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Original Article

Subgaleal drain versus dissection of subgaleal space and closure without drain after burr-hole drainage of chronic subdural hematoma

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ABSTRACT

Background: Chronic subdural hematoma (CSDH) is a collection of blood, blood degradation products, and fluid that accumulate on the surface of the brain between its arachnoid and dural coverings. This study is to evaluate the efficacy of subgaleal drain (SGD) versus subgaleal dissection without drainage as adjuncts to burr-hole evacuation of CSDH.

Methods: A retrospective study was conducted utilizing the data of 60 patients operated for symptomatic CSDH. Patients were divided into two groups, each thirty consecutive patients: Group I, in which a SGD was inserted after CSDH evacuation through a burr-hole; and Group II, the hematoma was evacuated as in the Group I, but with no SGD insertion but instead a subgaleal pocket was created for drainage.

Results: The neurological improvement at 24 h, discharge, 2 weeks, and 6 months after surgery was comparable in both groups. The overall recurrence was 4 cases (4/60, 6.7%). The rate of recurrence and surgical infection rate were comparable in both groups. Both groups showed similar incidences of postoperative seizures, bleeding, rates of medical complications, and neurological deficits. The overall postoperative mortality was five cases (5/60, 8.3%) with no significant difference between groups.

Conclusion: Blunt dissection to open the subgaleal space and closure without a drain is a safe and efficient alternative to the insertion of a drain after the burr-hole evacuation of CSDH.

Keywords: Chronic subdural, Dissection, Drain, Hematoma, Subgaleal

INTRODUCTION

Chronic subdural hematoma (CSDH) is a collection of blood, blood degradation products, and fluid that accumulate on the surface of the brain between its arachnoid and dural coverings. With the progression of size of CSDH, the brain becomes compressed, leading to neurological sequelae or even brain herniation.[18]

CSDH was first described in the literature in a report by Johannes Wepfer in 1657 about a patient who died as a result of an "apoplectic event, where he found a large blood-filled cyst under the dura." In 1857, Virchow implicated inflammation as the major cause of CSDH, and thus, it was termed "pachy meningitis hemorrhagica interna." Later, trauma was pointed out as the etiology of CSDH by Trotter In 1914. Controversy as regards the origin and natural history of CSDH remained till the end of the 20th century.[2] There is a consensus that the bleeding mostly originates from torn bridging veins as they traverse the dural cell layer of the dural border, often due to trauma in the presence of craniocerebral disproportion (i.e., brain-shrinkage with age), brain manipulation (cranial surgery), or intracranial hypotension. The walls of the veins tend to be thinnest at the dural cell border layer, being as thin as a single endothelial cell layer.[16] The dural cell border is composed of flattened, elongated cells with weak junctions that tend to separate, causing the accumulation of blood.[12] Due to the low pressure within the bridging veins, the bleeding may pass unnoticed for long periods after the initial insult before the patients become symptomatic. An inflammatory response is initiated, causing fibrinolysis of the clot, the release of angiogenic factors, and the formation of granulation tissue with the result of "neo-membrane" formation.[9]

As previously mentioned, cranial trauma accounts for the majority of CSDH patients, where it has been identified in 50–77% of cases.[24] Gaist *et al*., in their study of more than 10,000 patients, detected that the use of antithrombotic drugs, especially Vitamin K antagonists, was associated with a higher risk of subdural hematoma and hematoma-related mortality.[10] Cerebrospinal fluid (CSF) leaks have been incriminated as a cause of CSDH, mostly following procedures in which the dura was either intentionally or unintentionally opened. These include surgery of intradural lesions over-drainage of CSF during lumbar punctures or CSF drainage systems. The mechanism of CSDH formation in such instances involves inferior displacement of the brain due to low intracranial pressure and the lack of CSF-buffering, thus causing stretch and shearing of the cortical bridging veins.[13]

The incidence of CSHD increases with age, especially among the elderly; men are more commonly affected than women, and an increase in diagnosis has been observed with improvement and increased availability of computed tomography (CT) scanners.[3] CSDH clinical presentation has a very wide spectrum ranging from being asymptomatic and incidentally discovered to that of progressive deterioration of cognition and/or motor weakness.[33]

CT is the most used diagnostic tool for identification and follow-up of CSDH.[6] Density varies according to the age of the hematoma, where those imaged within hours and days of occurrence (hyperacute and acute) have a higher radiodensity than that of the cerebrum, while those isodense with cerebrum are of a duration <2 weeks (subacute), and those that are appearing hypodense are usually more than 3 weeks (chronic). Absence of gyrus visualization, ventricular collapse, membrane formation, midline shift, and brain herniation may be detected as well.[22] Surgical evacuation of CSDH is advised if the hematoma thickness is more than 10 mm, if there is a midline shift more than 7 mm, or if there is symptomatic mass effect or radiographic progression.[18]

The subgaleal space lies just deep to the galea and extends from the superior nuchal line posteriorly to the forehead anteriorly and ends laterally, where the galea extends with the temporalis fascia down to the zygomatic arches. This layer is avascular and has absorptive abilities.[23,28]

Von Mikulicz conducted the first ventriculosubgaleal shunt (VSGS) in 1896 by dissection of the subgaleal space, allowing the scalp to absorb the excess CSF. It has been utilized for chronic postoperative CSF fistulas, recurring subdural hematoma, tumors, repeated ventriculoperitoneal (VP) shunt infections, and acute head trauma. Numerous institutions favor VSGS because it is a simple and quick technique that eliminates the need for recurrent aspiration without incurring electrolyte and nutritional losses. It is linked with lower rates of infection compared to external ventricular drain due to the lack of external tubes and closed system of CSF drainage.[23,27,30]

In regions where there are insufficient hospital beds and where a rapid turnover is mandatory, it is impossible to discharge the patients with a drain, but it is possible to create a subgaleal pocket that acts as a closed drainage system and provides an absorptive surface. Thus, the purpose of this study is to evaluate to evaluate the efficacy of subgaleal drain (SGD) versus subgaleal dissection without drainage as adjuncts to burr-hole evacuation of CSDH.

MATERIALS AND METHODS

This retrospective study included the data of 60 patients who were operated on for symptomatic CSDH through burr-hole evacuation with and without SGD between January 2017 and January 2023. The study population included two groups; Group I included 30 consecutive patients in which a SGD was inserted after CSDH evacuation through two burr holes; and in Group II, 30 consecutive patients had hematoma evacuation as in Group I, but without SGD insertion, but instead a subgaleal pocket was created for drainage.

Inclusion criteria

The following criteria were included in the study:

- Patients aged 18 years or older who were presented with symptomatic CSDH proven by CT scan
- Patients with subacute (isodense in CT) or acute components (hyperdense components) on top of CSDH.

Exclusion criteria

The following criteria were excluded from the study:

- Patients with pure acute or subacute hematoma or extensive membranes necessitating craniotomy

- CSDH patients with underlying causative conditions (e.g., over drainage of a VP shunt).

On the day of admission, full history taking and neurological assessment were done, brain CT was performed, laboratory investigation (including bleeding and coagulation profile, complete blood picture, renal and hepatic function tests, and blood sugar levels), patients were evaluated for comorbidities, and informed consent was obtained. The severity of the CSDH was graded according to Markwalder's grading [Appendix 1].[17] The degree of disability or dependence of the patients was measured by the modified Rankin scale (mRS) [Appendix 2].[32]

Patients were operated on under general anesthesia unless the patients were unfit for general anesthesia local anesthesia, which was then performed. Patients were positioned in a supine position with a headrest. After localizing the maximum width of the hematoma, two separate burr holes, each with a minimum of 14 mm width, were drilled about 7 cm apart. A snip opening of the dura was performed to allow for controlled slow self-drainage of the hematoma, and once the tension was normalized, a cruciate incision of the dura mater was made, and the dural edges were coagulated with bipolar diathermy. The subdural collection was washed out with warm lactated Ringers' solution.

If a subdural membrane or loculations were found, they were not disrupted except for those under the burr holes. At the end of the procedure, the burr holes were left unsealed to allow free drainage to the subgaleal space. The subdural space was filled with warm lactated Ringers' solution [Video 1], and then, the scalp was closed in two layers.

In Group I, a 16 gouge catheter drain was inserted in the subgaleal space reaching from the anterior to the posterior burr hole, then tunneled for a minimum of 5 cm away from the scalp incision; the drain was connected to a soft collection bag that was kept in a dependent position for 48 h and then removed [Figure 1]. We recorded the type and amount of subdural fluid collected. In Group II cases, no drain was inserted; instead, a subgaleal pocket to accommodate any residual blood or re-bleeding was created by blunt dissection of the subgaleal space using a finger or blunt tipped curved artery forceps (care must be given to avoid injuring the highly vascular superficial scalp layer). The larger the pocket created the more likely it will survive longer. Dissection of the subgaleal space should be carried in all directions, preferably toward the ears but avoiding going toward the forehead [Figure 2 and Video 2].

Video 1: Ringers lactate injection to minimize pneumocephalus.

CT brain was performed on the 1st operative day to assess the extent of evacuation and repeated if any neurological deterioration occurred and on discharge. Once the condition of the patients was stationary and not need hospitalization, they were discharged. At discharge, perioperative data, complications, and full neurological assessment (Glasgow coma scale [GCS], mobility, motor power, and speech deficit) were recorded. The Markwalder grading and mRS were recorded at 24 h, at discharge, 2 weeks, and 6 months.

Appendix 1: Markwalder grading of CSDH severity.

Grade	Description
0	Neurologically normal
1	Alert and oriented; mild symptoms such as headache; absent or mild neurological deficit, such as reflex asymmetry.
2	Drowsy or disoriented with variable neurological deficit, such as hemiparesis.
3	Stuporous but responding appropriately to noxious stimuli; severe focal signs, such as hemiplegia.
4	Patient comatose with absent motor responses to painful stimuli; decerebrate or decorticate posturing.

CSDH: Chronic subdural hematomas

Appendix 2: The mRS.

Scale	Description
0	No symptoms
1	No significant disability. Able to carry out all usual activities despite some symptoms
2	Slight disability. Able to look after own affairs without assistance, but unable to carry out all previous activities
3	Moderate disability. Requires some help but is able to walk unassisted
4	Moderately severe disability. Unable to attend to own bodily needs without assistance and unable to walk unassisted
5	Severe disability. Requires constant nursing care and attention, bedridden, incontinent
6	Dead

mRS: Modified Rankin scale

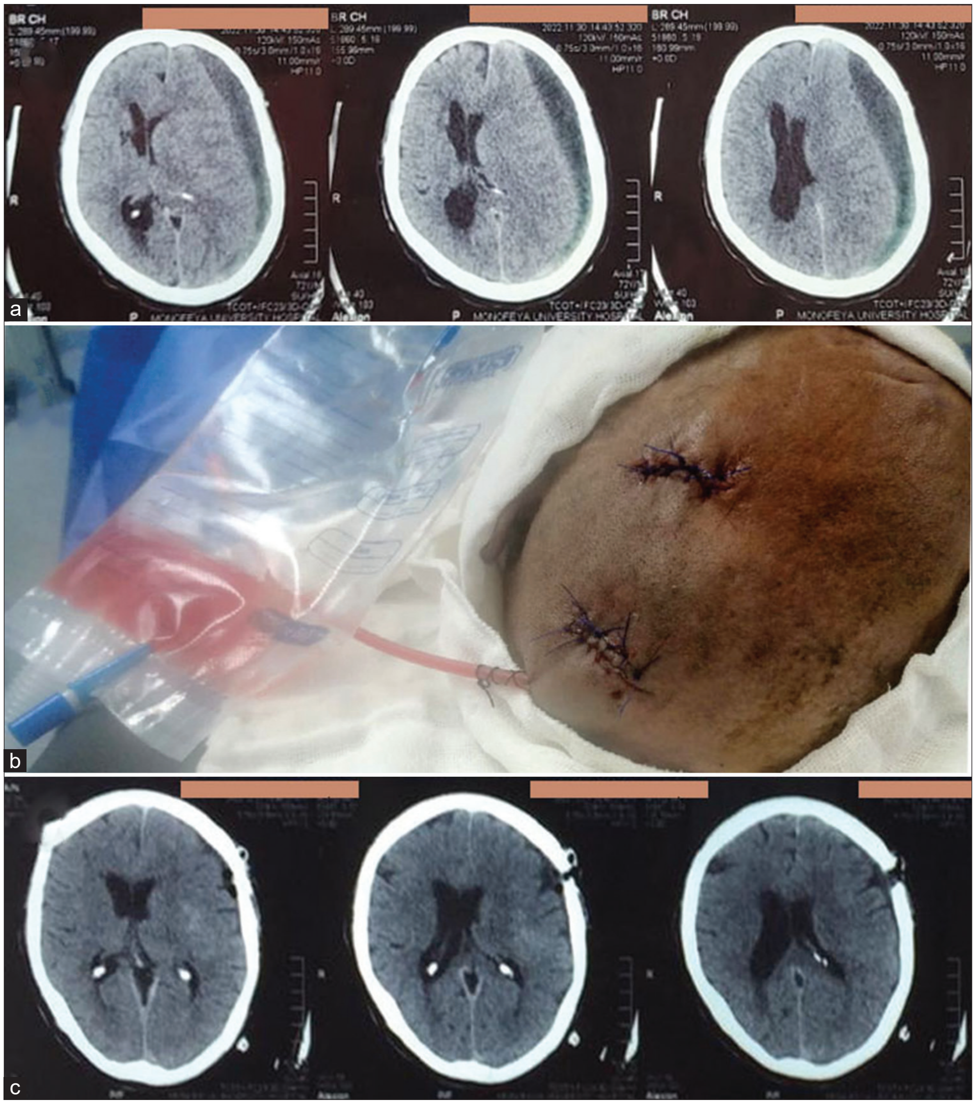

Figure 1: (a) Preoperative computed tomography (CT) of Lt frontoparietal chronic subdural hematomas. (b) Intraoperative picture showing the subgaleal drain connected to a collecting bag after surgical evacuation was done with left frontal and parietal burr holes. (c) Postoperative follow-up CT brain; showing good evacuation and resolving of midline shift.

If, within the first 6 postoperative months, the patients had signs and symptoms caused by a subdural hematoma ipsilateral to the side of initial hematoma evacuation, this was considered a recurrence. Re-evacuation of the hematoma was warranted if neurological deficits recurred or progressed.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences v26 (IBM Inc., Chicago, IL, USA). Histograms and Shapiro–Wilks confirmed data normality. The two groups were compared using unpaired Student's *t*-test for parametric variables' mean and standard deviation and Mann–Whitney test for non-parametric data's median and interquartile range. Chi-square or Fisher's exact tests compared qualitative variables' frequency and percentage. Two-tailed tests were considered significant when $P < 0.05$.

RESULTS

The demographic, clinical, and radiological characteristics were comparable between both groups [Table 1].

The consciousness level was improved postoperatively in 45 cases (45/60, 75%) and regained GCS 14–15 at discharge. The limb weakness was improved postoperatively in all cases that presented with preoperative limb weakness (43/43, 100%) at discharge. The mRS was improved postoperatively to reach 0–3 in 51 cases (51/60, 85%) at discharge. Fifty-two

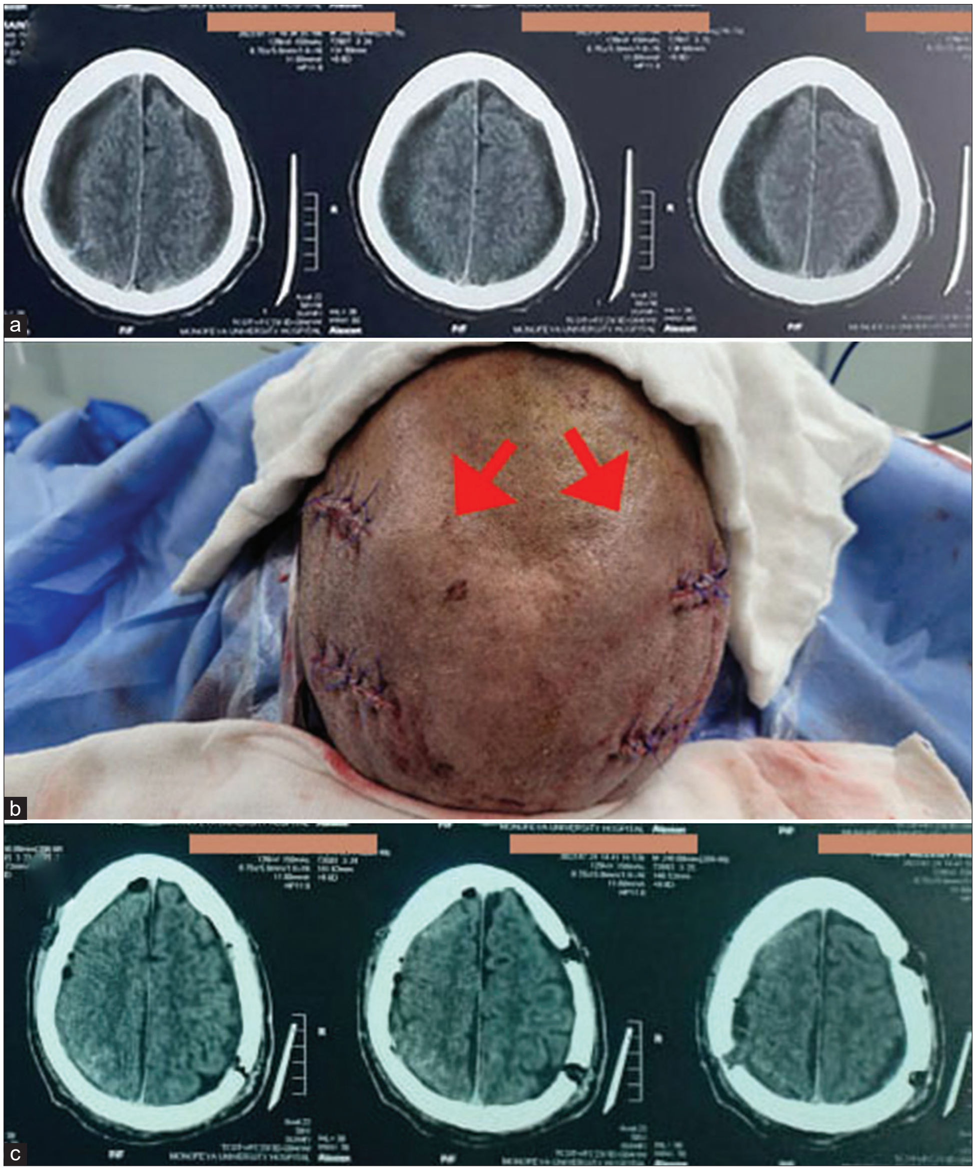

Figure 2: A male patient 68 years old presented with confusion, dysarthria, and quadriparesis. Glasgow coma scale = 13. (a) Preoperative computed tomography (CT) brain revealed bilateral chronic subdural hematomas with bilateral brain compression. (b) Surgical evacuation was done bilaterally at the same time with two burr holes on each side. Subgaleal pockets (red arrows) were created by blunt subgaleal dissection, which was done bilaterally, and closure was done without drain. (c) Postoperative CT brain revealed good decompression.

patients (52/60, 86.7%) improved to achieve a Markwalder score of 0–1 at discharge.

Both groups had similar clinical outcome measures and a similar distribution of patients with neurological improvement at 24 h, discharge, 2 weeks, and 6 months after surgery. There were no statistically significant differences seen in the radiological data at 24 h and 2 weeks post-surgery between the two groups, as shown in Table 2. Group 1 had a considerably longer duration of stay compared to group 2 ($P = 0.03$).

The overall recurrence was 4 cases (4/60, 6.7%). The rate of recurrence and surgical infection rate were comparable in both groups. There was a similar postoperative seizure frequency, postoperative bleeds, medical complications, and new postoperative neurological impairments between groups.

The overall postoperative mortality was 5 cases (5/60, 8.3%) with no significant difference between groups. Three cases in group 1, where a case died due to chest infection, a case due to decompensated liver disease, and the third case developed acute SDH and operated by craniotomy. Two cases in Group 2;

Table 1: Preoperative demographic, clinical, and radiological characteristics.

Characteristics	Group 1	Group 2	*P*-value
Age	47–82 years (74.8)	48–83 years (74.3)	0.839
Sex (female) (%)	10 (33)	10 (33)	>0.999
Medical history (%)			
Diabetes mellitus	12 (40)	13 (43)	0.793
Hypertension	22 (73)	21 (70)	0.774
Coronary arterial disease	12 (40)	11 (36.7)	0.791
Atrial fibrillation	9 (30)	8 (26.7)	0.774
Deep venous thrombosis	2 (6.7)	3 (10)	0.640
Pulmonary embolism	1 (3.3)	1 (3.3)	>0.999
Stroke/TIA	5 (16.7)	4 (13.3)	>0.999
Chronic renal failure	1 (3.3)	1 (3.3)	>0.999
Liver cirrhosis	6 (20)	7 (23.3)	0.754
None	4 (13.3)	3 (10)	>0.999
Drug history (%)			
Anticoagulant	9 (30)	8 (26.7)	0.774
Antiplatelet	14 (46.6)	11 (36.6)	0.432
History of trauma	18 (60)	19 (63.3)	0.791
Admission GCS (%)			
14–15	21 (70)	22 (73.3)	0.774
9–13	7 (23.3)	5 (16.7)	0.519
3–8	2 (6.7)	3 (10)	>0.999
Symptoms at presentation (%)			
Speech impediment	8 (26.7)	7 (23.3)	0.766
Limb weakness	21 (70)	22 (73.3)	0.774
Gait disturbance	21 (70)	22 (73.3)	0.774
Mental deterioration	15 (50)	13 (43.3)	0.605
Incontinence	3 (10)	4 (13.3)	>0.999
Headache	14 (46.7)	15 (50)	0.796
Seizure	3 (10)	2 (6.7)	>.999
Admission mRS score (%)			
0	0 (0)	0 (0)	0.988
1	3 (10)	3 (10)	
2	5 (16.7)	4 (13.3)	
3	6 (20)	7 (23.3)	
4	9 (30)	8 (26.7)	
5	7 (23.3)	8 (26.7)	
Median	4	4	0.917
Admission Markwalder (%)			
0	0 (0)	0 (0)	0.784
1	6 (20)	4 (13.3)	
2	9 (30)	10 (33.3)	
3	15 (50)	16 (53.3)	
4	0 (0)	0 (0)	
Median	3	3	0.869
Hematoma side (%)			
Right	12 (40)	14 (46.7)	0.858
Left	13 (43.3)	12 (40)	
Bilateral	5 (16.7)	4 (13.3.)	
Hematoma type (%)			
Chronic	18 (60)	16 (53.3)	0.866
Subacute on top of chronic	8 (26.7)	9 (30)	
Acute on top of chronic	4 (13.3.)	5 (16.7)	
Hematoma width in mm	24 (16–37)	23 (15–36)	0.649
Midline shift in mm	9.6 (3–18)	8.9 (4–19)	0.491

mRS: Modified Rankin scale, GCS: Glasgow coma scale, TIA: Transient ischemic attack

Video 2: Dissection of the subgaleal space to create a pocket.

one case was due to ischemic heart disease, while the second case was due to acute pulmonary embolism [Table 3].

Table 2: Outcomes between the studied groups.

Outcomes	Group 1 (*n*=30)	Group 2 (*n*=30)	*P*-value
Clinical Outcomes: At discharge (%)			
GCS 14–15	23 (76.7)	22 (73.3)	0.088
Improvement of limb weakness	21 (70)	22 (73.3)	0.774
mRS 0–3	25 (83.3)	26 (86.7)	0.869
Markwalder score 0–1	26 (86.7)	26 (86.7)	0.99
Length of stay in days	4 (2–7)	3 (1–6)	0.03*
Radiological outcomes			
Midline shift in mm			
24 h	2 (0–4)	2 (0–4)	>0.999
2 weeks	0	0	---
Remnant hemorrhage in mm			
24 h	6 (3–9)	5 (3–8)	0.089
2 weeks	3 (0–5)	2.5 (0–4)	0.274

Data is presented by median (range) or frequency (%). mRS: Modified Rankin scale, GCS: Glasgow coma scale

Table 3: Morbidity and mortality between groups.

Variable	Group 1 (*n*=30) (%)	Group 2 (*n*=30) (%)	*P*-value
Recurrence	2 (6.7)	2 (6.7)	>0.999
Surgical infections	3 (10)	1 (3.33)	0.612
Seizures	2 (6.7)	2 (6.7)	>0.999
Postoperative bleeds	3 (10)	2 (6.7)	>0.999
Acute SDH	2 (6.7)	1 (3.33)	>0.999
ICH	1 (3.33)	1 (3.33)	>0.999
Medical complications	7 (23.3)	8 (26.7)	0.766
New neurological deficit	1 (3.33)	1 (3.33)	>0.999
Mortality	3 (10)	2 (6.7)	>0.999

Data are presented as frequency (percentage), SDH: Subdural hematoma, ICH: Intracerebral hematoma

DISCUSSION

Chronic subdural hematoma has been managed by different surgical techniques.[4] Burr-hole evacuation for CSDH has been the most frequently utilized surgical technique worldwide, as it is very effective for draining simple CSDH with low recurrence and morbidity rates.[15]

There is no evidence to warrant opening the inner membrane. The inner membrane is highly vascularized and can cause acute hemorrhage. If the hemorrhage occurs away from the surgical site, it may be difficult to control.[25] If the hemorrhage cannot be stopped despite continuous irrigation, the burr holes must be converted to a craniotomy. Furthermore, a craniotomy may be necessary for CSDH in cases of hematoma recurrence and the existence of numerous membranes and cavities.[1]

The complications related to treatment are focused mainly on the recurrence post burr-hole evacuation of CSDHs. The rate of CSDH recurrence that requires re-intervention in the present study was comparable in both groups and comparable to that published in the literature, which varies from 9% to 33%.[21] Published data have shown that adjuvant middle meningeal artery-embolization and concomitant dexamethasone administration reduce the recurrence rate.[12,31]

Several variables, such as diabetes mellitus, and preoperative hematoma width (>20 mm), preoperative seizure, have been related to the recurrence of CSDH, with the role of antithrombotic drugs, which are still debated.[5,11,20] In addition, the presence of septations or membranes inhibits full hematoma evacuation, irrigation, and re-expansion of the brain. A midline shift of more than 5 millimeters postoperatively gives a poor prognosis. Hyperdense homogeneous and mixed density have been revealed by a systematic review of hematoma recurrence prognostic factors to be the highest predictor of recurrence.[19] None of the above variables was statistically proven to be linked to the recurrences in this study.

Although bilateral CSDH is reported to have a higher recurrence rate that may be attributed to a higher incidence of pneumocephalus or a poor re-expansion of the brain, especially when both sides are done at the same time,[14] this use not substantiated in this study, possibly due to the same sample size, or due to the technique implemented by filling the drained space with ringer lactate while tilting the head to evacuation of the pneumocephalus each side separately.

The use of drainage after burr-hole evacuation of chronic SDH has become debatable. Santarius *et al.* reported both a reduction in CSDH recurrence and an improvement in the functional outcomes with subdural drain (SDD) insertion.[26] However, proximity to the cortical surface, bridging veins, and hematoma membranes may cause structural iatrogenic injury and postoperative morbidity.[7] This technique was not implemented in this study for fear of iatrogenic acute subdural hemorrhage during drain removal.

Inserting subperiosteal/SGDs after burr-hole drainage of CSDH is an effective and safe substitute to inserting an SDD, with recurrence rates comparable to SDD and significant reduction in the rates of surgical infection, drain misplacements, and the occurrence of iatrogenic brain injuries, suggesting that SGDs can be utilized routinely, and thus, it was implemented in the first group of this study.[8,29]

There was neurological improvement and radiological measurements were comparable in the two studied groups. The overall rates of surgical morbidity and mortality were equally distributed between the two studied groups. The hospital stay was slightly shorter in the subgaleal dissection group compared to the SGD group, which needed hospitalization until the drain was removed. The group that operated through burr-hole evacuation without SGD had lower rates of surgical infection than the group that operated through burr-hole evacuation with SGD. Three (10%) cases in the group without SGD had wound infection, as opposed to 1 (3.33%) in the group with SGD. The total recurrences (recollection and acute) in both groups were 23%, of which recurrent CSDH constitutes 6.7 % for each group, which matches the reported rates in literature, which varies from 5% to 30% after surgical evacuation of CSDH.[26]

CONCLUSION

Blunt dissection to open the subgaleal space and closure without drain is a safe and efficient alternative to insertion of a drain after the burr-hole evacuation of CSDH with comparable recurrence rates and outcome, thus can be utilized in routine clinical practice.

Ethical approval

The research/study approved by the Institutional Review Board at the study was approved by the Local Ethical Scientific Committee of the Menoufia Faculty of Medicine. Menoufia, Egypt. The Institutional Review Board (IRB) approval number 7/2022NEUS9-2, dated 7/2022.

Declaration of patient consent

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

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Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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