Organized Chronic Subdural Haematoma with a Thick Calcified Inner Membrane Successfully Treated by Surgery: A Case Report

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The optimal surgical procedure for patients with calcified and organized chronic subdural haematoma (CSDH), or "armoured brain", has not been established because it is difficult to obtain good re-expansion of the brain after surgery. We present herein the case of a 32-year-old woman with huge calcified CSDH manifesting as refractory headache, periods of unconsciousness, and unsteady gait who obtained favourable results after craniotomy. Thinning of the thick calcified inner membrane using high-speed air drilling was performed after removal of the organized CSDH. The patient obtained good re-expansion after surgery. This observation illustrates that it is possible to perform such a surgery even on a huge calcified CSDH.

Key words: armoured brain, brain re-expansion, calcified chronic subdural haematoma, high-speed drilling, inner membrane

INTRODUCTION

It has been reported that most cases of chronic subdural haematoma (CSDH) are curable by performing single burr-hole irrigation using closed system drainage [1, 2]. Craniotomy for CSDH should be limited to multilobulated or multiseparated cases or to cases with organized or partially calcified haematoma that are intractable after burr-hole surgery [3, 4].

A huge calcified CSDH covering most of the cortical surface is referred to as an "armoured brain" [5, 6]. The optimal surgical procedure for patients with armoured brain has not been established because these patients have a thick calcified inner membrane, and it is difficult to obtain good re-expansion of the brain after surgery [6].

We present herein the case of a patient with huge calcified CSDH who obtained good re-expansion after thinning of the thick calcified inner membrane using high-speed air drilling and discuss this surgical technique.

CASE REPORT

History and examination

A 32-year-old woman was visiting another neurosurgical hospital as an outpatient for treatment of chronic headache that was unresponsive to drug therapy. Although she had been diagnosed with calcified CSDH by neuroimaging 4 years previously, no therapeutic procedure was undertaken. This decision to not treat was based on the patient's previous neurosurgeon, who believed that surgery carried too high a risk of possible complications without the guaranteed benefit of satisfactory improvement of headache. Three months before admission to our hospital, her headaches began getting worse and occurring more frequently; she also reported periods of unconsciousness and had developed an unsteady gait.

On the day of admission to our hospital, no abnormal findings were noted on neurologic examination except for a mild gait disturbance. Results of routine laboratory examinations were unremarkable except for mild iron deficiency anaemia; no infectious disease was suspected.

A noncontrast computed tomography (CT) scan **(Fig. 1A, B)** and magnetic resonance images, including T2* weighted images **(Fig. 2)** at admission, revealed a left subdural mass consisting of both a calcified thick inner membrane and organized haematoma with multiple heterogenous calcifications. CT also demonstrated a prominent mass in the left hemisphere, the so-called sulcus effacement sign.

To prevent postoperative seizures, the patient was prescribed anticonvulsant therapy beginning 10 days before surgery.

Operation

A preoperative view of the calcified CSDH is shown in **Fig. 3A**. An osteoplastic left craniotomy was performed over the haematoma with the patient under general anaesthesia. The thinned dura matter could be easily separated and removed from the outer membrane. The outer membrane was thickened and calcified and about 5 mm thick. This membrane was completely removed, little by little, using rongeur forceps to preserve the transitional zone between the inner and outer membrane **(Fig. 3B)**. Partially calcified grey mud- or coal-like materials were found under the outer

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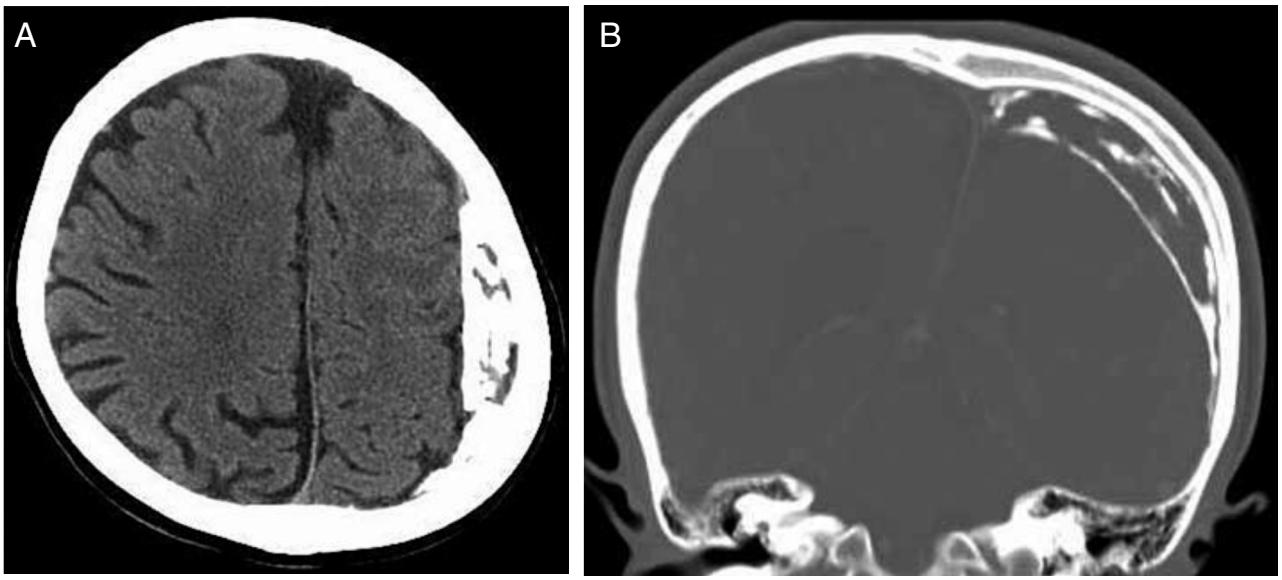

Fig. 1 Axial image of non-contrast computerized tomography (CT) scan **(A)** at the time of admission revealed a left subdural mass consisting of both of calcified thick inner membrane and organized haematoma with multiple calcification. A coronal CT image **(B)** demonstrated a huge calcification at the left subdural region with thick hyperdense calcified margins, the so-called armoured brain.

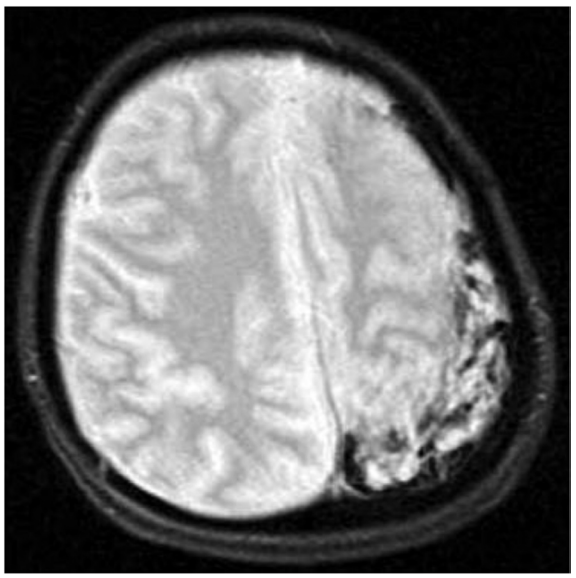

Fig. 2 Magnetic resonance images, including T2* weighted images at the time of admission, revealed a left subdural mass consisting of multiple heterogenous calcifications.

membrane, but no fluid was noted. After total evacuation of these materials, a thick, hard, and calcified inner membrane appeared, covering the cortical surface at the bottom of the haematoma. Because removal of this inner membrane seemed impossible without damaging the brain, the inner membrane was preserved and left on the brain surface. The entire surface of the calcified layer covering the true inner membrane was shaved and thinned using a high-speed air drill until the cortical surface was swollen and pulsating, as observed through the thinned inner membrane **(Fig. 3C)**.

No tenting sutures of the inner membrane were made. Careful and strict haemostasis of the surface of the inner membrane and transitional zone were performed by a bipolar coagulator. The free dura flaps were returned to cover the inner membrane and immobilized with sutures and fibrin glue. Complete obliteration of the subdural haematoma cavity and conversion of the subdural space into the epidural space was carried out using the method of Oku *et al.* [7]. The epidural drain was left in place, and scalp flaps were sutured in place **(Fig. 3D)**. The operation took approximately 5 hours.

Postoperative course

The postoperative course was uneventful, and no postoperative seizures occurred. Several days after surgery, the patient's headaches and gait disturbance improved remarkably. She was discharged with no neurological deficits.

About 3 years after surgery, follow-up CT demonstrated an improvement of mass effect and good re-expansion of the brain; sulcus effacement signs of the left hemisphere had disappeared (**Fig. 4**). No seizures developed after the patient stopped receiving anticonvulsant therapy.

DISCUSSION

Several authors have reported that craniotomy for patients with calcified CSDH—that is, armoured brain—has no effect on long-standing symptoms, and thus recommend surgery only when an acute or progressive neurological symptom is present [8–11]. However, most neurosurgeons recognize that some cases of armoured brain will require craniotomy. This surgery is

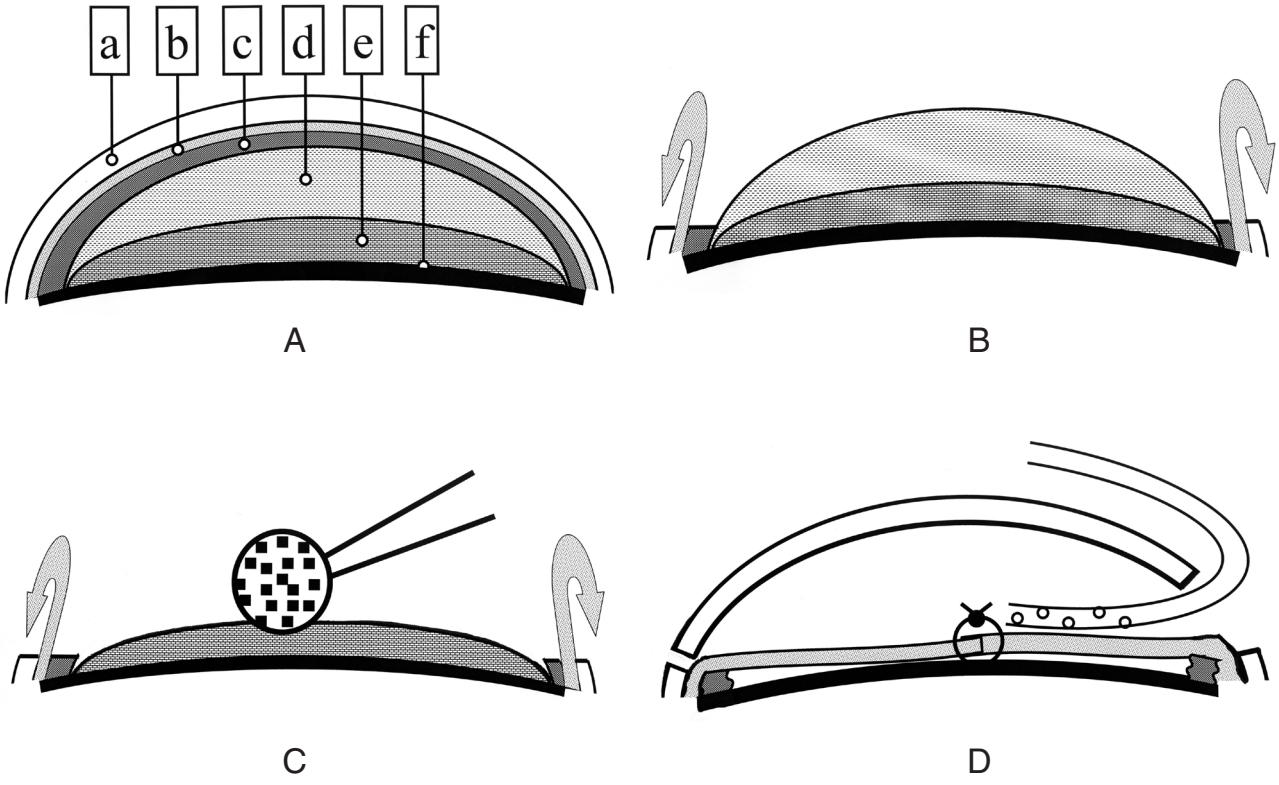

Fig. 3 Schematic illustration of the surgical procedure.
A: Preoperative view of the calcified chronic subdural haematoma. a, skull bone; b, dura matter; c, thick calcified outer membrane; d, partial calcified organized subdural haematoma; e, thick calcified layer above inner membrane; f, inner membrane.
B: After craniotomy, the dura matter was separated and removed from the outer membrane. The outer membrane was completely removed to preserve the transitional zone.
C: After total evacuation of the organized subdural haematoma, the thick calcified layer covering the true inner membrane was shaved and thinned using a high-speed air drill.
D: The free dura flaps were returned to cover the inner membrane. The subdural haematoma cavity was obliterated and converted to epidural space.

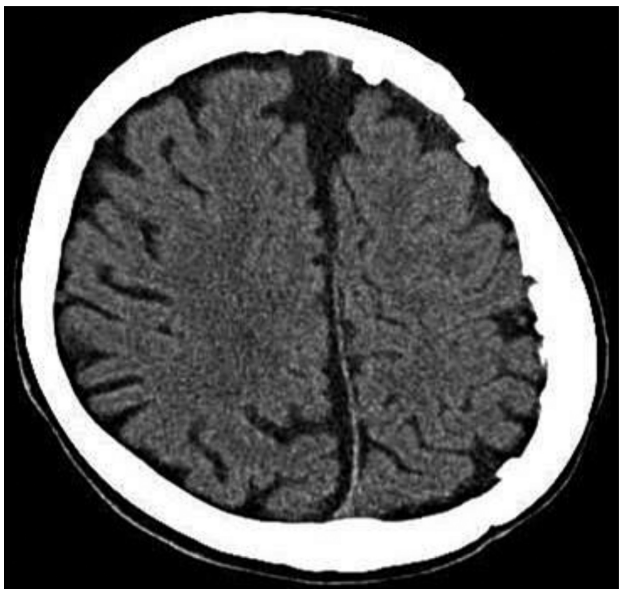

Fig. 4 About 3 years after surgery, follow-up computed tomography demonstrated an improvement of mass effect and good re-expansion of the brain. In addition, sulcus effacement signs in the left hemisphere had disappeared, and no recurrence of haematoma was noted.

problematic, because even if the outer membrane and organized haematoma are removed, it is difficult to obtain re-expansion of brain due to the residual hard, thick, calcified inner membrane [9]. In addition, when the calcified hard inner membrane adheres tightly to the brain cortex, as in this case, membrane dissection from the brain may cause brain contusion, bleeding, or the appearance of new neurologic deficits [9, 12–14]. Accordingly, when performing a craniotomy for patients with organized or calcified CSDH, Sakamoto *et al*. emphasized that the inner membrane should be preserved and left intact on the brain surface after removal of only the calcified layer [12]. In their report and our present case, the calcified layer at the bottom of the organized haematoma had adhered to the whole surface of true inner membrane.

Several authors have also reported that local hyperfibrinolysis and repetitive haemorrhage in the outer membrane may be the main cause of the gradual enlargement of the CSDH [15–17]. In contrast, it was reported that the inner membrane may be less important in CSDH enlargement. Accordingly, it is suggested that there is little recurrent risk of CSDH even if the inner membrane is preserved on the brain surface. For these reasons, we also recommend preserving the inner membrane for surgery of patients with organized or calcified CSDH.

In terms of thinning the calcified layer above the inner membrane, using a high-speed air drill, as reported by Niwa *et al*. [9], is recommended. As in the present case, thinning of the calcified layer should be stopped when the cortical surface is swollen and pulsating through the inner membrane to allow for good re-expansion of the brain after surgery.

We first used a steel burr to shave and thin the outer portion of the calcified layer above the inner membrane. Afterwards, we used a diamond burr to shave the calcified layer near the inner membrane to avoid damaging the inner membrane or cerebral cortex. However, it has been reported that high-speed air drilling using a diamond burr produces neural heat injury more easily than drilling with a steel burr [18]. To address this concern, when thinning the calcified layer using a high-speed air drill, neurosurgeons must take care to 1) avoid continuous and focal shaving of the calcified layer, 2) shave under continuous irrigation using fluid at a temperature lower than room temperature [18], and 3) preserve the true inner membrane as a protective layer for the brain surface.

In terms of the procedure after removal of both the outer membrane and organized calcified haematoma, Oku *et al*. [7] proposed an operative strategy for facilitation of adhesion between the dura matter and inner membrane surgery and to prevent recurrent haematoma. This surgery consists of complete obliteration of the subdural haematoma and conversion of the subdural haematoma cavity into epidural space. The merits of this surgery are 1) simplicity of the surgical procedure, 2) removal of both the organized haematoma and coagulation of neovascularization of the haematoma under direct vision, and 3) brain re-expansion following absorption of the converted epidural collection [7].

CONCLUSIONS

We present a case with calcified CSDH who obtained good re-expansion after shaving and thinning of the thick calcified inner membrane using a high-speed air drill after total removal of both the outer membrane and organized haematoma. Based on this favourable outcome, we think it is desirable to perform this procedure if surgery is required for progressive symptoms, even if a patient has huge calcified CSDH.

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