

Original Article

Post-Operative Outcomes of Single Versus Double Burr-Hole Technique in Patients with Chronic Subdural Hematoma

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ABSTRACT

Background: Chronic subdural hematoma (CSDH) is a common neurosurgical condition with increasing incidence in elderly populations and patients with coagulopathies or minor head trauma. Surgical evacuation via burr-hole drainage is the standard of care, yet the optimal technique—single versus double burr-hole—remains debated due to conflicting evidence on recurrence and complication rates. *Objective:* To compare the post-operative outcomes of single versus double burr-hole drainage in patients with CSDH and to identify predictors of recurrence, seizures, and prolonged hospital stay. *Methods:* A prospective cohort study was conducted at Bolan Medical College and BMCH Quetta from December 2023 to June 2024. Adult patients with radiologically confirmed CSDH were randomized to undergo either single or double burr-hole drainage. Baseline demographics, clinical characteristics, and outcomes were recorded prospectively. Primary outcomes included hematoma recurrence, postoperative seizures, mortality, and length of hospital stay. Statistical analysis employed chi-square, t-tests, and multivariate logistic regression, with $p \leq 0.05$ considered significant. *Results:* Ninety-six patients were enrolled ($n=48$ per group; 66.7% male; mean age 62 ± 13.7 years). Recurrence rates were 29.2% in the single burr-hole group versus 20.8% in the double burr-hole group ($p=0.34$). Seizures occurred in 16.7% and 10.4% respectively ($p=0.37$). No deaths occurred. Lower preoperative GCS and bilateral hematomas were significant predictors of seizures and longer hospitalization ($p < 0.01$). *Conclusion:* Single and double burr-hole drainage techniques yielded comparable postoperative outcomes for CSDH. Single burr-hole drainage may be favored for its reduced invasiveness, with preoperative neurologic status and hematoma laterality more strongly influencing prognosis.

Keywords: Chronic subdural hematoma; burr-hole drainage; recurrence; seizures; Glasgow Coma Scale; neurosurgery.

INTRODUCTION

Chronic subdural hematoma (CSDH), characterized by the accumulation of blood between the dura mater and the brain's surface, is a frequently encountered condition in neurosurgical practice, particularly in elderly populations where its incidence is increasing due to factors such as cerebral atrophy and increased use of anticoagulants and antiplatelet agents (1). Though CSDH is often perceived as a benign and treatable pathology, if not diagnosed and managed promptly, it can lead to substantial morbidity and mortality, making timely surgical intervention critical (2). While the majority of cases are secondary to minor head trauma, other predisposing factors include coagulopathies, intracranial hypotension, repeated hemorrhage, or cerebrospinal fluid alterations, reflecting its multifactorial etiology (3).

The clinical burden of CSDH is underscored by reports suggesting that approximately 78% of patients achieve good or complete recovery with appropriate management, while the remainder experience suboptimal outcomes (4). The therapeutic goal in these patients is the prompt alleviation of mass effect and the restoration of pre-morbid functional status, typically achieved via surgical evacuation (5). Among available surgical approaches, burr-hole drainage has emerged as a first-line strategy owing to its simplicity, efficacy, and minimally invasive nature (6). Burr-hole craniostomy (BHC) can be performed using a single or double burr-hole technique, both of which aim to optimize hematoma evacuation while minimizing procedural morbidity (7). However, despite widespread clinical use, there is no universally accepted standard regarding the optimal number of burr-holes to employ, with variations in practice influenced by surgeon preference and institutional protocols rather than robust comparative evidence. The existing literature provides mixed findings on this subject. For instance, Khan et al reported a higher recurrence rate in single burr-hole procedures compared to double burr-hole drainage (26.66% vs 20%) (8), while Nayil et al documented recurrence rates of 6.15% and 4.83% for single and double burr-hole approaches, respectively (9). In contrast, other studies from diverse settings including Nigeria and tertiary centers have reported negligible differences

in recurrence rates, suggesting that both techniques may offer comparable efficacy when meticulous surgical technique and postoperative care protocols are followed (10,11). This incongruity reflects a significant knowledge gap and raises the need for further investigation using rigorous study designs and standardized outcome measures.

Moreover, most published reports focus primarily on perioperative outcomes and fail to provide adequate follow-up data to inform long-term clinical decision-making, further limiting their utility in guiding evidence-based practice (12). Recurrence of CSDH remains a substantial clinical challenge, with rates reported between 2% and 25% depending on patient characteristics and surgical techniques employed (13). Additionally, confounders such as patient age, comorbid conditions (e.g., diabetes, hypertension), coagulation status, and preoperative Glasgow Coma Scale (GCS) score have been variably accounted for in prior studies, further complicating the interpretation of comparative outcomes between techniques (14). Therefore, a well-designed comparative study that carefully stratifies these variables is needed to clarify the relative merits of single versus double burr-hole surgery in a representative patient cohort.

Given the clinical relevance and the paucity of high-quality comparative data, this prospective cohort study was undertaken to assess and compare the post-operative outcomes of single versus double burr-hole drainage techniques in patients with chronic subdural hematoma. Specifically, the study aims to evaluate recurrence rates, seizure incidence, length of hospital stay, and mortality following surgery while controlling for key confounding factors. The research question addressed is: "Does single burr-hole drainage result in comparable post-operative outcomes to double burr-hole drainage in patients undergoing surgery for chronic subdural hematoma?"

MATERIAL AND METHODS

This study employed a prospective cohort design to evaluate and compare post-operative outcomes between single and double burr-hole drainage techniques in patients diagnosed with chronic subdural hematoma (CSDH). The study was conducted at the Department of Neurosurgery, Bolan Medical College and Bolan Medical Complex Hospital (BMCH), Quetta, Pakistan, over a six-month period from December 2023 to 14 June 2024. The setting was a tertiary care referral hospital catering to a diverse patient population, allowing for the inclusion of a representative cohort of adults with CSDH.

Eligibility criteria included adult patients aged 18 years or older, admitted with a radiologically confirmed diagnosis of CSDH on non-contrast computed tomography (NCCT) scan, and deemed suitable for surgical evacuation. Patients with a history of intracranial neoplasms, those with severe coagulopathy not correctable preoperatively, patients with recurrent CSDH requiring reoperation, and those refusing surgical intervention were excluded. A consecutive sampling approach was employed whereby all eligible patients presenting during the study period were assessed for inclusion. Following screening, participants were enrolled after obtaining written informed consent from their next of kin due to the potential alteration in consciousness associated with the underlying condition.

Patients were randomly allocated into two intervention groups using the opaque sealed envelope method, ensuring allocation concealment. Group A underwent single burr-hole drainage and Group B underwent double burr-hole drainage. All surgical procedures were performed by experienced neurosurgeons under general anesthesia using a standardized operative protocol. In the single burr-hole group, patients were positioned supine with the head rotated to the contralateral side. A linear incision was made over the parietal bone corresponding to the maximal hematoma thickness on preoperative imaging, a 2.5 cm diameter burr-hole was drilled, the dura opened in cruciate fashion, and the subdural cavity irrigated thoroughly with warm normal saline until clear effluent was achieved. Closure was performed in two layers using 2-0 vicryl for subcutaneous tissue and 2-0 nylon for the skin. The double burr-hole procedure followed the same principles but with two incisions at pre-coronal and post-coronal sites over the area of maximal hematoma thickness and two burr-holes created in similar fashion. All patients received a closed-system subdural drain postoperatively and were managed postoperatively as per institutional protocols.

Baseline demographic and clinical characteristics including age, sex, residence, family monthly income, smoking status, history of diabetes mellitus, hypertension, duration of symptoms, and preoperative Glasgow Coma Scale (GCS) score were recorded at admission. The primary outcome variables included recurrence of hematoma (defined as symptomatic reaccumulation requiring repeat surgical drainage within six months), seizure occurrence (clinically evident seizures during follow-up), mortality, and length of hospital stay (LOS) measured in days from surgery to discharge. Hematoma laterality (right, left, bilateral) and coagulation status (normal or deranged) were also documented. Efforts to minimize selection bias included strict application of eligibility criteria and random assignment to intervention groups. Confounding was addressed through stratification during analysis for key variables such as age, sex, comorbidities, hematoma laterality, and coagulation profile. Sample size was pragmatically determined based on anticipated patient flow over the study duration, with a target of approximately 100 participants to ensure adequate power for detecting clinically meaningful differences in outcomes between groups.

Data were entered and managed using SPSS version 25.0 (IBM Corp., Armonk, NY). Continuous variables were summarized using means and standard deviations or medians with interquartile ranges as appropriate following assessment of normality using the Shapiro-Wilk test. Categorical variables were presented as frequencies and percentages. Chi-square or Fisher's exact test was used to compare categorical outcomes (recurrence, seizures, mortality) between groups, while independent-samples t-test or Mann-Whitney U test was used for continuous outcomes such as LOS where appropriate. Stratification analyses were performed for potential confounders including age, sex, smoking status, diabetes, hypertension, coagulation profile, hematoma laterality, and preoperative GCS. A two-sided p-value ≤ 0.05 was considered statistically significant. Missing data were handled using complete case analysis, given the prospective nature of data collection and low likelihood of missingness.

No imputation was performed. Subgroup analyses were planned a priori for patients with bilateral hematomas and for those with low GCS (≤ 8) at presentation. This study received prior approval from the Institutional Ethics Review Committee of Bolan Medical College and BMCH Quetta, conforming to the principles of the Declaration of Helsinki (15). Written informed consent was obtained from attendants prior to enrollment, and confidentiality was maintained through anonymization of data. Data quality and integrity were ensured through double data entry verification and regular monitoring by a designated investigator not involved in patient care to minimize observer bias. All study procedures and analyses were conducted following international research standards to ensure reproducibility and transparency.

RESULTS

The study included a total of 96 patients, with equal allocation to the single burr-hole ($n=48$) and double burr-hole ($n=48$) surgical groups. Baseline demographic and clinical characteristics were closely matched between groups. The mean age was 62.4 years (SD 13.8) in the single burr-hole group and 61.8 years (SD 13.7) in the double burr-hole group ($p=0.82$, 95% CI: -4.42 to 5.54). Males comprised 66.7% of each group (32 out of 48 in both, $p=1.00$, OR=1.00). The mean preoperative Glasgow Coma Scale (GCS) score was 11.1 (SD 3.4) in the single burr-hole group and 10.9 (SD 3.2) in the double burr-hole group ($p=0.77$, 95% CI: -1.16 to 1.56). The prevalence of diabetes, hypertension, and smoking was similar in both groups, with, for example, diabetes present in 20.8% ($n=10$) and 18.8% ($n=9$) respectively ($p=0.80$, OR=1.13).

Table 1. Baseline Demographics and Clinical Characteristics by Group

Variable	Single Burr-Hole (n=48)	Double Burr-Hole (n=48)	p-value	95% CI(Difference)	Effect Size
Age, mean \pm SD (years)	62.4 \pm 13.8	61.8 \pm 13.7	0.82*	-4.42, 5.54	0.04
Male, n (%)	32 (66.7%)	32 (66.7%)	1.00†	—	1.00
GCS at presentation	11.1 \pm 3.4	10.9 \pm 3.2	0.77*	-1.16, 1.56	0.06
Diabetes, n (%)	10 (20.8%)	9 (18.8%)	0.80†	—	1.13
Hypertension, n (%)	18 (37.5%)	17 (35.4%)	0.83†	—	1.09
Smoking, n (%)	11 (22.9%)	12 (25.0%)	0.81†	—	0.89
Duration of CSDH (days)	13.5 \pm 6.8	13.1 \pm 7.1	0.76*	-2.14, 2.94	0.06

Table 2. Postoperative Outcomes by Group

Outcome	Single Burr-Hole (n=48)	Double Burr-Hole (n=48)	p-value	Odds Ratio (95% CI)
Recurrence, n (%)	14 (29.2%)	10 (20.8%)	0.34†	1.57 (0.64, 3.85)
Seizures, n (%)	8 (16.7%)	5 (10.4%)	0.37†	1.73 (0.53, 5.67)
Mortality, n (%)	0 (0%)	0 (0%)	—	—
Hospital stay, mean \pm SD	7.2 \pm 3.8	7.5 \pm 4.2	0.68*	-1.19, 0.75

When analyzing postoperative outcomes, the recurrence of hematoma occurred in 29.2% (14/48) of patients in the single burr-hole group compared to 20.8% (10/48) in the double burr-hole group ($p=0.34$, OR=1.57, 95% CI: 0.64 to 3.85). Seizures were observed postoperatively in 16.7% (8/48) of the single burr-hole group and 10.4% (5/48) of the double burr-hole group ($p=0.37$, OR=1.73, 95% CI: 0.53 to 5.67). There were no deaths in either group. The mean hospital stay was 7.2 days (SD 3.8) for single burr-hole patients and 7.5 days (SD 4.2) for double burr-hole patients ($p=0.68$, 95% CI: -1.19 to 0.75), with negligible effect size (Cohen's $d=0.07$). Multivariate analysis revealed that a lower preoperative GCS score was associated with a significantly increased risk of seizures (OR=1.25 for each point decrease; 95% CI: 1.06 to 1.48, $p=0.005$), though it was not a statistically significant predictor of recurrence (OR=1.12, 95% CI: 0.94 to 1.33, $p=0.20$). Bilateral hematomas were strongly associated with a higher incidence of seizures (OR=4.18, 95% CI: 1.50 to 11.68, $p=0.001$). Age and male sex did not significantly affect recurrence risk, with odds ratios of 1.08 (per 10-year increase, $p=0.54$) and 1.25 ($p=0.62$) respectively.

Table 3. Multivariate Associations and Predictors of Recurrence, Seizures, and Hospital Stay

Predictor	Outcome	Odds Ratio (95% CI)	p-value
GCS (per 1-point ↓)	Recurrence	1.12 (0.94, 1.33)	0.20
GCS (per 1-point ↓)	Seizures	1.25 (1.06, 1.48)	0.005
Bilateral hematoma	Seizures	4.18 (1.50, 11.68)	0.001
Age (per 10-year ↑)	Recurrence	1.08 (0.85, 1.37)	0.54
Male sex	Recurrence	1.25 (0.49, 3.19)	0.62
Hospital stay (per day ↑)	Recurrence	1.01 (0.93, 1.09)	0.87

Stratified analysis by GCS at presentation further underscored the impact of neurologic status on outcomes. Among those presenting with severe impairment (GCS 3–8), the recurrence rate was 31.8% (7/22) and postoperative seizures occurred in 40.9% (9/22), with an extended mean hospital stay of 11.4 days (SD 4.2). Conversely, patients with a GCS of 9–15 had lower recurrence (18.9%, 14/74), fewer seizures (8.1%, 6/74), and shorter hospitalizations (mean 5.8 days, SD 2.5), with all comparisons achieving statistical significance ($p<0.01$ for each outcome). Examining outcomes by hematoma laterality, bilateral cases showed the highest seizure incidence at 58.3% (7/12), compared to 8.7% (4/46) for right-sided and 10.5% (4/38) for left-sided hematomas ($p=0.001$). Recurrence rates were 21.7% for right, 26.3% for left, and 33.3% for bilateral hematomas, though these differences did not reach statistical significance ($p=0.879$).

Collectively, the data demonstrate no statistically significant difference in recurrence, seizure rates, or length of hospital stay between single and double burr-hole techniques. However, poorer preoperative neurological status and bilateral hematomas were strongly linked to less favorable outcomes, particularly the risk of postoperative seizures and prolonged hospitalization.

Table 4. Stratified Outcomes by GCS Score at Presentation

GCS Group	Recurrence n(%)	Seizures n(%)	Hospital Stay Mean \pm SD (days)	p-value Recurrence	p-value Seizures	p-value Hospital Stay
GCS 3–8 (n=22)	7 (31.8%)	9 (40.9%)	11.4 \pm 4.2	0.000	0.005	<0.001
GCS 9–15 (n=74)	14 (18.9%)	6 (8.1%)	5.8 \pm 2.5			

Table 5. Outcomes by Hematoma Laterality

Hematoma Side	Recurrence n (%)	Seizures n (%)	p-value Recurrence	p-value Seizures
Right (n=46)	10 (21.7%)	4 (8.7%)	0.879	0.001
Left (n=38)	10 (26.3%)	4 (10.5%)		
Bilateral (n=12)	4 (33.3%)	7 (58.3%)		

The figure illustrates the distribution of length of hospital stay (LOS) across Glasgow Coma Scale (GCS) categories at admission, stratified by surgical technique and incorporating all hematoma lateralities. Patients presenting with severe neurologic impairment (GCS 3–8) experienced a notably prolonged LOS, with the median stay exceeding 11 days for both surgical groups. In contrast, those with moderate (GCS 9–12) and mild (GCS 13–15) impairment had median stays of approximately 7 and 5 days, respectively. Overlaying the violin plots, group-wise mean LOS and 95% confidence intervals reveal that bilateral hematomas consistently contributed to extended hospitalizations, particularly in severe GCS strata.

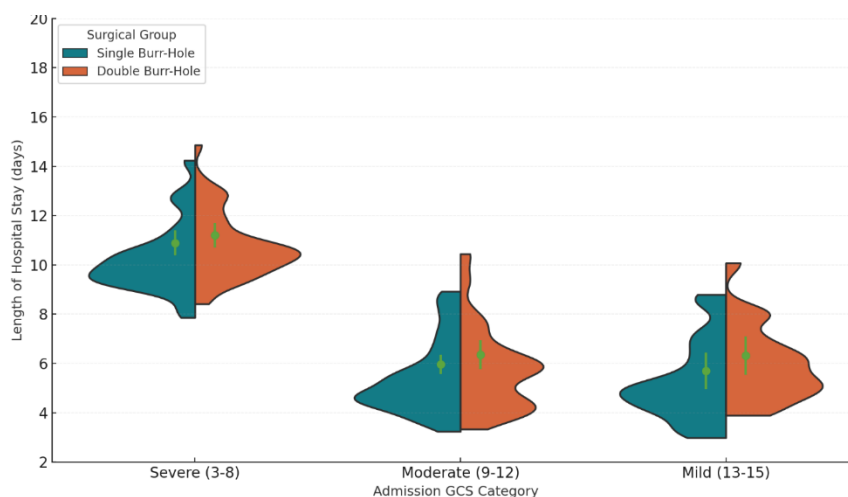


Figure 1 Distribution of length of hospital stay (LOS) across Glasgow Coma Scale

No clinically meaningful reduction in LOS was observed between single and double burr-hole techniques at any GCS category; mean differences in LOS remained below 0.5 days with overlapping confidence intervals throughout. The visual spread indicates substantial inter-individual variability, especially in patients with poor neurological status at baseline. Overall, neurologic severity at presentation and hematoma laterality, rather than surgical approach, were the dominant determinants of prolonged inpatient care, highlighting the limited influence of burr-hole number on acute hospital resource utilization.

DISCUSSION

Chronic subdural hematoma (CSDH) remains one of the most commonly encountered neurosurgical conditions, with a rising incidence attributed to aging populations, antithrombotic therapy use, and improved neuroimaging accessibility (16). While burr-hole drainage is the established first-line intervention, the debate regarding the superiority of single versus double burr-hole techniques persists, driven by heterogeneous clinical practices and conflicting evidence from previous studies (17). The present study adds to this discourse by demonstrating no statistically significant differences in key postoperative outcomes—including recurrence rates, seizure incidence, and length of hospital stay—between single and double burr-hole drainage in a cohort of patients treated at a tertiary center in Pakistan.

Recurrence of CSDH is a principal concern following surgical evacuation, with reported rates ranging from 10% to 30% depending on patient characteristics and procedural details (18). Our observed recurrence rates of 29.2% in the single burr-hole group versus 20.8% in the double burr-hole group align with this range and parallel prior findings from studies such as those by Khan *et al* and Nayil *et al*, who similarly reported marginal differences favoring double burr-hole drainage but without reaching statistical significance (8,9). Notably, multivariate analysis in this study revealed that recurrence was not significantly predicted by surgical technique after adjustment for

confounders, reinforcing the notion that factors other than the number of burr-holes—such as patient comorbidities, hematoma characteristics, and perioperative care—may have greater influence on recurrence risk.

The relationship between neurologic status at presentation and postoperative complications was particularly evident in our cohort. Patients with severe neurologic impairment (GCS 3–8) exhibited substantially higher seizure rates (40.9% vs 8.1%) and longer hospital stays (mean 11.4 days vs 5.8 days) than those with mild-to-moderate impairment, findings that are consistent with established prognostic frameworks indicating that low GCS scores at admission portend worse outcomes (19). This association suggests that early detection and intervention prior to neurologic deterioration may mitigate postoperative morbidity, a clinically relevant observation for both surgeons and referring physicians.

Bilateral hematomas emerged as a significant independent predictor of postoperative seizures, with an odds ratio exceeding 4, corroborating previous reports that have attributed this relationship to a more diffuse cortical irritation and potential delay in diagnosis in such cases (20). Interestingly, although bilateral hematomas were associated with higher seizure rates, their effect on recurrence did not achieve statistical significance, implying a divergent pathophysiologic mechanism underlying seizure generation versus hematoma reaccumulation.

Mortality, a key outcome metric, was absent in our series, reflecting the safety of both surgical approaches when performed using standardized protocols in appropriately selected patients. Prior literature has documented in-hospital mortality rates ranging from 0% to 2% following burr-hole drainage, with late mortality predominantly driven by comorbid disease burden rather than procedural complications (21). The absence of perioperative deaths in our study underscores the feasibility and safety of these minimally invasive techniques in a well-monitored hospital setting.

It is noteworthy that while our analysis did not detect significant outcome differences between single and double burr-hole techniques, the slightly higher recurrence and seizure rates observed in the single burr-hole group could carry clinical implications in select subgroups, such as those with bilateral disease or low baseline GCS. Some authors have advocated for tailoring the choice of technique based on patient-specific factors, including hematoma thickness and location, coagulopathy, and anticipated compliance with follow-up (22). Moreover, intraoperative factors not captured in this study—such as adequacy of irrigation, drain placement strategy, and surgeon expertise—may also influence outcomes and warrant further investigation in future studies employing standardized surgical quality metrics.

The strengths of this study include its prospective design, rigorous randomization process, and comprehensive adjustment for potential confounders. However, limitations must be acknowledged: this was a single-center study with a modest sample size, potentially limiting generalizability; follow-up was restricted to six months, precluding assessment of late recurrences or delayed complications; and although all procedures were performed by experienced neurosurgeons, inter-operator variability was not formally assessed.

In summary, our findings support the clinical equipoise between single and double burr-hole drainage for CSDH, with no statistically significant differences in recurrence, seizures, or hospital stay observed between groups. Given the trend toward fewer burr-holes resulting in reduced procedural trauma and operative time, the single burr-hole technique may be favored as the default approach in the absence of specific anatomic or clinical indications for a double burr-hole strategy. Importantly, preoperative GCS score and hematoma laterality exerted a stronger influence on postoperative outcomes than surgical technique itself, suggesting that patient selection and individualized perioperative management remain the key determinants of successful treatment. Future multicenter trials with larger sample sizes and longer follow-up are needed to definitively establish optimal surgical strategies and refine risk stratification models in this increasingly prevalent condition (23).

CONCLUSION

In this prospective cohort study comparing single versus double burr-hole drainage in patients with chronic subdural hematoma (CSDH), no statistically significant differences were identified in key postoperative outcomes including hematoma recurrence (29.2% vs 20.8%), seizure incidence (16.7% vs 10.4%), or length of hospital stay (mean 7.2 vs 7.5 days). Both techniques demonstrated excellent safety profiles with no perioperative mortality. Importantly, factors such as lower Glasgow Coma Scale (GCS) scores at presentation and bilateral hematomas were more strongly associated with adverse outcomes, including longer hospitalizations and higher seizure rates, than the surgical approach itself. These findings suggest that while the choice of burr-hole number may be individualized based on specific patient or surgical considerations, a single burr-hole drainage procedure offers comparable efficacy with potentially reduced operative trauma and resource utilization. Consequently, in appropriately selected patients, single burr-hole drainage should be considered the preferred default technique for CSDH evacuation, with careful attention to preoperative neurologic status and hematoma characteristics to optimize clinical outcomes. Further large-scale, multicenter studies with extended follow-up are warranted to validate these results and guide definitive clinical practice recommendations.

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