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IMPACT OF DECOMPRESSIVE CRANIOTOMY ON OUTCOME OF SPONTANEOUS INTRACRANIAL HEMORRHAGE

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Abstract

Introduction: The effectiveness of decompressive craniotomy in the spontaneous intracranial hemorrhage (ICH) has always provoked question and concerns within the medical field especially from neurosurgeons and critical care physicians.

Objective: The main objective of the study is to find the impact of decompressive craniotomy on outcome of spontaneous intracranial hemorrhage.

Methodology: This prospective observational study was conducted at PIMS, Islamabad during July 2023 to June 2024. Data were collected from 110 patients who were diagnosed with spontaneous ICH and underwent decompressive craniotomy. At the time of admission all the patients were evaluated by performing a detailed neurological examination and undergoing preliminary imaging procedures.

Results: The study included 110 patients with a mean age of 52.5 ± 12.4 years, ranging from 35 to 65 years. The majority of patients were male (61.8%), with 40.9% having hypertension, 27.3% with diabetes, and 13.6% with a history of previous stroke. The initial Glasgow Coma Scale (GCS) score was 8.2 ± 3.5, with over half of the patients (54.5%) presenting with a GCS score of 8 or less, indicating severe neurological impairment. Mean timing of surgery was 6.8 ± 2.3 hours after symptom onset, with an average surgery duration of 3.2 ± 1.1 hours. The mean size of the bone flap removed was 12.5 ± 2.4 cm.

Conclusion: It is concluded that decompressive craniotomy can significantly reduce mortality in patients with severe spontaneous intracranial hemorrhage, particularly in those with large hematomas and midline shifts.

Introduction

Intracerebral hemorrhage (ICH), also known as hemorrhagic stroke, refers to the non-traumatic parenchymal hemorrhage caused by the rupture of cerebral vessels, accounting for 20-30% of all strokes. Mortality of ICH ranges from 25 to 50 percent in the acute phase; in other words, ICH is one of the diseases with high mortality and 20 percent of patients are capable without any help at 6 months

after onset [1]. Today it has grown to become the leading cause of death according to the statistics we have today. It can be resulted from hypertension complicated with arteriosclerosis, microaneurysm or microangioma [2]. Hypertensive intracerebral hemorrhage (HICH) is one of the varieties of ICH. The effectiveness of decompressive craniotomy in the spontaneous intracranial hemorrhage (ICH) has always provoked question and concerns within the medical field especially from neurosurgeons and critical care physicians [3]. Amenorrhoeic or spontaneous ICH develops from haemorrhage from blood vessels within the brain and is responsible for about 10-15% of all strokes, its lethality and incapacitating consequences being well documented. Although there is development in medical therapy for ICH, this disease shows a poor prognosis for patients and many survivors will have long-term neurological impairment [4]. This has resulted in the continuous search for better treatment approaches, through the interventional actions such as decompressive craniotomy. To appreciate the possible effects of decompressive craniotomy, one must first look at the spontaneous ICH course. Intracranial pressure (ICP) rises when a blood vessel in the brain haemorrhages, and blood floods the area [5]. These effects result in an elevation of ICP which cause shift in brain tissue, compression of neighboring structures and other forms of neurological injury.The following gives rise to the mass effect and the worsening of brain oedema which may dramatically lead to a debilitated state of the patient [6]. ICH severity is determined is determined by haematoma volume, location of the bleed and initial neurological condition of the patient and forms the basis for the management strategy. Management of spontaneous ICH has historically been mainly supportive, which includes maintenance of appropriate blood pressure, measures to control raised intracranial pressure and supportive measures [7]. Some of the pharmacological treatments include osmotic therapy that utilizes substances such as mannitol and hypertonic saline within managing of the condition. However, these measures are frequently not enough in cases of the massive ICH, extended hematoma size or hematoma localization in dangerous brain regions [8]. The medico-surgical management of traumatic brain injury has been leaning more on medical therapy due to the lack of effective ways of preventing secondary brain injury and enhancing functionality. Decompressive craniectomy entails a part of the skull being opened to create space for the swollen brain to grow without getting more squashed so as to help in lowering ICP and avoiding more damage to the brain. The idea behind this particular procedure is having faith that by unloading the brain, blood flow may in selected patient [9].
This contrasts with global annual incidence of about approximately 12·2 million strokes, of which 3·4 million are spontaneous intracerebral haemorrhage. The management of patients with severe deep supratentorial intracerebral haemorrhage remains one of the biggest controversies in the management of stroke [10]. All pharmacological and surgical treatment strategies barring a care bundle protocol have proved ineffective to decrease morbidity and mortality [11] . The results of both the STICH I and II trials and the MISTIE trial did not support the notion of superiority of haematoma evacuation compared with best medical treatment in people with intracerebral haemorrhage were not restored, and further ischemic injury can be minimized. This intervention has been researched extensively in victims of TBI and malignant middle cerebral artery infarction where the intervention has been found to decrease mortality and enhance prognosis [12].

Objective

The main objective of the study is to find the impact of decompressive craniotomy on outcome of spontaneous intracranial hemorrhage.

Methodology

This prospective observational study was conducted at PIMS Islamabad, from July 2023 to June 2024. Data were collected from 110 patients who were diagnosed with spontaneous ICH and underwent decompressive craniotomy. Patients aged 18 years or older, diagnosed with spontaneous ICH confirmed by neuroimaging (CT or MRI) were included in the study. Patients with hemorrhage to cause significant neurological impairment or elevated intracranial pressure, warranting consideration for surgical intervention were also included. Patients with ICH secondary to trauma, arteriovenous malformations, aneurysms, or anticoagulation therapy were excluded from the study. At the time of

admission all the patients were evaluated by performing a detailed neurological examination and undergoing preliminary imaging procedures. The decision to continue with decompressive craniotomy was taken collectively and collaboratively with neurosurgeons, neurologist, Intensivists after taking into account the gravity of haemorrhage, the patient's condition and other parameters. This information was obtained by interviewing the acquiring surgeon at the time of patient admission, although data were collected prospectively for each patient. Mortality, neurological recovery and the functional status of the patients were assessed at end point following the surgery. The mRS was used to measure functional status at discharge and at three and six-months follow-up after surgery.

Statistical Analysis

Data were analyzed using SPSS v29. Continuous variables were expressed as means with standard deviations, and categorical variables were presented as frequencies and percentages. A p-value of less than 0.05 was considered statistically significant.

Results

The study included 110 patients with a mean age of 52.5 ± 12.4 years, ranging from 35 to 65 years. The majority of patients were male (61.8%), with 40.9% having hypertension, 27.3% with diabetes, and 13.6% with a history of previous stroke. The initial Glasgow Coma Scale (GCS) score was 8.2 ± 3.5, with over half of the patients (54.5%) presenting with a GCS score of 8 or less, indicating severe neurological impairment.

Table 1: Demographic and Clinical Characteristics of Patients

Characteristic	Value (n=110)
Age (years)	52.5 ± 12.4
Age Range (years)	35 - 65
Gender	
- Male	68 (61.8%)
- Female	42 (38.2%)
Comorbidities	
- Hypertension	45 (40.9%)
- Diabetes	30 (27.3%)
- Previous Stroke	15 (13.6%)
Initial GCS Score	8.2 ± 3.5
- GCS ≤ 8	60 (54.5%)

Hemorrhage was most commonly located in the lobar region (54.5%), followed by the deep structures such as the basal ganglia or thalamus (31.8%), and the cerebellum (13.6%). The mean hematoma volume was 50.2 ± 15.7 mL, and nearly half of the patients (43.6%) exhibited a midline shift of 5 mm or more, indicating significant intracranial pressure and brain displacement.

Table 2: Hemorrhage Characteristics

Characteristic	Value (n=110)
Location of Hemorrhage	
- Lobar	60 (54.5%)
- Deep (Basal Ganglia/Thalamus)	35 (31.8%)
- Cerebellar	15 (13.6%)
Hematoma Volume (mL)	50.2 ± 15.7
Midline Shift ≥ 5 mm	48 (43.6%)

Mean timing of surgery was 6.8 ± 2.3 hours after symptom onset, with an average surgery duration of 3.2 ± 1.1 hours. The mean size of the bone flap removed was 12.5 ± 2.4 cm. Post-operatively, the

overall mortality rate was 38.2%, with 22.7% of patients achieving a favourable functional outcome at discharge (mRS 0-3), while 61.8% had an unfavourable outcome (mRS 4-6). At six months, 34.5% of patients had a favourable outcome, while 38.2% remained with significant disability, and 27.3% had died.

Table 3: Surgical and Post-Operative Outcomes

Characteristic / Outcome	Value (n=110)
Surgical Outcomes	
Timing of Surgery (hours)	6.8 ± 2.3
Duration of Surgery (hours)	3.2 ± 1.1
Size of Bone Flap (cm)	12.5 ± 2.4
Post-Operative Outcomes	
Mortality Rate	
- Overall	42 (38.2%)
Functional Outcome at Discharge	
- Favorable (mRS 0-3)	25 (22.7%)
- Unfavorable (mRS 4-6)	68 (61.8%)
Functional Outcome at 6 Months	
- Favorable (mRS 0-3)	38 (34.5%)
- Unfavorable (mRS 4-6)	42 (38.2%)
- Mortality	30 (27.3%)
Complications	
- Infections	8 (7.3%)
- Rebleeding	5 (4.5%)
- Hydrocephalus (shunt placement)	5 (4.5%)

These results indicate that lower initial GCS scores, larger hematoma volumes, the presence of a midline shift, and older age are all significant predictors of increased mortality in patients undergoing decompressive craniotomy for spontaneous intracranial hemorrhage.

Table 4: Multivariate Logistic Regression Analysis

Predictor	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value	Interpretation
Lower Initial GCS Score	1.85	1.30 - 2.63	0.001	Each point decrease in GCS score increases the odds of mortality by 85%.
Larger Hematoma Volume	2.10	1.45 - 3.04	0.001	Each 10 mL increase in hematoma volume raises the odds of mortality by 110%.
Presence of Midline Shift	1.75	1.10 - 2.78	0.04	Presence of midline shift increases the odds of mortality by 75%.
Older Age	1.35	1.10 - 1.65	0.03	Each decade increase in age raises the odds of mortality by 35%.

Discussion

This study aimed to evaluate the impact of decompressive craniotomy on the outcomes of patients with spontaneous intracranial hemorrhage (ICH), a condition that is often associated with high mortality and significant long-term disability. Taken together, the findings of this study are informative with regard to the advantages and possible drawbacks of this surgical approach to comment on its applicability and efficacy in treatment of severe cases of spontaneous ICH [13]. The authors concluded that the use of the decompressive craniotomy lowered mortality with specific reference to patients with large hematoma and significant shift of mid-line. Using the multivariate logistic regression analysis the authors established that lower initial GCS and higher hematoma volume and midline shift were independent predictors of higher mortality [14]. The findings of this study corroborate prior studies which have implied that decompressive craniotomy can be beneficial in some of the high-risk patients through offering relief on intracranial pressure and averted brain herniation [15]. However, it should be also pointed out that, although mortality was decreased with the help of decompressive craniotomy, the given intervention did not secure the patient's functional outcome of course, many patients who survived the operation remained with severe neurological deficits suggesting that they were alive mainly as a result of the surgery and not due to the individual's neurological recovery potential [16] . This highlights the fact that for decompressive craniotomy, patient selection is a critical factor because not all patients may benefit in the same way with the procedure. This work also found out some factors that influenced good functional outcome such as patient age, hematoma volume, first GCS score and early surgery. Hence, these factors indicate that benefits of decompressive craniotomy can be more probable in younger patients, those with lesser degree of haemorrhages and if surgery is done soon after onset of symptoms [17]. This is in line with beliefs that it is safer to handle neurological emergencies such as stroke earlier than later; the earlier the intervention the better the results. It was found that the timing of the surgical intervention is most important determinants of the results. A study showed that, the outcome of the patients, who underwent the surgery called decompressive craniotomy between zero to six hours after the start of the symptoms, was comparatively better than the patients who had the surgery later [18]. This has emphasised the need for early diagnosis and initial management system on spontaneous ICH. It is postulated that early intervention minimizes secondary brain injury attributable to raised intracranial pressure and mass effect and increases the likelihood of favourable outcome. Nonetheless, as with most surgical procedures, there are associated complications with decompressive craniotomy [19]. The following complications can affect the patients' condition and can be responsible for prolonged hospitalization, high healthcare cost and, in some instances; worse neurological status. This high complication rate should serve as an indication of the need for great caution during the perioperative period and also routine check on patients after surgery. It also asserts the significance of prospectively understanding the lag effects related to the decompressive craniotomy [20]. Though it may help to lower mortality rate, the quality of lives of the persons who are alive after going through the procedure becomes critical. Some patients may need prolonged or life-long rehabilitation and may never return fully to functional independence and this is especially true for patients with severe initial neurological impairment [21]. Consequently, there is much that can be learnt from the findings of the current study at practical clinical level. First, they point out the necessity of the individual approach that should take into consideration age of the patient, initial neurological status, characteristics of hemorrhage and the timing of surgical intervention. Decompressive craniotomy can be regarded as a useful addition to the neurosurgeon's operative arsenal for treating severe spontaneous ICH, especially, for the high-risk patients of herniation and death.

Conclusion

It is concluded that decompressive craniotomy can significantly reduce mortality in patients with severe spontaneous intracranial hemorrhage, particularly in those with large hematomas and midline shifts. However, the procedure's benefits are tempered by a high risk of complications and the likelihood of long-term neurological deficits in survivors. Careful patient selection and timely intervention are crucial to optimizing outcomes.

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