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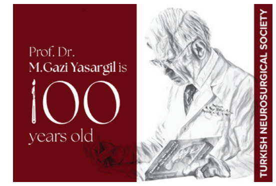

Efficacy of Decompression Surgery in Malignant Cerebral Edema After Endovascular Thromboembolectomy

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ABSTRACT

AIM: To evaluate the outcomes of decompression surgery in patients who developed malignant cerebral infarction after pharmacologic and endovascular thromboembolectomy treatment.

MATERIAL and METHODS: The study included 57 patients who underwent decompressive surgery for acute ischemic stroke between 2018 and 2023, having received either pharmacological treatment (intravenous tissue plasminogen activator; group A) or endovascular thromboembolectomy (group B). Age, sex, comorbid chronic diseases, location of thromboembolism at admission, side of ischemia, preoperative Glasgow Coma Scale scores, timing of surgery, and mortality rates were analyzed. The degree of recovery was measured using the modified Rankin Scale (mRS) score at 3 months.

RESULTS: The mortality rate after decompression surgery was 48% in group A and 50% in group B. Younger patients had lower mortality rates, with 38% in group A and 50% in group B. When considering all age groups, there was no significant between-group difference in mortality. The mean mRS score was 3.92 in group A and 3.93 in group B, with no significant between-group difference.

CONCLUSION: Endovascular thromboembolectomy does not appear to impact mortality and recovery rate in patients undergoing decompression surgery for malignant cerebral edema.

KEYWORDS: Decompressive craniectomy, Cerebral infarction, Middle cerebral artery, Endovascular thrombectomy

ABBREVIATIONS: ICA: Internal carotid artery, **MCA:** Middle cerebral artery, **tPA:** Tissue plasminogen activator, **GCS:** Glasgow coma scale, **mRS:** Modified rankin scale

INTRODUCTION

Thromboembolism in the internal carotid artery (ICA) and proximal middle cerebral artery (MCA) can lead to malignant cerebral infarction, a severe form of ischemia. Accounting for approximately 1%–10% of supratentorial ischemic strokes, malignant cerebral infarction is associated with high mortality and morbidity (2). Standard treatments for acute ischemia include intravenous tissue plasminogen activator (tPA) and/or endovascular thrombectomy. Despite vascular recanalization, approximately 10% of patients develop progressive malignant cerebral edema, resulting in mortality rates of up to 80% (3,5).

Edema following cerebral ischemia can lead to a significant increase in intracranial pressure and a decrease in cerebral blood flow. In some cases, medical treatment alone may be insufficient to reduce increased intracranial pressure. Especially in patients with malignant cerebral infarction, decompression surgery may be a critical treatment option (1,2,6). However, there is a notable gap in research regarding the effectiveness of surgical decompression in patients with malignant cerebral infarction who have undergone endovascular intervention, including thrombectomy.

In this study, we retrospectively compared the outcomes of decompression surgery in cases of malignant cerebral infarc-

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tion following pharmacological and endovascular thrombectomy treatment for cerebral artery occlusion.

MATERIAL and METHODS

This study included 57 patients who underwent pharmacological (intravenous tPA) treatment (group A) or endovascular thrombectomy (group B) for acute ischemic stroke between 2018 and 2023 at our hospital's stroke center. All patients subsequently underwent decompressive surgery due to malignant cerebral infarction. Cases with hemorrhagic transformation accompanying ischemia were excluded.

The age, sex, chronic diseases, location of thromboembolism at presentation, side of ischemia, Glasgow Coma Scale (GCS) scores before surgery, the timing of surgery, and mortality rates were recorded. Additionally, the degree of recovery was measured using the 3-month modified Rankin Scale (mRS) score. Statistical analysis was performed to compare the two groups.

Written informed consent was obtained from all patients. Local research ethics committee approved the study (01.11.2024-28593).

Statistical Analysis

IBM SPSS V22 software was used for data analysis. The normality of distribution of continuous variables was assessed using the Kolmogorov–Smirnov test. Due to non-normal distribution, continuous variables were presented as median (range), and between-group differences were assessed for statistical significance using the Mann–Whitney U test. Categorical variables were presented as frequency (percentage) and analyzed using the Pearson Chi-square test. A significance level of $p<0.05$ was accepted.

RESULTS

Group A comprised 27 patients who only received pharmacological treatment and subsequently underwent decompression surgery due to the development of malignant cerebral infarction. Group B comprised 30 patients who underwent endovascular thrombectomy followed by decompression surgery due to malignant cerebral infarction (Table I).

Age Distribution of Groups and Relationship with Prognosis

The median ages of patients in groups A and B were 60 (34–82) years and 57 (35–75) years, respectively, with no significant between-group difference. In group A, eight patients were aged 50 or younger, with a mortality rate of 38% (3/8). Among the 19 patients aged above 50, the mortality rate was 52% (10/19).

In group B, ten patients were aged 50 or younger, with a mortality rate of 50% (5/10). Among the 20 patients aged above 50, the mortality rate was 50% (10/20).

In group A, patients aged above 50 had a significantly higher mortality rate compared to those aged 50 and below. However, this difference was not statistically significant ($p=0.741$) when comparing the mortality rates between the two groups. The mortality rate was similar in patients aged 50 and below (38% in group A and 50% in group B) and in those aged above 50 (52% in group A and 50% in group B). There was no significant association between age and prognosis ($p=0.764$).

Sex Distribution of Groups and Relationship with Prognosis

In group A, 8 out of 13 deceased patients were female and 5 were male. In group B, 8 out of 15 deceased patients were female and 7 were male. There was no significant between-group difference regarding the relationship between sex and prognosis ($p=0.662$).

Relationship between Location of Thromboembolism and Prognosis

In group A, thromboembolisms were located in the MCA in 22 patients (13 right-sided, 9 left-sided) and the ICA in 5 patients (2 right-sided, 3 left-sided). Among the 13 deceased patients, 10 had MCA thromboembolisms (6 right-sided, 4 left-sided), and 3 had ICA thromboembolisms (1 right-sided, 2 left-sided).

In group B, thromboembolisms were located in the ICA in 14 patients (5 right-sided, 9 left-sided) and in the MCA in 16 patients (9 right-sided, 7 left-sided). Among the 15 deceased patients, 10 had MCA thromboembolisms (6 right-sided, 4 left-sided), and 5 had ICA thromboembolisms (3 right-sided, 2 left-sided).

There was no significant between-group difference regarding the relationship between the location of thromboembolism and prognosis ($p=0.942$).

Relationship between Side of Ischemia and Prognosis

In group A, 15 patients had right hemisphere ischemia and 12 had left hemisphere ischemia. Among the 13 deceased patients, 7 (53.8%) had right hemisphere involvement and 6 (46.1%) had left hemisphere involvement.

In group B, 14 patients had right hemisphere ischemia and 16 had left hemisphere ischemia. Among the 15 deceased patients, 8 (53.3%) had right hemisphere ischemia and 7 (46.6%) had left hemisphere ischemia.

There was no significant between-group difference regarding the relationship between the laterality of ischemia and prognosis ($p=0.978$).

Relationship between Preoperative GCS score and Prognosis

In group A, 8 patients had a GCS score of ≥10 before decompression surgery, while 19 patients had a GCS score between 5 and 10. All 13 patients who had a preoperative GCS score between 5 and 10 died during intensive care follow-up. None of the patients with a preoperative GCS score above 10 died.

In group B, 14 patients had a preoperative GCS score above 10, and 16 patients had a GCS score between 5 and 10. All 15 patients with a GCS score between 5 and 10 died during intensive care follow-up. None of the patients with a preoperative GCS score above 10 died.

Table I: Characteristics of Patients Who Underwent Pharmacological (Intravenous TPA) Treatment (Group A) and Endovascular Thrombectomy (Group B)

Attributes	Group A (n=27)	Group B (n=30)
Median Age (min-max) (years)	60 (34-82)	57 (35-75)
Gender M/F	18/9	15/15
Preoperative Glasgow Coma Scale (GCS) Score 5-10/ GCS >10	19/8	16/14
Ischemic Side (right/left)	15/12	14/16
Average time from symptom onset to surgery (Days)	2.1±	2.5±
Location of Thromboembolism		
Middle Cerebral Artery (right/left)	13/9	9/7
Internal Carotid Artery (right/left)	2/3	5/9
Modified Rankin Score at 3 months	3.92	3.93
Chronic Diseases	**n**	**n**
Hypertension	6	6
Diabetus Mellitus	2	4
Coronary Artery Disease	5	5

When all patients were evaluated collectively, a low preoperative GCS score was associated with a poorer prognosis. However, there was no significant between-group difference regarding the relationship between preoperative GCS and prognosis (p=0.187).

Time Interval before Decompression Surgery

In group A, patients underwent decompression surgery an average of 2.1± days after starting pharmacological treatment. In group B, decompression surgery was performed an average of 2.5± days after thrombectomy. There was no significant between-group difference in terms of the time interval before decompression surgery.

mRS Score after Decompression Surgery

The mean 3-month mRS scores after decompression surgery were 3.92 in group A and 3.93 in group B. In group A, the mean mRS score after decompression surgery was 3.8 for patients aged 50 or younger and 4 for those aged above 50.

In group B, the mean mRS score was 4.3 for those aged 50 or younger and 3.83 for those aged above 50.

There was no significant between-group difference regarding the 3-month mRS score after decompression surgery (p=0.850). When evaluating patients aged 50 and below, the mRS score of patients in group B was higher than that in group A. When comparing patients aged above 50, the mRS score in group A was higher (p=0.857).

Relationship between Chronic Diseases and Prognosis

In group A, nine patients had one or more comorbid chronic diseases (2 had diabetes mellitus, 6 had hypertension, 5 had coronary artery disease). The mortality rate was 66.7% (6/9) among patients with chronic diseases. Among the 18 patients without chronic diseases, the mortality rate was 38.8% (7/18).

In group B, 4 patients had diabetes mellitus, 5 had coronary artery disease, and 6 had hypertension. Among the 12 patients with chronic diseases, the mortality rate was 58.3% (7/12). Among the 18 patients without chronic diseases, the mortality rate was 44.4% (8/18).

Presence of a chronic disease was a risk factor for mortality in both groups. There was no significant between-group difference in this respect (p=0.851).

DISCUSSION

Development of malignant cerebral edema in cases of cerebral artery thromboembolism poses a serious challenge, even with successful reperfusion through pharmacological interventions and endovascular methods. Decompression surgery is widely performed in neurosurgical practice to reduce mortality and improve functional recovery in these cases (1,2,6).

Although decompression surgery for malignant cerebral edema does not significantly improve functional independence, it is widely accepted to reduce mortality, as noted in previous studies (4,6). In our study, mortality rates after decompression surgery were 48% in group A and 50% in group B. There was no significant difference in mortality rates between the groups, suggesting no positive or negative impact of endovascular thrombectomy before decompression surgery in patients with malignant cerebral edema.

Previous studies have shown that younger patients undergoing decompression surgery after ischemic stroke tend to have lower mortality rates and better functional recovery (1). One study reported a mortality rate of 32% in patients aged 50 or younger (2). In our study, the corresponding rate was 38% in group A and 50% in group B. Although the difference between groups was not statistically significant when considering all age groups (p = 0.889), the observed difference in patients aged 50 and younger is noteworthy. However, due to the small sample size, larger clinical series are needed to confirm this finding.

In our study, the median mRS score was 3.92 in group A and 3.93 in group B. There was no significant between-group difference in terms of the mRS score after decompression surgery. Endovascular thrombectomy before decompression surgery did not affect the mRS score positively or negatively. However, functional independence was better in patients aged 50 and below in group A, while the mRS score was better in patients aged above 50 in group B.

This difference in outcomes between age groups is noteworthy. In our study, the location and side of thromboembolism, which are known prognostic factors, did not significantly influence the prognosis between the groups. This finding indicates that when predicting the outcomes of decompression surgery after endovascular thrombectomy in patients with malignant cerebral infarction, these factors should be considered similarly to patients treated with IV tPA.

In our study, all cases underwent decompression surgery within 72 hours of neurological deterioration due to malignant cerebral infarction. The time to surgery was mean 2.1 ± days in group A and 2.5 ± days in group B, with endovascular thrombectomy having no apparent effect on the timing of surgery.

CONCLUSION

Our study suggests that endovascular thrombectomy does not considerably effect mortality and recovery rates after decompression surgery in patients with malignant cerebral edema after cerebral ischemia when compared with the pharmacological treatment.

Declarations

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

Disclosure: The authors declare no competing interests.

AUTHORSHIP CONTRIBUTION

Study conception and design: BE, IA

Data collection: BE, IA

Analysis and interpretation of results: BE, IA

Draft manuscript preparation: FSE, MK

Critical revision of the article: FSE, MK

All authors (BE, IA, MK, FSE) reviewed the results and approved the final version of the manuscript.

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