Minimally Access Surgery—"Burr Hole with Very Small Craniectomy" versus "Conventional Craniotomy" for Brain Contusions: An Institutional Experience

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Abstract

Objective This article aims to compare surgical outcome of brain contusions treated by "Conventional Osteoplastic/free bone flap craniotomy" (group A) with "burr hole with very small craniectomy" (group B) and evaluate for better outcomes.

Methods A total of 672 patients of brain contusions, from August 2013 through July 2014, were reviewed retrospectively from the computerized discharge summaries of the neurosurgery trauma ward. The patients with brain contusions who were treated surgically (110), were then divided into group A—"Conventional Osteoplastic/free bone flap craniotomy" (58 + 42 = 100) and group B—"burrhole with minimal craniectomy"(10).

Results Overall, 562 patients were managed conservatively. Groups were compared for demographic data, computed tomographic findings, Glasgow Coma Scale, duration of surgery, hospital stay, mortality, and Glasgow outcome scale. Mass effect on noncontrast head computed tomography was more in group A, pupillary reaction was worse. Blood loss and duration of surgery were higher in group A. Rest other parameters were not significantly different. Mortality was 11% (11/100) in group A and 0% (0/10) in group B. Overall, 48% (48/100) patients in group A and 100% (10/10) in group B had satisfactory outcome.

Conclusion "Burr hole with minimal craniectomy" in carefully selected contusion patients, who present with features of raised intracranial pressure clinically but not much radiographically, avoids a big flap. This approach minimizes blood loss and tissue handling and hence produces excellent outcome with minimal hospital stay.

Keywords
- ► contusion
- ► craniectomy
- ► minimal access
- ► burr hole

Introduction

Brain contusions are common sequelae of traumatic brain injury (TBI). They occur in upto 8% of all TBI and 13 to 35% of severe TBI.[1–4] Most patients have small contusions for which surgical intervention is not required. Surgical intervention is indicated if patients with parenchymal mass lesions and signs of progressive neurological deterioration referable to the lesion, medically refractory intracranial hypertension, or signs of mass effect on computed tomographic (CT) scan should be treated operatively. Patients with Glasgow Coma Scale (GCS) scores of 6–8 with frontal or temporal contusions greater than 20 cm^3 in volume with midline shift of at least 5 mm and/or cisternal compression on CT

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scan, and patients with any lesion greater than 50 cm^3 in volume should be treated operatively. Patients with parenchymal mass lesions who do not show evidence for neurological compromise have controlled intracranial pressure (ICP), and no significant signs of mass effect on CT scan may be managed nonoperatively with intensive monitoring and serial imaging.[1] The standard surgical approach is craniotomy with evacuation of brain contusion. The patients with contusions are surgically managed at our center with either "conventional osteoplastic/free bone flap craniotomy" (group A) or "burr hole with very small craniectomy" (group B). The purpose of this study is to evaluate the surgical outcome of patients with brain contusions and to compare two surgical approaches. Surgery for TBI itself causes a lot of morbidity, which can be minimized by reducing the blood loss, operating time, local tissue morbidity, and thereby improving the overall outcome. Therefore, we compared the conventional craniotomy with "a minimal invasive craniotomy" with the aim at improvements in prognosis (see ►**Figs. 1** and **2**).

Materials and Methods

A total of 672 traumatic brain contusions were treated at neurosurgery trauma ward, SCBMCH between August 2013 to July 2014. The demographic data, CT findings, pre-op GCS, time from injury to surgery, duration of surgery, hospital stay, mortality, and Glasgow outcome scale were retrieved from the discharge summary of these patients from the department database.

Surgical Procedure

The conventional craniotomy includes a free bone flap or an osteoplastic flap for the craniotomy. Depending on the location and the volume of the parenchymal contusion, either a free bone flap or an osteoplastic flap is made. But in instances where clinical signs of raised ICP is there with

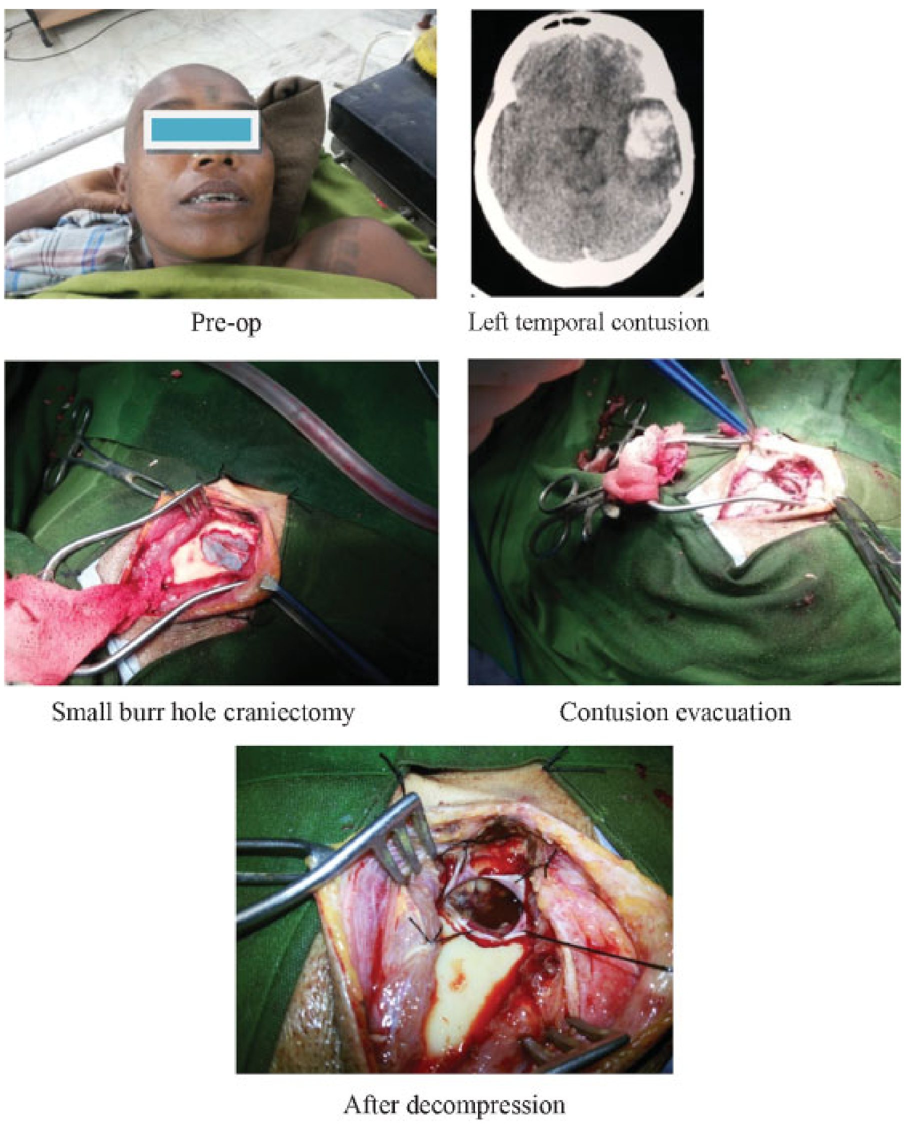

Fig. 1 A case with left temporal contusion.

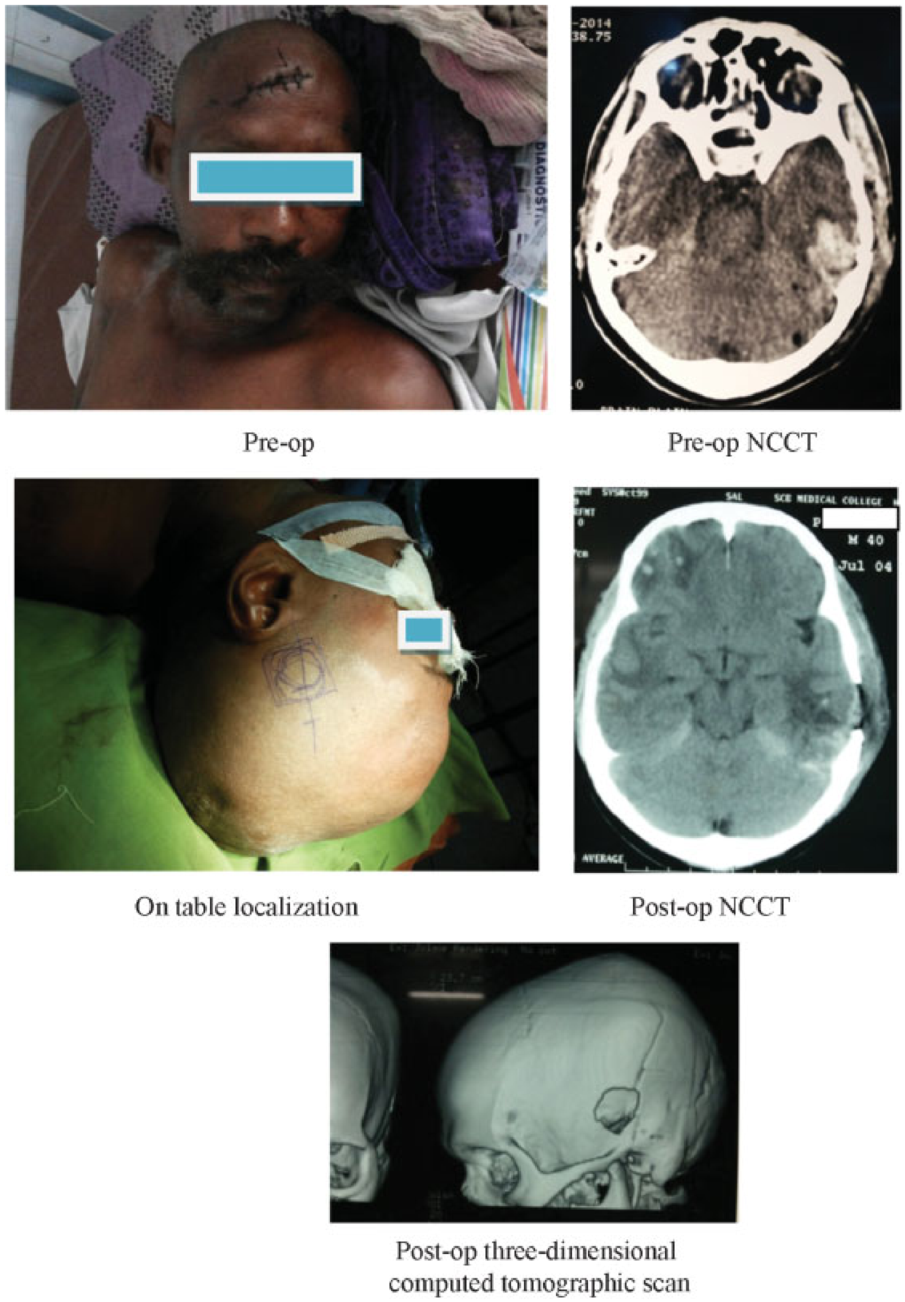

Fig. 2 Left temporal contusion. NCCT, noncontrast head computed tomography.

moderate pressure effects on NCCT scan, we can simply perform a burr hole at the site of localization along with minimal craniectomy. This allows us to reach the site of parenchymal contusion with minimal time and minimal blood loss. With minimal tissue handling and tissue trauma, the overall prognosis might be better.

Results

There were 672 patients of brain contusions of whom 100 were managed surgically. Group A had 100 patients (conventional free bone flap:[42]/osteoplastic flap:[58]) whereas 10 patients were in group B (burr hole with minimal craniectomy). The most common age group in group A is 41 to 60 years and group B is 21 to 40 years (median age of patients in group A being 42.4 and 34.7 years in group B) which shows that relatively young people with localized contusions are usually amenable to the "minimal access" method ($p > 0.05$)[►**Table 1**; ►**Fig. 3**]. Male–female ratio in group A = 7:3 and group B = 4:1 ($p > 0.05$) [►**Table 2**; ►**Fig. 4**].

The preoperative GCS of patients in group A (74% below GCS 8) worse than group B (90% above GCS 13). This signifies that the patients being operated in group B had focal contusions with either clinical or radiological features of raised ICP and hence not so grave GCS as group A patients ($p < 0.05$) [►**Table 3**; ►**Fig. 5**]. Preoperative pupillary examination showed 20% in group A versus 90% in group B

Table 1 Distribution of age

Age	Conservative	Conventional (A)	Minimal access (B)
0–10	7	0	0
11–20	34	3	1
21–30	186	13	3
31–40	97	4	4
41–50	85	36	0
51–60	78	37	2
61–70	75	7	0
	562	100	10

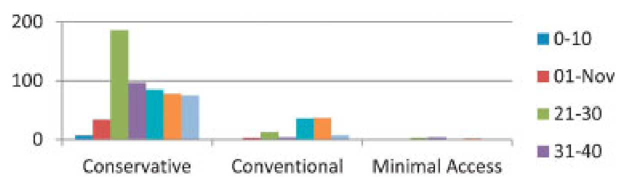

Fig. 3 Distribution of age.

had normal size; 29% in group A and 10% in group B had moderately dilated pupil and 51% (38% ipsilateral and 13% bilateral) in group A and none in group B had dilated pupil. Normal reaction to light was seen in 54% group A and 80% group B patients; sluggish reaction in 18% group A and 20% group B patients. Dilated and non reacting pupil was seen in 28% in group B and 7 0% in group A. ($p > 0.05$).

This analysis shows that patients selected for group A had worse neurological status from the beginning, which might have influenced the outcome (►**Table 4**).

Pre-op CT brain shows that the volume of the contusion

Table 2 Sex distribution

Sex	Conservative	Conventional (A)	Minimal access (B)
Male	417	72	8
Female	145	28	2
	562	100	10

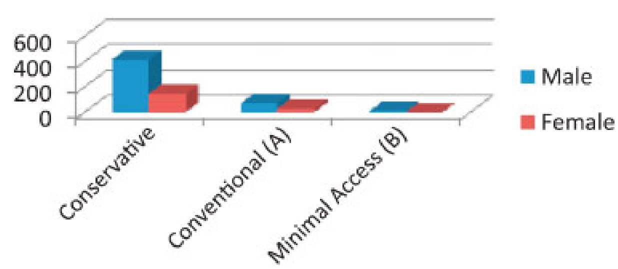

Fig. 4 Sex distribution.

Table 3 Preoperative GCS

GCS	Conservative	Conventional (A)	Minimal access (B)
3–7	137	27	0
8–12	297	47	1
13–15	128	26	9
	562	100	10

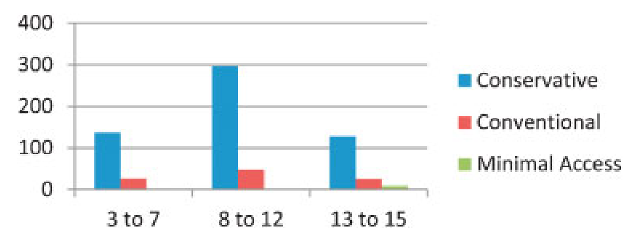

Fig. 5 Preoperative GCS.

was significantly larger in group A than the other group. As per the midline shift, 22% in group A and 40% group B had <5 mm; 23% in group A and 60% in group B had shift between 5 and 10 mm 55% in group A and none in group B had midline shift on pre-op noncontrast head computed tomography (NCCT) brain >10 mm. This shows that not only neurologically, but radiologically also, "minimal access" group B had patients with contusions those were more focal and hence could be taken out totally with smaller incisions [►**Table 5**; ►**Fig. 6**].

Operative time in group A was upto 180 minutes in 85% and that in group B was within 120 minutes in 100% ($p < 0.05$). Reduced operative time resulting in-reduced blood loss and decreased local tissue trauma; may be the factor behind better outcome [►**Table 6**; ►**Fig. 7**].

As per the hospital stay, 73% patients in group A were discharged within 10 days, whereas 100% in group B were discharged in group B ($p < 0.05$)[►**Table 7**; ►**Fig. 8**].

Mortality in group A was 11% whereas in group B, no one expired ($p < 0.05$). Though the difference is vast, caution may be applied in the interpretation as the patients selected in the respective groups came with separate surgical indications. Hence, the procedure-related mortality was bound to be higher in a radical approach. Still, in borderline cases where either procedure could have been selected, mortality was definitely lesser in a more conservative approach (group B) [►**Table 8**; ►**Fig. 9**].

As per Glasgow outcome score (GOS) at the time of discharge, favorable outcome (GOS 4 or 5) was noted with 67% patients in group A and 100% patients in group B. ($p < 0.05$)[►**Table 9**; ►**Fig. 10**].

Discussion

Brain contusions comprise approximately 20% of intracranial lesions.[2–6] Most of the brain contusions are of small size and do not require surgery. Of the variables investigated, only

Table 4 Pupillary size and reactivity

Pupil			Conservative	Conventional (A)	Minimal access (B)
Size	<4 mm		246	20	9
	4–6 mm		186	29	1
	>6 mm	Ipsilateral	96	38	0
		Bilateral	34	13	
Reaction to light	Normal		281	54	8
	Sluggish		157	18	2
	Nil	Ipsilateral	83	9	0
		Bilateral	41	19	
			562	100	10

Table 5 Pre-op NCCT brain findings

Noncontrast head computed tomography brain		Conservative	Conventional (A)	Minimal access (B)
Midline shift	<5 mm	248	22	4
	5–10 mm	207	23	6
	>10 mm	111	55	0
	562	100	10	

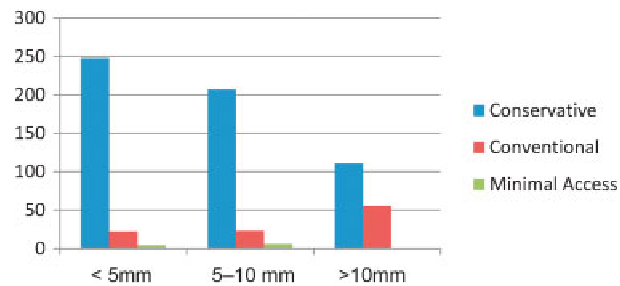

Fig. 6 Pre-op noncontrast head computed tomography brain findings.

anatomic location of injury was found to be predictive of early failure of nonoperative management, frontal intraparenchymal hematomas are particularly prone to early failure.[7] Larger contusions with mass effect may cause secondary brain injury leading to neurological deterioration.[8] It is recommended that patients with GCS 8 or less, contusion greater than 20 cm^3, midline shift of 5 mm or more, cisternal compression on CT scan and any lesion greater than 50 cm^3 must be treated surgically.[1–4] The standard surgical treatment for hemorrhagic contusion is craniotomy with evacuation of contusions. Brain swelling in a contused area is commonly seen and is often a common

Table 6 Operative time

Time of surgery (min)	Conservative	Conventional (A)	Minimal access (B)
1–60	–	2	0
1–120	–	29	10
1–180	–	56	0
>180	–	13	0
	562	100	10

Table 7 Hospital stay

Stay (d)	Conservative	Conventional (A)	Minimal access (B)
1–2	32	3	1
1–5	178	44	9
1–10	288	26	0
>10	64	27	0
	562	100	10

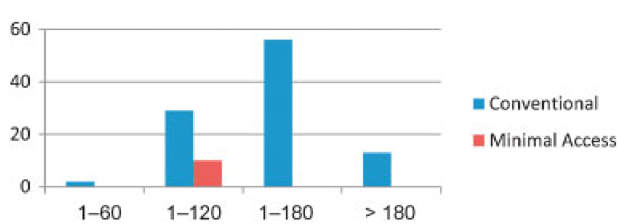

Fig. 7 Operative time.

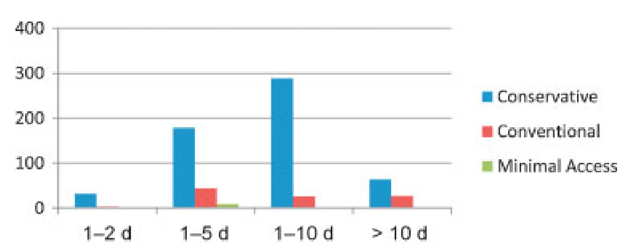

Fig. 8 Hospital stay.

Table 8 Mortality

	Conservative	Conventional (A)	Minimal access (B)
Death	89	11	0
	562	100	10

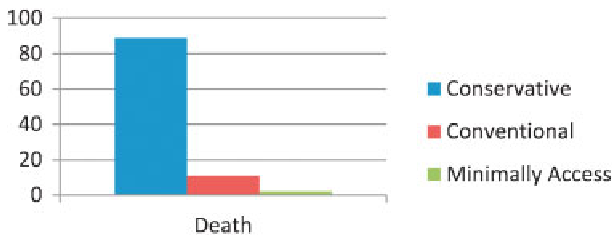

Fig. 9 Mortality.

Table 9 Glasgow outcome score

GOS	Conservative	Conventional (A)	Minimal access (B)
1	50	9	0
2	55	17	0
3	98	7	0
4	112	19	0
5	247	48	10
	562	100	10

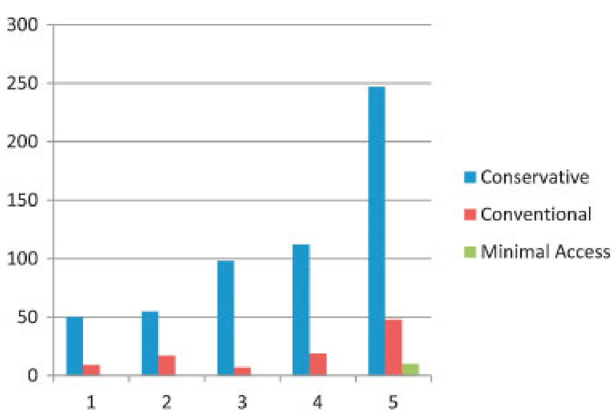

Fig. 10 Glasgow outcome score.

cause of neurological deterioration leading to death. The ultra early phase of brain swelling because of contusion occurs within first 24 hours and is often the cause of clinical deterioration. The second phase occurs after 24 to 72 hours. Craniotomy with evacuation is needed to ameliorate the raised ICP in large brain contusions because of the delayed development of edema in contused brain.[9] The benefits of removing the contused brain include the removal of edema producing osmotic load and abolition of necrotic and apoptotic cascades triggered off by blood degradation products.[10] Contusion evacuation benefits patients of severe head injury with contusion and intractable intracranial hypertension.[11] The survival and functional outcome after these procedures are acceptable. This is also observed in this series. The profile of patients in group A was worse in terms of pupillary reaction. This suggests that one should be very aggressive in managing patients with brain contusions. According to the literature, the mortality rate for patients with surgical intraparenchymal hemorrhagic lesions is 32 to 56%, which is much higher than our results.[1,2,5]

This study had several limitations.

1. Patient selection: it was nonrandomized selection based on the attending neurosurgeon's decision. Mostly not so bigger contusions, with midline shift between 5 and 10 mm, with clinical picture of raised ICP-bradycardia and hypertension, were treated with this approach.
2. Secondly, the study had inherent drawbacks of any retrospective study.
3. The patients were assessed at the time of discharge from the hospital and there was no follow-up data more than 6 to 8 weeks on average.

However, in future, more such trials can be designed with a large number of patients and double blinding for the patients and the operating neurosurgeon, also with a longer follow-up for outcome assessment.

Conclusion

Despite being a retrospective study, this study has brought out several findings of significance. Burr hole with minimal craniectomy is a useful adjuvant in the management of contusions which are localized and without massive mass effect, but significant bradycardia. Aggressive management of brain contusion with minimal craniectomy can lead to better outcome. Patient selection is a very important aspect for optimal treatment customized to individual patient's requirements.

Conflict of Interest
The authors have nothing to declare.

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