Original Article

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Surgery Section

Outcomes of Decompressive Craniectomy in Patients with Supratentorial Ischaemic Stroke: A Longitudinal Study

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ABSTRACT

Introduction: Decompressive Craniectomy (DC) is a surgical procedure that entails removing a section of the skull with the aim of preventing neuronal damage and improving the patient's prognosis. The goal was to determine if DC is associated with reduced risk of death and improved outcomes.

Aim: To study the outcome, morbidity and mortality associated with DC in patients with intracranial ischaemic infarct.

Materials and Methods: A longitudinal single-centre study was carried in the Department of Neurosurgery, GR Medical College and JA Group of Hospitals, Gwalior, Madhya Pradesh, India, from January 2019 to June 2020. A total of 25 cases were operated on and subsequently followed-up. Patients who were admitted with life-threatening supratentorial infarction and deemed eligible for DC based on clinical assessment {National Institute of Health Stroke Scale, Glasgow Coma Scale (GCS)} and neuroimaging with computed tomography head or Magnetic Resonance Imaging (MRI) brain were prospectively included in the study. The outcomes of the study were evaluated based on the functional impairment experienced by patients after a stroke. This was assessed using the Modified Rankin Scale (mRS), a seven-point scale that ranges from 0 (no symptoms) to 6 (death). The assessments were conducted at discharge, three months and six months. Paired t-test was used to analyse the functional outcomes of patients at admission, discharge, 3-month, and 6-month follow-up, using the mRS as the tool of evaluation. The relationship between patient characteristics and neurological outcome was analysed using the Chi-square test.

Results: In the study, 25 patients were analysed, with 76% being males. The right hemisphere was affected in 13 (52%) patients, while 12 (48%) patients had left hemisphere involvement. At admission, 23 (92%) patients had a mRS score of five and only 2 (8%) patients had an mRS score of 4. During hospitalisation, 8 (32%) patients died. After discharge, 7 (28%) patients had a mRS score of 4 or less, which increased to 9 (36%) patients at three months follow-up and 12 (48%) patients at six months follow-up.

Conclusion: The results of the present study revealed that decompressive hemicraniectomy improved neurological outcomes of patients with supratentorial ischaemic infarcts, with patient characteristics playing a significant role.

Keywords: Brain infarction, Cranial decompression, Hemicraniectomy, Outcome assessment, Prognosis, Stroke scale

INTRODUCTION

The World Health Organisation (WHO) defined stroke in the 1970s as rapidly developing clinical signs of focal or global disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than of vascular origin [1]. A study conducted by the World Stroke Organisation (WSO) found that the incidence of stroke in 2021-2022 was 158 per lakh population, of which 89% belonged to low and middle-income countries. This incidence had increased from 56 per lakh population in 1970-1979 and 117 per lakh population from 2000-2008 [2].

The majority of strokes were caused by cerebral infarction (70-85%) and a smaller percentage by intracerebral and subarachnoid haemorrhage (15-30%) [3]. A 20% of strokes occurred in the infratentorial brain [4]. The primary vasculature located in the infratentorial region includes the basilar artery and paired vertebral arteries, which supply the inferior thalamus, occipital lobes, midbrain, brainstem and cerebellum. Brainstem haemorrhages had a 65% mortality rate and cerebellar haemorrhages had a 40% mortality rate [5]. Uncontrolled hypertension caused prolonged damage to blood vessels leading to fragility and rupture, making supportive care the best treatment for most patients, as surgery was only possible for 25% of hospitalised cerebellar haemorrhage patients and the brainstem was not surgically accessible [6].

Severe morbidity and mortality after stroke are often attributed to large hemispheric infarctions, which are typically caused by insufficient collateral flow resulting from occlusion of the distal Internal Carotid Artery (ICA) or proximal Middle Cerebral Artery (MCA) trunk [7]. Malignant cerebral infarction affects approximately 10 to 20 individuals per 100,000 each year, with about 10% of all strokes resulting in neurological deterioration due to oedema [8,9]. Increased brain swelling and raised intracranial pressure can lead to herniation and progressive clinical deterioration in approximately 10-15% of patients with cerebral infarction in the MCA territory [10]. Oedema that occurs in cerebral infarction is caused by the dysfunction of the endothelium in the capillaries, leading to the breakdown of the blood-brain barrier. This type of oedema is typically observed between 2-5 days after the onset of the infarction and is linked to a poor outcome [11,12]. Major risk factors identified in India are hypertension (>95 mmHg diastolic), hyperglycaemia, tobacco use (smoking/chewing) and low normal haemoglobin levels (less than 10 gm) [13]. Previously described series, done by Rai AT et al., reported a fatality rate of approximately 80%, with most survivors experiencing severe disability, as done by Smith WS et al., in their study [10,14].

A surgical intervention, Decompressive Craniectomy (DC), was typically necessary due to the limited effectiveness of medical management for malignant infarction. DC involved removal of a portion of the skull to prevent neuronal damage and improve prognosis. The mortality rate for malignant MCA infarction was 80% with conservative treatment [10]. But there was insufficient evidence to suggest non surgical therapies beyond specialised care in a stroke unit or intensive care unit could improve outcomes.

The mortality rates reported for DC for malignant MCA infarct varied widely, ranging from 5.2-50%, in non randomised studies and 22% in a pooled analysis of randomised control trials [15-19]. These variations were due to the timing of DC, sample size, and when the mortality was measured after surgery, as the poststroke mortality rate increased with time. Hence, DC should be considered in patients with malignant MCA infarction as well as large cerebral infarction with clinical deterioration. This study was planned to evaluate the effectiveness of DC in the ischaemic infarct.

MATERIALS AND METHODS

The present longitudinal single-centre study was conducted in the Department of Neurosurgery, GR Medical College and JA Group of Hospitals, Gwalior, Madhya Pradesh, India, from January 2019 to June 2020. The Institutional Ethics Committee granted approval for the study protocol (D.No.116/IEC/GRMC/2018) and written informed consent was obtained from all participants.

Sample size calculation: The study consisted of 25 patients. Based on the results Of DC in patients with supratentorial ischaemic stroke, having an incidence of 1% of fatal space-occupying brain oedema with a supratentorial infarct with a confidence interval of 95% and expected error of 5% a sample size of 16 patients was required [20,21]. Hence, more than 16 patients were included for the present study.

Patients with malignant supratentorial ischaemic infarcts, who were recruited through admission in the neurosurgery department. Patients who were admitted with intracranial infarction that was deemed life-threatening and required DC were included in this study. Their eligibility was based on clinical evaluations such as National Institute of Health Stroke Scale [9] and Glasgow Coma Scale (GCS) [22], as well as neuroimaging using computed tomography head or Magnetic Resonance Imaging (MRI) brain). The enrolment was conducted prospectively.

Inclusion criteria: All admitted patients aged between 26 to 65 years having an ischaemic stroke in anterior circulation with a Computed Tomography (CT) scan showing intracerebral infarct of at least 50% MCA territory with midline shift >5 mm and/or Diffusion-weighted Image (DWI) volume >145 cc with clinical deterioration were included in the study.

Exclusion criteria: Patients with a GCS score of 3 and/or dilated and fixed pupils at the time of presentation were excluded from the study.

Study Procedure

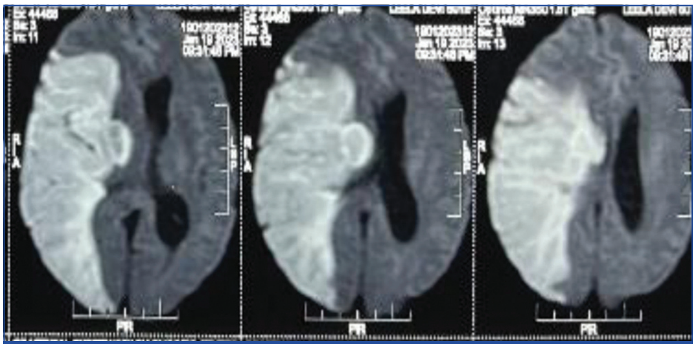
Patient demographics such as age, sex, medical history, presenting symptoms and signs, risk factors for stroke, blood pressure, and laboratory parameters (CBC, RFT, LFT, PT-INR, serum electrolytes, and lipid profile) were documented, as well as imaging findings (type of stroke, arterial territory involved, and midline shift). The GCS, National Institute Health Stroke Scale (NIHSS) score and mRS were recorded upon admission according to the prescribed proforma.

Glasgow coma scale [22]: The GCS is a widely used scoring system with good repeatability. It has three components which are eye response, motor response, and verbal response. Medical professionals can measure three distinct aspects of behaviour, including motor responsiveness, verbal performance, and eye-opening, which can be continuously assessed and documented on a chart. The sensitivity and specificity of the GCS score are 92% and 85%, respectively. As it is a numerical scale, so the changes in the examination may be more easily noticed over time and compared between different examiners. So, the GCS was used in this study for the daily neurological status of the patient.

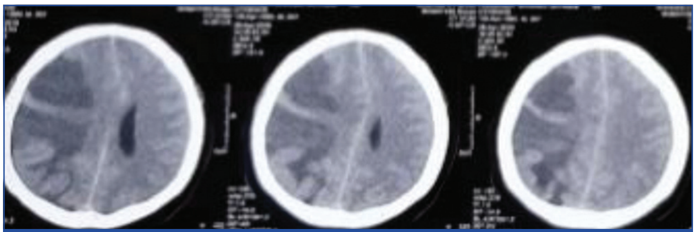
National Institute Health Stroke Scale (NIHSS) [9]: It is one of the most common scale used to determine the severity of stroke. The NIHSS is a 15-item non linear measure of neurological deficits used to assess symptoms related to acute anterior circulation stroke. The scale includes evaluation of consciousness, motor function, sensory function, coordination, neglect, language, visual fields and extraocular movements. The score ranges from 0 to 42 and higher scores indicate more severe stroke symptoms. This scale was used in this study to determine the severity of stroke.

Modified Rankin Scale (mRS) [23]: The mRS is a commonly used tool to measure the degree of disability or dependence after stroke. It has six categories, ranging from 0 to 5, with 0 indicating no symptoms and 5 indicating severe disability. In addition, a score of 6 is often added to indicate death. The mRS is widely used in both clinical trials and routine clinical practice for follow-up assessments after acute stroke.

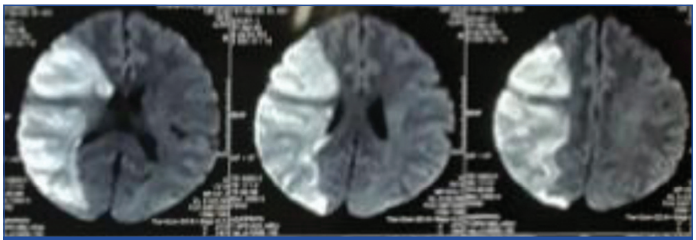
Patients were enrolled in this study based on MRI DWI that demonstrated an infarct volume of 145 cm^3 or more than 145 cm^3. A radiologist assisted in measuring the infarct volume (DWI volume) on the DWI scans (b-value 1000 s/mm^2) [24]. Initially, images showing the infarcted region as a bright signal were chosen. Using a semi-automated thresholding technique, the hyperintense area was delineated on each slice. The threshold was increased until the selected area matched the hyperintense area that would have been contoured manually. If multiple lesions were present, each one was contoured with the same method. The surface area of each lesion was added, and the DWI volume was calculated by multiplying the total surface area by the slice thickness. [Table/Fig-1,2a,2b] shows the radiological image of right MCA infarct.



[Table/Fig-1]: MRI DWI image showing right MCA infarct, showing infarct volume of more than 145 cm^3.

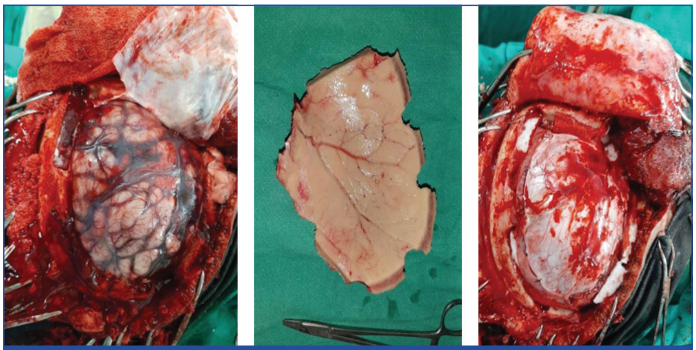


[Table/Fig-2a]: Preoperative CT scan of right MCA infarct.



[Table/Fig-2b]: Preoperative MRI scan of same patient with right MCA infarct.

Surgical procedure: The surgical procedure involved creating a reverse question mark-shaped incision, starting 2-3 cm lateral to midline behind the hairline and extending at least 12-15 cm posteriorly, curving around and down to the posterior root of the zygoma. A myocutaneous flap was formed by reflecting the skin and temporalis muscle anteriorly. The bone removal was limited to 2-3 cm from the midline, avoiding the frontal sinus and superior sagittal sinus, and extending at least 12 cm anteroposteriorly [Table/Fig-3]. A large bone flap, including the frontoparietaltemporal and sometimes occipital bone, was removed, and the dura was opened in a stellate fashion for maximum cerebral decompression [Table/Fig-3]. Pericranium was spread over the brain to cover the bulging brain, instead of performing a watertight duraplasty [Table/Fig-3]. The bone flap was placed in a subcutaneous pocket overlying the abdomen until subsequent cranioplasty.



[Table/Fig-3]: Intraoperative images of the same patient with right MCA infarct.

Outcome measure:

1) The primary outcome measure was the functional outcome, which was determined by a mRS score.
2) Secondary outcome measures were mortality and median time of survival. The follow-up assessment was conducted at the Outpatient Department (OPD) visits at 3, and 6 months using the mRS score. A score of ≤4 on the mRS was considered a favourable outcome.

STATISTICAL ANALYSIS

The data was entered into Microsoft Word software and then processed with statistical software programs, Statistical Package for the Social Sciences (SPSS) software version 16.0 and Epi Info version 7.0. Present study utilised the paired t-test to analyse the functional outcomes of patients at admission, discharge, 3-month, and six-month follow-up, using the mRS as the tool of evaluation. In addition, the Chi-square test was employed to examine the patient characteristics (age, sex, timing of surgery, co-morbidities like hypertension, DM, dyslipidemia, history of tobacco and alcohol intake, GCS, NIHSS score, and midline shift on radiological imaging) that were associated with good/bad neurological outcomes.

RESULTS

A total of 25 cases underwent surgery and were subsequently followed-up. There were 19 male and 6 female patients in the study and the male-female ratio was 3.1:1. The most common age groups were 61-65 years (24%) and 26-30 years (24%) with a mean age of 47.12 years [Table/Fig-4].

Variable	Number of patients (n)	Percentage
1. Patient Characteristics		
Gender		
Males	19	76%
Females	6	24%
Total	25	100%
Age (years)		
26-30	6	24%
31-35	1	4%
36-40	1	4%
41-45	2	8%
46-50	5	20%
51-55	2	8%
56-60	2	8%
61-65	6	24%
Total	25	100%
Hemisphere		
Right	13	52%
Left	12	48%
Total	25	100%
2. Timing of surgery		
Hours from onset to surgery		
≤48	14	56%
>48	11	44%
Total	25	100%

[Table/Fig-4]: Analysis of patient characteristics, stratified by the timing of surgery after hospital admission.

Most of the patients i.e., 20 (80%) were having MCA territory infarction while 5 (20%) had ICA territory infarction in their radiological studies. The cause of stroke could not be determined in 13 (52%) patients, either because their condition did not permit it or because the cause could not be identified [Table/Fig-5]. A thorough medical history, including evaluation of risk factors for cardiovascular disease, combined with diagnostic imaging modalities such as CT scan, MRI, and carotid artery colour doppler, as well as an Electrocardiogram (ECG) and 2-dimensional Echocardiography (2D ECHO), helped differentiate between brain infarcts caused by emboli and those caused by thrombosis.

Aetiological factors	No. of Patients	Percentage
Undetermined aetiology	13	52%
Carotid artery atherosclerosis	8	32%
Cardiac embolic	4	16%
Total	25	100%

[Table/Fig-5]: Aetiological factors.

Most of the patients, 17 (68%) presented with NIHSS Score >21 (severe stroke) while 8 patients (32%) presented with NIHSS score of 16-20 (moderate to severe stroke). It was observed that 17 patients, constituting 68% of the total, had a GCS score ranging from 9-13 [Table/Fig-6].

NIHSS score	No. of patients	Percentage
1-4 (Minor)	0	0%
5-15 (Moderate)	0	0%
16-20 (Moderate to Severe)	8	32%
21-42 (Severe)	17	68%
GCS score on admission		
14-15	4	16%
9-13	17	68%
3-8	4	16%

[Table/Fig-6]: NIHSS and GCS score at the time of admission.

Most of the patients 23 (92%), had an mRS score of 5, while only two (8%) patients had an mRS score of 4 on admission [Table/Fig-7]. The maximum hospital stay was 22 days and the minimum hospital stay was three days, with an average of 12.5 days. The average

Modified Rankin Scale (mRS) score at the time of admission	Number of patients (n)	Percentage
5	23	92%
4	2	8%
3	NIL	0%
2	NIL	0%
1	NIL	0%
0	NIL	0%

[Table/Fig-7]: Modified Rankin score at the time of admission.

Intensive Care Unit (ICU) stay was seven days, with a minimum stay of two days and a maximum stay of 12 days.

A total of 8 (32%) patients died during hospitalisation while receiving treatment. Two patients died on the 7th postoperative day due to respiratory infection and ventilator-associated pneumonia while one patient died on the 8th postoperative day due to septicaemia. Two patients developed pulmonary embolism on the 5th and 6th postoperative day, respectively, and did not survive. Another two patients developed acute myocardial infarction on the 3rd and 5th postoperative day, respectively. One patient's cause of death was unclear, but it was suspected that multiple age related comorbidities contributed, and they passed away on the 9th postoperative day.

At the time of discharge, 28% of patients had a mRS score of 4 or less. At three months follow-up, 36% of patients had a score of 4 or less, and 48% had a score of 4 or less on six months follow-up [Table/Fig-8].

mRS score	On admission	On discharge	3 months follow-up	6 months follow-up
5	23 (92%)	10 (40%)	8 (32%)	4 (16%)
4	2 (8%)	6 (24%)	7 (28%)	5 (20%)
3	0	1 (4%)	2 (8%)	7 (28%)
Total patients (n)	25	17	17	16

[Table/Fig-8]: MRS score on-follow-up.
Values are presented as n (%)

Among these variables, univariate analysis was done using the Chi-square test, which showed that there was a statistically significant association (p-value <0.05) between hypertension and age >45 years with poor outcomes at the time of discharge [Table/Fig-9].

Factors		Good outcome (n)	Poor outcome (n)	Total (n)	Chi-square test	p-value
Age (years)	≤45	6	4	10	8.466	**0.004**
	>45	1	14	15		
Sex	Male	7	13	20	2.431	0.119
	Female	0	5	5		
Timing of surgery (hours)	≤48	6	8	14	3.4841	0.062
	>48	1	10	11		
Hemisphere involvement	Left	2	10	12	1.470	0.225
	Right	5	8	13		
Artery involvement	MCA	7	13	20	2.431	0.119
	ICA	0	5	5		
Hypertension	Absent	6	5	11	6.866	**0.009***
	Present	1	13	14		
Diabetes mellitus	Absent	6	10	16	1.999	0.158
	Present	1	8	9		
Dyslipidaemia	Absent	6	11	17	1.402	0.236
	Present	1	7	8		
Coronary artery disease	Absent	6	12	18	0.907	0.341
	Present	1	6	7		
Tobacco	Absent	0	10	10	6.481	**0.011**
	Present	7	8	15		
Alcohol	Absent	1	12	13	5.54	**0.019**
	Present	6	6	12		
Smoking	Absent	4	9	13	0.103	0.748
	Present	3	9	12		
GCS	≤8	2	10	12	1.470	0.225
	>8	5	8	13		
NIHSS Score	≤18	2	0	2	5.590	**0.018**
	>18	5	18	23		
Midline shift	≤10	4	12	16	0.198	0.656
	>10	3	6	9		
Uncal herniation	Absent	1	3	5	0.021	0.884
	Present	6	15	21		

[Table/Fig-9]: Predictors of outcome at discharge.
Chi-square test was used; p-value in bold font indicates statistically significant values

Total of 17 (68%) Patients were available for follow-up at three months. All variables mentioned at the time of discharge including carotid atherosclerosis while excluding the hemisphere involved (right or left) and artery involved (ICA or MCA), were again analysed using Chi-square test to look for association with outcome. Age >45 years, presence of diabetes mellitus, hypertension, carotid atherosclerosis, history of alcoholism and tobacco chewing had showed significant association (p-value <0.05) with the poor functional outcome at three months follow-up [Table/Fig-10].

Factors		Good outcome (n)	Poor outcome (n)	Total (n)	Chi-square test	p-value
Age (years)	≤45	7	1	8	7.244	**0.007**
	>45	2	7	9		
Sex	Male	9	6	15	2.55	0.110
	Female	0	2	2		
Timing of surgery (hours)	≤48	9	6	15	2.55	0.110
	>48	0	2	2		
Hypertension	Absent	7	2	9	4.735	**0.030**
	Present	2	6	8		
Diabetes mellitus	Absent	7	4	11	1.431	**0.030**
	Present	2	4	6		
Dyslipidaemia	Absent	7	7	14	0.275	0.600
	Present	2	1	3		
Coronary artery disease	Absent	7	6	13	0.018	0.893
	Present	2	2	4		
Tobacco	Absent	0	6	6	10.432	**0.001**
	Present	9	2	11		
Alcohol	Absent	2	8	10	10.578	**0.001**
	Present	7	0	7		
Smoking	Absent	5	5	10	0.084	0.772
	Present	4	3	7		
Carotid atherosclerosis	Absent	8	2	10	7.137	**0.008**
	Present	1	6	7		
GCS	≤8	7	6	13	0.018	0.893
	>8	2	2	4		
NIHSS score	≤18	2	0	2	2.015	0.156
	>18	7	8	15		
Midline shift	≤10	1	2	3	0.562	0.453
	>10	8	6	14		
Uncal herniation	Absent	1	2	3	0.562	0.453
	Present	8	6	14		

[Table/Fig-10]: Predictors of outcome at three months.

A total of 16 (64%) patients were available for follow-up at six months while one patient expired during home care. All variables mentioned at the time of discharge were again analysed using the chi-square test except the hemisphere involved (right or left), artery involved, and midline shift to look for association with outcome. Female sex, presence of coronary artery disease, history of alcoholism and chewing tobacco showed significant association (p-value <0.05) with the poor functional outcome at six months follow-up [Table/Fig-11].

Factors		Good outcome	Poor outcome	Total	Chi-square test	p-value
Age (years)	≤45	7	1	8	1.333	0.248
	>45	5	3	8		
Sex	Male	12	2	14	6.857	**0.008**
	Female	0	2	2		
Timing of surgery (hours)	≤48	11	4	15	0.356	0.550
	>48	1	0	1		
Hypertension	Absent	8	1	9	2.116	0.146
	Present	4	3	7		
Diabetes mellitus	Absent	8	3	11	0.097	0.755
	Present	4	1	5		
Dyslipidaema	Absent	10	4	14	0.762	0.383
	Present	2	0	2		
Coronary artery disease	Absent	9	0	9	6.857	**0.009**
	Present	3	4	7		
Tobacco	Absent	1	4	5	11.733	**0.001**
	Present	11	0	11		
Alcohol	Absent	5	4	9	4.148	**0.042**
	Present	7	0	7		
Smoking	Absent	6	4	10	2.727	0.099
	Present	6	0	6		
GCS	≤8	10	3	13	0.137	0.711
	>8	2	1	3		
NIHSS score	≤18	2	0	2	0.762	0.383
	>18	10	4	14		
Uncal Herniation	Absent	1	2	3	3.419	0.064
	Present	11	2	13		

[Table/Fig-11]: Predictors of outcome at six months.

There was statistical significant difference between mRS on admission and mRS at three months (p-value=0.002), mRS on admission and mRS at six months (p-value=0.001), mRS on discharge and mRS at six months (p-value=0.004), and mRS at three months and mRS at six months (p-value=0.014) [Table/Fig-12].

Pairs	mRS	Mean±SD	Paired t-test (t-value)	p-value
Pair 1	mRS on admission	4.92±0.277	0.401	0.692
	mRS on discharge	5.00±0.866		
Pair 2	mRS on admission	5.00±0.000	3.801	**0.002**
	mRS at 3 months	4.35±0.072		
Pair 3	mRS on admission	5.0±0.000	4.518	**0.001**
	mRS at 6 months	3.94±0.966		
Pair 4	mRS on discharge	4.53±0.624	1.852	0.083
	mRS on 3 months	4.35±0.702		
Pair 5	mRS on discharge	4.53±0.624	3.405	**0.004**
	mRS at 6 months	3.94±0.966		
Pair 6	mRS at 3 months	4.35±0.782	2.746	**0.014**
	mRS at 6 months	3.94±0.966		

[Table/Fig-12]: Assessment of functional outcome by mRS.

DISCUSSION

The present study enrolled 25 patients who underwent decompressive hemicraniectomy for unilateral supratentorial hemispheric infarcts. Of the total, 19 (76%) were males and 6 (24%) were females. In the study by Pillai A et al., 26 patients were included, out of which 22 were males and four were females [25]. The DESTINY trial had a surgical group of 17 patients, all of whom were below the age of 60 years (range, 30-60 years) with a mean age of 42.7 years and 47% of them being males [26].

In the present study, 13 (52%) patients presented with right hemispheric involvement with left side hemiparesis to complete hemiplegia with cognitive impairments while 12 (48%) patients presented with left hemisphere involvement infarcts with aphasia and right side hemiparesis to complete hemiplegia. Kilincer C et al., reported that among the 36 patients, 49.5% had the infarct located in the dominant hemisphere, and there was no significant predilection of either hemisphere [27]. In the DESTINY trial, slight predilection towards the dominant hemisphere was observed in 53% of patients [26]. The present study found that 14 (56%) out of 25 patients underwent decompressive hemicraniectomy within 48 hours of symptom onset, while the remaining 11 patients (44%) underwent the surgery after 48 hours of symptom onset. The time range was 20-96 hours while mean was 50.64 hours. In the DESTINY trial, the mean timing of onset of surgery was 24 hours (range 13.9-36.6 hours), while in the HAMLET trial [28], for patients operated on within 48 hours, the mean interval from onset to surgery was 31 hours [28].

In present study, the leading cause of stroke was undetermined aetiology (either unknown or pending further investigations to confirm aetiology) in 13 (52%) patients, followed by large vessel atherosclerosis in 8 (32%) patients, and emboli due to cardiac disease in 4 (16%) patients. Bhatia R et al., reported that 58.3% of their stroke patients had undetermined causes and required further evaluation, while 27.7% had cardioembolic strokes, which was the next most common cause of stroke [29]. Chung JW et al., found that MCA territory infarcts were caused by cardiac emboli in 28.6% of patients, and ACA territory infarcts in only 10% of patients [30]. They also found that undetermined causes accounted for 35.5% of patients with MCA infarcts.

The present study showed a mortality rate of 32% during hospitalisation and one patient died during follow-up after three months. Other trials like the HeADDFIRST trial [31] had a mortality rate of 25%, DECIMAL trial had a mortality rate of 25%, DECIMAL trial had 25%, HAMLET trial had 16%, and DESTINY trial had 18% mortality at discharge or during the first month of follow-up [26,28,31,32]. According to Zhao J et al., patients as old as 80 years can benefit from this procedure. Out of the eight patients who died during discharge in the present study, four were below 60 years of age and four were above 60 years [33]. The deaths in our study were primarily attributed to medical comorbidities, which tend to increase with age. Therefore, age and medical comorbidities should be taken into consideration when analysing the outcomes of the procedure.

In the present study, a favourable outcome was defined as an mRS score of ≤4. At the time of discharge, 7 (28%) patients had an mRS score of ≤4, which increased to 9 (36%) patients at the 3-month follow-up, and 12 (48%) patients at the 6-month follow-up. In the HAMLET trial, DECIMAL trial and, DESTINY trial, the percentage of patients with an mRS score of <4 at the end of 12 months of follow-up was approximately 75% [26,28,32]. Similarly, in the study conducted by Daou B et al., almost 66% of patients had an mRS score of <4 at 90 days of follow-up [34]. In the study by Kiphuth IC et al., 60% of patients had an mRS score of <4 at six months and 65% at 1-year follow-up [35].

At six months of follow-up sex, coronary artery atherosclerosis, tobacco chewing and alcohol consumption were associated with poor functional outcomes. Several studies, such as HAMLET, DECIMAL and, DESTINY trials, have identified age >60 years as a predictor of poor short-term outcomes and excluded patients above this age from their study [26,28,32]. However, according to Zhao J et al., the benefits of the procedure may extend to patients aged 80 years and above. Pillai A et al., reported in their study that pre-existing hypertension is significantly associated with mortality [25]. In the present study, prior history of hypertension was associated with mortality and poor functional outcome. Daou B et al., noted in their study that a prior history of coronary heart disease and DM are associated with poor outcomes [34]. The present study was compared with previous studies in [Table/Fig-13] [25,26,32,36-38].

Author of the study	Year	Location	Sample size	Results
Pillai A et al., [25]	2007	Kerala, India	26	The study include 26 patients with a mean age of 48.4±11.2 years and mean preoperative GCS score of 9.9±3.2. The median time from stroke onset to surgery was 54 hours (range 13-288 hours). The one-year survival rate was 73%, with 33.3% achieving independence {Barthel Index (BI) >95} and 55.6% partially dependent (BI 60-95) at one-year follow-up. At one-year follow-up, 72% of patients regained the ability to walk independently. No patients remained in a vegetative state. Patient age was inversely correlated with one-year BI score (r-value=-0.47, p-value=0.048).
Vahedi K et al., [32]	2007	France	20	In this study, involving 38 randomised patients, those who underwent surgery had a higher proportion of modified Rankin scale (mRS) scores ≤3 at 6-month and 1-year follow-up (25% and 50%, respectively) compared to those who received no-surgery (5.6% and 22.2%, respectively), although the difference was not statistically significant (p-value=0.18 and p=0.10, respectively). However, there was a significant decrease in the absolute death rate after craniectomy compared to medical therapy only (52.8%, p-value=0.0001).
Jüttler E et al., [26]	2007	Germany	17	After enrolling 32 patients, this study suggested a statistically significant reduction in mortality was observed, with 88% of patients in the hemicraniectomy group and 47% in the conservative therapy group surviving after 30 days (p-value=0.02). At 6 and 12 months, 47% of patients in the surgical group had a modified Rankin Scale (mRS) score of 0-3 compared to 27% in the conservative treatment group, but this difference was not statistically significant (p-value=0.23).
Rai VK et al., [36]	2014	New Delhi, India	36	This study suggested that the surgical group had a significant absolute risk reduction of 45% in mortality at one year, with 20% of patients achieving a good outcome compared to none in the medical group (p-value=0.025). Over time, there was an increased proportion of patients improving, and surgery reduced the odds of moderate to severe disability (mRS ≥4) by 93.5% (odds ratio: 0.064, 95% confidence interval: 0.01-0.045, p-value=0.006).
Slezins J et al., [37]	2012	Latavia	11	In this study, the Decompressive Craniectomy (DC) group had five survivors, all of whom were younger than 60-year-old, while the Medically treated group had only one survivor (p-value=0.03/0.06). Among the survivors, none had a cerebral infarct volume exceeding 390 cm^3 (p-value=0.05), and all survivors in the Decompressive Craniectomy (DC) group had favourable outcomes. The NIHSS and GCS scores did not differ significantly between the groups or between survivors and non survivors (p-value>0.05).
Bansal H et al., [38]	2015	Ludhiana, India	53	In this study, 53 patients with a mean age of 54.92 ± 11.8 years were analysed. Approximately, 60% of patients were older than 60 years. Among patients operated within 48 hours (25 patients), approximately 74% had mRS 0-3 at discharge compared to 56% of patients operated after 48 hours, although the difference was not statistically significant. The study also found that 78% of patients below 60 years had mRS 0-3 at discharge, while only 38% of patients above 60 years had mRS 0-3 at discharge, which was statistically significant (p-value<0.008).
Present study	2020	Gwalior, India	25	In the study, 25 patients were analysed, with 76% being male and the majority belonging to age groups 26-30 and 61-65. The right hemisphere was affected in 13 (52%) patients, while 12 (48%) patients had left hemisphere involvement. At admission, 23 (92%) patients had an mRS score of 5 and only 2 (8%) patients had an mRS score of 4. During hospitalisation, 8 (32%) patients died. At discharge, 28% of patients had a Modified Rankin Scale (mRS) score of 4 or less, 36% at three months follow-up, and 48% at six months follow-up.

[Table/Fig-13]: Comparison of current study's findings with previously published studies on outcome of Decompressive Craniectomy (DC) in patients with supratentorial ischaemic infarct [25,26,32,36-38].

Limitation(s)

The present study had a few limitations, such as a relatively short follow-up period of six months. Additionally, the home-based care received by the present patients may limit the generalisability of this findings to settings where patients receive care in dedicated rehabilitation centres.

CONCLUSION(S)

Performing DC appears to be a viable option for reducing short-term and long-term neurological damage in patients with supratentorial ischaemic stroke, thereby increasing their chances of survival and achieving acceptable functional outcomes. The present study revealed that patients undergoing DC for supratentorial ischaemic infarct had poor outcomes if they were above the age of 45 years, had coronary artery disease, diabetes mellitus, hypertension, or a history of alcohol and tobacco consumption.

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