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Decompressive craniectomy for traumatic brain injury in a developing country: An initial observational study

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Abstract: This is a descriptive study of the possible role of decompressive craniectomy (DC) in traumatic brain injury (TBI) management in a Nigerian neurosurgical unit; a practice setting where dedicated neurocritical care service is lacking for the care of TBI. Over a 12-month period cases of TBI with clinical and radiological evidence of intracranial hypertension were selected for 'prophylactic' DC. Utilization of hospital services was quantified and outcome at discharge and at follow up was measured with the Glasgow Outcome Scale Extended. Of the 17 cases, outcome was good in 100% of those with mild head injury (HI), 66.7% of the moderate HI, and 56% of the severe HI. Utilization of hospital services, especially the intensive care unit (ICU), increased in proportion with the severity of the TBI.

Decompressive craniectomy may have a role to play in the developing countries in the preemptive treatment of posttraumatic raised intracranial pressure. It appears to hold a great potential in salvaging certain clinically benign cases of HI which usually have unfavorable outcome in this practice setting.

Keywords: Decompressive craniectomy; traumatic brain injury; developing countries

INTRODUCTION

There is renewed interest in the place of decompressive craniectomy (DC) in the management of raised intracranial pressure (ICP) from traumatic brain injury (TBI) in particular and in all cases of refractory intracranial hypertension in general[1,2]. Much of the literature on this subject however is from the developed countries with cutting-edge neurocritical care systems. In such advanced health systems, posttraumatic raised ICP in the absence of any immediately obvious surgically evacuable mass lesions is first treated medically under highly technologically advanced intensive care multimodal monitoring[3-5]. Decompressive craniectomy is then usually deployed as a second tier, perhaps even a last-ditch, effort in the management of post traumatic raised ICP[1,6,7]. Even so, some experts are now of the opinion that DC should more and more be considered early whenever it is indicated in this clinical setting[8,9].

This last proposal is very attractive for highly resource-limited practice setting of the developing countries. In our own practice for instance, there is no dedicated neurointensive care unit. There is also no facility for ICP monitoring[8,10]. Hence our ICP-targeted care of TBI is virtually limited to the empiric use of mannitol and furosemide and the basic physical/nursing management practices. In this vein, we have performed DC on a select group of head injured patients based on their clinical and cranial computed tomography (CT) findings. This study is a retrospective analysis of our clinical data on this group which was prospectively gathered over a 12-month period. It is an initial exploratory observational analysis of our clinical / radiological indications for DC, and the possible effects of this old surgical procedure on outcome in patients with TBI in a developing country.

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MATERIALS AND METHODS

All adult cases of TBI in which DC was performed personally by us between January and December 2008 form the basis for this observational study. The parameters evaluated include the patients' demographics, cause of injury, Glasgow Coma Scale (GCS) score on admission, clinical and neurologic deficits, associated extracranial systemic injuries, cranial CT findings, indications for surgery and the specific surgical procedures. Outcome measures studied were the postoperative clinical course, the duration of postoperative critical care and length of hospital stay. Outcome at hospital discharge and at the last clinic follow up was quantified with the extended Glasgow Outcome Scale (GOSE). Cases with lower moderate deficit up to upper normal were deemed to have good outcome whilst those whose outcome was worse than these on the GOSE were classified as poor outcome.

The data has been presented here both in tabular forms and in descriptive terms of sizes and proportions (means and percentages).

RESULTS

We personally performed DC for various indications following TBI in 18 adults in this study period. The indications for surgery were the findings on clinical and CT evaluations as outlined in Table 1. The clinical records of one case got missing leaving us 17 cases for this review. These comprised of 11 males and 6 females with the age range of 23 to 78 years, mean 41 and median 35 years. Road accident was the cause of injury in the majority, 14 of the 17 patients. Of the road accidents, 57% were from motorcycle accidents. Based on the admission GCS, 2 cases had mild HI (GCS 13-15). Indications for decompressive craniectomy in these (cases 3 and 8: Table 1) were clinical evidence of raised ICP and poor Marshall's grade[11] cranial CT findings (Figure 1).

Six and 9 cases respectively had moderate and severe HI. Apart from those with obvious mass lesions necessitating cranial surgical opening which we then converted to decompressive craniectomy, some others were offered decompressive craniectomy on the basis of poor grade CT findings in the absence of ICP monitors (Fig 2 & 3).

OUTCOME POST SURGICAL DECOMPRESSION

Postoperative outcome was generally dependent on the initial severity of the HI (Table 2). Both the cases with mild HI made good recovery till hospital discharge and at the last outpatient follow-up. None of them required postoperative care in the intensive care unit (ICU). They also had the shortest length of hospital stay. At the last follow up, about 56% of cases with severe HI had good outcome and the mortality rate in this group was 44% whilst two thirds (66.7%) of the moderate HI had good outcome and the mortality rate was 16.7%. Presence of multiple clinical determinants of poor outcome was documented in all the cases of severe HI, in half of the moderate HI and in none of the mild HI. Also, cases of moderate HI spent fewer days in the ICU and on the ventilator than the severe HI. The same trend was observed in the mean length of hospital stay between the two groups.

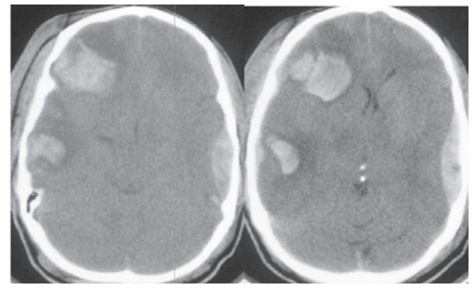

Fig 1 : Poor grade cranial CT of a clinically benign, GCS 14, case of HI (case 3, table 1) treated with DC. This man returned to his pre-trauma duties within 4 months.

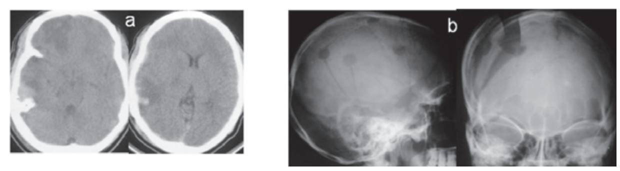

Fig 2 : a) Cranial CT of case 2, table 1. Moderate HI, GCS 12. Was offered DC when he developed severe systemic hypertension. b) Plain skull Xray film in the immediated post op period showing marked elevation of the cranial bone flap. This patient also made good recovery.

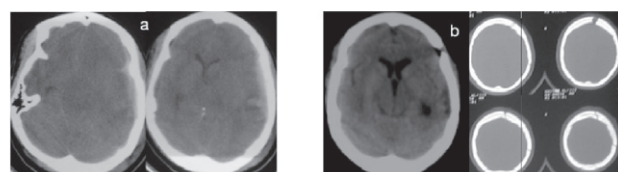

Fig 3 : a) Preoperative cranial CT of case 1, table 1. Severe HI with anisocoria and no facility for ICP monitoring. Offered DC and made good recovery resuming her trade 6 months postop. b) Cranial CT 3 months postop showing good cerebral decompression, and the bone flap already replaced.

DISCUSSION

The findings of this study suggest that DC might have a significant role to play in the surgical care of TBI in the developing countries. An encouraging percentage of clinically benign cases of HI but whom, judging from their cranial CT findings (Figure 1), might have had adverse outcome was salvaged[11]. This included 100% of selected cases of mild and at least two-thirds of moderate HI. Also, even in the presence of multiple determinants of poor outcome in all the cases, 56% of the selected cases of severe HI had good outcome at the last follow-up. This is an encouraging treatment outcome vis a vis the well known very poor outcome from severe HI in the developing countries[10,12,13].

Limitations of this study: This study is limited however in its universal applications by the fact that it is only a single surgeon, in-hospital practice audit. The cases have

Table 1: Decompressive craniectomy for TBI in Nigeria. Clinical details of the cases studied

S/N	Sex Age / yrs	Cause of injury	GCS on admi-ssion	Clinical and neurological Deficits	Other systemic Injuries	Cranial CTFindings	Reason for Surgery	Decompressive craniectomy and other operations
1	F/33	MCA pedestrian	8	Anisocoria, LOC 48hrs	Nil	Left ASDH, brain swelling, moderate cistern effacement / midline shift	No clinical improvement, no ICP monitor	Lt FTP decompressive craniectomy
2	M/40	MCA, pillion	12	Bleeding left ear	Nil	Multifocal brain contusion, worse on the right, brain swelling, moderate cistern effacement / midline shift	Severe systemic Hypertension, no ICP monitor	Rt FTP
3	M/35	MCA, pillion	14	Bleeding left ear	Fracture Rt zygoma	Lt parietal skull fracture / EDH, Rt multiple large ICH, brain swelling, effaced cisterns, ventricles and midline shift	Significant brain injury, no ICP monitor	Rt FTP, Lt EDH craniotomy
4	F/65	MVA, pedestrian	10	Bleeding left ear	Nil	Rt ASDH, brain contusions, swelling, effaced cisterns, ventricles	Deteriorating clinical status, no ICP monitor	Rt FTP
5	M/27	MCA, pillion	12	Bleeding pillion	Nil	Open depressed bifrontal fracture, basilar fracture, brain swelling, effaced cisterns, ventricles	Clinical deteriora-tion: hypoxia, dropped GCS	Bifrontal, complex skull base repair
6	M/33	MVA, passenger	8		Nil	Lt frontal, parietal ICH, multifocal contusion, brain swelling, effaced cisterns, ventricles; midline shift	Severe HI, no ICP monitor	Lt FTP, evacua-ation of ICH
7	F/78	Fall from height	8	Hypotension, delayed surgery	nil	Multifocal brain contusion worse on the left; Lt ASDH, frontal ICH	Severe HI, no ICP monitor	Lt FTP, evacua-tion of ASDH
8	M/35	MCA, rider	13	Lt otorrhoea	Nil	Lt temporoparietal ICH, brain swelling, effaced cisterns, ventricles	Severe headache, delirium, no ICP monitor	Lt FTP
9	F/74	MCA, pedestrian	8	Anisocoria, focal deficit	Nil	Lt ASDH, brain swelling, effaced cisterns, ventricle, focal deficit	Severe HI, focal deficit	Lt FTP
10	M/23	MCA, pillion	10	Anisocoria, focal deficit, pyrexia	Multiple soft tissue injury	Multifocal, bilateral haemorrhagic contusions, Rt temporal, frontal ICH, IVH, effaced cisterns, ventricles	Poor clinical status, extensive brain injury on CT scan	Lt FTP
11	F/27	MVA, passenger	7	Anisocoria, Multiple scalp lacerations	Nil	Focal Rt cerebral contusions, diffuse brain swelling, effaced cisterns, ventricles	Severe HI, no ICP monitor, seizures	Rt FTP
12	F/23	MVA, pedestrian	6	Rhinorrhoea Anisocoria	nil	Lt ASDH, brain swelling, effaced cisterns, ventricles, midline shift, frontobasal skull fracture	Severe HI, ASDH	Lt FTP
13	M/50	MCA, rider	8	Anisocoria, focal deficit	Zygomatic fracture	Multifocal haemorrhagic contusions, multiple calvarial linear skull fracture, brain swelling, Rt worse than Lt, effaced cisterns, ventricle, midline shift	Severe HI, brain swelling, no ICP monitor	Rt FTP
14	M/38	MVA, passenger	6	Pyrexia	Multiple bone , rib fractures	Diffuse brain swelling, Lt frontal multiple ICH, effaced cisterns, ventricles, basilar skull fracture	Severe HI, no ICP monitor	Lt FTP
15	M/42	Assault	6	LOC, Pyrexia, HIV	Nil	Brain swelling, Lt ASDH, ICH, effaced cisterns / ventricles, midline shift	Severe HI, poor grade CT	Lt FTP
16	M/50	MVA, pedestrian	9	Hypotension, pyrexia, anemia	Open tibia/ fibular fracture	Lt ASDH, brain swelling, effaced cisterns, ventricles	Poor grade CT	Lt FTP
17	M/26	Fall from height	9	Polytrauma, scalp laceration	Mandibular, femoral fractures	Rt ASDH, brain swelling, effaced cisterns, ventricle, midline shift	Poor grade CT	Rt FTP

Table 1: continue ...

Table 1: *continued ...*

S. No.	Post-op Course	No of days in ICU	No of Days Ventilated	No of days in hospital	Outcome at hospital discharge (GOSE)	Outcome last follow-up (GOSE)	Follow-up Duration/ months
1	Progressive,improvement, hadSeizures, pyrexia, anaemia	7	1	16	Lower moderate deficit	Upper normal Back to work	11
2	No space in ICU, nursed in regular Neurosurgical ward, slight CSF wound discharge treated non-surgically	Nil	Nil	11	Lower moderate deficit	Lower normal, back to work	4
3	Uneventful postoperative course	Nil	Nil	8	Upper moderatedeficit back to work	Upper normal,	4
4	No space in ICU, regular ward nursing, Slow neurologic recovery	Nil	Nil	13	Upper severe deficit	Lower moderate deficit	6
5	Pyrexia, slow neurological recovery	5	4	23	Upper severe deficit		Lost to follow up
6	No space in ICU, nursed in open ward; Pyrexia, slow neurological recovery	Nil	Nil	28	Lower moderate deficit	Lower normal	20
7	Ventilated ICU, Pyrexia, Anaemia, Hypokalaemia, tracheostomy	50	25	50	Death		
8	Uneventful postoperative course	Nil	Nil	15	Lower normal	Upper normal, back to work, driving trucks	7
9	Hypertension, pyrexia, Seizures, Hypokalaemia, tracheostomy	17	3	19	Death		
10	Initial post operative improvement, then progressive deterioration, pyrexia. No funds for post operative cranial CT scan	5	3	7	Death		
11	Seizures, pneumonia; progressive neurological recovery	10	7	40	Lower moderate deficit	Lower normal	16
12	Pyrexia, slow neurological recovery	12	10	60	Upper severe deficit	Lower moderate deficit	8
13	Pyrexia, slow neurological recovery, sinking bone flap	9	7	70	Upper severe deficit	Died at home 3 months post operation	
14	Poor postoperative status	4	4	4	Death		
15	Progressive neurological recovery	6	7	35	Lower moderate deficit	Upper moderate deficit	6
16	Prolonged ventilatory support, tracheo-stomy, Rt CSDH/Twist drill drainage	13	16	60	Upper severe deficit	Lower moderate deficit	4
17	Progressive neurological recovery, ORIF femoral and mandibular fractures	1	2	28	Upper moderate deficit	Upper normal	10

Abbreviations

ASDH = acute subdural haematoma; CSDH = chronic subdural haematoma; CSF = cerebrospinal fluid; CT=computerized tomography; EDH = extradural haematoma; FTP = frontotemporoparietal; GCS = Glasgow coma scale; GOSE = Glasgow outcome scale extended; HI = head injury; HIV=human immunodeficiency virus; ICH = intracerebral haemorrhage; ICP = intracranial pressure; ICU = intensive care unit; LOC = loss of consciousness; Lt = left; MCA = motor cycle accident; MVA = motor vehicle accident; ORIF = open reduction and internal fixation; Rt = right

been highly selected based on the clinical and cranial CT criteria itemized in the 'Methods' section of this paper. No rigorous scientific methods or statistical analysis has been applied in this simple descriptive study either. It can therefore be looked upon basically only as a surgical reconnaissance efforts to gather clinical insights as to what the possible role of decompressive craniectomy might be in the acute care of HI in Nigeria and other highly resource-limited countries. Even in the global literature, the larger issues being only initially explored here are yet to be fully clarified even by the body of literature on the subject emanating from high-volume,

Table 2 : Decompressive craniectomy for TBI in Nigeria. Postoperative in-hospital course, outcome at discharge and at follo up of the study population.

	Mild HI (GCS 13-15) N=2	Moderate HI (GCS 9-12) N=6	Severe HI (GCS 3-8) N=9
Mean post-operative number of days			
On mechanical ventilator	0.0	3.5	7.0
In ICU	0.0	4.7	12.9
In hospital	12.5	23.7	35.8
Multiple determinants of poor outcome			
Present	0 (0.0)	3 (50.0)	9 (100.0)
Absent	2 (100)	3 (50.0)	0 (0.0)
Outcome on GOSE			
At hospital discharge or death			
Good	2 (100.0)	2 (33.3)	4 (44.4)
Poor	0 (0.0)	4 (66.7)	5 (55.6)
At the last follow-up			
Good	2 (100.0)	4 (66.7)	5 (55.6)
Poor	0 (0.0)	2 (33.3)	4 (44.4)
Mortality	0 (0.0)	1 (16.7)	4 (44.4)
Length of follow-up in months			
Mean	5.5	6.0	6.8
Range	4-7	4-10	6-20

Abbreviations

GCS=Glasgow coma scale; GOSE=Glasgow outcome scale extended; HI=head injury; ICU=intensive care unit

Numbers in parentheses are percentages unless otherwise indicated.

technologically advanced practice settings[1,9]. All eyes are really still on the advertised ongoing randomized trials[14-16].

In the meantime, the very few neurosurgical on-the-field workers like us who daily confront the grim prevalence and outcome statistics of HI in the developing countries[10,13], are continually challenged to seek new ways of mitigating the damage. Such new ways, as in this case, may actually be merely new applications of some old way.

Decompressive craniectomy in the literature: Surgical opening of a window in the cranial vault to modulate the Monro-Kellie doctrine in intracranial hypertension was performed by early surgical masters like Theodore Kocher and Harvey Cushing[1]. Decompressive craniectomy for post traumatic raised ICP was however first critically explored by some workers in the mid-1900s[1,2]. With the continuing failure of satisfying response to rigorous medical treatment of raised ICP in brain trauma, the procedure of DC experienced a brisk resurgence in the closing decades of the last century[1,2]. The intuitive justification of this approach was that giving the injured brain more room to swell into would limit injury to the adjacent brain tissues[8,17].

Nonetheless, there still remain the difficulties, amongst others, of determining which specific groups of the head injured would benefit from the procedure, and at what optimal time[9]. Hence many professional neurosurgical working groups recommend that the use of DC be protocol-driven[6]. That it be used as the last of the second-tier treatment options for post traumatic refractory raised ICP. This means that DC is performed only after the failure of rigorous non-surgical measures to control raised ICP in neuro-intensive care units with multimodal monitoring capabilities[18,19]. The foregoing is the background of the settings of much of the literature on the use of DC in TBI.

This prescription could hardly be expected to work in the developing countries. Firstly, the cutting-edge neurocritical care as proposed for this level of care is hardly available. And secondly, accessibility to neuroimaging is severely limited for the CT-intensive commitments this would require[10,12,20]. There are still many more limitations. Suffice it to say however that it has actually been observed even in the developed countries that multimodal monitoring for the protocol-driven treatment of raised ICP might not be available in all units for all patients and at all times[8]. And that DC is comparatively inexpensive and may be the only method available for developing countries[8].

We know this assumption to be true to our situations.

Hence our deployment of DC for the management of this selected cohort of TBI in our practice. And it appears to us from our preliminary observations as presented that prompt, preemptive DC in the face of appropriate clinical / neurological presentation and the status of the initial cranial CT might impact positively on the extant grim statistics of severe head injuries in our practice[8,9,21]. What is more, it appears to hold a great potential in salvaging many clinically benign cases of head injury that do end up having very adverse outcomes[22].

CONCLUSIONS

Decompressive craniectomy may have a role to play in the developing countries in the preemptive treatment of post traumatic raised ICP. Outcome was improved in the cases of severe head injury in this study. Most note worthily, it appears to hold great potentials of salvaging certain cases of head injury with clinically benign but radiologically severe status that might have had adverse outcomes. These observations offer baseline information for more scientifically rigorous future studies of this subject in our practice setting.

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