Chronic Subdural Haematoma: A Comparative Study of Burr-Hole Craniostomy and Small Craniotomy in a Tertiary Care Teaching Hospital

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Abstract: ***Chronic subdural haematoma (cSDH) has been defined as a encapsulated collection of old liquefied haematoma in the subdural space with a characteristic outer and inner membrane and occurring, if at all associated with, at least 3 weeks after head injury. It is one of the most common pathological conditions presenting to the neurosurgical emergency with an incidence of 1-2 per 100,000, having a predilection for elderly males,[1]. Although burr-hole craniostomy has been the most commonly used procedure for this condition, there has been no consensus regarding the best surgical procedure for treating these lesions [2].In this paper we report our 4 year experience with burr hole craniostomy and small craniotomy in the management of cSDH at a tertiary care hospital in India.***

Keywords: CSDH, Chronic SDH, Burr hole, Craniostomy, Minicraniotomy, Craniotomy.

1. Materials and Methods

A retrospective study was performed using the data over 4 years, from 1st of August, 2017, at the Department of Neurosurgery, NRS Medical College and Hospital. Computed tomography (CT) scan was the primary imaging modality used. Burr hole craniostomy with subgaleal suction drain for the next 48 hours was done in those patients who had no evidence of non-liquefied haematoma and had no septations. However, patients with mixed density or hyperdense lesions, intrahaematomal membranes, organised or calcified cSDH and those with recurrence were selected for a small craniotomy. For the second group of patients, a square craniotomy of 4cm dimension on each side was performed centering the thickest part of the haematoma seen on CT Scan. Durotomy was done in a cross-shaped pattern. The outer membranes were removed. The haematoma cavity was repeatedly irrigated with normal saline until the return fluid was clear. The inner membrane was left undisturbed, except in 6 cases where there was underlying collection of blood breakdown products and there was no intraoperative expansion of the brain. In these cases the inner membrane was sharply incised with the tip of a no. 23 needle, and separated from the underlying arachnoid by hydro-dissection. On completing the procedure proper hemostasis was ensured and only the four tips of the dural flaps were apposed. The dural cut margins were properly coagulated. The bone flap was replaced and secured with absorbable sutures. Skin and galea were closed over a 14 Fr. suction drain. Neurological assessment of the patients was preoperatively and postoperatively evaluated by ”Markwalder's Neurological Grading System”, the most commonly used neurological grading system for cSDH (*vide Table 7).

2. Results

Of the 213 patients included in our study, 166 underwent burrhole and 47 underwent craniotomy. The mean age in the two groups, burr-hole and craniotomy group were 62.7 and 64.3 respectively, with a p-value of 0.92 between the two groups (vide Table 1, 6). 122 patients in the burr-hole group were male as compared to 30 patients in the craniotomy group (*vide Table 2). While 35 patients in the burr-hole group had bilateral cSDH, only one patient in the craniotomy group had bilateral cSDH. The patient with bilateral cSDH in the craniotomy group underwent craniotomy in one side initially for the larger cSDH and burr-hole in the other side, at a later date for the smaller one. Majority of patients in burr-hole group had a Markwalder Grade Scale (MGS) of “1” at presentation while majority of patients in the other group had a MGS of 2. Despite this, the mean MGS in the first group was higher (1.9) than the second group (1.7), due to the fact that quite a few patients in the burr-hole group had a MGS of 4 at presentation, while no patient in the craniotomy group had a MGS of 4 at presentation. Similarly, the mean MGS at discharge was higher in the burr-hole group (1.0) as compared to the craniotomy group (0.2). However, the p value in the two groups was not statistically significant (vide Table3, 5, 6). The operative time was significantly higher in the craniotomy group than in the burr-hole group (p value <0.0001) (vide Fig 1, Table 5,6). Since burr-hole craniotomy often resulted in incomplete evacuation of cSDH, and re-operations were frequently required, thereby increasing the patient's stay in hospital. The mean hospital stay in this group was found to be significantly higher than that in the craniotomy group (vide Table 5). Reoperation was frequently required in patients undergoing burrhole. 18 out of 166 patients required to be operated again, while none in the craniotomy group required re-operation. The reason for re-operation in the burr-hole group was residual collection of cSDH. All such patients underwent a repeat burr hole except one who was transferred to the craniotomy arm. The patients undergoing re-operation had a significantly longer hospital stay than those who didn't need a revision surgery (vide Table 6). Four patients in the craniotomy group developed pneumonia.

No other local or systemic complication was seen in any other patient in this group. 45 patients developed complications in the burr-hole group, of which 9 had wound infection, 9 developed new onset acute SDH, 18 patients had residual collection of cSDH, 3 patient developed pneumonia and 6 had developed pressure sores. However, no statistically significant difference was noted between the two groups (vide Table 4,5,6). There was no significant difference in mortality in the two groups of patients (vide Table 6). 6 patients died in the burr-hole group, three due to pneumonia, and three due to sepsis following pressure sore.. There was one death in the craniotomy group due to pneumonia.

3. Discussion

Chronic subdural haematoma has been documented as one of the most common conditions encountered by a neurosurgeon[2]. Although a variety of surgical treatment modalities have been available for treating cSDH, there has been quite the controversy in selecting the ideal type of treatment for this condition. The evolution of surgical management options for cSDH have been very well documented in literature. These lesions were initially treated by craniotomy or craniectomy, in the pre-CT era, often with membranectomy. Although membranectomy had been dismissed as an essential component for treatment of cSDH[3], a recent meta-analysis in 2017 suggested that craniotomy with membranectomy yields a lower likelihood of cSDH recurrence and secondary interventions[4]. In the initial days of CT scan era, a number of articles were published which reported successful decompression of cSDH by using twist drill craniostomy (TDC) or burr-hole craniostomy (BHC) with significantly lower mortality and morbidity than previous techniques[5,6]. Weigel et al., published the first evidence based review on the topic, demonstrating 1) higher morbidity with craniotomy compared with bore TDC and BHC, 2) non-statistically significant higher mortality rate with craniotomy, 3) similar cure rates between craniotomy and BHC, and 4) higher recurrence rates with TDC, suggesting craniotomy only be used as the last resort[7]. In Markwalder's review on cSDH in 1981[3], he proposed craniotomy only for the following conditions : 1)subdural reaccumulation, 2)failure of the brain to re-expand, and 3) removal of solid clot. Many other surgical techniques have been reported such as reservoir shunting for continuous irrigation and drainage[8], percutaneous needle trephination and open system drainage with repeated saline rinsing [9], replacement of the hematoma with oxygen via percutaneous subdural tapping without irrigation and drainage[10], continuous subgaleal suction drainage[11], etc. But these techniques were not popular worldwide nor are they practised recently. Very few articles are available in literature analysing the role of small craniotomy in management of cSDH and their comparison with BHC[2]. In this article we report the preliminary results of our experience with BHC and small craniotomy in cSDH. Our study population comprises 213 patients who were divided into two groups: Group I (n = 166), who underwent burr-hole, and Group II (n = 47), who underwent small craniotomy. Computed tomography (CT) scan was the primary imaging modality in our study. Rocchi et al., suggested that MRI should always be performed in the following cases: 1) unusual appearance on CT scan, heterogeneous areas with high density margins, multiple compartments, septations and various bleeding foci, 2) cases of recurrent SDH, and 3) enhancement of some portion of the haematoma and its membranes on contrast enhanced CT scan. Furthermore, they insisted that craniotomy be primarily performed in the above mentioned cases[12]. In addition to these conditions, Isobe and colleagues recommended craniotomy primarily for organised or calcified cSDH. They reviewed six patients diagnosed with an organised CSDH, five of whom had a history of burr-hole surgery. These patients collectively underwent four small craniotomies and two enlarged craniotomies. The authors emphasised that it was important to remove the organised CSDH and the outer membrane in proportion to the hematoma expansion[13]. Imaizumi et al., reported five cases with organised cSDH and proposed that large craniotomy is the best treatment modality for these cases associated with progressive symptoms[14]. In our study, 12 cases had organised cSDH for which craniotomy was done, with excellent postoperative results. Tanikawa et al., based on T2-weighted MR sequence obtained from gradient echo sequence, classified intrahaematomal membranes into two groups, namely type B, which included subdural haematoma which had no intrahaematomal membranes or had monolayer multilobular appearance and, type C, in which haematoma was divided into multiple layers by intrahaematomal membranes. While burr-hole was offered to all patients of type B membranes, craniotomy was done in the majority of patients with type C membranes (55.2%)[15].In our study craniotomy was done in 47 patients (21.43%). The primary reason for selection for craniotomy in our cases was 1) intrahaematomal membranes and 2) organised cSDH except one, which was operated for residual haematoma following a burr-hole craniostomy. The mean age of the patients who underwent burr hole and craniotomy in our study was 62.7 yrs and 64.3 yrs respectively. The findings were at par with those of Kim et al.[16], and Tanikawa et al.[15]. Of the 166 patients who underwent burr-hole craniostomy, 122 were male and 44 were female, whereas the craniotomy group had 30 male and 17 female patients. Lee and colleagues reported Male : Female ratio of 16 : 9 in the burr hole group and 24 : 6 in the craniotomy group[2]. Lee and colleagues, in their study found that, at presentation, the mean Markwalder's score in the burr hole craniostomy group and craniotomy group were 1.44 and 1.27 respectively[2], whereas, Kim et al., reported a mean of 1.48 and 2.37 in the respective groups[16]. In our study the mean Markwalder score at presentation in the burr hole craniostomy group and craniotomy group were 1.9 and 1.7 respectively, the difference not being statistically significant. It is quite obvious that making a single burr-hole will require less time than performing a craniotomy followed by irrigation. Since there is a chance of epidural haematoma following craniotomy, proper dural hitch sutures, careful handling of subdural membranes, tight dural closure followed by autologous bone flap fixation is needed. All these procedures mandate an increase in operating time in case of a craniotomy[2]. Lee et al, found a statistically significant difference in operating time between burr hole craniostomy and craniotomy group[2]. Regan and colleagues also reported similar findings in their study[17]. In our study the mean operating time in the two sets of patients (BHC & craniotomy) were 56.2 minutes and 90.3 minutes respectively, which were significantly different statistically.

In contrast to the other studies, patients in the craniotomy series in our study did not undergo a watertight dural closure. The tips of the dural flaps were apposed and the cut margins were coagulated before replacing the bone flap.

Although the criteria for selection of patients for craniotomy for cSDH evacuation have been discussed in many articles, there is no proper standardisation regarding the size of craniotomy. While many authors considered a craniotomy of 3-4 cm to be small[2,16], others specified a 4-5 cm craniotomy as a small one[15]. There are also no proper guidelines proposed for selection of patients for either a small or large craniotomy. Kim et al., have mentioned in their article that the choice of a small or large craniotomy was dependent on the operating surgeon's judgement, factors influencing this judgement being CT/MRI findings, age and neurological status of the patients. However, no significant difference was found in the two groups, considering the criteria for which craniotomy was planned[16]. In our study no comparison has been done between cases with small and large craniotomy.

One of the limitations in many studies is that it was poorly defined as to whether membranectomy was of the outer subdural membrane or inner subdural membrane (Sahyouni, 2017). The outer membrane is attached to the dura and vascular in nature whereas the inner layer is thin and avascular and adherent to the underlying arachnoid. Stripping the outer layer has been frowned upon in recent literature because of the tendency to bleed from the margins of the exposed dura. The inner layer may be microdissected off from the underlying arachnoid thereby releasing the underlying accumulated blood breakdown products and allowing the brain to re-expand. However, arachnoid tear may occur causing CSF to leak in the subdural space (Hohenstein, 2005; Shim, 2007). A recent meta-analysis on role of membranectomy in cSDH reveals lower likelihood of cSDH recurrence and secondary interventions with comparable mortality and morbidity rates of craniotomy with membranectomy to burr hole craniostomy or craniotomy without membranectomy[4]. In our study outer membranectomy was done in 36 cases and total membranectomy was done in 9 cases in the craniotomy group. There was no recurrence of cSDH in the craniotomy group. There was no CSF leak in the patients who underwent total membranectomy. Lee et al., reported 12.6% overall complication rate following evacuation of cSDH, of which 22.8% occurred following burr hole and 6.7% occurred following craniotomy. Complications included wound infection, cerebral haemorrhage, venous infarction, subdural hygroma, tension pneumocephalus, decreased higher mental functions, pneumonia, seizures and hemiparesis[2].

The p value of post-operative complication rate was 0.037 which was not statistically significant. Hamilton et al., and Kim et al., also did not find any statistically significant difference in postoperative complication rate between the burr hole and craniotomy group[16,18]. Another metaanalysis by Ducruet and colleagues in 2012 reported a complication rate of 9.3% following burr hole and 3.9% following craniotomy[19]. In our study, 45 patients in the burr-hole group developed complications, of which 9 had wound infection, 9 developed new onset acute SDH, 18 patients had residual collection of cSDH, 3 patients developed pneumonia and 6 had developed pressure sores. 4 patients in the craniotomy group developed pneumonia. Kim et al., reported operative mortality of 3.5% in the craniotomy group and 8.1% in the burr hole group with no significant difference (p value=0.671)[16]. In a study by Tanikawa and colleagues, only one death was reported following a burr hole craniostomy unrelated to cerebral decompression[15]. However, Ducruet et al., reported a mortality rate of 12.2% following craniotomy and 3.7% following burr hole craniostomy in their meta-analysis[19]. In our study mortality in the BHC and craniotomy group were 3.6% and 6.7% which were not significantly different.

There has been mixed review regarding postoperative hospital stay following a burr hole and craniotomy. While some studies suggest a longer hospital stay in the burr-hole group than craniotomy, others report otherwise. Tanikawa et al, noted a mean hospital stay of 22.6 days in the burr hole group and 16.8 days in the craniotomy group post-operatively, which was not significantly different statistically[15]. A study by Lee et al, revealed a mean hospital stay of 20.6 days and 37.9 days in the craniotomy and burr hole group respectively with a p value of 0.01[2]. However, in contrast, Regan and colleagues recorded a shorter hospital stay in the burr hole group than the craniotomy group[17]. The results of our study were similar to the initial studies, the burrhole group patients having a significantly more hospital stay than the craniotomy group.

Considering the revision rate of surgery, Lee et al, reported a revision rate of 3.3% in the small craniotomy group which was significantly lower (p value = 0.043) than that in the burr hole group (17.5%) [2]. Tanikawa and colleagues in their study noted a revision rate of 30.8% in the burr hole group for patients with type C membranes, whereas no re-operation was required for any patient in the craniotomy group[15]. However, Kim et al, reported a significantly lower revision rate in the burr-hole group (8.88%) than the small craniotomy group (50%)[16]. The reasons for reoperation in their series were recollection of subdural fluid and a small rebleed with collection of cSDH. On the other hand, the causes for revision surgery in the burr-hole group were residual subdural fluid in the haematoma cavity and failure of the brain to re-expand due to intrahaematomal septations. Acute rebleeding was the least common cause for re-operation in this group[16]. Their opinion on this matter was that the limited surgical view and partial membranectomy associated with small craniotomy caused difficulty in coagulating the neo vascularized vessels and removal of the membranes beyond the craniotomy margin, which resulted in rebleeding and recollection of the subdural fluid. They suggested a large craniotomy as a better alternative in this situation for superior and safer dealing of the haematoma, its membranes and occasional troublesome bleeding.

However, no significant age difference was noted in the two groups in this series[16]. We noted a revision rate of 10.9% in the burr-hole group. No patient in the craniotomy group had to be re-operated.

4. Conclusion

There have been very limited articles in literature regarding the role of small craniotomy in management of chronic subdural haematoma with mixed response. A randomised control study comparing small craniotomy with other surgical procedures for cSDH is yet to be performed. We observed that small craniotomy is a preferable option for management of cSDH with intrahaematomal membranes and septations. However, our study populations being small, further studies with larger population, preferably a randomized control trial are suggested for confirmation of our findings.

Conflict of Interest

There were no conflicts of interest in this study.

Funding Statement

Nil

Tables:

Table 1: Age distribution in burr- hole and craniotomy group

Age	Burr hole (n=166)	Craniotomy (n=47)
21-30	6	0
31-40	12	0
41-50	13	1
51-60	42	15
61-70	48	27
>70	45	4

Table 2: Sex distribution in burr- hole and craniotomy group

Sex	Burr hole (n=166)	Craniotomy (n=47)
Male	122	30
Female	44	17

Table 3: MGS score distribution (on admission and discharge) in two groups

MGS	Burr hole		Craniotomy	
Score	On admission	At discharge	On admission	At discharge
0	0	78	0	35
1	69	42	18	12
2	54	19	24	0
3	31	12	5	0
4	12	15	0	0

Table 4: Table showing postoperative complications in the two patient groups

Complication	Burr hole	Craniotomy
Residual cSDH	18	0
Acute SDH	9	0
Wound infection	9	0
Pressure Sores	6	0
Systemic Complication	3	4

Table 5: Illustration of various parameters studied in the 2 patient groups with their mean values

	Burr hole (n=166)	Craniotomy (n=47)
Male/Female	122/44	30/17
Age	62.7±29.8	64.3±12.2
Unilateral/Bilateral	131/35	46/1
MGS on admission	1.91±1.88	1.72±1.3
Duration of operation(minutes)	56.2±32.8	90.3±52.4
Hospital stay (days)	19.8±10.5	15.2±6.4
MGS at discharge	1±2.6	0.2±0.8
Complication rate		
- Residual cSDH	0.11	0
- Acute SDH	0.05	0
- Wound infection	0.05	0
- Pressure sores	0.04	0
- Systemic complications	0.02	0.09
Re-operation rate	0.11	0
Mortality	0.04	0.02

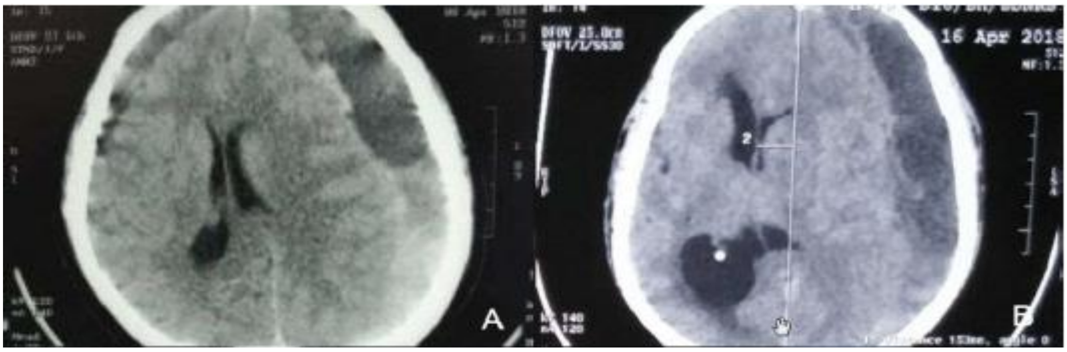
Table 6: Statistical analysis of various parameters in this study

Parameter	P value	Interpretation
Age	0.92	NS
Sex	0.54	NS
Laterality	0.18	NS
Duration of operation	<0.0001	Significant
Hospital stay	0	Significant
Complication	0.225	NS
Re-operation	0.18	NS
Mortality	0.67	NS

Table 7: Mark walder's Neurological Grading System

Grade 0	No neurologic deficits
Grade 1	Mild symptoms (i.e. headache, absent or mild neurologic deficits like reflex asymmetry)
Grade 2	Drowsiness or disoriented with variable neurologic deficit (i.e. hemiparesis)
Grade 3	Stupor, severe focal neurologic deficit (i.e. hemiplegia)
Grade 4	Coma, posturing, or absence of motor response to noxious stimulation

Images



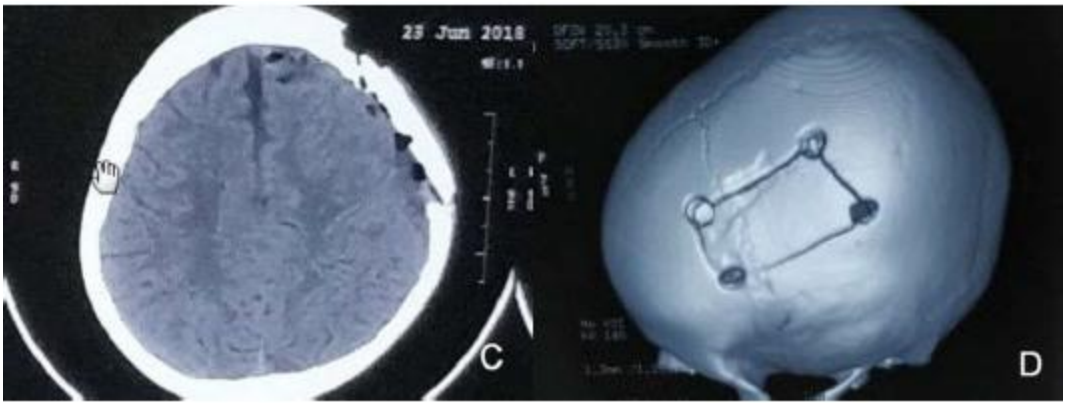


Figure 1: (A) Bilateral cSDH with intrahaematomal membranes on the left side (B) Left fronto- parietal cSDH with intrahaematomal membranes. (C) Post- operative CT scan following a small craniotomy for cSDH (D) 3D reconstructed CT scan image of the craniotomy flap of the same individual in Fig. 1.

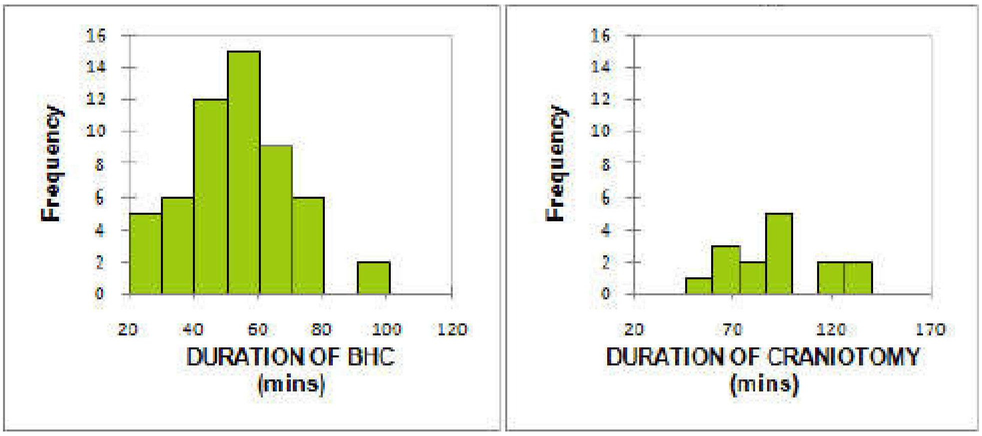


Figure 2: Histogram illustrating duration of surgery in the two patient groups

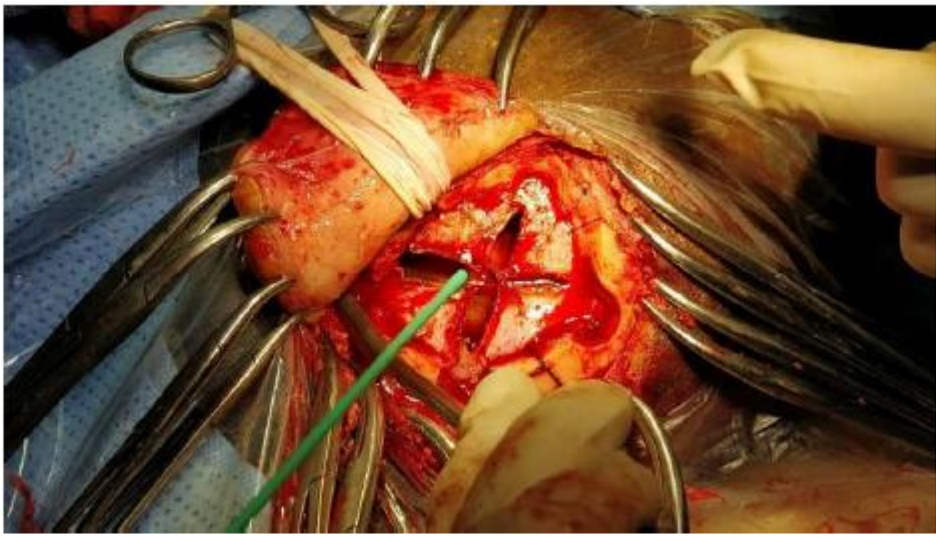


Figure 3: Peri- Operative image showing technique of durl cosure following small craniotomy

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