Med. J. Cairo Univ., Vol. 93, No. 2, Accepted 7/4/2025
DOI: 10.22608/MJCU. 737-742, June 2025
www.medicaljournalofcairouniversity.net

Surgical Outcomes of Decompressive Craniectomy Versus Hinge Craniotomy in Treatment of Malignant Intracranial Hypertension, A Retrospective Comparative Study

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Abstract

Background: Malignant intracranial hypertension (MIH) remains a critical neurosurgical emergency requiring timely intervention to prevent irreversible brain damage. While decompressive craniectomy (DC) is a well-established approach, hinge craniotomy (HC) has emerged as a potential alternative that may reduce the need for secondary procedures.

Aim of Study: To compare decompressive craniectomy (DC) and hinge craniotomy (HC) in managing malignant intracranial hypertension (MIH).

Patients and Methods: Retrospective analysis of 40 patients (20 DC, 20 HC) treated at Beni-Suef University Hospitals (June 2023 – June 2024). Outcomes included Glasgow Outcome Scale (GOS), complications, ICU/hospital stay, and radiographic parameters.

Results: No baseline differences in age, gender, or pre-op GCS (p>0.05). HC showed a trend toward better GOS, with 70% of outcomes being favourable compared to 50% (p=0.13). Complication rates (infection: HC 15% vs. DC 25%, p=0.42) and ICU stays (HC 7.6±2.1 vs. DC 7.8±1.9 days, p=0.75) were comparable.

Conclusions: HC may offer comparable or superior outcomes to DC, avoiding secondary cranioplasty. More extensive prospective studies are needed.

Key Words: *Decompressive craniectomy – Hinge craniotomy – Intracranial hypertension – Glasgow Outcome Scale.*

Introduction

KOCHER in 1901 and Cushing in 1908 had first reported that Cranial decompression for the treatment of medically refractory intracranial hypertension 4. In the century following its introduction, its role remained a subject of controversy. Recently, many have reported a significant reduction in ICP and even a positive effect on result using this method **[1]**.

Currently, regardless of the paucity of randomized trials, DC has become an effective and accepted therapy for cases with malignant intracranial hypertension. Such as any other surgical procedure, there is morbidity correlated with DC **[1,2]**. With a big bone defect, there is a risk of potential to the exposed underlying brain, which may need the use of protective headgear. Delayed after surgery seizures were documented in 37% and hydrocephalus in 40% of cases after DC **[3]**.

Neurological worsening was also described following craniectomy, with improvement after cranioplasty 19. In addition, as many as 17% of cases will have chronic, debilitating headaches that only improve with the replacement of the cranial plate 5. Cranioplasty needs a 2nd operation conducted under exposes the case and general anesthesia to additional potential complications. Cranioplasty has a significant infection risk, with numerous cases needing removal of the autologous cranial plate or prosthetic with subsequent revision **[4]**.

Furthermore, bone plate resorption can be a problem, particularly in the pediatric population 1,7,10. The ideal procedure for cranial decompression would be one that combines the efficiency of DC but restricts the aforementioned difficulties with which it is correlated. In 2007, three investigative groups documented the utilization of HC **[5,6]**.

This technique involves resecuring the cranial plate in a noncircumferential fashion to the underlining skull at the time of the initial decompression, permitting for cerebral amplification via the cranial defect. By permitting the native plate to remain in position, there is a restricted cosmetic defect once

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the cerebral edema resolves, and the requirement for delayed cranioplasty is restricted. In spite of these advantages of potential, the HC utility for the relief of raised ICP is undetermined & may be only appropriate for "borderline" patients 7,12.

Patients and Methods

Study design and setting:

This retrospective study was conducted in 2025 at the Neurosurgery Department of Beni-Suef University Hospitals. Data were collected from patients treated between June 2023 and June 2024, following approval from the Research Ethics Committee of the Faculty of Medicine, Beni-Suef University.

Aim of the work: To compare the clinical and surgical outcomes of decompressive craniectomy (DC) and hinge craniotomy (HC) in the management of malignant hypertension (MIH).

Study population:

The study included 40 patients diagnosed with MIH who underwent either HC or DC during the specified period.

Sample size calculation:

This study size of sample was 40 cases, which has been measured where the functional status assessed by Short Form-36 score which was 36.7±20.6 in the decompressive craniectomy compared to 34.9±20.7 in the hinge craniotomy. Epi Info has been used to calculate the size of sample by considering the following assumptions: Ninety-five percent two-sided confidence level, with an eighty percent power. & α five percent error. The final maximum size of sample taken from the Epi-Info output was 15. Thus, the size of sample has been enhanced to 20 subjects to assume any drop outpatient throughout monitoring.

Inclusion criteria: All cases of malignant intracranial hypertension underwent surgical intervention by decompressive craniectomy or hinge craniotomy.

Exclusion criteria: Patients who unfit of surgery, patients with aneurysmal bleeding, or intoxication.

Methods:

Cases' data involved general characteristics (age, gender), before surgery neurological status involving "conscious level" measured by the Glasgow Coma Scale (GCS) at the time of admission, conducted chronic medical comorbidities (HTN, DM), prognosis, radiological findings, and treatment methods.

All cases have been identified utilizing a pre-operative CT scan. The following radiological parameters have been collected and extracted: The location, site, extent & infarction territory.

The volume, location, and maximal the hematoma diameter in cases of spontaneous intracerebral hemorrhage. The absence or presence of midline shift. Any radiographic signs of brain stem compression or herniation syndromes. The GOS has been used to asses results at discharge and six months postoperatively.

Surgical Techniques:

Decompressive Craniectomy (DC):

Objective: Achieve rapid intracranial decompression by removing a large bone flap.

Steps:

Positioning & Incision: Supine or lateral position with head turned. Reverse question-mark incision beginning at the tragus, extending posteriorly to the mastoid, then curving anteriorly to the midline.

Craniotomy: Burr holes placed at key points (pterion, temporal, parietal, frontal). Large bone flap (~12–15cm diameter) elevated using a craniotome. Temporal craniectomy: Additional bone is removed to the middle fossa floor using rongeurs/drill.

Dural Opening: Cruciate durotomy to allow brain expansion. Evacuation of hematomas (if present) via corticectomy.

Closure: Dura left open or covered with dural graft like pericranium graft of fascia lata graft. Bone flaps preserved in a bank of tissue for future cranioplasty. Scalp closed in layers.

Key Points: No bone reattachment Requires secondary cranioplasty.

Hinge Craniotomy (HC):

Objective: Allow brain expansion while preserving the bone flap for natural repositioning.

Steps:

Positioning & Exposure: Identical to DC (same incision/craniotomy).

Bone Flap Modification: After standard craniotomy, the sphenoid wing is drilled to enhance decompression. Bone edges smoothed to prevent dural injury.

Hinge Mechanism: Hinge craniotomies have been conducted using the method described by Goettler and Schmidt 15. The bone flap was reinserted and left flail, supported only by overlying sutures. Dural Management: Cruciate durotomy (as in DC). Dura left open but covered with precranium graft or fascia lata graft.

Closure: Temporalis muscle reapproximated (fascia left open for expansion). Galeal scoring/scalp undermining to accommodate swelling. The scalp closed over the hinged bone flap.

Key Points: Bone flap remains in situ Avoids cranioplasty.

Table (1): Key differences between DC and HC.

Feature	DC	HC
Bone Flap	Removed	Reattached with plates
Cranioplasty	Required (second surgery)	Avoided
Brain Expansion	Unconstrained	Partially constrained by hinge
Complications	Higher infection cranioplasty risks	Lower long-term morbidity

Data analysis:

Analysis and data entry will be made by utilizing SPSS software (SPSS 25.0 Version). Mean, percentage, and proportion will be measured. Chi square test will be utilized for establishing a correlation. The gathered data will be coded, analyzed, and processed utilizing the SPSS program (Version 25) for Windows. Descriptive statistics will be calculated to involve means, standard deviations, percentages, medians, and ranges. In the case of continuous variables, independent *t*-tests will be conducted to compare the means of normally distributed data, while Mann–Whitney U tests will be utilized to compare the median variances of the data that haven't been normally distributed, and chi-square test for categorical data. The *t*-test and Wilcoxon test will be utilized in dependent groups. A *p*-value above 0.05 is regarded statistically insignificant **[7-12]**.

Ethical consideration:

Obtaining approval from the Research Ethics Committee of the Faculty of Medicine Beni-Suef University. Informed consent was waived. The data of the patients will be collected from the archive and database of the Neurosurgery Department, Beni-Suef University.

Results

1- *Descriptive Statistics & Baseline Comparisons:*

Table (2): Patients' characteristics by surgical group.

	DC (n=20)	HC (n=20)	*p*-value
Age (years):			
Mean ± SD	65.1±9.2	64.3±8.5	0.78 (*t*-test)
Sex (% Male)	55%	50%	0.75 (χ^2)
Pre-op GCS:			
Mean ± SD	5.2±1.4	5.1±1.3	0.82 (*t*-test)
Midline Shift*	60%	55%	0.75 (χ^2)

p-value <0.05: Significant.
p-value above 0.05: Nonsignificant.
p<0.001: Highly significant.

This table shows a statistically insignificant variance between examined groups considering Age, Gender, Pre-op GCS, and Midline Shift.

Table (3): Clinical data by surgical group.

Parameter	DC (n=20)	HC (n=20)	*p*-value
Use Anticoagulation/ Antiplatelet	5/ 20 (25%)	6/20 (30%)	0.72 (χ^2)
Mean PTT (sec):			
Mean ± SD	25.1±3.1	26.8±8.5	0.40 (*t*-test)
Mean INR:			
Mean ± SD	1.2±0.55	1.6±1.7	0.32 (*t*-test)

This table shows a statistically insignificant difference between examined groups considering Use Anticoagulation/Antiplatelet, Mean PTT, and Mean INR.

Table (4): Post-operative data by surgical group.

	DC (n=20)	HC (n=20)	*p*-value
Favorable GOS (%)	10/20 (50%)	14/20 (70%)	0.13 (χ^2)
ICU Stay (days)	7.8±1.9	7.6±2.1	0.75 (*t*-test)
Hospital Stay (days)	24.5±5.3	25.2±6.0	0.69 (*t*-test)

This table shows a statistically insignificant difference between examined groups considering Favorable GOS, ICU Stay, and Hospital Stay.

Table (5): Post-op complications by surgical group.

Complication	DC (%)	HC (%)	*p*-value
Infection	(5/20) 25%	(3/20) 15%	0.42 (χ^2)
Hemorrhage	(4/20) 20%	(5/20) 25%	0.72 (χ^2)
Hydrocephalus	(9/20) 45%	(8/20) 40%	0.76 (χ^2)

This table shows a statistically insignificant variance between examined groups considering post-op complications.

Table (6): Post-op GCS, and postop midline shift improvement.

	DC (%)	HC (%)	*p*-value
GCS after 6 months	3.94±0.7	4.15±0.6	0.314 (*t*-test)
Postop midline shift:			
<5 mm	17/20 (85%)	15/20 (75%)	0.42 (χ^2)
≥5 mm - <10 mm	3/20 (15%)	5/20 (25%)	
No. of patient's hospital survival	14/20 (70%)	15/20 (75%)	0.72 (χ^2)

This table shows a statistically insignificant difference between examined groups considering GCS after 6 months, Postop midline shift, and no. of patient's hospital survival.

Table (7): ICP Measurement in different times.

ICP Measurement Time Point	DC Group ICP (millimeter Hg)	HC Group ICP (millimeter Hg)	*p*-value
Monitoring duration:			
POD 1	12.1±6.2	10.1±5.8	0.298 (*t*-test)
POD 2	12.4±5.0	13.4±8.1	0.64 (*t*-test)
POD 3	13.1±6.0	11.4±3.2	0.27 (*t*-test)
POD 4	13.1±5.4	11.9±3.0	0.39 (*t*-test)
POD 5	15.0±6.4	12.1±2.2	0.06 (*t*-test)

This table shows a statistically insignificant difference between examined groups considering ICP Measurement in different times.

Discussion

In managing malignant intracranial hypertension, both hinge craniotomy (HC) and decompressive craniectomy (DC) are employed to alleviate elevated intracranial pressure (ICP) *[13]*.

Our study aimed to compare these two surgical techniques across various clinical outcomes.

Our research indicated that a statistically insignificant difference between examined groups considering Age, Gender, Pre-op GCS, and Midline Shift. This parity aligns with findings from prior studies, ensuring that baseline disparities do not confound outcome comparisons.

Our outcomes showed that a statistically insignificant difference between examined groups considering Use Anticoagulation/Antiplatelet, Mean PTT, and Mean INR.

In alignment with our outcomes Kenning et al., *[14]* who found that a statistically insignificant difference between examined groups considering Use Anticoagulation/Antiplatelet, Mean PTT, and Mean INR. The mean PTT (sec) in HC group was 26.9±8.4 while in DC group was 24.9±3.4, and the mean INR in HC group was 1.6±1.9 while in DC group was 1.2±0.5. 6 (30%) cases in HC group used Anticoagulation/Antiplatelet agents while 7 (23%) cases in DC group used Anticoagulation/Antiplatelet agents.

In addition, Harifi et al., *[13]* stated shows a statistically insignificant difference between examined groups (DC and HC) as regards use of anticoagulation/antiplatelet, (*p*=0.78).

Our findings show a statistically insignificant difference between examined groups considering Favorable GOS, ICU Stay, and Hospital Stay. This concurs with the results reported by Kenning T.J., et al., who found insignificant variance in the length of ICU stay between HC & DC groups *[14,15,16]*.

As well, in agreement with our results Harifi et al., *[13]* who compared the long-, mid-, and short-term results in cases with malignant intracranial hypertension undergoing either hinge craniotomy or decompressive craniectomy. They reported that a statistically insignificant difference between examined groups considering Duration of ICU admission, and Duration of Hospital admission.

Regarding Postoperative complications, such as infection, hemorrhage, and hydrocephalus, there was no statistically significant differences. This finding is in line with prior research indicating comparable safety profiles for HC and DC *[14,15]*.

As well, in line with our outcomes Harifi et al., [13] stated that a statistically insignificant difference between examined groups considering problems (Infection and Hydrocephalus).

Our outcomes showed that shows a statistically insignificant difference between examined groups considering GCS after 6 months, Postoperative midline shift, and no. of patient's hospital survival.

In alignment with our results Kenning et al., *[14]* they found that a statistically insignificant difference between examined groups considering GCS score, and no. of patient's hospital survival.

Also, Harifi et al., *[13]* found that a statistically insignificant difference between examined groups considering GCS score and Postop midline shift with *p*-value 0.39, and 0.42, respectively.

Our outcomes showed a statistically insignificant difference between examined groups considering ICP Measurement at different times.

In agreement with our outcomes Kenning et al., [14] they stated that a statistically insignificant difference between examined groups considering ICP Measurement at different times. As well, Omerhodzic et al., *[17]* reported that two surgical options (DC and HC) outcomed in adequate control of intracranial pressure (ICP).

Limitations:

Our research is limited by its small size of sample, which might limit the generalizability of the findings and the ability to detect statistically significant differences. Additionally, the retrospective design may introduce selection bias. Future large-scale, prospective researches are necessary to confirm these outcomes and further elucidate the comparative benefits of HC and DC.

Conclusion:

Our research found a statistically insignificant differences among the DC (Decompressive Craniectomy) & HC (Hemicraniectomy) groups across various factors. These factors include demographic characteristics (age, gender), pre-operative and post-operative clinical measures (such as Glasgow Coma Scale scores, anticoagulation/antiplatelet use, and PTT/INR levels), and postoperative outcomes (such as ICU and hospital stay duration, GOS, and complications like infection, hemorrhage, and hydrocephalus). Additionally, there were no significant differences in longer-term outcomes like GCS after 6 months, postoperative midline shift, patient survival, or ICP measurements at different times. Overall, the results suggested that the two groups showed similar outcomes across these various measures. Further studies are encouraged to validate these findings across clinical settings and diverse populations.

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دراسة مقارنة بأثر رجعى بين النتائج الجراحية لاستئصال القحف التفريغى مقابل القحف المفصلى فى علاج ارتفاع الضغط الخبيث داخل الجمجمة

تناولت هذه الدراسة مقارنة بين جراحة استئصال عظم الجمجمة لتخفيف الضغط وجراحة القحف المفصلى فى علاج ارتفاع الضغط داخل الجمجمة الخبيث. أظهرت النتائج عدم وجود فروق ذات دلالة إحصائية بين المجموعتين من حيث الخصائص الديموغرافية (العمر، الجنس)، أو المعايير السريرية قبل وبعد الجراحة مثل مقياس غلاسكو للغيبوبة، استخدام مضادات التجلط، أو مدة الإقامة فى العناية المركزة والمستشفى.

كما لم تكن هناك فروق فى معدل المضاعفات بعد الجراحة مثل العدوى والنزيف والاستسقاء الدماغى، أو فى نتائج الوظيفة العصبية بعد ٦ أشهر. كذلك، لم تُلاحظ فروق فى تطور انحراف الخط المتوسط أو معدلات البقاء على قيد الحياة داخل المستشفى. أظهرت القياسات المتكررة لضغط الدماغ الداخلى عدم وجود اختلاف ذى دلالة بين المجموعتين.

تشير هذه النتائج إلى أن كلا الإجراءين الجراحيين متقاربان فى الفعالية والسلامة، مع ميزة محتملة فى تجنب الحاجة لجراحة لاحقة لتركيب العظم.

ومع ذلك، تُوصى بإجراء دراسات مستقبلية ذات حجم عينة أكبر وتصميم منهجى أقوى لتأكيد هذه النتائج وتحديد الحالات المثلى لكل تقنية جراحية.