

MIDDLE MENINGEAL ARTERY EMBOLIZATION IN CHRONIC SUBDURAL HEMATOMA

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Received: 23-II-2024

Accepted: 10-VII-2024

Abstract

Chronic subdural hematoma (cSDH) is an increasingly prevalent condition, particularly among elderly population and is associated with elevated morbidity. The pathophysiology of cSDH involves proliferation of dural edge cells, fibroblasts, and release of vascular angiogenic factors leading to angiogenesis of a vascularized neomembrane perfused by the middle meningeal artery (MMA). MMA embolization is a technique that can be employed as treatment in conjunction with surgery or as a standalone therapy. Our aim is to describe our experience with treating selective cSDH patients with embolization of MMA in a university hospital in Argentina.

We deployed this procedure in 6 patients over a period of one year and a half years with a median age of 72.5, with a median SDH thickness of 12.5 mm and four of them had a midline deviation greater than 5mm. The decision of the embolization was done due to minor symptoms and the necessity of restart antiplatelet therapy or anticoagulation, formal contraindication for surgery or as adjuvant of surgery because of cSDH recurrence. After discharge, no patient required a new surgical intervention.

MMA embolization is impressive to be a safe and an option to treat cSDH. We present our experience in six patients in a hospital in Argentina.

Key words: middle meningeal artery, embolization, chronic subdural hematoma

Resumen

Embolización de la arteria meníngea media en hematoma subdural crónico

Los hematomas subdurales crónicos (HSDc) son una afección con una prevalencia en aumento, en particular en pacientes añosos, asociado a una elevada morbilidad. La patofisiología del HSDc incluye la proliferación de la células durales, de fibroblastos y de liberación de factores de crecimiento vascular que conllevan a angiogénesis de una neomembrana vascularizada irrigada por la arteria meníngea media (AMM). La embolización de dicha arteria es una técnica que puede ser empleada en conjunto con la cirugía o como tratamiento único. Nuestro objetivo es describir nuestra experiencia con la embolización de la AMM en pacientes seleccionados con

HSDc en un hospital universitario de Argentina. Realizamos dicho procedimiento en 6 pacientes a lo largo de un año y medio, con una edad promedio de 72.5 años, con un grosor medio de 12.5 mm de HSDc y de los cuales en 4 pacientes presentaban desviación de la línea media mayor a 5 mm. La elección de esta terapéutica en estos pacientes se debió a la poca sintomatología que generaban el HSD asociado al requerimiento de inicio precoz de terapia antiagregante o anticoagulante, a contraindicaciones formales para la cirugía o como adyuvante al tratamiento quirúrgico por la recurrencia del HSD. Luego del alta hospitalaria, ningún paciente requirió nueva intervención por recaída del HSD. La embolización de la AMM impresiona ser segura y ser una opción en el tratamiento del HSDc y presentamos nuestra experiencia en 6 pacientes en un hospital de Argentina.

Palabras clave: arteria meníngea media, embolización, hematoma subdural crónico

Chronic subdural hematoma (cSDH) is an increasingly prevalent condition and is associated with elevated morbidity¹⁻². The pathophysiology of chronic subdural hematoma has a proposed hypothesis suggesting the initiation of an inflammatory response post-hematoma formation that involves proliferation of dural edge cells, fibroblasts, and the release of vascular angiogenic factors, ultimately leading to angiogenesis of a vascularized neomembrane with highly permeable endothelial junctions, perfused by the middle meningeal artery (MMA)³.

Clinical presentations vary widely, ranging from complete asymptomatic cases or minimal headaches to pronounced neurological deficits or severe impairment of consciousness. Generally, asymptomatic patients without midline shift undergo conservative treatment. Conversely, symptomatic patients exhibiting a significant midline shift and/or cerebral compression, and with an acceptable surgical risk, are candidates for subdural hematoma drainage through surgical intervention.

An emerging therapeutic approach for cSDH involves the embolization of the middle meningeal artery. This method considers the theory of angiogenesis dependency on the middle meningeal artery. Embolization of this artery has the potential to inhibit blood flow to pathologically irrigated structures, thereby preventing recurrent vessel rupture and facilitating the gradual reabsorption of the hematoma over time. Important-

ly, this approach is associated with a low rate of peri-procedural complications⁴. Currently, middle meningeal artery embolization is employed either as an adjuvant treatment in conjunction with surgical drainage of cSDH or as a standalone therapy for patients exhibiting mild symptoms or those at a heightened surgical risk⁵.

In this article, we present a case series of six patients from a high-complexity hospital in Buenos Aires, Argentina, where middle meningeal artery embolization therapy was successfully employed for the treatment of chronic subdural hematoma from August 2022 to December 2023. This treatment was administered to patients either presenting with mild symptoms, with substantial comorbidities that contraindicated surgical drainage or as adjuvant treatment in conjunction with surgical drainage due to SDH recurrence.

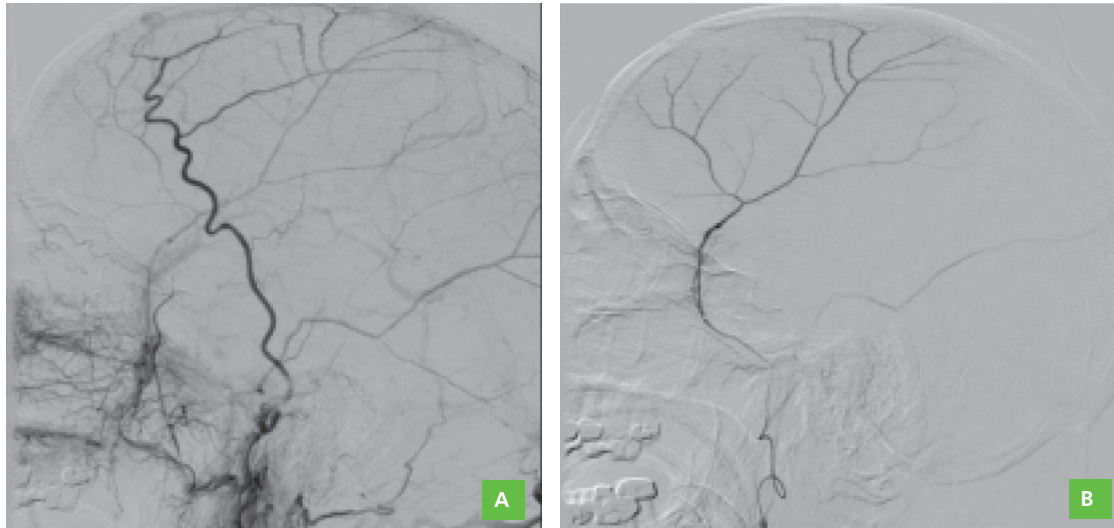
Clinical cases

From August 2022 to December 2023 MMA embolization was performed in 6 patients with exacerbated chronic subdural hematoma admitted to the intensive care unit. The embolization of the SDH was performed either because they presented mild symptoms, due to the high surgical risk and the need for early resumption of antiplatelet or anticoagulant therapy required by these patients or had a contraindication for surgery or as adjuvant treatment due to SDH recurrence. The decision to perform such treatment was made by consensus in conjunction with neurosurgery and neurointensive care physicians. As in any invasive procedure, patients and/or family members were informed about the benefits and potential risks of the intervention and informed consent was signed for its performance in all cases.

All interventions were performed in the angiography room, under general anesthesia. Seldinger puncture was performed on femoral artery and hyperselective catheterization of the external carotid artery was performed in all cases: in three patients 300-700 embolization spheres were injected to occlude dural branches of the middle meningeal artery, and in the other embolization with liquid cement (Glubrand 2[®]) was used (Fig. 1).

Of the 6 patients, 2 were male and the median age was 72.5 (interquartile range 60-76). Two were under antiplatelet therapy with aspirin due to recent diagnosis of coronary artery disease and peripheral vascular disease with aortic stenting. Additionally, one patient was receiving anticoagulation with apixaban secondary to an atrial fibrillation with a recent ischemic stroke. Among the co-

Figure 1 | A: Brain angiography revealed dependent hyperemia of middle meningeal artery (patient #1). B: After embolization of artery, the flow has decreased



hort of six patients, one individual presented with critical thrombocytopenia due to a recent diagnosis of hematologic disease, specifically type B lymphoma, so she has a contraindication for the surgery and MMA embolization was performed. Other patient had no comorbidities and the surgery risk was low but the MMA embolization was done because of the SDH recurrence after two surgical evacuation.

Among the clinical presentations, 5 of 6 patients were admitted to the emergency room with a GCS of 15 with minor symptoms (mild to moderate headache) with a Markwalder score of 0 or 1 while the remaining patient was admitted with a decline in consciousness attributed to seizure, with a GCS of 8 requiring orotracheal intubation. The median SDH thickness was 12.5 mm (IQR 10 - 18.5 mm) and four of the 6 patients had a midline deviation greater than 5 mm. Only one patient had bilateral frontoparietal subdural hematoma while the other patients had unilateral cSDH.

Two required reinitiation of antiplatelet and anticoagulant medication due to their recent history and did so on the first and second day post-procedure, respectively, without hemorrhagic complications. Of the 6 patients, only one required a subsequent surgical intervention during hospitalization with drainage of chronic SDH through trephine holes due to the appearance of a new neurological focus and a progression of Markwalder score. As a periprocedural complication, only one patient had a hematoma at the puncture site, requiring only a compressive bandage without associated aneurysm.

The median days spent in the ICU and in hospital was 10 (IQR 7-13) and 11 (IQR 7-28) respectively. There were two patients that had a prolonged stay at hospital: patient #1 stayed for 39 days because of the diagnoses of lymphoma and the specific treatment of the hematological disease and patient #3 had a prolonged stay because of an hematoma at the puncture site, that required suspension of the anticoagulation and compressive bandage for several days and after that, had a psychiatric decompensation that required specific psychiatric evaluation and treatment. After discharge, none of them required surgical intervention for relapse of the subdural hematoma within six months.

At 6 months, 5 patients had a good neurological outcome (defined as mRS between 0-2) and one patient died: the cause of death being progression of his extracranial hemato-oncologic disease. All patients were followed by the neurosurgeon with clinical and brain tomography at 3 and 6 months after hospital discharge.

In Table 1 we summarize the principal demographic, medical history, clinical and cSDH characteristics and outcome surrogates and complications of the 6 patients report.

All patients have given verbal consent for the publication of the cases.

Discussion

Traditional surgical treatment of chronic subdural hematoma consists in evacuation via cranial burr holes combined with the use of a

Tabla 1 | Demographics characteristics

	Patient #1	Patient #2	Patient #3	Patient #4	Patient #5	Patient #6
Sex and age	♀ 76	♂ 74	♀ 71	♀ 31	♂ 95	♀ 60
Charlson	5	6	6	4	7	3
Anti-platelet	N	Y	N	N	Y	N
Anticoagulation	N	N	Y	N	N	N
Thrombocytopenia	Y	N	N	N	N	N
GCS at admission	15	15	8	15	15	15
Markwalder score	1	1	4	1	0	1
cSDH location	Bilateral convexity	Left rietal	Right rietal	Left rietal	Left rietal	Left rietal
Thickness (mm)	17	11	11	17	20	14
Deviation midline (mm)	1.5	6.5	0	10	9	13
Material embolization	Bilateral: spheras 300-400 micrones	Unilateral: liquid cement	Unilateral: liquid cement	Unilateral: spheras 500-700 micrones	Unilateral: liquid cement	Unilateral: spheras 500-700 micrones
Surgery post embolization	N	N	N	N	Y	N
Peri-embolization complications	N	N	Y (hematoma at the puncture site)	N	N	N
Hospital stay (days)	39	7	28	3	6	14
Rebleeding post discharge	N	N	N	N	N	N
6 month mRS	6	0	2	0	1	0

GCS: Glasgow Coma Scale; cSDH: chronic subdural hematoma; mRS: modified Rankin Scale; Y: yes; N: no

postoperative drain. However, this technique still has a high rate of recurrence requiring reoperation in the range of 10% to 20% of the cases, meaning an increase in morbidity and mortality of the patients⁶. Furthermore, the patient population tends to be elderly with various comorbidities and usually takes anti-platelet or anticoagulant medication, making surgical decisions difficult. Considering the pathophysiology of cSDH there were various non-surgical treatments (for example corticosteroids, antifibrinolytics and statins) that tried to improve neurological outcomes but benefits not quite established⁷. Although corticosteroids were considered safe and effective when used in addition to surgery with the aim of reducing the risk of recurrence or as stand-alone therapy with the aim of avoiding surgery, a recent trial

showed that treatment with dexamethasone resulted in a fewer favorable outcome than placebo at 6 month⁸. Also, another trial suggests that the use of prednisone as an adjuvant treatment to surgery has no clear clinical benefits and produces an increase in psychiatric disorders and insomnia⁹. Antifibrinolytics as tranexamic acid (TXA) also has been used to reduce hematoma volume and reoperation rate in retrospective studies¹⁰; however, the role of TXA is still lacking in evidence as randomized trials are ongoing to reveal the effectiveness of these drug¹¹. Another drug that have been used is statins because of its action by reducing inflammation in the vessel wall and mobilize endothelial progenitor cells for vascular repairs that may be beneficial in the management of cSDH. Although Jian et al phase II trial concludes that 20 mg daily of

atorvastatin is safe and effective for the non-surgical treatment of cSDH, a phase III trial is still missing and it is important to note that the study was conducted among Chinese patients, which is a limitation for extrapolating the conclusions in other ethnicities¹². Due to all limitations of non-surgical treatments is that middle meningeal artery embolization is an attractive and novel strategy for treatment cSDH being a minimally invasive procedure that can provide an alternative or adjunct to conventional surgical techniques. The MMA gives rise to capillary feeders of hematomas so embolization this artery is thought to inhibit blood flow into pathologic structures, control bleeding from the cSDH membrane, and enhance spontaneous resolution of the hematoma¹. MMA embolization for cSDH has been described in small case reports and series over the past years with a rapidly increasing number of studies analyzing this innovative and largely successful technique. More recently, a single-center, prospective, randomized, pilot study was designed by Ng et al¹³, comparing surgery with and without MMA embolization in patients with cSDH. The authors concluded that the addition of MMA embolization to surgical treatment led to an increase in cSDH resorption at 3 months and no treatment-related complications were recorded. Based on all the literature published until now, MMA embolization has been shown to be effective and safe, especially in patients with recurrent cSDH or those for whom surgical intervention is associated with a high risk (e.g., due to receipt of anticoagulation medication or advanced comorbid conditions), and may significantly reduce the morbidity and mortality associated with cSDH.

We present our cases series of embolization of cSDH in 6 patients that had minor symptomatology (patient #4), had to restart promptly antiplatelet medication (patient #2) or anticoagulation (case #3), had elevated morbidity to be someted to a surgery (patient #5), had a formal contraindication to the surgery because of severe thrombocytopenia (case # 1) and had recurrence of cSDH (patient #6). Only one patient had a subsequent surgical intervention during hospitalization with drainage of chronic SDH due to progression of Markwalder score and no patient had rebleeding after hospital discharge. At 6 months, five patients has a good mRS and one died due to progression of onco hematological diseases (case # 1).

Several randomized control trials are ongoing investigating the efficacy, safety and utility of MMA embolization for cSDHs^{14,15}, and surely will provide us sufficient evidence to be able to determine which patients benefit from this technique.

To conclude, MMA embolization is a technique that appears to be a safe option to treat cSDH. It can be used to treat both asymptomatic and symptomatic cSDH, patients with a contraindication of surgery or an elevated morbidity and also as an adjuvant therapy with surgery to lead better treatment outcomes and potentially improved prognosis. There are ongoing prospective clinical trials that will provide us with sufficient evidence to be able to determine which patients benefit from this technique. We present our experience in a university hospital in Argentina with good functional results.

Conflict of interest: None to declare

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