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Endovascular treatment of dural arteriovenous fistulas using dual lumen balloon microcatheter: Technical aspects and results

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ABSTRACT

Objective: We report our results of our experience using transarterial balloon-assisted embolization of aggressive DAVFs using a dual lumen balloon microcatheter. The advantages and disadvantages of this technique when compared to different Onyx embolization techniques are discussed.
Patients and methods: All patients with aggressive DAVFs who were treated with Onyx using transarterial balloon-assisted technique with a dual lumen balloon microcatheter were included. Clinical presentation, location of DAVF, Borden type, dual lumen balloon microcatheter used, amount of Onyx used, Onyx injection duration, complications, immediate angiographic and follow up results were included in the analysis.
Results: Five patients fulfilled the selection criteria. Their ages ranged from 24 to 62 years old. In 4 cases the dual lumen balloon microcatheter was a Scepter-C 4 mm × 10 mm (Microvention, Tustin, CA); in the other patient the device used was an Ascent 4 mm × 10 mm (Codman, Raynham, MA). In all 5 patients the dual lumen balloon microcatheter was used with the objective to cure the lesion and it was successful in all 5 cases. There was no vessel injury, unwanted embolization, retained microcather, microcatheter rupture or cranial nerve deficits in our series. Our mean Onyx injection time was 6.4 min (range from 2 to 10 min). There were no procedural complications in our series. Four out of 5 patients had angiographic follow up demonstrating persistent angiographic cure (follow up mean 6 months – range 4–7 months).
Conclusions: Our experience in this small series of patients indicates that the use of dual lumen balloon microcatheters is safe and feasible, facilitating the use of Onyx for embolization of DAVFs.

1. Introduction

Dural arteriovenous fistulas (DAVFs) associated with cortical venous drainage are aggressive lesions that require prompt attention and treatment [1–4]. These lesions carry approximately 15% annual neurological event rate with 10% annual mortality rate [1]. Since its introduction, Onyx (Covidien, Irvine, CA) became the main embolic agent for the treatment of this type of dural arteriovenus fistulas. Its safety and efficacy in the treatment of DAVFs has been demonstrated [2–5]. The use of Onyx compared to other liquid embolic agents allows for a more controllable and prolonged injection facilitating the penetration of the fistulous connections and proximal cortical draining vein. Despite its advantages, Onyx embolization is not free of problems. Microcatheter retention, unwanted embolization, cranial neuropathy, as well as failure to deliver the embolic agent due to difficult tortuous arteries have been described [2,5–12].

The use of transarterial balloon-assisted embolization using dual lumen microcatheters in the treatment of aggressive DAVFs has been described, however it has not been well established [13]. We report our experience using transarterial balloon-assisted embolization of aggressive DAVFs using a dual lumen balloon microcatheter. The advantages and disadvantages of this technique when compared to different Onyx embolization techniques are discussed as well.

2. Patients and methods

All patients with aggressive DAVFs who were treated with Onyx using transarterial balloon-assisted technique with a dual lumen balloon microcatheter were included. Aggressive DAVFs were defined as Borden 2 and 3.

All procedures were performed under general anesthesia by one of two interventional neuroradiologists (GD or MMG). After completion of a 6-vessel diagnostic cerebral angiography, a 5-Fr guide catheter was positioned in the respective external carotid artery.

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The dual lumen balloon microcatheter was then used to select the main branch supplying the fistulous connections over a standad 014 microwire of operator's choice. After positioned in the selected location the wire was removed and the balloon inflated creating a temporary plug. Onyx was then injected until the lesion was cured or the appropriate compartment occluded. To check the progression of the embolization the balloon was deflated and angiography performed through the guide catheter. The double lumen balloon microcatheter was then removed.

Clinical presentation, location of DAVF, Borden type, double lumen balloon microcatheter used, amount of Onyx used, Onyx injection duration, complications, immediate angiographic result and follow ups are shown in Table 1. Cure was defined as clinical improvement associated with no angiographic evidence of residual or recurrent DAVF.

3. Results

Five patients fulfilled the selection criteria. Their ages ranged from 24 to 62 years old. In 4 cases the dual lumen balloon microcatheter was a Scepter-C 4 mm × 10 mm (Microvention, Tustin, CA); in the other patient the device used was an Ascent 4 mm × 10 mm (Codman, Raynham, MA). The choice of dual lumen balloon microcatheter was based on operator preference or device availability. In all 5 patients the dual lumen balloon microcatheter was used with the objective to cure the lesion and it was successful in all 5 cases. There was no vessel injury, unwanted embolization, retained microcather, microcatheter rupture or cranial nerve deficits in our series. Our mean Onyx injection time was 6.4 min (range from 2 to 10 min). There were no procedural complications in our series. Four out of 5 patients had angiographic follow up demonstrating persistent angiographic cure (follow up mean 6 months – range 4–7 months).

4. Case presentations

4.1. Patient 1 (Fig. 1)

A patient in his/her early 20s with history of head trauma presenting with pulsatile tinnitus. Diagnostic cerebral angiography revealed a large Borden type 2 DAVF in the left transverse-sigmoid with cortical reflux. The patient was treated initially with transarterial and tranvenous embolization that decreased the flow through the lesion. The symptoms persisted and the patient underwent a second embolization session. Because of the small size and tortuosity of the residual feeders the balloon microcatheter was positioned in a transosseous branch the occipital artery. Despite a suboptimal location, Onyx embolization was then successfully performed with good penetration of the fistulous connections resulting in angiographic cure of the lesion. Immediately after the embolization, the symptoms had resolved. A 7-month follow up angiography revealed angiographic cure of the lesion.

4.2. Patient 2 (Fig. 2)

A patient in his/her early 60s with a known history of DAVF who was told at an outside institution that was not treatable, presented with right hemiparesis due to a left fronto-parietal intraparenchymal hemorrhage. Diagnostic cerebral angiography revealed a Borden type 3 DAVF in the left parasagittal parietal region. The lesion was then successfully occluded with Onyx embolization using a Scepter-C balloon through the middle meningeal artery resulting in angiographic cure of the lesion. A 7-month follow up angiography revealed angiographic cure of the lesion.

4.3. Patient 3 (Fig. 3)

A patient in his/her early 60s presented with sudden onset of severe headaches. Computed tomography revealed subarachnoid hemorrhage in the left parietal region around the convexity. Diagnostic cerebral angiography revealed a Borden type 3 DAVF in the left parasagittal parietal region. Despite the small diameter of the middle meningeal artery a Scepter-C balloon microcatheter was navigated distally and positioned close to the fistulous point. Onyx embolization was performed resulting in angiographic cure. A follow up angiography at 4 months revealed complete occlusion of the lesion.

4.4. Patient 4 (Fig. 4)

A patient in his/hers early 60s presented with seizures to an outside hospital. A CT scan demonstrated a small right temporal intraparenchymal hemorrhage. A 6-vessel cerebral angiography confirmed the presence of a Borden type 3 right tentorial DAVF. A Scepter-C dual lumen microcatheter was navigated through a markedly tortuous transosseous branch of the right occipital artery. Despite proximal positioning of the tip of the balloon microcatheter, Onyx embolization was performed with good penetration of the fistulous connections and proximal draining vein resulting in angiographic cure of the lesion.

4.5. Patient 5

A patient in his/hers late 50s and history of headaches underwent an MRI that was suspicious for a left temporal vascular malformation. A 6-vessel cerebral angiography confirmed the presence of a Borden type 3 left tentorial DAVF. An Ascent dual lumen microcatheter was navigated into the posterior branch of the middle meningeal artery where embolization with Onyx was successfully performed resulting in angiographic cure. A follow up angiography at 6 months revealed complete occlusion of the lesion.

5. Discussion

The treatment of DAVFs using Onyx as primary embolic agent is well established [2–5]. Several publications are available demonstrating that transarterial embolization with Onyx is safe and effective. In one of the early publications, Cognard et al. studied 30 cases of DAVFs associated with cortical venous drainage treated with Onyx; in this study cure was achieved in 24 cases with good safety profile [2]. In another study, 10 out of 12 patients were cured after transarterial embolization with Onyx; no significant complications were noted [4]. A recent report on a large number of patients treated with transarterial embolization using Onyx demonstrated that when Onyx was used as a sole embolic agent angiographic cure was seen in 87% of the DAVFs [5]. In our small series all patients' DAVFs were completely occluded during the treatment and the angiographic cure was stable on the angiographic follow ups.

Transarterial embolization using a single lumen microcatether positioned as close as possible to the fistulous connections and draining veins is the usual technique when Onyx is used for the treatment of DAVFs or arteriovenous malformations [2–5,8,9]. Despite its advantages, Onyx embolization is not free of problems. Microcatheter retention, unwanted embolization, cranial neuropathy, as well as failure to penetrate the fistulous connections and draining veins or failure to deliver the embolic agent due to difficult tortuous arteries have been described [2,5–12,14]. In an attempt to overcome these problems other techniques such as transvenous injection, transarterial or transvenous with balloon assistance, and more recently transarterial injection using a double lumen