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Original Article

Burr Hole versus Twist Drill Craniostomy for Chronic Subdural Hematoma: A Blinded Randomized Study

Authors
Dr Mallika Sinha[1], Dr Sunil Kumar Singh[2], Dr Chhitij Srivastava[3], Dr Bal Krishna Ojha[4], Dr Anil Chandra[5]
[1]Assistant Professor, Neurosurgery Bhopal Memorial Hospital & Research Centre, Bhopal, MP, India
[2,3,4,5]Professor, Neurosurgery King George Medical University, Lucknow, UP, India

Abstract
Objective: *To compare outcomes of Burr hole craniostomy (BHC) and Twist drill craniostomy (TDC) for unilateral chronic subdural hematoma (CSDH).*
Methods: *A prospective blinded randomized study was conducted in King George Medical University, Lucknow, India from April 2010 to September 2011 in 110 adult patients of unilateral hemispheric CSDH and were randomly assigned into two groups of 55 patients. One group underwent BHC and the other underwent TDC. Patients were followed up at 1, 3, and 6 month. The primary outcome variable was recurrence, other variables compared were mortality, morbidity and surgical complications, duration of hospital stay and cure rates. This study was started after ethical approval from national authorities.*
Results: *The two groups were similar in demographic characteristics, clinical presentations and predisposing factors but, the preoperative clinical and radiological data favored burr hole craniostomy group [mean GCS at admission {13.36 vs 12.6(p= 0.032)}, mean thickness of hematoma {21.44 vs 23.27(p=0.033)}, density of hematoma (p=0.020), mean midline shift 11mm vs 10mm (p=0.071 non-significant) in twist drill and burr hole craniostomy groups respectively]. Recurrence rates were 5.4% and 1.8%(p=0.618), morbidity 16.3% and 10.9%(p=0.405), mortality 5.5% and 0%(p=0.253), mean duration of hospital stay 7.6 days and 6.36 days(p=0.074), and contralateral chronic SDH 5.5% and 3.6%(p=0.618) respectively in twist drill and burr hole craniostomy groups, showing non-significant difference however, cure rates (GOS 5 at 1 month) was higher in burr hole group (97% vs 84%, p=0.025).*
Conclusions: *BHC and TDC both are equally effective procedure for treatment of chronic subdural hematoma. TDC can be an effective bed side procedure in moribund patients where patient cannot be immediately shifted to operating room for urgent decompression.*
Keywords: *Burr Hole craniostomy, Twist Drill craniostomy, Chronic subdural hematoma, Randomized study.*

Introduction

Chronic subdural hematoma (CSDH) is one of the most commonly encountered neurosurgical conditions, common in elderly population.[1] It may be associated with substantial morbidity and mortality and its incidence is estimated to be 13.1 cases per 100,000 populations in recent studies.[2] Surgical evacuation results in rapid improvement in neurological condition.[3]

A wide range of surgical techniques with a variety of perioperative adjuvant procedures are currently used. Three most commonly used surgical techniques are burr hole craniostomy (BHC) (5-30mm), twist drill craniostomy (TDC) (diameter <5mm), and craniotomy (>30 mm).[4]

While BHC is the most widely used procedure, TDC is an effective alternative with less invasiveness and good results.[5,6] Weigel and co-workers[4] in their evidence based meta-analysis have shown that both TDC and BHC have similar morbidity and mortality, but, recurrence rate is more with twist drill craniostomy (33% vs 12.15%).

The need for class I evidence to decide the superiority among these two commonly performed surgical techniques for chronic SDH has been repeatedly recognized and further evidence form randomized studies is required to guide the treatment. This study aimed to compare recurrence rate, mortality, morbidity, surgical complications, duration of hospital stay and cure rates of these two procedures.

Patient and Methods

Trial Design: A blinded randomized study comparing BHC with TDC for unilateral hemispheric CSDH was carried out from April 2010 to September 2011 in the Department of Neurosurgery, King George Medical University, India (figure1). 110 unilateral CSDH patients of more than 10 mm thickness on CT scan were included, and thin CSDH, bilaterally significant CSDH, radiologically doubtful hygroma or empyema and infantile subdural collection were excluded. Fifty five patients underwent BHC and the other 55 TDC. Patients were followed up at 1, 3 and 6 months. Primary outcome variable was recurrence rate and other variables were morbidity, mortality, surgical complications, duration of hospital stay and cure rates. Protocol was approved by institutional ethical committee and was registered with the clinical trial registry of India (reg. no. CTRI/2010/091/000359) and a written informed consent was obtained from patient/ next of kin before enrolling patient in the study.

Sample size Considering recurrence rates (0.15 for BHC and 0.40 for TDC) and power of study as 90% for a difference of 25% in two groups, a total of 110 subjects were enrolled(55 subjects in each arm).

Randomization and blinding Patients were randomized by Startrek random number generator list. Randomization cards were provided to 3 faculty members. Resident on duty after assessing for eligibility and after enrolling the patient informed the faculty member who blindly allocated patients according to the number in their card and then stroke off those numbers (1= TDC, 2= BHC). At the time of follow up at 1, 3 and 6 month, interviewers were unknown of the type of procedure.

Clinical and Radiological assessment

Preoperative clinical assessment was done using Glasgow coma scale (GCS), Markwalder grading system (MGS) for chronic SDH and functional assessment was done by Karnofsky performance scale (KPS). Post operative assessment for statistical analysis was done on 5th post operative day with these scales. Assessment at 1 month follow up period was done using Glasgow outcome scale, MGS and KPS by an independent observer who was blinded for the type of procedure. Patients were again interviewed at 3rd and 6th month for any clinical symptom.

In preoperative CT scan, parameters recorded were maximum thickness of hematoma, density and midline shift. Postoperative CT scans were obtained on 5th postoperative day and at 1 month follow up, and apart from the above parameters, any complications like parenchymal injury or pneumocephalus were also noted. Patients who had residual collection at 1 month follow up were considered for CT scan at 3rd month follow up.

Procedure: Patients in TDC group underwent double (frontal and parietal) twist drill craniostomy (using a twist drill or hand held cranial perforator) under local anesthesia. Skull openings of <5mm were made after giving a 5mm

stab incision with no.11 surgical blade, dura was opened with the sharp drill tip. Gradual egress of hematoma fluid was allowed. The subdural cavity was irrigated with saline using a soft silicon catheter. A closed system silicon drain was placed in frontal subdural space through the frontal trephination.

Patients in BHC group underwent surgery under local anesthesia/monitored analgesia. Standard double burr hole craniostomy (>12 mm diameter) at frontal and parietal sites was performed. Subdural irrigation was done and subdural drain was kept for 48 hours. Surgical steps were similar in both the groups except the size of trephination

Terminology

1. Residual hematoma: residual collection with any midline shift on 5th postoperative day CT scan.
2. Recurrence: clinically symptomatic ipsilateral residual collection on CT scan within 3 months of primary treatment which required reoperation
3. Mortality: any death within 30 days of surgery and procedure related mortality as any complication during surgery leading to death in immediate postoperative period or during hospital stay.
4. Morbidity was considered as any procedure related complication during or after surgery other than recurrence and mortality (such as parenchymal injury, wound infection, seizures).

Statistical Analysis

Chi square test was done for comparison of proportional data. Mean values were compared using the 't' test for two variables, ANOVA was used for more than 3 variables. Binary logistic regression was used as a multivariate test to find association between outcome and independent variables. Confidence level of study was kept as 95%, hence 'p' value <0.05 was considered as significant association.

Results

Demographic characteristics: Age ranged from 20-87 years with a mean of 58.02 ± 14.3 years in BHC and 57.73 ± 12.5 years in TDC group and a male female ratio of 9:1. Most common predisposing factor was trauma (62%) followed by hypertension and alcoholism (10% each), Diabetes mellitus (5.4%) and only one patient (0.09%) had a history of anticoagulant use. Presenting complaints were headache (60.9%), hemiparesis (56 patients, 50.9%) and symptoms of raised ICP (48.2%). Groups were similar in demographics, predisposing factors and presenting complaints (table 1).

Pre operative assessment: Data showed significant difference in GCS at admission (p= 0.032) [mean GCS of 12.61 in TDC and 13.61 in BHC groups (table 2), maximum thickness of hematoma (p= 0.033) and density of hematoma (p=0.020) [table 3]. Mean thickness of hematoma was 23.27± 5.1 mm vs 21.44 ± 4.34 mm (p= 0.033) and mean midline shift 11.09 ± 3.58mm vs 10 ± 2.64mm (p=0.070, NS) in TDC and BHC groups respectively. TDC group had more cases of mixed density hematoma (25 vs 14) and BHC group had more hypodense hematomas (25 vs 12) [table 3]. Thus, the data was favorable for BHC group.

Post operative assessment (5th post operative day): Mean GCS was 14.30 ± 2.20 vs 14.91 ± 0.35 (p = 0.126) in TDC and BHC grups respectively, also similar on MGS scale (p = 0.098) but, mean KPS was 88.73 vs 96.18 respectively with significant difference (p = 0.020). CT scans showed non-significant difference in thickness (p = 0.143), density of hematoma (p = 0.357) and midline shift (p = 0.155).

Duration of hospital stay: Patients were discharged after post operative CT Scan on 5th post operative day and a minimum duration of hospitalization was kept as 5 days. Mean hospital was 7.60 days vs 6.36 days (p= 0.074) in TDC and BHC groups respectively.

Follow up at 1 month: GOS at 1 month follow up (p = 0.112) and MGS (p = 0.181) were similar but, KPS was different (p = 0.012) with a mean of 87.68 vs 98.73 in TDC and BHC groups respectively.

Admission and 1 month follow up: there was significant association between GCS at admission and GOS at 1 month (p = 0.007) and also between MGS at admission and at 1 month follow up (p < 0.001) however, association was not found between KPS at admission and at 1 month follow up [table 2].

Morbidity and surgical complications: No significant difference was observed for any of the parameters except pneumocephalus which was more in TDC group (p=0.021) [table 4]. Two patients in TDC group and none in BHC group developed acute subdural hematoma. 3 patients (5.8%) in TDC group and 2 (3.6%) in BHC group had parenchymal hematoma (p= 0.500). All these cases were managed conservatively.

Pneumocephalus was seen in 11(20%) cases of TDC and 3(5.5%) cases of BHC group (p=0.021) but none had tension pneumocephalus and resolved spontaneously at 1 month follow up CT scan with the expansion of brain. Two (3.6%) patients in BHC group and none in TDC group developed mild wound infection (p= 0.495), subsided with dressings and oral antibiotics. 4(7.3%) patients in TDC group and 2(3.6%) in BHC group had seizures in post operative period (p=0.678) and none of these had a preop history of seizures. All patients were given anticonvulsant treatment which was stopped after tapering in follow up period. One (1.8%) patient in TDC group underwent burr-hole evacuation followed by craniectomy for repeated EDH formation. She later developed cerebritis, but none had such complication in BHC group (p = 1). The overall morbidity was11% and 7.3% in TDC and BHC group respectively (p=0.405)

Recurrence and residual collection Each group had 16(29.1%) radiological residual subdural collection (total 32/110). 28 of these (13 in TDC group and 15 in BHC group) showed good clinical improvement, but 4 required reoperation due to persistent symptoms (Recurrence), 1(1.8%) in BHC group and 3(5.4%) in TDC group [figure 2]. The groups were similar for residual (p=1) and recurrent hematoma (p=0.618).

Out of these 3 recurrences in TDC groups 2 required re-do twist drill procedure and 1 had marked midline shift with clinical symptoms, required larger burr hole procedure. one recurrence of BHC groups required re-aspiration due to clinical deterioration. Residual hematoma in post-op CT showed significant association with preoperative density of hematoma (P=0.033) and preoperative midline shift (p < 0.001) but, no association with thickness of CSDH (p= 0.927). Isodense and mixed density hematomas were more prone to develop residual collection. Recurrence was not associated with any preoperative CT finding like thickness, midline shift, or density of hematoma.

Mortality: Overall mortality upto 1 month follow up in our study was 3(2.7%) and all these were in TDC group (3/55, 5.5%) with no difference (p=0.25). Two of these had transtentorial herniation at admission with GCS 4/15 and MGS of grade 4 [figure 3]. One died on 2nd and the other on 6th post op day and cause of death appears to be herniation. One patient (known case of RHD) was discharged home in a GCS of 15/15, died due to cardiac cause on 15th postop day. Thus, there was no procedure related mortality.

Cure rate: The cure rates (GOS 5 at 1 month follow up) were 97% for BHC group and 84 % for TDC group with significant (p=0.025) difference.

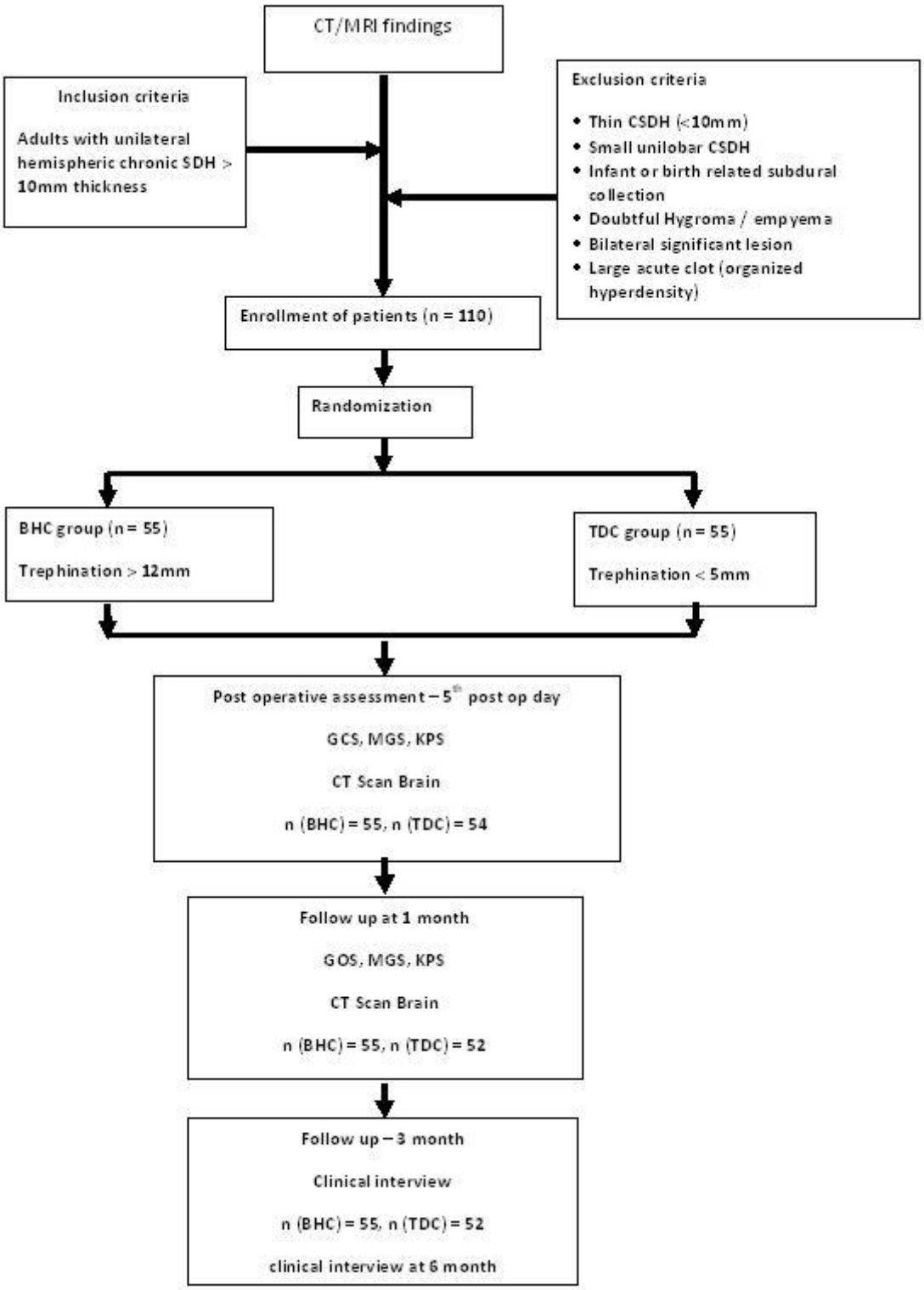

Figure: Twist drill versus burr hole craniostomy for CSDH – Trial overview

Figure 1: Recurrence requiring reoperations

Fig 1A: Recurrence following left TDC

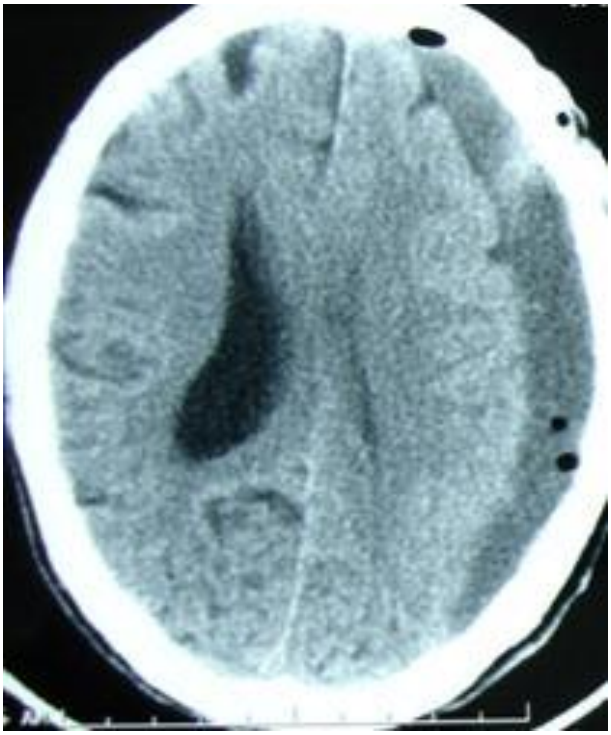

Fig 1B: Recurrence following left BHC

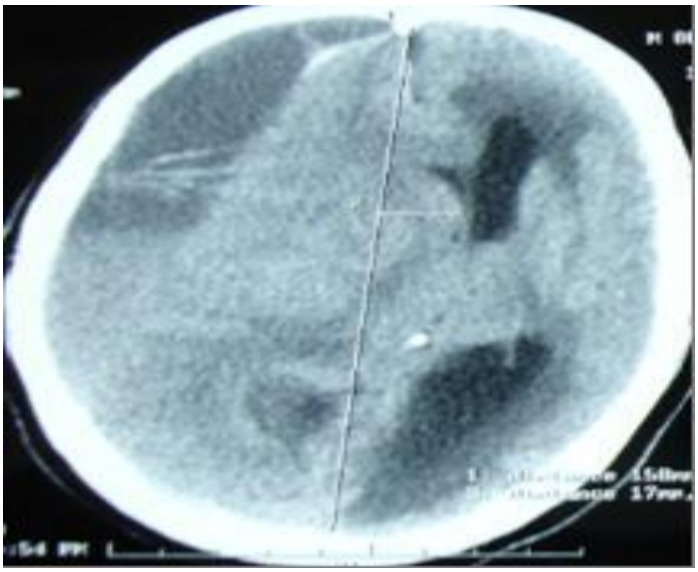

Figure 2: Transtentorial herniation in preop CT scan

Table 1: Demographic characterstics, predisposing factors and clinical features of the two groups: Mean ± SD or N (%)

Features	TDC group	BHC group
N	**55**	**55**
Age (years)	**57±12.5**	**58±14.3**
Male	**48**	**51**
Female	**7**	**4**
Predisposing factors N(%)		
Trauma 64(61.8%)	**32**	**32**
Hypertension 11(10%)	**4**	**7**
Alcoholism 11(10%)	**3**	**8**
Diabetes mellitus 6(5.4%)	**2**	**4**
Anticoagulant use1(1.8%)	**1**	**0**
Presenting complaints total(%)		
Headache 67(60.9%)	**35**	**32**
Hemiparesis 56(50.9%)	**24**	**30**
Vomiting 53(48.2%)	**25**	**28**
Altered sensorium 37(33.6%)	**20**	**17**
Urinary incontinence 24(21.8%)	**12**	**12**
Memory loss 12(10.9%)	**5**	**7**
Gait ataxia11(10%)	**4**	**7**
Speech disturbances 5(4.5%)	**4**	**1**
Others : diarrhea 4(3.6%)	**3**	**1**

BHC= Burr hole craniostomy, TDC= Twist drill craniostomy

Table 2: Comparison of neurological status of two groups

Clinical assessment scale	Groups	Admission	5th POD	Follow up at 1 month	Association between preop clinical status and outcome on same scale
GCS (mean)	TDC	12.61	14.30 ± 2.20	**(GOS 5)** 83.6%	GCS – GOS association Significant **(p= 0.007)**
	BHC	13.36	14.91 ± 0.35	96.4%	
	Significance	**p=0.032**	p=0.126	p= 0.112	
MGS (Most common grade)	TDC	Grade 2	Grade 0	Grade 0	Significant **(p< 0.001)**
	BHC	Grade 2	Grade 0	Grade 0	
	Significance	p= 0.404	p=0.198	p= 0.181	
KPS (mean)	TDC	55.64	88.73	87.64	Non- significant (p= 0.328)
	BHC	62.73	96.18	98.73	
	Significance	p= 0.279	**p=0.020**	**p= 0.012**	

BHC = Burr Hole Craniostomy, TDC = Twist Drill Craniostomy, GCS= Glasgow Coma Scale, MGS = Markwalder Grading System, KPS= Karnofsky Performance Scale, GOS = Glasgow Outcome Scale

Table 3: comparison of radiological features of two groups

Radiological features	Groups		Admission	5th POD	Follow up at 1 month
Mean thickness of hematoma (mm)	TDC		23.71 ± 5.10	8.51 ± 4.71	2.69 ± 4.54
	BHC		21.44 ± 4.34	7.24 ± 4.25	0.58 ± 2.18
	Significance		**p=0.033**	p=0.143)	**p=0.003**
Density	**TDC**	Hypo	12 (21.8%)	43 (79.6%)	10 (18.2%)
		Iso	18 (32.7%)	0 (0%)	2 (3.6%)
		Mixed	25 (45.5%)	6 (11.2%)	Normal CT 40 (72.7%)
	BHC	Hypo	25 (45.5%)	46 (83.6%)	3 (5.5%)
		Iso	16 (29.1%)	2 (3.6%)	2 (3.6%)
		Mixed	14 (25.5%)	2 (3.6%)	Normal CT 50 (90.9%)
		Signifi-cance	**p=0.020**	p=0.357	p=0.091
Mean midline shift (mm)	TDC		11.09 ± 3.58	2.61 ± 4.01	0.37 ± 2.14
	BHC		10.00 ± 2.64	1.71 ± 2.82	0.13 ± 0.94
	Significance		p=0.071	p=0.155	p=0.454

BHC= Burr hole craniostomy, TDC= Twist drill craniostomy

Table 4: Comparison of morbidity and mortality among two groups: N(%)

Complications N(%)	TDC group	BHC group
Morbidity	6(11%)#	4(7.3%)*
Acute SDH	2(3.6%)	0
Parenchymal hematoma	3(5.8%)	2(3.6%)
Wound infection	0	2(3.6%)
Seizures	4(7.3%)	2(3.6%)
Meningitis/cerebritis	1(1.8%)	0
EDH	1(1.8%)	0
Mortality	3(5.5%)	0
Procedure related mortality	0	0

(*) two patients with parenchymal hematoma presented with seizures
(#) three patients of parenchymal hematoma and one with EDH presented with seizures, patient with EDH developed cerebritis
BHC= Burr hole craniostomy, TDC= Twist drill craniostomy

Table 5: Prospective studies comparing TDC with BHC for CSDH

Features		**Smely *and co-workers***	**Horn *and co-workers***	**Muzzii *and co-workers***	**Gokmen *and co-workers***	**Present study**
Type of study		prospective TDC with retrospective BHC	Prospective	Prospective	Prospective	Prospective
Randomization		Non randomized	Non randomized	Randomized	Randomized	Blinded randomization
Cases	Total	66	79(91 CSDH)	47	70	110
	BHC	**33**	24	24	32	55
	TDC	**33**	55	22	38	55
Duration of study		January –September 1996	August 2001 to October 2002	Prelimnary results published in 2005	November 2002 to April 2006	2010 - 2011
BHC	**Trephination**	Single burr	Single burr	_	Single burr at anterior portion ot CSDH	Double burr(frontal, and parietal)
	Irrigation	Used	Used	Used	Used	Used
	Drainage	_	Used	_	Frontal subdural drainage	Frontal subdural drainage
TDC	**Trephination**	Single at maximum thickness	Single	_	_	Double twist drill (frontal, and parietal)
	Irrigation	No irrigation	Irrigation with sterile water	Irrigation	No irrigation	Irrigation with copious amount of isotonic normal saline
	Drainage	Extended subdural catheter (CORDIS)	Used	Subdural expansion catheter + suction reservoir	Frontal subdural drainage	Frontal subdural drainage

(_) = unknown status
CSDH = chronic subdural hematoma,TDC = twist drill craniostomy, BHC = burr hole craniostomy

Table 6: Results of prospective studies comparing TDC versus BHC for CSDH

Features		**Weigel and co-workers meta-analysis**	**Smely and co-workers**	**Horn and co-workers**	**Gokmen and co-workers**	**Present study**
Recurrence (%)	**TDC**	33 (3-76)	18	28	3	5.4
	BHC	12 (0-28)	33	21	7	1.8
Mortality (%)	**TDC**	2.9 (0-7.9)	6	7[€]	2.6	3.6 (0*)
	BHC	2.7 (0-32)	9	13[€]	3	0
Morbidity (%)	**TDC**	3 (0-7.6)	¥	36	2.7	16.3
	BHC	3.8 (0-9)	¥	33	0	10.9
Duration of hospital stay (days)	**TDC**	¥	4.9	7.3 ± 0.6	[#]	7.6
	BHC	¥	9.6	7.8 ± 0.9	[#]	6.36
Cure rates (%)	**TDC**	77-100	¥	84	70.3	84
	BHC	52-98	¥	74	83	97

(*) procedure related mortality, ([#]) no significant difference, (_) absent, ([€]) significant difference between two groups, (¥) = unknown status
CSDH = chronic subdural hematoma,TDC = twist drill craniostomy, BHC = burr hole craniostomy

Discussion

Surgery is the standard treatment in symptomatic patients of CSDH and it significantly improves the outcome by immediate decompression of space occupying hematoma.[4] Three principal surgical techniques based on size of trephination are Twist Drill Craniostomy (TDC) (up to a diameter of 5 mm); Burr Hole Craniostomy (BHC) (between 5 and 30 mm in diameter) and craniotomy (larger than 30 mm in diameter).[4] Until the mid-1960s, craniotomy was the prevailing technique, Markwalder's review[7] on CSDH in 1981 was an important step in minimizing the invasiveness of the surgical treatment. Hamilton and co-workers[8], Svein and Gelety[9] Robinson[10] and Markwalder *et al.*[11] advocated only BHC for evacuation of CSDH. BHC is the most commonly performed procedure for CSDH within the past 20 years.[4] Additional adjuvant measures such as irrigation and drain insertion increase the number of treatment options. Only few studies have compared TDC and BHC [5,6,12,13,14] but none of these could provide conclusive evidence as to which one is the most appropriate for CSDH [table 6]. Smely and co-workers[13] in their nonrandomized study in 1993, performed TDC in 33 consecutive patients prospectively and compared data with retrospective 33 patients of BHC, concluded TDC as better procedure. Horn and co-workers[6] carried out prospective nonrandomized study from August 2001 to October 2002 in 79 patients with 91 CSDH, with BHC in 24 and TDC in 55 patients, recommended TDC as the first line treatment of CSDH and reserved BHC and craniotomy for recurrent and unresponsive cases. Muzii and co-workers[12] carried out prospective randomized study in 47 patients, performed TDC in 22 patients and BHC in 24 patients had published their preliminary results. Gokmen and co-workers[5] carried out prospective randomized study with simple randomization in 70 patients from November 2002 to April 2006, and performed TDC in 38 patients and BHC in 32 patients, concluded that both the procedures are effective and comparable with respect to mortality, morbidity, surgical complications, duration of hospital stay and cure.

Considering surgical procedure of these studies, Smely and co-workers[13] had performed single burr hole over the area of maximal hematoma width and irrigation with isotonic normal saline in BHC group and single twist drill trephination at maximal hematoma width and inserted extended subdural catheter without irrigation in TDC group. Horn and co-workers[6] had performed single twist drill craniostomy in anterior portion of hematoma with several rounds of flushing with sterile water and drainage and single burr, irrigation and closed system drainage in BHC group. Muzii and co-workers[12] had performed burr hole and irrigation with closed system drainage in BHC group and closed system drainage with subdural expansion catheter and suction reservoir in TDC group. Gokmen and co-workers[6] had performed single burr hole with irrigation and frontal subdural drainage and twist drill craniostomy without irrigation and similar frontal subdural drainage

This is a blinded prospective randomized study of 110 patients with two equal groups, which is the largest randomized study till date showing direct comparison of the two procedures. Two burr holes with irrigation and frontal subdural drainage was done in BHC group similarly, two twist drill trephination (<5 mm) with irrigation and frontal subdural drainage was performed in TDC group. The technique differed only in the size of the craniostomy, all other factors like number of burr holes/trephination, irrigation, drainage method and perioperative care were kept similar. Thus, we had tried to eliminate all the factors associated with recurrence and ensured comparability in the groups to study the difference in the type of surgical approach that is TDC and BHC.

Residual collection and recurrence There were 32(29%) cases of residual collection in our study and except for 4 cases of recurrence, all other showed complete resolution in 3 months. Markwalder and coworkers[11,7] had also demonstrated persistent subdural collection in

78% of cases on 10th day of surgery after burr hole evacuation and closed system drainage. He suggested that blood vessel dysfunction, impairment of cerebral blood flow and well developed subdural neo-membranes are crucial factors for cerebral re-expansion, which takes at least 10 to 20 days and re-do procedures like repeat tapping, craniostomy and membranectomy or even craniectomy should not be considered within 20 days after the initial surgical procedure unless there is clinical deterioration. All his cases had complete resolution on CT scan by 2-3 months following discharge from hospital. This is similar to our study. Our study followed recommendation by Krauss JK[15] and Weigel R, that residual fluid in subdural space in early post operative CT scan is common and usually disappears on follow up examination in majority of patients and cases where hematoma increases, causes neurological deterioration or persistent or progressive headache should be considered for retreatment.

Weigel and co-workers[4] in their meta analysis have reported 33% (3-76%) recurrence in TDC group and 12.1% (0-28%) recurrence in BHC group with a significant difference. Gokmen and co-workers[5] 3% and 7%, Horn and co-workers[6] 25% and 21% reoperations, Smely and co-workers[13] 18% and 33% reoperation rates respectively in TDC and BHC groups without difference. Recurrence rate in our study groups appear similar (p= 0.618) and is comparatively less (1.8% for BHC and 5.4% for TDC group) than other studies, which may be attributed by the use of irrigation as evidenced by Hennig R and co-workers[16] and Ram Z *et al.*[17] and frontal subdural drainage as shown by Nakaguchi and coworkers.[18]

Mortality**:** Weigel and co-workers[4] in their meta-analysis had shown average mortality 2.9% (0-7.9%) vs 2.7% (0-32%), Smely and co-workers[13] 6% and 9%, Horn and co-workers[6] 7% and 13%, Gokmen and co-workers[5] 2.6% a and 3%, respectively in TDC and BHC group with no difference in groups except in study of Horn and co-workers[6]. Mortality rates in our study groups was also similar (p=0.25). GCS at admission and GOS at 1 month showed significant association in our study, therefore, we suggest that preoperative GCS is an important predictor of operative mortality than the surgical method. Gokmen and co-workers[5], Vilgrasa and co-workers,[19] and Sanatarius and co-workers[3] have predicted the same.

Morbidity and surgical complications**:** Weigel and co-workers[4] had demonstrated 3% (0-7.6%) vs 3.8% (0-9%) morbidity, Horn and co-workers[6] 36% vs 33% overall complication rate, Gokmen and co-workers[5] 2.7 and 0% morbidity respectively in TDC and BHC group without significant difference, similar to Muzii and co-workers.[12] Morbidity in our study was also similar (p= 0.405). Our TDC group had slightly increased morbidity due to higher number of surgical complications which might be contributed as surgery was performed by novel residents under the expert guidance in the department.

Duration of hospital stay**:** Smely and co-workers[13] reported longer hospitalization in BHC-treated patients of 9.6 days vs 4.9 days in TDC group but, no difference was found in the other prospective clinical trials similar to our study (p=0.074). Gokmen and co-workers[5] have reported longer hospitalization in TDC group, but without difference. The longer mean hospitalization in our TDC group (7.6 vs 6.36 days) was due to increased number of operative complications, reoperations and increased morbidity. Minimum duration of hospitalization in our study was kept as 5 days to obtain 1st post operative CT scan, therefore, our duration of hospital stay may be biased.

Cure rates**:** Cure rates were not significantly different in studies by Horn and co-workers,[6] Gokmen and co-workers[5] and in meta-analysis by Wiegel and co-workers.[4] However, William and co-workers[14] and Lega and co-workers[20] in their decision analysis have proven superiority of BHC over TDC similar to our study(97% vs 84%, p=0.025). But in our study, clinical and

radiological data at admission was favourable for BHC group with significant difference, also operative complications were higher in TDC group, therefore, cure rates may not be reliable.

Follow up period**:** Patients who had shown complete resolution of CSDH by 1 month were asymptomatic at 3rd and 6th month follow up in the present study, similar to 6 month follow up study of Gokmen and co-workers.[5] They suggested that 3 month follow-up was sufficient and to discontinue follow-up after that to save resources (money and workforce). We also suggest that follow up upto 3 months is sufficient and patients with persistent clinical symptoms or with any operative complication should only undergo CT scan during the follow up period.

Limitations

Despite blinded randomization with fairly large number of cases in our study (110), there was significant difference in preoperative data with respect to GCS at admission, hematoma thickness and hematoma density in favour of BHC group hence, the results were also affected. We would recommend multicenter trials with large number of cases representing the population equally in pre operative data.

Conclusion

Burr hole craniostomy (BHC) and twist drill craniostomy (TDC) both are equally effective procedures for chronic SDH with respect to recurrence rate, morbidity and mortality but not for cure rates (BHC is better). Pre-operative CT scan findings of chronic SDH i.e. density of hematoma and midline shift are predictors of residual subdural collection in postoperative CT scan. Re-operation should be considered in cases of residual collection only if there are persistent progressive symptoms or deterioration. Follow up upto 3 months in cases of unilateral chronic subdural hematoma is sufficient.

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Abbreviations

CSDH = Chronic Subdural Hematoma, BHC = Burr Hole Craniostomy, TDC = Twist Drill Craniostomy, GCS= Glasgow Coma Scale, MGS = Markwalder Grading System, KPS= Karnofsky Performance Scale, GOS = Glasgow Outcome Scale, CT= Computerised Tomogram, NS= Non Significant, vs = versus