# High-speed drill craniostomy as a minimally invasive method of chronic subdural hematoma management. Preliminary results of a pilot study

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## Abstract

**Objectives:** The objective of this study was to assess the safety and efficiency of minimally invasive high-speed drill craniostomy in the treatment of chronic subdural hematomas.

**Study design:** The study was designed as a retrospective case series study.

**Patients and Methods:** The patients with compressive chronic subdural hematomas were treated by minimally invasive high-speed craniostomy performed under local anesthesia or conscious sedation. A minimal skin incision was followed by a single high-speed drill hole placement in the frontal or parietal region, over the area of maximal hematoma thickness. After hematoma aspiration, a 1.9 mm silicone catheter was placed in subdural space and connected to gravity-assisted drainage. Patients were ambulatory immediately after surgery. Data on clinical course and outcome were recorded and analyzed.

**Results:** There were 23 patients (5 female, 21.7%) included in the study. The median patient age was 77.5 years (interquartile range 67 - 83). Six (26.1%) of the patients had bilateral subdural hematomas. Septated/multiloculated hematomas were observed in 6 (26.1%) patients. Heterodense hematomas denoting more recent bleeding were recorded in 16 (69.5%) patients. The median duration of subdural drainage was 4 days (interquartile range 3 to 5). The median length of hospital stay was 9.5 days (interquartile range 6 - 16). One patient died of sepsis following a nosocomial respiratory infection. One patient developed a wound infection with subdural empyema, requiring subsequent craniotomy. One patient had deep venous thrombosis and pulmonary embolism. In all patients, postoperative CT scans showed a significant reduction of hematoma volume and midline shifting. No postoperative seizures were observed.

**Conclusion:** High-speed drill craniostomy is a safe, simple, straightforward, and effective treatment for the management of chronic subdural hematomas, including multiloculated and heterodense lesions. Elderly patients could most benefit from such a procedure, avoiding general anesthesia, prolonged intracranial procedures, and lengthy hospital stays.

**Keywords:** chronic subdural hematoma; high-speed drill, craniostomy

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## Introduction

Traumatic brain injury of a lower degree is generally regarded as the main cause of chronic subdural hematoma (cSDH)[1]. It typifies a common, but intricate clinical entity as being a challenge in surgical management due to various comorbidities, and its tendency for recurrence that may affect management strategies and outcomes[2, 3]. Therefore, the plethora of techniques chosen for surgical management remains controversial[4]. Such a hematoma is principally serious when it occurs in the elderly due to their fragile cerebral vessels accompanying cortical atrophy, and various medical conditions, including coagulopathies urging a prolonged use of different types of anticoagulants and/or blood thinners[5]. Hence, the global incidence of cSDH is constantly increasing predominantly due to the overall aging of the population and more frequent usage of antiplatelet/anticoagulant therapy[6, 7].

Although the main postulates of cSDH surgery have been well-established in symptomatic patients, some controversies about optimal management strategy remain concerning the most effective treatment methods to improve outcomes, evade recurrence, reduce postoperative complications, and patients' prolonged hospital stay[8, 9].

The proposed surgical options for cSDH management include classic osteoplastic/osteoclastic craniotomy followed by hematoma evacuation and subdural passive drainage, as well as burr-hole trephination to minimize skull bone damage and drill craniostomy performed by twist drills or high-speed drills[10]. Being less invasive than a classic craniotomy, the latter two methods are frequently utilized for the initial cSDH evacuation in selected patients[11, 12]. Additionally, high-speed drill craniostomy is usually performed with local anesthesia, which is a simpler and safer method promoting better patient recovery[13] and reducing operative time and hospital stay[14].

A technique of obliterating the distal branches of the middle meningeal artery by a super-selective endovascular approach to devascularize the hematoma outer membrane has also been recently accepted as an alternative or adjuvant method in cSDH management[15-19].

The aim of this retrospective study is the assessment of the safety and efficiency of minimally invasive high-speed drill craniostomy in the treatment of chronic subdural hematomas.

## 2. Methods

The study was designed as a cross-sectional study of historical data for patients surgically treated for com-

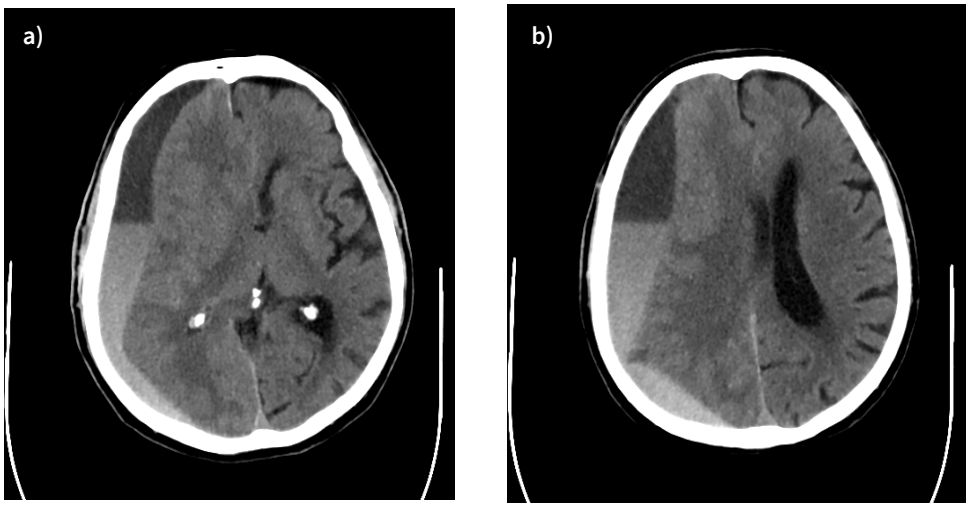


Figure 1. **A native axial head CT showing an extra-axial mixed-density subdural compressive lesion of the right cerebral hemisphere indicating chronic subdural hematoma (a). The multilobulated hematoma is accompanied by a marked midline shifting and compression of the right lateral ventricle (b).**

pressive chronic subdural hematomas during a three-year period (2018 – 2020) (Figure 1.). The study was approved by the hospital's Institutional Review Board.

The study included adult patients with compressive subdural hematomas verified by computed tomography (CT) scan and requiring surgical intervention. Compressive subdural hematomas were defined by a hematoma thickness of > 10 mm and/or the presence of midline shifting. The side of bleeding was categorized as being unilateral or bilateral, while its CT appearance was differentiated between isodense and heterodense, as well as between single and multiloculated.

All procedures were performed by the same team of surgeons. All patients were operated on under local anesthesia (bupivacaine + epinephine 1:100 000) or under conscious sedation. A minimal skin incision of approximately 5 mm was made over the area of maximal hematoma thickness, in the frontal or parietal region. Craniostomy was performed using a high-speed drill with a 5 mm diamond drill bit (Figure 2.). Dura was incised by the drill itself or by a tunneller. A silicone catheter 1.9 mm in diameter, routinely used for external ventricular drainage (EVD) was advanced into subdural space. Hematoma content was gradually aspirated. The skin was reconstructed in a single layer using skin staples. A catheter was connected to gravity-assisted drainage and removed after cessation of drainage. Peroral dexamethasone 8 mg q 12 was administered to all patients for three weeks postoperatively.

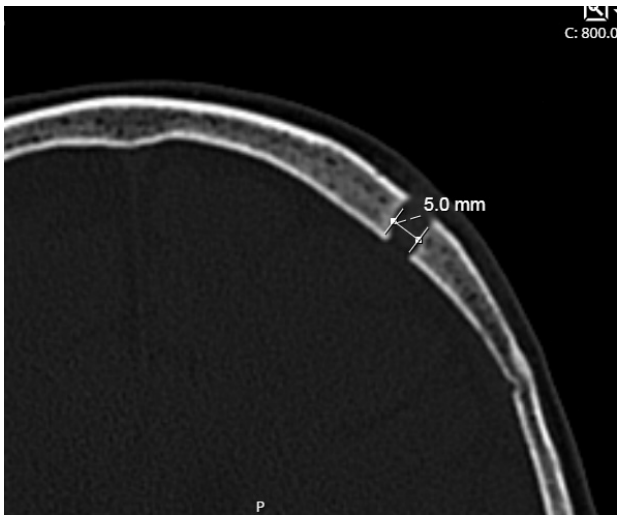


Figure 2. **A segmental bone window reconstruction of native axial head CT showing a high-speed drill hole of the left frontal bone measuring 5 mm in diameter.**

Patients were mobilized immediately after the procedure and a postoperative CT scan as well as clinical assessment was performed at the 3-month mark.

Basic demographical data of age and gender were recorded. The following clinical and radiographical parameters were analyzed: presence or absence of bilateral lesions, presence or absence of multiloculated/septated hematomas, hematoma density, length of hospital stay, surgical complications and mortality. Clinical performance outcome was assessed by the five-point Markwalder Grading Scale (MGS) where a lower grade indicated better cognitive functioning[20].

Statistical analysis was performed using STATISTICA 13 software (StatSoft, Tulsa, OK, USA). Categorical variables were presented with absolute and relative frequencies. Numerical data were presented with median and interquartile ranges. The distribution of the variables was tested using the Shapiro-Wilk test. Differences between categorical variables were tested using the chi-square test. All p values are two-sided. The statistical significance level was set at alpha=0.05.

## Results

The study included a total of 23 patients. There were 18 (78.3%) male patients and 5 (21.7%) female patients. A statistically significant male predominance was observed (chi-square test, p=0.014). The median patient age was 77.5 years, with an interquartile range of 67 – 83 years. Six (26.1%) of the patients had bilateral subdural hematomas.

Septated/multiloculated hematomas were observed in 6 (26.1%) patients (Figure 3.). Heterodense hematomas denoting more recent bleeding were recorded in 16 (69.5%) of the patients. The median duration of subdural drainage was 4 days, with an interquartile range of 3 to 5. The median length of hospital stay was 9.5 days with an interquartile range of 6 – 16. One patient died of sepsis following a nosocomial respiratory infection. One patient developed wound infection with subdural empyema, requiring subsequent craniotomy and empyema evacuation. One patient had deep venous thrombosis and pulmonary embolism (Figure 4.).

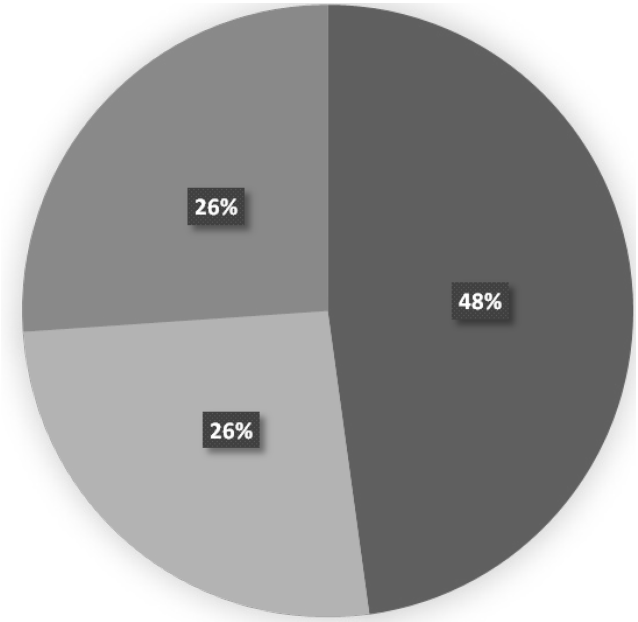


Figure 3. **Distribution of chronic subdural hematoma according to their CT appearance.**

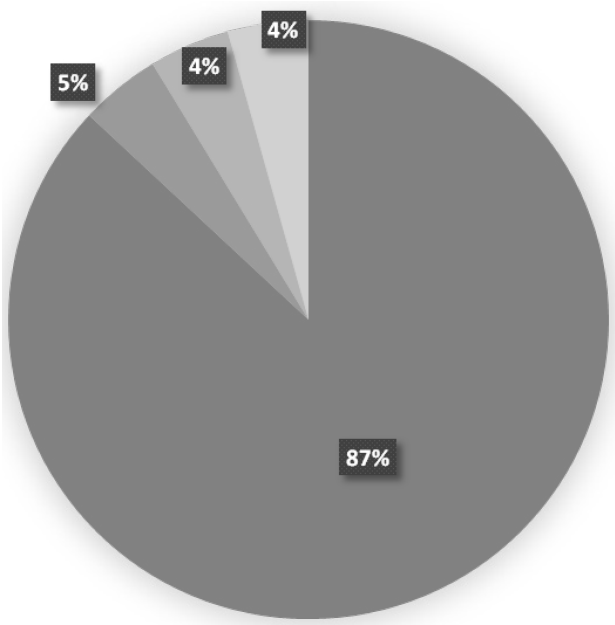


Figure 4. **Division of patients according to the outcome and scope of postoperative complications.**

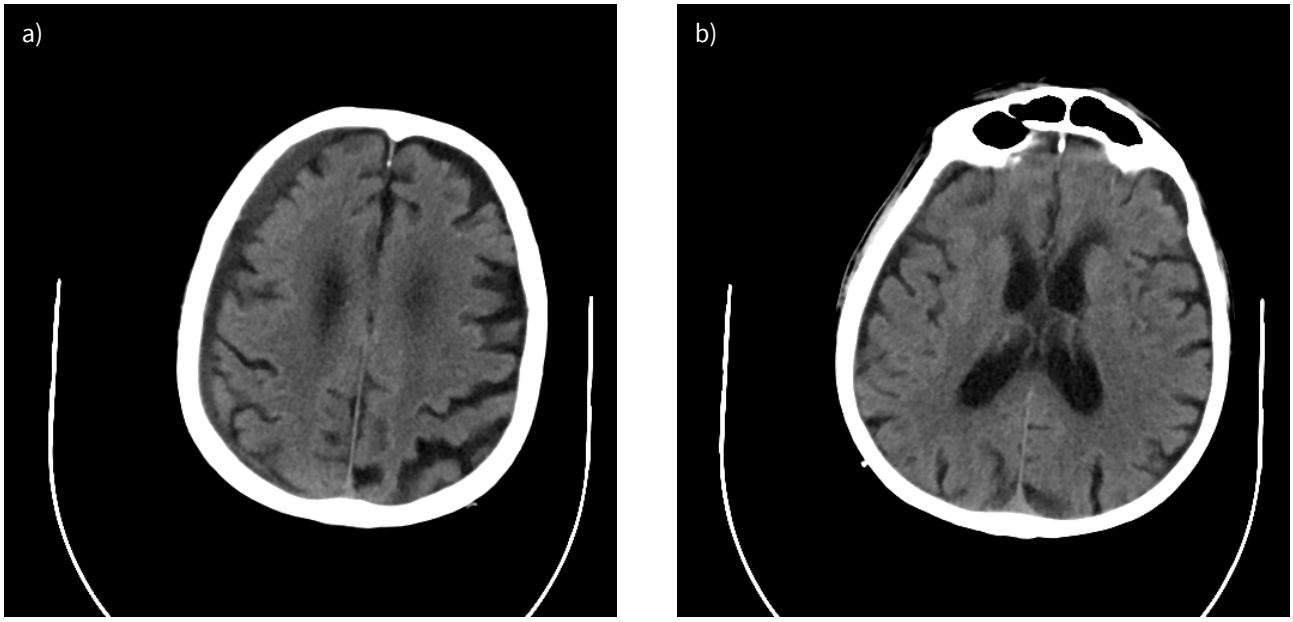


Figure 5. **Postoperative native axial head CT showing a satisfactory hematoma resolution and the right brain hemisphere reexpansion (a), as well as reestablishing of normal ventricular configuration with no midline shifting (b).**

In all patients, postoperative CT scans showed a significant reduction of hematoma volume and midline shifting (Figure 5). No postoperative hematoma recurrence or seizures were observed.

All the surviving patients had an excellent recovery, and were MHS 0, having a normal cognitive performance at the 3-month follow-up.

## Discussion

Because of the exponentially growing proportion of elderly, a substantial increase in cSDH incidence today is followed by an enlarged interest in its treatment[21-23] (Almenawer, Nouri, Toi). Surgical cSDH evacuation by burr hole trephination and subdural drainage remains the most widely used treatment method[24]. It balances a low recurrence with a low incidence of highly morbid complications[10]. However, its recurrence rates after surgical evacuation still range up to 30%[3]. Furthermore, the majority of cSDH patients mostly belong to the elderly, engraved with multiple comorbidities and usually enduring antithrombotic medication, which could potentially endanger surgical outcomes[5], especially during extended surgery. Consequently, optimal surgical strategies for cSDH management remain consensus-lacking[3, 25], mostly advocating less invasive treatment choices like twist drilling that should be preferred in selected elderly patients[26]. However, Williams et al.[4], have found that 64% of twist-drill patients from their series required repeat evacuations due to frequent recurrences. To avoid it, the cSDH treatment ought to include the resection of abnormally thickened hematoma membranes separating the subdural space in multiloculated hematomas[27]. Nevertheless, such an approach is almost impossible using a high-speed drill craniostomy technique. Since only a small fraction (26.1%) of our patients experienced multiloculated cSDHs, we believe that this was a potential reason for the non-existent recurrence found in our series.

Besides twist drilling, it seems that high-speed drill craniostomy may offer satisfactory results regarding hematoma recurrence and the outcomes as another minimally invasive treatment option, which remains underreported. The method consisted of the pre-coronal placement of a single high-speed drill hole measuring 4 – 5 mm in diameter, followed by hematoma aspiration, and a 1.9 mm silicone subdural catheter insertion for gravity-assisted drainage. We executed such a protocol with all 23 carefully selected patients obtaining satisfactory outcomes for the great majority of them.

Concerning the results of this pilot study, the low rate of complications, morbidity, and mortality following this minimally invasive surgical procedure was observed. Thus far, we did not observe any radiological signs of cSDH recurrence in our patients in whom control brain CT scans were performed at 3-month check-ups.

Considering our initial experience, it seems that high-speed drill craniostomy is a promising minimally invasive alternative method to sidestep potential disadvantages of cSDH classic surgical removal and to lower its recurrence rate. Elderly patients could most benefit from such a procedure, avoiding general anesthesia, a prolonged intracranial procedure, and lengthy hospital stays.

At the end of this paper, we would like to accentuate that its aim was not to establish recommendations for the best cSDH management but to present our newly gained initial experience in its handling, as well as to discuss certain benefits and controversies in its contemporary minimally invasive treatment.

Due to the small sample series and retrospective nature of the study, prospective randomized research on a larger scale is advised to confirm these preliminary results. The role of antiplatelet/anticoagulant usage in cSDH etiology, particularly in elderly patients, should also be comprehensively investigated and discussed. However, it was not the point of interest of this study limiting its scope further.

In conclusion, high-speed drill craniostomy is a safe, simple, straightforward, and effective minimally invasive alternative method for the management of selected patients with chronic subdural hematomas, including recurrent ones.

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# Liječenje kroničnih subduralnih hematoma minimalno invazivnom metodom trepanacije visokoobrtajnom brusilicom. Preliminarni rezultati pilot-studije

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## Sažetak

**Cilj:** Cilj je ovoga istraživanja procjena učinkovitosti i sigurnosti trepanacije visokoobrtajnom brusilicom u liječenju kroničnih subduralnih hematoma.

**Nacrt studije:** Presječna studija s povijesnim podacima.

**Ispitanici i metode:** Bolesnici s kompresijskim kroničnim subduralnim hematomima operacijski su liječeni minimalno invazivnom metodom trepanacije visokoobrtajnom brusilicom u lokalnoj anesteziji ili sedaciji. Primijenjena je minimalna incizija kože i trepanacija visokoobrtajnom brusilicom u čeonoj ili tjemenoj regiji, u području maksimalne debljine hematoma. Nakon aspiracije hematoma, silikonski kateter promjera 1,9 mm postavljen je u subduralni prostor i spojen na gravitacijsku drenažu. Bolesnici su mobilizirani neposredno po operaciji. Zabilježeni su i analizirani podaci o tijeku i uspješnosti liječenja.

**Rezultati:** U istraživanje je uključeno 23 bolesnika (pet ženskoga spola, 21,7%). Medijan životne dobi bolesnika iznosio je 77,5 godina (interkvartilni raspon 67 – 83). Šest (26,1%) bolesnika imalo je obostrane subduralne hematome. Septirani i multilokularni hematomi opaženi su u šest (26,1%) bolesnika. Heterodenzne lezije koje odgovaraju recentnijim hematomima zabilježene su u 16 (69,5%) bolesnika. Medijan trajanja hospitalizacije iznosio je 9,5 dana (interkvartilni raspon 6 – 16). U jednoga je bolesnika zabilježen letalni ishod kao posljedica nozokomijalne infekcije i sepse. U jednoga je bolesnika zabilježena infekcija rane s razvojem subduralnoga empijema, što je zahtijevalo kraniotomiju. Jedan je bolesnik razvio duboku vensku trombozu i plućnu emboliju. U svih je bolesnika poslijeoperacijskim CT oslikavanjem zabilježena znatna redukcija volumena hematoma i pomaka središnjih mozgovnih struktura. U ovoj skupini bolesnika nisu zabilježeni epileptički napadaji nakon operacije.

**Zaključak:** Trepanacija visokoobrtajnom brusilicom sigurna je, jednostavna i učinkovita metoda liječenja kroničnih subduralnih hematoma, uključujući multilokularne i heterodenzne lezije. Posebice je prikladna u bolesnika starije životne dobi, zbog izbjegavanja opće anestezije i dugoga trajanja operacije te kratke duljine hospitalizacije.

**Ključne riječi:** kronični subduralni hematom, trepanacija visokoobrtajnom brusilicom