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Original Article

Burr hole drainage without irrigation for chronic subdural hematoma

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ABSTRACT

Background: Chronic subdural hematoma (CSDH) is one of the most common neurosurgical conditions, with different strategies for treatment. Most recent trials favor the use of drainage to reduce the recurrence rate. However, few reports have discussed the efficacy of burr hole drainage without irrigation for treating CSDH. This study aimed to examine the efficacy of burr hole drainage without irrigation in a series of 385 symptomatic CSDH lesions.

Methods: This retrospective study included a series of 385 symptomatic CSDH lesions in 309 patients, who underwent burr hole drainage without irrigation, between September 2009 and August 2017 at the Department of Neurosurgery, Yao Tokushukai General Hospital, Japan. The risk of recurrence was evaluated based on the patients' age, sex, preoperative magnetic resonance imaging (MRI) findings, preoperative anticoagulants, hematoma drainage rate, and bilaterality.

Results: Of the 385 lesions, 41 cases (16 with inadequate follow-up periods and 25 with contraindications for MRI) were excluded from the analysis. The overall recurrence rate in the index study was 4.9% (17/344 lesions). The effects of the preoperative hematoma volume and nonhyperintensity on T1-weighted imaging on the recurrence rate were significant.

Conclusion: Our findings indicated that burr hole drainage without irrigation is a good surgical modality in patients with CSDH, and preoperative MRI findings can evaluate the risk of recurrence.

Keywords: Burr hole, Chronic subdural hematoma, Drainage without irrigation, Magnetic resonance imaging, Risk factors

INTRODUCTION

Neurosurgeons often treat patients with chronic subdural hematoma (CSDH). Although CSDH is commonly thought to be a benign disease, the overall recurrence rate for CSDH is 13.1% in Japan, and the functional outcome at discharge is poor at 28.4%.[11]

Burr hole surgery is the most commonly employed procedure for the surgical treatment of CSDH.[3] Several studies have documented the comparison between burr hole drainage and burr hole irrigation.[4,19] It was speculated that rapid evacuation of hematoma and overdrainage

of cerebrospinal fluid might cause remote intracranial hemorrhage after burr hole surgery.[7,16] In our institution, we insert a drainage tube into the hematoma cavity through a small dura incision and do not perform intraoperative irrigation to avoid a rapid decrease in the intracranial pressure. The drainage would be gradually initiated after the surgery. The intracranial pressure and the amount of collected fluid were carefully monitored using a semi-closed drainage system in the ward.

Few reports have described the efficacy of burr hole drainage without irrigation.[8,14,18,24,27] These important studies had a small sample size and were unable to fully determine the efficacy of this procedure.

Our surgical algorithm involves preoperative examination, burr hole drainage without irrigation, and postoperative management. This study aimed to examine the efficacy of burr hole drainage without irrigation in a series of 385 symptomatic CSDH lesions.

MATERIALS AND METHODS

Patient population

A series of 385 symptomatic CSDH lesions in 309 patients, who underwent burr hole drainage without irrigation, between September 2009 and August 2017 at the Department of Neurosurgery, Yao Tokushukai General Hospital, were included in this study. The participants included patients with ipsilateral lesions who underwent repeat surgery. None of the patients exhibited growth of the contralateral CSDH within 60 days after unilateral surgery. The patients consisted of 213 men and 96 women, with a mean age of 76.0 years (range, 33–106 years). Two hundred and forty-one patients had unilateral and 68 patients had bilateral subdural hematomas. Patients who were contraindicated for MRI or underwent ≤60 days of follow-up were excluded from this study. Those who underwent repeat surgery due to signs and symptoms of hematoma growth were defined as patients with recurrent lesions.

Imaging evaluation

The presence or absence of CSDH was determined with the aid of brain computed tomography (CT) before detailed brain MRI evaluation. The hematoma volume was measured on fluid-attenuated inversion recovery coronal images using a workstation (ZioStation®; Ziosoft, Osaka, Japan). The presence or absence of a septa within the hematoma cavity was evaluated on the basis of the presence or absence of black bands on T2*-weighted images.[13] The burr hole site was determined based on the location of the thickest hematoma on the CT image. Nonhyperintense lesions on T1-weighted imaging (T1WI), which have been reported to be risk factors for recurrence,[5,17] were also examined in this study.

Surgical procedure

The patient was placed in the lateral position with the head fixed on a horseshoe-shaped pillow, provided that the burr hole site was at the highest point [Figure 1a and b], after sedation with intravenous administration of midazolam (0.06–0.08 mg/kg body weight). A 3–4 cm linear skin incision was made around the proposed burr hole site in the cephalocaudal direction, under local anesthesia (lidocaine 1% with epinephrine). The burr hole was completed following subperiosteal dissection. Immediately after resection of the outer membrane of the hematoma, a 5 L ventricular drainage tube was inserted 3 cm deep into the hematoma cavity. The drain was subcutaneous and secured to the skin, 1 cm cranial to the wound edge. Neither irrigation nor suction was performed. Oxidized cellulose (Gelfoam, Pfizer, New York, NY, USA) was placed over the surgical site and the bone fragments that were collected during burr hole drilling were used to fill the burr hole [Figure 1c]. The patient was repositioned in cases with

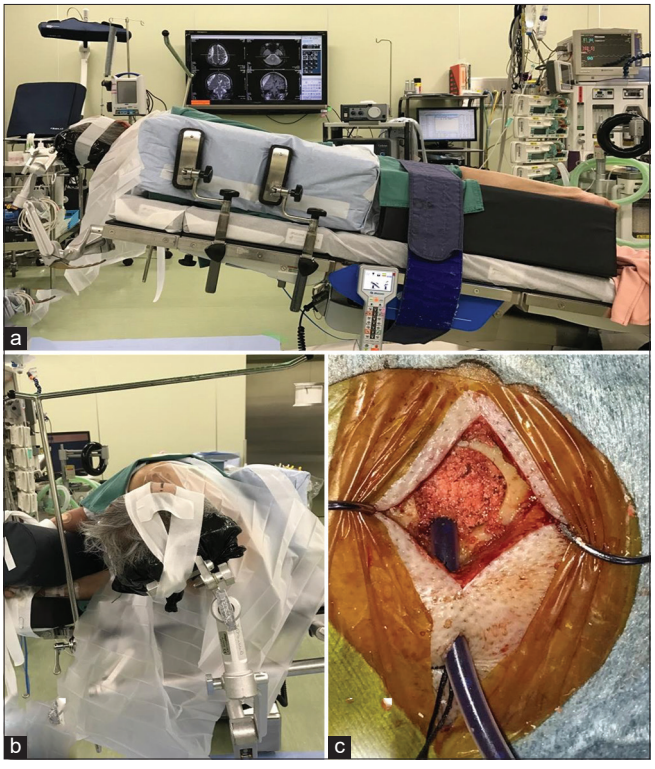

Figure 1: Surgical procedure for burr hole drainage without irrigation. (a) The patient is placed in the lateral position, (b) the head is fixed within the head holder, and the burr hole is positioned at the highest point of the operative field, (c) the drainage tube is inserted at a depth of 3 cm into the hematoma cavity, and the burr hole is filled with bone dust and a cellulose sponge.

bilateral hematomas and similar a procedure was performed after redisinfection and redraping.

Postoperative drainage was performed in the supine position without head elevation. Slow drainage was performed with a semi-closed drainage circuit, set at the level of the external auditory canal [Figure 2]. If the drainage output was ≤5 mL/h, the pressure setting was lowered in increments of 5 cm from the level of the external auditory canal, with 10 cm as the lower limit. The drainage tube was removed when the drainage stopped or reached the target amount. The drain insertion site was then sutured. Oral administration of carbazochrome sodium sulfonate (90 mg/day) and goreisan (7.5 g/day)/saireito (9.0 g/day) was started 1 day after surgery for all patients.

Postoperative evaluation

Postoperative follow-up was performed by evaluation of the neurological status and brain CT. Oral administration was continued in cases of hematoma regrowth on the CT image, even if no worsening of neurological symptoms was observed. Repeat surgery was performed if any neurological symptoms resulting from hematoma regrowth were observed.

Statistical analysis

The risk factors for recurrence (i.e., age, sex, preoperative MRI findings, the presence or absence of preoperative antithrombotic therapy, hematoma drainage rate, and hematoma bilaterality) were evaluated using the Chi-squared test for sex, nonhyperintense lesions on T1WI, the presence or absence of septa, the presence or absence of preoperative antithrombotic therapy, hematoma drainage rate of <50%, and hematoma bilaterality, or the Mann–Whitney U-test for age and preoperative hematoma volume using SPSS (SPSS inc., Chicago, IL, USA).

Figure 2: Semi-closed drainage system used at the ward. The external auditory meatus is used as a reference for height.

RESULTS

Of the 385 lesions, 41 cases (16 with inadequate follow-up periods and 25 with contraindications for MRI) were excluded from the analysis. Seventeen (4.9%) out of 344 lesions exhibited recurrence. The mean time for recurrence was 26.4 days (range, 1–59 days). Perioperative complications consisted of subdural empyema (n = 3), cerebral contusion due to the drainage tube (n = 1), and cardiogenic cerebral embolism (n = 1). Subdural empyema was treated with drainage and antimicrobial therapy. Cerebral contusion without neurological symptoms improved with conservative treatment. Cardiogenic cerebral embolism improved after mechanical thrombectomy.

There were no significant differences in the recurrence rate between the male group (10/234 lesions) and the female group (7/110 lesions) (P = 0.429), the presence of septum group (10/160 lesions) and the absence of septum group (7/284 lesions) (P = 0.327), the hematoma drainage rate <50% group (4/40 lesions) and the hematoma drainage rate ≤50% group (13/304 lesions) (P = 0.122), or the presence of preoperative anticoagulants therapy group (3/84 lesions) and the absence of preoperative anticoagulants therapy group (14/260 lesions) (P = 0.772), according to the Chi-squared test.

On the other hand, there was a significant difference in the recurrence rate between nonhyperintensity on T1WI group (6/54 lesions) and hyperintensity on T1WI group (11/290 lesions) (P = 0.035), according to the Chi-squared test. There was no significant effect of age (nonrecurrence group: mean age 75.6 years [30–103 years] and recurrence group: mean age 77.9 years [49–91 years]) on the recurrence rate (P = 0.462), according to the Mann–Whitney U-test.

Our results indicated a significant effect of preoperative hematoma volume on the recurrence rate (P = 0.014), according to the Mann–Whitney U-test. The mean preoperative hematoma volume was 155 mL (33–275 mL) and 188 mL (100–300 mL) in the nonrecurrence and recurrence groups, respectively. Evaluation using the Youden index[26] identified a hematoma volume ≥160 mL as the threshold for significant recurrence risk. An analysis with the number of patients with recurrence as the denominator revealed was no significant difference in the recurrence rate between the bilateral (3/57 patients) and the unilateral subdural hematoma groups (14/252 patients) (P = 0.927). Similarly, an analysis of the number of lesions with recurrence as the denominator revealed no significant difference in the recurrence rate between the bilateral (4/114 lesions) and unilateral (13/230 lesions) subdural hematoma groups (P = 0.375). The distribution of factors for 344 lesions for the nonrecurrence and recurrence groups is shown in Table 1. Accordingly, we found no significant effects of sex, age, the presence or absence of a

septum, the presence or absence of preoperative anticoagulants therapy, the hematoma drainage rate, or hematoma bilaterality on the recurrence rate [Figure 3: illustrative case 1]. However, our results indicated significant effects of the preoperative hematoma volume and nonhyperintensity on T1WI on the recurrence rate [Figure 4: illustrative case 2].

This study indicated that burr hole drainage without irrigation is a good surgical option in patients with CSDH and that preoperative MRI findings can help evaluate the risk of recurrence.

DISCUSSION

Burr hole types for CSDH

It has been reported that CSDH has a relatively good prognosis, with a mortality rate of approximately 2%.[25] However, the postoperative recurrence rate is reportedly 5–33%.[25] Since the disease is common among the elderly,[11] the reduction in recurrence rate is essential, to prevent deterioration in the activities of daily living caused by prolonged hospitalization.

Table 1: Baseline characteristics, preoperative MRI findings, and drainage rate for 344 lesions distributed between the nonrecurrence group and the recurrence group.

	Nonrecurrence (*n*=327)	Recurrence (*n*=17)	*P*-value
Number of males	224	10	0.429
Mean age (years)	75.6 (33–103)	77.9 (49–91)	0.462
Preoperative hematoma volume (ml)	155 (33–275)	188 (100–300)	0.014*
Nonhyperintensity on T1WI	48	6	0.035*
Presence of septum	150	10	0.327
Hematoma drainage rate <50%	36	4	0.122
Preoperative anticoagulants	81	3	0.772
Bilaterality	110	4	0.375

*Significant, MRI: Magnetic resonance imaging, TIWI: T1-weighted image

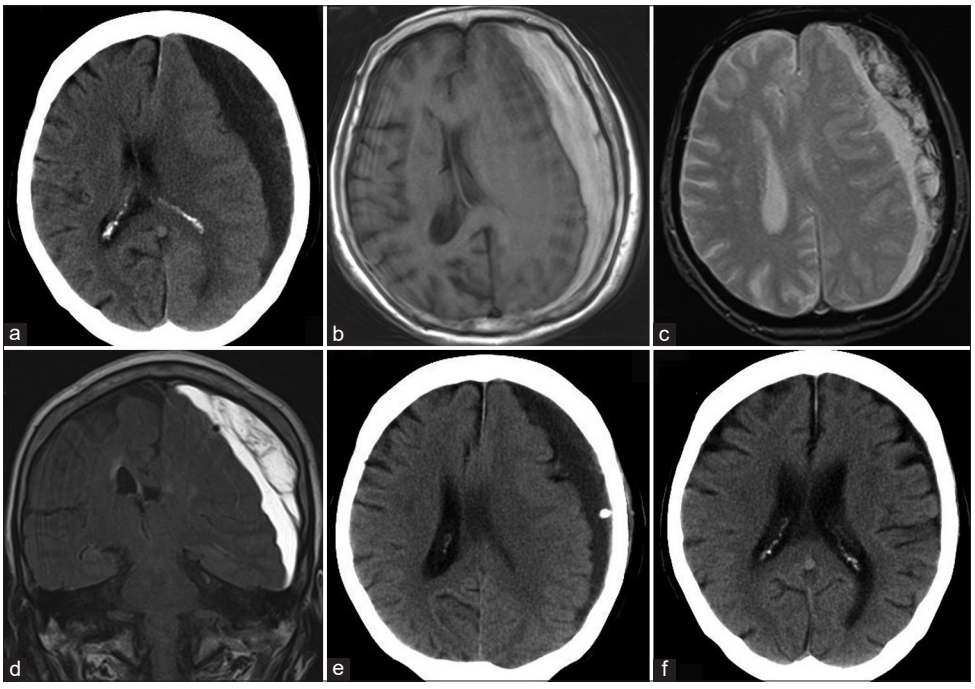

Figure 3: A 74-year-old woman with the left CSDH (a) the preoperative CT scan reveals a mixed density subdural hematoma with a midline shift, (b) hematoma showing hyperintensity on TIWI, (c) the presence of black bands on T2*-weighted images implies the presence of septa within the hematoma cavity, (d) the preoperative hematoma volume was 173 mL, as measured on fluid-attenuated inversion recovery coronal images, (e) CT scan 1 day after surgery revealing little air collection in hematoma cavity. The drainage rate was 36%. (f) The subdural hematoma disappeared 2 months after surgery. The patient recovered completely from right-sided hemiparesis in this case. CT: Computed tomography, CSDH: Chronic subdural hematoma.

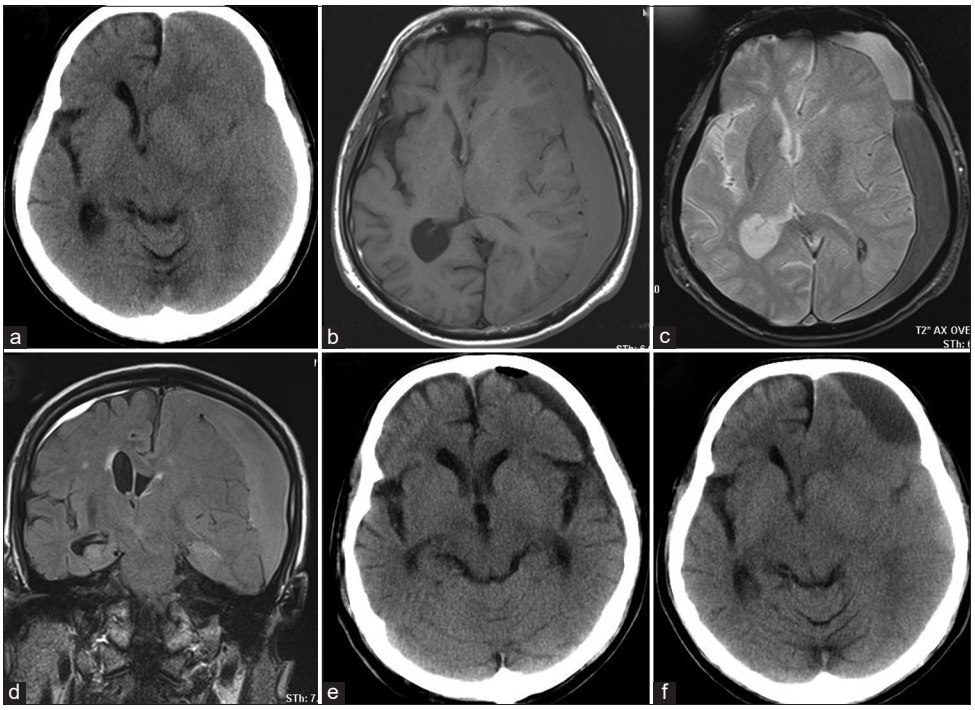

Figure 4: Recurrence in an 83-year-old man with bilateral CSDH (a) preoperative CT scans revealing midline shift with a hyperdense subdural hematoma, (b) hematoma showing low intensity on TIWI, (c) the presence of black bands on T2*-weighted images imply the presence of septa within the hematoma cavity, (d) the preoperative hematoma volume was 237 mL, as measured on fluid-attenuated inversion recovery coronal imaging, (e) CT scan revealing little air collection in the hematoma cavity, 1 day after surgery. The subdural hematoma drained very well. (f) The subdural hematoma recurred 23 days after surgery with right hemiparesis. CT: Computed tomography, CSDH: Chronic subdural hematoma.

Burr hole surgery is commonly performed to treat CSDH.[3] The surgical method is categorized into three types: burr hole drainage without irrigation, burr hole irrigation, and burr hole drainage with irrigation.[4] Several studies have compared burr hole drainage without irrigation to burr hole drainage with irrigation.[4,19] It has been reported that burr hole drainage with irrigation can most effectively eliminate hematoma and reduce the recurrence rate.[4,19] However, the reported benefit of burr hole irrigation is a shorter duration of bed rest.[4] In this study, the drainage tube was removed within 24 h of surgery in all patients. The patients were ambulatory from day 1 after surgery, thereby demonstrating the minimal influence of drainage on bed rest time.

Among the studies comparing burr hole drainage with irrigation to burr hole drainage without irrigation, some reported that surgery with irrigation reduces the recurrence rate,[14] while another meta-analyses concluded that no significant difference exists in recurrence rate between the two methods.[4,19] It has been reported that the benefit of burr hole drainage without irrigation is less invasive air entrainment, but this method is also limited with regard to hematoma elimination, which is difficult in the presence of blood clots and a septum.[4,8,14,18,24,27] There was no significant difference in the recurrence rate between the hematoma drainage rate of ≤50% group and the hematoma drainage rate of >50% group and between the presence of septum group and the absence of septum group in this study. Moreover, the overall recurrence rate in this study (4.9%) was relatively low; earlier studies have reported that the recurrence rate in patients who underwent burr hole drainage without irrigation was 1.7–14%.[4,8,14,18,24,27]

We should also evaluate the efficacy of Kampo medications for comparison with earlier reports. It has been reported that Kampo medication (e.g. goreisan and saireito) is effective in improving the symptoms of subdural hematoma,[6,10,21] suggesting that it may reduce the postoperative recurrence rate.

The surgeons at our index institute often place patients in the lateral position, such that the burr hole site is at the highest point. However, such positioning may increase the risk of decubitus and falls. Fortunately, appropriate sedation and gentle position fixation ensured no complications due to positioning at our institute. Sedation is induced by intravenous administration of midazolam (0.06–0.08 mg/kg body weight) under oxygen administration, and additional administration of midazolam (0.02–0.03 mg/kg body weight) depending on the sedation state. Moreover, pentazocine

(15 mg) was administered intravenously to relieve pain. The dose was adjusted depending on age and the state of consciousness. There are no reports detailing the appropriate intraoperative positions in burr hole drainage without irrigation.

Three patients (0.8%) experienced perioperative complications, including subdural empyema, which was successfully treated in all patients. According to earlier reports, the incidence of subdural empyema after burr hole surgery is 0–2.1%.[20,22] Although the risk of infection related to this surgical method may be associated with drainage tube placement, comparison of the current results with those of earlier studies did not reveal any significant differences.

Nonhyperintensity on T1WI

This study identified nonhyperintensity on T1WI and a preoperative hematoma volume of ≥160 mL as risk factors for recurrence. Earlier studies have also reported nonhyperintensity on T1WI as a risk factor for recurrence.[5,17] Bradley reported that hyperacute and acute intracranial hemorrhage were hypointense on T1WI.[2] Thus, *de novo* hematoma may cause recurrence. In such cases, burr hole drainage without irrigation and active removal of the hematoma through a small craniotomy or combined use of endoscopy, followed by injection of artificial cerebrospinal fluid into the hematoma cavity, may be effective.[15,23]

Adjuvant therapy for CSDH

Middle meningeal artery embolization has also been reported to be effective in the treatment of subdural hematomas that exhibit nonhyperintensity on T1WI.[1] Although several reports have demonstrated no significant effects of preoperative hematoma volume on the recurrence rate,[9,12] active removal of the hematoma using surgical methods, such as small craniotomy, in addition to the consideration of the hematoma characteristics may be essential. However, no significant effects of previously reported risk factors for recurrence, such as age, sex, and the presence or absence of preoperative antithrombotic therapy or septa, were found in this study. Therefore, there is no need to change the surgical methods based on these factors.

This was a single retrospective study. Future investigations should include a greater number of cases and prospective studies with larger samples.

CONCLUSION

We examined in detail, the efficacy of burr hole drainage without irrigation and the risk factors for recurrence of CSDH in a series of 385 symptomatic lesions. The overall recurrence rate was 4.9% and was the preoperative hematoma volume and nonhyperintensity on T1WI was identified as risk factors for recurrence. Burr hole drainage without irrigation is a good surgical option for CSDH cases, and preoperative MRI findings can help evaluate the risk of recurrence.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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