



Single Versus Double Burr Hole Craniostomy in Surgical Treatment of Chronic Subdural Hematoma: A Meta-Analysis

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BACKGROUND: Chronic subdural hematoma (cSDH) is one of the most common illnesses seen in neurosurgery departments worldwide. For surgical treatment, some neurosurgeons prefer single burr hole craniostomy (SBHC), whereas others prefer double burr hole craniostomy (DBHC). We performed a meta-analysis to investigate whether DBHC is associated with increased risks of recurrence, complications and mortality compared with SBHC in patients with cSDH.

METHODS: Retrospective observational trial or randomized controlled trial (RCT) studies concerning burr hole craniostomy to treat cSDH were systematically identified through a search of electronic databases: PubMed, Web of Science, Embase, and Cochrane. Inclusion and exclusion criteria were defined for the eligible studies. The random fixed-effects model was used when heterogeneity was indicated; otherwise, a fixed-effects model was adopted.

RESULTS: This meta-analysis included 12 studies, 3 of which were RCTs. Our findings can be summarized as follows. First, SBHC did not increase the risk of recurrence compared with DBHC in patients with cSDH (odds ratio [OR], 1.28; 95% confidence interval [CI], 0.92–1.78; $P = 0.07$). Second, DBHC was not associated with an increased complication rate compared with SBHC in patients with cSDH (OR, 0.74; 95% CI, 0.20–2.76; $P = 0.11$). Third, DBHC did not increase mortality compared with SBHC in patients with cSDH (OR, 1.38; 95% CI, 0.55–3.46; $P = 0.58$).

CONCLUSIONS: This meta-analysis demonstrates that there are no significant differences in recurrence rate,

complication rate, and morbidity between SBHC and DBHC in the treatment of patients with cSDH.

INTRODUCTION

Chronic subdural hematoma (cSDH) is one of the most common disorders seen in neurosurgery departments worldwide, with an incidence of 1.72–13.1/1,000,000 population per year, and is especially prevalent in elderly persons.¹ Surgical treatment is suitable for patients with cSDH with neurologic symptoms. The available surgical approaches include burr hole craniostomy (BHC), twist drill craniostomy, craniotomy, and endoscopic burr hole.^{2–4} Studies comparing surgical approaches have identified BHC as the best approach, associated with the fewest complications among these techniques.^{5–7} However, there remains disagreement among neurosurgeons as to the optimal number of burr holes (single vs. double) to drain cSDH.^{8–10} Many neurosurgeons tend to perform single burr hole craniostomy (SBHC) because this procedure is fast and involves only 1 incision; however, others believe that a single hole is insufficient to evacuate a hematoma and thus may increase the risk of recurrent hematoma compared with double burr hole craniostomy (DBHC).

A meta-analysis published in 2013 compared the recurrence rate of SBHC versus DBHC.¹¹ However, that meta-analysis included only 5 studies, all of which were retrospective observational studies.^{8–10,12} Since then, 7 other studies have been published comparing recurrence rates and other aspects in SBHC and DBHC,^{13–19} including 3 randomized controlled trials (RCTs). Here we report our updated meta-analysis conducted to analyze and compare the recurrence rate, complication rate, and mortality in

Key words

- Chronic subdural hematoma
- Craniostomy
- Double burr hole craniostomy
- Meta-analysis
- Single burr hole craniostomy

Abbreviations and Acronyms

- BCH:** Burr hole craniostomy
- CI:** Confidence interval
- cSDH:** Chronic subdural hematoma
- DBHC:** Double burr hole craniostomy
- OR:** Odds ratio

RCT: Randomized controlled trial

SBHC: Single burr hole craniostomy

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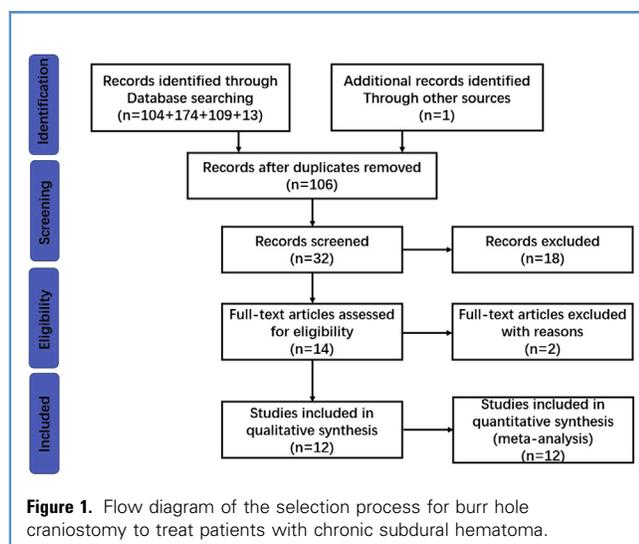
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cSDH patients who underwent SBHC and those who underwent DHBC. We aim to provide doctors with evidence-based guidelines for the treatment of cSDH.

MATERIALS AND METHODS

Literature Search and Study Identification

We systematically searched for qualifying studies in the PubMed, Web of Science, Embase, and Cochrane online databases. The search

terms used were “chronic subdural hematoma,” “burr hole craniotomy,” and “recurrence”. All articles written in English and published before January 2019 were included. Two authors independently evaluated the search results by reading the article titles, and 2 other authors independently reviewed the abstracts of the initially screened articles. Disagreements were settled by the senior author.

Inclusion and Exclusion Criteria

Our criteria for inclusion in the meta-analysis were as follows: cSDH patients who underwent BHC; RCT or prospective observational study; quality score of >5 on the Newcastle–Ottawa Scale²⁰ or a modified Jadad Scale score of >3 .²¹ The exclusion criteria were as follows: system review or case report, only an abstract available, and not written in English.

Data Extraction

Two reviews extracted data using a uniform standard form. The primary outcome was recurrence incidence; secondary outcomes were complication rate and mortality after surgery. Other related factors, such as first author’s name, publishing year, country, and population characteristics, were also extracted.

Statistical Analysis

All results are presented as odds ratio (OR) with 95% confidence interval (CI) and P values. Heterogeneity was assessed by the I^2 value and interpreted as follows: $I^2 = 0$, no heterogeneity; $0 < I^2 < 40\%$, mild heterogeneity; $30\% < I^2 < 60\%$, moderate heterogeneity; $50\% < I^2 < 90\%$, substantial heterogeneity; $75\% < I^2 < 100\%$, considerable heterogeneity. A fixed-effects model was

Table 1. Main Characteristics of the Studies Included in this Meta-Analysis

Study	Country	NOS				Modified Jadad Score				
		Selection	Comparability	Exposure	Score	Randomization	Concealment of Allocation	Double Blinding	Withdrawals and Dropouts	Score
Taussky et al., 2008 ⁸	Switzerland	***	**	***	8					
Lee et al., 2009 ¹²	Korea	***	**	***	8					
Han et al., 2009 ⁹	Korea	***	**	***	8					
Kansal et al., 2010 ¹⁰	India	***	*	***	7					
Pickett, 2010 ¹¹	Canada	***	*	***	7					
Pahatouridis et al., 2013 ¹³	Greece	***	*	***	7					
Jang et al., 2015 ¹⁵	Korea	***	**	***	8					
Agrawal et al., 2017 ¹⁶	India	***	*	***	7					
Heringen et al., 2017 ¹⁷	Brazil	***	**	***	8					
Nayil 2014 ¹⁴	India					2	1	0	1	4
Rafi et al. 2018 ¹⁹	Eruasia					2	1	1	1	5
D’Oria et al., 2018 ¹⁸	Italy					2	1	1	1	5

NOS, Newcastle-Ottawa Scale.
 *One item positive.
 **Two items positive.
 ***Three items positive.

used when $I^2 < 50\%$; otherwise, a random-effects model was adopted. In addition, funnel plots were created to assess for potential publication bias. Review Manager (version 5.1, The Nordic Cochrane Center, The Cochrane Collaboration, Copenhagen, Denmark) was applied to analyze the data in our meta-analysis. A P value < 0.5 was considered to indicate a statistically significant difference.

RESULTS

Study Selection and Characteristics

The details of our search are presented in a flow diagram in **Figure 1**. A total of 106 records remained after removal of duplicates, and after screening of titles and abstracts, 32 studies for which full-text were available were retained for further analysis. Finally, 12 studies were included in this meta-analysis, 3 of which were RCTs.⁸⁻¹⁹ All the included studies demonstrated high methodological quality (**Table 1**). In these 12 articles, the influence

of burr hole number on the recurrence of cSDH was assessed in a total of 1723 cases. For all analyses pertaining to efficacy and acceptability, no heterogeneity was detected.

Effect of Burr Hole Number on Recurrence Rate

Of the 1723 patients from 12 studies analyzed, 816 underwent SBHC and 907 underwent DBHC. SBHC was not associated with an increased risk of cSDH recurrence compared with DBHC (odds ratio [OR], 1.28; 95% confidence interval [CI], 0.92–1.78; $P = 0.07$; $I^2 = 40\%$) (**Figure 2A**). No publication bias was evident in the funnel plot (**Figure 2B**).

Effect of Burr Hole Number on Complication Rate

The complication rate associated with BHC was evaluated in 4 studies with a total of 506 patients (260 who underwent SBHC and 246 who underwent DBHC). DBHC was not associated with an increased rate of complications compared with SBHC (OR, 0.74;

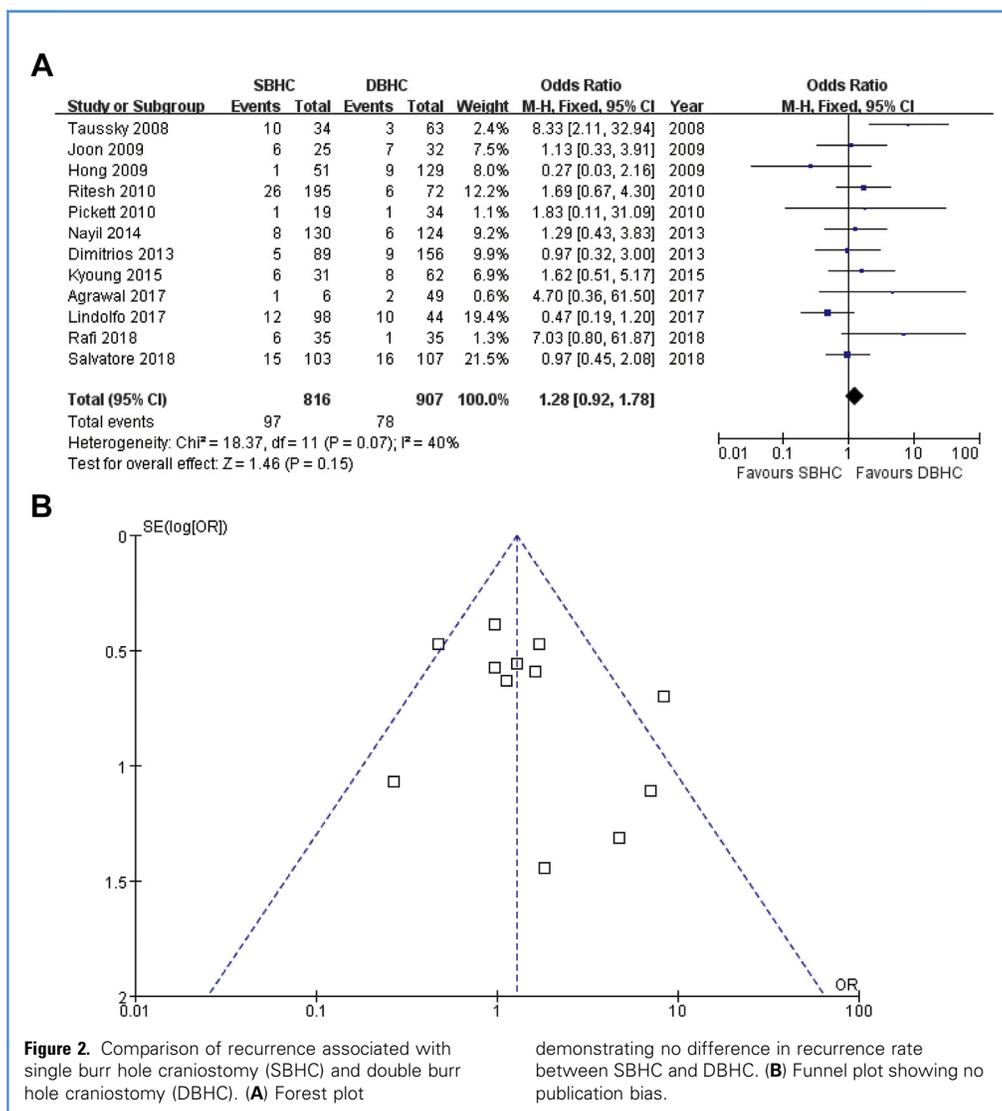
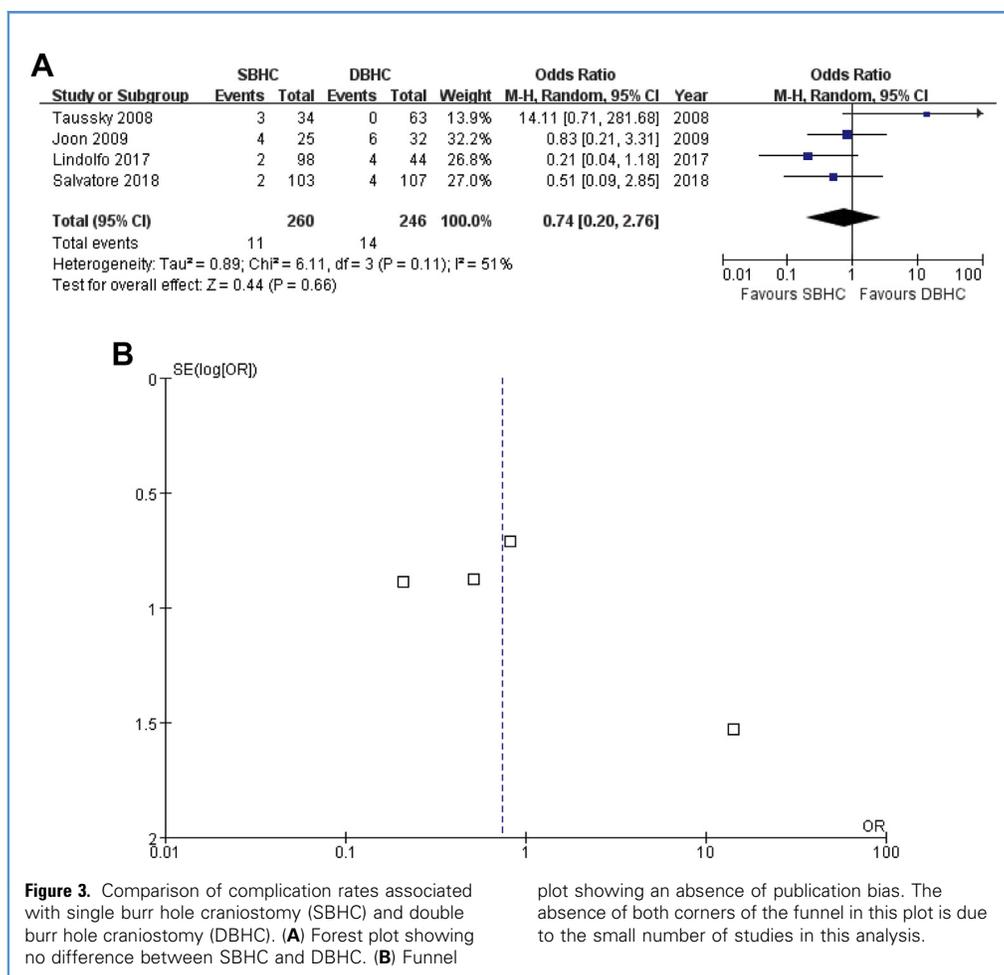


Figure 2. Comparison of recurrence associated with single burr hole craniostomy (SBHC) and double burr hole craniostomy (DBHC). **(A)** Forest plot

demonstrating no difference in recurrence rate between SBHC and DBHC. **(B)** Funnel plot showing no publication bias.



95% CI, 0.20–2.76; $P = 0.11$; $I^2 = 51\%$) (Figure 3A). No publication bias was evident in the funnel plot (Figure 3B).

Effect of Burr Hole Number on Mortality

Mortality associated with BHC was evaluated in 5 studies including a total of 525 patients, 209 who underwent SBHC and 316 who underwent DBHC. DBHC was not associated with an increased risk of mortality in patients with cSDH compared with SBHC (OR, 1.38; 95% CI, 0.55–3.46; $P = 0.58$; $I^2 = 0\%$) (Figure 4A). The funnel plot showed no publication bias (Figure 4B).

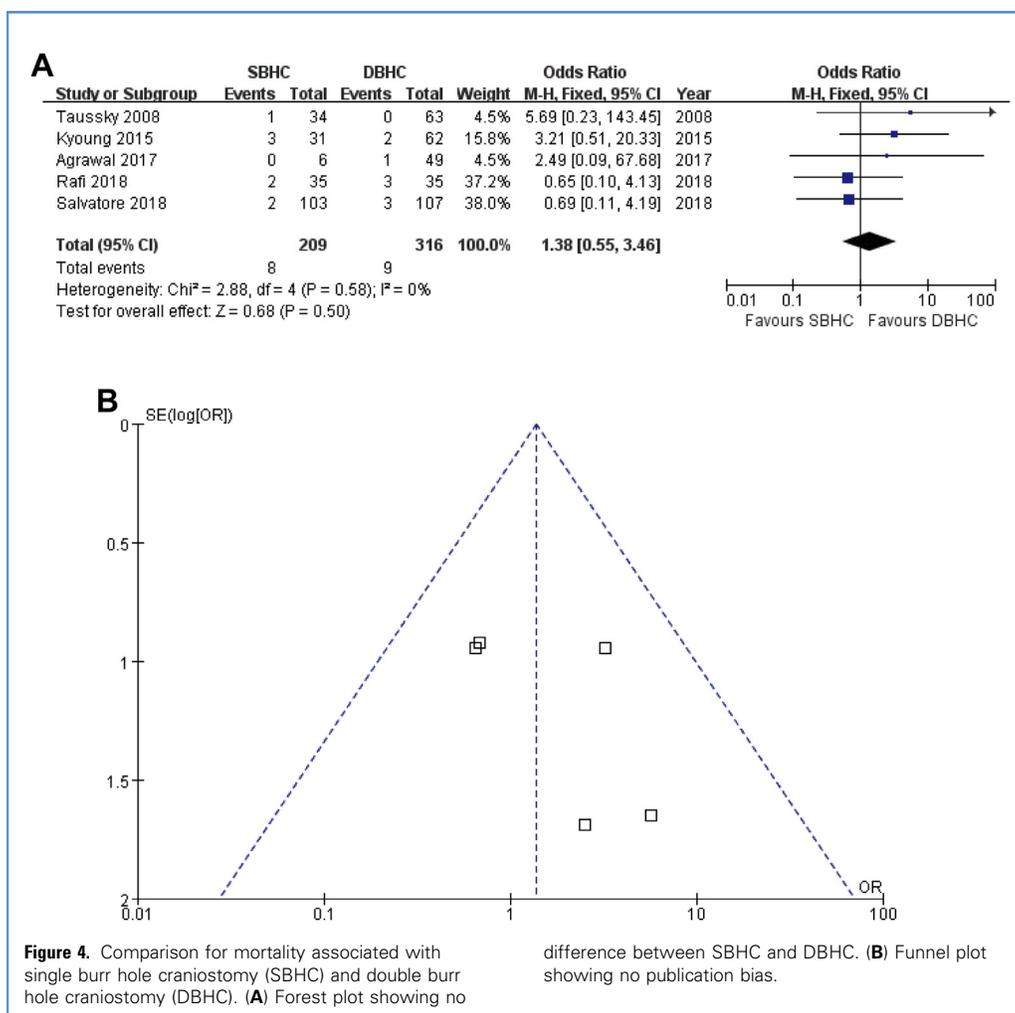
DISCUSSION

The revision operation rate of cSDH varies from 2.3% to 38.7%, which is related to warfarin use, degree of hematoma loculation, and the amount of hematoma evacuated.²² Some neurosurgeons believe that DBHC can remove the hematoma more effectively and reduce the recurrence rate compared with SBHC in the treatment of cSDH patients, because DBHC can back-and-forth irrigation hematoma. Some studies found a statistically significantly higher postoperative recurrence rate associated with SBHC compared with DBHC in patients with

cSDH.^{8,15,16,19} Other studies support the opposite conclusion, however. In 2009, Han et al.⁹ reported recurrence rates after SBHC and DBHC of 2% and 7%, respectively, in patients with cSDH, and in 2017, Heringer et al.¹⁷ reported these rates as 12.2% and 22.7%. Neurosurgeons' levels of surgical skill and experience can influence the recurrence rate of cSDH. In addition, some studies showed no difference in recurrence rate between SBHC and DBHC to treat cSDH.^{11–13,18} Our meta-analysis concluded that SBHC did not increase the risk of recurrence of cSDH compared with DBHC.

We analyzed the complication rates associated with the 2 surgical approaches reported in 4 studies.^{8,12,17,18} In these studies, the most common surgical complications after BHC surgery are seizure, wound infection, subdural empyema, and intracerebral hemorrhage, with rates ranging from 3% to 28%.^{23,24} Patients with cSDH are generally older and have serious associated medical complications, the most common of which is pneumonia.²⁴ Our meta-analysis concluded that DBHC was not associated with an increased risk of complications compared with SBHC in patients with cSDH.

In theory, DBHC will have higher mortality compared with SBHC due to the 2 burr holes in the skull, 2 incisions, and longer durations of surgery and anesthesia.²⁵ However, our analysis of



surgery-associated mortality in 5 studies^{8,15,16,18,19} found no significant difference in mortality between patients who underwent SBHC and those who underwent DBHC. The reported causes of death after BHC are diverse, including multiorgan failure, ventricular tachycardia, ventilator-associated pneumonia, and catheter-induced sepsis.^{15,18} cSDH usually occurs in elderly people who have some basic illness. Some cSDH patients died post-operative due to deterioration of their basic illness instead of brain surgery and its complications.^{26,27} So, it is reasonable to conclude that there is no difference between the 2 procedures.

This meta-analysis has several limitations. First, only 3 RCTs were included, and most of the other included studies were

retrospective, so heterogeneity was an inevitable factor. Second, differences in the diagnostic criteria and surgical technique and experience across the institutions in the studies might have yielded inconsistent results.

In conclusion, this meta-analysis of studies comparing the recurrence rate, complication rate, and morbidity associated with SBHC versus DBHC in the treatment of cSDH patients found no significant difference between the 2 surgical techniques. We conclude that SBHC is as effective and safe as DBHC. However, more RCTs are needed to further confirm this conclusion, with the ultimate aim of improving treatment and the prognosis for these patients.

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