

Clinical Article



Clinical and Radiologic Outcomes of Single Burr Hole Drainage and Minicraniotomy in the Treatment of Inhomogeneous Chronic Subdural Hematoma: A Retrospective Study

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Conflict of Interest

The authors have no financial conflicts of interest.

ABSTRACT

Objective: The optimal treatment for inhomogeneous chronic subdural hematoma (CSH) remains unclear. This study thus aimed to compare single burr hole drainage with minicraniotomy in the treatment of inhomogeneous CSH, including complication and recurrence rates.

Methods: The clinical and radiologic data of 240 patients with inhomogeneous CSH who underwent surgery between January 2005 and January 2021 were retrieved. A total of 111 patients were included in this study. Clinical and radiological outcomes were compared between the groups undergoing different surgery types.

Results: A total of 102 (91.8%) patients showed clinical improvement after surgery; 81 (93.1%) and 21 (87.5%) patients showed improvements in clinical symptoms in the single burr hole and minicraniotomy groups, respectively. A total of 102 (91.9%) patients showed favorable radiological findings after the surgery, including inhomogeneous CSH disappearance in 64 (73.6%) burr hole and 13 (54.2%) minicraniotomy patients, and inhomogeneous CSH improvement in 17 (19.5%) burr hole and 8 (33.3%) minicraniotomy patients. There were no significant differences in the patient characteristics or surgical outcomes between the groups.

Conclusion: Single burr hole drainage showed a slightly better improvement in clinical and radiologic findings and lower recurrence and complication rates than minicraniotomy. There were no statistically significant differences between the two groups.

Keywords: Chronic subdural hematoma; Trephination; Craniotomy; Inhomogeneous subdural hematoma

INTRODUCTION

Chronic subdural hematoma (CSH) is among the most common types of intracranial hemorrhage, often observed older adults, and with the general incidence estimated at 3 per 100,000 population, and higher in the geriatric population.⁸⁾ The rates of CSH are likely increased in older adults due to antithrombotic medication use, venous vulnerability,

subdural space augmentation, and consequences of frequent falls.¹⁾ Surgical drainage is recommended for symptomatic CSH patients; however, the optimum approach remains unclear.⁷⁾ CSH forms in the dural border cell layer of the hematoma cavity enclosed by outer and inner membranes.²⁾ The outer membrane contains numerous fragile macrocapillaries (sinusoidal vessels), while there are few blood vessels in the inner membrane; these fragile macrocapillaries are often the source of repeated multifocal bleeding,¹¹⁾ which may result in the progressive enlargement of hematomas that develop after a minor head injury. Meanwhile, the inner membrane is associated with liquefaction of the subdural space.²⁾ CSH takes the form of a fibrous capsule that consists of a liquefied hematoma surrounded by inner and outer membranes. In some cases, the internal architecture of the hematoma may appear multiseptated, calcified,³⁾ multilobulated, or multilayered. This subtype of CSH is known as inhomogeneous CSH (as laminar, layered, trabecular types in textbook). Based on actual surgical findings, it involves thick membranes with multiple septations, leading to the formation of a solid component in an encapsulated region. On computed tomography (CT) scans, inhomogeneous CSH often presents with mixed density, multiseptated CSH, signs of recent hemorrhage, midline shift, thickening, or calcification of the inner membrane.³⁾ Magnetic resonance imaging (MRI) findings of the inhomogeneous CSH tend to be hyperintense in both T1–T2 weighted images, and sometimes hypointense in T1 and hyperintense in T2; all cases present a hypointense net- or web-like structure in the hematoma cavity.^{5,6)}

The most common surgical procedures for the treatment of CSH are single or multiple burr hole drainage, twist drill craniostomy, and craniotomy.⁴⁴⁾ Burr hole drainage is considered superior to twist-drill craniotomy and craniotomy because of its low recurrence and morbidity rates.^{27,44)} However, class I evidence comparing these treatments is lacking and controversies regarding the optimum treatment remain, while surgical approaches are often selected based on patient characteristics or hematoma structure.⁴⁴⁾ Previous studies have reported that inhomogeneous CSH requires a large craniotomy for initial treatment,^{3,4,20)} suggesting that burr hole trephination may be insufficient in this context. Craniotomy advocates suggest that the wide facilitation allows for loculations to be shattered and membranes to be revealed, increasing subdural drainage and decreasing recurrence risk. Moreover, craniotomies are a safe and effective approach to hematomas, their membranes, and bleeding. However, extended outer and inner membranectomy may cause acute hemorrhage or infection.^{3,4,18,20)} Consequently, the extent of surgical treatment required for CSH remains controversial, and the suitable approach to inhomogeneous CSH remains unclear.¹⁰⁾ This study aimed to compare the characteristics and outcomes of burr hole drainage and minicraniotomy in the treatment of inhomogeneous CSH, including complication and recurrence rates.

MATERIALS AND METHODS

No ethics board approval was obtained for this study. This was a retrospective review of the medical records of patients treated for CSH at our medical center from September 2016 to June 2021. A total of 183 patients underwent surgical treatment for CSH; among them, 111 patients with inhomogeneous CSH were included in this study. At our neurosurgical center, burr hole irrigation, drainage system use, and minicraniotomy performed under general anesthesia are the preferred surgical methods for the treatment of inhomogeneous CSH. The choice of surgical approach was at the discretion of the attending surgeon. To

find out the factors influencing the outcome, data on preoperative clinical and radiological findings were collected, including sex, age, risk factors (antiplatelet or anticoagulant agent use, coagulopathy diagnosis) underlying disease, presenting neurological signs and symptoms (**SUPPLEMENTARY TABLE 1**), and radiologic findings on CT and/or MRI scans. Comorbidities of interest included arterial hypertension, diabetes mellitus, heart failure, hyperlipidemia, cerebrovascular accident history, and neurodegenerative disease. The location (frontal, temporal, parietal, and interhemispheric) and laterality (unilateral, bilateral) of the CSH were recorded. The compression of the ventricles and midline shift were examined. The density of CSH on CT scans was classified as hypodense, isodense, hyperdense, or mixed. CT and MRI scans were used to confirm the injury to brain parenchyma (including, diffusion restriction, contusion) and presence of neomembrane, multi-layer, multi-septation, multi-lobulation, or solid portion. Immediately after surgery, the extent of removed/remaining subdural hematoma, last follow up CT status, and rates of peri- and post-surgical complications were recorded. Findings from the last CT scan were classified as resolved, improved, deteriorating, or unchanged. The patients' neurological status was assessed before and after surgery using the Markwalder Neurological Grading System (**SUPPLEMENTARY TABLE 2**), which is the standard neurological grading system for CSH.²⁸⁾ The patients' post-surgical clinical and radiological status were evaluated at the time of discharge. The latest follow-up data were recorded. Consistent criteria were used to define the mortality, complication, and recurrence rates. "Complications" were defined as all clinical and surgical events other than recurrence or mortality during hospitalization. Surgical complications were directly related to surgical intervention. Recurrence was defined as reoperation for ipsilateral symptomatic CSH within 6 months after the index surgery.

Surgical techniques

Single burr hole

The patient was in the supine position; the head was rotated or maintained in a neutral position in cases of unilateral and bilateral inhomogeneous CSH, respectively. All procedures were performed under general anesthesia. A small linear incision was made over the inhomogeneous CSH site, most often on the parietal eminence. The dura mater and subdural membrane were coagulated and opened sufficiently to pass a ventricular catheter into the subdural space. Irrigation in all directions was performed to remove subdural hematoma, ensuring that there was no active bleeding. Ventricular catheters were externalized through a stab incision. A water-filled syringe that removed the pulling portion was connected to the external end of the ventricular catheter and placed as high as possible. Using the differences in hydrostatic pressure, we allowed water to enter the subdural space naturally. Subsequently, catheter was placed as low as possible to allow air to come out. This process was performed 2–3 times to drain the air from the subdural space and to reduce the risk of tension pneumocephalus. In addition, saline was injected through the catheter to further reduce pneumocephalus by draining air. Finally, the catheter was connected to the standard external ventricular drainage systems. Both sides were simultaneously treated using the same technique. Bilateral collections are commonly drained simultaneously through separate incisions, burr holes, or separate outer catheters. After the operation, the drainage systems were maintained at or below the head level.

It shows the image of a patient who underwent single burr hole drainage surgery for inhomogeneous CSH in right cerebral convexity in **FIGURE 1**. Multiseptated inhomogeneous CSH can be identified on CT and MRI T2, T1 images. Six months after burr hole drainage surgery, CSH was improved on CT image.

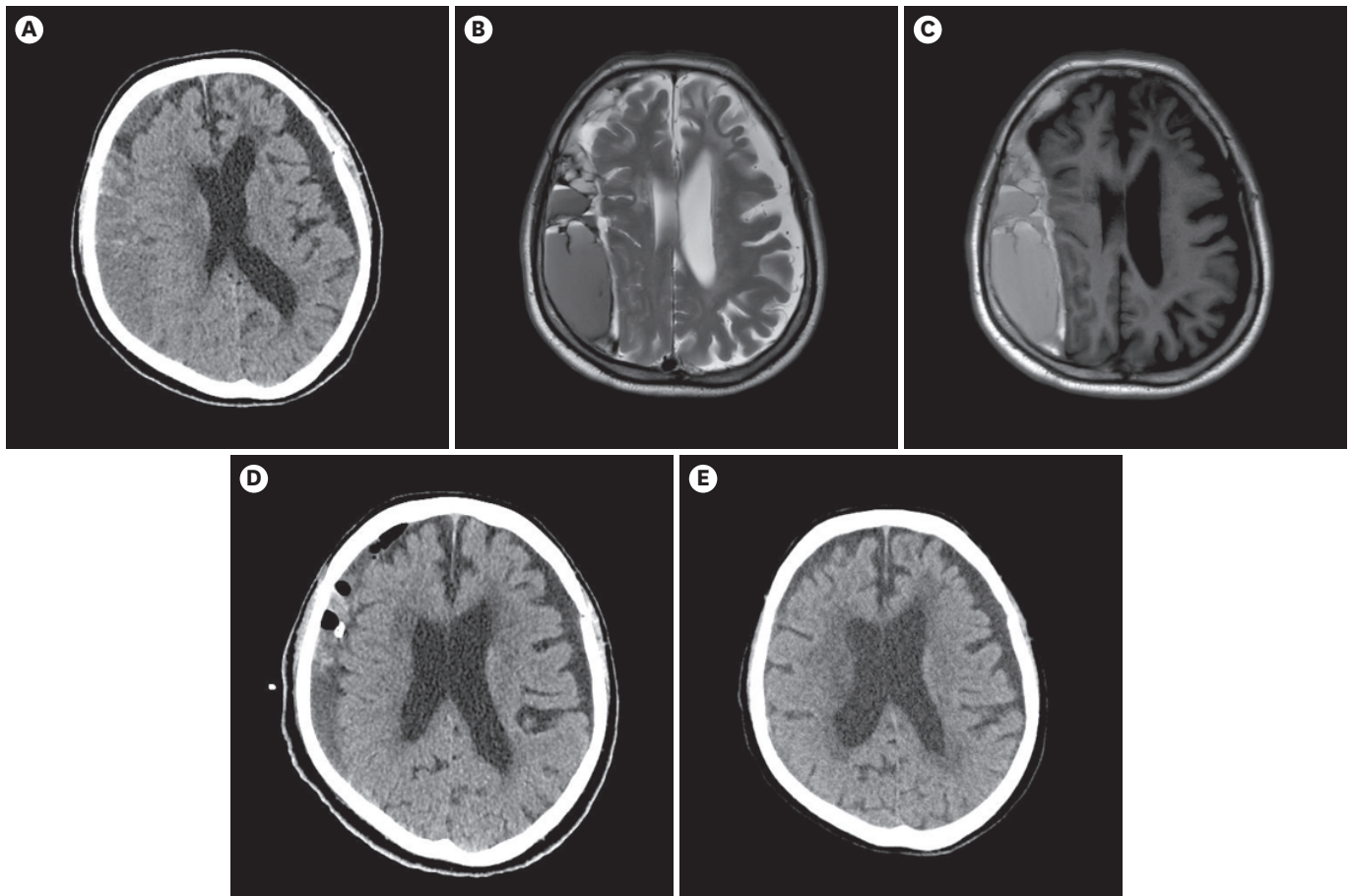


FIGURE 1. It shows the image of a patient who underwent single burr hole drainage surgery for inhomogeneous CSH in right cerebral convexity in Figure 1. Multiseptated inhomogeneous CSH can be identified on CT and MRI T2, T1 images. Six months after burr hole drainage surgery, CSH was improved on CT image. (A) Preoperative CT. (B) Preoperative MRI T2. (C) Preoperative MRI T1. (D) Postoperative CT. (E) CT image 6 months after single burr hole drainage. CSH: chronic subdural hematoma, CT: computed tomography, MRI: magnetic resonance imaging.

Minicraniotomy

Craniotomy involves an opening of the skull of >30 mm in diameter, and the repositioning of the bone flap at the end of the operation. In minicraniotomy, the diameter of the bone flap remains limited to 40 mm. An opening with a diameter of 5–30 mm is called a burr hole, and that of <5 mm is called a twist drill craniostomy. We performed minicraniotomies with a bone flap less than 40 mm. After the minicraniotomy, the dura was incised, and outer membrane of the hematoma was maximally opened and coagulated. Following the initial removal of the hematoma or remaining clots, the subdural space was irrigated strictly with physiological warm saline until the drained fluid became clear. The outer and inner membranes surrounding the hematoma were incised with thin needles, and if possible, additional hemostasis and removal were performed through bipolar coagulator. A ventricular catheter was then placed into the subdural space, the bone flap was replaced, and wound was sutured. Also intracranial air was removed in the same procedure as in single burr hole drainage. Catheters were maintained for a minimum of 24 hours (mean, 72 hours). Removal of the drainage catheter depended on the amount of remaining subdural hematoma and postoperative CT or MRI imaging findings.

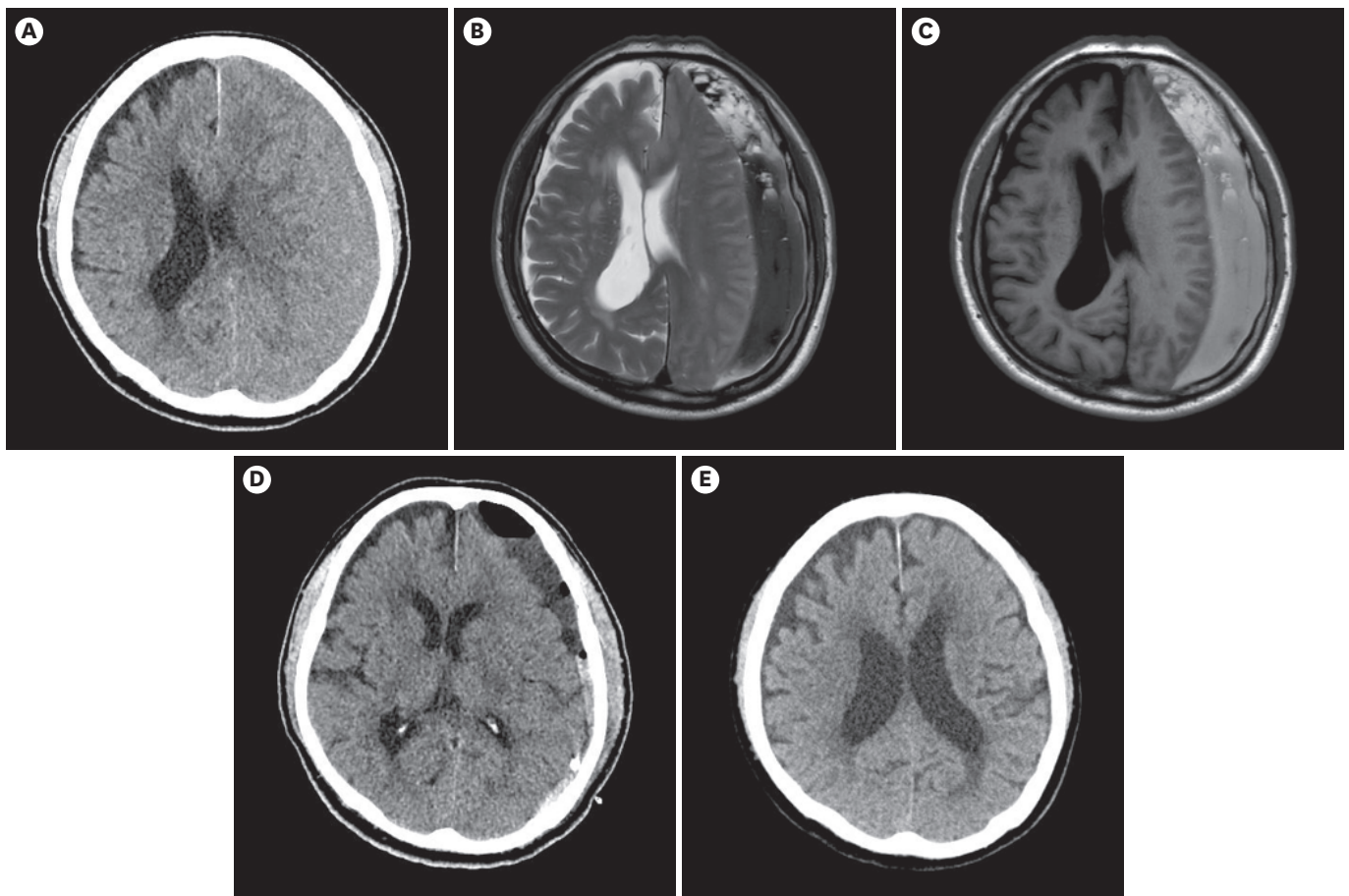


FIGURE 2. The case of minicraniotomy in inhomogeneous CSH patient can be seen in Figure 2. CSH with different properties can be confirmed on CT and MRI images. Air was minimized by the method described above, and it can be confirmed that it was improved six months after minicraniotomy surgery. (A) Preoperative CT. (B) Preoperative MRI T2. (C) Preoperative MRI T1. (D) Postoperative CT. (E) CT image 6 months after minicraniotomy. CSH: chronic subdural hematoma, CT: computed tomography, MRI: magnetic resonance imaging.

The case of minicraniotomy in inhomogeneous CSH patient can be seen in **FIGURE 2**. CSH with different properties can be confirmed on CT and MRI images. Air was minimized by the method described above, and it can be confirmed that it was improved six months after minicraniotomy surgery.

Statistical analysis

Variables considered in the statistical analysis included sex, age, hypertension, diabetes mellitus, heart failure, renal failure, antiplatelet therapy, anticoagulant therapy, and coagulopathy. All analyses were performed in IBM Statistical Package for the Social Sciences (SPSS, Version 25; IBM, Armonk, NY, USA). Univariable analyses were performed to evaluate the relationship between each independent variable and outcome (complications, mortality, and recurrence rates) using the Mann-Whitney U test and the χ^2 test, multivariate logistic regression model. The *p*-values of <0.05 were considered indicative of statistically significant findings.

RESULTS

During the 6-year study period, 240 patients underwent surgery for CSH. Among them, 111 patients had multiple inhomogeneous, septated, multiple staged hematomas and were included in this study; the remaining 129 patients with homonymous hematoma were excluded from this study. A total of 78 (70.3%) patients were male. The patients' age ranged from 49 to 94 years old; the mean age estimates of the included men and women were 76.7 and 74.5 years, respectively. A total of 103 (92.7%) patients had at least one medical comorbidity such as hypertension, diabetes mellitus, hyperlipidemia, heart failure, history of stroke, and neurodegenerative disease. A total of 110 (99.0%) patients had a history of trauma. In one case, the cause of inhomogeneous CSH could not be determined. Almost half of the patients (22/111; 19.8%) were treated with anticoagulant (n=1) or antiplatelet (n=21) agents. No patient had coagulopathy. A total of 22 (20.0%) patients with a history of trauma were taking anticoagulant or antiplatelet agents. The inhomogeneous CSH was observed in the left and right hemispheres in 56 (50.4%) and 34 (30.6%) patients, respectively, and bilaterally in 18 (16.2%) patients. Heterogeneous or mixed density radiologic findings on CT and/or MRI scans were observed in all patients. Patients with homogeneously hypodense or homogeneously isodense CT findings were excluded from this study. The patients' demographic characteristics are presented in **TABLE 1**. There was no statistically significant difference between the burr hole drainage and minicraniotomy groups. The patients in each group showed even distribution in preoperative characteristics. The patients had various symptoms at the time of hospitalization. The most frequent neurological symptom at presentation was motor deficit, observed in 38 (34.2%) patients, ranging from weakness of the local limbs to hemiplegia, followed by altered consciousness, headache, dysphasia, gait disturbance, and seizures in 10 (9.0%), 57 (51.4%), 2 (1.8%), and 3 (2.7%) patients, and 1 (0.9%) patient, respectively. Patients with a high grading score complained of more than one symptom. Two patients were comatose (Markwalder grade 4).

Outcome

Overall, 102 (91.8%) patients showed clinical improvement in indicators such as a decrease in the Markwalder score upon discharge (clinical improvement rate of burr hole vs.

TABLE 1. Preoperative demographic characteristics of patients treated for inhomogeneous CSH

Characteristics	Surgical procedure		Total No.	p-value
	Burr hole placement	Mini-craniotomy		
No of patients	87	24	111	
Sex				0.946
Male	61	17	78	
Female	26	7	33	
Mean age (yr)	75.9	76.9		0.443
≥70	66 (75.9%)	20 (83.3%)	86	
<70	21 (24.1%)	4 (16.7%)	25	
Antiplatelet	15 (17.2%)	6 (25.0%)	21	0.395
Anticoagulant	1 (1.1%)	0 (0%)	1	0.602
HTN	44 (50.6%)	15 (62.5%)	59	0.304
DM	17 (19.5%)	6 (25.0%)	23	0.563
Lipid	9 (10.3%)	2 (8.3%)	11	0.773
HF	9 (10.3%)	1 (4.2%)	10	0.354
Unilateral	71 (81.6%)	22 (91.6%)	93	
Right	27	10	37	
Left	44	12	56	
Bilateral	16 (18.4%)	2 (8.4%)	18	

CSH: chronic subdural hematoma, HTN: hypertension, DM: diabetes mellitus, HF: heart failure.

TABLE 2. Markwalder score preoperatively and at discharge

Markwalder score	Burr hole		Mini-craniotomy		No. of patients	p-values
	Pre-op	Post-op	Pre-op	Post-op		
Grade 0		81		21		
Grade 1	48	3	9	0		
Grade 2	38	1	15	1		
Grade 3	1	1		1		
Grade 4		1		1		
Improved	81 (93.1%)		21 (87.5%)		102	0.302
No change	4 (4.6%)		2 (8.3%)		6	
Worse	2 (2.3%)		1 (4.2%)		3	
Death	1 (1.1%)		2 (8.3%)		3	0.117
Recurrence	9 (10.3%)		3 (12.5%)		12	0.505

op: operative.

minicraniotomy: 93.1% vs. 87.5%). Six patients (5.4%) had the same Markwalder score before and after treatment (burr hole vs. minicraniotomy: 4.6% vs. 8.3%). Three (2.7%) patients had poorer scores after than before surgery (2.3% vs. 4.2%). Among the patients that presented without improvement or with decline, 3 (2.7%) patients died (1.1% vs. 8.3%). At discharge, 102 (91.8%) patients were asymptomatic (Markwalder score of 0), and 3 (2.7%) patients had minimal residual symptoms (Markwalder score of 1). A total of 2 (1.8%) patients had neurological deficits (Markwalder 2), and 4 (3.6%) patients had several focal signs (Markwalder scores of 3 and 4). Subdural hematoma recurrence requiring surgery occurred in 12 (10.8%) patients (9 [10.3%] and 3 [12.5%] patients in the burr hole and minicraniotomy groups, respectively) (TABLE 2). There was no significant difference in clinical outcomes or recurrence rates between the groups. A total of 102 (91.8%) patients showed improvement in imaging findings six months after surgery. Subdural hematoma disappeared after surgical treatment in 77 (69.4%) patients; meanwhile, significant improvement was observed in 25 (22.5%) patients. No noteworthy change in the amount of subdural hematoma after surgery was observed in 6 (5.4%) patients; aggravation was observed in three patients. When the two groups (burr hole vs. minicraniotomy) were compared, subdural hematoma in CT findings disappeared (73.6% [n=64] vs. 54.2% [n=13]), improved (19.5% [n=17] vs. 33.3% [n=8]), no change (n=4 vs. n=2), and worse (n=2 vs. n=1), were observed (TABLE 3). Radiological findings were similar in both groups. Postoperative complications occurred in 4 (3.7%) patients, including medical and surgical complications observed in 2 (1.8%) and 2 (1.8%) patients, respectively (SUPPLEMENTARY TABLE 3). Medical complication cases included 1 (0.9%) patient with pulmonary infection and 1 (0.9%) patient with acute renal failure. Among surgical complication cases, hemorrhage and infarction each occurred in 1 (0.9%) patient. Three (2.7%) patients died (1.1% vs. 8.3% in the burr hole and minicraniotomy groups, respectively). Complication rates were similar in both groups. The characteristics of patients requiring revision surgery and those with complications or fatal outcomes are shown. Univariate analysis revealed no association among the outcomes of interest (recurrence, complication, and morality rates) and patient characteristics.

TABLE 3. Outcomes in CT imaging on 6 months later after surgery

Outcomes	Burr hole	Mini-craniotomy	No. of patients	p-values
Disappeared	64 (73.6%)	13 (54.2%)	77	0.060
Improved	17 (19.5%)	8 (33.3%)	25	0.125
Unchanged	4	2	6	
Aggravated	2	1	3	
Re op.	9	3	12	

CT: computed tomography, op: operative.

DISCUSSION

In the present study, there was no difference in outcomes between the groups undergoing different surgical procedures. This study did not reveal any patient characteristic associated with surgical outcomes, suggesting that single burr hole drainage may be a feasible alternative to craniotomy in the treatment of inhomogeneous CSH.

CSH is among the most common diseases eligible for neurosurgery. It is common among older adults aged 60–70 years, and its incidence increases with age. CSH is associated with trauma, alcohol consumption, anticoagulant use, and coagulopathy disorders. Approximately 60%–80% of cases occur after head trauma. Head trauma is often mild, and patients may not recognize it; in fact, it has been estimated that 46.7% of patients affected by head trauma fail to recognize it.⁴⁵⁾ Numerous treatments have been proposed for the initial management of CSH.^{9,10)} Chronic CSH may be treated with medical or surgical approaches. Many patients undergo surgery in this context, unless they are not eligible for surgery or the hematoma is asymptomatic.^{36,45)} The most common surgical approaches include burr hole drainage, twist drill craniostomy, and craniotomy, and have been associated with re-operation rates in the range of 5%–27.8%; meanwhile, the associated mortality and morbidity rates vary.^{14,26,35)} Consequently, the extent of surgical treatment required for CSH remains controversial,¹²⁾ and the optimal treatment remains unclear.¹⁰⁾ Mondorf et. al. reported the number of craniotomy patients as more than three times that of the burr hole drainage patients.³¹⁾ Sambasivan compared outcomes of 2,300 cases of CSH, including more than 2,200 and 51 cases treated with craniotomy and burr hole drainage, respectively.³⁵⁾ Lee et al.²⁶⁾ compared 38 and 13 patients undergoing burr hole drainage and craniotomy, respectively. Given the discrepancies in the number of patients undergoing each surgery type, findings remain uncertain, making treatment choices challenging; in fact, the surgical technique for CSH treatment is often determined by the level of the hematoma organization.⁴⁾

Burr hole drainage is the most frequently used operative method in chronic subdural hematoma due to its efficacy and low complication rates. The overall morbidity rate has been estimated in the range of 0%–2% and the recurrence rate has been estimated in the range of 5%–30%. Burr holes with drainage are commonly used for non-septated and mostly liquified CSH.^{13,16)} A small craniotomy is recommended in cases of repeated recurrences, solid hematomas, or septations in subdural hematoma. In particular, when excessive formation of the solid neomembrane,³⁾ multilayered intrahematoma architecture, and nonliquefied hematoma with different hemorrhagic foci with layering effects are observed,⁶⁾ burr hole drainage may be incomplete, and cortical vein injury may occur during drainage catheter insertion, leading to acute hemorrhage; therefore, small craniotomy is recommended.^{40,42,43)} In fact, small craniotomy through irrigation and closed system drainage can be considered as a surgical option in patients with inhomogeneous CSH.^{17,18)} Conversely, general craniotomy may be an appropriate surgical treatment option in cases of inhomogeneous CSH, re-accumulation of CSH, solid hematoma, failure of brain re-expansion, or significant edema close to hematoma.^{3,4,19)} In inhomogeneous CSH cases, a two-burr hole craniostomy is not suitable as an initial approach.^{4,5,18)} In fact, inhomogeneous CSH may require a large craniotomy for initial treatment.^{3–5,20)} Large craniotomies for inhomogeneous CSH may be the safest and most suitable approach to hematoma, its membranes, and intermittent troublesome bleeding.^{3,4,18,20)} Extended outer and inner membranectomy are important for brain expansion in the subdural space.^{3,20)} The outer membrane is affected by hematoma enlargement due to recurring hemorrhages,^{2,21)} whereas the inner membrane is related to

subdural hematoma.^{2,11)} Extended inner membrane resection may facilitate the expansion of the brain into the subdural space. Although partial inner membrane resection for inhomogeneous CSH can cause brain herniation, this complication rarely occurs in practice.^{22,23,37)} Brain stiffness may affect brain re-expansion after CSH evacuation.¹⁹⁾

In our experience, good outcomes in inhomogeneous CSH can be achieved with single burr hole irrigation and drainage. The inner membrane is thin; if the liquefied hematoma is drained through sufficient irrigation and CSH pressure is reduced, the inner membrane is unlikely to interfere with brain expansion. Meanwhile, a thick membrane may interfere with the expansion of the brain. However, mild brain stiffness and relatively new CSH are unlikely to interfere with brain expansion. Future studies are required to validate the present findings and account for the discrepancies between the present and previous study findings.

Pneumocephalus refers to the presence of intracranial air, which may develop after neurosurgical procedures, including CSH drainage, and which may result from craniofacial trauma and basilar tumors. Pneumocephalus rarely develops spontaneously.^{28,30-32)} Risk factors for pneumocephalus include head position, duration of surgery, nitrous oxide anesthesia, hydrocephalus, intraoperative osmotherapy, hyperventilation, spinal anesthesia, barotrauma, continuous cerebrospinal fluid drainage through lumbar drain or shunting system,³⁴⁾ epidural anesthesia, infections, dural defect after craniotomy,³⁸⁾ tear of the arachnoid membrane and neoplasms. Clinical complaints include headaches, nausea and vomiting, seizures, dizziness, and decreased neurological status.^{28,31,39)}

Tension pneumocephalus increases intracranial pressure and accelerates neurological deterioration. It can be a life-threatening complication after hematoma evacuation,²⁹⁾ whereby the subdural air separates and compresses the frontal lobes. The typical “peaking” of the frontal lobes in the subdural tension pneumocephalus is accounted for by the bridging veins entering the superior sagittal sinus. Stretching and rupturing of these veins may cause acute or recurrent subdural hematoma.²⁴⁾ The compressed frontal lobes, with widened interhemispheric space between the frontal poles, mimic the shape of Mount Fuji; in fact, some neurosurgeons refer to the corresponding CT findings as “Mount Fuji” signs.⁴¹⁾ The presence of air between the frontal poles associated with massive air volume over the frontal lobes presumably indicates the increased tension of the subdural air. Multiple small air bubbles in the subarachnoid space, specifically, in the cisterns, may also present. The incidence rate of tension pneumocephalus after craniotomy with membrane excision has been estimated as 28.5%, and that after burr hole drainage has been estimated in the range of 4%–8%.³³⁾ Tension pneumocephalus-related complications may occur more frequently after large craniotomy than after burr hole drainage.⁴⁶⁾ Preventing air from entering the subdural space, complete replacement of subdural hematoma with normal saline, and careful hemostasis can improve surgical outcomes for patients with CSH.²⁵⁾

After the evacuation of OSCH in older adults, the expansion of the brain into the subdural space may be insufficient.¹⁹⁾ In these cases, the negative pressure effect contributes to the formation of tension pneumocephalus. No case of tension pneumocephalus was observed in the present study; however, to prevent this complication, we removed as many subdural hematomas as possible through sufficient irrigation with normal saline. To replace normal saline in the empty subdural cavity, after removing the pulling part of the syringe, the front of the syringe was connected to the end of the drain catheter. The syringe was lifted as high as possible, the empty syringe was filled with saline, and the saline entered the subdural

space given the pressure difference. When saline no longer entered, the syringe was placed as low as possible to induce saline and air flows through the draining catheter. After several repetitions of this procedure, the conduit was connected to the closing bag. This approach helped reduce the internal pressure and air volume, supporting saline entering the area where the intracranial pressure was not increased.

CONCLUSION

Single burr hole drainage was associated with slightly better clinical and radiologic findings than minicraniotomy. There was no statistically significant difference between the groups. The recurrence and complication rates were similar between both groups; however, they were slightly lower in the single burr hole group than in the minicraniotomy group. Single burr hole drainage may be a feasible alternative to craniotomy in the treatment of inhomogeneous CSH.

SUPPLEMENTARY MATERIALS

SUPPLEMENTARY TABLE 1

Initial symptoms and sign at admission

[Click here to view](#)

SUPPLEMENTARY TABLE 2

Markwalder grading score

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SUPPLEMENTARY TABLE 3

Medical and surgical related complications

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