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Original Article

Hemorrhagic complications after decompressive craniectomy

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ABSTRACT

Background: Decompressive craniectomy (DC) is the preferred surgical management option for lowering refractory intracranial pressure in cases of traumatic brain injury (TBI). A number of randomized controlled trials have demonstrated decreased mortality but increased morbidity following DC for TBI patients. Here, we reviewed the frequency of postoperative hemorrhagic complications following DC correlating with poor outcomes.

Methods: We retrospectively reviewed the medical records of patients who presented with TBI and underwent DC during the years 2015–2017. The frequency and characteristics of hemorrhagic complications were correlated with the patients' outcomes.

Results: There were 74 patients with TBI included in the study who underwent DC. Of these, 31 patients developed expansion of existing hemorrhagic lesions, 13 had new contusions, three developed new extradural hemorrhages, two developed new subdural hematomas, and one patient developed an intraventricular hemorrhage. Those who developed expansion of existing hemorrhagic lesions following DC had longer ICU stays and poorer outcomes (Glasgow outcome scale).

Conclusion: After 74 DC performed in TBI patients, 67% developed new hemorrhagic lesions or expansion of previously existing hemorrhages. This finding negatively impacted clinical outcomes, including mortality.

Keywords: Decompressive craniectomy, Glasgow coma scale, Revised trauma score, Traumatic brain injury

INTRODUCTION

Decompressive craniectomy (DC) is increasingly utilized in traumatic brain injury (TBI) patients to control raised ICP refractory to best medical management.[2,6] Despite the mention of DC in TBI management guidelines, there is still disagreement regarding its indications, optimal timing, and impact on clinical outcomes. Further, DC results in a varied incidence of postoperative complications not fully evaluated in the literature.[2,6]

Here, we report a single-center experience with DC in patients with TBI by estimating the frequency, type, and clinical outcomes of hemorrhagic complications observed following the performance of DC.

MATERIALS AND METHODS

This was a retrospective review and analysis of 74 patients undergoing DC for raised ICP secondary to severe TBI from 2015 to 2017 at our tertiary care referral hospital [Table 1].

Definitions and scales

We utilized the Rotterdam score to describe and standardize CT studies in these 74 patients following DC.[7] Clinical outcomes were assessed using the Glasgow outcome scale (GOS). For the purpose of differentiation, contusions were defined as hemorrhage when blood constituted more than half the volume of a contusion.

Analysis

Pearson's correlation was used to test for a correlation between RCTS at presentation and postresuscitation GCS, length of stay, and GOS. Data were analyzed using SPSS version 20 (IBM Inc, Armonk, NY, USA).

RESULTS

Patients demographics and clinical characteristics

A total of 74 patients undergoing DC were included in the study [Table 2]. Patients averaged 31.3 (±18) years of age, and 87.8% (n = 65) were male. TBIs were attributed in 63.5% of patients to motor vehicle accidents, while 17.6% were due to falls. The median postresuscitation GCS score at presentation was 7 (range: 3–15). The median revised trauma score was 10 (range: 6–12). Notably, 46% (n = 34) of patients had pupillary abnormalities at the time of presentation.

Preoperative studies showed contusions in 37.8% (n = 28) of patients, subdural hematomas in 28.4% (n = 21) of patients, while 20.3% (n = 15) of patients had both [Table 3].

Surgical procedures

Surgery included in 21.6% (n = 16) bifrontal DC, in 41.9% (n = 31) unilateral DC, and in 36.5% (n = 27) DC with clot evacuation [Table 3].

Postoperative new CT findings in 74 TBI patients

The postoperative CT scans performed during the index hospitalization revealed following new postoperative findings not documented on preoperative CT scans; 41.9% (n = 31) showed expansion of the previously existing contusion/ hemorrhages, 17.6% (n = 13) showed contusions that were not present on the preoperative scans, 4.1% (n = 3) developed new extradural hematomas, 2.7% (n = 2) exhibited new acute subdural hemorrhages, and 1.3% (n = 1) showed a new-onset intraventricular hemorrhage [Table 3].

Length of hospital stay (LOS)

The overall mean floor and special care unit stay were 4.33 days (±4.40) for the no expansion/flare-up group versus 6.04 days (±6.23) for those who developed expansion/ flare of the original TBI; there was no significant difference

Table 1: The inclusion criteria and some important variables that we studied.

Inclusion criteria
Age >18 years
Isolated TBI
Unilateral or bilateral DC
Data collection
PreDC
Demographics
Preoperative Glasgow coma score
Preoperative revised trauma score
Laboratory investigations
Pupillary response
Rotterdam CT score
Marshall CT score
Hospital course
Total length of hospital stay
Surgical procedure
Days in intensive care unit
Duration of surgery
Estimated blood loss
Intraoperative use of blood products
PostDC complications on postoperative CT scans
Clinical outcomes
Glasgow Outcomes Score

Table 2: Patients' clinical and surgical characteristics.

Patient characteristics	*n* (%)/(range)
Age*	31.32±17.94
Gender: female	9 (12.2%)
Comorbidity	
Diabetes mellitus	6 (8.1%)
Hypertension	4 (5.4%)
Ischemic heart disease	4 (5.4%)
Mechanism of injury	
Road traffic accident (motor bike)	33 (44.6%)
Road traffic accident (pedestrian)	14 (18.9%)
Fall	13 (17.6%)
GCS at presentation**	7 (3-15)
Revised trauma score**	10 (6-12)
Pupils	
BERL	32 (43.2%)
Anisocoric	30 (40.5%)
Fixed and dilated	4 (5.4%)

*Mean±standard deviation. **Median (range). GCS: Glasgow coma scale, BERL: Bilaterally equal and reactive to light

between these two groups [Table 4]. The mean intensive care unit (ICU) stay for those demonstrating expansion, however, was longer versus those without expansion (6.32 vs. 3.16 days, $P = 0.029$).

Table 3: Brain CT findings.

Characteristic	*n* (%)
Preoperative CT findings (at presentations)	
Cisterns	
Normal	8 (10.8)
Compressed	23 (31.1)
Absent	20 (27.0)
Midline shift	
<5 mm	17 (23.0)
>5 mm	34 (45.9)
ASDH	21 (28.4)
Contusion	28 (37.8)
SDH and contusion	15 (20.3)
Lesion side	
Right	21 (28.4)
Left	33 (44.6)
Bilateral	17 (23.0)
Rotterdam CT score of TBI*	4 (4.16±1.24)
Marshall CT score of TBI*	4 (4.30±1.36)
Postoperative CT findings and clinical outcomes	
Worsening of existing contusion or hemorrhage	31 (41.9)
New findings, other than worsening contusion or hemorrhage	
New contusion	13 (17.6)
Acute extradural hematoma	3 (4.1)
Acute subdural hematoma	2 (2.7)
Intraventricular hemorrhage	1 (1.4)
GOS=5	28 (37.8)
Mortality (GOS=1)	24 (32.4)

*Median (mean±standard deviation)

Patient outcomes

Out of the cohort of 74 patients, 37.8% ($n = 28$) had GOS of 5 with a mortality rate of 32.4% ($n = 24$) over the mean follow-up duration of 10.88 (±14.88) months [Table 4]. Patients who had no expansion were more likely to have undergone DC and clot evacuation (25.68% vs. 10.81%), which were more likely to have had longer operative times (2.99 vs. 2.10 h, $P = 0.007$), shorter lengths of ICU stays (6.32 vs. 3.16, $P = 0.029$), and overall better outcomes including mortality (20.9% vs. 48.4%, $P = 0.013$); these results were statistically significant.

DISCUSSION

Incidence of CT-documented contusion expansion following TBI

In this study, the decision for DC decompression was based on the CT scan findings and the patients' clinical status; 50% of patients in groups RCTS 5 or 6 developed worsening of their primary lesions. Flint *et al.* reported contusion expansion in 80% of their patients with initial RCTS of 5–6.[1]

LOS

In the literature, the LOS for moderate-to-severe TBI patients ranged from 5.9 to 17.5 days and is proportional to the severity of the injuries.[3,4] Here, there was no difference in the average

Table 4: Hospital stay, surgical characteristics, and postsurgical outcomes.

	All patients	Expansion/flare-up		
		Yes	No	*P*-value
Total length of hospital stay (days)	17.26±10.54	17.35±13.04	17.19±8.47	0.946
Ward stay (days)	4.33±4.40	4.25±5.15	4.43± 3.55	0.914
Special care unit stay (days)	6.04±6.23	5.96±6.94	6.10±5.67	0.934
Intensive care unit stay (days)	4.57±5.42	6.32±7.05	3.16±3.09	0.029
Surgical procedure*				0.057
Bifrontal decompressive craniectomy	16 (21.6%)	5 (6.76%)	11 (14.86%)	
Unilateral decompressive craniectomy	31 (41.9%)	18 (24.32%)	13 (17.57%)	
Decompressive craniotomy and clot evacuation	27 (36.5%)	8 (10.81%)	19 (25.68%)	
Duration of surgical procedure (h)	2.53±0.89	2.10±0.74	2.99±0.83	0.007
Intraoperative blood loss (ml)	903.70±806.1	1042.86±1008.1	753.85±510.1	0.362
Number of intraoperative packed RBC transfused	1.30±1.44	1.57±1.60	1.00±1.23	0.311
Number of intraoperativeFFPs transfused	1.22±2.68	1.29±2.27	1.15±3.16	0.901
Number of intraoperative platelets transfused	0.70±1.84	1.21±2.42	0.15±0.56	0.136
Glasgow outcomes scale	2.89±1.74	2.42±1.67	3.53±1.65	0.006
Mortality	24 (32.4%)	15 (48.4%)	9 (20.9%)	0.013

*Number (%)

LOS on the hospital floor or special care unit for patients with or without expansion of their primary lesions. However, the ICU stay for those with expanding lesions was significantly longer versus those without expansion (6.32 vs. 3.16 days, $P = 0.029$).

CT-documented complications of DC

The literature documents multiple complications of DC; primary contusion expansion, the formation of subdural hematoma subdural hygroma, and plus others.[6] Here, our most common complication was hemorrhagic expansion of the primary contusion (n = 31, 41.9%), followed by new contusions (n = 13, 17.6%), new extradural hematomas (n = 3, 4.1%), new subdural hematomas (n = 2, 2.7%), and one postoperative intraventricular hemorrhage (n = 1, 1.4%). Interestingly, 44.6% (n = 33) of our patients showed favorable outcome with GOS of ≥4, a finding consistent with that reported in other studies.[5]

Most RCTS on DC remain inconclusive in terms of meaningful neurological and functional benefits of DC in patients with severe TBI. One repeated argument against DC is that the expansion of the brain causes damage to white matter tracts and allows the contusions to expand, the latter shown in our series in two-thirds of cases. Although these patients had poorer outcomes in our study, our methodology has limitations (retrospective data collection, lack of functional outcomes, lack of randomization, etc.), and it is, therefore, beyond the scope of this paper to discuss whether our findings can be extrapolated to comment on the benefits or lack thereof, of DC for hemorrhagic contusions.

CONCLUSION

In our series of 74 TBI patients, the expansion of hemorrhagic contusions was seen in 67% of patients after DC. Patients who had no expansion were more likely to have undergone clot evacuation along with DC, which were more likely to have had longer operative time, shorter length of ICU stay, and overall better outcomes including mortality.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

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