Original article

Outcome Following Decompressive Craniectomy in a Tertiary Care Center in Nepal

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Abstract

Introduction
Decompressive Craniectomy (DC) is a common neurosurgical procedure performed to reduce the intractable intracranial pressure in various neurosurgical diseases (infarction, hemorrhage, traumatic brain injury). The main aim of the study was to describe the demographic, clinical and operative characteristics of patients who underwent DC for different conditions and to correlate the outcome with various preoperative and intraoperative factors in our center.

Methods
This was a retrospective study of patients who underwent DC for various neurosurgical diseases from January 2019 to January 2021 in Tribhuvan University Teaching Hospital, Kathmandu, Nepal. The chart of the patients were retrieved from the medical records and additional information obtained via telephone.

Results
A total of 55 patients were enrolled in the study with a mean age of 43.0 + 17.3 years and male:female ratio of 1.5:1. There were 20 (36.4%) patients who presented with trauma and 35 (63.6%) patients with non traumatic origin. Among them, 28 (51%) patients presented with GCS<8 and 27 (49%) patients with GCS>8 and 37 (67.3%) patients with unequal pupil. At the end of six months follow up, the favorable outcome was seen in 23 (41.8%) patients. The only factor significantly associated with favorable outcome was the preoperative pupillary status.

Conclusion
In our cohort the preoperative pupillary status (bilateral equal and reactive pupil) was the variable significant for favourable outcome in patients undergoing DC.

Keywords: Decompressive Craniectomy; Infarction; Traumatic Brain Injury.

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Introduction

Though there have been an immense development in the field of neurosurgery, the mortality and morbidity due to raised intractable intracranial pressure (ICP) has been troublesome.[1,2] The primary treatment option is to treat the cause and deploy modalities to lower the raised ICP. All efforts should be put in place to reduce the raised ICP as early as possible.[2,3] Timely surgical intervention with Decompressive Craniectomy (DC) is an option for reducing raised ICP but still has its own complications including seizure, subdural hygroma, hydrocephalus and infection.[4] Currently, DC is employed as a surgical procedure for treating intractable intracranial hypertension after all other modalities fail.[5] The role of DC in ischemic stroke is more clear as evidenced by DECIMAL, HAMLET, DESTINY trials which confirmed the mortality benefits as compared to best medical management in patients with malignant Middle Cerebral Artery (MCA) infarction less than 60 years of age.[6–8] The role of DC in Traumatic Brain Injury(TBI) has been addressed by two new trials (DECRA and RESCUEicp) regarding the outcome.[9,10] The DECRA trial did not show any added advantage of surgery over medical management in patients with TBI but rather increased the controversy of surgery, indications, timing and candidates of patients for DC with TBI. The RESCUEicp trial showed mortality benefit of patients after DC compared to medical management but at the cost of higher states of vegetative and severe disability states.

DC has been occasionally used in various other conditions such as postoperative brain swelling after tumor, aneurysm surgery and intracerebral hematomas. A study done by Shah et al in Nepal showed a favourable outcome in 39% patients following DC in TBI at a 3-month follow-up.[11] Another study looked at the outcome for ischemic stroke patients which showed a favourable outcome in 35.5% at the end of six months.[12]

The aim of our study was to describe the demographic, clinical and operative characteristics of patients who underwent DC for different conditions in our university hospital. In addition, we correlated the outcome with various preoperative and intraoperative factors.

Methods

This was a retrospective chart review of all patients who underwent DC in the Department of Neurosurgery, Tribhuvan University Teaching Hospital, Nepal from January 2019 to January 2021. Additional information of the patients was obtained from OPD charts and via telephone. Follow up period was up to six months.

The following variables were assessed- age, sex, preoperative diagnosis, preoperative Glasgow Coma Scale (GCS), co-morbidities, imaging findings (diagnosis, degree of midline shift), intraoperative findings, type of procedure (primary or secondary), the timing of DC from presentation, length of intensive care unit (ICU) stay, length of hospital stay, additional procedures done, and complications. The outcome in six months was assessed using Glasgow Outcome Scale (GOS).[13] Patients with GOS < 3 were categorized as unfavorable outcome and those with GOS >3 as favorable outcome.

All data were initially tabulated in MS Excel 2016 and then presented as mean+ SD and the analysis between the categorical variables was computed with the chi-squared test using SPSS version 21.

Management Protocol

Patients presenting with TBI, stroke (hemorrhagic or ischemic), or other mass lesions who had poor GCS at initial presentation or with asymmetrical pupils were subjected to DC otherwise those patients who can be managed medically were admitted and started with the ICP lowering strategies. Neurologically worsening patients or patients with worsening change on imaging despite maximal ICP lowering strategies were candidates for DC (**Figure 1**).

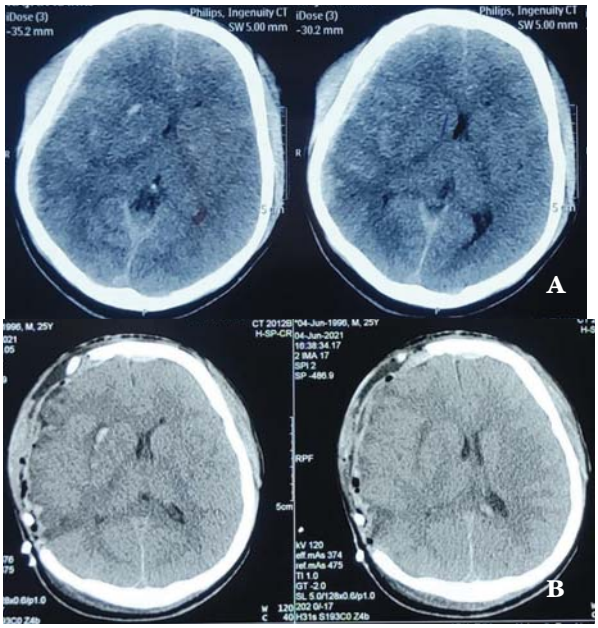

Figure 1. CT scan of the patient with right frontotemporoparietal Acute SDH with significant midline shift (A). Postoperative CT scan of the same patient showing evidence of DC and improvement in the midline shift (B).

The patients underwent either a frontotemporoparietal craniectomy or a bifrontal craniectomy based on the site and nature of the lesion. Additionally, depending on the timing of the surgery it could be a primary or a secondary craniectomy. In primary DC, the craniotomy bone flap was not replaced after the completion of the primary surgery and the secondary DC was a procedure performed as a last-tier intervention in patients with severe intracranial hypertension refractory to medical management.

Post Operative Management & Additional Procedures
The patients were managed in ICU or high care unit after the surgery in standard fashion. The ICP lowering treatment modalities (e.g. hyperventilation, hyperosmotic agents, etc.) were continued in the post-operative period based on the patient's neurological and imaging status. Cranioplasty was performed once the patients were stable neurologically and imaging showed complete resolution of the mass effect.

The outcome in six months was assessed using Glasgow Outcome Scale.[13] Patients with GOS < 3 were categorized as unfavorable outcome and those with GOS >3 as favorable outcome.

Results

A total of 55 patients underwent DC in our study period.

Demographic Characteristics
The minimum age of the patients was eight years and the maximum age was 75 years with a mean age of 43.0+17.3 years. The male:female ratio was 1.5:1. Thirty-two (58.2%) patients did not have any co-morbidities while 20(36.4%) of them had hypertension, one(1.8%) had diabetes and two(3.6%) had both hypertension and diabetes.

Clinical Characteristics
Twenty (36.4%) presented with trauma and 35 (63.6%) patients were non-traumatic.

For patients with non-trauma, the median time of presentation from the time of onset of symptoms was 24 hours and for the patients with trauma, it was six hours. Similarly, the median time from presentation to surgery for non-traumatic patients was three hours and for traumatic patients was two hours.

Preoperative GCS and pupillary Status
Of the total patients who underwent DC; 28 (51%) patients had a GCS < 8 and 27 (49%) had GCS > 8. The lowest GCS of the patient was 4 and the highest GCS was 14.

Thirty-seven (67.3%) patients had unequal pupils prior to DC.

Imaging findings
The majority of the patients who underwent DC for TBI had acute subdural hematoma (SDH) with contusion as shown in **Table 1**.

Table 1 . Imaging characteristics of the patients with trauma

Imaging Diagnosis	Number of Patients
Acute SDH with contusion	17
Acute EDH with contusion	1
Contusion	2
Total	20

SDH=Subdural Hematoma, EDH=Extradural Hematoma

A total of 35 (63.6%) patients underwent DC for non-traumatic conditions. Eleven (20%) of them had an acute ischemic stroke and 8(14.5%) had an intracranial tumor as shown in **Table 2**.

Table 2. Imaging characteristics of the patients with non-trauma

Imaging Diagnosis	Number of patients
Ischemic Stroke	11
Haemorrhagic Stroke	7
Tumor	8
Infectious	2
Others	7
Total	35

Types of DC
Forty-one (74.5%) patients underwent primary DC whereas 14 (25.5%) patients underwent secondary DC. Out of 20 (36.3%) patients who underwent DC for trauma, 18 (32.7%) underwent primary DC, eight (14.5%) out of the 11 patients with ischemic stroke underwent primary DC and seven (12.72%) patients with primary haemorrhagic stroke underwent primary DC.

Duration of ICU and hospital stay
The mean duration of ICU stay was 10.1+6.1 days (Range 2–27 days) and the median duration of hospital stay was 21 days.

Outcome
The outcome of the patients was analysed using the GOS at 6 months. 32 (58.2%) patients had an unfavourable outcome at six months. (**Table 3**)

Table 3. Proportion of patients as per the GOS

GOS	Number of Patients
1	25
2	3
3	4
4	11
5	12
Total	55

Relation between age & outcome
There were 37 (67.2%) patients below the age of 50 who underwent DC and 18 (32.7%) of them had a favourable outcome. However, only five (9.09%) of the 18 (32.7%) patients had a favourable outcome above the age of 50 years as shown in **Table 4**.

Table 4. Relation between age & outcome

Age	Favourable	Unfavourable	chi-square test
<50	18	19	p =0.197
>50	5	13	

Relation between preoperative pupillary status and outcome

There were 37 (67.27%) patients with unequal pupils and 27 (49.09%) of them had an unfavourable outcome. Of the total 18 (32.72%) patients with equal pupils, 13 (23.63%) had a favourable outcome as in **Table 5**.

Table 5. Relation between preoperative pupillary status and outcome (chi-square test)

Pupillary Status	Favourable	Unfavourable	chi-square test
Pupil equal	13	5	p=0.001
Pupil unequal	10	27	
Total	22	33	

Relation between etiology and outcome

Of the total 20 (36.36%) patients with trauma, 11(20%) had a favourable outcome. Similarly, six (10.9%) patients with ischemic stroke and none of the patients with hemorrhagic stroke had a favourable outcome. There was no difference in outcome based on the etiology as in **Table 6**.

Table 6. Relation between etiology and outcome

Etiology	Favourable	Unfavourable	chi-square test
Trauma	11	9	p=0.314
Ischemic	6	5	
Hemorrhagic	0	7	
Tumor	2	6	
Infectious	1	1	
Others	3	4	

Relation between preoperative GCS and outcome

There were 28 (51%) patients with a preoperative GCS < 8 and 19 (34.54%) of them had an unfavourable outcome. Of the total 27 (49%) patients with GCS >8, 14(25.45%) had a favourable outcome. However, there was no difference in outcome based on the preoperative GCS as in **Table 7**.

Table 7. Relation between preoperative GCS and outcome

GCS	Favourable	Unfavourable	
< 8	9	19	p=0.139
>8	14	13	

Discussion

In our retrospective study, a total of 55 patients were enrolled among which 20 (36.4%) patients presented with trauma and 35 (63.6%) patients with non-traumatic conditions. In our study, favourable outcome was more common in DC done for trauma and ischemic stroke. The role of DC in treating trauma and large hemispheric ischemic stroke is widely established and is recommended by the related guidelines.[2,14] Studies have shown that decompressive hemicraniectomy in acute ischemic stroke and traumatic brain injury decreases intracranial pressure and improves perfusion and blood flow.[15,16] In acute ischemic stroke this is true not only in ipsilateral penumbral tissue but in the contralateral hemisphere as well.[15]

In this study, favorable outcome was minimal in DC done for hemorrhage. The optimum treatment for patients with spontaneous intracerebral hemorrhage remains controversial and the role of DC is not well established.[17] The widely known cause of brain injury in hemorrhage is raised ICP.[18] Immediate hematoma evacuation is the most commonly studied and practiced surgical method for reducing raised ICP.[18] However, hematoma evacuation alone may not be sufficient to relieve raised ICP. Soon after bleeding occurs, a series of negative pathogenic mechanisms are triggered, which can lead to the loss of the brain's auto-regulatory function. Therefore, even if hematoma is evacuated early, within a few hours after the evacuation, ICP can rise again and reach disastrous levels thus herniating the brain tissue.[19] Decompressive hemicraniectomy has been considered as an option to resolve this problem.[18,19] However, the results are not as expected in theory. Randomized trials (STICH I and II) comparing surgery to conservative management have not demonstrated a clear benefit for surgical intervention.[20,21] Moreover, the generalizability of the results of these trials can be questioned, because patients at risk for herniation were excluded. Based on these studies, the current AHA/ASA ICH guideline provide Class IIb (Level of Evidence C) recommendation for DC with or without hematoma evacuation for patients with supratentorial ICH who are in a coma, have large hematomas with significant midline shift, or have elevated ICP refractory to medical management.[22] However, the SWITCH trial (ClinicalTrials.gov Identifier: NCT02258919) is ongoing and will attempt to further define the role of decompressive hemicraniectomy in patients with supratentorial ICH. The result of SWITCH trial is expected to be completed in 2023.

There was no role of age for the outcome of decompressive hemicraniectomy in our study. Similarly, another study done by Pankaj et al showed that there was no role of age < 50 or >50 for the outcome of DC in patients with malignant MCA infarction.[12] However, in another study by Shah et al, favorable outcomes were significantly high in patients below the age of 50 undergoing DC for TBI.[11] So, a further large cohort study is required to validate our findings. Several factors are known to mediate the influence of age on clinical outcome following DC, including admission mRS, cognitive status, and socioeconomic status. In addition, although the decline of neuroplasticity in elderly patients may hinder the chances of good clinical recovery, advanced age itself is not considered as a limiting factor for rehabilitation after brain injury. Functional outcome is a complex measurement, especially in elderly patients because the ability to do daily activities changes with aging and hence the functional outcome score may vary with the age of the patient.[23] Although the modified Rankin scale is widely used as a basic standard scale in neurological diseases, it has limitations as it only demonstrates the motor

functional independence and is not related to cognitive and psychological aspects.[24] Poor, and cognitive and psychological aspects are usually affected in the elderly. Therefore, the outcome measures for DC in older patients should use not only stroke assessment tools but also age-sensitive assessment tools, such as the Stroke Impact Scale and the Assessment of Motor and Process Skills.[24]

The patients with GCS <8 had unfavorable outcomes in 34.54% and with GCS>8 had unfavorable outcomes in 25.45% but this difference was not significant in our study (p=0.139). These findings contradict the findings of Shah et al from Nepal where preoperative GCS was associated with favorable outcomes in their study.[11] GCS can stratify the risk and prognosis in patients with brain injury but with caution as these patients usually have polytrauma and other injuries can modify the morbidity and mortality. However, in our study, the favorable outcome with intact bilateral pupillary reflexes (72%; p=0.001) was in good concordance with the results of Shah et al.[11]

Our study has several limitations. This is a retrospective single-center study with DC patients having non-uniform baseline status and etiologies. A prospective study with larger sample size is recommended to assess the overall status of decompressive craniectomy in our population.

Conclusion

Outcome of DC was better in traumatic and malignant acute ischemic stroke patients compared to patients with hemorrhage. The preoperative pupillary status (bilateral equal and reactive) was the variable significant for a favorable outcome in patients undergoing DC.

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