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Case Report

Preoperative middle meningeal artery embolization in the treatment of organized chronic subdural hematoma ☆

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ABSTRACT

Organized chronic subdural hematoma is a rare form of chronic subdural hematoma. The optimal treatment method is still controversial. Preoperative middle meningeal artery embolization and craniotomy are effective methods for chronic subdural hematoma. However, there are not many reports investigating the effectiveness of these methods in treating organized chronic subdural hematoma. We report the case of a 61-year-old male patient who had a twist-drill craniostomy to treat a left hemisphere subdural hematoma. After surgery, there was a recurrence on the same side in the form of an organized subdural hematoma. The patient received preoperative left middle meningeal artery embolization. After 3 months of follow-up, a small portion of the hematoma remained, causing pressure and slightly shifting the midline to the right by 6.5 mm, and the patient no longer had clinical symptoms.

Introduction

Chronic subdural hematoma (CSDH), which commonly occurs in elderly patients, is a condition frequently diagnosed in neurosurgery. The overall incidence of CSDH is estimated to be 1, 72–20.6/100,000 per year and increasing significantly in populations >65 years of age [1]. The reasons why this type of hematoma occurs frequently in the elderly include an increase in antithrombotic drugs, fragility of the veins, an increase in the subdural space, an increased risk of concussion and injuries due to frequent falls. CSDH is thought to form

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between the border cell layer surrounded by the outer and inner membranes. While the inner membrane has few blood vessels, the outer membrane contains many fragile capillaries (also called sinusoidal vessels) that are often the source of repeated multifocal bleeding. This repeated hemorrhage from the outer membrane is considered to be the causative factor in the progressive expansion of the hematoma, which occurs after a minor head injury, while the inner membrane is implicated in the liquefaction of the subdural hematoma [2]. However, organized subdural chronic hematoma (OSDH) is rare, accounting for about 0.5%-2%. [3]. Some internal structures of CSDH may appear as multilocular, calcified, multilobulated, or multilayered. This type of CSDH is defined as organized CSDH (OSDH), in which thick membranes with multiple septa develop, leading to the formation of densely bounded regions [4].

Middle meningeal artery embolization (MMAE) is an adjunctive therapy that treats the pathophysiology of CSDH through embolization of neovascular vessels with an embolic agent to interrupt the vascular supply to the hematoma [5]. Reduced reoperation rates have been shown to be consistent with endovascular treatment as a stand-alone treatment as well as adjunctive to surgical resection (reoperation rate 1.7%) compared with surgical treatment alone (reoperation rate 27.5%) in previous studies [5]. We report the case of a 61-year-old male patient with a history of chronic subdural hematoma in the left hemisphere, who underwent twist-drill craniostomy with ipsilateral recurrence in the form of organized subdural hematoma. The patient received preoperative left middle meningeal artery embolization. After 3 months of follow-up, a small portion of the hematoma remained, causing pressure and slightly shifting the midline to the right by 6.5 mm, and the patient no longer had clinical symptoms.

Case report

A 61-year-old male patient with a history of chronic subdural hematoma in the left hemisphere had undergone twist-drill craniostomy, with no other medical history. This time the patient was admitted to the hospital due to headaches, no weakness, no focal neurological signs. On the computed tomography scan, there was an image of a subdural hematoma in the left hemisphere at its thickest point of 48 mm, with a part inside calcification in the form of an organized subdural hematoma (Fig. 1), causing pressure to push the midline 15 mm to the right, herniation through the cerebral crescent and herniation of the medial temporal gyrus downward.

The patient simultaneously underwent a cranial magnetic resonance imaging with contrast agent injection, which showed no malignant lesions of the brain parenchyma or meninges (Fig. 2). Basic blood count and coagulation tests showed no abnormalities.

The patient was embolized 1 day before surgery. On the DSA scan, the hypervascular areas was seen from the frontal and parietal branches of the left middle meningeal artery. Insert the microcatheter 2.2F microcatheter (Carnelian,. Tokai Medical Products, Aichi, Japan) by micro guidewire 0.014″ (Run & Run, Piolax Medical Devices) to the junction of the frontal branch and the parietal branch. Embolization of proliferating

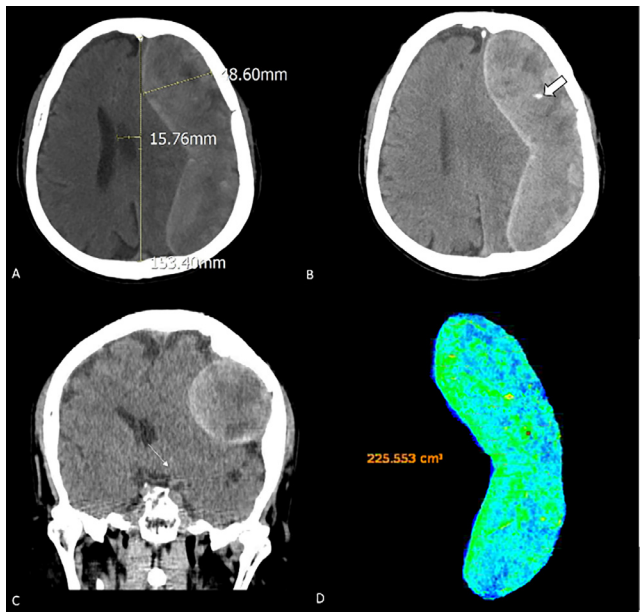

Fig. 1 – Non-contrast computed tomography of the head before craniotomy. (A) The density of the hematoma is heterogeneous, the thickest hematoma is 48mm, causing pressure to push the midline 16 mm to the right. (B) Hematoma density is heterogeneous, with calcification inside (empty arrow). (C) Medial temporal gyrus herniation through the Bichat fissure (arrow). (D) Hematoma volume.

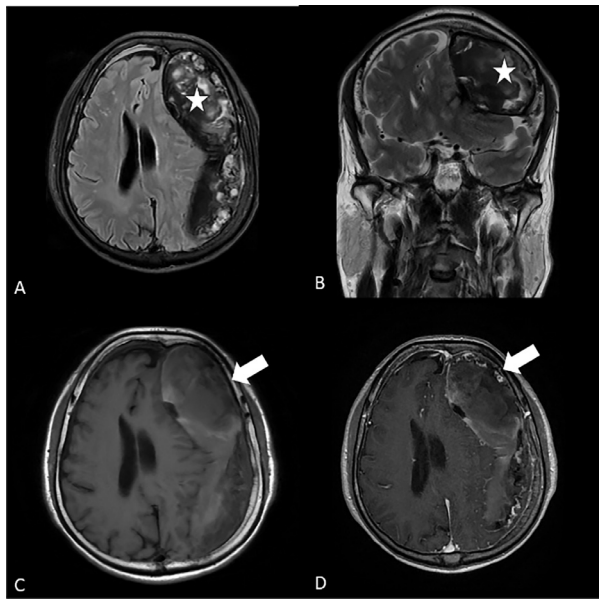

Fig. 2 – Magnetic resonance imaging of the brain with contrast enhancement. (A) Axial FLAIR: mixed signal subdural hematoma, with many internal septa (star shape). (B) Coronal T2W: mixed signal subdural hematoma, with many internal septa (star shape). (C,D) T1W before and after injection Gadolinium: mild dural thickening and diffuse inflammatory enhancement (empty arrow), no abnormal enhancing mass seen.

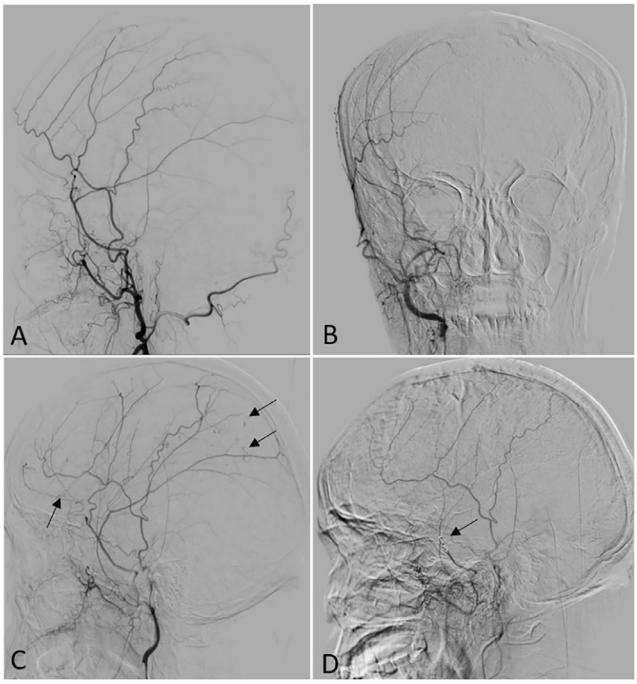

Fig. 3 – Angiogram of the right middle meningeal artery and the pre- and post-embolization angiogram of the left middle meningeal artery. (A, B) Right middle meningeal angiogram shows no vascular damage. (C) Left middle meningeal angiogram shows hyper vascular areas from the frontal and parietal branches (arrow). (D) Post-embolization examination with coil and PVA beads showed complete occlusion of the middle meningeal artery (arrow).

branches with PVA particles (Contour, Boston Scientific, Natick, MA, USA, 250-350 μm) mixed with Heparin 500 UI. Middle meningeal artery pedicle occlusion with 02 coils. Fibered Platinum Coils (VortX-18 Diamond shape) 4 × 3.7, 5 × 5.5 mm. An examination after the embolization showed complete blockage of the intersection between the frontal branch and the apical branch of the middle meningeal artery, indicating successful occlusion of blood flow to the targeted area (Fig. 3).

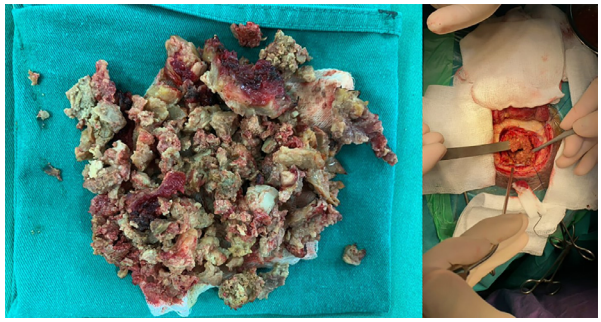

Fig. 4 – Craniotomy image shows organized subdural hematoma.

The patient underwent a craniotomy to remove the entire organized hematoma (Fig. 4). Pathology of the hematoma revealed no malignant lesions.

After 3 months of follow-up, a small portion of the hematoma remained, causing pressure and slightly shifting the midline to the right by 6.5 mm, and the patient no longer had clinical symptoms (Fig. 5).

Discussion

Chronic subdural hematoma (CSDH) is becoming increasingly prevalent and stands as one of the most frequent conditions necessitating interventional or surgical treatment. Its incidence in the general population is approximately 14 per 100,000, rising to 17 per 100,000 in individuals older than 70 years [5]. On the other hand, OSDH is exceedingly rare, constituting only 0.5% to 2% of all SDH cases [3]. CSDH lesions can develop into OSDH in about 6 to 12 months [6]. In an organized hematoma, neo membrane develops similarly to granulation tissue and proliferates fragile sinusoidal vessels causing repeated multifocal hemorrhages [7]. Fibrotic lesions gradually increase in volume, forming a solid structure in which the inner and outer membranes tend to fuse completely [8].

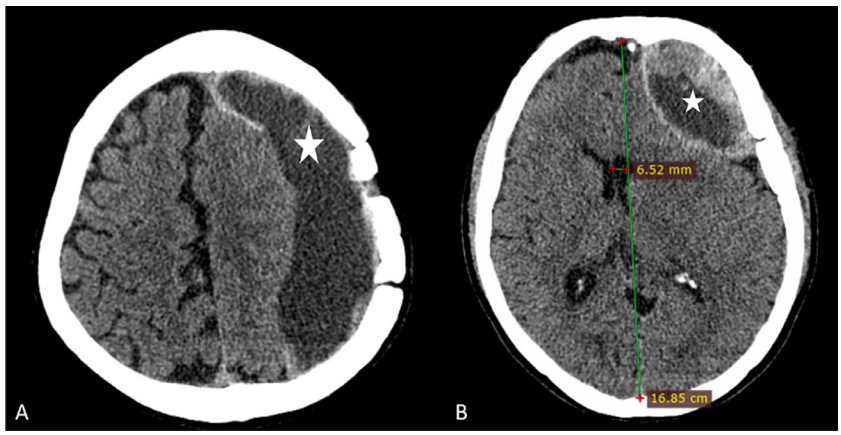

Fig. 5 – Non-contrast computed tomography of the head after craniotomy. (A, B) The small subdural hematoma in the left hemisphere caused a slight mass effect that pushed the midline to the left by 6.5 mm (star shape).

OSDH presents CT features suggesting mixed-density hematoma, calcification, or a multilocular structure. Magnetic resonance imaging of OSDH often reveals a heterogeneous network-like structure within the hematoma cavity [3]. The CT scan of the reported patient displayed an image of subdural hematoma in the left hemisphere with internal calcification, while magnetic resonance imaging revealed an inhomogeneous signal consistent with OSDH characteristics.

To treat CSDH, numerous surgical approaches have been proposed; however, the optimal treatment remains inconsistent. The choice of surgical technique for CSDH must be determined based on the degree of hematoma organization. Twist-drill craniostomy with drainage is required for disorganized and mainly liquid CSDH. However, research by Andrew F Ducruet suggests a recurrence rate of up to 11.7% when treated with skull hole drilling [9]. The causes include factors such as overdevelopment of the dura mater, multilayered subdural hematoma structure, nonliquefied hematoma with different hemorrhagic foci with layering effects [4]. Comorbid medical conditions that increase the patient's recurrence rate include advanced age, diabetes, hypertension, intracranial hypotension, alcohol consumption, as well as the use of antiplatelet or anticoagulant drugs [10]. Additionally, imaging features associated with recurrence include bilateral hematomas, preoperative hematoma thickness and midline shift, hematoma density and internal structures, brain atrophy, as well as hematoma volume [11]. Furthermore, procedural risk factors such as surgical technique, hemorrhage, postoperative position, and subdural air accumulation after surgery, are also considered causes of CSDH recurrence [12]. Therefore, to reduce the recurrence rate, some studies suggest that small craniotomy irrigation and closed system drainage can be considered as treatment options in patients with CSDH. For OSDH, burr hole craniostomy is not considered the first-line treatment method due to the hematoma's heterogeneous nature, dural proliferation, and vascular proliferation. Instead, craniotomy is deemed to be the most appropriate [4].

Studies indicate that the inflammatory response of the dura mater is involved in the pathophysiology of CSDH by promoting neovascularization and the formation of bleeding granulation tissue (neoplastic membrane) [13]. This neovascularization is supplied by branches of the middle meningeal artery (MMA). Therefore, MMA embolization, which blocks the blood supply through the dura mater to the periosteum of the hematoma, has become one of preoperative methods to help reduce the risk of CSDH recurrence, particularly in the treatment of recurrent CSDH [5]. Studies have shown that MMA occlusion is more than 90% effective in treating refractory cases of CSDH [14]. Additionally, a recent systematic review reported that the recurrence rate after MMA embolization for CSDH was 3%-6%, not limited to refractory cases [15]. Similarly, in the case of OSDH, MMA embolization may be effective in treating OSDH because OSDH supplies blood from MMA via fragile sinusoidal vessels at the junction of the inner and outer membranes [7]. Shigeomi Yokoya's study reported 2 OSDH patients treated with MMA embolization before surgery and showed no recurrence [16].

Several precautions can be taken for effective and safe MMA embolization. First, the embolization target should be the distal portion of the MMA, where pre-embolization angiography shows lesions requiring embolization. Among the interventional materials used, Polyvinyl alcohol (PVA) beads are most commonly used for MMA embolization in the preoperative treatment of CSDH [15]. A recent study by Schwarz et al. [17] that used PVA particles (250-350 μm) for postoperative prophylaxis showed a recurrence rate of 4.5% among 44 treated cSDH, similar to a 5% recurrence rate reported by Dowlati et al. [18] who performed MMA embolization on 20 patients who underwent surgery. Sam Ng et al. [19] studied in 41 patients using smaller PVA particles (Contour, Boston Scientific, Natick, MA, USA, 150-250 μm) to embolize MMA before twist-drill craniotomy, resulting in significant improvement including reduction in hematoma volume and recurrence in only 1 patient.

Coil embolization is one of the materials that causes flow changes and the activation of coagulation factors leading to MMA occlusion. Subsequent fibrosis and vascular remodeling favor long-term occlusion of MMA [20]. The coil embolization mechanism, compared to that of particle or liquid agents, may be advantageous because there is no leakage of particle or liquid agents that could cause inadvertent migration and ischemia to the tissues. Therefore, nontarget embolization with coil is exceedingly rare [21]. Particle agents, such as PVA, are more commonly used in combination with coils than liquid embolic [21]. The authors point out that coil combined with PVA in MMAE may be indicated when there are dangerous circulations to the ophthalmic artery, variant anatomy of MMA [22].

In a single-center study of 132 patients, Onyinzo et al. [23] provided insight into the incidence of treatment-related complications associated with MMAE as an adjunct or alternative therapy to conventional surgery. The authors noted no significant differences in complications, hematoma recurrence, acute rebleeding, and cerebrospinal fluid leak, between MMA embolization and surgery compared with the surgery-only groups. This shows the safety and effectiveness of MMAE combined with surgery [23]. Therefore, in our case, it showed drug-eluting lesions in the distal part of the MMA. Hence, the intervention material chosen was PVA particles with a size of 250-350μm to occlude the distal lesions and use Fibered Platinum Coils coils (VortX-18 Diamond shape) to block the base to help minimize the proliferation of fragile sinusoidal vessels.

Conclusion

Middle meningeal artery embolization is a promising method for the treatment of chronic subdural hematoma. In which, preoperative middle meningeal artery embolization is an effective support method for craniotomy in the treatment of organized chronic subdural hematoma.

Patient consent

Informed consent for patient information to be published in this article was obtained.

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