Craniotomy or Craniectomy for Acute Subdural Hematoma? Difference in Patient Characteristics and Outcomes at a Tertiary Care Hospital

Saad Bin Anis[1] Saad Akhtar Khan[1] Rida Mitha[1] Muhammad Shahzad Shamim[1]

[1] Section of Neurosurgery, Department of Surgery, The Aga Khan University Hospital, Karachi, Pakistan

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Address for correspondence Muhammad Shahzad Shamim, MCPS, MRCS, FCPS, FEBNS, FACS, FRCS(Eng), FRCSGlas(Neuro Surg), Section of Neurosurgery, Department of Surgery, The Aga Khan University Hospital, Karachi, 74800, Pakistan (e-mail: shahzad.shamim@aku.edu).

Abstract

Objective This article compares the outcomes of patients with traumatic acute subdural hemorrhage (SDH) managed either with craniotomy (CO) or with decompressive craniectomy (DC).

Methods In this single-center, retrospective analysis we included all adult patients with acute traumatic SDH who were treated either using CO or DC. Sixteen-year hospital data was reviewed for patient demographics, injury details, and hospital course. Outcomes were noted in terms of intraoperative blood loss, intensive care unit stay, need for tracheostomy, post-surgery Glasgow Coma Score (GCS; calculated immediately after surgery), delayed GCS (DGCS; calculated 1 week after surgery), and delayed Glasgow Outcome Score (DGOS) after 6 months of surgery. Postoperative complications were noted during hospital stay, while mortality was noted within 6 months of surgery for each patient.

Results Patients who underwent DC were younger (mean age 34.4 ± 16.8 years vs. 42.4 ± 19.9 years in the CO group) ($p = 0.006$). Patients who underwent DC also had worst degree of traumatic brain injury as per Marshall grade (62.4% patients with Marshall grade 4 in the DC group vs. only 41.2% patients in the CO group) ($p = 0.037$). Mean size of hematoma was 23.8 ± 24.6 mm in the DC group versus 11.3 ± 8.2 mm in the CO group ($p = 0.001$). Mean postop GCS was lower in the DC group; 8.0 ± 4 versus 10.8 ± 4 in the CO group ($p < 0.001$). However, there was no significant difference in DGCS and DGOS between the DC and CO groups ($p = 0.76$ and 0.90, respectively). Mortality rate was 24 (30.8%) in the DC group versus 18 (20.7%) in the CO group ($p = 0.14$).

Conclusion The patients who underwent DC were younger, had larger size hematoma, and poor Marshall grade. We did not find any significant difference in the outcomes of CO and DC for management of subdural hematoma.

Keywords
- subdural hematoma
- craniotomy
- decompressive craniectomy

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Introduction

Acute subdural hematoma (ASDH) occurs in a third of all patients of traumatic brain injury (TBI).[1,2] Immediate surgical evacuation of hematoma is the recommended management for patients with ASDH and mass effect.[3,4] Bullock et al recommends surgical evacuation for ASDH with thickness greater than 10 mm, midline shift less than 5 mm, initial Glasgow Coma Score (GCS) less than 9, or reduction in GCS of 2 from admission GCS, or abnormal pupil change.[1] Despite advances in transportation, diagnostic modalities, and intensive care management, mortality rate of ASDH remains high, ranging from 40 to 60% in some series.[5,6]

Decompressive craniectomy (DC) and craniotomy (CO) are two widely used surgical options for managing patients with ASDH. In DC, the bone flap is removed to create space and accommodate brain swelling, and the bone is not immediately replaced. It is further augmented through an expansile duroplasty. This technique is used quite often, especially in young patients, as the injured brain may swell immensely, leading to secondary injury from raised intracranial pressure (ICP) despite the evacuation of ASDH. The bone flap is replaced several weeks later, once the ICP is controlled and patient is stable, through a procedure called cranioplasty that is associated with its own risks and complications.[7,8] In CO, the bone flap is replaced immediately after the clot is evacuated and fixed with plates.

There is some disagreement with regards to the best surgical management for ASDH, that is, DC or CO.[9,10] The decision to choose one over the other is sometimes straightforward, as in the case of an elderly patients with a relaxed brain after evacuation of hematoma, or in a young patient with a massively swollen brain that does not allow the option of replacing the bone back. It is the cases that lie in between the two extremes, wherein the choice of procedure remains on the surgeons' discretion; hence, more evidence is required to standardize care.[1,10] Some authors have argued that DC may be a superior option as it offers better control of ICP and postop swelling.[11,12] However, this argument is limited by the fact that not every patient will have postoperative cerebral swelling and some studies have even shown inconsistent results in terms of ICP control.[13,14] Moreover, DC is associated with some of its own complications including those associated with cranioplasty.[15] Both of these procedures are routinely used globally, with no clear guidelines on which procedure should be adopted in which subset of patients. The decision therefore is usually based on the discretion of the operating surgeon. A multicenter, parallel group randomized trial is currently in its final stages that aims to compare DC and CO in adult patients with ASDH.

The objective of present study is to compare outcomes of DC with CO for evacuation of ASDH.

Methods

In this retrospective analysis we included patients of ASDH who were treated either with CO or DC in our department over a duration of 16 years (from 2002 to 2018). Patients with coexisting significant TBI other than ASDH (contusions, extradural hematoma), patients with spontaneous subdural hemorrhages, patients with acute on chronic SDH, and those with significant coexisting systemic injuries were excluded. The study was approved by the hospital ethics review committee.

Data regarding age, gender, mechanism of injury, arrival time to hospital after injury, and presurgery GCS were obtained. Presurgery computed tomography (CT) scan findings were also obtained that included the information regarding volume and location of hematoma, midline shift, obliteration of basal-cistern, and associated injury.

All procedures were performed through fronto-temporoparietal CO of size 10×12 cm or bigger if needed. The decision to go for CO or DC was based on the decision of the operating surgeon.

Data of postoperative outcomes was noted in terms of intraop blood lose, intensive care unit (ICU) stay, need for tracheostomy, postsurgery GCS (calculated immediately after surgery), delayed GCS (DGCS; calculated after 1 week of surgery), and delayed Glasgow Outcome Score (DGOS) after 6 months of surgery. Postoperative complications were noted during hospital stay, while mortality was noted within 6 months after surgery for each patient.

Data analysis was done using SPSS v23 software. Quantitative variables were compared using independent sample *t*-test between the CO and DC groups. Chi-square test was used to compare qualitative variables between the groups. A *p*-value of 0.05 or less was taken as significant difference.

Results

Patients who underwent DC were younger (mean age 34.4 ± 16.8 years) as compared with those who underwent CO (mean age 42.4 ± 20.0 years) ($p = 0.006$). Seventy (89.7%) patients in the study presented with blunt trauma in the DC group, while 87 (100%) patients presented with blunt trauma in the CO group ($p = 0.002$). Mean midline shift was 9.9 ± 10.8 mm in the DC group compared with 6.18 ± 6.8 mm in the CO group. Note that 62.4% patients had Marshall grade 4 in the DC group compared with only 41.2% patients in the CO group ($p = 0.037$). Mean size of hematoma was 23.8 ± 24.6 mm in the DC group compared with 11.3 ± 8.2 mm in the CO group ($p = 0.001$). Detail data of baseline study-related variables is presented in ►**Table 1**.

Mean operative time and ICU stay time was higher in the DC group as compared with the CO group ($p = 0.03$ and 0.03). Postop GCS score was 8.0 ± 4.1 in the DC group compared with 10.8 ± 4.6 in the CO group ($p < 0.001$). However, there was no significant difference in DGCS and DGOS between the DC and CO groups. There was also no difference in early and late complications between the groups. Mortality was 24 (30.8%) in the DC group versus 18 (20.7%) in the CO group (p 0.14) (►**Table 2**).

Discussion

In patients with ASDH causing mass effect and midline shift, surgery is the preferred management option, with the aim to

Table 1 Comparison of baseline variables

	CO ($N=87$)	DC ($N=78$)	*p*-Value
Age	42.4 ± 19.9	34.4 ± 16.7	0.006
Male gender	73 (83.9%)	72 (92.3%)	0.09
Type of injury			
Blunt	87 (100%)	70 (89.7%)	0.002
Penetrating	0.0	08 (10.3%)	
Injury to arrival delay (min)	231.8 ± 264.0	285.3 ± 470.8	0.40
Arrival GCS	8.9 ± 4.0	7.9 ± 3.4	0.11
Midline shift (mm)	6.2 ± 6.8	9.9 ± 10.8	0.01
Cistern			
Present	30 (38.0%)	14 (20.6%)	0.02
Absent	49 (47.6%)	54 (79.4%)	
Marshall grade (missing data = 33 patients)			
2	24 (35.3%)	12 (18.8%)	0.03
3	16 (57.1%)	12 (18.8%)	
4	28 (41.2%)	40 (62.4%)	
Size of hematoma (mm)	11.3 ± 8.2	23.8 ± 24.6	0.001
ER to OR shifting time (min)	231.3 ± 467.6	556.8 ± 1,067.6	0.01

Abbreviations: CO, craniotomy; DC, decompressive craniectomy; ER, emergency room; GCS, Glasgow Coma Score; OR, operating room.

prevent or reduce the severity of secondary surgery.[16] However, the morbidity and mortality associated with ASDH is still high after surgical management. DC and CO are two very commonly used approaches for management of ASDH. There is still no consensus regarding the superiority of one over the other for management of ASDH and the choice of procedure is largely based on the surgeon's preferences. A questionnaire-based survey by the NeuroCritical Care Network,

Table 2 Comparison of study outcomes

	CO ($N=87$)	DC ($N=78$)	*p*-Value
OR time (min)	246.0 ± 78.3	273.9 ± 82.8	0.03
Blood loss (mL)	674.3 ± 534.4	809.4 ± 701.2	0.18
ICU stay	3.4 ± 2.2	4.6 ± 3.3	0.03
Need for tracheostomy			
Yes	26 (29.9%)	36 (46.2%)	0.03
No	61 (70.1%)	42 (53.8%)	
Postop GCS	10.8 ± 4.6	8.0 ± 4.1	< 0.001
Postoperative complications			
Wound infection	02 (2.3%)	00 (0.0%)	0.49
Chest infection	02 (2.3%)	04 (5.1%)	0.33
Renal insufficiency	02 (2.3%)	00 (0.0%)	0.49
Bed sore	04 (4.6%)	04 (5.1%)	0.87
Seizure	04 (4.6%)	04 (5.1%)	0.87
Reoperations within 30 days	02 (2.29%)	04 (5.12%)	0.33
Duration of follow-up (mo)	24.6 ± 32.3	23.0 ± 24.5	0.76
Delayed GCS	12.8 ± 3.7	12.6 ± 3.1	0.76
Delayed GOS	4.3 ± 1.0	4.3 ± 1.0	0.90
Mortality	18 (20.7%)	24 (30.8%)	0.14

Abbreviations: CO, craniotomy; DC, decompressive craniectomy; GCS, Glasgow Coma Score; GOS, Glasgow Outcome Score; ICU, intensive care unit; OR, operating room.

European Association of Neurosurgical Societies, British Neurosurgical Trainees' Association, and the Society of British Neurological Surgeons, conducted in 2011 reported that in continental Europe, approximately 44% neurosurgeons use DC in more than half of their cases as compared with only in 21% cases by the Irish and British surgeons.[9,10] While a study based on one of the largest surgical databases of National Surgical Quality Improvement Program reported that use of CO is 10 times higher in America as compared with DC.[17] This unusually wide variation in practice across different countries is an indicator to a lack of consensus in the superiority of one procedure over the other when it comes to the surgical management of ASDH.[3] In the present study, out of total of 165 procedures performed during the study period, there were 87 (52.7%) patients who underwent CO and remaining 78 (47.3%) underwent craniectomy, indicating almost equal proportion of these procedures in our setup.

In our study, patients who underwent DC were younger as compared with those who underwent CO. Rush et al and Li et al, both reported the group undergoing DC was significantly younger than the group undergoing CO.[17,18] Furthermore, our preoperative GCS findings were also similar to the experience reported by Li et al.[18] There was a higher proportion of patients presenting with GCS or 8 or lower in the DC group in our study (59% in DC compared with 48.25% in CO) similar to the findings by Li et al (78% in DC compared with 39% in CO).[18] Phan at el also showed that more severe GCS (3–8) were found in higher proportion in the DC group than in the CO group.[3]

Other preoperative indicators could also determine which surgical procedure will be a better choice for a particular patient although these indicators have not shown to be statistically significant. In our study patients with a greater midline shift (9.9 ± 10.8 mm in DC compared with| 6.1 ± 6.8 mm in CO), greater cisternal obliteration on initial CT scan, with poorer Marshall grade, and a delayed presentation were more likely to undergo DC. Li et al also reported a greater midline shift in patients undergoing DC (11 in DC vs. 9 in CO); however, the difference between the two groups was also not statistically significant.[18]

In our study, we did not find any significant difference in mortality between the two groups ($p = 0.14$) much like previous studies.[17] On the contrary, some authors have reported a higher mortality rate in the DC group.[19,20] A meta-analysis by Phan et al also reported higher mortality rate of 40.5% in the DC group as compared with only 13.9% in the CO group ($p = 0.004$).[3] In our study, the mortality rate was 10% higher in the DC group as compared with CO, but this difference was not statistically significant which may be due to small sample size of our study. Also, in our study, the two groups were not similar, and the mortality rate was not adjusted for the difference in the two groups, and therefore may not be a true indicator of the outcome.

We found wound infections in 2 (2.29%), chest infections in 2 (2.29%), and renal insufficiency in 2 (2.29%) patients in the DC group, while there were no wound infections and renal insufficiency in the CO group; chest infections were reported in 4 (5.12%) patients in the CO group. A study by Gooch et al reported complications rate of 34% in DC patients, the main complications in their study were wound infections, wound breakdown, intracerebral hemorrhage, and bone resorption.[21] Kwon et al also reported postop complications in the DC group, out of 26 patients complications occurred in 4 patients; epidural hematoma in 4, infections in 1, and cerebrospinal fluid leak in 1 patient.[5] We have a policy to perform early tracheostomy in patients with severe TBI undergoing cranial surgery, and patients in the DC groups were found more likely to require a tracheostomy.[22] This can be explained on other predictors of patients requiring a tracheostomy, that is poorer preoperative and postoperative GCS, delay in presentation, longer operative time, and longer ICU stay, all factors more common in the DC group.[22]

It is interesting to note that despite a significant difference in patient characteristics of the two groups, the outcome of survivors, that is, GCS at 1 week and GOS at 30 days, was the same in both groups.

Conclusion

The patients who underwent DC were younger, had delayed presentation to the hospital, had larger hematoma size, midline shift and cisternal obliteration on CT scans, and higher Marshall grade. Patients who had DC also had relatively delayed transfer to operating room, longer operative time, poorer postop GCS, longer ICU stay, and were more likely to require a tracheostomy. Patients with DC also had a relatively higher mortality although this was not statistically significant. The GCS at 1 week (DGCS) and GOS at 30 days (DGOS) were the same in surviving patients regardless of the choice of procedure.

Conflict of Interest
None declared.

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