

# Delayed intracranial subdural empyema following burr hole drainage

## Case series and literature review

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### Abstract

**Rationale:** A subdural empyema (SDE) following burr hole drainage of a chronic subdural hematoma (CSDH) can be difficult to distinguish from a recurrence of the CSDH, especially when imaging data is limited to a computed tomography (CT) scan.

**Patients concerns:** All patients underwent burr hole drainage of the CSDH at first, and the appearance of the SDE occurred within one month.

**Diagnoses:** A contrast-enhanced magnetic resonance imaging (MRI) scan, with diffusion-weighted imaging (DWI), revealed both the SDE and diffuse meningitis in all patients.

**Interventions:** In Case 1, because the patient was very young, burr hole drainage of the SDE, rather than craniotomy, was performed. However, subsequent craniotomy was required due to recurrence of the SDE. In Cases 2 and 3, an initial craniotomy was performed without burr hole drainage.

**Outcomes:** Symptoms improved for all patients, and each was discharged without any neurologic deficits or subsequent recurrence.

**Lessons:** Neurosurgeons should consider the possibility of infection if recurrence of CSDH occurs within 1 month following drainage of a subdural hematoma. A contrast-enhanced MRI with DWI should be performed to differentiate SDE from CSDH. In addition, surgical evacuation of the empyema via wide craniotomy is preferred to burr hole drainage.

**Abbreviations:** CSDH = chronic subdural hematoma, CT = computed tomography, DWI = diffusion weighted imaging, MRI = magnetic resonance imaging, SDE = subdural empyema.

**Keywords:** burr hole drainage, chronic subdural hematoma, craniotomy, diffusion-weighted imaging, subdural empyema

## 1. Introduction

Subdural empyema (SDE) refers to the collection of pus in the subdural space. Because the subdural space lacks anatomical structures that could prevent the pus from spreading, SDE has a rapid course and a poor prognosis.<sup>[1]</sup> If misdiagnosed or delayed, it can be associated with significant morbidity and mortality

resulting from severe neurologic deficit and seizures.<sup>[2,3]</sup> Therefore, rapid diagnosis and a combination of surgical drainage and antibiotic treatment are important.<sup>[2,4]</sup> However, SDE can be difficult to diagnose due to its nonspecific clinical features, including headache and vomiting.<sup>[1,5]</sup> In addition, it is more difficult to differentiate between recurrent chronic subdural hematoma (CSDH) and surgery-related infection following burr hole drainage of CSDH without special imaging evaluation such as magnetic resonance imaging (MRI).<sup>[6,7]</sup> Here, we report the clinical course, diagnosis, treatment, and outcomes of 3 cases diagnosed with SDE, following burr hole drainage of CSDH.

## 2. Methods

We retrospectively reviewed 3 patients with SDE following burr hole drainage of CSDH who were admitted to the Chonnam National University Hospital, South Korea, from February 2014 to January 2016. This study was approved by the Chonnam National University Hospital Institutional Review Board (IRB) and informed consent was obtained from all patients. Patients with SDE following burr hole drainage of CSDH were included. None of the patients had any relevant prior underlying diseases, including infections. All patients were treated with craniotomy and removal of the abscess, by the same surgeon, with the inner membrane adherent to the cerebral cortex left intact, in order to avoid damaging the cortex. Follow-up CT or MRI scans at 12 months post-craniotomy were performed for all patients.

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The patients (or guardian, when appropriate) have consented to the submission of this case report.

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### 3. Results

#### 3.1. Case 1

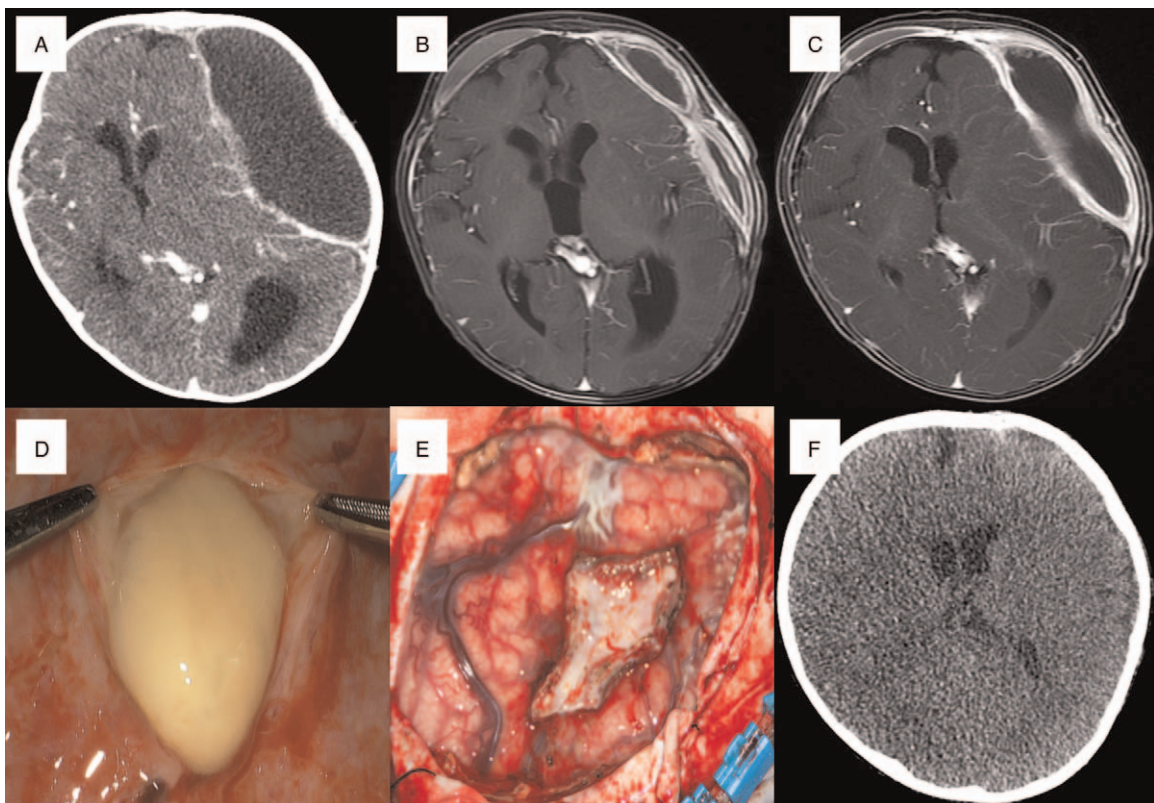
A 9-month-old infant was admitted to our hospital with fever and lethargy following burr hole drainage of a CSDH within the previous month. On physical examination, bulging of the anterior fontanel with excessive irritability was observed. A contrast-enhanced computed tomography (CT) revealed a large hypodense lesion with rim enhancement indicating an SDE (Fig. 1A). Because the infant was very young, burr hole drainage was performed under local anesthesia. After drainage of pus and antibiotic treatment, the infant gradually recovered and a follow-up MRI showed a reduction of the SDE with improved midline shifting (Fig. 1B). However, fever and irritability recurred after 3 weeks and a follow-up MRI showed an increase in the SDE, with midline shifting (Fig. 1C). Therefore, we performed an abscess removal via craniotomy. Intraoperatively, purulent pus was discharged after opening the thick outer capsule wall (Fig. 1D). The remaining pus and capsule wall were removed peripherally. However, portion of the inner capsule wall that was strongly adherent to the cerebral cortex was not removed, in order to avoid damaging the cortex (Fig. 1E). *Staphylococcus epidermidis* was identified and the patient was treated with ceftriaxone, vancomycin, and metronidazole for 6 weeks. The infant gradually recovered and was discharged without any neurologic deficits. A follow-up CT 12 months after removal of the abscess showed no significant remaining fluid or abnormal density lesions (Fig. 1F).

#### 3.2. Case 2

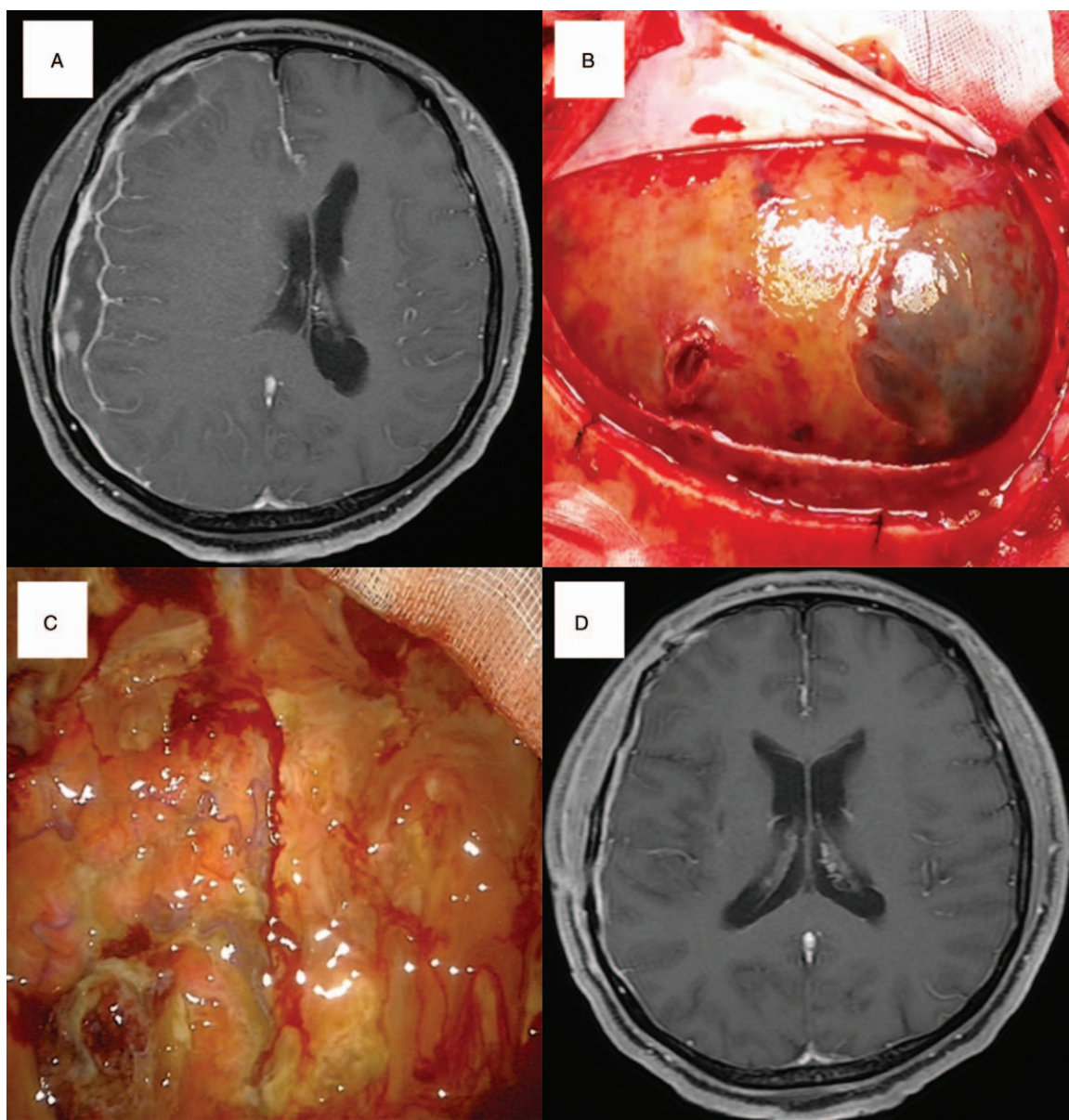
A 50-year-old man was transferred to our hospital with persistent headache 1 month after burr hole drainage of a CSDH. A CT scan was performed, which showed recurrence of the CSDH with perilesional edema. However, CT or MRI with contrast was not performed at this time. A second burr hole drainage was performed at another site; however, there was insufficient drainage of the hematoma. The patient was readmitted to our hospital due to wound infection. A contrast-enhanced MRI showed an SDE with diffuse leptomeningitis in the right cerebral hemisphere (Fig. 2A). Craniotomy and removal of the abscess was performed and purulent pus was drained after opening the thick outer capsule wall (Fig. 3B, C). As in the first case, the abscess and capsule wall were removed as much as possible, with the exception of the inner capsule wall, which was strongly adherent to the cerebral cortex. *Enterobacter aerogenes* was identified and meropenem was prescribed for 8 weeks. The patient was discharged without neurologic deficits. A follow-up contrast-enhanced MRI at 12 months revealed no recurrent lesions (Fig. 3D).

#### 3.3. Case 3

A 54-year-old man presented with right hemiparesis following burr hole drainage of a CSDH at another hospital within the previous month. Recurrence of the CSDH was observed on CT scan and the patient underwent a second burr hole drainage.



**Figure 1.** (A) Contrast-enhanced CT revealed a large hypodense lesion with rim enhancement in the left cerebral hemisphere indicating the presence of an SDE. (B) Contrast-enhanced MRI showed a reduction of the SDE after burr hole drainage. (C) Serial follow-up contrast-enhanced MRI revealed an enlargement of the SDE with midline shifting 3 weeks after burr hole drainage. (D) Purulent pus was discharged after opening the thick outer capsule wall. (E) A small portion of the inner capsule wall that was strongly adherent to the cerebral cortex was not disturbed, in order to avoid damaging the cortex. (F) A CT at 12 months after removal of abscess demonstrated no recurrent lesion. CT=computed tomography, MRI=magnetic resonance imaging, SDE=subdural empyema.



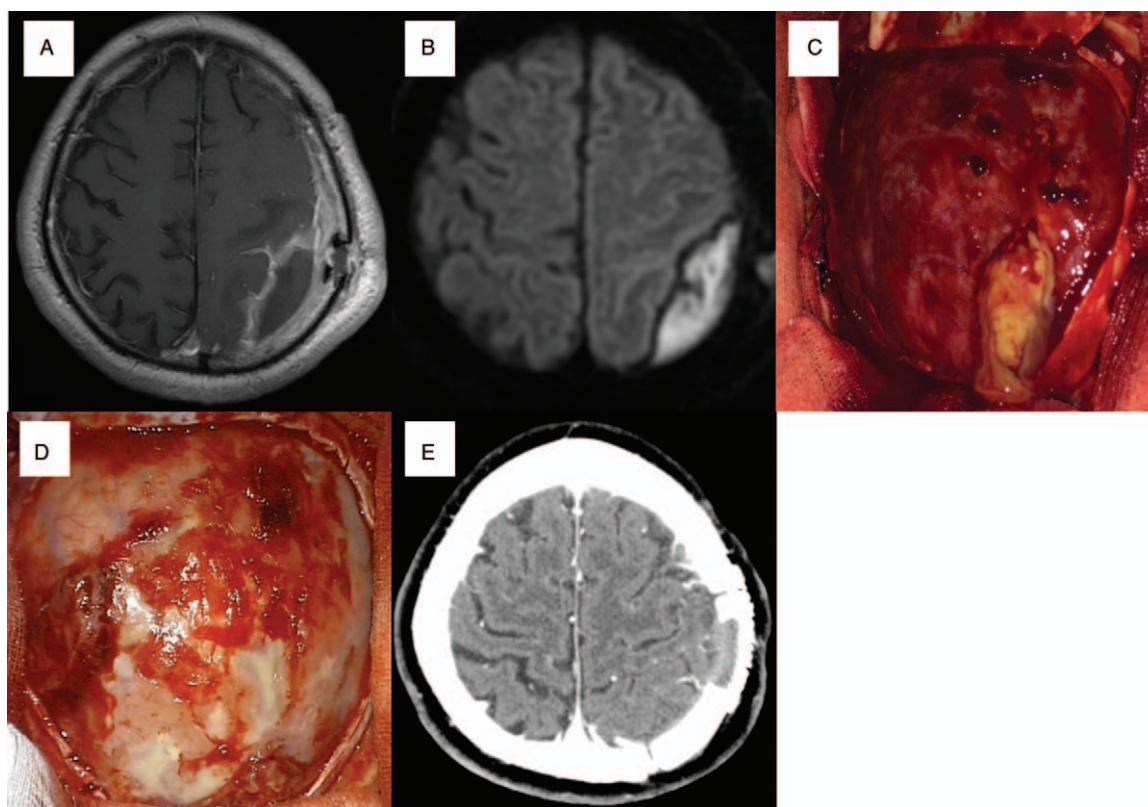
**Figure 2.** (A) Contrast-enhanced MRI revealed an SDE with diffuse leptomeningitis in the right cerebral hemisphere. (B) Thick and yellowish capsule with evidence of prior burr hole drainage was observed after dural incision. (C) After the thick outer capsule was removed, purulent and yellowish pus was observed. (D) A follow-up contrast-enhanced MRI 12 months after removal of the abscess revealed no remaining lesion or abnormal signals. MRI=magnetic resonance imaging, SDE= subdural empyema.

However, there was no improvement in symptoms. A contrast-enhanced MRI revealed an SDE with leptomeningitis and adjacent osteomyelitis (Fig. 3A). A diffusion-weighted imaging (DWI) revealed increased diffusion (high signal intensity) in the cavity (Fig. 3B). As in the previous cases, purulent pus was discharged after opening the thick outer capsule and the inner capsule wall that was strongly adherent to the cerebral cortex was preserved in order to avoid damaging the cortex (Fig. 3C, D). *S. epidermidis* was identified and the patient was treated with ceftriaxone, vancomycin, and metronidazole for 8 weeks. The patient recovered and was discharged with no neurologic deficits. Contrast-enhanced CT at 12 months revealed no recurrent lesions, with improved leptomeningitis (Fig. 3E).

#### 4. Discussion

Although SDE is rare, it accounts for 15% to 20% of all intracranial infections, according to some reports.<sup>[3,8]</sup> Recently, mortality in SDE cases has decreased due to the development of improved imaging modalities and broad-spectrum antibiotics. However, prognosis remains poor, because the subdural space has no anatomical barriers, leading to fulminant and rapid disease course. Therefore, accurate diagnosis and early treatment are necessary for a favorable prognosis.

The etiology of SDE includes sinusitis, otitis, meningitis, or previous craniotomy.<sup>[4]</sup> Recently, postoperative infection has become an important cause of SDE, due to the increasing frequency of cranial surgery.<sup>[9,10]</sup> The most common procedure that causes SDE is drainage of subdural hematomas.<sup>[2,11]</sup> Aoki



**Figure 3.** (A) Contrast-enhanced MRI revealed an SDE with diffuse leptomeningitis and adjacent osteomyelitis in the left parietal convexity. (B) DWI showed high signal intensity in the same region. (C) Purulent pus was discharged after opening the thick outer capsule wall. (D) The inner capsule wall that was strongly adherent to the cerebral cortex was left undisturbed, in order to avoid damaging the cortex. (E) Contrast-enhanced CT at 12 months post-craniotomy demonstrated no recurrent lesion, with improved leptomeningitis. CT=computed tomography, DWI=diffusion weighted imaging, MRI=magnetic resonance imaging, SDE=subdural empyema.

et al<sup>[6]</sup> reported that the membrane of the CSDH is a potential site for infection because it contains rich vascular capillary beds.

In our experience, neurosurgeons should consider the possibility of infection if recurrence of CSDH occurs within 1 month after drainage of a subdural hematoma. However, it may be difficult to differentiate SDE from CSDH by CT scan alone, either with or without contrast.<sup>[9,12,13]</sup> The patient's medical history and the physical exam, including an assessment of potential wound infection, are also important. In addition, contrast-enhanced MRI with DWI can be helpful in distinguishing between SDE and a recurrence of CSDH.<sup>[7]</sup> Typically, contrast-enhanced MRI with DWI showed capsular enhancement and reduced diffusion in SDE.<sup>[7,14,15]</sup> Therefore, MRI should be performed when recurrence of CSDH occurs within 1 month after surgery, even when laboratory findings are normal. We experienced failure of drainage and also rapid progression, in Cases 2 and 3, respectively.

SDE usually requires surgical treatment unless the size of the empyema is very small, because the pus is contained in a hard, fibrous encapsulated pocket that antibiotics may not be able to penetrate.

Various surgical methods have been proposed for treatment, although there is controversy regarding the best method. Common methods include drainage via burr hole or craniotomy. Burr hole drainage may be effective at the acute stage if the pus is thin and liquid, especially in infants.<sup>[16,17]</sup> However, burr hole drainage has a high recurrence rate and may cause damage to friable hyperemic cortex from the catheter, wash solution, or antibiotics.<sup>[18,19]</sup> Based on our experience, burr hole drainage is

not effective when a severe mass effect and/or a thick membrane are detected on imaging findings. In all of our cases, we removed the pus and thick capsule via craniotomy and obtained good outcomes. Several previous reports also support the conclusion that craniotomy is superior to burr hole drainage for SDE.<sup>[2,4,17]</sup> Thus, we recommend the removal of infected hematoma capsules by craniotomy rather than burr hole drainage.

In summary, drainage via craniotomy is recommended except in patients with septic shock or who are in frail condition. Importantly, the bone flap should be larger than the size of the lesion seen on the MRI, in order to remove the encapsulated membrane. In addition, the partial membrane fragment that is strongly adherent to the brain cortex should not be removed, in order to avoid damaging the cortex.

## 5. Conclusions

SDE typically causes permanent neurologic deficits if treatment is delayed. Therefore, accurate and early diagnosis is essential. Contrast enhanced MRI with DWI should be performed if the CSDH has recurred within 1 month. In addition, we recommend surgical drainage via a wide craniotomy rather than burr hole drainage, to improve clinical outcomes.

## Author contributions

SHK and SPJ performed the operations and evaluated the patients. YSK and SHK wrote the manuscript. SPJ and TSK

provided writing assistance. DJS collected the data and reviewed the charts.

**Data curation:** Dong-Jun Song.

**Supervision:** Sung-Pil Joo, Tae-Sun Kim.

**Writing – original draft:** You-Sub Kim, Sung-Hyun Kim.

**Writing – review & editing:** You-Sub Kim.

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