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Technical Notes & Surgical Techniques

A comparative study of chronic subdural hematoma Burr hole craniostomy treatment: To irrigate or not to irrigate

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ABSTRACT

Background: Chronic subdural hematomas (CSDHs) are increasingly prevalent in the neurosurgical field and are treated using three general methods, of which the most common is the burr hole craniostomy (BHC). However, the efficacy of various methods of irrigation used during BHC remains uncertain.
Objective: To investigate the use of no irrigation versus in situ irrigation in the BHC treatment of CSDH.
Patients and methods: We retrospectively reviewed 258 CSDH cases at our institution between 2000 and 2014. Group A ($N = 184$) underwent BHC without irrigation, and Group B ($N = 74$) BHC with in situ irrigation. Fisher exact tests were used to compare postoperative recurrent CSDH and acute postoperative hemorrhagic complications (e.g., contusions, ICH, acute SDH) rates between the groups. Logistic regression analysis was used to determine clinical predictive factors for postoperative recurrent CSDH and acute postoperative hemorrhagic complications in both groups.
Results: No differences were found in baseline characteristics between the two study groups. Overall, 194 study participants were male (75%). The mean age at diagnosis was 73 years (SD = 13.9). 19.4% (50/258) of patients had recurrent CSDH and 7.4% (19/258) had acute postoperative hemorrhagic complications. There was no significant difference in the number of recurrent CSDH cases (34/184 in Group A vs. 16/74 in Group B, $p = 0.60$) or the number of acute postoperative hemorrhagic complications (12/184 in Group A vs. 7/74 in Group B, $p = 0.43$) between the two groups. Also, there was no significant association between the type of irrigation, demographic or clinical factors and postoperative recurrent CSDH or acute postoperative hemorrhagic complications.
Conclusions: This study results showed no differences in the recurrence of CSDH and acute postoperative hemorrhagic complications in patients undergoing BHC alone or with in situ irrigation. Future randomized controlled trials are needed to determine the clinical impact of the irrigation method in BHC.

1. Introduction

Chronic subdural hematomas (CSDH) are collections of blood and its degradation products located beneath the dura mater, which may cause cerebral tissue compression and thus lead to neurological changes. It is generally thought to have two origins: one from subdural hygromas (SDG) and the other from acute subdural hematoma (SDH). SDG represent an accumulation of cerebrospinal fluid (CSF) underneath the dura. When they do not resolve, the dural border cells proliferate to form a neomembrane and a CSDH develops with multiple micro-hemorrhages of the fragile vessels formed in and around the neomembrane. On the contrary, an acute SDH is usually traumatic, resulting from direct or indirect trauma to the cranium, and leading to tearing of the parasagittal bridging veins [1,2]. When there is sufficient potential subdural space, the SDH can become a CSDH, which will enlarge as long as re-bleeding exceeds absorption. Local hyperfibrinolysis and continuous hemorrhage from neomembrane vessels have long been identified as important etiologic factors in the development of CSDH [2]. Nevertheless, the fate of a CSDH depends on the effects of absorption-expansion, the maturation and thus stability of the neomembranes, as well as the premorbid status of the patient [1].

The three most common surgical techniques for treating CSDH

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include burr hole craniostomy (BHC), bedside twist drill craniostomy (TDC) and craniotomy. These can be performed with or without irrigation and/or drainage. When used, types of irrigation include in situ irrigation (irrigation from within the surgical cavity, using a catheter) and simple irrigation (irrigation from outside the surgical cavity). TDC generally involves a < 0.5 cm diameter craniostomy, whereas a craniotomy is typically > 3 cm in diameter, and values in between are generally reserved for BHC. In their meta-analysis, Weigel et al. showed that all these techniques had about the same mortality rate (2–4%) [3]. However, craniotomy had a much higher morbidity than craniostomy (12.3% vs. 3% TDC or 3.8% BHC) and the recurrence rate was increased with TDC (3–76%) compared to BHC (0–28.8%) or craniotomy (0–44%) [3]. Furthermore, Almenawer et al. found in their study that craniotomy is associated with higher complication rates if considered initially, whereas it is superior to the other procedures in the management of recurrences [4]. Based on the most complete evidence we have so far, BHC with drainage has become the most popular surgical technique used for the initial treatment of CSDH worldwide [5,6]. The recurrence of CSDH after this surgical procedure has been reported to be 5–30% in the literature [6].

CSDH is very commonly encountered in the neurosurgical field today, especially in the elderly population frequently after minor head injuries [9,10]. Its incidence has been reported to be 5 cases per 100,000 people/year in the general population, with values ten times higher in the elderly population [7]. Given the calculated increase of the elderly population in the next 20 years [6,8], it has become paramount to determine the most effective treatment method for CSDH, while reducing morbidity/mortality as well as CSDH recurrence [2,8,9]. A recent randomized trial for the management of CSDH was performed to determine the effect of drains used after BHC on CSDH recurrence and other clinical outcomes [6]. In their single center block-randomized controlled trial, Santarius et al. found that the use of a drain significantly reduced CSDH recurrence from 24% to 9.3% and as well, reduced 6-month mortality from 18.1% to 8.6%, without significantly increasing surgical complications [6]. These findings have been recently supported by the results of the Almenawer et al. meta-analysis that showed a significant reduction in recurrences with the use of drains [4].

There is limited published literature regarding the efficacy of irrigation in the treatment of CSDH and even less for the rate of acute postoperative hemorrhagic complications (e.g., intracerebral hemorrhage (ICH) and acute subdural hemorrhage (SDH). Irrigation remains a contentious issue in the treatment of CSDH as there are studies supporting either side of the debate of whether or not irrigation reduces recurrence of CSDH or increases the risk of complications or morbidity. Moreover, the currently available research is sometimes vague with respect to how exactly irrigation is used in the treatment of CSDH.

2. Objectives and hypothesis

At The Ottawa Hospital – Civic Campus, most patients with CSDH are treated with a BHC, using a drain, as well as either no irrigation or in situ irrigation. The purpose of this study was to compare the use of in situ irrigation versus no irrigation in the BHC treatment of CSDH patients. We determined the prevalence of recurrent CSDH and acute postoperative hemorrhagic complications (e.g., contusions, ICH or acute SDH) among the study participants after using these techniques. Based on the study results, we hoped to provide future patients with accurate information regarding the risks of the provided surgical procedures in our hospital, allowing patients and their families to make more informed decisions about their medical and surgical care, along with providing medical professionals in the neurosurgery field with more data to support recommendation decisions for the treatment of CSDH. We hypothesized that in situ irrigation is associated with lower recurrent CSDH rates but higher rates of post-operative hemorrhagic complications.

3. Methods

This is a retrospective cohort study examining patients aged 18 years and above with first time presentation of symptomatic unilateral CSDH. The patients were treated with BHC with no irrigation or in situ irrigation at The Ottawa Hospital – Civic Campus, between January 1st, 2000 and July 20th, 2014. Exclusion criteria included bilateral CSDH, recurrent CSDH, and absence of postoperative CT Head within 72 hours postoperatively. Sample size calculation was based on a 20% difference in CSDH recurrence found in BHC with irrigation in previous published studies [13,14]. There were 258 patients included in the study. Depending on the type of surgical intervention, each patient was assigned to one of the two study groups: Group A ($N = 184$) included all study participants treated with BHC and no irrigation; Group B ($N = 74$) included study participants treated with BHC and in situ irrigation.

The primary outcome was to compare the two study groups' rates of recurrent CSDH requiring re-intervention within 6 months after initial evacuation and also the rates of acute postoperative hemorrhagic complications (e.g., contusions, ICH or acute SDH) occurring within 3 days of CSDH evacuation. The secondary outcome was to determine the clinical predictive factors for postoperative recurrent CSDH and acute postoperative hemorrhagic complications in both groups.

3.1. Data management

Information gathered included patient demographics (e.g. age, sex, occupation, activity level) as well as clinical information including laterality and size of CSDH, initial clinical presentation, GCS at hospital admission and discharge, initial CT imaging report (e.g., presence of midline shift on initial imaging), operative technique, duration before recurrence, and repeat surgical technique. This data was retrospectively abstracted from patient charts.

3.2. Statistical analysis

First, we performed a descriptive analysis using demographic (e.g., age, gender), clinical (presentation symptomatology, size and location of SDH) and intervention type data. Then, using Fisher exact test (two-sided, p value < 0.5 was considered statistically significant) we compared the rates of recurrent CSDH and acute postoperative hemorrhagic complications between the two study groups. Finally, logistic regression analysis was used to determine if there was a relationship between BHC with in situ or no irrigation, demographic (e.g., age, gender), clinical factors (e.g., presentation symptoms, size of SDH, location of SDH) and postoperative recurrent CSDH or acute postoperative hemorrhagic complications. SAS software (SAS version 9.4 for Windows, SAS Institute Inc., Cary, NC, USA) was used for the statistical analysis.

4. Results

A total of 258 patients who met the inclusion criteria were treated for CSDH at The Ottawa Hospital – Civic Campus, between January 1st, 2000 and July 20th, 2014. The mean age at diagnosis was 73 years (SD = 13.9, range: 24–98), with 75% (194/258) of the patients being male. Overall, the most common symptoms at presentation were headaches (94/258, 36.4%), falls (92/258, 35.6%), weakness (86/258, 33.3%) and confusion (78/258, 30.2%). More than half of the study participants (159/258, 61.6%) had a CSDH size over 2 cm. Furthermore, the majority of the CSDH patients in the study (184/258, 71.3%) were treated with BHC without irrigation, and just 28.7% (74/258) were treated with BHC and in situ irrigation. Overall, there were a small number of patients with postoperative recurrent CSDH (50/258, 19.4%) and acute postoperative hemorrhagic complications (19/258, 7.4%). (Table 1) Moreover, 7 out of 19 cases (2.7%) with acute postoperative hemorrhagic complications were radiologically diagnosed (by

Table 1
Overall baseline characteristics and outcomes of study participants admitted to The Ottawa Hospital – Civic Campus during period of January 1st, 2000 and June 20th, 2014.

Variable	Number of patients (N = 258)	Percentage
Age at diagnosis (years)		
Mean age	73	
Range	24–98	
Age groups		
20–39	6	(2.33%)
40–59	38	(14.79%)
60–79	109	(42.41%)
80–99	104	(40.47%)
Gender		
Female	64	(24.81%)
Male	194	(75.19%)
Presentation Symptoms		
Headache		
No	164	(63.56%)
Yes	94	(36.43%)
Falls		
No	166	(64.34%)
Yes	92	(35.66%)
Weakness		
No	172	(66.67%)
Yes	86	(33.34%)
Confusion		
No	180	(69.77%)
Yes	78	(30.23%)
Size of SDH (mm)		
< 20	99	(38.37%)
≥ 20	159	(61.63%)
Location		
Right	111	(43.02%)
Left	147	(56.98%)
Type of Intervention		
No irrigation	184	(71.32%)
In situ irrigation	74	(28.68%)
Outcomes		
Recurrent CSDH		
No	208	(80.62%)
Yes	50	(19.38%)
Post-op ICH or acute SDH		
No	239	(92.64%)
Yes	19	(7.36%)

Table 2
Baseline characteristics across study groups.

Variable	Study Groups			
	BHC with no irrigation (N = 184)	Percentage	BHC with in situ irrigation (N = 74)	Percentage
Gender				
Male	138	75	57	77
Female	46	25	17	23
Patient age at diagnosis				
Mean (years)	74.8		70	
Range (years)	30–98		24–96	
Number of patients on anticoagulants	5	2.7	0	0
SDH location				
Left	106	57.6	41	55.4
Right	78	42.4	33	44.6
Size of SDH				
Mean (mm)	21.9		22.9	
Range (mm)	6–44		8–37	
Number of patients with recurrent CSDH	34	18.5	16	21.6
Number patients with postoperative	12	6.5	7	9.5
Contusions	4	2.2	3	4.1
ICH	2	1.1	2	2.7
Acute SDH	6	3.2	2	2.7

Computed tomography scan) with postoperative contusions, then 8 cases (3.1%) with postoperative acute SDH and the rest of 4 cases (1.6%) with postoperative ICH.

There were no differences in baseline characteristics among the patients included in both study groups except with respect to use for anticoagulation (5 patients in Group A vs. 0 patients in Group B) (Table 2).

Fisher exact test results showed no significant difference between the study groups in the occurrence of postoperative recurrent CSHD or acute postoperative hemorrhagic complications (e.g., contusions, ICH or acute SDH) (Table 3).

Based on the logistic regression analysis results, there was no significant association between the type of surgical intervention (BHC with or without irrigation) and postoperative recurrent CSDH (p = 0.56) as well as acute postoperative complications (p = 0.22).

Finally, there was no significant association between demographic (e.g., age, gender) or clinical factors (e.g., presentation symptomatology, size or location of SDH) and postoperative recurrent CSDH or acute postoperative hemorrhagic complications.

5. Discussion

There is no consensus in the literature regarding an optimal treatment of CSDH with respect to all treatment parameters: surgical technique, type of drainage, and type of irrigation. Although BHC is generally considered to be the most favourable operative approach, the preferable method of irrigation, if any, has long been a source of controversy in neurosurgical practice. Nevertheless, many previous studies have sought to link the type of irrigation, used in conjunction with BHC, with postoperative outcome. For example, in their retrospective study comparing treatment with BHC drainage alone (Group A) versus BHC drainage with in situ irrigation (Group B), Ishibashi et al. found that although there were no significant differences in good outcomes or mortality rates between the two treatment groups, the poor outcomes were significantly more frequent in patients treated without irrigation and this group also had a higher recurrence rate (10.3% in Group A vs. 2.9% in Group B) [10]. In this study, good outcome was defined as patients with Glasgow Outcome Scale (GOS) showing good recovery or moderate disability, whereas poor outcome was defined as patients with GOS showing severe disability, vegetative state or death [10]. These results are similar to those reported by Zakaraia et al. in their cross-sectional study of patients treated with BHC drainage, with or without irrigation [11]. Patients treated with BHC drainage with irrigation had a higher rate of good outcomes (87% vs. 83.3%) and a lower recurrence rate (10% vs. 14.3%) [11]. Of note, in this study there was no significant difference between the two groups, with respect to good outcomes, poor outcomes or recurrence [11]. Comparably, Almenawer et al. found that there was no clear statistical evidence supporting improvement in mortality, morbidity or recurrence rates with the use of irrigation. [4]

Although there is evidence for the safety and efficacy of irrigation in BHC drainage, many authors have also discouraged its use. Aung et al. denounce the use of irrigation as it is thought to lead to increased cerebral edema and hemorrhage, as well as seizures [12]. Okada et al. reported an increase in the recurrence rate for patients treated with BHC drainage with irrigation (25%) versus those treated with BHC drainage alone (5%) [13]. They speculated that irrigation reduces intracranial pressure (ICP), which may cause damage to traversing veins and thus CSDH recurrence [13]. Also, irrigation is more likely to introduce air into the cavity (pneumocranium), thus inhibiting brain expansion and with this drop in ICP, leading to tension pneumocephalus, intracapsular hemorrhage and intracerebral hemorrhage (ICH) [13].

Table 3
Comparing outcomes across study groups.

Surgical Intervention	Patients with recurrent CSDH	Patients without recurrent CSDH	Fisher exact *p*-value	Patients with post-op contusions, ICH or acute SDH	Patients without post-op contusions, ICH or acute SDH	Fisher exact p-value
No irrigation	34	150	0.60	12	172	0.43
In situ irrigation	16	58		7	67	

Zakaraia et al. did find that there was a higher rate of pneumocranium in the irrigation group (40%) versus the drainage alone group (26.2%), however this difference was not significant and the postoperative recurrence rate in patients with pneumocranium (7.3%) was not significantly different from the recurrence rate in those without pneumocranium (4.9%) [11].

In our study, the calculated rates for postoperative recurrent CSDH (19.4%), acute postoperative SDH (3.1%) and ICH (1.6%) were comparable to those reported previously [3,6,15–18].

This study does have several limitations, one of those being that it is based on data from one institution only, reflecting the operative biases at one institution. However, the data was collected from the practice of numerous surgeons, trained in different locations, with varying operative practices. This is also a retrospective study, with the limitations inherent in database collection and the potential for bias. For example, the patients included in the study are only those who had the requisite inclusion criteria documented in their charts. Given the heterogeneity of caregivers and data recording, not all pertinent risk factors, confounders or outcomes were always consistently recorded, especially regarding functional outcome. Also, some patients were lost to follow up for the 6-month period after initial evacuation. In addition, the method of irrigation during BHC was not chosen according to established patient criteria nor determined by a standardized protocol, but rather a clinical decision made by each surgeon based on his or her preference. Nevertheless, the lack of significant difference in each group's baseline characteristics makes the direct comparison of the two intervention groups more reliable. Also, given that these are retrospective database results from a small group of patients, taken from the case logs of a few neurosurgeons in one institution, there may be a role for a multicenter randomized controlled trial to further investigates the role of irrigation in BHC treatment of CSDH.

So far, there has been no conclusive research published regarding the comparative outcomes of in situ and no irrigation, as used during BHC to evacuate CSDHs. We sought to address this knowledge gap and ultimately, we found that there was no statistically significant difference between the study groups. There was also no clinical or demographic factor that served as a good predictor of CSDH recurrence or acute postoperative hemorrhagic complications, including the size of the SDH and the method of irrigation used for treatment. These findings are consistent with some other retrospective studies that examined the relationship between irrigation and CSDH. Nonetheless, our study offers a more complete clinical perspective as it has compiled more information about types of irrigation and their respective relationships with recurrence of CSDH and acute postoperative hemorrhagic complications.

The two study groups, Group A ($N = 184$) underwent BHC without irrigation and Group B ($N = 74$) BHC with in situ irrigation, were not free from selection bias. However, the selection of the operative method (Group A or Group B) described in this study made no significant difference between the two groups' postoperative outcomes.

6. Conclusion

The optimum method of irrigation to be performed during BHC for treatment of CSDH is indeterminate in today's published literature. In our retrospective cohort study, we have established that this lack of clear, evidence-based standard is in fact well-founded; there was no significant difference in risk of recurrent CSDH and acute postoperative hemorrhagic complications (e.g., ICH or acute SDH) in patients treated with BHC with no or with in situ irrigation. A multicenter randomized trial may be useful in determining each method of irrigation's full extent of clinical impact.

Ethics approval and consent to participate

This study protocol was approved by Ottawa Health Science Network Research Ethics Board (OHSN-REB Protocol # 20140521-01 H).

This is a retrospective study collecting patient data from the hospital electronic medical records, therefore there were no direct risks to patients enrolled in the study. Also, no patient consent was required for this study.

Consent for publication

Not applicable.

Availability of data and materials

The research data is confidential.

Authors' contributions

All authors have contributed to the conception and design of the study.

IE and AT did the acquisition of data.

IE, IDM, and FA contributed to the analysis and interpretation of data.

All authors contributed to the drafting of the article and revising it critically for important intellectual content.

All authors have given final approval of the version to be submitted.

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Declaration of Competing Interest

The authors declare that they have no competing interests.

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