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Investigation of Mortality and Additional Morbidity Factors in Stroke Patients Who Have Undergone Decompressive Surgery

Gökhan Görken[1*], Arif Sari[2], Aysel Milanlioğlu[2], Mehmet Edip Akyol[3]

[1]*Department of Neurology, Health Sciences University Van Training and Research Hospital, Van, Turkey*
[2]*Department of Neurology, Yuzuncu Yıl University, Van, Turkey*
[3]*Department of Neurosurgery, Yuzuncu Yıl University, Van, Turkey*

ABSTRACT

We aimed to investigate the factors that may determine the effects of decompressive craniectomy by analyzing the data of patients who experienced ischemic and hemorrhagic stroke following the decompressive surgical procedure performed at our stroke center. Thus, we sought to establish a consensus on decompressive surgery practices.

Within the scope of this research, we conducted a retrospective analysis of the files of all stroke patients who underwent decompressive craniectomy and were followed between 2015 and 2020. The contributing factors influencing prognosis were examined. A total of 27 patients were included in the study. We recorded and statistically compared the sociodemographic characteristics of these patients, along with their NIH score at admission, GCS, and mRS after 3-6 months.

Out of the 27 patients, 16 (59.3%) had ischemic stroke and 11 (40.7%) had hemorrhagic stroke. The average age of the patients was 56±13.2 years. The mean NIHSS score was 16±7.2. After decompressive surgery, 70% of patients were deceased prior to discharge. The average craniectomy dimensions for all patients were calculated as 9.4±1.5 cm x 7.7±1.5 cm. We observed that factors such as the timing of decompressive surgery, Glasgow coma score, length of hospital stay, stroke hemisphere, glucose, and hemoglobin values did not affect prognosis post-surgery. Patients who underwent decompressive surgery due to hemorrhagic stroke demonstrated better outcomes after the procedure.

The selection of patients for surgery and the timing of the procedure should be guided by each clinic's own experience.

Keywords: Stroke, decompressive surgery, craniotomy, ischemic, hemorrhagic

Introduction

Stroke is the leading cause of disability and the second most common cause of death worldwide (1). With the rapid increase in the elderly population, the incidence of stroke is also increasing, especially in the age group of 65 years and above. Approximately 80% of stroke cases are ischemic stroke, while approximately 15% are associated with intracerebral hemorrhage and 5% with subarachnoid hemorrhage (2).

After the primary damage in the acute phase of stroke, the main mechanism of secondary damage is brain edema and increased intracranial pressure (3, 4). The effects of edema and high intracranial pressure that develop in the first five days are associated with a high risk of death by increasing neurological deterioration and subsequent herniation risk (5). High mortality rates due to edema depend on factors such as the type, location, and size of the stroke, and how to address this situation with effective medical treatment and precautions is still controversial (6 – 9). In cases where edema continues despite medical treatment and poses a life-threatening risk, decompressive surgery is generally accepted (10, 11). However, it is not yet clear which patients will benefit more from decompressive treatment. Today, the results of decompressive surgery performed in various centers are frequently analyzed.

In this study, we aimed to analyze the data of stroke patients who underwent decompressive surgery, to elucidate the factors that may affect decompressive surgery, to establish a consensus by determining which patients and for what period of time decompressive surgery benefits, and to contribute to the literature.

***Corresponding Author:** Gökhan Görken, Department of Neurology, Van Training And Research Hospital, Van, Turkey
E-Mail: -doktorazad@gmail.com, Phone: 0534 857 92 55
ORCID ID: Gökhan Görken: 0000-0001-9197-8298, **Arif Sari:** 0000-0002-9870-8730, **Aysel Milanlioğlu:** 0000-0003-2298-9596, **Mehmet Edip Akyol:** 0000-0002-5198-0219
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Materials and Methods

All stroke patients who were followed up at Van Yuzuncu Yıl University Faculty of Medicine Neurology Clinic and underwent decompressive surgery between 2015 and 2020 were retrospectively analyzed.

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. As this was a retrospective analysis, no informed consent was obtained from participants.

Demographic characteristics of the patients, detailed clinical history, comorbidities, examination, GCS, NIHSS, laboratory and radiological findings, time of admission to decompressive surgery, and surgical technique were recorded. The modified Rankin scores (mRS) of the patients at discharge, in the third month, and in the sixth month were recorded for statistical comparison.

Inclusion Criteria: All patients who were admitted to the intensive care unit due to stroke and received decompressive treatment in our clinic were included in this study.

Exclusion Criteria: Patients with comorbidities other than stroke that could affect prognosis, patients who underwent different surgical methods other than decompressive (for example, hematoma aspiration), and cases of non-spontaneous hemorrhage.

Statistical Analysis: The study data were analyzed using the SPSS (IBM SPSS for Windows, version 26) statistical package program. Descriptive statistics for the variables were expressed as mean, standard deviation, number (n), and percentage (%). The chi-square and ANOVA test was used to determine the relationships between categorical variables.

To calculate the sample size, a minimum power of 80% (Power of Test) and a 5% Type I error rate were considered for each variable. The level of statistical significance (α) was set at 5% ($p<0.05$).

Results

A total of 27 patients were included in the study, of which 16 (59.3%) were cases of ischemic stroke and 11 (40.7%) were cases of hemorrhagic stroke. The average age of the patients was found to be 56±13.2 years. The ischemic stroke cases constituted 16 patients (12 males and four females), while the number of patients in hemorrhagic stroke cases was 11 (6 males and five females). The patients' mean National Institute of Health Stroke Scale (NIHSS) score at the time of admission was 16±7.2.

It was determined that 48.1% (n=13) of the ischemic stroke cases and 22.2% (n=6) of the hemorrhagic stroke cases included in the study were deceased before being discharged from the hospital. The average craniotomy dimensions of the patients were 9.4±1.5 cm x 7.7±1.5 cm. The clinical information of the patients is denoted in Table 1.

When the factors that may affect the patients' modified Rankin scores during discharge and 6 months later were examined, it was found that the timing of decompressive surgery, NIHSS and Glasgow Coma Score (GCS) at admission, hospital stay, stroke region, glucose and hemoglobin values did not affect mRS scores statistically significantly. It was noted that the mRS scores 6 months later in patients who received decompressive treatment for hemorrhagic stroke cases were lower compared to those with ischemic stroke (Table 2).

Discussion

Decompressive craniotomy is used as a surgical procedure to reduce the impact of resistant intracranial hypertension against a non-expandable skull. This method was first used in the treatment of post-traumatic brain edema and began to be applied in large strokes over time (12, 13). Studies have shown that decompressive surgery applied to stroke patients reduces intracranial pressure and increases perfusion and blood flow not only in the stroke area but also in the opposite hemisphere (14 – 16). However, the best results can be achieved in which patients, in which type of stroke, and especially when it is applied, have been discussed as controversial issues (17). Therefore, we aimed to determine the factors that may affect this treatment in a total of 27 stroke patients who underwent decompressive surgery in our clinic between 2015 and 2020.

It was determined that the majority of patients who underwent decompressive surgery in our clinic were patients with ischemic stroke in the left hemisphere, and their NIHSS scores in the developmental stage were mostly above 15, and their GCS scores were below 7. However, neither the stroke site nor the GCS and NIHSS scores had any effect on mortality and morbidity in patients who underwent decompressive surgery.

Table 1: The Baseline Demographics of The Study Population

		Ischemic Stroke(n)	Hemorrhagic Stroke(n)
Gender	Male	12	6
	Female	4	5
Hemisphere	Right	4	6
	Left	10	5
	Cerebellum	2	0
Glasgow Coma Scale at admission	Mild (12-15)	2	0
	Moderate (8-11)	5	5
	Severe (3-7)	9	6
NIHSS	*5-14	6	2
	15-20	8	7
	21<	2	2
Rankin score at discharge	mRS:4	2	4
	mRS:5	1	1
	mRS:6	13	6
Time of decompressive surgery	First 24 hours	8	5
	24-48 hours	3	4
	48< hours	5	2

Tablo 2: Statistical Significance of Factors That May Affect mRS at Discharge and 6 Months Later

	mRS at discharge *p-value	mRS in 6 months *p-value
Time of decompressive surgery	0,612	0,491
NIHSS at admission	0,147	0,279
Duration of hospital stay	0,755	0,946
Type of stroke	0,288	0,001**
Glasgow Score at admission	0,085	0,381
Hemisphere Localisation	0,890	0,955
Glucose level(mg/dl)	0,794	0,652
Hemoglobin level(g/dl)	0,433	0,374

In fact, there was not enough data to determine whether dominant hemisphere strokes or non-dominant hemisphere strokes would have a worse course. In the analysis of many studies examining the benefit of decompressive surgery at the stroke site, no significant difference was found, similar to our study (18 – 21). However, aphasia seen in dominant hemisphere strokes is associated with high NIHSS and GCS scores and is therefore perceived more negatively by physicians, which may indicate that dominant hemisphere stroke patients who undergo decompressive surgery are more easily selected.

The majority of patients underwent decompressive surgery, usually within the first 48 hours, and generally within the first 24 hours in our institution. However, no significant difference was detected between this timing and mRS scores. Similarly, other studies have noted that there was no significant difference between surgery timings, especially in decompressive surgeries performed within the first 72 hours (20, 22, 23). However, the necessity of surgery before herniation develops is supported by pathophysiological evidence (24). Cho et al. reported that the mortality rate decreased in patients who underwent decompressive surgery very early (in the first 4.25 hours); on the other hand, deciding for surgery at such an early time could lead to serious errors in terms of the necessity of surgery (25).

A notable finding of our study was that hemorrhagic stroke patients benefited more from decompressive surgery than ischemic stroke

patients. Many studies have shown that decompressive surgery is beneficial in patients with spontaneous intracerebral hemorrhage (26 – 28).

However, similar to our study, it was observed that there was no study investigating the benefits of decompressive surgery performed on ischemic and hemorrhagic stroke patients in the same center. Some of the reasons for this benefit may be that the clinical condition of hematoma patients is more severe, edema develops faster, herniation develops in a shorter time, and decompressive surgery is performed more quickly because the edema effect and secondary injury are more pronounced.

As a result, the benefits of decompressive surgery to prevent edema and herniation in ischemic and hemorrhagic strokes are known. However, how to select patients for surgery and the timing of surgery can be evaluated based on each clinic's own experience.

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Ozan.Batigun@outlook.com

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