



Mini-Perforated Craniotomy with Subperiosteal Drain for Evacuation of Chronic Subdural Hematoma: A New Technique and Clinical Study

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Indian J Neurosurg 2023;12:210–214.

Abstract

Background Chronic subdural hematoma (cSDH) is a frequent disease of the elderly with favorable outcomes. The main choice of treatment is surgery. Along with many surgical techniques described for evacuation of cSDH, we are presenting the preliminary outcomes of a novel surgical method, mini-perforated craniotomy with a subperiosteal drain.

Material and Methods Patients in whom cSDH with thickness of >10 mm was observed in computed tomography (CT) scans with parenchymal compression and/or midline shift were included in this study. Age, sex, complaint, neurological status, and medical history were recorded along with CT findings. Mini-perforated craniotomy was performed on all patients. A subperiosteal drain was used. The postoperative follow-up period was 3 months.

Results Ten cSDH patients who were admitted to Prof. Dr. Cemil Tascioglu City Hospital between December 2020 and May 2021 were included in this study. The mean age was 64.3 ± 6.272 , and the most common admission complaint was a headache. Postoperatively, one patient showed acute rebleeding after the operation due to dual anticoagulant therapy. Besides, in 3 months follow-up, rebleeding, subdural or epidural effusion, wound infection, or cosmetic problems were not observed.

Conclusion Mini-perforated craniotomy with a subperiosteal drain may be an alternative method for evacuation of cSDH with low complication rates especially when the hematoma is suspected to be septated.

Keywords

- chronic subdural hematoma
- mini-craniotomy
- subperiosteal drain
- subdural hematoma

Introduction

Chronic subdural hematoma (cSDH) is a curable neurological disease with gradually increasing prevalence. It is seen in the geriatric population more commonly and the incidence ranges from 3.4 per 100,000 in people younger than 65 years of age and 8 to 58 per 100,000 in patients older than 65 years.¹ cSDH is a consequence of an accumulation of

hematoma in the subdural space. Many theories have been postulated regarding the pathophysiology underlying cSDH. Recent studies have reported that the transformation of chronic subdural hygromas with consequent damage in fragile neovascularized vessels leads to the formation of cSDH.^{2–5}

Surgical drainage is the preferred treatment modality in cSDH, however, conservative management may be reserved

article published online
December 23, 2022

DOI <https://doi.org/10.1055/s-0042-1758658>.
ISSN 2277-954X.

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for some cases. Conservative management includes atorvastatin, corticosteroids, angiotensin-converting enzyme inhibitors, and tranexamic acid.⁶ Burr hole craniostomy and twist drill craniostomy are the most commonly applied surgical techniques. A craniotomy is usually reserved for reaccumulation of the subdural collection after the prior surgery, hematoma with a solid nature, or failure of brain expansion after the previous surgery.⁷ The middle meningeal artery embolization and endoscopic evacuation of cSDH have recently been reported.^{8,9} The most important postoperative complications are rebleeding, tension pneumocephalus, intracranial hypotension, development of new acute hematoma, subdural empyema, infection, and cosmetic deformities.¹⁰⁻¹² New surgical techniques are evolving to elude these complications and therefore improve outcomes. In this paper, we describe the mini-perforated craniotomy with a subperiosteal drainage technique performed in 10 patients, present the preliminary outcomes of these patients, and discuss the feasibility of the technique.

Materials and Method

This study includes patients who were admitted to Prof. Dr. Cemil Tascioglu State Hospital between December 2020 and May 2021, in whom cSDH was detected via head computed tomography (CT) scans and a decision of surgical hematoma evacuation was held. All patients or their substitute decision-makers signed an informed consent form on the surgical procedure and publication of their data prior to the treatment.

Inclusion criteria were:

1. cSDH with >10 mm thickness measured in CT scan.
2. Midline shift and/or evident parenchymal compression.
3. Neurological impairment.
4. Recurrent cSDH.
5. The mixed density of hematoma in CT scan.
5. Multiple septal appearances in CT scan.

Demographic information of the patients was obtained before surgery. Patient age, sex, complaint, neurological status, medical history, chronic diseases, medications used (including anticoagulant drugs), and trauma history were

recorded. In preoperative CT scans, localization and largest thickness of hematoma, amount of midline shift, and density of the hematoma (grouped as homogenous or heterogenous/membranous) were recorded.

Surgery was performed on all patients within 24 hours of admittance to the hospital. For patients who were under antiplatelet therapy, platelet-rich plasma was administered before surgery. All of the patients underwent general anesthesia for the operation. During the surgery, the patient was positioned on a horseshoe-shaped head holder with a slight rotation to the contralateral side via a silicon pad inserted behind the ipsilateral shoulder. After appropriate sterilization of the surgical site, a linear skin incision of approximately 4 to 5 cm was made parallel to the coronal suture on the largest diameter of the hematoma in coronal sections. Galea was dissected via a periosteal elevator. A burr hole was inserted into the posterior edge of the surgical site via a high-speed drill. An ellipse-shaped craniotomy flap was removed with the longer edge of the ellipsoid parallel to the sagittal suture. Dura mater was opened via a 15-mm scalpel in a cruciate shape (→Fig. 1). The subdural hematoma was evacuated via an aspirator. Septal membranes were opened via either a dissector or hook. Subdural irrigation was performed with saline solutions at room temperature until the space was clear of hematoma.

Multiple small holes were opened on the craniotomy flap via a high-speed drill. Four leaves of the dura were connected to the holes on the flap via 3-0 silk sutures. The flap was reinserted and connected to the skull via mini-plaques and screws. A circular plaque was placed on the burr hole defect. A Hemovac drain was inserted in the subperiosteal space. To prevent pneumocephalus, the subdural space was irrigated with saline solution again and the skin was closed.

Per/postoperative complications (rebleeding, recurrence, infection) timing of postoperative extubation, postoperative immediate, and 3-months follow-up neurological status were recorded.

Results

cSDH was evacuated via the above-explained surgical technique in 10 patients admitted to our institute.



Fig. 1 Perioperative images. (A) Craniotomy flap is removed and the dura is opened in a cruciate fashion – subdural membranes are encountered. (B) After the evacuation of hematoma and brain expansion. (C) Craniotomy flap is perforated. Dural leaves are hung to the craniotomy flap with silk sutures along the perforations. The flap is fixed to the skull via mini-plaque and screw systems and a Hemovac drain is placed in the subperiosteal space.

Table 1 Demographic information of the patients

Patient	Age	Sex	Complaint	Neurological status	Medical history	Drugs used	History of trauma
Pt.1	78	M	Left UE weakness	Left UE paresis	Cardiac bypass, HT	ASA 81 mg, clopidogrel 75 mg	2 wk ago
Pt.2	52	F	Headache	n/a	Hyperthyroidism	n/a	n/a
Pt.3	68	M	Headache	n/a	HT	n/a	n/a
Pt.4	65	M	Nausea	n/a	n/a	n/a	n/a
Pt.5	62	M	Right UE + LE weakness	Right UE + LE paresis	n/a	n/a	3 wk ago
Pt.6	70	M	Ataxia	n/a	Cardiac stent	ASA 100 mg	n/a
Pt.7	47	M	Headache	n/a	n/a	n/a	n/a
Pt.8	81	M	Ataxia	Left LE paresis	HT	n/a	n/a
Pt.9	63	M	Headache	n/a	DM	n/a	1 mo ago
Pt.10	57	F	Slurring speech	Dysarthria	n/a	n/a	n/a

Abbreviation: ASA, acetylsalicylic acid; n/a, not available; UE, upper extremity; LE, lower extremity; HT, hypertension; DM, Diabetes mellitus.

Demographic information and preoperative evaluation of the patients are provided in ►Table 1. The age of the patients ranged between 47 and 81 (64.3 ± 6.272) years, and 80% of the patients were male. The most prominent symptom was headache ($n=4$), followed by ataxia ($n=2$) and weakness in the extremities ($n=2$). In the neurological examination, one patient had left upper extremity paresis (3/5) (Pt.1), one patient had right hemiparesis (4/5) (pt. 5), and one patient had left lower extremity paresis (3/5) (pt.8). Pt. 1 was using acetylsalicylic acid (ASA) 81 mg and clopidogrel 75 mg daily due to cardiac bypass surgery history and pt. 6 was using ASA 100 mg daily due to cardiac stent insertion 7 months ago. Three of the patients mentioned a recently occurring trauma to the head.

cSDH was detected in CT scans of all patients. The largest diameter of the hematoma ranged from 11.4 to 23 mm (15.9 ± 2.341). The average amount of midline shift ranged from 0 to 4.1 mm (1.52 ± 0.848). None of the patients encountered any perioperative complications. However, patient 1 presented with rebleeding 4 hours after the initial surgery and a larger craniotomy with a subdural drain insertion was performed to evacuate the acute hematoma. The patient stayed intubated in the intensive care unit for 9 days and was discharged with a tracheostomy cannula and dependent on a home ventilator.

Postoperative control CT scans were taken 4 hours after the operation and prior to discharge in all patients. The subperiosteal drain was extracted on the postoperative third day. The mean duration of stay in the hospital was 5.4 days ranging from 3 to 19 days.

In 3 months follow-up, none of the patients presented with any further complications such as rebleeding, subdural and epidural effusion, wound infection, or cosmetic problems. Only in patient 1, left hemiparesis persisted and he remained tracheostomy dependent (►Table 2).

Discussion

Despite the fact that cSDH is a very common neurosurgical pathology in practice, evidence is still lacking on the superiority of outcomes of the techniques among each other. Main debates on cSDH evacuation focus on the most convenient surgical method (burr hole or craniotomy), subdural or subperiosteal drain insertions, the number of burr holes, membranectomy, and the number of days that drain stays in the operation site.^{13–15} Even though placing subgaleal suction drains with the burr hole technique was suggested previously, mini-perforated craniotomy with subperiosteal drain insertion is suggested for the first time in the literature and combines the increased efficiency of the suction drain with better visualization of the surgical site, especially in membranous cSDH.^{16,17} This method emerged intending to lower the risks of postoperative rebleeding, subdural effusion, and cosmetic deformities.

Many surgical techniques are defined for evacuation of cSDH, of which the predominantly performed ones are burr hole craniostomy, twist drill craniostomy, and craniotomy.¹ The subdural evacuating port system, middle meningeal artery embolization, and endoscopic hematoma removal are also recently described methods.^{18,19} A randomized controlled trial compared outcomes of burr hole and twist drill craniostomy and concluded that efficacy was the same with both techniques; on the contrary, the neurological score improved and length of hospital stay shortened with twist drill craniostomy.²⁰ Similarly, a single-centered retrospective study with 414 patients concluded that recurrence rates and functional outcome scores were similar for burr hole drainage and craniotomy.²¹

Even though conservative management is reserved for a minority of the patients and surgical evacuation is the treatment of choice, there are complications associated with surgical management. These are rebleeding, infection, seizure, cerebral edema, tension pneumocephalus, and

Table 2 Radiological appearance of cSDH and per/postoperative information

Patient	Localization of hematoma	Thickness of hematoma	Midline shift	Density of hematoma	Complications	3-months follow-up
Pt.1	Right temporoparietal	23 mm	4.1 mm	Heterogenous	Postoperative acute hematoma	Left hemiparesis, tracheostomy
Pt.2	Left frontotemporal	14.7 mm	1.6 mm	Homogenous	n/a	Normal
Pt.3	Right temporoparietal	12.4 mm	0.3 mm	Homogenous	n/a	Normal
Pt.4	Right temporal	21.3 mm	3.1 mm	Heterogenous	n/a	Normal
Pt.5	Left frontotemporal	14.6 mm	0.7 mm	Heterogenous	n/a	Right hemiparesis improved
Pt.6	Bilateral frontoparietal	18.3 mm	2.7 mm	Heterogenous	n/a	Normal
Pt.7	Right temporoparietal	12.5 mm	0.2	Homogenous	n/a	Normal
Pt.8	Right temporoparietal	17.6 mm	2.2 mm	Heterogenous	n/a	Left LE paresis improved
Pt.9	Left frontoparietal	13.2 mm	0.3 mm	Homogenous	n/a	Normal
Pt.10	Left frontotemporal	11.4 mm	n/a	Heterogenous	n/a	Normal

Abbreviation: cSDH, chronic subdural hematoma; LE, Lower extremity.

failure of expansion of the brain.²² Recurrence of cSDH is suggested to be associated with the preoperative homogenous hyperdense appearance in CT scans and the duration of postoperative subdural drainage.²³ Studies showed that the insertion of subdural and subperiosteal drains has similar outcomes and the recurrence rate is not correlated with the location of the drain.^{24,25} Nonetheless, a multicenter prospective trial concluded that subperiosteal drains led to lower recurrence rates and a limited number of surgery-associated infections.²⁶ In our technique, we preferred placing a Hemovac drain in the subperiosteal space to decrease the recurrence rate and rebleeding. There is a risk of damaging bridging veins while extracting the drain from subdural space, especially in elderly patients in whom vessel walls are more susceptible to rupture. We also avoided this risk via a subperiosteal drain. For increasing the efficacy of the drain, we perforated the bone flap and did not suture the dural leaves tightly. Therefore, any bleeding in the subdural space was permitted to leak into the subperiosteal space for further drainage. In 3-months follow-up, none of our patients had a recurrence of the hematoma. Only in patient 1, acute bleeding was observed postoperatively which was due to dual antiplatelet therapy and the patient underwent a large craniotomy in the second operation.

Another advantage of our technique is a less cosmetic deformity. Our skin incision was approximately 4 to 5 cm and the bone flap was repositioned via mini-plates and screws on the scalp. Undesirable scalp depression may result in poor cosmetic results, especially in the burr hole craniotomy technique, in which large burr holes are trephined. A study concluded that 92% of burr holes performed in 50 patients for cSDH resulted in skin depression.²⁷ Autologous bone, muscle, hydroxyapatite, polymethyl methacrylate, and titanium burr hole covers are suggested for the reestablishment of skull defects.¹² In our surgical technique, a plaque was inserted in the burr hole and the

craniotomy flap was fixed to the skull via a mini-plate and screw system. There was no flap misplacement or skin depression. Even though there is no objective scale for comparing the cosmetic results of our technique with other surgical methods, it may be assumed that our technique is not associated with undesired cosmetic deformities.

This surgical technique and study have limitations. Mini-perforated craniotomy may not be feasible in cases that require a traditional large craniotomy such as recurrent hematoma. Additionally, despite the fact that the duration of surgery is approximately similar between burr hole craniotomy and mini-perforated craniotomy, for high-risk patients with comorbidities or bleeding diatheses, burr hole craniotomy or twist drill craniotomy may be preferred due to its less invasive nature. However, mini-perforated craniotomy is an alternative technique, especially in septated hematoma since it provides a wider visualization area for dissection of the septae. Another limitation of our study is the low number of patients and short duration of follow-up. For instance, multiple holes are drilled in the craniotomy flap. Especially in the elderly, if vascularization of the flap is diminished, it may result in flap necrosis. Even though antibiotics are given preoperatively and postoperatively to each patient, this would be an undesired consequence if incided. To compare the long-term outcomes of this method with traditionally applied methods, a clinical trial with a larger patient population and longer follow-up data are still in progress by the authors.

Conclusion

For surgical management of cSDH, mini-perforated craniotomy with a subperiosteal drain is a feasible method. It prevents the accumulation of residual hematoma in subdural space via evacuation from small holes on the craniotomy flap, provides better visualization

of the surgical site to dissect the septal membranes, proceeds good cosmetic outcomes, and increases attainment of the subperiosteal drain via suctioning. Therefore, it may be an alternative method for decreasing postoperative short- and long-term complications.

Conflict of Interest

None declared.

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