Onyx (Micro Therapeutics, Inc., Irvine, USA) is a relatively new embolic material consisting of ethylene vinyl alcohol polymer dissolved in dimethyl sulfoxide (DMSO) that is mainly used for embolization of a brain arteriovenous malformations (AVM) (1–4). The solidification of Onyx occurs in an ‘outside-in’ precipitation process which often allows better forward penetration than n-butyl cyanoacrylate (NBCA) (2). However, experiences of using Onyx in spinal cord AVM are limited (5–7).

We present an unusual case of complication associated with Onyx embolization of spinal cord AVM.

CASE REPORT

A 49-year-old male presented with left buttock pain and left leg paresthesia with weakness (grade 4) which developed a week ago. Fifteen years earlier, he had developed sudden lower back pain with paresthesia and had been diagnosed as spinal cord AVM at another hospital. However, embolization had failed and the patient had been managed conservatively.

Magnetic resonance imaging (MRI) revealed intracanalicular spinal vascular flow voids without definite signs of cord signal intensity change. Spinal angiogram showed spinal cord AVM nidus at the L1 conus level with feeders from left T11 posterior spinal artery (PSA), right T10 PSA, and left L1 anterior spinal artery (ASA). Aneurysmal dilatation was seen within the nidus supplied mainly by the ASA. Thus, under general anesthesia and heparinization (2,000IU), the ASA feeder was superselected and embolization was performed with 25% NBCA at the L1 lower body level. The residual nidus was targeted via the left T11 PSA. The feeder was superselected with a Sonic microcatheter (Balt Extrusion, Montmorency, France) and Onyx 18 (1cc) embolization was performed. After successful embolization of the nidus supplied from the left T11 PSA, the microcatheter was withdrawn with gentle traction. Some resistance was noted during traction and after withdrawal, the final angiogram showed disconnection and caudal displacement of the left T11 radicular artery apex, probably due to vessel tear. Protamine sulfate 20 mg was infused intravenously for reversal of heparin. Additional angiograms showed no persistent leakage. The patient complained of back pain without development of other new neurological signs and the immediate post procedural computed tomography (CT) showed hemorrhage in the spinal

Key Words: Spine; Arteriovenous malformation; Embolization
canal. The back pain resolved, however, the patient showed persistent left leg paresthesia on 6-month follow-up.

**DISCUSSION**

Traditional NBCA and the newly introduced Onyx are both liquid embolic agents, which precipitate when in contact with blood. However, the characteristics of Onyx differ from NBCA which may have different consequences on clinical applications. The precipitation and solidification of Onyx occur much slower than NBCA which allows slower injections over several minutes and may lower the risks of gluing the microcatheter. Also, with better control of injection speed there may be a lower risk of premature occlusion of the venous side of the nidus (6). These potential advantages of Onyx have mostly been exploited in embolization of brain arteriovenous malformations (1, 3, 4, 8, 9).

There is limited experience in the use of Onyx for spinal AVMs (5–7). The largest series by Corkill et al report total/subtotal occlusion of the nidus in about 70% of cases with 82% showing an overall good clinical outcome (6).

Concerns for complications associated with Onyx embolization have traditionally been focused on the angiotoxicity of DMSO solvent. However, animal studies have shown that this effect can be minimized by prolonged slow infusions (10). Another potential complication associated with Onyx may be hemorrhage (1, 3, 4, 6).

**Fig. 1.** Anteroposterior view of the left T11 intercostal angiogram shows the AVM nidus supplied by the posterior spinal artery (A). The proximal two markers of the Sonic microcatheter are seen after embolization with Onyx. Notice the flow stagnation in the aneurysmal pouch of the nidus (arrow, B). Anteroposterior view of the roadmap image during microcatheter withdrawal. After completion of the Onyx injection, gentle tractionsal force was exerted on the microcatheter for withdrawal. Notice the straightening of the posterior spinal artery (arrows, C). After withdrawal of the microcatheter, abrupt disconnection of the apex of the posterior spinal artery was seen. Caudal migration of the apex of the radicular artery is noted (arrow, D). Immediate post procedural CT shows intracanalicular hemorrhage (E).
A particular cause of hemorrhage which needs extra caution is related to the mechanical traction and withdrawal of the microcatheter after Onyx embolization. Even though a detachable microcatheter was used with relatively easy withdrawal process in our case, the radicular artery was torn at its apex with resultant subarachnoid hemorrhage. Immediate post procedural angiogram showed vasospasm of the radicular artery without active hemorrhage.

Despite the prolonged injection of Onyx with slower solidification, retrieval of the microcatheter may be associated with some traction force. This should be of greater concern when the microcatheter is placed beyond the radicular artery in an acutely angulated radicular artery in the lower thoracic or lumbar segment such as in our case. The angulation of the radicular artery at the junction with the radiculomedullary or radiculopial arteries on the surface of the spinal cord and the small calibered pial or medullary feeders may be a weak point for withstanding the acutely angulated tractional vector forces.

In conclusion, Onyx may be an option for embolization of the spinal cord AVM. However, due to its unique physical characteristics, the embolized vessel is exposed to the tractional tension necessary for withdrawal of the microcatheter which may result in vessel injury. Extra caution is warranted in embolization of acutely angulated spinal radicular arteries with Onyx.

References

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