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Validating the Efficacy of Two Burr-Hole Craniostomy over Mini-Craniotomy for Chronic Subdural Hematoma Drainage

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Abstract

Background There is an increasing incidence of chronic subdural hematoma due to extended life expectancy and associated trauma and fall risk. This retrospective study evaluates the efficacy of two burr-hole craniotomy over mini-craniotomy.

Methods Sixty-five patients were recruited over 2 years, of which 56 were male and 9 were females. A patient with a chronic subdural hematoma either underwent burr-hole craniostomy or mini-craniotomy for hematoma evacuation. Glasgow coma scale (GCS) and modified Rankin score were used to assess the neurological status and interventional outcome at discharge and follow-up, respectively. A head CT scan was performed at 3 week and 3 month follow-up.

Statistical Analysis Categorical data are presented as frequency and percentage, while non-categorical data are represented as mean $\pm$ SD. Statistical significance for difference in outcome between the two groups was analyzed using the chi-square test and *p*-value less than 0.05 was considered statistically significant.

Results The mean age of patients was 55.6 years. Headache (35 cases), hemiparesis, and altered sensorium were seen in 20 patients, each with the main presenting symptoms. Trauma history was noted in 69.2% of patients. One (3.7%) hematoma recurrence in the burr-hole group and four (8.3%) in the mini-craniotomy group was recorded. The mean operative time was longer in the minicraniotomy group (124.2 min vs. 75.4 min; $p < 0.001$). A higher incidence of recurrence was noted in the craniotomy group (8.3%) than the burr-hole group (3.7%). No statistical difference in the recurrence rate, duration of hospital stay, GCS at discharge, modified Rankin score between the two study groups at discharge was noted.

Conclusion Two burr-hole craniostomy is a safe and effective surgical option to treat chronic subdural hematoma. It is also validated in patients on anticoagulants and antiplatelet medications with adequate pre-surgical correction of coagulation parameters.

Keywords
- burr-hole
- chronic subdural hematoma
- craniotomy
- membrane
- recurrence

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Introduction

Chronic subdural hematoma is a common neurosurgical condition requiring treatment and has an incidence of 1 to 2 per 100,000 population per year.[1] There is a higher incidence in the elderly population-a rate of 1 to 2 per 100,000 population at 60 years and 7.4 per 100,000 at 70 years.[2] The incidence can be as high as 58 per 1,00,000 in the population aged above 70 years.[3] There are multiple factors that produce expansion of a chronic subdural hematoma (cSDH). It is not restricted to repeated venous bleed into the subdural bleeds following trivial or accidental trauma. A complex process mediated by inflammation, membrane formation, angiogenesis, and fibrinolysis is known to increase the cSDH volume.[4] The chronicity of the bleed leads to outer and inner membrane thickening and loculations within the cSDH. There has been debate on which among the two surgical procedures—burr-hole washout or mini-craniotomy—is the superior technique for management of cSDH. Embolization of middle meningeal arterial feeders to the vascularized membrane has come about as an alternative to surgical management of cSDH.[5] However, surgery remains the proven modality for the management of cSDH, especially in symptomatic patients with altered levels of consciousness or focal neurological deficits.[6] This study addresses the outcome of management of cSDH patients in both treatment groups with respect to their clinical outcome, recurrence rate, length of hospital stay, duration of surgery, and morbidity.

Materials and Methods

This is a cross-sectional, retrospective, clinical, single-center study conducted over a 2-year period from January 2018 to December 2019.

Inclusion and Exclusion Criteria

Patients above 18 years of age with a cSDH, treated surgically at the author's hospital, were included in the study. Patients with acute and subacute hematoma, subdural hygroma, subdural bleed due to neoplastic, infective process, or from vascular malformations were excluded from the study.

The patients were evaluated with either a CT or MR scanning before surgery. Patients were allotted to the burr-hole evacuation arm or mini-craniotomy arm based on operator preference. Patient demographics, clinical and radiological information, details of preoperative assessment, intra-operative observation including the duration of surgery, postoperative course, and follow-up were collected from hospital electronic health records. A neurological examination including the Glasgow Coma Scale (GCS) was used to evaluate the patient in the perioperative period and the modified Rankin score was used to evaluate outcome at follow-up. A head CT scan was performed at 3 weeks and 3 months following the surgery as a follow-up protocol. An early recurrence is defined as a re-accumulation of the hematoma within 3 months of surgery.[7]

Statistical Analysis

Patient characteristics were described by percentages for categorical variables and by median and standard deviation for continuous data. For categorical variables, significant differences between groups were examined by the two-sided Fisher's exact test at the 0.05 level, using SPSS for Windows (SPSS; SPSS Inc., Chicago, IL, United States). Descriptive statistics for comparison between the two treatment groups were analyzed and summarized in terms of percentage and its 95% confidence interval was estimated. The chi-squared test at the 0.05 level was used for this comparison.

Surgery

In the burr-hole arm of the study, two burr-holes were placed —one in the frontal region and the other in the parietal region based on the radiological imaging (►**Fig. 1A**). The cavity was irrigated with normal saline until the point of clear return, after initial evacuation of the cSDH. Post-evacuation of the hematoma, a subdural drain with no suction was placed and attached to a closed drainage system. It is placed for 48 to 72 hours and removed when the drainage stops or when the drain fluid is clear.[8]

In the mini-craniotomy arm, a curvilinear incision was made over the most prominent part of the hematoma just posterior to the coronal suture, extending from 1 cm below superior temporal line to 2 cm lateral to the midline (►**Fig. 1B**). The superficial temporalis muscle is reflected inferiorly. A single burr-hole was placed and a 4×4 cm craniotomy was performed. After hitching the dura, a cruciate incision was placed on it. The outer subdural membrane was excised widely to expose the hematoma cavity (►**Fig. 2A**). The loculations were dissected and internal membrane if any was excised (►**Fig. 2B**). After hematoma evacuation, the cavity was irrigated with warm normal saline. A subdural closed drain without suction was placed and the dura was closed with tacking sutures. The bone flap was replaced, a subgaleal suction drain was placed and incision was closed in layers.

Results

There were 65 patients in the study, of which 56 (86.2%) were male and 9 (13.8%) were females with a mean age of 55.6 years (median 51; range 40–81 years). The most common presentation was headache ($n = 35$), followed by hemiparesis ($n = 20$) and decreased level of consciousness ($n = 20$). Other clinical presentations were seizures, slurred speech, urinary incontinence and vertigo with vomiting. The average age of patients in the burr-hole arm was 55.05 years and those who underwent mini-craniotomy was 58.5 years. Among the nine female patients, two underwent burr-hole evacuation, and seven underwent mini craniotomy, and out of the 56 male patients, 21 underwent burr-hole evacuation and 35 underwent mini-craniotomy. A total of 15 patients were on anticoagulants or anti-platelet agents. Four out of these 15 patients were in the burr-hole group and 11 were in the mini-craniotomy group. A history of trauma was seen in 45 (69.2%) out of 65 patients studied and was almost equally

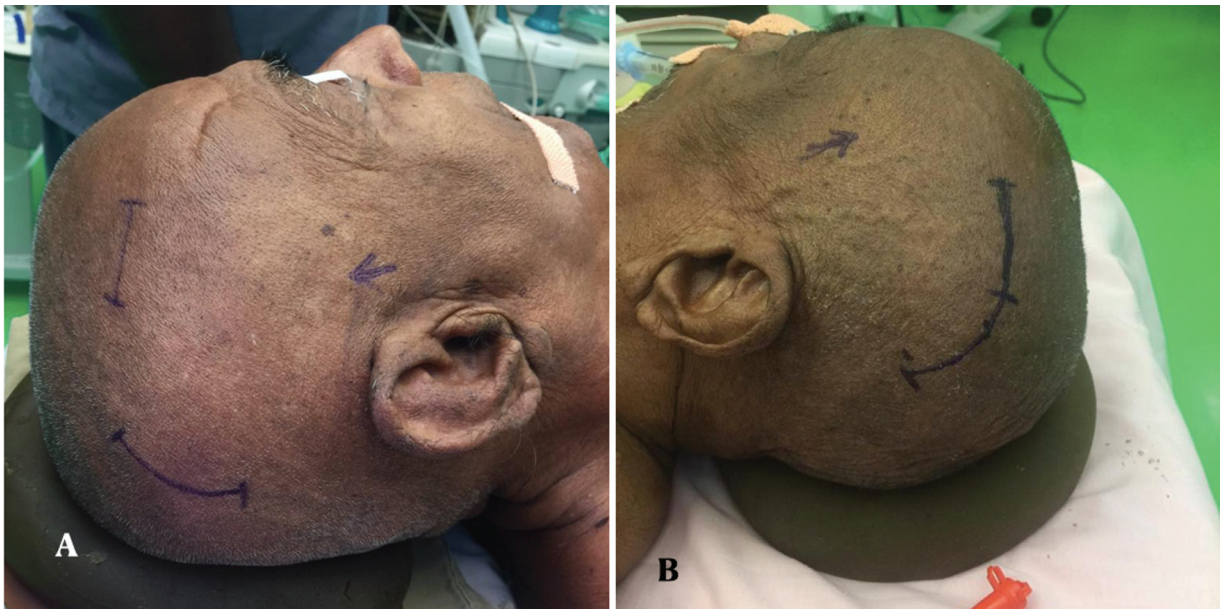

Fig. 1 Incision marking for (**A**) two burr-hole craniostomy and (**B**) mini-craniotomy.

divided in both groups (22 in burr-hole group versus 23 in mini craniotomy). Twenty-one patients had history of hypertension, 15 were diabetic, 3 patients were on anti-coagulants (2 for atrial fibrillation and 1 for stroke), and 12 were on anti-platelet medications for cardiac indications or stroke prophylaxis. There were nine active smokers and three had history of alcohol abuse among the patients.

During the study period, 65 patients collectively underwent 27 burr-hole procedures (each treated hemisphere was considered a separate procedure) and 48 minicraniotomy procedures. In the burr-hole group, among 23 patients, 27 procedures were performed (hemispheres treated). In the minicraniotomy group, 42 patients underwent 48 mini-craniotomies. There was one (3.7%) recurrence of subdural blood collection in the burr-hole group and four (8.3%) in the mini-craniotomy group.

All patients were at follow-up at 3 weeks and 59 (90.7%) patients at 3 months after surgery. Three recurrences were noted at 3-week and one at 3-month follow-up. The patients were symptomatic (two with recurrent headaches and one each with limb weakness and seizure) and were operated with either a fresh mini-craniotomy in the burr-hole group or re-exploration of previous craniotomy in the mini-craniotomy group. There was no statistical difference in the recurrence rate, duration of hospital stay, GCS at discharge, modified Rankin score between the two study groups. As expected, the mean operative time was statistically higher in the mini-craniotomy group versus the burr-hole treatment

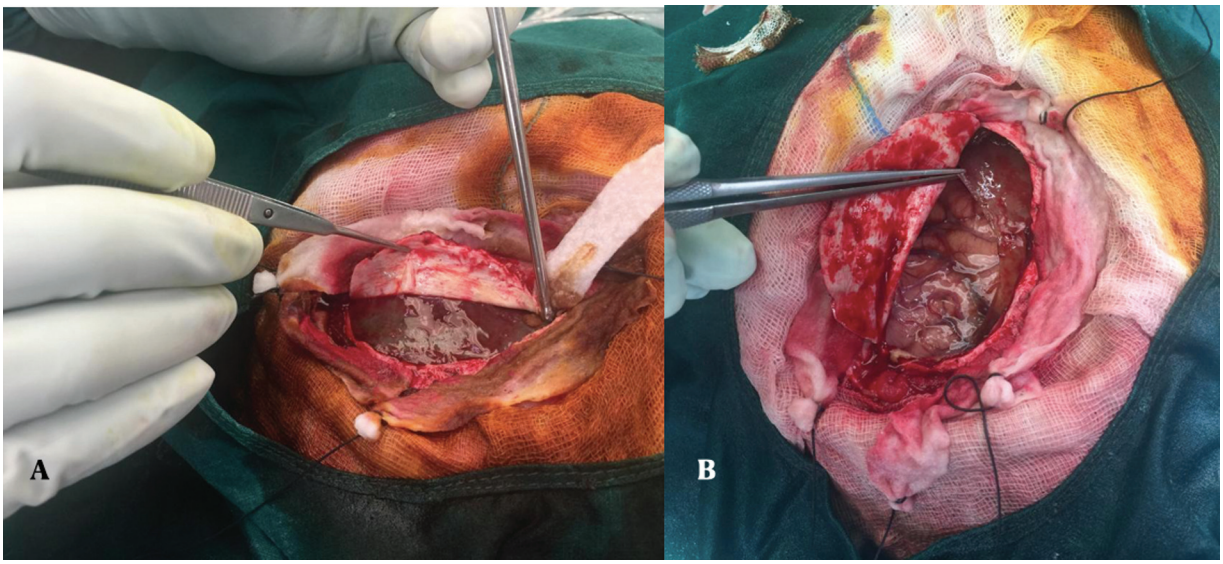

Fig. 2 (**A**) Visualization of outer membrane of the cSDH after durotomy. (**B**) Excision of the inner membrane.

Table 1 Surgical outcomes of two intervention arms

	Burr-hole	Minicraniotomy	*p*-Value
Recurrence rates	1 (3.7%)	4 (8.3%)	0.08
Operative time (min)	75.4	124.2	$< 0.001^{*}$
Length of stay (d)	6	9	0.07
GCS at discharge (range; mode)	14.5 (13–15;14)	13.6 (13–15;14)	
Modified Rankin score at follow-up (range; median)	1.7 (0–3;1)	1.6 (0–2;1)	

arm (124.2 min vs. 75.4 min; $p < 0.001$). The results are summarized in ►**Table 1**. A patient in the mini-craniotomy arm developed postoperative wound infection requiring re-exploration and bone flap removal. There were no mortalities recorded in the two groups.

Discussion

The first documented report of a cSDH was made by Johannes Wepfer in 1657.[9] Over the years, the surgical management of cSDH has focused on the usage of single versus two burr-hole drainage, placement of subdural or subperiosteal drain after hematoma evacuation, simple hematoma drainage versus irrigation of the subdural space, mini-craniotomy followed by hematoma drainage based on radiological findings, and endoscopic drainage of the cSDH.[1,2,10–12] The incidence of cSDH is increasing due to longer life expectancy, a greater fall risk or trivial head trauma in the elderly population, associated co-morbidities such as alcohol abuse and use of anticoagulants and blood thinners for cardiac prophylaxis and stroke prevention. The recurrence rates for cSDH have been quoted in the range of 12 to 33% for various surgical interventions in the indexed literature.[3,13] Female gender, an atrophic brain in elderly, subdural space volume of more than 50 cm^3, a thick subdural membrane preventing expansion of the brain, insufficient drainage during the initial surgery, preoperative cardiovascular co-morbidities, low GCS at admission, and postoperative subdural air are risks for cSDH recurrence after surgery.[3,8]

A higher incidence of recurrence was noted in the craniotomy group (8.3%) when compared with the burr-hole group (3.7%). Though not statistically significant, it can be attributed to extensive surgery, which includes craniotomy, dural opening, and removal of a vascularized membrane and septations that can give rise to re-accumulation of blood in the subdural space.[1,2,12,13] Besides, the duration of surgery and postoperative hospital stay, which is longer in the craniotomy group, add to the risk of intra and postoperative complications such as venous thrombosis, pulmonary embolism, atelectasis, and metabolic abnormalities, especially in the elderly, frail population with co-morbidities. In this study, the patients underwent either procedures independent of their preoperative coagulation status, which was adequately corrected if needed before surgery.

A meta-analysis of 402 studies for 32 risk factors identified male gender, bilateral cSDH, and absence of postoperative drain placement as the factors associated with evidence for hematoma recurrence after surgery. In the same study, a higher recurrence rate was noted in the craniotomy group in comparison with the burr-hole group.[12] However, Lee et al noted a shorter duration of hospital stay and recurrence rate in patients who underwent craniotomy when compared with those with a single or dual burr-hole cSDH drainage. He ascribed it to meticulous irrigation and evacuation of the bleed, dissection. and removal of subdural septations and loculated blood collections, removal of hematoma membranes. and visualized placement of subdural drainage system.[1] In this retrospective study, there were 57 patients collectively in the single and dual burr-hole group versus 30 patients in the small craniotomy group. Besides, not all patients in the single burr-hole group had a subdural drain placed after surgery.

A multi-center retrospective cohort study involving 560 patients led by Zolfaghari compared the outcome of burrhole craniostomy with active subgaleal drain and mini-craniotomy with a passive subdural drain. The study concluded that there was no significant difference in the recurrence rates or 30-day mortality between the two groups. However, medical and surgical complications were significantly more in the mini-craniotomy group, with eight acute subdural hematomas recorded in the mini-craniotomy group.[14]

Limitations

There are some limitations of the study. The study population was small to derive a meaningful statistical outcome of the effect of age, gender. and pre-existing co-morbidities on the recurrence rate for hematoma after surgery. A higher number of patients in the craniotomy group were on anticoagulants or anti-platelet agents. However, the coagulation profile was normalized in all patients on anticoagulants with administration of fresh frozen plasma or by platelet transfusion in patients on anti-platelet agents before surgery. The management of septations or loculations within the cSDH cavity usually accessed after mini-craniotomy was not addressed in the study. This is addressed in the retrospective study by Shim et al, which evaluated the outcome of patients who underwent either burr-hole or craniotomy based on the CT image findings. The study concluded that burr-hole drainage was adequate to evacuate cSDH with a lower recurrence rate than the small craniotomy group (13.3 vs. 46.7%). However, a small craniotomy was needed in some cases of cSDH with clotted blood or multiple septa.[2]

Conclusion

This study validates the advantage of burr-hole drainage over mini-craniotomy for the treatment of cSDH. A shorter duration of surgery and hospitalization, a lower recurrence rate was seen in the burr-hole craniostomy group. These findings are noted irrespective of either the pre-operative anti-coagulation/anti-platelet usage status (adequately addressed before surgery in both groups) or radiological imaging findings of the cSDH. This pilot study also attests the efficacy and safety profile of simple two burr-hole drainage over mini-craniotomy.

Funding
None.

Conflict of Interest
None declared.

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