# Endovascular Balloon-Assisted Embolization of High-Flow Peripheral Vascular Lesions Using Dual-Lumen Coaxial Balloon Microcatheter and Onyx: Initial Experience

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## ABSTRACT

Balloon-assisted embolization performed by delivering Onyx ethylene vinyl alcohol copolymer through a dual-lumen coaxial balloon microcatheter is a new technique for the management of peripheral vascular lesions. This technique does not require an initial reflux of Onyx to form around the tip of the microcatheter before antegrade flow of Onyx can commence. In a series of four patients who were treated with the use of this technique, the absence of significant reflux of Onyx was noted, as were excellent navigability and easy retrieval of the balloon microcatheter. However, in one patient, there was inadvertent adverse embolization of a digital artery, which was not caused by reflux of Onyx but could still be related to balloon inflation.

## ABBREVIATIONS

AVM = arteriovenous malformation, CF = cystic fibrosis, DMSO = dimethyl sulfoxide, DSA = digital subtraction angiography, IMA = internal mammary artery, PA = posteroanterior

Ethylene vinyl alcohol copolymer (Onyx; ev3, Irvine, California) has been used to treat peripheral vascular malformations and pseudoaneurysms (1–4). In the present report, we present our initial experience with a transarterial embolization technique in which Onyx was administered through a coaxial dual-lumen balloon microcatheter (Scepter C; Microvention, Tustin, California).

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## CASE SERIES

We retrospectively analyzed a prospectively maintained database of all interventional radiology procedures for cases in which Onyx was administered through the Scepter C coaxial dual-lumen balloon microcatheter between July 15, 2011, and September 30, 2013. This analysis was approved by our institutional review board.

Since January 2012, a series of six separate embolization sessions were performed on a series of four patients (one male and three female) by using this technique (**Table**). Two of these patients had a congenital arteriovenous malformation (AVM) in an extremity, one had cystic fibrosis (CF) with recruited collateral vessels between systemic arteries and the right pulmonary artery, and one had hepatoportal shunting from multiple vessels in a transplanted liver. Each of these lesions is described in detail as part of the case series.

### Procedural Technique

Three of the embolization sessions were carried out under general anesthesia, which was required for two pediatric patients and the the 28-year-old patient with

**Table**. Details of Patients' Vascular Malformations and Procedures

| Pt. No. | Age (y)/ Sex | Type/Location | Symptoms/ Signs | Onyx Concentration/ Volume (mL) | Complications | Technical Success | Fluoroscopy Time (min) |
|---|---|---|---|---|---|---|---|
| 1 | 14/F | Local high-flow AVM/left thigh | Groin and knee pain | 18/2 | None | 50%–60% reduction of AVM flow | 34 |
| 2 | 13/F | High-flow intraosseous AVM of left hand (third/fourth digit) | Pain | 18/3<br>34/0.25 | None<br>Nontarget embolization (distal) | Flow dramatically reduced | 15<br>35 |
| 3 | 28/M | Systemic–pulmonary shunt | New-onset hemoptysis | 34/2, 18/3 | None | Resolution of hemoptysis | 14.5 |
| 4 | 61/F | Hepatoportal shunt | Recurrent ascites | 18/6 (session 1)<br>18/4 (session 2) | None<br>None | Follow-up awaited | 45<br>52.7 |

AVM = arteriovenous malformation.

CF, who was in hemodynamically unstable condition. In all cases, vascular access was established in the common femoral artery with a 6-F sheath. A 6-F guide catheter (which is the minimum guide catheter size needed to accommodate the balloon microcatheter) was then positioned within a parent artery from which the arterial feeders arise. Thereafter, a compliant 4 × 10-mm dual-lumen, coaxial Scepter C balloon microcatheter (2.8-F outer diameter and 1.7-F inner lumen) was prepared with a mixture of 50% saline solution and Visipaque 320 (GE Healthcare, Princeton, New Jersey). The balloon microcatheter was then introduced into the guide catheter, and navigated over a 0.014-inch microwire into an arterial feeder vessel until its tip was as close to the site of high-flow shunting as possible. Pre- and postinflation superselective runs were then performed through the balloon microcatheter, and changes in flow rate with balloon inflation were evaluated. If there was a marked decrease in flow rate, Onyx 18 was chosen as the embolic agent. If there was persistent high flow rate after inflation (secondary to the shunts being fed by multiple other arteries), Onyx 34 was chosen as the embolic agent. The balloon was then deflated, and the dead space of the balloon catheter (0.46–0.48 mL) was filled with dimethyl sulfoxide (DMSO). Injection of Onyx 18 or 34 was then initiated at approximately 0.1 mL/min with the balloon left deflated to allow for DMSO in the dead space to flow freely into the shunt and diffuse away. After approximately 3 minutes, when it was expected that the Onyx would shortly reach the tip of the microcatheter, the balloon was reinflated after confirming with fluoroscopy that the Onyx had not yet reached or exited the tip of the microcatheter, and Onyx injection was continued. The balloon was not deflated during the procedure, as reflux of Onyx can occur at any time following initial antegrade flow. After Onyx injection, the balloon was deflated and withdrawn slowly under fluoroscopy.

## Case 1

A 14-year-old female patient had a left thigh intramuscular arterial–capillary–venous malformation causing diffuse enlargement of her left lower limb, increased leg length, and nonlocalized lower-extremity pain. She had persistent symptoms despite previous embolization with n-butyl cyanoacrylate and particles. Balloon-assisted Onyx embolization of the AVM was then performed from three of the multiple arterial feeder vessels given off by the distal portion of her left superficial femoral artery. After embolization, there was a marked decrease in arteriovenous shunting, and the patient remains asymptomatic at 9 months after the procedure.

## Case 2

A 13-year-old female patient had a high-flow intraosseous AVM of the left hand, causing pain and enlargement of the hand. Imaging showed multiple arterial feeder vessels arising from the superficial palmar arch, in close proximity to and anastomosing with the digital arteries of the third and fourth digits. In the initial embolization session, a total of 3 mL Onyx 18 was injected through the balloon microcatheter, with excellent obliteration of the nidus within the third metacarpal and adjacent soft tissue and preservation of the digital arteries (Fig 1). At 51 days later, a second embolization was performed with the use of 2.5 mL of Onyx 18. Although there was no reflux, there was retrograde passage of a small amount of Onyx via the nidus to a digital artery feeding the third digit, causing the digit to become slightly cyanotic. This Onyx cast was surgically removed from the vessel on an emergent basis. At 9-month follow-up, the patient had normal function of the digit without pain.

## Case 3

A 28-year-old man with a history of CF was diagnosed with persistent bleeding into the upper lobe of the right