Section: Neurosurgery

Original Research Article

A HOSPITAL BASED PROSPECTIVE STUDY TO ASSESS THE OUTCOME OF DECOMPRESSIVE CRANIECTOMY IN PATIENT WITH INTRACRANIAL ISCHEMIC INFARCT AT TERTIARY CARE CENTER

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ABSTRACT

Background: Malignant stroke occurs in a subgroup of patients suffering from ischemic cerebral infarction and is characterized by neurological deterioration due to progressive edema, raised intracranial pressure, and cerebral herniation. Decompressive craniectomy (DC) is a surgical technique aiming to open the "closed box" represented by the non-expandable skull in cases of refractory intracranial hypertension. Hence, DC should be considered in patients with malignant middle cerebral artery infarction as well as large cerebral infarction with clinical deterioration. The present study is to plan to evaluate the effectiveness of decompressive craniectomy in ischaemic infarct.

Materials and Methods: This is a non-randomized, prospective, single institute, observational study done on 30 patients in the department of Neurosurgery at the G. R. Medical College between January 2019 and June 2020. All admitted patients with life threatening intracranial infarction indicated to undergo Decompressive Craniectomy on the basis of clinical assessment (National Institute of Health Stroke Scale), Glasgow coma scale [GCS]) and neuroimaging (computed tomography head or MRI Brain) were prospectively enrolled. Details of demographics including age, sex, address, contact number, detailed history of event, presenting symptoms and signs, risk factors for stroke, blood pressure, GCS and NIHSS score, laboratory parameters and imaging findings (type of stroke, arterial territory involved, midline shift) were noted.

Results: A total of 30 patients were enrolled. Most common age group was 61-65 years of age (24%) and 26-30 years of age (24%). Variable studies are Age, gender, onset of symptoms to decision of surgery, co-morbidities, etiology of stroke, pre-operative clinical signs and symptoms based on MRS, NIHSS, GCS, Hemisphere involved based on dominance, Imaging data like arterial territory involved, MLS and uncal herniation. Among these variables, uni-variate analysis showed age > 45 years and presence hypertension showed significant association ($p < 0.05$) with poor outcome at the time of discharge.

Conclusion: Careful individualized patient selection and surgery may improve the functional outcome for these patients. Furthermore, the possibility of long term cognitive and physical dependence needs to be discussed with the patients and their families before deciding upon decompressive hemicraniectomy as most of the patients receive home-based care through family members and local physicians in their long term follow up.

Keywords: Decompressive Hemicraniectomy, NIHSS, GCS, MRS, CT scan, Intracranial ischemic infarct.

INTRODUCTION

The World Health Organization (WHO) definition of stroke from the 1970s is the following: "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] Patients with symptoms resolving within 24h are denoted as suffering from a transient ischaemic attack (TIA). This definition of stroke does not reveal the underlying pathophysiology. The proportion of stroke caused by cerebral infarction is 70-85%, while 15-30% is caused by intracerebral and subarachnoid haemorrhage (bleeding). Infarction is defined as irreversible cell death caused by ischaemia. Cerebral ischaemia denotes a state of insufficient blood flow to uphold the energetic requirements of the brain. This disruption of the blood flow is caused by obstruction of the blood vessels supplying the cerebral tissue.

Accounting for up to 46% of acute ischemic strokes (AISs), LVOs possess outsized clinical importance as they more than doubled the risk of death or dependence as compared to non-LVO AISs in the pre-endovascular era.[2-5]

Large hemispheric infarctions have malignant course and constitute a major cause of severe morbidity and mortality after stroke. It is usually due to occlusion of distal internal carotid artery (ICA) or proximal middle cerebral artery (MCA) trunk without sufficient collateral flow.[6] The incidence of malignant cerebral infarction is 10 to 20 per 100 000 per year. Neurological deterioration due to edema occurs in 10% of all strokes.[7]

About 10-15% patients with middle cerebral artery (MCA) territory cerebral infarction suffer from progressive clinical deterioration because of increased brain swelling, raised intracranial pressure, and subsequent herniation.[8-10] Edema associated with these infarcts is usually observed between the 2nd and 5th day after the index event and is associated with a poor prognosis.[9] Previously described series, have observed fatality rates of about 80%, and most survivors were left severely disabled.[4,5] Unfortunately, medical management for malignant MCA infarction is generally ineffective, necessitating a surgical approach for its relief.[7]

The benefit of surgical management of cerebellar infarct has not been subjected to a randomized controlled trial because of a lack of clinical equipoise. It is generally recommended that patients with cerebellar infarcts who deteriorate neurologically undergo suboccipital craniectomy,[11] and that decompression should occur as soon as clinical signs of brainstem compression occur. Furthermore, resection of infarcted tissue should be used if necessary to ensure adequate decompression of the brainstem.[12,13] Although several studies have described management of cerebellar stoke in select patients using ventriculostomy alone with good results,[14,15] it is generally accepted that this practice may pose a risk of upward herniation60 and should be avoided. Clinical outcomes following suboccipital decompression are better than in the case of supratentorial ischemia, with 40% to 50% of survivors living with mild disability or better.[14,16]

Patients with large hemispheric infarction may suffer from increasing intracranial pressure (ICP) resulting in cerebral herniation and subsequent mechanical and ischemic damage of healthy cerebral territories. With decompressive craniectomy (DC), a proportion of the skull is surgically removed to allow the edematous brain tissue to herniate to the outside and thus preventing neuronal damage in other regions of the brain. Two principal groups of stroke patients who may benefit from craniectomy can be distinguished: First, patients with large cerebral infarction and subsequent suboccipital craniectomy (SCC) and secondly patients with large infarction of the middle cerebral artery territory also called malignant middle cerebral artery infarction.

Prognosis of the patients with malignant middle cerebral artery infarction is poor with a mortality rate of approximately 80% if treated conservatively. There is only insufficient evidence that additional non-surgical therapeutic regimes other than specialized care on a stroke unit or intensive care unit can improve patient's outcomes. Hence, DC should be considered in patients with malignant middle cerebral artery infarction as well as large cerebral infarction with clinical deterioration. The present study is to plan to evaluate the effectiveness of decompressive craniectomy in ischaemic infarct.

MATERIALS AND METHODS

This is a non-randomized, prospective, single institute, observational study done on 30 patients in the department of Neurosurgery at the G. R. Medical College & J.A. Group of Hospitals, Gwalior (M.P.) between January 2019 and June 2020. The study protocol was approved by the Institutional Ethics Committee and written informed consent was obtained from all participants. All admitted patients with life threatening intracranial infarction indicated to undergo Decompressive Craniectomy on the basis of clinical assessment (National Institute of Health Stroke Scale), Glasgow coma scale [GCS]) and neuroimaging (computed tomography head or MRI Brain) were prospectively enrolled.

Inclusion Criteria

1. All admitted patients age between 15 to 65 years with CT scan showing intracerebral infarct of at least 50% MCA territory with midline shift > 5mm and/or DWI (Diffusion weighted image) volume >145 cc with clinical deterioration.

2. Cerebellar infarct with neurological deterioration with or without hydrocephalus.

Exclusion Criteria

1. Patient not willing for surgery.
2. Patients with Glasgow Coma Scale (GCS) score 3 and/or dilated and fixed pupils at the time of presentation.
3. Patients with coagulopathy.

Study Protocol and Data Collection

Patient with age between 15 to 65 years having ischemic stroke in anterior circulation with at least one of the following NIHSS score 16 or more, Glasgow Coma Scale score less than 13, decrease in level of consciousness, clinical sign of herniation and radiological evidence of ischemic stroke (CT Scan >50% MCA territory infarct with midline shift and/or MRI brain infarct volume> 145 cc with clinical deterioration) were prospectively enrolled.

Patients with posterior fossa infarct were included in study if, a initially conscious patient having clinical deterioration in absence of acute hydrocephalus or a clinical deterioration in setting of acute hydrocephalus despite of venticulostomy. A written consent has been taken from the patient or their attendants.

Details of demographics including age, sex, address, contact number, detailed history of event, presenting symptoms and signs, risk factors for stroke, blood pressure, GCS and NIHSS score, laboratory parameters and imaging findings (type of stroke, arterial territory involved, midline shift) were noted.

Surgical technique

Skin incision: A large reverse question mark skin incision was made. The incision begins 2 to 3 cm lateral to midline behind the hairline, extends at least 12-15cms posteriorly, and then curves around and down to the posterior root of zygoma. The skin and temporalis muscle were reflected anteriorly as a myo-cutaneous flap.

Bone removal: The limits of bone removal were 2-3 cm from midline, avoiding frontal sinus and superior sagittal sinus, till middle cranial fossa base. The antero-posterior extent was atleast 12 cm. a large bone flap as large as possible including fronto-parieto-temporal sometimes occipital free bone flap and duroplasty.

Dural opening: The dura was opened in a stellate fashion to maximize cerebral decompression. The bulging brain covered with pericranium spread over the brain instead of a watertight duraplasty. The bone flap was placed in a subcutaneous pocket overlying the abdomen until subsequent cranioplasty.

For Posterior Fossa Infarction

Surgical Technique

The procedure was performed with the patient in a prone or semi-prone/lateral position/sitting position. A linear midline incision was made from the inion to the upper cervical spine, and the muscular layers were subsequently separated in the midline avascular plane, exposing the suboccipital skull, atlanto-occipital membrane, and posterior arch of the atlas. A wide craniectomy was performed extending into the foramen magnum. The dura was then usually opened in a Y-shaped fashion, and an expansion duroplasty was performed.

In patients undergoing suboccipital DC, the bone flaps are not preserved, the craniectomy defect will cover by the neck muscles.

Follow up

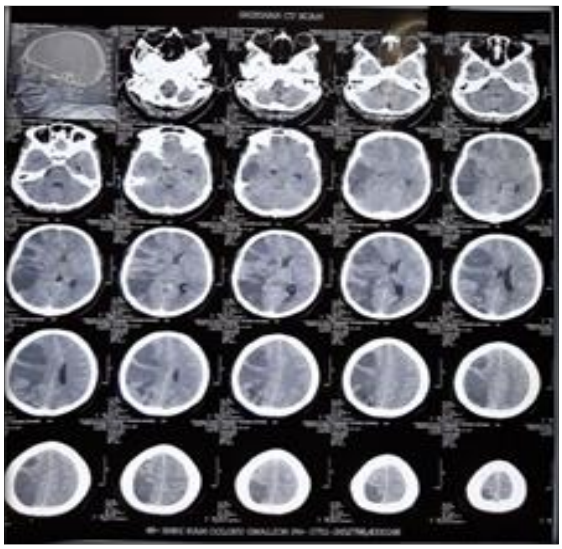
Discharge MRS was collected from the medical records as per proforma appended. At 3 month and 12 months after surgery, the patients clinical outcome were assessed with the modified Rankin Score (mRS) to rate physical disabilities. The patients with a score of 0 to 4 were included in the good outcome group, and patients with a score of 5 to 6 were included in the poor outcome group.

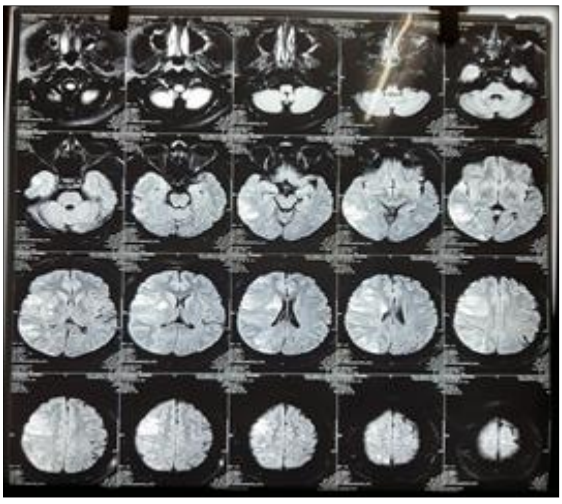
Outcome on follow-up were assessed by using mRS score during out-patient department (OPD) visits or telephonically at 1, 3 and 6 months. mRS score of ≤ 3 is taken as a good outcome.

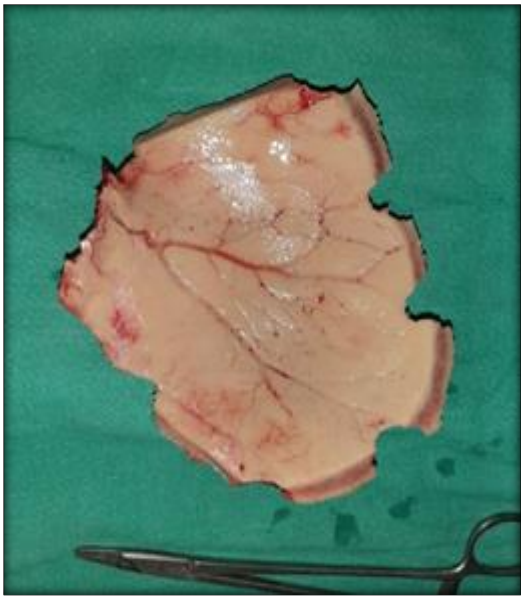
Statistics Analysis

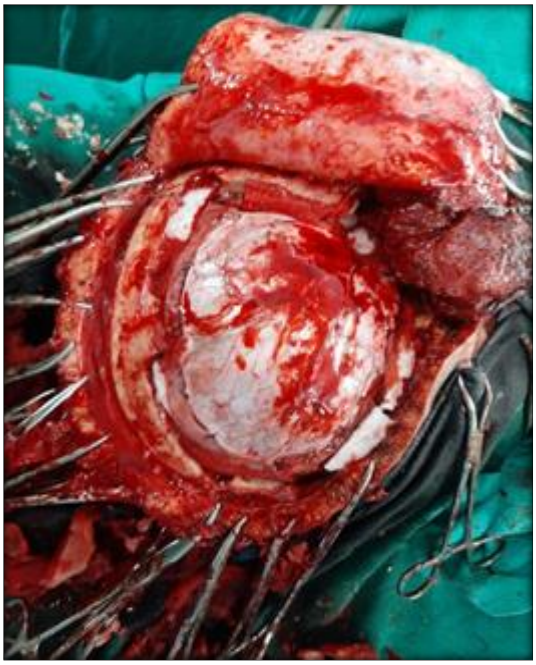
Data was entered in Microsoft Word and analyzed using SPSS version 16.0 and EPI INFO version 7.0. Appropriate statistical test was applied to analyze the data.

Case 1









RESULTS

A total 25 patients of intracranial infarction were included in this study and underwent Decompressive Hemi-craniectomy. There were 19 male and 6 female patients in the study and male female ratio was 3.1:1. Most common age group was 61-65 years of age (24%) and 26-30 years of age (24%). As a tertiary referral center, many patients reached hospital after 48 hours from onset of symptoms. 14(56%) patients were operated on within 48 hours while 11(44%) patients were operated after 48 hours after onset of symptoms.

All patients (25 patients) were having altered sensorium while 60% had hemiparesis and 52% patient having aphasia while 40% patients were having hemiplegia16% patients having seizures with presenting complaints. The most common Co-morbidity was Hypertension in 14 (56%) patients followed by Diabetes mellitus in 9(36%) and dyslipidaemia 8(32%).

Most patients 17(68%) were presented with NIHSS Score > 21(severe stroke) while 8 patients (32%) presented with NIHSS score 16-20 (moderate to severe stroke). In this study 16% (4) patients having midline shift ≤5mm, 48% (12) patients having 5-10mm and 36% (9) patients having midline shift >10mm. 21 patients (84%) having uncal herniation while 4 patients (16%) presented with MCA hyperdense sign, and 4 patients (16%) show hemorrhagic conversion.

The most common intraoperative finding was tense duramater followed by 21 patients (84%) show effaced sulci while 20 patients (80%) have pale appearance of brain and brain pulsation was present in 12 patients (48%) and 16% patient (4) have hemorrhagic patches intraoperative.

Our study showed that multivariable analysis suggests that age > 45 years of age, NIHSS score >18, presence of hypertension and history of alcohol

and tobacco consumption associated with high mortality.

Outcome: 17(68%) patients survived at the time of discharge. With MRS <4 considered as favourable outcome in this study; we considered multiple variables pre-operatively to know the association of them with the outcome. Variable studies are Age, gender, onset of symptoms to decision of surgery, co-morbidities, etiology of stroke, pre-operative clinical signs and symptoms based on MRS, NIHSS, GCS, Hemisphere involved based on dominance, Imaging data like arterial territory involved, MLS and uncal herniation. Among these variables, uni-variate analysis showed age > 45 years and presence hypertension showed significant association (p <0.05) with poor outcome at the time of discharge.

At 3-month follow-up: 17(68%) were available for follow up at 3 months. All variable mentioned at the time of discharge were again studied to look association with outcome. Age < 45 years, presence of diabetes mellitus, hypertension, carotid atherosclerosis, history of alcohol and tobacco consumption showed significant association (p<0.05) with poor outcome at 3 months follow-up.

At 6-month follow-up: 16(64%) were available for follow up at 6 months while one patient was expired during home care. All variable mentioned at the time of discharge were again studied to look association with outcome. Sex, presence of coronary artery disease, history of alcohol and tobacco consumption showed significant association (p<0.05) with poor outcome at 6 months follow-up.

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Table 1: Factors Associated with Mortality Before Discharge

FACTORS		GOOD OUTCOME	POOR OUTCOME	TOTAL	CHI-SQUARE TEST	P VALUE
AGE	≤45	6	4	10	0.466	0.004
	>45	1	14	15		
SEX	MALE	7	13	20	2.431	0.0.119
	FEMALE	0	5	5		
TIMING OF SURGERY	≤48	11	4	15	0.463	0.496
	>48	1	1	2		
HEMISHPHERE INVOLVEMENT	DOMINANT	2	10	12	1.470	0.225
	NON-DOMINANT	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		
DM	**ABSENT**	6	10	16	1.990	0.158
	PRESENT	1	8	9		
DYSLIPEDEMISA	**ABSENT**	6	11	17	1.402	0.236
	PRESENT	1	7	8		
CAD	**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	5.540	0.019
	PRESENT	6	6	12		
SMOKING	**ABSENT**	4	9	13	0.103	0.748
	PRESENT	3	9	12		
GCS	**≤8**	0	5	5	2.431	0.119
	>8	7	13	20		
NIHSS SCORE	**≤18**	2	0	2	5.590	0.018
	>18	5	18	23		
MIDLINE SHIFT	**<10**	4	12	16	0.198	0.656
	>11	3	6	9		
UNCAL HERNIATION	**ABSENT**	1	3	4	0.021	0.684

Table 2: Predictors of Outcome at Discharge

FACTORS		GOOD OUTCOME	POOR OUTCOME	TOTAL	CHI-SQUARE TEST	P VALUE
AGE	**≤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	**<48**	6	8	14	3.4841	0.062
	>48	1	10	11		
HEMISHPHERE INVOLVEMENT	**DOMINANT**	2	10	12	1.470	0.225
	NON DOMINANT	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		
DM	**ABSENT**	6	10	16	1.999	0.158
	PRESENT	1	8	9		
DYSLIPEDEMISA	**ABSENT**	6	11	17	1.402	0.236
	PRESENT	1	7	8		
CAD	**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 3: Outcome at 3 Months

FACTORS		GOOD OUTCOME	POOR OUTCOME	TOTAL	CHI-SQUARE TEST	P VALUE
AGE	**≤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	**<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		
DM	**ABSENT**	7	4	11	1.431	0.030

	PRESENT	2	4	6		
DYSLIPEDEMISA	**ABSENT**	7	7	14	0.275	0.600
	PRESENT	2	1	3		
CAD	**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

Table 4: Predictors of Outcome at 6 Months

FACTORS		GOOD OUTCOME	POOR OUTCOME	TOTAL	CHI-SQUARE TEST	P VALUE
AGE	**≤45**	7	1	8	2.082	0.149
	>45	5	4	9		
SEX	**MALE**	12	3	15	5.440	0.020
	FEMALE	0	2	2		
TIMING OF SURGERY	**<48**	11	4	15	0.463	0.496
	>48	1	1	2		
HYPERTENSION	**ABSENT**	8	1	9	3.085	0.079
	PRESENT	4	4	8		
DM	**ABSENT**	8	3	11	0.069	0.793
	PRESENT	4	2	6		
DYSLIPEDEMISA	**ABSENT**	10	4	14	0.027	0.870
	PRESENT	2	1	3		
CAD	**ABSENT**	9	1	10	4.408	0.036
	PRESENT	3	4	7		
TOBACCO	**ABSENT**	1	5	6	12.986	0.001
	PRESENT	11	0	11		
ALCOHOL	**ABSENT**	5	5	10	4.958	0.026
	PRESENT	7	0	7		
SMOKING	**ABSENT**	6	4	10	1.311	0.252
	PRESENT	6	1	7		
GCS	**<8**	10	3	13	1.068	0.301
	>8	2	2	4		
NIHSS SCORE	**<18**	2	0	2	0.944	0.331
	>18	10	5	15		
UNCAL HERNIATION	**ABSENT**	1	2	3	2.435	0.119
	PRESENT	11	3	14		

DISCUSSION

A total of 25 patients were included in this study who underwent Decompressive Hemicraniectomy for unilateral supra-tentorial hemispheric infarcts. There were 19 male (76%) and 6 (24%) female patients with mean age 47.12 years. DESTINY trial,[17] included 17 patients in their surgical group and all patients were below 60 years age (range, 30-60 years) with mean of 42.7 years with 47% of male population. DECIMAL trail,[18] included 20 patients with mean age of 43.5 years, (range 22-55 years), with 45% of patients being male. HAMLET trail,[19] included patients 32 patients, less than 60 years of age group with mean of 50.5 years and 63% of patients being male. Bhatia et al20 study included a total of 36 patients. Mean age was 49.6 (range: 20-91) years and 15 patients (25%) were above 60 years of age. There were 72% male patients. Our study has 27.7% of patients above 60 years of age. Many of the RCT's done in European countries excluded patients above 60 years of age, with their sample size being below 40 patients. There was more of male sex predominance in Indian studies compared to western population even though not statistically significant.

8(32%) patients died at the time of discharge. None of the patients died due to direct cause of surgery per-say. Heaadfirs Ttrial,[21] mortality was 25%, HAMLET trail,[19] had 16%, DECIMAL trail,[18] had 25%, DESTINY trail,[17] had 18% mortality at the discharge or during 1st month of follow up. Most of the above-mentioned RCT's had significant high mortality in the medically managed group. Bhatia et al20 had 62% patients died during the hospital stay in medical management group as compared to 13%

deaths in the hemicraniectomy group. Most European studies excluded patient's age above 60 years but over study included patients above 60 years. Zhao et al,[22] have reported that the benefit of the procedure can be extended to patients 80 years of age. Among the 8 patients who died during discharge in this study 4 patients were below 60 yrs of age and 4 were above 60 years. As most of the deaths in our study related to medical comorbidities and co-morbidities increase as age increase so these are to be taken into consideration along with increasing age. None of the patients died due to direct cause of surgery per-say hence surgery may not be attributed directly the cause of death.

MRS score of <4 was considered favorable outcome in our study. 7 (28%) of patients had <4 MRS at discharge and 9(36%) patients had < 4 MRS at 3 months follow up. At 6 months follow up 12 (48%) patients had <4 MRS. Bhatia et al20 had 58.5% with MRS <4 at the discharge as well as 3 months of follow up and at 12 months it was 66.2%, Hamlet trial[19], Decimal trial,[18] and Destiny trial,[17] had around 75% patient with MRS below 4 at the end of 12 months follow up. Schwake M et al,[23] emphasized that DH procedure not only reduces mortality, but also improves outcome as the follow up increases. However, Holtkemp et al,[24] stressed that most patients require extensive rehabilitative therapy and lifelong assistance. We should admit that the differences between discharge, 3 months and 6 months outcomes are highly dependent on the quality of the long-term care and rehabilitation. Most of our patients in our setting receive home-based care through family members and local physicians with no standardized post-hospital care units are available. This lack of standardized care can be the main limitation in the assessment of long-term functional outcome.

Among the multiple variables analysis showed that age >45 years, NIHSS score > 18, prior history of hypertension and alcoholism showed significant association with poor outcome at the time of discharge. At 3 months follow up age, hypertension, diabetes mellitus, tobacco consumption, alcohol consumption and carotid artery atherosclerosis were showed poor outcome. At 6 months of follow up sex, coronary artery atherosclerosis, tobacco chewing and alcohol consumption were associated with poor outcome. Many studies like Hamlet,[19] Decimal,[18] Destiny,[17] trails had considered age >60 years as bad outcome predictors at short term follow up and did not included patients above 60 years in their study. Vahedi K et al,[25] studied all the patients above 60 years of age and found that only 8% of patients above 60 years had good outcome in comparison with 58% good outcome in younger patients. Other studies like Zhao et al,[22] have reported that the benefit of the procedure can be extended to patients 80 years of age. In our study prior history of hypertension was associated with mortality and poor functional outcome. It is important to note that since incidence of co morbidities like hypertension, coronary artery disease and diabetes increases with age, older patient may seem to be at higher risk of poor functional outcome. Destiny II,[17] trial reported that hemicraniectomy significantly improves survival without being associated with severe disability in patients 61 years of age and older (38%) compared with 18% in the control group with a lower mortality rate in the surgery group. Pre-operative poor GCS with MRS > 4 and NIHSS >16, with mid line shift and uncal herniation sets in from 2-4 days of stroke onset. Pre-operative low sensorium, with NIHSS>16 and MRS>4 is associated with poor outcome in immediate course which is supported by many studies in literature.[5,26]

CONCLUSION

Decompressive craniectomy for malignant supra-tentorial unilateral hemispheric infarction increases the probability of survival that can yield acceptable functional outcomes in many of the patients. Careful individualized patient selection and surgery may improve the functional outcome for these patients. Furthermore, the possibility of long term cognitive and physical dependance needs to be discussed with the patients and their families before deciding upon decompressive hemicraniectomy as most of the patients receive home-based care through family members and local physicians in their long term follow up.

REFERENCES

1. Aho K, Harmsen P, Hatano S, Marquardsen J, Smirnov VE, Strasser T. Cerebrovascular disease in the community: results of a WHO collaborative study. Bulletin of the World Health Organization. 1980;58(1):113-30
2. MalhotraK, GornbeinJ, SaverJL. Ischemic strokes due to large-vessel occlusions contribute disproportionately to stroke-related dependence and death: a review. FrontNeurol.2017;8:651.
3. Dozois A, Hampton L, Kingston CW, et al. PLUMBER study (prevalence of large vessel occlusion strokes in Mecklenburg county emergency response). Stroke. 2017; 48(12):3397-3399.
4. Rai AT, Seldon AE, Boo S, et al. A population-based incidence of acute large vessel occlusions and thrombectomy eligible patients indicates significant potential for growth of endovascular stroke therapy in the USA. J NeuroIntervent Surg. 2017;9(8):722-726.
5. Smith WS, Lev MH, English JD, et al. Significance of large vessel intracranial occlusion causing acute ischemic stroke and TIA. Stroke.2009;40(12):3834-3840.
6. Kimberly WT, Sheth KN. Approach to severe hemispheric stroke. Neurology. 2011;76(Suppl 2): S50-6.
7. Hofmeijer J, van der Worp HB, Kappelle LJ. Treatment of space-occupying cerebral infarction. Crit Care Med 2003; 31:617-25
8. Berrouschot J, Sterker M, Bettin S, Köster J, Schneider D. Mortality of space-occupying (′malignant′) middle cerebral artery infarction under conservative intensive care. Intensive Care Med 1998; 24:620-3.
9. Hacke W, Schwab S, Horn M, Spranger M, De Georgia M, von Kummer R. ′Malignant′ middle cerebral artery territory infarction: Clinical course and prognostic signs. Arch Neurol 1996; 53:309-15.

10. Rieke K, Schwab S, Krieger D, vonKummer R, Aschoff A, Schuchardt V, et al. Decompressive surgery in space-occupying hemispheric infarction: Results of an open, prospective trial. Crit Care Med 1995; 23:1576-87.
11. Wijdicks EFM, et al. Recommendations for the management of cerebral and cerebellar infarction with swelling: a statement for healthcare professionals from the American Heart Association/ American Stroke Association. Stroke. 2014; 45:1222¬1238.
12. Heros RC. Surgical treatment of cerebellar infarction. Stroke. 1992; 23:937¬938.
13. Pfefferkorn T, et al. Long term outcome after suboccipital decompressive craniectomy for malignant cerebellar infarction. Stroke. 2009; 40:3045¬3050.
14. Jauss M, Krieger D, Hornig C, et al. Surgical and medical management of patients with massive cerebellar infarctions: results of the German ¬Austrian Cerebellar Infarction Study. J Neurol. 1999;246: 257¬264.
15. Jüttler E, et al. Long term outcome after surgical treatment for space occupying cerebellar infarction experience in 56 patients. Stroke. 2009; 40:3060¬3066.
16. Kase CS, Wolf PA. Cerebellar infarction: upward transtentorial herniation after ventriculostomy. Stroke J Cereb Circ. 1993;24: 1096¬1098
17. Jüttler E, Schwab S, Schmiedek P, Unterberg A, Hennerici M, Woitzik J, et al. Decompressive surgery for the treatment of malignant infarction of the middle cerebral artery (DESTINY): a randomized, controlled trial. Stroke (2007) 38:2518–25.
18. Vahedi K, Vicaut E, Mateo J, Kurtz A, Orabi M, Guichard J-P, et al. Sequential design, multicenter, randomized, controlled trial of early decompressive craniectomy in malignant middle cerebral artery infarction (DECIMAL Trial). Stroke (2007) 38:2506–17.
19. Hofmeijer J, Kappelle LJ, Algra A, Amelink GJ, van Gijn J, van der Worp HB. Surgical decompression for space-occupying cerebral infarction (the Hemicraniectomy After Middle Cerebral Artery infarction with Life threatening Edema Trial HAMLET): a multicentre, open, randomised trial. Lancet Neurol. (2009) 8:326–33.
20. Bhatia R, Padma Srivastava M, Prasad K, Rai V, Rai N, Singh S, et al. Long-term outcome of decompressive hemicraniectomy in patients with malignant middle cerebral artery infarction: A prospective observational study. Neurol India [Internet]. 2014;62(1):26.
21. Chua AE, Buckley BS, Capitan MCM, Jamora RDG. Hemicraniectomy for malignant middle cerebral artery infarction (HeMMI): a Hemicraniectomy for malignant middle cerebral artery infarction (HeMMI): randomised controlled clinical trail of decompressive hemicraniectomy with standardised medical care versus standardised medical care alone. Acta Med Philipp. (2015) 49
22. Zhao J, Su YY, Zhang Y et al. Decompressive hemicraniectomy in malignant middle cerebral artery infarct: a randomized controlled trial enrolling patients up to 80 years old. Neurocrit Care. 2012;17(2):161-171.
23. Schwake M, Schipmann S, Müther M, Stögbauer L, Hanning U, Sporns PB, et al. Second-look strokectomy of cerebral infarction areas in patients with severe herniation. J. Neurosurg. 2019:1–9.
24. Holtkamp M, Buchheim K, Unterberg A, Hovmann O, Schielke E, Weber JR, etal. Hemicraniectomy in elderly patients with space occupying media infarction: improved survival but poor functional outcome [Internet]. [cited 2018 Jul 25]. Available from: www.jnnp.com
25. Vahedi K, Hofmeijer J, Juettler E, Vicaut E, George B, Algra A, et al. Early decompressive surgery in malignant infarction of the middle cerebral artery: apooled analysis of three randomised controlled trials. Lancet Neurol.2007;6(3):215–22.
26. Hofmeijer J, Algra A, Kappelle LJ, van der Worp HB. Predictors of life-threatening brain edema in middle cerebral artery infarction. Cerebrovasc Dis. 2008; 25:176-184.