Outcome of Decompressive Craniectomy Surgery: A Study at King Khalid Hospital, Hail

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ABSTRACT

Background: Decompressive craniectomy (DC) is a life-saving surgical intervention for managing elevated intracranial pressure (ICP) due to malignant middle cerebral artery (MCA) infarction and intracranial hemorrhage (ICH). However, outcomes vary based on patient and procedural factors. **Objective:** This study aimed to evaluate the clinical outcomes, prognostic factors, and mortality associated with DC performed at King Khalid Hospital, Hail, Saudi Arabia.

Patients and Methods: A retrospective analysis was conducted on 20 patients (16 males, 4 females; mean age 49 ± 10.5 years) who underwent DC between January 2022 and December 2024. Data included demographics, clinical presentation, radiological findings, surgical details, and outcomes. Preoperative Glasgow Coma Scale (GCS) scores, pathology type, and onset characteristics were analyzed. Mortality rates and functional outcomes were compared between MCA infarction and ICH cases using descriptive and inferential statistics.

Results: The cohort included 10 patients with MCA infarction and 10 with ICH. The mean preoperative GCS was 8.0 ± 2.3. Mortality was 50% (10/20), with higher rates in MCA infarction (60%) compared to ICH (40%). Patients with left-sided pathologies exhibited better functional recovery ($p < 0.05$). Survivors demonstrated significant variability in outcomes, with higher preoperative GCS scores associated with improved recovery.

Conclusion: DC remains an effective intervention for refractory ICP, with survival influenced by preoperative GCS, pathology type, and hemispheric involvement. Early intervention may improve outcomes, underscoring the need for timely surgical decision-making and comprehensive postoperative care.

Keywords: Decompressive craniectomy, Intracranial hemorrhage, Middle cerebral artery infarction, Outcomes.

INTRODUCTION

Decompressive craniectomy (DC) is a critical surgical procedure designed to alleviate elevated intracranial pressure (ICP) that is unresponsive to conservative management. The procedure involves removing a portion of the skull, often the fronto-temporal-occipital bone over one or both cranial hemispheres, or performing a bilateral removal to accommodate the swollen brain [1,2]. By increasing the intracranial volume available under the scalp, DC reduces pressure, prevents herniation, and may minimize ischemic damage through improved cerebral blood flow and tissue oxygenation [2]. The most common indications for DC include malignant middle cerebral artery (MCA) infarction, traumatic brain injury (TBI), and intracranial hemorrhage (ICH). Despite its life-saving potential, DC is primarily utilized as a salvage procedure after all other options for managing ICP have been exhausted [3,4].

The timing and outcomes of DC are influenced by several factors, including the patient's age, preoperative neurological status, and underlying pathology. While timely intervention is associated with improved outcomes, variability in results underscores the importance of patient selection and individualized treatment strategies [5]. This study aimed to contribute to the growing body of evidence by analyzing the outcomes and prognostic factors associated with DC in a single-center cohort.

PATIENTS AND METHODS

Study Design

This retrospective study was conducted at King Khalid Hospital, Hail, Saudi Arabia. The medical records of patients who underwent decompressive craniectomy (DC) between January 2022 and December 2024 were reviewed to evaluate outcomes and prognostic factors.

Inclusion Criteria: Patients included in the study were those who underwent DC for malignant middle cerebral artery (MCA) infarction or intracranial hemorrhage (ICH). Participants were required to be older than 18 years and have documented preoperative and postoperative clinical data available for analysis.

Exclusion Criteria:

Patients with incomplete medical records, those who underwent DC for non-neurological indications, and patients operated on in hospitals other than King Khalid Hospital, Hail, were excluded from the study.

Data Collection

Data were extracted from electronic medical records and included comprehensive demographic information, clinical presentations, radiological findings, surgical details, and outcomes. Variables analyzed encompassed age, sex, type of pathology (MCA infarction or ICH), onset (spontaneous or post-traumatic), and the affected hemisphere (left or right). Preoperative neurological status was assessed using the Glasgow Coma Scale (GCS). Outcomes were evaluated in terms of mortality and functional recovery. This structured approach facilitated a thorough assessment of the factors influencing the efficacy and outcomes of decompressive craniectomy.

Ethical Considerations: The study was conducted following approval from the Research Ethics Committee at King Khalid Hospital, Hail, Saudi Arabia. Written informed consent was obtained from all patients or their legal representatives prior to

Received: 08/08/2024
Accepted: 08/10/2024

their admission to the hospital. The consent form clearly outlined their agreement to participate and the potential use of anonymized data for publication, ensuring strict confidentiality and privacy. This research adhered to the principles outlined in the Declaration of Helsinki and followed the ethical standards of the World Medical Association for studies involving human participants.

Statistical Analysis: Descriptive statistics were used to summarize the data. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as means, range, and medians. Statistical significance was assessed using t-tests, with a p-value <0.05 considered significant.

RESULTS

Patient Demographics and Clinical Characteristics:

The study cohort consisted of 20 patients (16 males, 4 females) with a mean age of 45.2 years (range: 28–64 years). Pathologies included 10 cases of MCA infarction and 10 cases of ICH. Fourteen cases had a spontaneous onset, while 6 were post-traumatic. Pathologies were left-sided in 12 cases and right-sided in 8.

Neurological Status: The median and mean GCS scores at presentation were 8/15. Patients with spontaneous onset had slightly better GCS scores compared to those with traumatic onset (p=0.03).

Mortality and Outcomes

The overall mortality rate was 50% (10 cases). Mortality was higher in MCA infarctions (6/10 cases) compared to ICH (4/10 cases). Survivors demonstrated variable degrees of functional recovery, with better outcomes observed in patients with higher preoperative GCS scores and left-sided pathologies.

Table 1: Patient Demographics and Clinical Characteristics

Variable	Value
Total Patients	20
Male: Female Ratio	16:4
Mean age	49 years
Pathology	10 MCA, 10 ICH
Onset	14 Spontaneous, 6 Traumatic
Pathology Side	12 Left, 8 Right
Mean GCS	8/15
Mortality	10/20 (50%)

Table 2: Mortality Distribution by Pathology

Pathology		Mortality	Mortality Rate (%)
MCA Infarction	10	6	60%
Intracranial Hemorrhage	10	4	40%

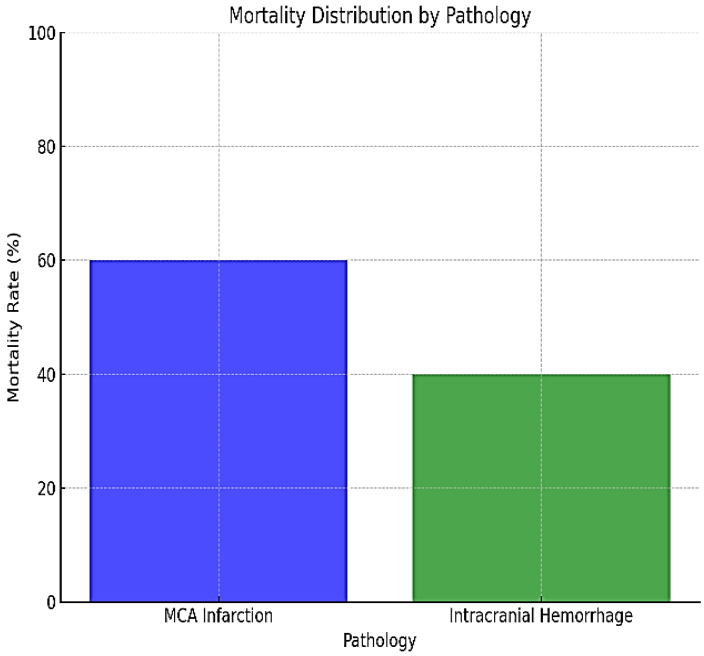

Figure 1: Mortality Distribution by Pathology
(A bar chart comparing mortality rates between MCA infarction and ICH cases.)

CASE 1

37 years old male patient, medically free fell down from height. GCS 13/15 vitally stable pupils equal, reactive regular no vomiting no seizures, no apparent weakness, brain CT scan showed left frontotemporal subdural hematoma with subarachnoid hemorrhage more evident at left frontal area. There was right occipital fissure fracture extended to foramen magnum, normal ventricular system, and normal posterior fosse structures. On admission in ICU, IV fluids, antiepileptic TTT were given Pt GCS deteriorated after 18 hours, CT brain follow up done showed increasing edema and midline shift of 10 mm. Lifesaving decompressive craniotomy was performed.

Post op patient gained consciousness, GCS 15/15, no fits or deficits.

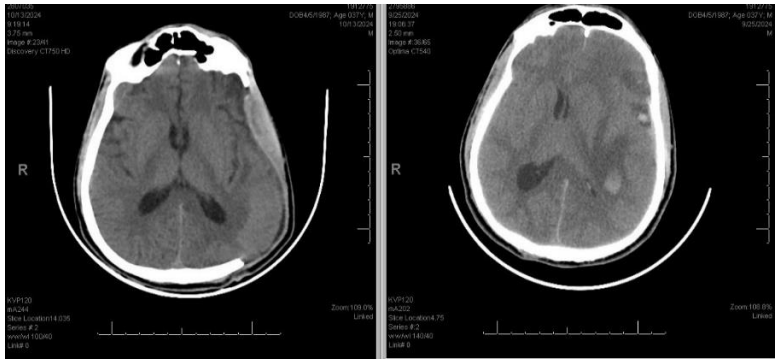

Fig. (2) showing pre op intracerebral hematoma with brain edema, midline shift (RT CT axial cut), and post decompressive craniectomy (LT CT axial cut).

CASE 2

56 years old male diabetic patient came to er as case of stroke, code stroke was activated, as pt out of the window, no thrombolytic therapy was given, single antiplatelet TTT was given. Patient was in his usual state of health conscious, hemiparesis of lt sided g 4/5, no speech deficit, no fits. 2 days after admission pt GCS was 14/15 and he was hemiplegic aphasic. Pre op CT findings: progression in the mass effect of the right large cerebral infarction upon the central structures and ventricles with significant midline shift to left side measured 12 mm with early right uncal herniation. There was gyral streaks and hyperdensities; likely hemorrhagic components.

Lifesaving rt decompressive craniectomy was done, post op patient was admitted at ICU for 1 day, then to normal ward, fully conscious, with lt sided hemiplegia, and aphasic.

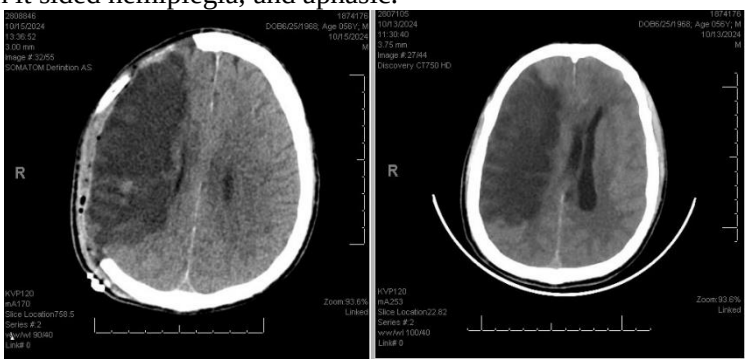

Fig. (3) showing pre op rt MCA infarction, midline shift (RT CT axial cut), and post decompressive craniectomy (LT CT axial cut).

DISCUSSION

Decompressive craniectomy is a well-considered tool in the management of elevated ICP due to malignant MCA infarction and ICH [1].

The findings of this study align with existing literature, highlighting the procedure's life-saving potential and also underscoring its limitations in achieving functional recovery.

Mortality and Prognostic Factors

The mortality rate of 50% observed in this cohort is consistent with global reports, where rates range from 40% to 60%. MCA infarctions exhibited higher mortality compared to ICH, likely due to the extensive cerebral edema and secondary complications associated with ischemic strokes.

Albanèse *et al.* reported worse outcomes and a mortality of 52% in their early-DC group as opposed to 23% in the late group. The early group was defined as those operated on within 24 h of admission to the hospital and the late group were patients that required DC after ICP became medically unmanageable (ICP > 35 mm Hg despite maximum medical treatment) 2–6 days after admission [6].

Mortality observed in this cohort underscores the necessity of comprehensive postoperative monitoring and rehabilitation. While **Schwab *et al.*** found that the mortality rates were 34.4% (11/32) in the late group and 16% (5/31) in the early group [7].

Left-sided pathologies were associated with better outcomes, in a prospective study by **Kilincer *et al.*** [7] of 32 patients, 6 out of the 7 patients with good outcome after 6 months (modified Rankin Score 0–3) were all patients with dominant side infarctions. One explanation proposed for this trend is that left-sided infarctions causing total aphasia may have lowered the patient's initial Glasgow Coma Score compared to similar right-sided infarctions. Subsequently, this lowered GCS score led to an earlier surgical decision, which minimized the ischemic damage and improved patient outcome. **Georgiadis *et al.*** concluded that DC should be the treatment of choice even in dominant-side infarction [8].

Role of GCS

The median GCS score of 8/15 indicates severe neurological compromise at presentation. Higher preoperative GCS scores were correlated with improved survival and functional outcomes. In support of these findings, **Münch *et al.*** [9] found that an initial GCS > 8 or age < 50 years predicted better outcome.

Timing of Surgery

Timing of DC is another critical factor influencing outcomes. Literature suggests that early intervention, particularly within 48 hours of symptom onset, is associated with better outcomes in malignant MCA infarctions. Delayed surgeries, often performed as a last resort, may fail to reverse established ischemic damage or secondary injury cascades [2].

Despite most cases has been operated on emergency basis, in this study timing data were not systematically analyzed but should be a focus of future research to refine surgical guidelines.

Cho *et al*. concluded that the timing of DC was explored in a study of 52 malignant MCA infarction patients separated into 3 cohorts: Ultra-early DC (within 6 h of symptom onset), DC after 6 h, and no DC at all. The Ultra-early group had a mortality of 8.3% (1/12), compared to 36.7% (11/30) for the later DC group and 80% (8/10) for the medically treated group [10].

Age at presentation

Mean age in this study was 49 years, with increasing morbidity and mortality with age. This can be explained by reduced brain plasticity, an increased rate

of underlying disease, and a general disability to cope with the stress of surgery. However, the exact age cut-off for better outcome remains unclear with some authors as **Erban *et al.*** advocating 55 years [11].

Postoperative Complications

Postoperative complications such as infection, hydrocephalus, and seizures were not extensively documented in this study but are well-recognized in the literature. These complications can significantly impact recovery and highlight the need for meticulous perioperative care. Hygroma was the most common complication found by **Guerra and colleagues** [12], seen in 15 out of 57 patients (26%), and also by **Aarabi *et al.*** [13] who found half of their patients (25/50) developing hygroma. **Kilincer *et al.*** [7] reported a contralateral subdural effusion after DC for an SAH patient and suggested that this could be a complication more specifically related to the concomitant SAH treatment. **Albanèse *et al.*** reported a high 22% incidence of meningitis, which was not seen in other studies [14]. Bone resorption after cranioplasty has also been seen in a number of cases in **Grant *et al.*** study [15].

Functional Outcomes

While this study primarily focused on mortality, functional outcomes remain a critical aspect of evaluating DC's efficacy. Survivors often face significant challenges, including motor deficits, cognitive impairments, and reduced quality of life. **Pillai *et al.*** [16] reported a 37% incidence of delayed postoperative seizures after 6–9 months. **Kan *et al.*** also reported seizure development in 20% of 6 pediatric DC patients as well as shunt-dependent hydrocephalus in 40% [17].

Limitations and Future Directions

This study's limitations include its small sample size and retrospective design, which may introduce selection bias. Additionally, the lack of long-term follow-up data limits our understanding of functional recovery and quality of life post-DC. Future research should focus on larger, multicenter cohorts with standardized data collection protocols. Incorporating advanced imaging modalities and biomarkers may also enhance the predictive accuracy of outcomes.

CONCLUSION

Decompressive craniectomy is an effective intervention for managing refractory ICP in cases of malignant MCA infarction and ICH. While it reduces mortality, it is influenced by factors such as preoperative GCS scores, pathology type, and hemispheric involvement. These findings underscore the need for careful patient selection and timely surgical intervention

The dichotomy between life-saving potential and the risk of severe disability necessitates a balanced discussion with patients and families during the decision-making process.

Financial support and sponsorship: Nil.
Conflict of interest: Nil.

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