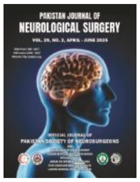

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Original Research

Functional Outcomes After Surgery for Acute Subdural Hematoma: A Comparison Between Decompressive Craniectomy Versus Craniotomy in Post-Traumatic Patients

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ABSTRACT

Objectives: The present study was aimed to compare two surgical techniques of craniotomy (CO) and decompressive craniectomy (DC) and patients were evaluated on basis of the Glasgow Outcome Scale.

Methodology: For this purpose, non-probability purposive sampling followed by randomization by the balloting method was used. There were 100 patients in all, with 50 cases in each group. Through balloting, the cases were divided into two groups, DC and CO, at random. In Group DC decompressive craniectomy surgery was performed while in Group CO craniotomy with three months follow up. The data were analyzed using SPSSv.25. Mean ± S.D was given for numeric variables. A Chi-square test was used to compare the proportion of complications between both procedures. A p-value of ≤ 0.05 was considered statistically significant.

Results: Patients in group CO were 48.3 ± 6.8 years old on the mean, while those in group DC were 49.4 ± 6.3 years old on mean. Moreover, it was found that there was no difference in terms of GOS and complications between both groups.

Conclusion: It can be concluded form our study that decompressive craniectomy is associated with high incidence GOS-4 and GOS-5.

Keywords: Acute subdural hematoma, decompressive craniectomy, expansion duraplasty, craniotomy, Glasgow coma score, Glassgow outcome scale.

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INTRODUCTION

An external mechanical force can produce trauma to the brain parenchyma, which is known as traumatic brain injury (TBI). TBI is a major cause of disability in developed nations and has a substantial social and economic impact. According to data from public sector hospitals, the annual incidence of TBI in Pakistan is 50 per 100,000 people.[1] Males are more likely than females to suffer from TBI, and the most prevalent age range is 30 to 50 years old.[2] According to estimates, the age-specific incidence of TBI is bimodal, peaking between the ages of 15 and 24 and again beyond the age of 65.[2] Post-traumatic amnesia (PTA) and loss of consciousness are markers of the severity of the condition; according to GCS upon presentation, PTA has been categorized as mild (13–15), moderate (9–12), and severe (< 8).[3]

The majority of TBI patients arrive at the neurosurgical unit within a few hours of the insult, and the majority of patients either have severe TBI or a fixed neurologic deficit at admission.[2] Acute subdural hematomas (ASDH) are present in one-third of patients with severe TBI.[4] ASDH usually develops in the space between the dura and arachnoid membranes as a result of arterial rupture or bridging vein ripping. The treatment of ASDH might range from various surgical evacuation procedures to essential surveillance. The 2006 Brain Trauma Foundation guidelines state that surgical intervention is necessary for ASDH that is thicker than 10 mm or that shifts the midline more than 5 mm on a CT scan.[5]

The death rates of ASDH are quite high, ranging from 55% to 79%, even with the greatest surgical care and critical care management.[6] The two most common surgical techniques are craniotomy (CO) and decompressive craniectomy (DC). In CO, the subdural hematoma is removed, the osteoplastic bone flap is raised, and then the flap is closed. With or without an additional expansile duroplasty, DC removes the skull bone, i.e., the bone flap and hematoma, in order to expand the edematous brain tissue.

MATERIALS AND METHODS

Study Design

The Department of Neurosurgery , Punjab Institute of Neurosciences, Lahore General Hospital, Lahore, was the site of this prospective parallel-randomized controlled experiment. The study was conducted over a period of 12 months, followed by a three-month follow-up.

METHODOLOGY

The projected number of patients was 100, with 50 instances in each category. The sample size was calculated using the formula below. Following non-probability purposive selection, the voting procedure was randomly assigned. Using a random number table, participants were divided into two groups at random, with each group receiving a 1:1 allocation ratio with no limitations. Here, n = 100 patients randomized into two groups:

- Group DC: Decompressive craniectomy (n=50).
- Group CO: Craniotomy (n=50).

A total of 100 patients were enrolled in the trial after meeting the inclusion criteria. Written and informed consent was provided by each patient. The demographic information was recorded using a pro-forma. A complete history and neurological examination were obtained.

ASDH was diagnosed based on history, examination, and CT scan brain plain. The primary survey was done, and any associated injuries was addressed. A bedside neurological examination was performed after stabilizing and resuscitating the patient. At random, the cases were divided into two groups (A and B). Group B will receive CO and Group A will receive DC. In the emergency operating room, the same neurosurgical team will operate on both groups. All patients received an intravenous single-shot broad-spectrum antibiotic at the time of induction and general anesthesia. An intensive care unit was used for all of the patients. Patients were watched for worsening neurological impairments after surgery. During the first post-operative day, eight and forty-eight hours after the surgery, at the time of discharge, and at their OPD Follow Up Visits (one week and one month later), the patients were reviewed, according to the GOS. The success was labeled as yes, where there is at least a 1-point improvement in GOS. All the results were collected and recorded on Pro-forma.

Sample Selection

Inclusion Criteria

- Written informed consent from patients.
- Cases in between 18-60 years are diagnosed with acute subdural hematoma, with a thickness greater than 1cm on CT scan axial and midline shift of more than 5mm.
- Acute subdural hematoma secondary to trauma.
- Patients from both genders.
- GCS (5-8).

Exclusion Criteria

- Multiple brain contusions.
- Primary Brain injury.
- Patients with redo surgery (on medical record).
- Co morbidities.
- Anticoagulant medications.
- Polytrauma.

Surgical Procedures

Craniotomy

The patient was taken to the operation theatre where GA was given. The patient was marked according to the size and position of the hematoma. The skin and muscle were lifted off the bone and secured. The bone flap was raised and secured and Dura was exposed, incised, and secured to expose the brain. The acute subdural hematoma was evacuated and hemostasis was secured. The bone flap was placed back. Skin was closed in a reverse manner and an aseptic dressing was done.

Decompressive Craniectomy

GA was administered after the patient was brought to the operating room. With rolled towels under the ipsilateral shoulder and the head toward the contralateral side, the patient was in a supine position. After marking the midline, a reverse question mark incision was made, extending posteriorly 15 cm behind the keyhole and extending all the way down to the skull. They lifted the myocutaneous flap. Five burr holes were found in the following locations: the parietal and frontal parasagittal region, superior to the zygomatic process inferiorly, the superior temporal line posteroinferiorly, the temporal squamous bone, and the keyhole area behind the zygomatic arch anteriorly. Under the bone, Dura had been dissected. The burr holes were then repaired and the bone flap removed. . The edges of the bones were waxed. At the edges of the craniectomy, a dural hitch was taken. The acute subdural hematoma was removed by cutting the dura. After maintaining the suction drain, the skin was closed in the opposite direction. They utilized the antiseptic.

Data Analysis

Every piece of data was entered and examined using SPSS 25. Among the quantitative variables displayed using the mean and standard deviation were age, GCS, and GOS.

Success and complications were examples of qualitative statistics that were presented as frequency and percentages. To see how these factors impacted the outcome variable, success, stratification criteria such as age, gender, surgery type, GCS, and GOS were employed. If our hypothesis is correct, statistical analysis will show that DC is superior to CO in people with ASDH brought on by severe traumatic brain injury. The two groups were compared after the quantitative and qualitative data were totaled. P-values for the odds ratio and chi-squared will be deemed significant if they are less than 0.05.

RESULTS

In this study, a total of 100 cases with acute subdural hematoma meeting inclusion criteria (GCS score 5-8) were included. The study was first authorized by the ethics committee of the Lahore General Hospital's Department of Neurosurgery Unit III.

Every case was randomly assigned to one of two groups, group DC or group CO. Fifty cases had craniotomy (CO) in group B, while fifty cases underwent decompressive craniectomy (DC) in group A. Lastly, the Glasgow outcome scale and complications were used to compare the results of the two surgical methods.

Age Distribution

Of all the cases , 46% were between the ages of 51 and 59, 28% were between the ages of 46 and 50, and 26% were between the ages of 35 and 45. The patient was 35 years old at the youngest age and 59 years old at the oldest. Nonetheless, Table 1: shows that the patients' mean age was 48.8 + 6.5 years.

Table 1: *Age distribution frequency in both groups.*

Age (in Years)	No. of Patients	%	p-value
35 – 45	26	26%	0.253
46 – 50	28	28%	
51 – 59	46	46%	
Total	**100**	**100%**	

Age Comparison

According to Table :2, the average age of the patients in groups DC and OC was 49.4 ± 6.3 and 48.3 ± 6.8 years, respectively. The difference between the OC and DC groups in terms of mean age (p = 0.668) and age distribution (p = 0.253) was not significant, according to the independent sample t-test.

Table 2: *The mean age of DC and CO is compared*

Mean ± SD	Mean ± SD	Minimum	Maximum	p-value
Group-DC	49.4 ± 6.3	36 years	59 years	0.668
Group-CO	48.3 ± 6.8	35 years	59 years	

Gender

According to Table 3, 70% of patients in group CO were male and 30% were female, whereas 80% of patients in group DC were male and 20% were female. The gender distribution in the DC and OC groups was assessed using the chi-square test, and the findings showed no discernible differences between the two groups (Table 3).

Table 3: *Geder distribution comparison between DC and CO.*

Gender	Group DC	Group CO	p-value
Male	40 (80%)	10 (20%)	
Female	35 (70%)	15 (30%)	0.356
Total	**75**	**25**	

Pupils

In group DC, 60% patients have both pupils reactive while 22% patients have one pupil reactive and in 18% patients both of the pupils were unreactive. On the other hand, in group CO, 64% patients have both pupils reactive while 16% patients have one pupil reactive and in 20% patients both of the pupils were unreactive (Table 4). The results of the chi-square test indicated that the reactiveness of the students in the DC and CO groups did not differ significantly.

Table 4: *Pupil reactiveness comparison between DC and OC.*

Gender	Group DC	Group CO	p-value
Both Reactive	30 (60%)	32 (64%)	0.744
One Reactive	11 (22%)	8 (16%)	
None Reactive	9 (18%)	10 (20%)	
Total	**50**	**50**	

Glasgow Coma Scale (GCS)

In group DC,18% patients had GCS-5, 40% patients had GCS-6, 28% patients had GCS-7 and 14% patients had GCS-8. On the other hand, in group CO, 10% patients had GCS-5, 64% patients had GCS-6, 16% patients had GCS-7 and 10% patients had GCS-8 (Table: 5). Average GCS in group DC was 6.4 ± 0.9 while in group CO the average GCS was 6.3 ± 0.8. The DC and CO groups did not significantly differ in GCS, according to the chi-square test results.

Table 5: *Glasgow Coma Scale (GCS) in DC and OC.*

GCS Scale	Group DC No. of Patients	Group DC %	Group CO No. of Patients	Group CO %	p-value
GCS-5	9	18%	5	10%	0.118
GCS-6	20	40%	32	64%	
GCS-7	14	28%	8	16%	
GCS-8	7	14%	5	10%	
Total	50	100%	50	100%	
Avg. GCS	**6.4 ± 0.9**		**6.3± 0.8**		

GLASGOW OUTCOME SCALE

With regards to clinical improvement of disease, in group DC, 8% patients had GOS-1, 12% patients had GOS-2, 14% patients had GOS-3, 32% patients had GOS-4 and 34% patients had GOS-5. On the other hand, in group CO, 14% patients had GOS-1, 16% patients had GOS-2, 18% patients had GOS-3, 22% patients had GOS-4 and 32% patients had GOS-5 (Table 6). When it came to GOS, which represents clinical improvements, there was no discernible difference between groups DC and CO in the chi-square test.

Table 6: *Glasgow Outcome Scale in DC and CO.*

GOS Scale	Group DC No. of Patients	Group DC %	Group CO No. of Patients	Group CO %	p-value
GOS-1	4	8%	7	14%	0.662
GOS-2	6	12%	8	16%	
GOS-3	7	14%	9	18%	
GOS-4	16	32%	11	22%	
GOS-5	17	34%	15	30%	
Total	**50**	**100%**	**50**	**100%**	

COMPLICATIONS

In terms of the frequency of complications, 29 occurrences of post-surgery issues were recorded. Post-operative seizures are the most common of them, occurring in 14% of patients in group CO and 18% of cases in group DC. The next most frequent occurrence is CSF leaks, which happen in groups DC and CO at 6% and 4%, respectively. In addition, group DC also had surgical site hematoma (2%), surgical site infection (4%), and new-onset neurological impairment (4%).

In the meantime, group CO also reported 2% problems for each category of surgical site hematoma, surgical site infection, and new-onset neurological deficiency, respectively (Table: 7). The independent sample t-test revealed no discernible difference in post-operative complications between groups DC and CO.

DISCUSSION

ASDH affects one-third of individuals with TBI. Despite advancements in surgical and emergency medical procedures, ASDH continues to be a fatal intracranial injury.[8] The ASDH is evacuated via trephination, CO, and DC. In 2006, the Brain Trauma Foundation recommended surgical treatment for ASDH with a 10 mm thickness or a 5 mm midline shift.[9] Even with surgery, the mortality rate for ASDH ranges from 55 to 79%. Following the report, DC was suggested as the preferred surgical technique for ASDH.[10] Honeybul[11] discovered that people with TBI benefit from DC. DC is utilized to reduce intracranial pressure and postoperative brain edema. Neurosurgeons evaluate clinical state and CT results to determine whether to perform a DC or CO, which might be perplexing if intraoperative brain swelling is not observed following hematoma evacuation.

Table 7: *Complications in DC and CO.*

Complications	Group DC		Group CO		p-value
	No. of Patients	%	No. of Patients	%	
CSF Leak	3	6%	2	4%	0.363
Seizures	9	18%	7	14%	0.280
Surgical Site Hematoma	1	2%	1	2%	0.245
New-onset Neurological Deficit	2	4%	1	2%	0.245
Surgical Site Infection	2	4%	1	2%	0.245
Total	**17**	**34%**	**12**	**24%**	0.648

Numerous retrospective investigations compare CO with DC. Chen et al,[12] examined the outcomes of ASDH surgery in Colorado and the District of Columbia. Age and herniation symptoms had the largest effect on patient outcomes, it was discovered. DC and CO's therapeutic advantages in ASDH were the most significant preoperative clinical factors influencing the outcome. Li et al,[13] used CRASH-CT to reduce the impact of preoperative clinical condition. In retrospect, the results for 85 patients were predicted. 45% of CO patients had positive results, compared to 42% of DC patients (p=0.83); nevertheless, the standardized morbidity ratio was 0.90 for CO and 0.75 for DC. 20 of 26 patients in the DC group had an inadequate mRS, compared to 8 of 20 patients in the CO group (p=0.004). Patients in the DC group may have a higher incidence of concurrent CT lesions, low GCS,[14] and unresponsive pupils. Our data exhibit the same results against patients with poor preoperative health that neurosurgeons do while doing DC (Table 1, 2, 3, 4, 5, 6 and 7). To clarify, we tallied the undesirable characteristics that could affect the outcome for each patient.

Neurosurgeons must understand DC problems. Among the consequences of DC include subgaleal bleeding, herniation via the cranial defect, subdural effusion, and hydrocephalus. Due to the difficulties of the cranioplasty treatment, two patients in our series experienced severe skin flap sinking, and one patient underwent reoperation for a subgaleal hematoma.[10] Cranioplasty is necessary for DC, which is risky. Malcolm et al,[15] discovered that the immediate post-operative consequences of cranioplasty after DC included infection, wound disintegration, cerebral hemorrhage, and bone resorption. CO might help in ASDH's evacuation. This study is small, single-center, and retrospective. Conclusions on CO or DC for ASDH are hampered by selection bias. According to Miki et al,[16] a bigger patient group and carefully chosen criteria are required to determine the best surgical strategy for ASDH patients.

Complexity characterizes functional prognosis following a severe TBI.[17] Despite contradictory outcomes for initial neurological condition, radiological abnormalities, gender, age, and accompanying traumas is associated with a bad prognosis.[7] Decompressive craniectomy reduces intracranial pressure after a TBI.[18] In patients with ASDH, decompressive craniectomy may be a planned main treatment, an intraoperative decision for fulminant intraoperative swelling, or a follow-up procedure for persistent intracranial pressure after hematoma evacuation.[19]

In a randomized study conducted by Hutchinson et al,[20] DC improved functional status in 27.4% more DC patients than non-surgical patients, reducing mortality at 6 months from 48.9% in non-surgical patients to 26.9% in DC patients. Similar to Hutchinson et al, 34% of this study's patients had a positive functional neurological outcome (Table 7). In the multicenter study by Leitgeb et al, 65.3% of ASDH cases had a poor outcome (46.7% mortality and poor functional status), 32.2% of cases had a favourable outcome, and 2.5% of cases had an unknown outcome.[4] GCS examines neurological status following a TBI. McMillan et al, established a link between GCS and TBI outcomes.[21]

DC reduces adult mortality and intracranial pressure, but is related with vegetative and debilitating conditions.[20] TBI outcomes in the elderly are typically dismal.[22] In a retrospective examination of older patients who underwent surgery for ASDH, 42% of patients died, 33% experienced severe impairment, and just 24% were able to be sent to a nursing home. Patients over the age of 80, those with a GCS of 8, and those with cerebral edema are more likely to die following DC.[23] Women with TBI have a poorer prognosis than men,[24] however there are no differences in immediate complications or outcomes[25] following TBI (Table 7). Elderly cases were included in the current study, and all of them had poor outcomes; however, pediatric patients under 16 years of age fared better (Table 2). Due to the small number of patients in each group, this observation cannot be generalized to all patient populations so more research is necessary.

Strengths

The relative GOS outcomes of decompressive craniectomy (DC) and craniotomy (CO) surgery are less well studied in Pakistan. This could act as a spur for more research in this area. Furthermore, by helping us identify the optimal course of action in these significant cases, our study enabled us to plan early surgical therapy of these patients rather than waiting for other options.

Limitations

Since the treatment modality was not chosen at random, our results are influenced by the surgeon's judgment, the reason for the surgery, the severity of the condition, and the operating technique used. In the absence of follow-up, we were unable to detect any cranioplasty issues. Second, our findings' external validity was limited because the study was only carried out at one institution.

Future Recommendation

The foundation for further research has been laid by this study. Future study should consider longitudinal investigations to ascertain the long-term effects and differences in the result of surgical issues. Future studies will need a larger sample size and standardized randomization to identify the best surgical method for severe TBI.

CONCLUSION

In summary, there was no difference in the results and complications between patients who had a craniotomy or decompressive craniectomy and those who had severe head traumas. Based on the results, we came to the conclusion that either approach might be used for surgical treatment of patients with low GCS scores.

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Additional information

Disclosures: The authors confirm that there are no conflicts of interest associated with this research.
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Conflicts of Interest: In compliance with the ICMJE uniform disclosure form, the authors declare the following:

- **Financial Relationships:** The authors confirm that they have had no financial affiliations with any organizations that could have an interest in this work, either currently or within the past three years.
- **Other Relationships:** The authors state that there are no other affiliations or activities that could have influenced the submitted work.

AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Ch. Arslan Ahmad	1. Study design and methodology.
2.	M. Salman Ahmed	2. Paper writing.
3.	Salman Ahmed	3. Data collection and calculations.
4.	Muhammad Naveed Majeed	4. Analysis of data and interpretation of results.
5.	Maheen Shahid	5. Literature review and referencing.
6.	Chaudhary Zeeshan Ahmad	6. Editing and quality insurer.
7.	Zubair Mustafa Khan	7. Quality assurance /review.
8.	Asif Bashir	8. Supervision.