old male patient presented with lower limb weakness, lower limb pains after walking which subsides after rest and gait disturbances of one-year duration. (A) Spinal angiography demonstrates left 7: intercostal artery (arrowhead), enlarged perimedullary veins (black arrows), and other branches of the intercostal artery that we did not want to embolize (white arrows). (B) Dual-lumen balloon inflated inside the intercostal artery (arrowhead) and coil embolization where we do not want onyx penetration (arrows). (C) Angiographic control demonstrates onyx penetrating inside the distal veins (arrow) and total occlusion of the SDAVF.

Magnetic resonance images showed the disappearance of the spinal cord edema accompanied by progressive clinical improvement at month 6.

DISCUSSION

There are two treatment modalities for SDAVFs: surgical occlusion of the intradural vein at the segment that received blood from the feeder (i.e., the fistula site), and endovascular therapy using a liquid embolic agent after superselective catheterization of the feeding artery [4]. The main purpose of endovascular treatment is to occlude the distal part of the artery together with the most proximal part of the draining vein. If the embolizing agent does not reach the venous site due to proximal embolization, the fistula can be recanalized via the rich collateral networks of the dura [1,5]. Liquid embolic agents are preferred in endovascular therapy for SDAVF, because coils and particles tend to cause proximal occlusion [5]. NBCA has long been used as the standard embolizing agent in SDAVF patients [6]. However, when the microcatheter cannot reach near the fistula site, unsuccessful embolization and/or early recanalization may occur; proximal reflux is another problem in such cases. Onyx is less adhesive liquid polymer and supplies to eliminate the risk of gluing the microcatheter and subsequently to perform a more durable injection with a larger amount of agent delivered in a single injection [7]. The dual-lumen balloon catheter can solve both problems because it can push the Onyx more distally while the balloon is inflated.

Use of the dual-lumen balloon catheter with a liquid embolic agent was able to mitigate the problems associated with single-lumen catheters and dual-microcatheters [8]. Using standard techniques, a success rate of 25%–75% was achieved in SDAVF patients [2]. This relatively low success rate is thought to be due to the inability to fully penetrate narrow and tortuous feeding vessels to the target fistula; this can be overcome by the dual-lumen balloon catheter, which ensures continuous antegrade flow [9]. This procedure may be contraindicated in cases where the radiculomedullary artery that supplies the anterior or posterior spinal artery, arises from the same segmental artery. A careful angiographic examination is therefore mandatory before using the dual-lumen balloon catheter technique. Surgical treatment is a good option when embolization is considered to be unsafe [1]. Herein, we presented three successive cases of SDAVF treated endovascularly by the dual-lumen balloon catheter technique, performed with the use of Onyx. In all three cases, the fistulas had relatively long and tortuous feeding arteries. Only four cases of SDAVF treated by the dual-lumen balloon catheter technique have been reported in the literature [10,11], whereas numerous articles have demonstrated its usefulness in cranial dural arteriovenous fistula patients [12]. In all four previous SDAVF cases, as well as in our three cases, the dual-lumen balloon catheter technique was effective and safe and led to no complications. However, further reports of patients treated with this technique are required to validate its safety and effectiveness in the treatment of SDAVF.

LEARNING OBJECTIVES

- In SDAVF, the goal is to occlude the fistula site and the proximal part of the draining vein (ideal embolization).
- Ideal embolization may be impossible in certain patients with tortuous and/or long feeding arteries.
- The use of a dual-lumen balloon catheter in conjunction with the Onyx can result in safe and successful embolization in such cases.
- The dual-lumen balloon catheter technique may be contraindicated in cases where the radiculomedullary artery arises from the same segmental artery.
- A careful angiographic examination is mandatory before making the decision to use the dual-lumen balloon catheter technique.

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