Endovascular Treatment of Cerebral AVMs with a New Material: Onyx[®]. Partial Results

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Introduction

Arteriovenous malformations (AVMs) are the most common intracranial vascular malformation. They consist of a tangle of vessels of different wall thicknesses and diameters with associated arteriovenous shunting.

The goal of treatment is to eliminate this nidus from the cerebral vascular circulation, and the treatment options for AVMs include catheter-based therapies, surgery, radiation therapy, or a combination of these treatments.

Recent improvements in endovascular techniques include a new material to embolize (Onyx[®]).

Our experience using Onyx in embolization will be presented, including some cases where Onyx was used in combination with NBCA. Our final objective is the complete occlusion of the AVM by embolization, if possible.

Patient characteristics

24 patients, 13 females and 11 males were embolized with Onyx for AVMs from August 2004 to June 2005. Their ages ranged from 12 to 58 years, with a mean age of 36 years. 15 patients harbored small AVMs less than 3 cm in diameter and two patients presented with large AVMs, greater than 6 cm in diameter.

Clinical presentation

Seven patients were admitted after having suffered from intracerebral hemorrhages, 10 patients presented with seizures and four patients experienced headaches. One patient presented focal neurological deficits, leading to the diagnosis of AVM. In general, in cases of hemorrhages a stable neurological state is preferred in order to embolize. In two cases, the AVM was discovered due to the bleeding of an adjacent aneurysm. One of these was a PICA aneurysm and this was embolized together with the AVM.

Technique

Onyx was considered the embolic material of first choice and was used in all cases in which an intra-nidal DMSO-compatible micro-catheter placement was possible. Only two of 24 patients needed at least one NBCA injection in addition to Onyx embolization. In one case, this occurred because of a true direct AV fistula. The other was a result of a perforation during the navigation with the catheter before Onyx embolization.

After reaching an intranidal position of the micro-catheter it is very important to choose an adequate projection that allows controlling flow back through the artery pedicle, as well as

A

B

C

D

E

F

FIGURE 1 CASE 1:

Male, 15-years-old with seizures. Frontal left ICA shows the nidus in frontal view (A) and lateral view (B). Micro-catheter serie intranidal position (C). Left ICA post Onyx embolization in front view (D) with a frontal cast (E) and lateral view (F) and the lateral cast (G), with total occlusion in one session by one pedicle, during 19 minutes of Onyx embolization.

G

the passage of Onyx through the vein that may lead to the eventual risk of venous occlusion.

At the beginning of the injection with Onyx it is important to create a flow back of several millimeters around the catheter (less than 15 mm) to then have an advance of embolization material inside the nidus in order to accede to zones that are not even visible after the injection of contrast in this pedicle. Removal of the micro-catheter was performed quickly. After two cases of bleeding without clinical consequences, we decided to counteract the effect of the heparin with an injection of protamine before removing the micro-catheter.

After hemorrhagic complications due to a complete occlusion of the nidus, we decided that in AVMs larger than 3cm, it was necessary to perform only a partial occlusion of up to 50% in the first embolization session.

Follow-up

Angiogram controls were performed on all 19 patients at three months post-procedure. All patients underwent full clinical follow-up examinations three months after embolization and were evaluated according to their scores on the Rankin scale.

Morphological results

Thirty-five procedures had been made in 24 patients. In 11 patients the endovascular management is already completed. In seven patients complete angiographic cure was achieved by em-

bolization alone. Only two patients were operated on post embolization and two patients were treated by stereotactic irradiation post embolization. The therapeutic management was stopped in one case after a large hematoma occurred post embolization with severe neurological after effects. Therapeutic management is still on going in 12 patients, all in the process of endovascular occlusion.

Current rate of occlusion is: < 70%: 12 patients; 70-79%: one patient, 80-89%: one patient; 90-99%: three patients; 100%: seven patients.

In total 35 procedures were made.

Morbidity and mortality

The overall morbidity accounts for four patients and the mortality is 0. Of the four morbidity cases, two patients had a small hematoma post procedure and have had complete recovery. Another patient ranked 0, suffered a large hematoma five days after 100% occlusion, worsened to 1 on the Rankin Scale, and needed surgery and a craniotomy.

The other patient had a large deep AVM (60 mm), and presented, after 80% occlusion, bleeding several hours after the procedure. This patient, ranked 1 pre-procedure on the modified Rankin scale worsened to 3.

Technical complications

Two technical complications occurred: in one case, a perforation of the nidus with the micro-

A

B

C

D

E

F

G

H

FIGURE 2 CASE 2:

Female, 58-year-old, with cerebellar syndrome. Left vertebral front view (A) and lateral view (B) shows the nidus in posterior fossa with a large venous drainage. After Onyx embolization, in one session by two pedicles, during 10 and 25 minutes Onyx embolization, angiogram front view (C) and lateral view (E, F) show complete occlusion, with view cast (D, G). Left ICA lateral angiogram shows no participation to left ECA (H). Five days after embolization the patient presented cardiac arrest due to hematoma (I, L) in posterior fossa that needs surgery, with partial clinical recovery.

I

L

catheter-microguide occurred, without leading to clinical consequences. This case required emergency NBCA embolization. In the other case, one micro-catheter was trapped in the AVM. This micro-catheter was left close to the femoral artery and treated with two months of Aspirin® 325 mg.

Discussion

For many years, the goal of endovascular treatment in intracerebral AVMs was a pre-surgical procedure. Different papers showed up to 30% of cases totally cured by endovascular therapy.

Onyx is a liquid embolic material that is delivered by an intranidal micro-catheter. After delivery of the embolic material, the liquid in contact with blood quickly is transformed into a solid polymer cast and a skin is formed similar to lava, which solidifies on the outside. This permits and facilitates the progression of Onyx into different compartments in the nidus. The embolization can last up to 45 minutes per pedicle, but after 20 minutes it becomes necessary to consider leaving the micro-catheter in the nidus, in order to lower the risk of bleeding in the AVM or making a dissection in the afferents artery.

In the partially occluded AVMs, endovascular therapy plays a major role in dramatically reducing the size of the AVM, and makes surgery or stereotactic radiosurgery easier.

In our experience, of 11 totally cured patients, 6 cases were due exclusively to embolization treatment. The patients treated by surgery or radiation arrived to therapy after around 90% occlusion post embolization.

There are also 12 patients in the course of embolization treatment that will probably have a very high percentage of occlusion. Therefore, we expect to reach 60%-70% complete occlusion only using Onyx.

In large AVMs in which cianocrylate embolization is not possible, with Onyx it is possible to reduce the nidus and permit radiation therapy, surgery or diminish the possibility of bleeding by embolizing the weak points of the nidus or of the venous drainage.

In all of the patients where a 100% occlusion was reached of the malformed nidus, one or two sessions of embolization was performed. This demonstrates the greater capacity of occlusion of this material.

Finally, after two patients with hemorrhagic complications with clinical consequences, we decided that in AVMs 3 cm or greater, not to occlude more than 50% of the nidus in the first session. In addition, it was decided to revert the effect of Heparin® before retiring the micro-catheter.

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