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Case report

ROLE OF ENDOVASCULAR EMBOLIZATION IN THE MULTIDISCIPLINARY MANAGEMENT OF RUPTURED BRAIN ARTERIOVENOUS MALFORMATIONS

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ABSTRACT

Brain arteriovenous malformations (bAVMs) are congenital defects of vasculogenesis, the natural history of which is characterized by a significant morbidity and mortality related to the risk of bleeding. Their management remains challenging, since complete eradication is often difficult. Embolization, surgery, or radiosurgery alone are safe and effective for small unruptured AVMs, while a multidisciplinary approach should be pursued for larger ones. We report a case of intracerebral haemorrhage due to the rupture of a large bAVM, for which a multidisciplinary approach was adopted: endovascular partial embolization followed by complete surgical removal.

1. Introduction

Brain arteriovenous malformations (bAVMs) are congenital defects of vasculogenesis, the natural history of which is characterized by a significant morbidity and mortality related to the risk of bleeding (1); 45-50% of cases present with intracranial hemorrhage , and with an increasing risk of rebleeeding of 3% per year, the morbidity rate is severe (2). When a bAVM is suspected on head CT or clearly detected on CT angiography (CTA) or on brain MRI scan, digital subtraction angiography (DSA) is essential to understand the angio-architectural and hemodynamic characteristics, to better understand the hemorrhagic risk and proceed with the best therapeutic option (3).

The Spetzler-Martin (SM) scale (table 1) is one of the most commonly used classifications which best correlates with the risk of neurosurgical intervention. It is based on the size of the nidus, on the relationship with the critical parenchyma, called eloquent area, and on the presence of deep venous drainage (4).

The SM scale will allow for categorisation of the patient on a grade of I to V: embolization, surgery, or radiosurgery alone are safe and effective for small AVMs (SM I-II), while in the case of larger ones or deep venous drainage, a multidisciplinary approach is preferred (SM III); Spetzler Martin 4 and 5 AVMs often remain untreatable due to the high morbidity and mortality risk rates of intervention (5).

AVMs management remains challenging, since complete eradication is often difficult.

We report the case of a patient presenting with a cerebral hemorrhage due to the rupture of a large bAVM, for which a multidisciplinary approach was adopted: endovascular partial emobolization, before complete surgical removal.

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2. Case report

A 66-year-old male was admitted to our department because the sudden onset of severe headache, unresponsive to analgesics. The patient underwent head CT scan followed by intracranial CTA (Figure 1) which revealed the presence of an intraparenchymal haemorrhage, due to the presence of extensive bleeding bAVM. At physical examination, the patient was awake and mentally responsive, with no motor deficits but with bilateral deafness (II grade Hunt & Hess). DSA confirmed the presence of the bleeding AVM, with a nidus measured at 37x25x29mm, in the left parieto-occipital lobes, with no deep venous drainage (SM grade III) (Figure 2).

After multidisciplinary discussion, it was decided to proceed with a combined approach, with targeted pre-surgical embolization, in order to make the lesion hemodynamically more stable, and reduce the risk of intraoperative bleedings.

Under general anaesthesia, maintaining a mean arterial pressure (MAP) of 100-120 mmHg, with right femoral access and triaxial support, a long sheath was introduced into the left internal carotid artery (ICA) to allow superselective microcatetherism of deeper feeding vessel of the bAVM. From a distal ectasic branch of the left middle cerebral artery (MCA), using a flow-directed microcatethere, 2.5 mL of an elastic copolymer (ethylene vinyl alcohol copolymer, EVOH), dissolved in dimethyl-sulfoxide (DMSO) (Onyx; ev3, neurovascular, Irvine, California, USA) was slowly injected under fluoroscopic control at a rate of 0.1 ml/min. To note, the EVOH was opportunely mixed about 20 minutes before being injected, and at the same time the microcatetheter was washed with no less than 5ml of nonheparinized solution, and the internal lumen of the microcatetheter filled with DMSO, in order to avoid any obstructive clots. Almost two thirds of the nidus of the bAVM was embolized before removing the microcatheter.

The neurosurgical approach was scheduled three days after the neurovascular intervention and allowed for the complete removal of the bAVM with a left parasagittal-occipital craniotomy approach.

On head CT follow-ups no neuroradiological signs of complications were identified.

The DSA follow-up documented the complete removal of the bleeding AVM (Figure 3).

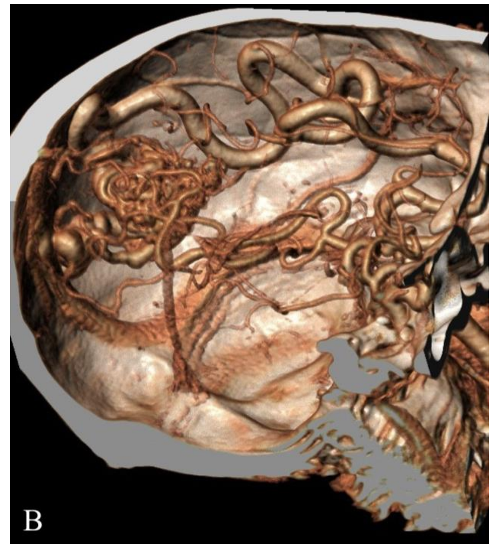

Figure 1. Head CT scan demonstrating intraparenchymal hemorrhage in the left parieto-occipital lobes with intraventricular bleeding in the ipsilateral lateral ventricle (a-b); the presence on multiple small calcifications and dilated vessels already raises the strong suspicion of the presence of a bAVM. CTA confirmed the presence of a large bAVM, main feeding vessels of which arise from the left MCA and from the ipsilateral posterior cerebral artery. The venous drainage is superficial, through a dilated vein reaching the transverse sinus as demonstrated by volume rendering reconstructions from CTA (b).

Figure 2. Left MCA DSA (latero-lateral projection) demonstrating the ruptured bAVM the nidus (N) of which is fed by a temporo-occipital branch (black arrow) and cortical drainage converging at upper sagittal sinus (white arrowhead).

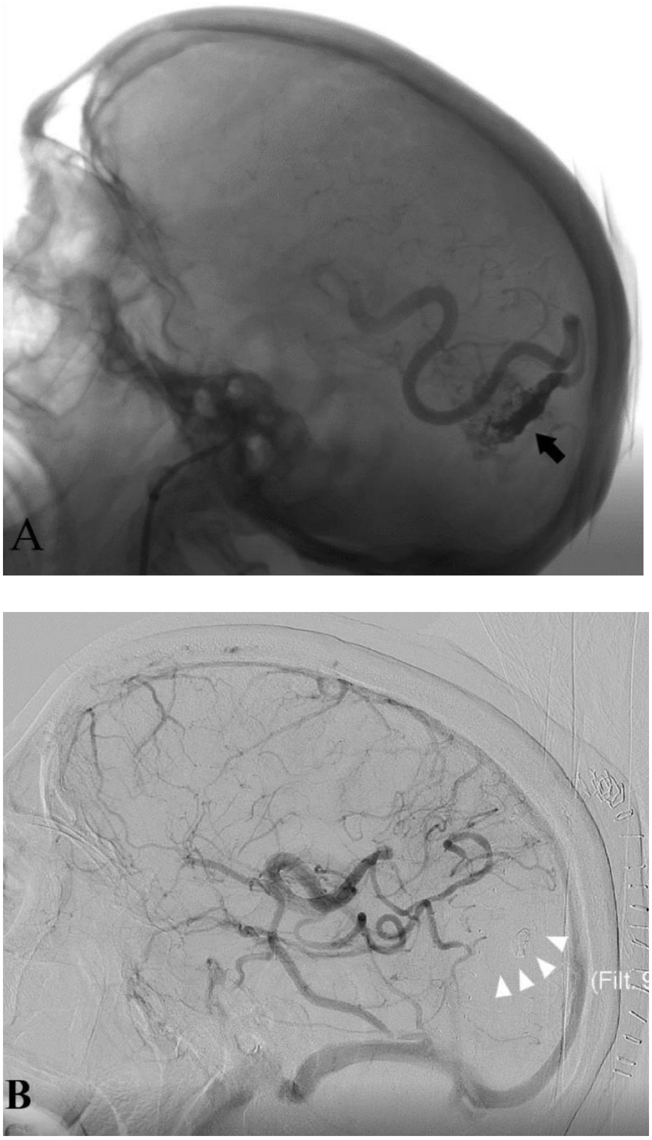

Figure 3. Post-embolization angiography without bone subtraction (latero-lateral projection) showing the reduction of the anterior portion of the nidus, with the residual cast (black arrow in A). DSA (latero-lateral projection) performed after surgical removal, showing the absence any residual rediopacity (white arrowheads).

3. Discussion

The goal of bAVM treatment is to avoid any risk of intracranial hemorrhage, to preserve a patient's eloquent areas.

Nowadays, many options are available (i.e.: embolization, neurosurgery, radiosurgery and combined approaches) to achieve complete obliteration of a bAVM, and the operationalisation of these depends on the local physicians' expertise, since no well-defined guidelines exist (1).

Although the ultimate goal is the complete obliteration of the nidus, this is not always possible as in cases of SM type IV and V bAVM (5).

The advantage of pre-surgical embolization is the down-grading of the highly inoperable Spetzler-Martin grade lesions to lower-grade operable lesions (6), since through the occlusion of deep feeding arteries, it is possible to achieve the reduction of the volume of the nidus and to control the devascularisation of the deeper territories that are inaccessible or very risky to the surgeon. Furthermore, by occluding the feeding artery pedicle or nidal aneurysms (which have either bled or are at risk of bleeding), further blood loss is prevented, making surgical resection or radiosurgery easier to perform, with better outcomes (1, 2 , 6, 7).

A great improvement in bAVM' endovascular approach, was reached with the development of new materials, in particular with the development of liquid embolic agents such as Onyx (1, 2, 7) that it is flow-independent, able to move toward endovascular spaces with the lowest gradient of pressure resulting in very handy intra-nidal injections, that allows the operator to achieve a progressive occlusion of the AVM's nidus, with a relatively short retrograde occlusion of the functional artery (1,2,8).

This technique leads to an immediately intraoperative reduction of the volume and blood flow of the bAVM, already demonstrated at post-embolization angiography. However, the use of liquid embolic agents is not void of risks, which are mainly due to inappropriate venous occlusion of a partially embolized AVM, post-embolization increased pressure in feeding arteries with perfusion pressure breakthrough, redistribution of cerebral blood flow into adjacent regions and even secondary venous thrombosis (9).

For these reasons, the injection of liquid embolic agents should always be performed carefully, constantly verifying the progression into the nidus under fluoroscopic guidance, to avoid complications such as hemorrhage, ischemia, and difficulty or inability to extract the microcatheter (2, 9, 10).

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4. Conclusions

For large AVMs, curative embolization should be avoided since it may lead to a low obliteration rate with a high risk of complications. A multidisciplinary involvement is therefore highly recommended in selected and more problematic cases, with the aim of achieving a partial embolization with the first endovascular approach followed by radiosurgery or neurosurgery for as radical a resection as possible. This multidisciplinary approach may ensure the neutralization of the feeding vessels that are more difficult to manage during conventional surgery and reduce the complication rates leading to shorter surgical time and better outcomes.

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