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DECOMPRESSIVE CRANIOTOMY IN MANAGEMENT OF ACUTE CEREBRAL ISCHEMIA

By

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ABSTRACT

Background: Ischemic stroke is a medical emergency and the most common affection of the central nervous system (CNS). This is the second-leading cause of death worldwide and the first causes of morbidity. Ischemic stroke correspond to 85% of all strokes with a mortality of 10-50%. Large space-occupying infarction accounts for 1-10% of all supratentorial infarction with signs of elevated intracranial pressure (ICP) and brain herniation usually in the second to the fifth day leading to a mortality rate of 53% to 89%.

Objective: To evaluate the clinical and radiological outcome of decompressive surgery in the setting of cerebral infarctions, and to study its effect in reducing the overall mortality rates of this fatal condition.

Patients and methods: This study is descriptive and analytic clinical trial study for evaluating the clinical and functional outcomes of surgical cases with massive cerebral infarction. Over one year, Between January 2018 and January 2019, at Dar Alshifa Hospital, and Al-Azhar University Hospitals in Cairo.

Results: Twenty cases with cerebral infarctions were included in this. In our study, there was 12 males (60%) and 8 females (40%) male: female ratio 1.5:1.The age of the cases ranged from 37 to 77 years. The mean age was 57.65 years. Four cases were less than 50 years (20%), 6 cases between 50 and 60 years (30%), 8 cases between 60 and 70 years (40%), and 2 cases above 70 years (10%). Eighteen cases had middle cerebral artery (MCA) infarctions (90/%), while 2 cases had both MCA and anterior cerebral artery (ACA) infarctions. eleven cases were right sided while 9 cases were having left-sided infarctions.

Conclusion: The preoperative clinical condition , higher GCS score at presentation were strongly related to a favorable clinical outcome .Some ICU related complications such as contra lateral infarction, hemorrhagic infarction, pulmonary embolism, pneumonia can worse the patient outcome .Other complication related to the surgery such as CSF leak, wound infection did not effect on patient prognosis. Factors like patients' age, sex, site of infarction, and preoperative midline shift did not affect the final outcome. A study with larger sample size and longer follow-up is recommended for better confirmation of these facts.

Keywords: Decompressive Craniotomy, Acute Cerebral Ischemia, middle cerebral artery infarction.

INTRODUCTION

Ischemic stroke is a medical emergency and the most common affection of the central nervous system (CNS). This is the second-leading cause of death worldwide and the first cause of morbidity *(Mattos et al., 2010).*

Ischemic stroke corresponds to 85% of all strokes with a mortality of 10-50%. Large space-occupying infarction accounts for 1-10% of all supratentorial infarction with signs of elevated

intracranial pressure (ICP), and brain herniation usually in the second to the fifth day leading to a mortality rate of 53% to 89% *(Sumana et al., 2013).*

Large space-occupying infarction is generally secondary to an occlusion of the carotid artery or the M1 segment of the middle cerebral artery (MCA), including or not the anterior cerebral artery (ACA) or the posterior cerebral artery (PCA). Neuroimaging criteria varies between the authors: infarct volume on diffusion-weighted magnetic resonance imaging (MRI) of more than 145 cm3; brain computed tomography (CT) ischemic changes affecting more than two-thirds of the MCA territory and including the basal ganglia; brain CT ischemic changes affecting at least two-thirds of the MCA territory with space-occupying edema; signs on CT of an infarct of at least 50% of the MCA territory, with or without additional infarction in the territory of the anterior or posterior cerebral artery on the same side *(Godoy et al., 2016).*

The neurological manifestations of cerebrovascular stroke are more severe in cases of malignant MCA infarctions, including hemiplegia, cranial nerve affections, hemianasthesia, and global aphasia. These signs usually progress to disturbed conscious level and death with 24 to 72 h. Other terms used to describe this condition include space-occupying MCA infarction, massive MCA infarction, and cerebral infarction with swelling *(Refaat et al., 2018).*

Decompressive craniectomy has been already proven to be effective in the management of elevated intracranial pressure related to trauma, though its effectiveness in setting of malignant stokes is still under debate. However, several studies report a 40–50% increase in survival rates when decompressive craniectomy is performed in cases with malignant MCA infarctions *(Brown et al., 2017).*

Medical management should take place in a specialized neuro-intensive care unit, with a primary goal of reducing intracranial pressure and maintaining adequate cerebral perfusion pressure, as well as cerebral blood flow. Medical treatment includes hyperventilation, body positioning, hypothermia, brain dehydrating measures (mannitol, hypertonic saline, and corticosteroids), and barbiturate coma *(Mitchell et al., 2015).*

The standard technique for surgical decompression is decompressive hemicraniectomy (or in situ hinged craniotomy) combined with augmentation duroplasty. There is still a controversy concerning the optimal time for surgical intervention and also the cutoff age limit for surgical decompression *(Watts et al., 2014).*

Many studies have suggested that decompressive surgery, consisting of a hemicraniectomy and duraplasty, reduces mortality and improves outcome in patients with massive brain infarctions *(Yang et al., 2015).*

The goal of this study was to evaluate the clinical and radiological outcome of decompressive surgery in the setting of cerebral infarctions and to study its effect in reducing the overall mortality rates of this fatal condition.

PATIENTS AND METHODS

This was a descriptive and analytic clinical trial study for evaluating the clinical and functional outcomes of surgical cases with massive cerebral infarction. Over one year, between January 2018 and January 2019. The patients have massive cerebral infarction who was admitted at Dar Alshifa Hospital, and Al-Azhar University Hospitals in Cairo.

This was a study conducted on 20 patients diagnosed to have malignant MCA infarction (may be combined with ACA territory) on brain computed tomography (CT) or diffusion-weighted imaging (DWI) whenever available.

The study group was selected to have midline shift more than 5 mm. The mean preoperative midline shift was 7.9 mm. Thirty percent of cases had preoperative midline shift between 5 and 7.5 mm, 60% had midline shift between 7.5 and 10 mm, while 10% had midline shift more than 10 mm.

All cases were operated upon within 6 hours from the initial presentation in 15 cases (75%), while the remaining 25% of cases were managed conservatively initially as they did not meet our inclusion criteria, but they deteriorated and were included in the study. They were operated upon also within 6 hours from the deterioration. All cases were operated upon by decompressive hemicraniectomy and duroplasty. The bone flap was placed subcutaneously in the anterior abdomen in 80% of cases or kept in situ flail hinged to the temporalis muscle in 20% of cases. We did not meet intraoperative complications or mortalities in any of our cases.

Inclusion criteria:

- Both sexes.
- Any age.
- Patients showing clinical evidence of ischemic insult, disturbed conscious level (Glasgow Coma Scale (GCS) ≤ 12).
- Patients have CT scan brain showing evidence of massive brain edema with midline shift more than 5 mm (calculated at the level of the septum pellucidum).
- Written informed consent.

Exclusion criteria:

- Patients associated with brain tumors.
- Patients associated with interacerebral hemorrhage.
- Patients associated with interacerebral infection.
- Recent intracranial surgical intervention.
- Patients with lost brain stem reflexes, GCS ≤ 4.
- Patients with severe hemodynamic instability.

Preoperative Assessment:

History: Personal history was taken from the patients relatives including sex, age, occupation, special habit, and co morbid medical condition like hypertension, diabetes mellitus, hepatitis C virus, coagulopathy.

Present history, and past history of DVT, cardiothoracic surgeries like valve replacement or open heart surgery.

Examination:

General (weight, height, vital signs, head, chest, heart abdomen, pelvis) searching for primary infection or systemic disease that may affect the surgery.

Detailed neurological examination: Measurements for assessment the clinical progress:

1. Level of consciousness was evaluated using The Glasgow Coma Scale (GCS).
2. Muscle strength was determined using Medical research council grading system- Motor examination for Muscle state, tone, power and deep tendon reflexes. Motor power was assessed according to United Kingdom medical research council *(MRC, 1976)*.
3. The patients were classified according to the national institutes of health stroke scale (NIHSS):

   The level of stroke severity as measured by the NIH stroke scale scoring system:

   - 0 = no stroke.
   - 1-4 = minor stroke.
   - 5-15 = moderate stroke.
   - 15-20 = moderate/severe stroke.
   - 21-42 = severe stroke.

Investigations:

- CT of the brain for ischemic changes affecting at least two-thirds of the MCA territory with space-occupying edema or both MCA and ACA or PCA infarctions leading to a minimum of 50% hemispherical volume compromised.
- CT cerebral angiography.
- Carotid ultrasound Doppler.
- Complete laboratory investigation CBC, coagulation profile, renal function tests, and liver function tests.

The mean operative time, the mean blood loss, the intra operative complications and the surgical procedure were estimated.

Post-Operative Data:

All patients were admitted into the Intensive Care Unit (ICU) after just surgery, and still intubated on hyperventilation mode for 48 hours at least. Removal of the drain was usually after 72 hours. Follow up CT brain was used in comparative follow up.

Follow up evaluation:

Post-operative follow up was continued both clinically and radio graphically.

· Any post-operative complications like added motor deficit, cerebrospinal fluid leakage, head swelling, limited range of motion of any joint, and wound infection were recorded. The average return to work period in days, type of work, and daily activity performance will be documented post operatively.

RESULTS

Descriptive and analytic demographic data of studied patients:

Twenty cases with cerebral infarctions were included in this study during the period from January2018 to January 2019. There were 12 males (60%) and 8 females (40%) male. The female ratio was 1.5:1 **(Table 1)**.

Table (1): Distribution of sex among the studied sample

Samples / Parameters	NO	%
Males	12	60
Females	8	40
Total	20	100

The age of the cases ranged from 37 to 77 years. The mean age was 57.65 years. Four cases were less than 50 years (20%), 6 cases between 50 and 60 years (30%), 8 cases between 60 and 70 years (40%), and 2 cases above 70 years (10%). Eighteen cases had MCA infarctions (90/%), while 2 cases had both MCA and ACA infarctions. eleven cases were right sided while 9 cases were having left-sided infarctions.

It was the first ischemic insult in 18 cases (90%), while it was on top of a previous stoke in 2 cases (10%). Seventy percent of cases were hypertensive, 40% were diabetic, 35% had atrial fibrillation, and 20% had ischemic heart disease. Cases included in this study were selected to have GCS scores more than 4 and less than 13. 55% of cases had GCS scores between 7 and 10, 15% had GCS scores 5 and 6, while 30% had GCS scores 11 and 12. The mean preoperative GCS score was 9.1 **(Table 2)**.

Table (2): Relationship between outcome and INITIAL GCS among the studied cases

GCS before	Good recovery	Moderate disability	Severe disability	Death	P. value
<8	0	3	2	3	0.014
no.	0.0	37.5	25.0	37.5	
%					
9-10	4	0	1	1	
no.	66.7	0.0	16.7	16.7	
%					
11-15	5	0	1	0	
no.	83.3	0.0	16.7	0.0	
%					

Good outcome (GCS) was achieved in 12 cases (60%), while poor outcome (GCS) was found in 8 cases (40%). four cases of these poor outcome were died. The mean GCS at the end of the follow-up period was 10.

All cases showed radiological improvement concerning the midline shift

in the follow-up CT scans. The mean postoperative midline shift in the first 24 h follow-up CT was 4.8 mm. The midline shift resolved in all cases within 7 postoperative days; the mean was 4 days. There was 4 mortality cases in this study (20%): two of these cases did not show any clinical improvement after surgical decompression (despite radiologic improvement of midline shift), while the remaining 2 cases showed initial clinical improvement but later on died. one of the cases (5%) had hemorrhagic transformation of the stroke after decompression and this case was managed conservatively. ICU-related complications (wound infection, CSF leak, pneumonia, DVT, PE and sepsis) occurred in 9 cases (45%) and were fatal in 4 cases (20%) **(Table 3)**.

Table (3): Relationship between outcome and complication among the studied cases

Outcome / Complication		Good recovery	Moderate disability	Severe disability	Death	P. value
Contralateral infarction	No	0	0	0	1	0.028
	%	0.0	0.0	0.0	5	
CSF leak	No	1	1	0	0	
	%	5	5	0.0	0.0	
DVT	No	0	1	0	0	
	%	0.0	5	0.0	0.0	
Hemorrhagic infarction	No	0	0	0	1	
	%	0.0	0.0	0.0	5	
PE	No	0	0	0	1	
	%	0.0	0.0	0.0	5	
Pneumonia	No	0	0	1	0	
	%	0.0	0.0	5	0.0	
Sepsis	No	0	0	0	1	
	%	0.0	0.0	0.0	5	
Wound infection	No	1	0	0	0	
	%	5	0.0	0.0	0.0	
No	No	7	1	3	0	
	%	35	5	15	0.0	

DISCUSSION

This study included 20 patients admitted to the Neurosurgery Department, Al-Azhar University Hospitals, and Neurosurgery Department, Dar Al-shifa Hospital in Cairo, all cases with massive cerebral infarction and underwent to surgical management by decompressive craniotomy. All data regarding these patients were reviewed, including age, sex, medical history, clinical presentation, radiological findings and prognosis. The management protocols were also maintained for each patient. The study done over one year, period from January 2018 to January 2019, there were 12 males (60%) and 8 females (40%), the age of the cases ranged from 37 to 77 years. The mean age was 57.65 years. Eighteen cases had MCA infarctions (90%), while 2 cases had both MCA and ACA infarctions. Eleven cases were right sided while 9 cases were having left sided infarctions. Cases included in this study were selected to have GCS scores more

than 4 and less than 13. The study group was selected to have midline shift more than 5 mm. The mean preoperative midline shift was 7.9 mm. All cases were operated upon by decompressive hemicraniectomy and duroplasty within 6 hours from presentation or deterioration. The bone flap was placed subcutaneously in the anterior abdomen in 80% of cases or kept in situ flail hinged to the temporalis muscle in 20% of cases. We did not meet intraoperative complications or mortalities in any of our cases. All cases showed radiological improvement concerning the midline shift in the follow-up CT scans. The mean postoperative midline shift in the first 24 hours follow-up CT was 4.8 mm. The midline shift resolved in all cases within 7 postoperative days. There were 4 mortality cases in this study (20%), two of these cases did not show any clinical improvement after surgical decompression (despite radiologic improvement of midline shift). Some complications like (pneumonia, PE and sepsis) occurred in 9 cases (45%) and were fatal in 4 cases (20%), while other complication like (wound infection, CSF leak, DVT) have no effect in favorable outcome. Good outcome (GCS) was achieved in 12 cases (60%), while poor outcome (GCS) was found in 8 cases (40%); four cases of these poor outcomes were died. The mean GCS at the end of the follow-up period was 10.

Several studies were conducted during the last 10 years for the roll of decompressive craniectomy in cerebral ischemia. Almost all studies reached the conclusion that the decompressive crainectomy reduce the mortality in cases of massive cerebral infarction and improve the patient outcome but cannot reduce disability *(Pallesen et al., 2019).*

Bansal et al. (2015) conducted a study that Decompressive craniectomy has reduced morbidity and mortality especially in people aged below 60 years and those operated within 48 hours of malignant MCA stroke though those operated outside 48 hours of stroke also fare well neurologically. Approximately, 60% patients were older than 60 years, 74% patients operated within 48 hours (25 patients) had mRS 0–3 at discharge while 56% patients operated after 48 hours had mRS 0–3 at discharge which is not significant statistically. 78% patients aged below 60 years had mRS 0–3 at discharge while only 38% patients aged above 60 years had mRS 0–3 at discharge which was statistically significant. In our study the mean age was 58 years. All 20 patients were operated within 48 hours from presentation, we noted the patients with age below than 58 years old have better outcome than who are above 58 years old, but that was not statistically significant.

Raffiq et al. (2014) conducted that decompressive craniectomy significantly reduces mortality rate and improves functional outcome. Factors significantly influencing outcome in this study were age, GCS on admission and preoperatively, extent of infarction and mass effect, and time interval from onset to surgery. Additional vascular territory involvement and midline shift of more than 10 mm were significantly associated with poor outcome at 6 months. Dominant hemisphere involvement had no significant effect on outcome in this study. The issue of age limit remains unclear as older patients subjected to surgery had

lower mortality rate compared to older patients who were treated medically. In our study we used GCS for evaluation of the patient's pre and post-operative and we conducted that higher GCS score at presentation were strongly related to a favorable clinical outcome. Other factors like age, midline shift and side of infarction did not affect the final outcome.

A Chinese study, conducted at four study sites, showed no significant difference between both groups regarding poor functional outcome (mRS scores >3) at 6 months and 12 months *(Zhao J et al., 2012)*. In our study we have good outcome achieved in 12 cases (60%), while poor outcome was found in 8 cases (40%), four cases of these poor outcome were died.

Slezins et al. (2012) a study from Latvia enrolled 24 patients with massive middle cerebral infarction, eleven patients (45.8%) received DC and the other 13 (54.2%) received best medical treatment. After 1 year, 5 of 11 patients (45.5%) with DC survived compared to 1 of 13 patients (7.7%) in the best medical treatment group. In our study all the 20 patients were operated, 16 of them survived (80%).

Chua et al. (2015) found that 38% of patients with a low GCS who had surgery had a poor outcome. In our study 12 patients had a favorable outcome as we operated at GCS 5-12 within the first 48 hours.

CONCLUSION

The preoperative clinical conditions, higher GCS score at presentation were strongly related to a favorable clinical outcome.

Some ICU related complications such as contralateral infarction, hemorrhagic infarction, pulmonary embolism, pneumonia can worse the patient outcome. Other complication related to the surgery such as CSF leak, wound infection did not effect on patient prognosis.

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قطع القحف المخفف للضغط في مناجزة الإقفار المخي الحاد

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خلفية البحث: يعتبر الاقفار المخى الحاد من الامراض الطارئة التى تصيب الجهاز العصبى المركزى ويعتبر السبب الثانى على مستوى العالم لحدوث الوفاة.

الهدف من البحث: تقييم جراحة قطع القحف المخفف للضغط في مناجزة الإقفار المخي الحاد.

المرضى وطرق البحث: تمت الدراسة على عشرين حالة يعانون من الاقفار المخى الحاد وقد تم اجراء جراحة القطع القحفى للجمجمة.

نتائج البحث: تم اجراء الدراسة على عشرين حالة يعانون من الاقفار المخى الحاد 12 حالة من الرجال و8 من السيدات حدث وفاة لأربع حالات وهناك 9 حالات اظهروا تحسنا كبيرا وباقى الحالات لم يحدث لهم تحسنا فى االحالة الصحية.

الإستنتاج: تقلل عملية القطع القحفى المخفف للضغط فى مناجزة الاقفار المخى الحاد من نسبة العجز وتمنع من حدوث الوفاة المباشرة.

الكلمات الدالة: القطع القحفى،الإقفار المخى الحاد،الشريان الدماغى الأوسط.