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# REMARK ON SOME FACTORS RELATED TO THE OUTCOMES OF DECOMPRESSIVE CRANIECTOMY IN PATIENTS WITH ISCHEMIC STROKE DUE TO MIDDLE CEREBRAL ARTERY OCCLUSION AT THE MILITARY CENTRAL HOSPITAL 108

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## ABSTRACT

**Objectives:** *To evaluate some factors related to the decompressive craniectomy in patients with ischemic stroke caused by middle cerebral artery occlusion*

**Subjects and methods**: *A retrospective descriptive, uncontrolled study combined with a prospective study was conducted on 31 patients with ischemic stroke due to middle cerebral artery occlusion who underwent decompressive craniectomy at Military Central Hospital 108 from January 2022 to December 2024.*

**Results:** *The mean time from stroke onset to surgery was 44.1 ± 26.0 hours. The rate of good outcomes was 56.3% in patients younger than 60 years, 47.4% in patients undergoing surgery within 48 hours, and 45.8% in patients with a midline shift of less than 10 mm. These rates were all higher than those observed in patients older than 60 years (13.3%), patients undergoing surgery after 48 hours (16.7%), and patients with midline shift greater than 10 mm (0%), respectively; the differences were statistically significant ($p < 0.05$). The rate of good outcomes among patients with preoperative Glasgow Coma Scale scores > 8 (43.7%) was higher than among those with scores ≤ 8 (26.7%), although the difference was not statistically significant ($p > 0.05$). Three out of 22 patients experienced seizures within 6 months after surgery.*

**Conclusion**: *Decompressive craniectomy for large territorial ischemic stroke caused by middle cerebral artery occlusion should be performed early, within 48 hours. Higher rates of good outcomes were observed in patients younger than 60 years old and in those with a midline shift of less than 10 mm.*

**Keywords:** Stroke, cerebral infarction, decompressive craniectomy.

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## 1. INTRODUCTION

Stroke is one of the leading pathological causes of mortality and disability worldwide. Stroke is classified into two main types: cerebral infarction and intracerebral hemorrhage, among which cerebral infarction accounts for approximately 80-85% of all cases. Among the clinical forms of ischemic stroke, infarction caused by middle cerebral artery occlusion has the highest incidence [1]. In cases of massive cerebral infarction, progressive cerebral edema may increase intracranial pressure, leading to a high risk of death.

Decompressive craniectomy has been proven to be an effective intervention to increase cranial volume and reduce intracranial pressure, thereby contributing to reduced mortality and disability rates in patients with ischemic stroke. However, the outcomes of decompressive craniectomy depend on multiple factors related to clinical characteristics, paraclinical findings, and timing of intervention.

Based on this clinical reality, we conducted this study to evaluate several factors related to the outcomes of decompressive craniectomy in patients with ischemic stroke due to middle cerebral artery occlusion at Military Central Hospital 108.

## 2. SUBJECTS AND METHODS

### 2.1. Subjects

Thirty-one patients with massive ischemic stroke due to middle cerebral artery occlusion who underwent decompressive craniectomy at the Department of Neurosurgery, Military Central Hospital 108, from January 2022 to December 2024.

Inclusion criteria: Patients diagnosed with massive ischemic stroke due to middle cerebral artery occlusion according to the American Heart Association/American Stroke Association (AHA/ASA) criteria: infarct area > 50% of the middle cerebral artery territory on cranial computed tomography (CT). Patients indicated for decompressive craniectomy according to Juttler E (2011) [2].

Exclusion criteria: Patients with previous stroke sequelae with modified Rankin Scale (mRS) score ≥ 2; bilateral fixed dilated pupils; or contralateral hemispheric ischemia. Patients with an expected survival of less than 3 years due to severe underlying diseases or irreversible systemic conditions. Patients with coagulopathy or uncontrolled systemic bleeding. Patients with contraindications to anesthesia. Patients or legal representatives refuse to participate in the study.

### 2.2. Methods

- Study design: Retrospective descriptive, uncontrolled study combined with a prospective study.

+ Retrospective study: Collection of data from medical records of eligible patients from January 2022 to April 2024.

+ Prospective study: Enrollment of eligible patients from May 2024 to December 2024.

- Sampling method: Convenience sampling.

- Study indicators:

+ Preoperative treatment methods: medical resuscitation, thrombolysis, mechanical thrombectomy, etc.

+ Long-term surgical outcomes (6 months postoperatively): Modified Rankin Scale (mRS).

+ Factors related to long-term surgical outcomes: age, timing of surgery, preoperative Glasgow score, preoperative midline shift, pupillary dilation, etc.

+ Long-term sequelae 6 months after surgery.

- Evaluation criteria used in the study:

+ Assessment of patient consciousness level at admission and before surgery using the Glasgow Coma Scale [3] (eye, verbal, and motor responses): > 8 points (mild to moderate consciousness disturbance); ≤ 8 points (severe consciousness disturbance or deep coma).

+ Assessment of midline shift according to Liao CC (2018) [4]: Grade I (1-5 mm shift); Grade II (5-10 mm shift); Grade III (> 10 mm shift).

+ Assessment of long-term surgical outcomes (6 months postoperatively) using the Modified Rankin Scale (mRS), divided into two groups: good outcome (mRS 0-3) and bad outcome (mRS 4-6) [1].

- Data processing: using SPSS version 20.0 software and standard statistical algorithms.

- Ethics: The study was approved by the Biomedical Research Ethics Committee of Military Central Hospital 108 (Certificate No. 3898/GCN-BV dated June 24, 2024). Collected data were kept confidential and used solely for research purposes. The authors declared no conflicts of interest related to the study.

## 3. RESULTS

- Preoperative treatment methods:

In our study, 100% of patients received medical resuscitation before surgery. Five of 31 patients (16.1%) underwent intravenous thrombolysis before surgery, and 9 of 31 patients (29.0%) underwent mechanical thrombectomy.

Distribution of patients according to time from initial stroke symptoms to surgery:

Table 1 shows that 19/31 patients (61.3%) underwent surgical intervention within 48 hours after ischemic stroke onset (mean time: 44.1 ± 26.0 hours).

**Table 1. Distribution of patients by surgical timing**

| Time from symptom onset to surgery | Number of patients (n = 31) | Percentage (%) |
|---|---|---|
| Within 48 hours | 19 | 61.3 |
| After 48 hours | 12 | 38.7 |
| Mean ± SD (minimum-maximum) (hours) | 44.1 ± 26.0 (11-96 hours) | |

- Some factors affecting long-term outcomes (6 months postoperatively)

**Table 2. Some factors affecting surgical outcomes at 6 months after discharge**

| Factors | | Good outcome (mRS 0-3) | | Bad outcome (mRS 4-6) | | p | OR |
|---|---|---|---|---|---|---|---|
| | | No. of patients | Percentage (%) | No. of patients | Percentage (%) | | |
| Age | ≤ 60 years (n = 16) | 9 | 56.3 | 7 | 43.7 | < 0.05 | 8.4 |
| | > 60 years (n = 15) | 2 | 13.3 | 13 | 86.7 | | |
| Timing of surgery | ≤ 48 hours (n = 19) | 9 | 47.4 | 10 | 52.6 | < 0.05 | 4.5 |
| | > 48 hours (n = 12) | 2 | 16.7 | 10 | 83.3 | | |
| Midline shift | ≤ 10 mm (n = 24) | 11 | 45.8 | 13 | 54.2 | < 0.05 | 1.8 |
| | > 10 mm (n = 7) | 0 | 0 | 7 | 100.0 | | |
| Pupils | Dilated (n = 14) | 6 | 42.8 | 8 | 57.2 | > 0.05 | 1.8 |
| | Non-dilated (n = 17) | 5 | 29.4 | 12 | 70.6 | | |
| Preoperative Glasgow score | > 8 points (n = 16) | 7 | 43.7 | 9 | 56.3 | > 0.05 | 2.1 |
| | ≤ 8 points (n = 15) | 4 | 26.7 | 11 | 73.3 | | |

At 6 months postoperatively, the rate of good outcomes was higher in patients aged ≤ 60 years, patients operated on within 48 hours, and patients with midline shift ≤ 10 mm compared with their respective counterparts. These differences were statistically significant ($p < 0.05$).

- Long-term postoperative complications:

More than 6 months after surgery, 22/31 patients returned for follow-up examination. Among them, 3/22 cases (13.6%) were identified with seizure complications. No cases of hydrocephalus or "sinking skin flap syndrome" were detected.

## 4. DISCUSSION

### 4.1. Preoperative Treatment

Before surgery, 5/31 patients (16.1%) received intravenous thrombolytic therapy and 9/31 patients (29.0%) underwent mechanical thrombectomy. These are modern and highly effective techniques for patients with early-detected ischemic stroke, consistent with the recommendations of the American Heart Association and the American Stroke Association [5]. However, the study by Powers W.J. [1] showed that intravenous thrombolysis has a failure rate of up to 50-70%; Goyal M. reported a failure rate of 10-20% for mechanical thrombectomy, and some patients may experience re-occlusion after the procedure or hemorrhagic transformation within infarcted areas [6].

The timing of surgery (defined as the interval from symptom onset to surgical intervention in patients with ischemic stroke) in this study ranged from 11 to 96 hours, with a mean of 44.1 ± 26.0 hours; most patients underwent surgery within 48 hours after stroke onset (61.3%). This result is comparable to the study by Alhumaid L. et al. [7], in which 78% of patients underwent surgery within 48 hours.

Some studies suggest that early decompressive craniectomy reduces the risk of damage to healthy brain parenchyma and reduces intracranial pressure caused by progressive cerebral edema, notably the study by Juttler E. [2], in which the interval from symptom onset to surgery was 24.4 ± 6.9 hours. However, other studies, such as DESTINY [8] and DECIMAL [9], suggested that cerebral edema often peaks later, beyond 48 hours after symptom onset. A pooled analysis of European randomized multicenter studies demonstrated that early surgery yielded better overall outcomes. However, no significant difference was observed between treatments initiated within 24 hours and those initiated within 48 hours [10]. Surgery performed within 48 hours reduced the rate of severe disability or death (mRS 5 or 6), whereas delayed surgery could adversely affect patient recovery [11].

. In our study, 12 patients underwent surgery more than 48 hours after symptom onset. This delay may have resulted from deceptively stable clinical progression leading physicians to adopt a "wait-and-monitor" approach, as well as difficulties in the early prediction of malignant ischemic stroke.

### 4.2. Some factors affecting long-term surgical outcomes (6 months postoperatively)

Age was a factor influencing long-term postoperative outcomes. The proportion of good outcomes in patients younger than 60 years (56.3%) was higher than in those older than 60 years (13.3%), with a statistically significant difference ($p < 0.05$). Through pooled analyses of studies such as DECIMAL, DESTINY, and HAMLET, we found that age is a long-term factor affecting neurological recovery after surgery and should be considered when indicating surgery for patients older than 60 years [12].

The study by Uhl E. et al. (2004) [13] involving 188 patients with malignant cerebral infarction caused by middle cerebral artery occlusion, reported that the age of patients > 50 years was significantly associated with long-term postoperative recovery. According to the 2021 guidelines of the European Stroke Organisation [14], decompressive craniectomy within the first 48 hours has different therapeutic value depending on patient age. In patients younger than 60 years, surgery within 48 hours reduces mortality and improves the likelihood of functional recovery (walking and independent daily activities). In contrast, although surgery within 48 hours may reduce mortality in patients older than 60 years, functional recovery remains limited, and many survivors experience significant disability.

Research by Uhl E et al. (2004) [13] on 188 patients with cerebral infarction showed that the characteristics of middle cerebral artery occlusion, including patients over 50 years, were significantly associated with the long-term recovery rate after surgery. According to the guidelines of the European Stroke Organisation (2021) [14]

Regarding surgical timing, the proportion of patients undergoing surgery within 48 hours who achieved good outcomes (47.4%) was higher than that of patients treated after 48 hours (16.7%), with a statistically significant difference ($p < 0.05$). This finding is consistent with the studies by Alhumaid L. (2021) [7] and Paliwal P. [15]. After a large ischemic stroke, cerebral edema usually peaks within 48-72 hours. Decompressive craniectomy performed before peak edema helps reduce intracranial pressure, prevent brain herniation, improve perfusion to viable brain tissue, limit secondary injury, and improve neurological function [16]. Therefore, determining the optimal timing of intervention plays a critical role in improving prognosis for patients with malignant ischemic stroke.

Regarding the degree of midline shift, good outcomes were more common in patients with a midline shift of less than 10 mm (45.8%) compared with those with a shift greater than 10 mm (0%). This result is comparable to the study by Raffiq M.A. [16], which found that a midline shift of less than 10 mm was associated with an increased rate of good outcomes, and the study by Jeon S.B. [17], which showed that a smaller midline shift was associated with improved consciousness and survival rate. These findings suggest that maintaining the degree of midline shift below 10 mm may play an important role in improving patient survival.

### 4.3. Long-Term Complications after decompressive craniectomy

More than 6 months after surgery, there were 9 deaths; these deaths were not directly related to the surgical procedure. Among the remaining 22 patients, the seizure rate was 13.6% (3/22 patients). According to Kurland D.B. et al. (2015) [18], the incidence of seizures varied considerably among studies, ranging from 11% to more than 60%, and it remains unclear whether seizures are a complication of surgery or a consequence of post-stroke brain injury. Kurland D.B. (2015) [18] also noted that although the overall complication rate may appear high, serious complications related to decompressive craniectomy are rare and generally manageable. When present, these complications are usually treatable and acceptable, especially when considering the mortality associated with conservative treatment (mortality rate up to 80%).

Among the long-term postoperative complications in our study, only seizures were observed; other complications reported in the literature, such as hydrocephalus and sinking skin flap syndrome, were not detected. This may be due to the small sample size and relatively short follow-up duration in our study.

## 5. CONCLUSION

Decompressive craniectomy in the treatment of patients with large territorial ischemic stroke caused by middle cerebral artery occlusion should be performed early (within 48 hours) to reduce disability and mortality rates. The most common long-term complication was seizures. Age and degree of midline shift influenced surgical outcomes.

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