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Surgical Outcome Of Decompressive Craniectomy In A Neurosurgical centre

Clinical Research

KEYWORDS: decompressive craniectomy. brain trauma . cerebral infarction . intracranial bleed

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ABSTRACT

Introduction : Decompressive craniectomy is a life saving procedure in patients with intractably raised intracranial pressure. The causes are many. The most common causes are head injury, intracranial hemmorrhages, cerebral infarction, or malignant brain swelling due to any other cause. Decompressive craniectomy aims primarily at the survival of patients and secondarily at the long-term quality of life.

Aims and Objectives : To analyze the functional outcome, complications and factors which predict the outcome of the patients who underwent decompressive craniectomy for the common causes of brain swelling at Apollo Health City , Jubilee hills,Hyderabad, a tertiary care centre.

Materials and Methods : In this prospectively designed study conducted from August 2010 to December 2012, decompressive craniectomy was performed in 112 patients. The 112 cases comprised of 40 traumatic brain injuries, 35 large hemispheric infarcts and 30 intracranial bleeds, (18 capsuloganglionic and 12 bleeds due to cortical venous thrombosis) and 7 post operative brain swelling patients. All these patients were admitted in the department of neurology and neurosurgery at NIMS. Patients having poor Glasgow Coma Scale (GCS) equal to 3, diffuse axonal injuries(DAI), with severe comorbidities and those with primary brainstem injuries were excluded from the study. Detailed neurological examination and imageological studies like Computed Tomography(CT) scan brain, Magnetic Resonnce Imaging(MRI) brain whenever necessary were performed in all patients. The variables that were studied included patient's age, sex, preoperative GCS, preoperative anisocoria, time of injury to surgery or time of deterioration to surgery, pre-operative risk factors and post operative complications. Outcome assessed using modified Rankins Scale (mRS), Barthel index and Glasgow Coma Outcome Scale (GOS) at the time of discharge and at follow up of 3 and 6 months. The characters compared using SPSS version 17 software and Fisher exact test was used to compare proportions for categorical variables. A "p" value of less than or equal to 0.05 was considered statistically significant.

Results : In traumatic brain injury patients, 31 out of (77.5%) patients had a good outcome (GOS more than or equal to 4). In stroke group, 17 out of 35 patients (48.57%) with cerebral infarction had a good outcome (mRS less than or equal to 3) while 10 out 18 patients (55.55%) with capsulo ganglionic bleed had a good outcome. out of 12 patients, 8 patients of CSVT (66.66%) had a good outcome. 7 patients, aneurysms (n=3), olfactory groove meningioma (n=1), sphenoidal wing meningioma (n=2), craniopharyngioma (n=1), had post operative brain swelling leading to conversion to decompressive craniectomy later on. Of these one patient died while one was in persistent vegetative state and two were dependent. The chief complications across all groups were subgaleal collections(n=4), post operative seizures(n=4), pneumonia (n=10), abdominal wound site infection (n=4), hydrocephalus (n=3), syndrome of inappropriate secretion of anti diuretic hormone (SIADH) (n=7), sunken bone flap syndrome (n=1), renal failure (n=2), deep vein thrombosis (n=1), urinary tract infection (n=3) and sub galeal empyema (n=1). After analysis of multiple variables, we found younger age, GCS more than 7, absence of anisocoria, and surgical intervention less than 48 hours as factors affecting the good outcome ($p < 0.05$).

Conclusions : Decompressive craniectomy is a life saving procedure. Timely recognition of failure of medical management and an appropriately timed surgical intervention may help to salvage patients who develop malignant cerebral oedema and succumb to it. Younger age, pre-operative GCS more than 7, absence of anisocoria and intervention less then 48 hours after failure of medical therapy has shown a better outcome in this study. A large multi-centric study involving the more no of patients may help further in elucidating the factors predicting the outcome in various neurosurgical emergencies.

Introduction

Decompressive craniectomy is a life saving procedure which dates back to 1901. It was first described by Kocher for the treatment of post-traumatic brain oedema.[1] A few years later, Cushing in 1905 performed decompressive craniectomy for relief of intracranial pressure (ICP) in a patient with a massive intracranial tumour.[2] Since then, decompressive craniectomy has become a regular surgery in any neurosurgical centre across the world. The indications are many and most common ones comprised of traumatic head injuries,[3] subdural hematomas,[4] edema resulting from vasospasm secondary to subarachnoid hemorrhage,[5] encephalitis,[6] intracerebral hematomas, cerebral venous sinus thrombosis,[7] supra- infra tentorial infarcts.

There is renewed interest in the surgery of decompressive craniectomy (DC) in the management of raised ICP from traumatic brain injury (TBI) in particular and in all cases of refractory intracranial hypertension in general. DC is usually deployed as a second tier alternative to medical decompressive therapy in order to salvage the patients with intractably raised ICP.[9]

Decompressive craniectomy for large hemispheric stroke usually due to middle cerebral artery (MCA) infarct. Massive unilateral hemispheric infarction involving the entire MCA territory occurs in 10 to 15% of all supratentorial infarction cases and is associated with severe brain swelling and death resulting from brain herniation. This "malignant" hemispheric infarction of the MCA territory is usually due to embolic internal carotid artery (ICA) or proximal MCA segment (M1) occlusion. 78 percent of malignant MCA infarctions result in uncal herniation. Mortality rates for unselected groups of patients with MCA infarctions of different sizes and locations are between 30% and 66%.[10] However, the mortality for malignant MCA infarction may be as high as 80% . Therefore, treatment of malignant MCA infarction should be more aggressive.[11] CSVT is rare life threatening disease with estimated annual incidence of 3-4 cases per million in young adults and these patients require decompressive craniectomy when there is diffuse brain edema refractory to medical therapy. The rationale for decompressive surgery in such cases is to reduce intracranial pressure and to interrupt the vicious cycle of extensive edema and further infarction.[12] The aim of the study was to analyze functional outcome, complications and factors which predict the outcome of

the patients who undergo decompressive craniectomy for the common causes of brain swelling.

Materials and Methods

In this prospectively designed study conducted from August 2010 to December 2015, decompressive craniectomy was performed in 112 patients. All adult patients admitted in either department of neurology or neurosurgery at Apollo Health City who underwent decompressive craniectomy were enrolled in the study. The causes for intracranial hypertension and indications for decompressive craniectomy were noted. The inclusion criteria for decompresive craniectomy were patients with severe traumatic brain injuries, cerebral infarctions, cerebral bleeds in capsuloganglionic region and cerebral sinus venous thrombosis and post operative brain swellings due to various causes. The institutional protocol for decompressive craniectomy was failure of medical therapy along with drop in GCS score by 1or 2 points since the time of admission, pupillary asymmetry and or brain imaging showing features of mass effect with midline shift of 5 mm to 1 cm. Patients having poor Glasgow coma scale equal to 3, diffuse axonal injuries, those with severe comorbidities and those with primary brainstem injury were excluded from the study. Detailed neurological examination and necessary imageological studies were performed in all the patients. The decompressive craniectomy was done after evaluation of basic surgical profiling. Data collected included patients demography, imageological findings, pre-existing medical conditions, GCS at the time of admission and deterioration, presence of anisocoria and time interval to surgery.

Surgical Technique

Patient was positioned supine with the head turned contralaterally by 45-60 degrees. A question mark skin incision beginning 1 cm anterior to the tragus was made to avoid injury to facial nerve, with the scalp and temporalis muscles reflected together anteriorly. The craniotomy was done as widely as possible on the affected side with removal of the frontal, temporal and parietal bones. The temporal burr hole was carefully positioned as close to the floor of the middle cranial fossa. The anteroposterior dimension of at least 13cm and the superoinferior dimension of 9 cm was ensured to allow adequate decompression of the hemisphere in most of the cases but the size of craniotomy was varied in different patients depending on surgeon and preoperative findings. The standard size of crianiotomy was 13x9cm in most of the cases. After craniotomy, the dura was opened in a stellate fashion up to the bony margins. The dura was approximated with pericranium graft or dura was kept open and covered with gelfoam. The temporalis muscle was loosely reapproximated, and the remainder of the wound was closed in two layers. The bone flap was placed in a subcutaneous pocket of the abdomen parieties for preservation until subsequent cranioplasty which was usually performed after 1- 3 months. Intraoperatively varied observations were made as per timing of surgery and extent of pre-operative mass effect.

Follow-up

The follow-up was done at 3 and 6 months after surgery, where the patients clinical outcome was assessed using Barthel Index (BI), modified Rankin Score (mRS) and Glasgow Outcome Score (GOS). The patients with a BI of >50, mRS of 0-3 and GOS of 4-5 were categorized as the good outcome group while BI of < 50, mRS of 4-6 and GOS of 0-3 were categorized as the poor outcome group.

Statistical analysis

The characters of the two groups were compared using SPSS software version 17. Chi-square test, Fisher's exact test was used to compare proportions for the categorical variables. A 'p' value of less than or equal to 0.05 was considered statistically significant.

Results

112 patients underwent decompressive craniectomy between August 2010 and December 2012, comprising of 40 traumatic brain injuries, 35 large hemispheric infarcts and 30 intracranial bleeds (18 capsuloganglionic bleeds and 12 bleeds due to cortical venous thrombosis) and 7 post operative brain swelling patients. The results were analyzed under following sub-headings.

I. Head Injury

40 underwent decompressive craniectomy for traumatic brain injury. Out of these 40 patients, 32 were male and 8 were female. Median age of the patients was 37 years (age ranging from 14-60 years). Patients were grouped in to two groups (≤ 40 or >40).Outcome was assessed with the Glasgow coma Outcome Score at the time of discharge and at the end of 3 months and 6months of follow up.

The association between the preoperative variables and outcome in patients undergoing decompressive craniectomy for head trauma is shown in table 1.

There was statistically significant association between increasing age (p-0.0386), pre-operative GCS less than or equal to 7 (p-0.028), presence of anisocoria(0.0245), time of surgery >48hours (0.096) and poor outcome.

Table 2

Age	No of pts	Good outcome	Poor outcome	P value
<40	28	25	3	
>40	12	6	6	0.0386
Pre op GCS				
<7 or 7	6	3	3	
>7	34	8	26	0.028
Pre op anisocoria				
Present	11	6	5	
Absent	29	25	4	0.0245
Time of injury to surgery				
<48 hours	29	25	4	
>48hours	11	6	5	0.096

II.Stroke

65 patients with stroke who underwent decompressive craniectomy were evaluated. Out of them, 35 patients had infarction , 18 patients had capsuloganglionic bleed and 12 patients had CSVT.

a). Infarction

Out of thirty 35 patients with cerebral infarction, 28 patients (81.08%) were male and 7 (18.91%) patients were female. The mean age of the patients was 38yrs (with age ranging from 24-70yrs). Patients were grouped in to two groups (≤ 50 or >50)

The association between the preoperative variables and outcome in patients undergoing decompressive craniectomy for infarction is shown in table 2.

No statistical significance noted between age (p-0.73), anisocoria (p-0.734), pre-op GCS (0.228), timing of surgery (p-0.314) and outcome.

Table 2 :

Age	No of pts	Good outcome	Poor outcome	P value
<50	21	11	10	
>50	14	6	8	0.73
Pre op GCS				
<7 or 7	8	2	6	
>7	27	15	12	0.228
Pre op anisocoria				
Present	8	2	6	
Absent	27	15	12	0.734
Time of deteri oration to Surgery				
<48 hours	19	11	8	
>48hours	16	6	10	0.314

b). Stroke with capsuloganglionic bleed.

18 patients had capsuloganglionic bleed. Out of them, 15(83.33%)

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were male. The mean age of the patients was 42 years (with age ranging from 35-65). The relation between the variables and outcome analyzed is shown in table 3. There was no association between age (p-0.63), anisocoria (p-0.63), timing of surgery (p-0.34), pre-operative GCS (p-0.6) and outcome.

Table 3.

Age	No of pts	Good outcome	Poor outcome	P value
<40	5	2	3	
>40	13	8	5	0.60
Pre op GCS				
<7 or 7	5	2	3	
>7	13	8	5	0.60
Pre op anisocoria				
Present	7	3	4	
Absent	11	7	4	0.63
Time of deteri oration to Surgery				
<48 hours	10	7	3	
>48hours	8	3	5	0.34

c).Cerebral sinus venous thrombosis

12 patients underwent decompressive craniectomy for cerebral sinous venous thrombosis. The relation between the variables and outcome analyzed are shown in table 4.

Patients with preoperative GCS more than 7 (p-0.018) and those underwent surgery within 48hours (0.034) were found to have statistically significant better outcome.

Table 4

Age	No of pts	Good outcome	Poor outcome	P value
<40	7	6	1	
>40	5	2	3	0.22
Pre op GCS				
<7 or 7	3	3	0	
>7	9	1	8	0.018
Pre op anisocoria				
Present	5	3	2	
Absent	7	5	2	0.98
Time of deteri oration to Surgery				
<48 hours	9	7	2	
>48hours	3	1	2	0.034

III. Postoperative brain swelling

7 patients had post operative brain swellings in post operative patients of due to middle cerebral artery (MCA) bifurcation aneurysms (n=2), right P2 segment posterior cerebral artery aneuyrysm (n=1), craniopharyngioma(=1), sphenoidal wing meningioma (n=2), olfactory groove meningioma(n=1). Out of seven patients, 2 patients had good outcome while 1 patient was dependent for daily activities. 3 patients died, and 1 patient still continues to be persistent vegetative state.

Discussion

In this study we have evaluated and addressed the several known predictors of outcome in patients who have undergone decompressive craniectomy for traumatic brain injury, cerebral infarction, capsuloganglionic bleeds, cerebral sinus venous thrombosis and post operative brain swellings. In our series, 40 patients who underwent decompressive craniectomy for head injury, 77.5% patients had a good functional recovery, 5 patients died. Thus overall mortality rate was 12.5 %. Guerra et al reported in their series of 55 patients, 60% had a good outcome.[13] Ecker et al in 2011 reported in their series of 30 patients, 60% had a good outcome.[14] 11 (40%) had a poor outcome while 7 (23%) patients had died.[14] Morgalla reported in case series out of 33 patients. 51.55% had a good outcome.[15] When we compared age with outcome. We found that there was clear association between increasing age and poor outcome. According to Kunze et al[16] and Munch et al[17] young patients responded better compared with older age group as seen in our studies.

In cerebral infarct patients, no statistical significance noted between age and outcome. However 52.38% of patients under 50 years had a good outcome. Carter and coworkers had similar results in their series of 11 patients.[19] In patients with capsuloganglionic bleed, 61.53% of patients less than 40 years of age had a good outcome. In patients with CSVT, 81.71% of patients less than 40 years of age had a good outcome. Hence apart from head injury no statistical significance achieved between age and outcome in cerebral infarct, capsuloganglionic bleed and CSVT patients.

In our series patients with preoperative GCS of more than 7 had better functional outcome when compared to patients with GCS less than or equal to 7 as reported by Eghwrudjakpor et al that patients with GCS of 8 and above have good outcome than those with GCS<8,[18] also Aarabi et al have reported that patients with admission GCS 6-15 were 10 fold more likely to have good outcome compared with patients having admission GCS scores of 3-5.[19]

Kilincer reported that patients with anisocoria had poor outcome after decompressive surgery and suggested that surgery should be performed before pupillary dilatation.[20] We found that 25 out of 29 patients without anisocoria faired much better than their contempararies and 80% of these had a good outcome. In our series 29 underwent surgery within 48 hours after injury, 25(86.20%) of 29 patients had good outcome as compared those underwent after 48 hours. Polin et al, reported that patients undergoing surgery within 48 hours of admission had favourable outcome in 13(46%)of 28 cases ,compared to no favourable outcome in 7 patients who were operated after 48 hours (P=0.022).[18] Munch et al reported in his series that mortality rate was 30% when decompressive craniectomy was performed within first 4 hours of trauma; however it is increased to 90% when the operation was performed after 4hours.[17]

The randomized controlled trials on decompressive craniectomy in patients with traumatic brain injury are RESCUEicp trial and DECRA trial. The RESCUEicp trial[18] (Randomised Evaluation of Surgery with Craniectomy for Uncontrollable Elevation of ICP) is an ongoing trial aimed to provide class I evidence as to whether decompressive craniectomy is effective for the management of patients with raised and refractory ICP following traumatic brain injury (TBI). Over 280 patients have been recruited to date from more than 40 centres in 17 countries. The results of this trial are expected soon then only final conclusion can be drawn.

The results of the DECRA trial was published in March 2011, where the study investigators found that decompressive craniectomy was associated with worse functional outcomes, as measured by a standard metric, than best medical care. There were no differences in deaths between groups.[19] 65 patients with stroke were analysed . Out of them, 35 patients had infarction , 18 patients had capsuloganglionic bleed, 12 patients had CSVT.

Despite intensive care such as osmodiuretics , hyperventilation and barbiturate coma , the mortality rate of large supratentorial infarction is reported to be as high as 80%.[20] Various studies in the literature have reported that decompressive craniectomy will reduce the mortality from 80% to approximately 30% in patients suffering from malignant infarction. Kentaro Mori et al reported that out of 73 patients, mortality in surgery group (4%) significantly lesser than conservative group (61.9%).[21] In our study, out of 35 patients with cerebral infarction, 51.42% had poor outcome and 48.57% had good outcome at 6month follow up and mortality rate was 31.42% . 7 patients survived but were dependent on others because of residual hemiparesis and aphasia. In study by Killincer et al in their series of 32 patients , one month mortality rate was 31%, mortality at 6 months 50%. Schwab et al reported that 73% of patients survived (mortality

rate was 27%) after decompressive craniectomy.[22] According to Reddy et al from this institute, 46.87% of patients had good outcome after decompressive craniectomy while mortality rate was 40%.[23] In our study, 68% survived after surgery and 31% died at 6 months follow up, similar to other studies in the literature. This clearly indicates that decompressive craniectomy can reduce the mortality associated with massive hemispheric infarction.

Eighteen patients with capsuloganglionic bleed who underwent decompressive craniectomy although 55.55% patients had good outcome 16.66% patients died and 27.77% patients were dependent for daily activities. Murthy et al[24] had survival rate 98% and Ramnarayana et al[25] had 56.52% of patients with outcome. Many studies have shown similar results in the available literature.[26]

66.66% of patients with CSVT had a good outcome in this study as echoed by Zuurbier et al.[27] similarly Vivekaran et al[28] in one of the largest series published till date, have reported 76.47% of patients having a good outcome. While Umredhker et al [29] maintain this at 84.61% as good outcome. Many a times, patients develop ischemic insult post operatively and this usually leads to delayed DC.

Complications

The complications following decompressive craniectomy in our study were different in different groups were shown in table 5.

Table 5.

complications	Head injury	Cerebral infarct	Capsuloganglionic bleed	CSVT
Sub galeal collection	2	2		
Post op seizures	4			
pneumonia	4	3	2	1
Abdominal site infection	2	2		
hydrocephalus	1	2		
SIADH		5	2	
Sunken bone flap syndrome		1		
Urinary tract infection			3	
Renal failure		1	1	
Sub galeal empyema				1
Deep vein thrombosis		1		

Conclusions

From this study it is reaffirmed that decompressive craniectomy is a lifesaving procedure. Timely recognition of failure of medical management and an appropriately timed surgical intervention will help to salvage patients who develop malignant cerebral oedema and succumb to it. Decompressive craniectomy confers a clear survival benefit in patients who present with neurologic deterioration due to massive cerebral ischemia. Younger age, GCS more than 7, absence of anisocoria and surgical intervention less than 48 hours after deterioration following maximal decongestive therapy has shown a better outcome in this study. Decompressive craniectomy improves survival rate and functional outcome in patients with raised ICP due to stroke as result of capsuloganglionic bleed and cortical sinus venous thrombosis.

Limitations of the study

The limitations of the study were unavailability of the ICP monitoring devices and small sample size.

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