Section: Neurosurgery

Original Research Article

CLINICAL STUDY OF DECOMPRESSIVE CRANIECTOMY

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Abstract

Background: Increased intracranial pressure and brain herniation are seen in various pathological conditions in neurocritical unit which carries high mortality rate. Study aims at analyzing different clinical aspects and outcomes in traumatic and nontraumatic brain injury following decompressive craniectomy Study design: Prospective single centre hospital based study. **Materials and Methods:** Patients of TBI, Spontaneous ICH and MCAI with features of raised ICP and brain edema were enrolled. Data recorded included were demographic profiles, clinical features and cranial computed tomogram (CT scan). All patients underwent primary unilateral DC of bone flap size 15*12 cm2 with augmentation duroplasty. **Result:** Out of 200 patients (139 TBI, 40 spontaneous ICH and 21 MCAI) 76 (38%) died within 1 month. 29 in TBI, 6 each in Spontaneous ICH and MCAI. Low GCS score, age more than 60 years and high Rotterdam CT score were seen in patients who died ($p<0.05$). **Conclusion:** Low GCS score, age more than 60 years, were independent predictors for mortality. Most of the patients had good functional recovery. DC has a role in patients with increased ICP and Brain edema.

INTRODUCTION

As a leading cause of mortality and morbidity in the neurointensive care unit, increased intracranial pressure (ICP) has received considerable attention in clinical practice.[1,2] Various neurocritical illnesses, including malignant middle cerebral artery infarction (MCAI) and severe traumatic brain injury (TBI), lead to increased ICP and may result in cerebral herniation, death or permanent disability.[3,4] Unfortunately, although the well-known deleterious effects of increased ICP have long been recognized, medical and surgical interventions remain limited, and advances in treatment have been modest. The current options for the management of increased ICP consist of conservative treatment or surgical decompression.[5,6]In recent years, DC, as a second-tier therapeutic measure, has been a focus and appears to be a promising approach to control ICP.[7,8] It is postulated that DC can allow brain tissue to expand, consequently facilitating control of increased ICP and reducing the risk of herniation.

Although there are still no clinical trial data on DC in any of these other conditions. In traumatic brain injury, subarachnoid hemorrhage and cerebral venous infarction, surgical decompression is aimed at controlling raised ICP secondary to diffuse edema and brain swelling. According to the Brain Trauma Foundation guidelines, Frontotemporoparietal DC is indicated within 48 hours of injury for patients with diffuse, posttraumatic cerebral edema and medically refractory elevated ICP.

In the above background, the present study is conceived to analyse the outcomes of DC in a tertiary care setup (Apollo Hospitals, Bhubaneswar). An observational study in this setup will throw light on success rate in terms of survival rate and Good outcome following DC. Researcher has not come across any such study in Odisha setup. This will provide insight to the treating physician in the present setup and also in other hospital setup in Odisha and other states.

MATERIALS AND METHODS

This is an observational and prospective study done in a Single centre study in Apollo hospitals Bhubaneswar, Odisha in comprised of brain injury cases both traumatic (non-penetrating) and non-traumatic from April 2016 to June 2018.

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Therefore, minimum sample size determination for estimating a population proportion will be adopted here (67) using the reference

n= 4pq/d2

Where n = Minimum sample size

∝/ = value of the standard normal variant for 1−∝/2 level of significance= 1.96.

P = Anticipated population proportion 100(1−∝) % = Confidence level

d= absolute precession required on either side of the population.

The inclusion criteria for the study are as follows:

1. Patients of Age group of 15-85 years.
2. Patients with Glasgow coma scale score of 4 and above.
3. Patients with clinical or radiological evidence of brain herniation and decrease in level of consciousness to a score 1 or greater on item 1a of the National Institute of Health Stroke Scale for MCAI.
4. Patients with Large MCA infarct (left and right) defined as an ischemic lesion volume >150 cm^3 on diffusion-weighted MRI or CT evidence of at least >50% MCA territory infarction by visual inspection
5. Patients with Midline shift of more than 5mm in NCCT brain secondary to various pathologies in traumatic brain injury
6. Patients with Mass effect, volume size more than 50 cc in supratentorial spontaneous ICH

The exclusion criteria for the study are as follows:

1. Patient with bilateral fixed and dilated pupils.
2. Patient with bleeding diathesis.
3. Patients with devastating injuries; patient not expected to survive > 24 h.

Methodology

After stabilization of patients in emergency room further detailed Systemic and Neurological examinations done. Patients were managed in Neurocritical care. All patients were operated by two senior consultant Neurosurgeons all patients undergone primary unilateral frontotemperoparietal DC and Intra-operatively details of parenchymal injury and presence or absence of brain pulsation, braincolour, brain edema noted.

Statistical Analysis: Data so obtained were subjected to statistical analysis. Data analysis was done by SPSS software ® version 22.0. Descriptive statistical analysis, which included frequency and percentages, was used to characterize the data. Inferential statistics included chi-square test and independent samples t test for different dependent variables of the study and $p < 0.05$ was considered statistically significant.

RESULTS

Out of 200 samples subjects 139 were TBI, 40 were spontaneous ICH and 21 were MCAI. the distribution of TBI by age group and gender is presented in. Out of 139 TBI, 129 (93%) were males and only 10 (7%) were females. Maximum traumatic injury has been presented between 40-59 yrs age group with a share of 43.5%. The age group 60-79 yrs accounted for 30.9 % of TBI. The 19- 39 yrs age group accounted for nearly $1/5^{th}$ of injuries (22.3%). In female group 10 TBI cases were equally divided in age group 19-39 and 40 -59 yrs. Age distribution among males is similar to total pattern of age distribution. [Table 1]

As per [Table 2] the age distribution among Spontaneous ICH group and MCAI follows nearly same pattern as that of TBI. The age group 40-59 yr and 60-79 yr were more vulnerable than age group 19-39 and ≥80 yrs. In Spontaneous ICH group 11 were females out of 40 patients, while in MCAI 9 were females out of 21 patients.

Time lapse between injuries to surgery is presented Mean time lapse between injury to surgery is 16.15±19.5hrs for TBI, 17.38±12.74 hrs for ICH and 26.14±7.98 hrs for MCAI. There is huge gap between minimum and maximum time lapse between TBI and non TBI. High value of SD for TBI indicated wide dispersion in time lag in surgery from the time, the injury takes place. This critical indicator has a direct impact on the outcome. [Table 3]

As per [Table 4] in all three injury groups multiple intra-operative findings were observed which comprised of EDH, ASDH, contusions, brain edema, SAH and non pulsatile brain in TBI. Brain edema, non pulsatile brain, blackish disclouration in MCAI and brain edema and non pulsatile brain in ICH. In TBI 127 (91.4%) were having multiple findings while only 12 cases had isolated finding like non pulsatile brain (6) brain edema (4) and contusion (2).In ICH 8 isolated cases of brain edema were found . While among MCAI one isolated case of non pulsatile brain was found. In TBI only craniectomy was performed in 105 cases followed by multiple procedures in 20 cases. In ICH out of 40 cases 21 (52.5%) had clot removal and craniectomy while 8 had multiple procedures and 11 had only craniectomy. In the MCAI all 21 cases had only craniectomy.

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Figure 1: Intra operative view after exposure of skull bone. Four burr holes made and connected using craniotome

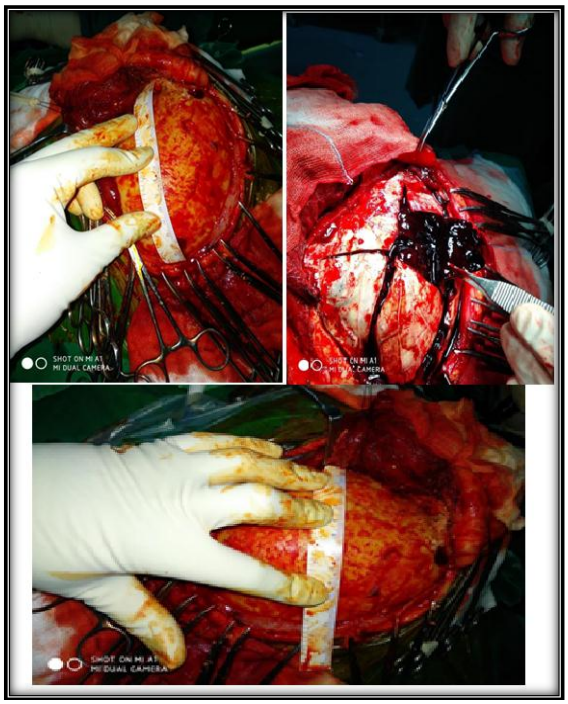

Figure 2: NCCT brain showing left hemispheric ASDH with mass effect with MLS more than 5 mm

As per [Table 5] fifty post of complications reported among TBI, expansion of Hematoma on the same side was reported in 13 cases while expansion of Hematoma in opposite side was reported in nine cases. Increased cerebral edema reported in nine cases respectively. Among ICH reported complications where expansion of Hematoma same side 3, increase cerebral edema 4, HCP 3, cranial SSI 1 and extradural/ subdural collection 2. Among MCAI 8 out of 21 cases reported complications reported complications were extradural/subdural collection.

When outcome is good (GOSE is more than or equal to 5) mean time lapse was 14.0 ± 14.9hrs in TBI and for bad outcome (GOSE less than or equal to 4) mean time was 15.5 ± 19.2hrs, however the difference was not significant (p=0.609). For ICH mean time lapse for good and bad outcome were 19.9 6 ±8.61 hours and 14.2 ± 15.69 hrs respectively. The difference was not significant. Similarly for infarction good and bad of outcome had a mean time lapse between injuries to surgery was 16 hours and 27.21 ± 7.62 hrs respectively. This was also statistically not significant and more over in MCAI there were two cases of good outcome which is inadequate for comparison outcome decreased from 82.6% to 45.3%. [Table 6]

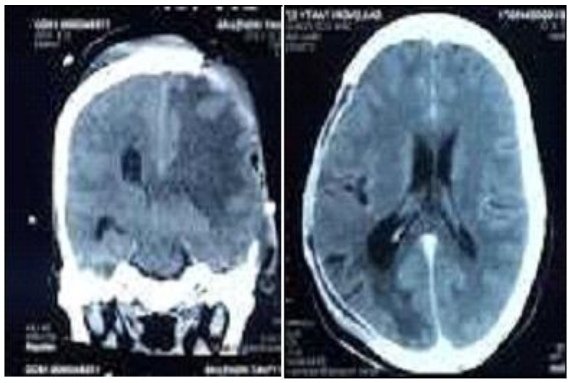

Figure 3: Post-Operative NCCT brain showing adequate DC both left and right side

Table 1: Distribution of Traumatic brain injury by gender and age

Age Group	TBI					
	Male		Female		Total	
	No.	%	No.	%	No.	%
19-39	26	20.2	5	50	31	22.3
40-59	58	45.0	5	50	63	45.3
60-79	43	33.3	0	0	43	30.9
≥80	2	1.6	0	0	2	1.4
Total	129	100	10	100	139	100

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Table 2: Distribution of non-traumatic brain injury by gender and age

Age Group	Spontaneous ICH						MCAI					
	M le		Female		Total		Male		Female		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
19-39	6	20.7	0	0.0	6	15.0	4	33.3	2	22.2	6	28.6
40-59	14	48.3	4	36.4	18	45.0	4	33.3	2	22.2	6	28.6
60-79	9	31.0	6	54.5	15	37.5	4	33.3	3	33.3	7	33.3
≥80	0	0.0	1	9.1	1	2.5	0	0.0	2	22.2	2	9.5
Total	29	100	11	100	40	100	12	100	9	100	21	100

Table 3: Time lapse between injuries to surgery in different groups

Statistics	TBI	Spontaneous ICH	MCAI
N	139	40	21
Mean	16.15	17.38	26.14
SD	19.50	12.47	7.98
Minimum	0.5	1	12
Maximum	79	49	40
Q1	4.5	4.25	24
Q2 (Median)	8	18	25
Q3	18	25.75	33

Table 4: Intra operative findings and procedure in different groups

Intra-operative Findings	TBI		SpontaneousICH		MCAI	
	No.	%	No.	%	No.	%
EDH	2	1.4	0	0	0	0.0
ASDH	30	21.6	0	0	0	0.0
Brain Edema	4	2.9	8	20	8	38.1
Nonpulsatile Brain and brain edema	6	4.3	2	5	1	4.8
Contusion	10	7.2	0	0	0	0.0
Multiple	87	62.6	30	75	12	57.1
Total	139	100	40	100	21	100
Procedure						
Clot removal &Craniectomy	7	5.0	21	52.5	0	0
Contusectomy&Craniectomy	4	2.9	0	0.0	0	0
Lobectomy &Craniectomy	2	1.4	0	0.0	0	0
EVD &Craniectomy	1	0.7	0	0.0	0	0
Multiple (More than two)	20	14.4	8	20.0	0	0
Craniectomy only	105	75.5	11	27.5	21	100
Total	139	100	40	100	21	100

Table 5: Distribution of post-op complication in various types of Brain injury

Post op Complications	TBI		Spontaneous IC		MCAI	
	No.	%	No.	%	No.	%
Expansion of Hematoma of same side	13	26	3	23.1	4	50
Expansion of Hematoma Opposite Side	9	18	0	0.0	1	12.5
Increased Cerebral Edema	9	18	4	30.8	1	12.5
HCP	3	6	3	23.1	1	12.5
SSI	4	8	1	7.7	0	0.0
Extradural/Subdural Collections	12	24	2	15.4	1	12.5
Total	50	100	13	100	8	100

Table 6: Association of outcome in TBI 6 months post surgery (GOSE) with age groups, M. score, GCS score, Rotterdam score, pupil size, reaction and laterality of injury

Age Group	Good		Bad		Total		χ2, p
	No.	%	No.	%	No.	%	
<60	60	68.2	28	31.8	88	100	□□= 19.498 p= 0.000
>=60	15	34.9	28	31.8	43	100	
Total	75	57.3	56	42.7	131	100	
GCS Score (grade)							
Mild	19	82.6	4	17.4	23	100	□□= 9.164 p= 0.010
Moderate	32	58.2	23	41.8	55	100	
Severe	24	45.3	29	54.7	53	100	
Total	75	57.3	56	42.7	131	100	
Rotterdam Score							
2	2	100	0	0	2	100	□□= 3.029 p= 0.553
3	23	63.9	13	36.1	36	100	
4	33	55	27	45	60	100	
5	15	53.6	13	46.4	28	100	
6	2	40	3	60	5	100	
Total	75	57.3	56	42.7	131	100	

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Pupil size							
Equal	51	54.8	42	45.2	93	100	□□= 0.674 p= 0.412
Unequal	16	64	9	36	25	100	
Total	67	56.8	51	43.2	118	100	
Pupil Reaction							
Both reactive	48	60	32	40	80	100	□□= 2.83 p= 0.243
One side non reactive	4	36.4	7	63.6	11	100	
Both non reactive	11	47.8	12	52.2	23	100	
Total	63	55.3	51	44.7	114	100	
Laterality of brain injury							
Left side	34	54	29	46	63	100	□□= 0.535 p= 0.465
Right side	41	60.3	27	39.7	68	100	
Total	75	57.3	56	42.7	131	100	
M score							
2	4	33.3	8	66.7	12	100.0	□□= 7.508 p= 0.111
3	12	38.7	19	61.3	31	100.0	
4	9	42.9	12	57.1	21	100.0	
5	45	54.2	38	45.8	83	100.0	
6	29	64.4	16	35.6	45	100.0	
Total	99	51.6	93	48.4	192	100.0	

DISCUSSION

Observational study on different clinical aspects and outcomes in TBI and NON TBI following DC has brought out findings relating to demographic profile, clinical manifestation and outcomes. The study also found very high proportion of males and they attribute this to road traffic accidents, where males have relatively very higher risk in comparison to females because of higher exposure to road traffic. Study subjects have preponderance in the middle age group 40 -59 years. A quarter of TBI were in the young age group of 19-39 years. We observed that more 34% of patients were more than 60 years in our study.[9-11]

In MCAI more than 80% of patients were having Motor component of GCS score of 5 and above, but following 24 hrs after surgery DC 47% of patients deteriorated below Motor component of GCS score 5. It has been suggested that early reperfusion therapy can increase the degree of oedema to critical levels within the first 24 hrs after stroke, as suggested by Jaush et al.[12]

Case fatality for spontaneous ICH at 30 days is 44 % as reported few studies in their study reported mortality of 33 % at 1 month following DC and did not found difference between with and without clot evacuation following DC.[13,14] Bhatia R et al. reported 41% of death rate following DC in their study. In contrast our study had death rate of 15%. It was observed in our study that survival was affected by Age and preoperative Motor component of GCS score. Younger age and good M score improved survival rate following DC. We observed ICH score had an impact on death rate we also seen that all deaths happened in patients of age more than 60 years.

Expansion of hematoma on same side of DC was noted in 26% of our patients. This depends upon severity of injury and age of the patients. Severity of the head injury as judged by the Rotterdam score of the initial CT scan correlated with risk of contusion expansion. Patients with expansion of hematoma on opposite side noted in 18% of our patients.[15]

CONCLUSION

We observed survival rate and functional outcome following DC in TBI was high compared to previous literature. In MCAI more patients survived with severe disability compared to previous literatures. It was observed from the study that distribution of age shows predominance in 4-5th decade (45%) for both TBI and Spontaneous ICH, whereas in MCAI 6-7th decade predominated (33%). Male patients outnumbered in all groups. Only 1.4%, 2.5% and 9.5% were more than 80 years in TBI, Spontaneous ICH and MCAI respectively. We noticed increased rate of immediate postoperative complications,however this should not deter from taking DC as initial therapy for raised ICP and brain edema. Large multicentre trial will evaluate further the role of DC in various pathological conditions of increased ICP and cerebral edema.

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