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Coil migration during pressure-cooker technique for cerebral AVM. A case report

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ABSTRACT

Introduction: In recent decades, the endovascular treatment of cerebral arteriovenous malformations (AVMs) has advanced. However, it still carries risks of unanticipated complications. Coil migration is a reported complication of aneurysmal coiling procedures. Herein, we report a case of early intraprocedural coil migration during pressure cooker technique embolization of right thalamic AVM, discussing the management and potential explanations. The literature showed no report of coil migration after the pressure cooker technique in the form of coil-augmented Onyx injection technique (CAIT).

Case description: An otherwise healthy 26-year-old female suddenly developed a severe headache with no loss of consciousness. Computed tomography (CT) scan of the head illustrated intraventricular haemorrhage. Magnetic resonance imaging (MRI) showed the bag of worms' sign in the right thalamic area. The size and location of the AVM prompted the decision for multistage endovascular embolization using onyx. In the anterior circulation, the right A5 arterial feeder has a high flow which indicates the pressure cooker technique embolization in the form of CAIT. In the procedure, early detachment and migration of the coil occurred in the medial prefrontal branch through the anterior cerebral artery. No intervention to retrieve the coil was carried out because the detachment piece is small and lodged distally. Onyx was injected directly without the coil because of the risk of radiation to the patient. Otherwise, the intraprocedural and postprocedural courses went uneventful.

Conclusion: This is the first report of coil migration during the pressure cooker technique with CAIT for the right thalamic AVM.

INTRODUCTION

Therapeutic embolization of cerebral arteriovenous malformations (AVMs) was documented for the first time by Luessenhop and Spence in 1960 (3). Since then, endovascular treatment has advanced

Keywords

arteriovenous malformations,
pressure cooker technique,
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significantly in recent years, particularly for AVMs, and it is now utilized as a preoperative adjuvant before microsurgery or radiosurgery and as a curative option (11). However, this treatment still carries the potential for unanticipated complications (5,15). Coil migration is a reported complication of aneurysmal coiling procedures with up to 6% of the cases (4). However, the literature showed no report of coil migration after the pressure cooker technique in the form of coil-augmented Onyx injection technique (CAIT) or balloon-assisted embolization of AVM. Herein, we report a case of early intraprocedural coil migration during CAIT of right thalamic AVM with a discussion about the management and potential explanation.

CASE DESCRIPTION

An otherwise healthy 26-year-old female suddenly developed a severe headache which made her seek the private clinic. Her initial Glasgow coma scale (GCS) is 15/15 and muscle power grade 5 bilaterally on the Medical Research Council of Canada (MRC) scale. Her initial computed tomography (CT) scan of the head illustrated intraventricular hemorrhage in the lateral ventricles. Her magnetic resonance imaging (MRI) showed the bag of worms' sign in the right thalamic area. She was advised to undergo diagnostic catheter angiography, which showed right thalamic arteriovenous malformation with multiple arterial feeders from both anterior and posterior circulations (Figure 1). The patient doesn't have other associated abnormalities such as aneurysm, varix, stenosis, and steal phenomenon.



Figure 1. DSA with anteroposterior right Internal carotid artery (ICA) and its branches showing right thalamic AVM with feeders

from ipsilateral ACA with Onyx from the first embolization procedure.



Figure 2. DSA with the AP view of the right ICA showing (A) the detached coil in the contralateral collosomarginal branch of the right ACA (Black arrow) with Onyx from the previous embolization (Red arrow). (B) The detached coil migrated more distally in the contralateral ACA (Black arrow) in the road map image.

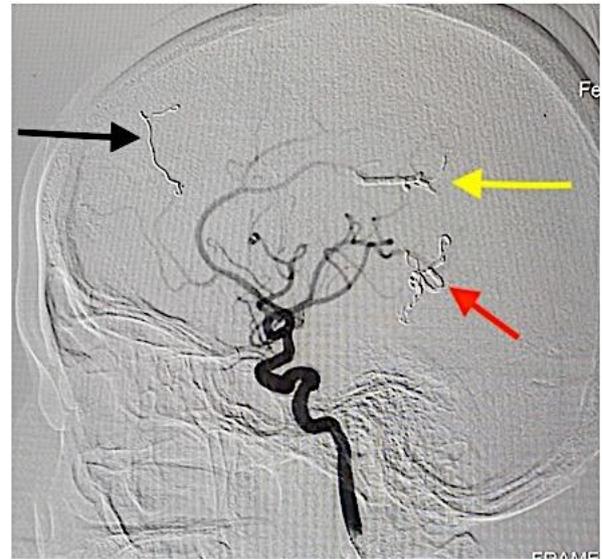


Figure 3. DSA of AP view of right ICA showing the coil migration in a distal branch of ACA (back arrow). It also shows complete obliteration of the AVM nidus with embolization of the arterial feeder from A5 (Yellow arrow). The first stage embolization Onyx is also noted (Red arrow). Note: the CMA in this case is a segmented artery with the 2 segments originating separately from the pericallosal artery.

The size and the location of the AVM prompted the decision for multistage endovascular embolization using onyx. The first stage was performed through embolization of the posterior choroidal artery by passing through the posterior cerebral artery and utilizing onyx as the liquid embolizing agent. Two weeks later, the second stage was contemplated. However, in the anterior circulation, the right A5

arterial feeder has a high flow. Right A5 Feeder coiling was considered prior to the onyx to raise proximal resistance and facilitate plug formation, leading to improved reflux control and better distal penetration. All these steps are with the pressure cooker technique in the form of CAIT. Balloon-assisted embolization was one of the options, but the high cost of this method and lack of medical insurance in Iraq make the utilization of this option unlikely. In the procedure, early detachment and migration of the coil occurred in the prefrontal medial branch through the contralateral callosomarginal branch of the anterior cerebral artery (ACA) (Figure 2).

Distal migration of the coil happened pre-onyx injection, and no intervention to retrieve the coil was carried out because the detachment piece is small and lodged distally (Figure 3). Onyx was injected directly without the coil because of the risk of radiation to the patient. Postprocedural digital subtraction angiography (DSA) imaging exhibits 90% obliteration of the AVM. Otherwise, the procedure went uneventful. Postprocedural examination showed GCS 15/15 and MRC grade 5 bilaterally. Patient follow-up includes antiepileptic drugs, diagnostic catheter angiography three months after the second stage of embolization, and referral for gamma knife radiotherapy.

DISCUSSION

Treatment of cerebral AVMs successfully is a major challenge (14). Embolization has become more essential in the therapy of cerebral AVMs as endovascular materials and experience have improved (1). Nidus reduction before surgery or radiosurgery, as well as curative embolization, are the two main goals of AVM embolization. The goal of Nidus reduction is to reduce operative difficulty and risk during surgical removal (18). Curative embolization aims for the entire obliteration of the AVMs, and in the cases of partial occlusion, embolization can reduce the volume of the nidus, allowing radiosurgery to be attempted (10). Similarly, while waiting for the delayed occlusion accomplished by radiosurgery, embolizing the feeding artery can lower the risk of hemorrhage (3,10). The pressure cooker technique as CAIT of AVM and balloon-assisted coiling has specific indications, which are highlighted with AVM of high flow feeders and large caliber such as in the current report. CAIT, according

to Gao X et al has several advantages, including 1), the microcatheter used for coil infusion is far more navigable than the balloon, 2), the coil can provide sufficient proximal resistance to enable plug formation and obtain better distal penetration, allowing more Onyx to be injected from a single feeding pedicle while reducing procedure time and radiation exposure (8). In our case, CAIT was used because, in the anterior circulation, right A5 was a high flow feeder. In addition, balloon-assisted coiling was off the choice because healthcare insurance in Iraq is immature, making costs significantly elevated for the patient.

The hemodynamics of the AVM in the arterial system is working as a suction device in which the majority of the flow is in the direction of the main feeder. When the navigation is performed by microwire, microcatheter, or coiling, it is easy to carry out within the flow of the main feeder as it has negative pressure. In our case, the presence of the microcatheter in the proximal part of the feeder (in our case, right ACA) may result in a decrease in the feeder's flow and a change in the hemodynamics of the AVM, which was apparent in the migration of the coil in the contralateral ACA. This could be unexpected if the hemodynamics of the AVM is unchanged and all pressure is within the nidus direction.

AVM embolization can result in significant treatment-related morbidity and mortality (6). Complication rates associated with AVM embolization have been observed to range from 5% to 15% (7). According to a recent meta-analysis by van Beijnum et al., complications after AVM embolization resulted in irreversible neurological impairments or death in 6.6 percent (range 0–18 percent) of patients (16). After 846 embolizations in 408 individuals, Baharvahdat et al. observed an 11 percent procedural complication rate. After embolization, 7.6% and 1.6 percent of patients, respectively, reported persistent, new impairment and mortality due to hemorrhage (2). In addition, coil migration is a potential complication in CAIT in the AVM, which was not reported in the literature yet. In the present report, coil migration occurred pre-onyx injection and migrated distally to the prefrontal medial branch through the contralateral callosomarginal branch of ACA. However, the patient was assessed clinically and radiologically

intraoperatively, which was unremarkable, and stayed asymptomatic through the follow-up period.

Our experience in coil migration in terms of classification is based on general principles mainly derived from the studies in aneurysmal coiling. Migration can be categorized into acute procedure migration and delayed postprocedural migration depending on the time the migrated coil was identified (1). Coil migration found after the coiling technique was completed is referred to as delayed migration (1,12). The period between endovascular coiling and detection of the migrating coil should be noted. The location of the migrated coil is classified as proximal or distal. The mentioned classifications are more related to the endovascular coiling in aneurysms, but the general principle can be applied to the CAIT of the AVM. Although, in CAIT of AVM with high caliber and flow feeders, as in the case, the potential migration of the coil after its detachment may occur before or after the onyx injection, and the migration was acute procedural with distal migration.

In general, coil migration management differed depending on the timing of migration (acute or delayed), the location of the migrated coil (proximal or distal), the target vessel's patency, and the vascular territory's eloquence (1,4). When a migrated coil relocates intraprocedurally, lodges in a proximal or eloquent position, and/or there is a concomitant accessible vascular obstruction, migrated coil retrieval should be performed endovascularly or by open surgery (9,17). In contrast, distal migration requires conservative treatment (1,13). In the present report, the management of coil migration depends on the principles that were extracted mainly from the literature on aneurysmal coiling. In AVM with high vessel caliber and increased flow feeders, as in the current study, distal migration was managed conservatively. Otherwise, early assessment of the patient within the procedure and after the procedure, along with early intervention, may lead to better management of the patient's condition.

In summary, endovascular embolization by CAIT may result in size reduction in AVM nidus or complete obliteration, especially for the arterial feeder with the high flow as in our case. We report a case of coil migration in CAIT of AVM. In this report, contralateral ACA distal coil migration was managed conservatively.

CONCLUSIONS

Coil migration is a rare complication in aneurysms. This report is the first case of coil migration during the pressure cooker technique with CAIT for the right thalamic AVM.

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