Journal of Neuroradiology (2013) 40, 294—302

Available online at
SciVerse ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en

TECHNICAL NOTE

Onyx embolization using dual-lumen balloon catheter: Initial experience and technical note

Srinivasan Paramasivam*, Yasunari Niimi, Johanna Fifi, Alejandro Berenstein

Hyman Newman Institute for Neurology and Neurosurgery, Centre for Endovascular Surgery, Roosevelt Hospital, 1000 Tenth Avenue, Suite 10 G, New York, 10019, United States

KEYWORDS
Onyx;
Balloon catheter;
Dual-lumen balloon catheter;
DMSO compatible catheter;
Dural fisutlas;
Facial AVM

Summary
Introduction: Onyx as an embolization agent for the management of vascular malformation is well established. We report our initial experience with dimethyl-sulphoxide (DMSO) compatible double lumen balloon catheters used for Onyx embolization.
Methods and technique: Between December 2011 and March 2013, we treated 22 patients aged between 1.5 to 70 years with two types of DMSO compatible dual-lumen balloon catheters (Scepter C and Ascent) to treat dural arteriovenous fistulas, brain arteriovenous malformation (AVM) with dural feeders, mandibular, facial, lingual, vertebral and paravertebral AVMs. The catheter has good navigability, compliant balloon on inflation formed a ''plug'' that has more resistance than Onyx plug enhancing better penetration. During injection, the balloon remained stable without spontaneous deflation or rupture and withstood the pressure build-up well. The retrieval of the catheter in most cases took less than a minute (19/28) while in five, it was less than five minutes and in the remaining four, it was longer that includes a trapped catheter on prolonged attempted retrieval resulted in an epidural hematoma, requiring emergent surgical evacuation. The fluoroscopy time is reduced, as we do not form a proximal onyx plug, the injection time is shorter along with easy and instantaneous removal of the catheter after balloon deflation in most cases.
Conclusion: Dual-lumen balloon catheter Onyx embolization is a safe and effective technique. Currently, an important tool to circumvent some of the shortcomings associated with Onyx embolization. The catheter has good navigability, the balloon has stability, tolerance, enhances penetrability. It is easy to retrieve the microcatheter. With the experience gained, and with more compliant balloon catheters available, this technique can be applied to cerebral vessels in near future.

Introduction

As an embolization agent for the management of vascular malformations, Onyx has been well established for the

* Corresponding author. Tel.: +917 714 6678; fax: +212 636 3296.
E-mail address: kpsvasan@hotmail.com (S. Paramasivam).

0150-9861/$ - see front matter © 2013 Published by Elsevier Masson SAS.
http://dx.doi.org/10.1016/j.neurad.2013.08.001

treatment of brain arteriovenous malformations (AVMs), dural AVMs, and facial and vertebral vascular malformations [1—3]. The recent introduction of dimethyl-sulfoxide (DMSO)-compatible double-lumen balloon catheters has enhanced the ability to overcome some of the shortcomings associated with Onyx embolization. This report describes our initial experience as well as the embolization techniques and advantages of using DMSO-compatible double-lumen balloon catheters.

Methods and technique

Between December 2011 to March 2013, two types of DMSO-compatible dual-lumen balloon catheters — the Scepter C (MicroVention Terumo, Tustin, CA, USA) and the Ascent (Codman Neurovascular, Raynham, MA, USA) — were used to treat craniofacial vascular malformations such as dural arteriovenous fistulas, brain AVMs with dural feeders, and mandibular, facial, lingual, vertebral and paravertebral AVMs. In 22 patients aged 1.5—70 years, 30 attempts were made to use dual-lumen balloon catheters and were successful in 28 attempts. Overall, the Scepter C balloon catheter was used in 26 instances and the Ascent balloon catheter in the remaining two.

Dual-lumen balloon catheters have a central lumen for injection that can accept microguidewires up to 0.014 inches in diameter, and a second side port for infusion of contrast to inflate the balloon. In our patients, 45% contrast material (iopamidol, Isovue-400) was used to inflate the balloon. The Scepter C balloon is prepared by slow and steady forward injection of contrast to push any air through the purge hole at the tip of the catheter, which sits inside a bowl of fluid to reveal any eliminated air as bubbles. At the end of purging, the hole of the balloon port at the tip of the catheter is sealed off with contrast by exposing the tip to steam for 40 to 50 seconds after deflating the balloon. The Ascent balloon has no purge hole and so is prepared by sucking the air back into a syringe, which results in contrast being pushed up from below (negative pressure).

All embolizations were performed under general anesthesia using a biplane angiography unit. Vascular access was obtained with a 5-Fr or larger guiding system through which the dual-lumen balloon catheter was navigated until it reached the desired location. Appropriate placement of the balloon is critical for the success of treatment. In most instances (28 out of 30 attempts), the catheter could be positioned at the desired location, avoiding normal branches and anastomotic channels, which was distal to the origins of blood vessels and away from the cranial nerves. Placing the balloon in a curved segment of vessel and across a bony canal is recommended, as the balloon is more stable at such locations and its inflation is limited when placed across a bony foramen. Superselective angiography is then performed to reassess blood flow, including the presence and location of any washout, which is an indication of collateral flow, and invaluable for predicting and monitoring the progression of the Onyx injection; it may also help to assess flow within the malformation. Once the decision is made to embolize, a subtracted mask is taken and the balloon inflated under fluoroscopy guidance by injecting 45% contrast *via* the balloon port, using a Cadence syringe. The balloon inflated in all but one of our cases and was very flexible, taking the shape of the vessel (Fig. 1). Repeat superselective angiography was then performed to analyze flow changes as a result of balloon inflation.

Injection of Onyx

Prior to Onyx injection, 1 mL of lidocaine (20 mg/mL) was infused, followed by 3—6 ml of a saline flush to ensure that no residual contrast/lidocaine remained in the catheter. The dead space in the microballoon catheter was filled with DMSO (0.45 mL). The DMSO was then removed from the hub of the microcatheter and replaced by Onyx, and the DMSO in the catheter was injected slowly over 1 minute. Once Onyx starts to fill the malformation, the injection rate is determined by how rapidly the Onyx spreads within the malformation. The advantage of this catheter is that there is no need to form a plug at the catheter tip as required by conventional Onyx injection techniques, thanks to inflation of the balloon. As Onyx is injected continuously into the feeders, it is also carefully watched for penetration into the desired location. The injection is stopped for 15 seconds to 1 minute if the Onyx is seen to fill any other compartments, then resumed.

During each injection, in addition to watching out for reflux, the inflated balloon is also kept under constant observation for balloon deflation due to contrast leak or balloon rupture, or any proximal movement of the balloon due to pressure build-up, given the larger caliber of the proximal vessel. Any Onyx reflux around the balloon is also noted, which can be better visualized on a non-subtracted image (Fig. 2). If reflux is observed, this is dealt with by slight additional balloon inflation that, in most cases, will reinstate antegrade Onyx progression.

On completion of Onyx injection, the balloon is deflated using a subtracted mask and pulled out under gradually increasing pressure. In our series, removal of the catheter was instantaneous in most cases, although in a few cases the tip beyond the balloon — approximately 5 mm in length — was embedded in the Onyx cast and so took longer to be released.

Results

In the present series, all of the catheterizations attempted were in either dural or extracranial vessels. In all, 30 attempts were made using the dual-lumen balloon catheter, which was successfully placed at the desired location in 28 cases. An Ascent balloon catheter was used twice and the Scepter C balloon catheter in all the others. Four patients required more than one embolization using the balloon catheter (Table 1).

Onyx injection time in our series ranged from 4 to 78 minutes. The obliteration achieved with Onyx using the dual-lumen balloon catheter was defined as optimal when complete obliteration or desired occlusion using the catheterized pedicle was achieved. All other results were considered suboptimal. Optimal obliteration was achieved in most cases (19/28, 68%), with suboptimal obliteration in nine patients (9/28, 32%). The latter was due to either persistent reflux across the balloon, Onyx filling into an