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# Craniotomy vs. Burr Hole in the Management of Chronic Subdural Hematoma: A Literature Review

Alpasca Firdaus[*1] , Danang Bagus Untoro[1]
[1] *Bedah Saraf, Universitas Padjadjaran, Indonesia*
[*]Corresponding Author: alpascafirdaus@gmail.com

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**ABSTRACT**

**Introduction:** Chronic subdural hematoma (CSDH) is a common condition, especially in the elderly, often requiring surgical intervention. Burr hole drainage and craniotomy are the two main surgical approaches. However, the optimal technique remains debated due to differences in recurrence rates, complications, and outcomes.

**Methods:** A comprehensive literature review was conducted using databases such as PubMed, Scopus, and Google Scholar to compare burr hole drainage and craniotomy in the management of CSDH. Studies were selected based on relevance to surgical technique, recurrence, complications, and patient outcomes.

**Results and Discussion:** Burr hole drainage is less invasive, associated with shorter operative time, reduced hospital stay, and fewer complications. It is widely considered the first-line surgical option. However, some studies report higher recurrence rates compared to craniotomy. Craniotomy, while more invasive, may be more effective in cases with organized or recurrent hematomas, offering more thorough evacuation. It carries a higher risk of complications, particularly in elderly or comorbid patients. Clinical decision-making often depends on hematoma characteristics and patient condition.

**Conclusion:** Both burr hole drainage and craniotomy are effective for CSDH, but each has distinct advantages and drawbacks. Burr hole drainage is generally preferred due to its safety and efficacy, while craniotomy may be reserved for complex or recurrent cases. A patient-centered approach considering clinical and radiological factors is essential. Further randomized studies are needed to refine surgical guidelines.

**Keywords:** Chronic subdural hematoma, burr hole drainage, craniotomy, neurosurgery, recurrence, surgical outcomes, complications

## 1. Introduction

Chronic subdural hematoma (CSDH) is a common form of intracranial hemorrhage, especially in the elderly population. The incidence of CSDH is estimated to range from 8 to 14 cases per 100,000 people per year, with the highest incidence rate in the age group above 70 years.[1] With the increase in the elderly population, the incidence of CSDH is expected to increase significantly in the future. This condition may result from venous bleeding from ruptured bridging veins, leading to the accumulation of blood in the subdural space. Over time, the retained blood degrades and forms a fibrous membrane that can rebleed due to neoangiogenesis, increasing the volume of the hematoma and increasing the risk of recurrence.[2]

In clinical practice, there are several surgical procedure options to treat CSDH, including burr hole craniostomy (BHC), twist drill craniostomy (TDC) and craniotomy.[3] Burr hole craniostomy is currently the

most commonly used method as it is less invasive than craniotomy and has a lower complication rate. However, recurrence remains a major challenge in this procedure, with reported rates ranging from 9.2% to 26.5%.[4] Some studies also suggest that factors such as large preoperative hematoma volume, hematoma type, as well as burr hole location may increase the risk of recurrence after this procedure.[5]

On the other hand, (mini)craniotomy is also one of the alternatives given regarding the management of SDH. Mini-craniotomy involves creating a cranial hole with a diameter of 3-4 cm, providing wider access for hematoma evacuation and allowing more effective excision of the subdural membrane.[4] Recent studies have shown that this technique has a lower recurrence rate compared to burr hole craniostomy, as well as providing better visualization of subdural structures, which allows for more optimal control of hemostasis.[5] However, despite the promise of this technique, there is still debate regarding its effectiveness compared to other methods, especially in terms of the duration of surgery, complication rate, and higher cost compared to burr hole craniostomy.[6]

With the various advantages and disadvantages of each technique, further research is needed to compare different methods of CSDH evacuation more thoroughly. Comparative studies based on multicentre randomized clinical trials are needed to determine the most effective method with minimal recurrence and complications, and to provide evidence-based recommendations in clinical practice.[3]

## 2. Method

This research uses a literature study method by analyzing references obtained from Semantic Scholar, PubMed, and Google Scholar with a publication time span in the last 5 years (2020 - 2025). “chronic subdural hematoma,” ‘surgical management,’ ‘risk factors,’ and ‘recurrence rate’ ‘Burr Hole’ and ‘Craniotomy’ Articles included were publications within the last 5 years with a focus on clinical studies, research and systematic reviews. The inclusion criteria applied included: 1) Included articles consisted of research, editorials, commentaries, or literature reviews using quantitative, qualitative, or mixed methods; 2) Health-related articles or relevant topics published within the last 5 years; 3) Articles that addressed topics related to craniotomy and burr holes in SDH; 4) Articles published in reputable journals, both Scopus and non-Scopus indexed. Exclusion criteria were publications that were not included in the 2020-2025 range and paid journals. In the final stage, the assessment was carried out by removing journals with the same title and author, as well as incomplete text. The protocol in the literature search strategy uses PRISMA (Preferred Reporting Items for Systematic Review and Meta Analysis) to determine the choice of research found and adapted to the theme of the literature review, namely craniotomy and burr hole analysis in subdural hematoma.

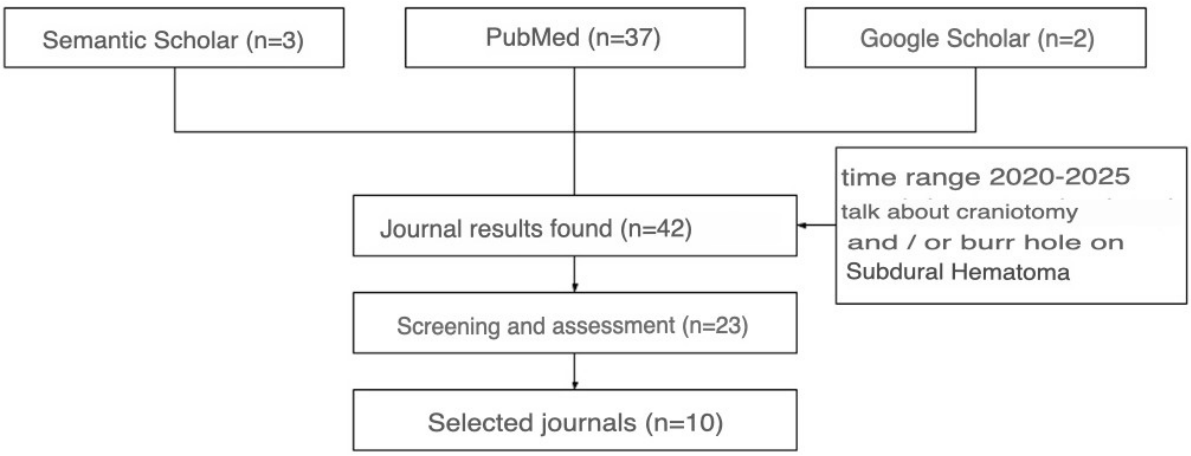


Figure 1. Flowchart

Through the article review and selection process, we obtained 10 journals that met the inclusion and exclusion criteria and were relevant to this study. All articles used were in English.

## 3. Discussion

Subdural hematoma as a form of intracranial hemorrhage

Chronic subdural hematoma (CSDH) is an accumulation of blood and its degradation products between the dura mater and arachnoid, which can cause neurological disorders with fluctuating symptoms depending on its size and location. The incidence of CSDH is estimated to be between 8.2 to 14.0 cases per 100,000 people per year, with the highest incidence in the elderly population, especially over 70 years old, and is predicted to double by 2037 as the elderly population grows.[1] Initially, CSDH was believed to originate from venous bleeding due to connecting vein rupture, which triggers blood accumulation and acute hematoma formation. If this hematoma persists, a fibrous membrane will form through the process of neoangiogenesis, causing rebleeding from small capillary vessels in the dura, which contributes to the growth and recurrence of CSDH.[2] However, the pathophysiology of CSDH is still not fully understood, as the condition can also develop from an initially conservatively managed acute subdural hematoma (ASDH) that does not undergo resolution, but rather fuses and enlarges, with a fluctuating risk of impaired consciousness. Approximately 6.5% of ASDH cases have delayed surgery, which may worsen the patient's condition.[3]

CSDH has various etiopathogenetic mechanisms, including intracranial hypotension due to cerebrospinal fluid (CSF) leakage, which is more common in young patients without a history of trauma or hematologic disorders. This condition may develop after microdiscectomy surgical procedures or sudden decompression due to intracranial pathology, such as arachnoid cyst fenestration and endoscopic third ventriculostomy. In addition, blood clotting disorders, the use of antiplatelet and anticoagulant therapy, and the presence of intracranial arachnoid cysts also contribute to the development of CSDH, with a complication incidence of approximately 6.5%.[3] In CSDH caused by bleeding due to bridge vein trauma, fibrin and fibroblasts begin to form a thin membrane layer within one day. Within two weeks, the outer membrane develops with fibroblast proliferation and active angiogenesis, producing new capillaries that support hematoma growth. Older hematomas (40 days post-trauma) show many thin-walled sinusoidal blood vessels, whereas in hematomas older than 60 days, many blood vessels in the outer membrane are blocked by blood clots.[4]

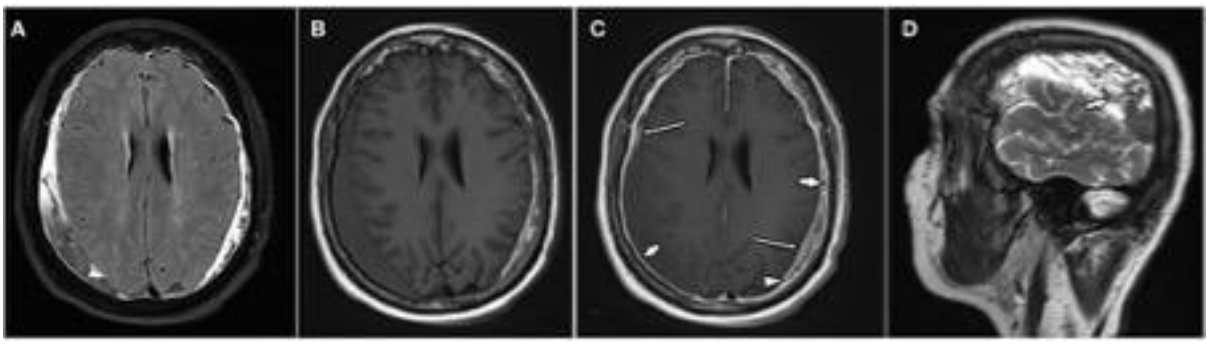


Figure 2. Chronic Subdural Hematoma

Management of SDH

Standard treatment for chronic subdural hematoma (CSDH) generally involves evacuation of the hematoma to reduce mass effect and relieve symptoms. Although in some rare cases the hematoma may undergo spontaneous resolution, in general patients with focal symptoms or changes in neurological status

should immediately undergo a surgical evacuation procedure. Effective evacuation not only improves the patient's clinical condition but also reduces the chance of recurrence.[1]

In the past decade, the use of neuroendoscopy in hematoma evacuation procedures has been increasing. In the treatment of intracerebral hemorrhage, technological developments have enabled hematoma evacuation procedures to be performed with direct visualization using modern surgical tools. As more case reports of subdural hematoma evacuation using neuroendoscopy appear in the medical literature, it is important for the field of neurosurgery to keep abreast of more modern cranial access techniques, evacuation methods and postoperative drainage strategies. This aims to optimize clinical outcomes and improve the effectiveness of CSDH treatment with safer and minimally invasive techniques. Evacuation of chronic subdural hematoma (CSDH) can be performed through three main techniques, namely twist drill craniostomy, burr hole craniostomy (BHC), and craniotomy, each of which has advantages and limitations (Rodriguez et al., 2023).

Twist drill craniostomy

Twist drill craniostomy is the most minimally invasive technique performed by creating a small hole (<5 mm) using a twist drill. Once the dura mater is incised, a cannula is inserted to passively drain the hematoma. The procedure is often performed at the patient's bedside under local anesthesia only, making it safer for elderly patients or those with comorbidities. The main advantage of this technique is its lower risk compared to other techniques, but the recurrence rate is quite high, at around 28.1-31.3%. To increase its effectiveness, this technique can be combined with a negative pressure evacuation (NPE) system, which uses a stainless steel port connected to a suction reservoir to help actively drain the hematoma.[1]

Burr hole craniostomy (BHC)

BHC is the most commonly used method in CSDH evacuation. This technique involves making one or two holes with a diameter of 12-14 mm in the convexity of the brain at a distance of 5-8 cm from each other, then the dura is incised and the hematoma is removed using a combination of suction and irrigation. Irrigation is generally performed with normal saline (NS), although some studies have shown that the use of artificial cerebrospinal fluid (ACSF) can reduce the recurrence rate from 23.8% (NS) to 9.0%. In addition, irrigation with body temperature fluids has also been reported to reduce recurrence rates compared to irrigation with room temperature fluids. Although this procedure is usually performed under general anesthesia, local anesthesia can also be used as an alternative to reduce complications. The recurrence rate of this technique ranges from 10.5-12.0%, which is lower than twist drill craniostomy, making it a top choice for elderly patients as it is safer than craniotomy.[2]

Craniotomy

Craniotomy is the most invasive yet most effective method for CSDH evacuation. The procedure involves creating a bone flap of 3-5 cm or larger, allowing thorough removal of the hematoma as well as cauterization or removal of the hematoma membrane to prevent rebleeding. Once the hematoma is cleared, the dura is closed again and the bone flap is returned to its original position. This technique is most effective in removing CSDH, but carries a higher risk, especially for elderly patients or those with weakened health conditions. Craniotomy is performed in the operating room under general anesthesia, and has a morbidity rate of 4-12%, a mortality rate of 4.6-12.2%, and a recurrence rate of 11-19.4%.[1]

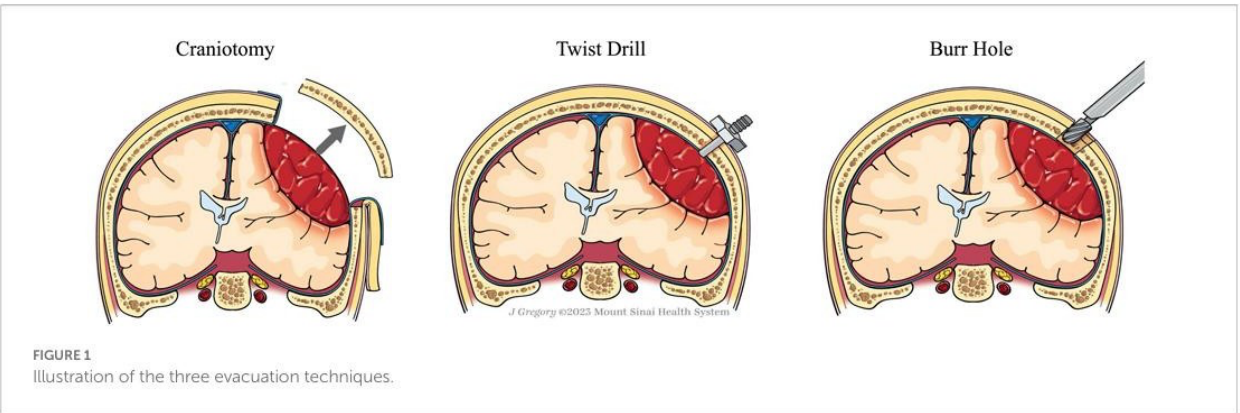


Figure 3: Differences in three SDH management techniques

Burr Hole Technique in SDH

BHC is the most commonly used method in CSDH evacuation. The recurrence rate of this technique ranges from 10.5-12.0%, making BHC the main technique for SDH management.[1] In his study, Gomaa et al., reported that the average duration of surgical procedures in patients with CSDH was 35.75 minutes, with an average length of hospitalization of 5.93 days.[6] Most patients had a significant improvement in the Glasgow Coma Scale (GCS) of 0.89 points and an average motor strength improvement of 0.4 points. Further analysis showed that older patients had less motor improvement and required longer hospitalization time, possibly due to the presence of comorbidities such as hypertension and anticoagulant use that require special attention before surgery, as well as the need for postoperative intensive care.[6] this is in accordance with several previous studies where several previous studies found that the use of subdural drains did not have a significant effect on recovery rates or mortality, but this study shows that the use of drains can reduce the risk of symptomatic recurrence and the need for reoperation. In addition, this study confirmed that the benefits of subdural drains were more pronounced in preventing long-term recurrence (up to six months postoperatively).[5] However, the BHC technique cannot necessarily be used without consideration. one of the things to consider is the factors that can affect recurrence in BHC.

Factors that may affect recurrence in BHC

In a study by Hashimoto et.al., which examined the relationship between chronic subdural hematoma (CSDH) volume, burr hole location, and recurrence risk after single burr hole surgery with a closed drainage system, showed that a larger CSDH volume was associated with a higher recurrence risk, with an optimal threshold of 165 mL or 39 mm thickness.[5] In addition, laminar and separate CSDH types had the highest recurrence rates, while trabecular types had the lowest recurrence rates. A more lateral and ventral position of the burr hole is associated with a higher risk of recurrence, so it is recommended to make the burr hole more parietal and avoid the temporal muscle. Although postoperative air volume was previously considered a risk factor for recurrence, this study shows that the main factors are poor brain expansion and large preoperative CSDH volume, while air volume is only a consequence. This study also confirmed that age, bilateral CSDH, and postoperative neurological deficits were associated with the risk of recurrence. Although a single burr hole surgery method is considered consistent in Japan, this study has limitations, such as its retrospective nature, variability in the use of anticoagulants or hematoma irrigation, as well as potential bias in the determination of burr hole location.[7]

Craniotomy Technique in Subdural Hematoma (SDH)

Craniotomy is the most invasive yet the most effective method for the evacuation of chronic subdural hematoma (CSDH).[1] A study conducted by Sudha Ram and Visvanathan K found that the average duration of the mini-craniotomy procedure for CSDH was approximately 66 minutes.[8] The majority of patients (60%) underwent the procedure in 60 minutes or less. However, there was a significant difference in operative duration based on the type of anesthesia used. Patients who underwent the procedure under general anesthesia (GA) had a longer operative time, averaging 71 minutes, compared to those who underwent the procedure under local anesthesia (LA), which lasted an average of 55 minutes. This difference was statistically significant ($p < 0.05$), indicating that the use of GA may contribute to a longer procedural duration.[9]

Additionally, the length of hospital stay after surgery varied between 3 to 19 days, with an average of 6 days. Although there was a trend suggesting that patients with longer operative times experienced prolonged hospitalization, this difference was not statistically significant. This suggests that other factors, such as the patient's preoperative medical condition and postoperative complications, may play a more significant role in determining the length of hospital stay.[8]

One patient with CSDH caused by thrombocytopenia was the only case that experienced fluid re-accumulation and required reoperation on the second postoperative day. This hematoma re-accumulation was likely related to coagulation disorders due to thrombocytopenia, which increased the risk of recurrent bleeding. Initially, this patient had a Glasgow Coma Scale (GCS) score of 8/15 before surgery, indicating a significant level of impaired consciousness. However, after the first evacuation procedure and subsequent reoperation, the patient's condition improved significantly, with an increase in GCS to 15/15 upon discharge from the hospital, without any remaining neurological deficits. This suggests that the recurrence rate of SDH patients undergoing craniotomy is relatively low.[7]

Craniotomy vs. Burr Hole

Surgical evacuation is the primary option in managing chronic subdural hematoma (CSDH) when the hematoma causes clinical symptoms due to pressure exerted on the brain tissue. This procedure is generally considered safe, with most patients showing good clinical outcomes after surgery. However, despite being relatively simple, it still carries the potential for serious complications, such as disability and even death, particularly if not optimally managed or if the patient has pre-existing medical conditions that worsen the prognosis.[9]

The decision to perform surgery is usually based on CT or MRI scan results, which provide an overview of the hematoma's size, location, and impact on brain structures. The two primary methods used globally for CSDH management are craniotomy and burr hole drainage. Craniotomy involves creating a larger opening in the skull to allow broader access to the hematoma, whereas burr hole drainage is a less invasive procedure that involves making a small hole to drain the hematoma.[9]

A study conducted by Edem, I., et al., indicated that burr hole drainage is more effective than craniotomy in certain aspects. This procedure offers advantages such as a shorter operative duration, smaller incision wounds, and the ability to be performed under local anesthesia, enabling patients to recover more quickly and return to daily activities earlier than those undergoing craniotomy.[9]

Additionally, the study results demonstrated that burr hole drainage contributed to a shorter hospital stay compared to craniotomy. Postoperative evaluations using the Glasgow Outcome Scale (GOS) also showed that patients who underwent burr hole drainage experienced better recovery than those who underwent craniotomy. This finding was supported by Receiver Operating Characteristic (ROC) analysis, which indicated that burr hole drainage had higher sensitivity and specificity, making it a superior method for managing CSDH.[8]

Another study conducted by Graham, R. S., et al., compared the effectiveness of early craniotomy with delayed burr hole procedures in elderly patients with acute subdural hematoma (aSDH) resulting from low-energy trauma.[10] The findings revealed that patients who underwent delayed burr hole procedures had lower complication rates compared to those who underwent early craniotomy. Furthermore, the mortality rate in the delayed burr hole group was lower (7%) than in the early craniotomy group (19%). Further analysis indicated that the degree of midline brain shift was the primary factor influencing the likelihood of hematoma reaccumulation after surgery, while the patient's initial Glasgow Coma Scale (GCS) score correlated with the length of stay in the intensive care unit (ICU).[9]

The results of this study support previous findings suggesting that delayed surgical intervention, particularly the burr hole procedure, can reduce treatment costs, decrease reoperation rates, and increase the likelihood of patients being discharged directly home compared to the craniotomy method.[3] Previous studies have also indicated that elderly patients with high GCS scores after trauma can benefit from this strategy. However, the decision to delay or expedite surgery should consider the patient's specific condition, including the risks of morbidity and mortality, as well as factors such as the use of antithrombotic therapy, which may increase the risk of bleeding.[10]

Prognosis and Complications

In patients with subdural hematoma (SDH), hematoma removal can lead to sudden changes in intracranial pressure (ICP) dynamics.[3] Normally, the brain has a cerebrovascular autoregulatory mechanism that maintains stable blood flow despite pressure fluctuations. However, in patients with severe brain injuries, this mechanism is often impaired. Consequently, after hematoma evacuation, blood flow to the previously compressed area may increase excessively. This uncontrolled increase in blood flow, known as post-decompression hyperemia, can cause progressive brain edema. As a result, the brain tissue may swell and protrude through the craniectomy window, a condition referred to as malignant intraoperative brain bulge.[4]

In addition to autoregulatory dysfunction, blood-brain barrier (BBB) impairment also contributes to postoperative brain edema formation. Primary brain injuries caused by trauma and secondary injuries resulting from pressure changes after decompression can damage BBB integrity, allowing plasma leakage and fluid entry into brain tissue. Studies have shown that BBB disruption contributes to extracellular fluid accumulation, further exacerbating brain edema.[4] Furthermore, the post-traumatic inflammatory response plays a crucial role in the development of brain edema. The release of pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α) has been proven to worsen vascular dysfunction, increase capillary permeability, and accelerate cerebral edema formation.[3]

Another factor contributing to post-decompression brain swelling is osmotic dysregulation, which can cause fluid shifts from blood vessels into brain tissue.[1] Changes in osmolarity within the brain tissue may occur due to metabolic disturbances following injury, triggering increased hydrostatic pressure and leading to greater fluid migration into the brain's extracellular space. Additionally, elevated intracranial venous pressure due to impaired venous outflow from the brain can worsen this condition. Venous flow obstruction can cause vascular congestion that exacerbates brain edema, further increasing the risk of worsening neurological deficits, brain herniation, and even death.[4]

Therefore, in managing SDH patients undergoing surgical decompression, it is crucial to implement preventive strategies against post-hematoma evacuation brain edema.[4] Strict ICP monitoring, the use of hyperosmolar therapy such as mannitol or hypertonic saline, and optimal blood pressure control can help reduce the risk of fatal brain swelling. Moreover, a more cautious approach in adjusting the speed of hematoma decompression can mitigate the risk of post-decompression hyperemia and help maintain cerebral hemodynamic balance.[8]

## 4. Conclusion

This literature review highlights the ongoing debate regarding the optimal surgical approach for managing chronic subdural hematoma. Both craniotomy and burr hole drainage are widely utilized, each with distinct advantages and limitations. Burr hole drainage generally demonstrates lower morbidity, shorter operative times, and reduced hospital stays, making it a preferred option in many cases. However, craniotomy may offer benefits in selected patients, particularly those with organized hematomas or recurrent cases where more extensive evacuation is required.

Recurrence rates appear to be slightly higher with burr hole drainage, but this is often offset by its favorable safety profile and less invasive nature. Ultimately, the choice of surgical technique should be individualized, taking into account patient-specific factors such as age, comorbidities, hematoma characteristics, and surgeon expertise.

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