**DOI:** 10.5137/1019-5149.JTN.19747-16.2
Received: 25.12.2016 / Accepted: 31.08.2017
Published Online: 11.10.2017

*Original Investigation*

# Burr-Hole Craniostomy Irrigation with and without Drainage During the Surgical Treatment of Chronic Subdural Haematoma: A Retrospective Study of 87 Cases

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**ABSTRACT**

**AIM:** To evaluate the surgical treatment of a chronic subdural haematoma (CSDH). We compared two surgical treatments of CSDH: burr-hole craniostomy irrigation with and without drainage.

**MATERIAL and METHODS:** We retrospectively studied patients with chronic subdural haematomas admitted to our hospital. A total of 87 patients underwent surgery: 57 were treated via burr-hole irrigation with postoperative drainage (Group BD) and 30 were treated via irrigation without drainage (Group BI).

**RESULTS:** Two instances of rebleeding developed in Group BD. The cerebral cortex did not expand in one case. One instance of rebleeding developed in Group BI but the cerebral cortex expanded in all cases. The average length of hospitalisation, number of postoperative complications, incidence of rebleeding, and extent of expansion of the cerebral cortex did not differ between the two groups (all p values > 0.05). At the 6-month follow-up, most patients had recovered well. The Glasgow Outcome Scale (GOS) revealed no significant differences between the groups. No significant difference was found between the two surgical treatments in terms of the length of hospitalisation, rebleeding, or expansion of the cerebral cortex (which was complete in all but one patient).

**CONCLUSION:** We believe that the key feature of CSDH surgery is thorough irrigation during the operation; whether to use postoperative drainage is not of great importance. We currently use burr-hole irrigation without postoperative drainage.

**KEYWORDS:** Burr hole, Chronic subdural haematoma, Drainage, Irrigation

## INTRODUCTION

Chronic subdural haematomas (CSDH) are frequent in the elderly; 10% of these haematomas are intracranial. The disorder is becoming increasingly common, occurring in approximately 5 per 100,000 per year in the general population (12). There are many kinds of methods to address it, including conservative treatment and surgical treatment. Conservative treatment includes the reversal of anticoagulation, antiplatelet therapy, etc. Surgical treatment includes twist drill craniostomy, burr-hole craniostomy, craniotomy, etc (1). In this work, we only studied a surgical treatment. The generally accepted mode of treatment is burr-hole irrigation with drainage (BD) (18); however, we found that, clinically, burr-hole irrigation without drainage (BI) after evacuation of the CSDH affords good outcomes.

## MATERIAL and METHODS

### General

We retrospectively studied patients with chronic subdural haematomas treated with burr-hole craniostomy that were admitted to our hospital, the First People's Hospital of Kunshan, China, from January 2010 to December 2014. Those patients

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treated by conservative treatment along with craniotomy were excluded. Thus, 87 patients were enrolled. These patients had no recent history of application of anticoagulation and antiplatelet drugs. The age of the enrolled patients ranged from 23 to 87 years. All patients were treated with burr-hole irrigation with drainage (n=57; group BD) or without drainage (n=30; group BI). The surgical method was at the discretion of the individual surgeon. Of the BD group, 52 were male, and 5 were female (age, 23–87 years; average, 64.6 years). Of the BI group, 27 were male, and 3 were female (age, 26–87 years; average, 67.1 years). The ages of the two groups did not differ significantly [independent samples t-test, F =0.962; analysis of variance, p=0.417 (>0.05)]. Of all the cases, 69 had a history of trauma while 18 denied any history of trauma (Table I).

**Clinical Manifestations**

A total of 80 patients suffered from headache, dizziness, or limb weakness. One patient hospitalised in the gastroenterology department due to abdominal distension was transferred to our department after neurosurgical consultation. Five cases were unresponsive post-trauma cases mistakenly diagnosed with senile dementia. Two patients were hospitalised in coma. Seven patients underwent emergency operations due to the disturbance of consciousness, urinary incontinence, or

**Table I:** Baseline Characteristics

| Variable | All (n=87) | BD (n=57) | BI (n=30) | $X^2$ | p-value |
|---|---|---|---|---|---|
| Mean age (years) | 65.45 | 64.58 | 67.17 | | |
| ≤40 | 5 (5.8%) | 2 (3.5%) | 3 (10.0%) | 0.565 | p>0.05 |
| 41~50 | 5 (5.8%) | 4 (7.0%) | 1 (3.3%) | 0.011 | p>0.05 |
| 51~60 | 15 (17.2%) | 12 (21.0%) | 3 (10.0%) | 2.547 | p>0.05 |
| 61~70 | 28 (32.2%) | 19 (33.3%) | 9 (30.0%) | 0.100 | p>0.05 |
| 71~80 | 30 (34.4%) | 18 (31.6%) | 12 (40.0%) | 0.617 | p>0.05 |
| ≥81 | 4 (4.6%) | 2 (3.5%) | 2 (6.7%) | 0.168 | p>0.05 |
| Sex | | | | | |
| Male | 79 (90.8%) | 52 (91.2%) | 27 (90.0%) | | |
| Female | 8 (9.2%) | 5 (8.8%) | 3 (10.0%) | 0.041 | p>0.05 |
| Etiological factor | | | | | |
| Trauma | 69 (79.3%) | 47 (82.5%) | 22 (73.3%) | 0.997 | p>0.05 |
| Symptoms | | | | | |
| Headache, dizziness and limb weakness | 80 (92.0%) | 55 (96.4%) | 25 (83.3%) | 0.079 | p>0.05 |
| Dementia | 5 (5.7%) | 1 (1.8%) | 4 (13.3%) | 2.962 | p>0.05 |
| Coma | 2 (2.3%) | 1 (1.8%) | 1 (3.4%) | 0.081 | p>0.05 |
| Density | | | | | |
| Hypodense | 52 (59.8%) | 35 (61.4%) | 17 (56.7%) | 0.183 | p>0.05 |
| Mixed | 25 (28.7%) | 16 (28.1%) | 9 (30.0%) | 0.036 | p>0.05 |
| Hyperdense | 10 (11.5%) | 6 (10.5%) | 4 (13.3%) | 0.001 | p>0.05 |
| Clinical condition | | | | | |
| Grade 0 | 3 (3.4%) | 2 (3.5%) | 1 (3.3%) | 0.331 | p>0.05 |
| Grade 1 | 53 (61.0%) | 36 (63.2%) | 17 (56.7%) | 0.348 | p>0.05 |
| Grade 2 | 22 (25.3%) | 15 (26.3%) | 7 (23.3%) | 0.109 | p>0.05 |
| Grade 3 | 8 (9.2%) | 3 (5.3%) | 5 (16.7%) | 1.848 | p>0.05 |
| Grade 4 | 1 (1.1%) | 1 (1.8%) | 0 (0%) | Δp=0.68 | |
| Δ: T<1, exact probability method | | | | | |

*There were no statistically significant differences.* $X^2 < 3.84$ *p>0.05.*

early-stage brain hernia developing during preparation for operation (Table I).

**Additional Examinations**

Three cases were diagnosed by magnetic resonance imaging (MRI); all other cases were diagnosed by computed tomography (CT). The measurement of the density of the haematoma depended on the judgement of the preoperative CT image by one neurosurgeon. CT revealed lesions of low density in 52 cases, of high density in 10, and of mixed density in 25 (Tables I and II) (F-values: 0.183, 0.001, and 0.036, respectively; all p values were >0.05, i.e., no significant differences). There were 70 cases of unilateral haematoma and 17 of bilateral haematoma. All unilateral haematomas were frontotemporal or (parietal) subdural. The clinical conditions are listed in Table III (16).

**Surgical Technique**

**Anaesthesia:** Conscious cooperative patients underwent local anaesthesia (1% [w/v] lidocaine). Unconscious or uncooperative patients underwent general anaesthesia.

**Methods**

**BD group**: A hole was drilled 3–4 cm above the auricle. The dura underwent electric coagulation haemostasis. The dura mater was periosteally sutured along the edge of the hole at two or three positions, cross-cut, and slowly evacuated. A soft silicone tube was inserted into the haematoma cavity, followed by extensive washing with physiological saline until the rinse solution became clear. The silicone tube was left in the haematoma cavity as a drain and exited from the scalp approximately 1 cm distant to the point of scalp incision. Saline was run through the tube to irrigate the haematoma cavity, all air was removed, and the scalp incision was sutured in two layers. Depending on the volume and colour of the drainage fluid, the tube was generally removed 2–3 days later.

**BI group:** The operative technique was initially that described above, but after irrigating the haematoma cavity and removing the air, the scalp incision was directly sutured; no drainage tube was placed.

The patients with bilateral CSDH underwent bilateral burr-hole craniostomy on both sides. When the statistics were analysed, the patient was considered as one case.

Patients of both groups were told to stay in bed without pillows for 24–48 hours postoperatively, to take 2–2.5 L of liquid daily, and to avoid dehydrating agents. A postoperative cranial CT was performed on all patients to evaluate whether the haematoma had recurred. If, intra-operatively, we found that the haematoma was coated with a thick peplos, a craniotomy was performed under general anaesthesia. Such patients were not included in the present study.

We used the neurological grading system of Markwalder et al., as follows:

Grade 0: Neurologically normal;

Grade 1: Patient alert and oriented; symptoms (such as headache) absent or mild; neurological deficits (such as reflex asymmetry) absent or mild;

Grade 2: Patient drowsy or disoriented with variable neurological deficits such as hemiparesis;

Grade 3: Patient stuporous but responding appropriately to noxious stimuli; severe focal signs such as hemiplegia; and

Grade 4: Patient comatose with no motor response to painful stimuli; posture decerebrate or decorticate.

**Statistical Methods**

We used the SPSS ver. 10 statistical software (IBM Corp., Armonk, NY, USA) to compare all data employing the independent samples t-test. The sampling rates were compared using the chi-squared test; ($1 \leq T < 5$; $n > 40$) with correction of continuity. The exact probability method was used to construct a 4×4 chi-squared test table using the formula $T < 1$.

**Informed Consent and Approval by the Ethics Committee**

This retrospective, descriptive study was performed from January 2010 to December 2014 at our hospital. No change in our current clinical practice and no randomization were used. None of the patients' characteristics and private information, such as name, gender, and date of birth, has been shared outside of this study.

Additionally, per French legislation (articles L.1121-1 paragraph 1 and R1121-2, Public Health Code), neither informed consent nor approval of the ethics committee was needed to use these data for an epidemiologic study (11).

## ■ RESULTS

From the computed tomography scan, we found that the subdural haematoma often depressed the brain cortex

**Table II:** Hematoma Density of the Two Groups

| Density | Total | |
|---|---|---|
| | Group BD | Group BI |
| **Hypodense** | 35 | 17 |
| **Mixed** | 16 | 9 |
| **Hyperdense** | 6 | 4 |

*There was no statistically significant difference (p>0.05).*

**Table III:** Clinical Condition of the Two Groups

| Clinical condition | Group BD | Group BI |
|---|---|---|
| Grade 0 | 2 | 1 |
| Grade 1 | 36 | 17 |
| Grade 2 | 15 | 7 |
| Grade 3 | 3 | 5 |
| Grade 4 | 1 | 0 |

*There was no statistically significant difference (p>0.05).*

preoperatively. There was a certain gap between the cortex and skull, ranging approximately 1 to 2 cm. After the evacuation, the cortex often could not expand fully, and the gap between the cortex and skull decreased. We defined the process of decreasing the gap as "expansion of the cortex". The haemorrhage that occurred within 24 h postoperatively was defined as a rebleeding case. Two instances of rebleeding developed in group BD, were treated with craniotomy, and recovered well. The cerebral cortex did not expand in one case, and it was treated with burr hole with drainage again and recovered well. One instance of rebleeding developed in group BI, which was treated with craniotomy and recovered well; however, the cerebral cortex expanded in all cases.

No tension pneumocephalus, symptoms that did not improve or even worsened, or numerous areas of air identified by CT scan that needed reoperation were noted in any patient. All patients exhibited a few intracranial pneumatoses, which resolved spontaneously. Like most of the authors (3,12), we defined recurrence as the occurrence of an ipsilateral haematoma postoperatively within 6 months. Fortunately, there was no instance of recurrence. No seizure or intracranial infection was noted.

The average length of hospitalisation (Table IV), the number of postoperative complications (Table V), the incidence of rebleeding (Table VI), and the extent of the expansion of the cerebral cortex (Table VII) did not differ between the two groups (all p values > 0.05).

Most of the patients had recovered well between 2 months postoperatively and the 6-month follow-up (Figure 1).

The GOS revealed no significant differences between the groups. Two cases were lost to follow-up: one experienced heart failure, and the other changed hospitals (Table VIII).

## ■ DISCUSSION

### Surgical Method

Common surgical methods used to treat CSDH include twist-drill craniostomy with or without drainage, burr-hole

**Table IV:** Days of Hospitalization

| Group | N | Mean (days) | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum (days) | Maximum (days) |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| **BD** | 57 | 10.5088 | 3.0829 | 0.4083 | 9.6908 | 11.3268 | 3 | 22 |
| **BI** | 30 | 12.0000 | 4.7922 | 0.8749 | 10.2106 | 13.7894 | 4 | 25 |
| **Total** | 87 | 11.0230 | 3.8002 | 0.4074 | 10.2131 | 11.8329 | 3 | 25 |

*There was no statistically significant difference (F=11.992, p=0.130).*

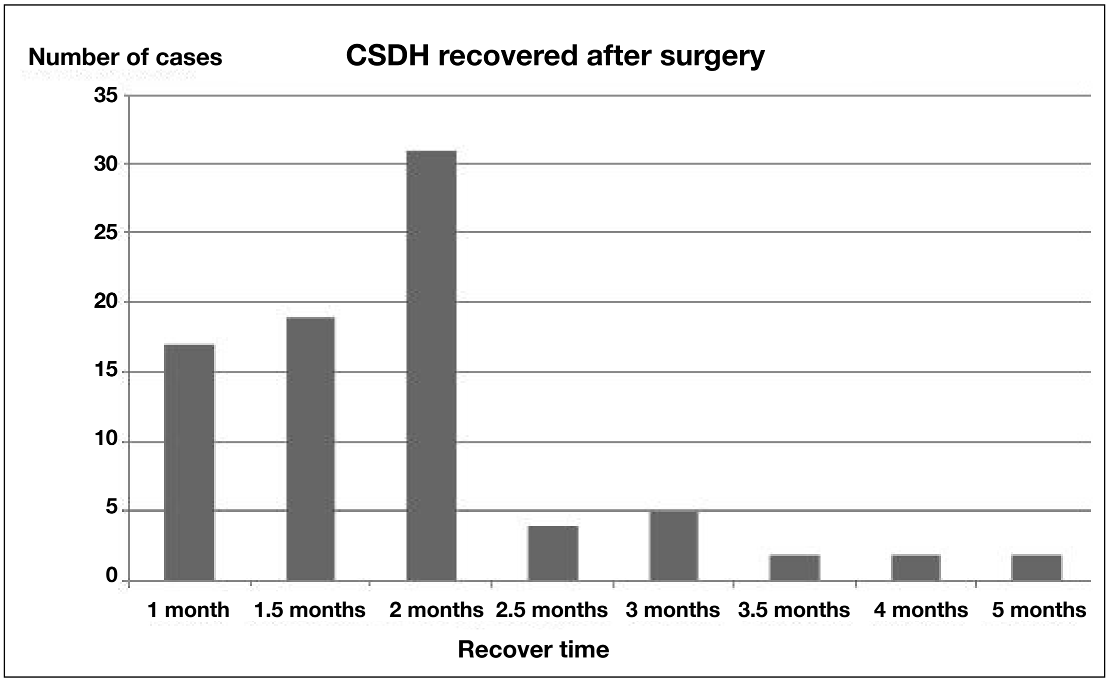


**Figure 1:** CSDH recovered after surgery. Most of the patients had recovered well within 2 months postoperatively.

craniostomy with or without drainage, and craniotomy (2,5,10,12). The optimal surgical method remains controversial. Most neurosurgeons (6,7,13,17) advocate for craniostomy with drainage; however, the recurrence rates associated with drainage are significantly higher than those without drainage. Although drainage is thought to be important, patients treated without drainage serve as control groups in most studies. Santarius et al.(12) indicated that a drain was placed only when such placement was considered safe. Thus, the absence of a drain does not compromise safety.

**Table V:** Rebleeding

| Four $X^2$ test table of special formula, correction for continuity, 1 ≤ T<5, n>40 | | |
|---|---|---|
| **Group** | **Rebleeding** | **No rebleeding** |
| BD | 2 | 55 |
| BI | 1 | 29 |
| $X^2$=0.331<3.84, p>0.05 | | |

*There was no statistically significant difference.*

**Table VI:** No Expansion of Cerebral Cortex (Need Reoperation)

| T<1, exact probability method | | |
|---|---|---|
| **Group** | **No expansion** | **Expanded** |
| BD | 1 | 56 |
| BI | 0 | 30 |
| p=0.66 | | |

*There was no statistically significant difference.*

**Table VII:** Days of Hospitalization, Rebleeding, No Expansion of Cerebral Cortex in the Two Groups

| Variable | All (n=87) | BD (n=57) | BI (n=30) | $X^2$ | p-value |
|---|---|---|---|---|---|
| Days of Hospitalization (days) | | | | | |
| <7 | 4 (4.7%) | 2 (3.5%) | 2 (6.7%) | 0.017 | p>0.05 |
| 7~10 | 39 (44.8%) | 27 (47.4) | 12 (40.0%) | 0.435 | p>0.05 |
| 11~16 | 35 (40.2%) | 24 (42.1%) | 11 (36.6%) | 0.242 | p>0.05 |
| >16 | 9 (10.3%) | 4 (7.0%) | 5 (16.7%) | 1.070 | p>0.05 |
| Rebleeding | | | | | |
| Rebleeding | 3 (3.4%) | 2 (3.5%) | 1 (3.7%) | | |
| No rebleeding | 84 (96.6%) | 55 (96.5%) | 29 (96.3%) | 0.331 | p>0.05 |
| No expansion of cerebral cortex | | | | | |
| No expansion | 1 (1.1%) | 1 (1.8%) | 0 (0%) | | |
| Expanded | 86 (98.9%) | 56 (98.2%) | 30 (100%) | Δp=0.66 | |
| Δ: T<1, exact probability method | | | | | |

*There were no statistically significant differences.*

**Table VIII:** GOS After 6-Month Follow-up

| GOS | All (n=87) | BD (n=57) | BI (n=30) | $X^2$ | p-value |
|---|---|---|---|---|---|
| 5 | 74 (88.1%) | 49 (85.9%) | 25 (83.4%) | 0.107 | p>0.05 |
| 4 | 8 (9.2%) | 5 (8.7%) | 3 (10.0%) | 0.041 | p>0.05 |
| 3 | 1 (1.1%) | 1 (1.7%) | 0 | Δp=0.66 | |
| 2 | 2 (2.3%) | 1 (1.7%) | 1 | 0.081 | p>0.05 |
| 1 | 0 | 0 | 0 | | |
| lost | 2 (2.3%) | 1 (1.7%) | 1 (3.3%) | | |
| Δ: T<1, exact probability method | | | | | |

*There was no statistically significant difference (p>0.05).*

Accordingly, many neurosurgeons prefer to not place a drain. Javadi et al. (3) compared single-hole operations with or without drainage and found no obvious difference in CSDH recurrence, postoperative morbidity, or mortality; in this case, bodily condition, age, preoperative consciousness status, and other diseases were more relevant in terms of postoperative complications. Our results are consistent with such findings. One of our cases (Figure 2A-D) had not been thoroughly

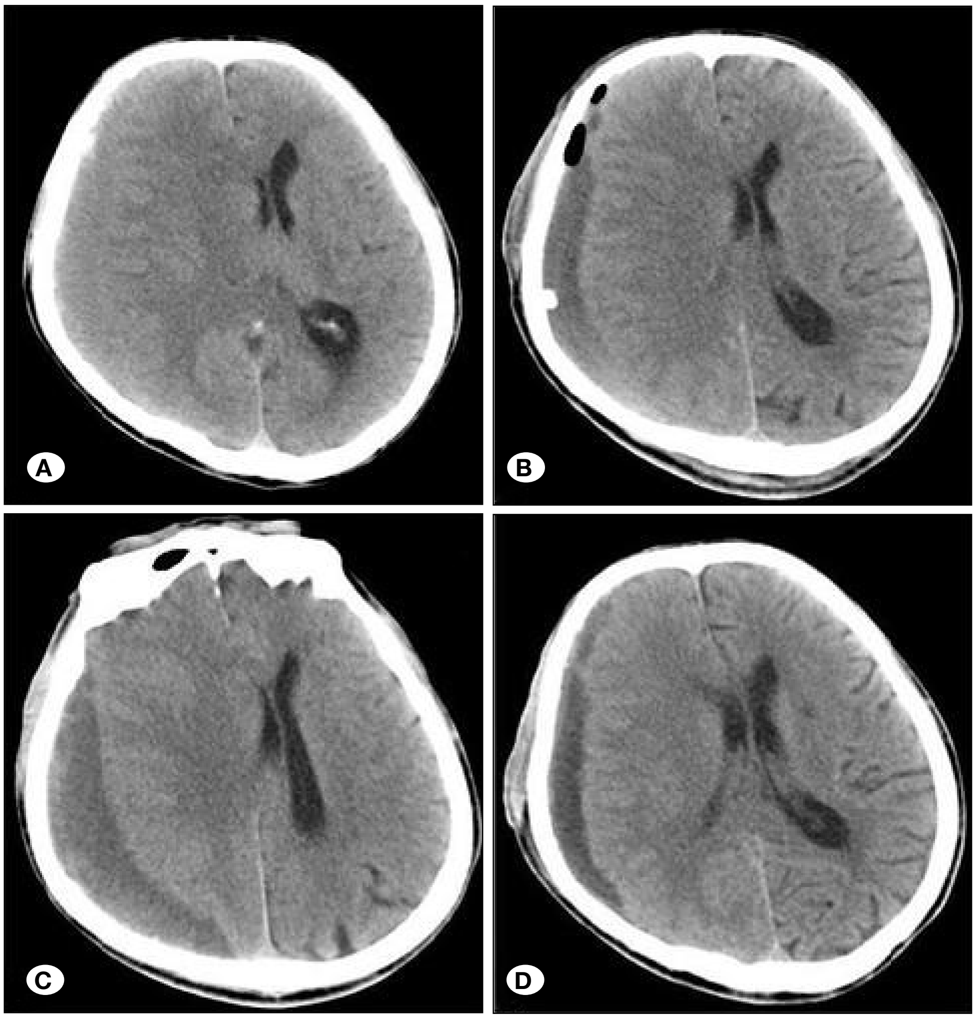


**Figure 2:** A case for whom irrigation was successful after drainage failed. **A)** Preoperative computed tomography scan. **B)** A scan taken one day after the first operation (drainage was evident in the cavity of the hematoma). **C)** A scan taken three days after the first operation (no drainage, but the hematoma was aggravated). **D)** A scan taken one day after reoperation without drainage (the cerebral cortex had expanded).

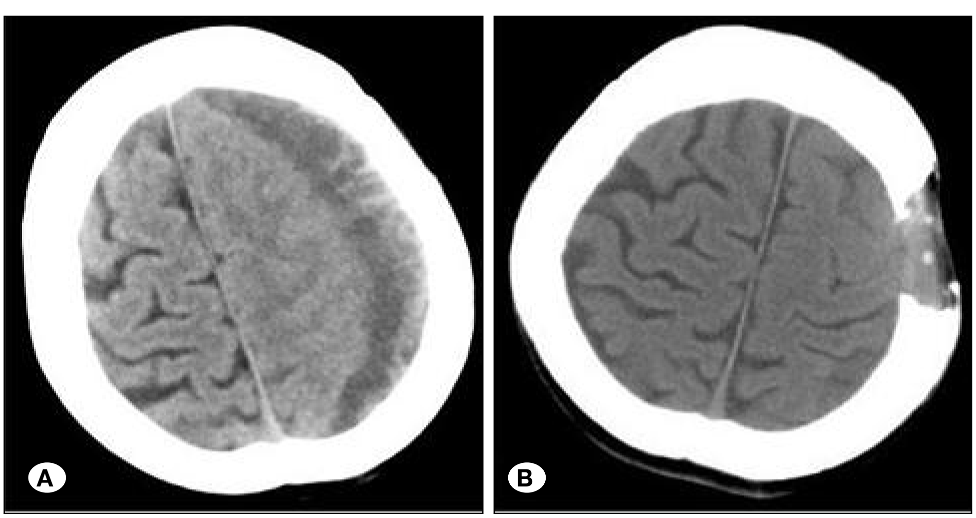


**Figure 3:** A case in whom CSDH with a thick peplos was cured by mini-craniotomy.
**A)** A preoperative computed tomography image.
**B)** A postoperative image with a skull defect diameter of about 3 cm.

irrigated during the first operation. Although a postoperative drain was placed, the cerebral cortex did not expand, and the haematoma became aggravated. The patient underwent re-operation with thorough irrigation without postoperative drainage. The cerebral cortex expanded 10 days later and recovered.

**Irrigation**

Some authors (17) have found no relationship between irrigation and the recurrence rate; however, others did. For example, Erol et al. (2) found that irrigation was superior to drainage, although statistical significance was not attained. Other factors, such as the vascular endothelial derived growth factor (VEGF) and basic fibroblast growth factor (bFGF) levels (18), may be in play. When the balance is re-established after irrigation, the CSDH becomes cured. Further trials are required to verify this effect. We hope that, in the future, the aetiology of CSDH will become clearer and the treatments more effective.

Some authors (8) consider that CSDH is a self-limiting disease. The prognosis depends on the dynamics of haematoma absorption and the maturation of the haematoma peplos. Clinically, patients are operated upon even when the peplos is immature to treat brain dysfunctions caused by increased intracranial pressure. This may partially explain the recurrence. If the peplos is mature, removal of highly fibrinolytic haematoma fluid is more effective than simply removing the haematoma, which is consistent with the fact that CSDH patients can be cured without removing the haematoma peplos.

We encountered one case in which the peplos was thick (as noted during the operation); in this case, we changed the technique to a mini-craniotomy, creating a hole ~3.5 cm in diameter. After membranectomy, the haematoma cavity was irrigated; however, a postoperative drain was not applied. The patient recovered without any recurrence; this outcome may be attributable to either the membranectomy or saline irrigation. Figure 3A, B shows how the cerebral cortex expanded even though the peplos was thick and wide. Yadav et al. (18) considered that CSDH was a very complicated condition that may recur even after complete removal of the haematoma and the membrane; CSDH could be cured only by partial removal of the membrane.

Our CT data showed that in the BD group, the cerebral cortex generally did not expand totally, and residual subdural material was evident for several days after the operation. The BI group exhibited similar findings. This illustrates the importance of irrigation during the operation to treat CSDH.

**Comparison of Two Methods:**

**1. Hospitalisation Expenses:** Such costs are growing annually and comparisons with past expenses are inappropriate. Indeed, even current hospitalisation expenses cannot be compared due to differences in the treatments and social factors.

**2. Operative Times:** Neurosurgeons vary in their skills, and patients differ in terms of the complexity of their presentation. Operative times thus cannot be compared. For patients, the quality of treatment, not the duration of the operation, is the key consideration.

**3. Recurrence:** Many neurosurgeons use recurrence levels to compare operative methods (4,9,14,15); however, we encountered no recurrence and, thus, have no data to compare.

None of the following differed significantly between the two groups: length of hospitalisation, extent of expansion of the cerebral cortex, or rebleeding frequency; however, irrigation with postoperative drainage may trigger seizures, and the cerebral cortex may be stimulated by the drainage tube. During the operation, BD patients underwent drainage, and BI patients did not. In the BD group, the operative time was prolonged, and pain was increased. Subsequent removal of the drainage tube caused additional pain. The placement of a drainage tube is associated with risks of tube suturing during the operation, pneumocephalus, cerebrospinal fluid leakage, and even intracranial haemorrhage. Thus, we prioritise irrigation without postoperative drainage.

## ■ CONCLUSION

Our study had certain limitations. Our patient number was small, and we found no instance of recurrence. The operative technique was based on the preference of the surgeon, and we did not perform a randomized trial. Finally, some choice bias may be in play. Despite these shortcomings, we believe that our experience is relevant and that the key feature of an operation to treat CSDH is thorough irrigation during the operation. Whether to employ postoperative drainage is much less important.

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