Journal of Cerebrovascular and Endovascular Neurosurgery
ISSN 2234-8565, EISSN 2287-3139, http://dx.doi.org/10.7461/jcen.2012.14.2.65

Original Article

Outcome Following Decompressive Craniectomy for Malignant Middle Cerebral Artery Infarction in Patients Older Than 70 Years Old

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Objective : Malignant middle cerebral artery (MCA) infarction occurs in 10% of all ischemic strokes and these severe strokes are associated with high mortality rates. Recent clinical trials demonstrated that early decompressive craniectomy reduce mortality rates and improves functional outcomes in healthy young patients (less than 61 years of age) with a malignant infarction. The purpose of this study was to assess the efficacy of decompressive craniectomy in elderly patients (older than 70 years of age) with a malignant MCA infarction.

Methods : Between February 2008 and October 2011, 131 patients were diagnosed with malignant MCA infarctions. We divided these patients into two groups: patients who underwent decompressive craniectomy (n = 58) and those who underwent conservative care (n = 73). A cut-off point of 70 years of age was set, and the study population was segregated into those who fell above or below this point. Mortality rates and functional outcome scores were assessed, and a modified Rankin Scale (mRS) score of > 3 was considered to represent a poor outcome.

Results : Mortality rates were significantly lower at 29.3% (one-month mortality rate) and 48.3% (six-month mortality rate) in the craniectomy group as compared to 58.9% and 71.2%, respectively, in the conservative care group (p < 0.001, p = 0.007). Age (≧ 70 years vs. < 70 years) did not statistically differ between groups for the six-month mortality rate (p = 0.137). However, the pre-operative National Institutes of Health Stroke Scale (NIHSS) score did contribute to the six-month mortality rate (p = 0.047).

Conclusion : Decompressive craniectomy is effective for patients with a malignant MCA infarction regardless of their age. Therefore, factors other than age should be considered and the treatment should be individualized in elderly patients with malignant infarctions.

Keywords Age, Mortality, Middle cerebral artery, Cerebral infarction, Decompressive craniectomy

J Cerebrovasc Endovasc Neurosurg. 2012 Jun;14(2):65~74

Received : 4 February 2012
Revised : 22 February 2012
Accepted : 26 March 2012

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This work was supported by the Dong-A University Research Fund.

INTRODUCTION

Among all cases of supratentorial infarction, 10-15% involve the entire middle cerebral artery (MCA). Patients with MCA infarct that sometimes accompanies a large space occupying edema reported to have a mortality rate of up to 80% even with the appropriate conservative medical therapy. Therefore, the term "malignant MCA infarction" was introduced for these types of massive cerebral infarcts. They are very

often associated with early death due to increased intracranial pressure (ICP) and subsequent uncal herniation.[1)3)6-8)10-14)21)23-26)]

Many studies have examined the results of decompressive surgery, with particular focus on factors such as clinical and radiological findings, the degree of ICP and the timing of decompressive surgery.[3)5)12)19)26)]

Recently, three separate studies investigated the effectiveness of decompressive craniectomy after malignant MCA infarction in controlled trials with patients less than 61 years of age.[7)10)23)] These were demonstrated that hemicraniectomy reduced the mortality rate by 49% at one year after stroke when compared with conventional medical treatments. However, the question of how applicable the results are to patients older than 60 years of age still remains unanswered.

When neurosurgeons recommend decompressive surgery for patients with malignant infarcts, patients' relatives often refuse the operation because of the patients' age, past medical history or comorbidity. Such a situation occurs more frequently when the patient is older than 70 years of age.

The aim of this study was to compare the mortality rates and functional outcomes between conservative care and surgical treatment of malignant MCA infarction, in patients older than 70 years of age and those who younger than 70 years of age.

MATERIALS AND METHODS

In this retrospective study, 131 patients with a malignant infarct, which means a space-occupying total infarction in the region of the MCA or both the MCA and the anterior cerebral artery (ACA), received either a decompressive craniectomy or conservative care at our hospital stroke center, from February 2008 to October 2011.

Patient selection

During the study period, 725 patients with large hemispheric infarctions were admitted to our hospital. Of these, 131 patients were found to have a malignant infarction. Malignant MCA infarction was defined as the following; (1) visible signs of ischemia involving more than 2/3 of the MCA territory on brain computed tomography (CT) or a diffusion- weighted

Table 1. Eligibility Criteria

Inclusion criteria
Age > 18 years old
Within 48 hours after symptom onset
NIHSS score ≧ 18 for lesion of right-sided infarction
NIHSS score ≧ 20 for lesion of left-sided infarction
Decrease in the level of consciousness (NIHSS ≧ 1 in 1a. level of consciousness)
Visuable ischemic sign involving > 2/3 of MCA territory on CT or DWI infarct volume > 145 cm^3 (with or without ACA of PCA involvement)
Possibility to start surgery after decision
Written, informed consent by the patient of legal representative
Exclusion criteria
Preexisting significant disability (mRS ≧ 4)
Both pupil fixed and dilated
Significant contralateral infarction
Hemorrhagic infarction > 50% MCA territory on CT
Life expectancy < 3 years or any serious illness
Contra-indication for anesthesia
Pregnancy

NIHSS = National Institutes of Health Stroke Scale; CT = Computed Tomography; MCA = Middle Cerebral Artery; DWI = Diffusion-Weighted Image; ACA = Anterior Cerebral Artery; PCA = Posterior Cerebral Artery; mRS = modified Rankin Scale

imaging (DWI) infarct volume > 145 cm^3 with an acute onset of corresponding clinical signs and symptoms (such as hemiplegia, hemianopsia, hemianesthesia and progressive deterioration in consciousness); and (2) neuroradiological evidence of local brain swelling such as midline shifting of 5 mm or more indicating space-occupying edema.

For eligibility criteria see Table 1. Fifty-eight patients with a malignant infarction underwent decompressive craniectomy and received medical treatment (craniectomy group), and 73 patients received conservative care alone (conservative care group). A cut-off point of 70 years of age was set, and the study population was segregated into those above and those below this age limit.

We collected data such as age, sex, past medical history, distribution of the infarction, affected hemispheric dominancy, initial National Institutes of Health Stroke Scale (NIHSS) score, pre-operative NIHSS, measurement of the midline shifting at the septum pellucidum level, and functional recovery six months after surgery as assessed by the modified Rankin Scale (mRS) score.

Surgical technique

All patients were treated within 48 hours of the stroke event. For the craniectomy group, the principal surgical technique was a large decompressive craniectomy with duroplasty. Briefly, a question mark-shaped skin flap that began at the ear was created and a wide craniotomy was performed on the affected side with partial removal of the frontal, temporal, and parietal bones, so that the floor of the middle fossa could be exposed and the bone flap would have a minimum of 12 cm diameter. The dura was opened in a "C" shape all over and 1 cm distant to the border of the craniotomy, and an augmented dural patch was inserted. The position of the temporalis muscle and skin flap was approximated and then re-secured. Infarcted brain tissue was not resected. After the operation, patients were transferred to a neurological intensive care unit. The bone flap was reimplanted six weeks to three months after surgery, having been stored under sterile conditions at -80°C.

Conservative care

In both groups of patients, standard medical treatment was based on published guidelines for the early management of patients with ischemic stroke. Endotracheal intubation or nasal probe was recommended to maintain adequate tissue oxygenation in patients with severely increased levels of ICP. Normoglycemia, normothermia and high perfusion pressure levels were obtained. To assist venous drainage, the head of the bed was elevated at an angle of 30 degrees. Administration of intravenous mannitol (0.25-0.5g/kg) was recommended in patients whose condition was rapidly worsening because of brain edema, without additional recommendations on loading doses.

Follow-up

The clinical status of each patient was rated both at admission and at the time of operation using NIHSS scoring. One-month and six-month mortality rates were defined as patient death one month and six months after surgery, respectively. At six months after surgery, each patient's functional outcome was assessed using the mRS score to rate physical disabilities. The six-month functional outcome was dichotomized between mRS score zero to three (favorable outcome) versus four to six (poor outcome).

Statistical analysis

A *t*-test was used to compare group variables. Pearson's Chi-square test was used to compare group mortality rates and age, and a logistic regression analysis was used to examine the likelihood of a better mRS score at six months after surgery. Univariate analyses were used to determine the effects of age, gender, hypertension, diabetes mellitus, atrial fibrillation, ischemic heart disease, hemorrhagic transformation, old infarction, midline shifting, and treatment modalities on mRS at six months after operation. Variables that were found to be significantly associated with better mortality rates and mRS score were

subjected to multivariate analyses. Differences were regarded as significant if their probability values were $p < 0.05$. Statistical analyses were performed using SAS version 9.2.

RESULTS

Among 725 patients with a large hemispheric infarction, we enrolled 131 patients in this study. Table 2 summarizes the demographic characteristics of these 131 patients. There were 71 men and 60 women with an overall mean age of 67.9 years (range, 31-96 years). Fifty-eight of these patients underwent craniectomy and 73 patients were treated conservatively. In the craniectomy group, 20 patients(34.5%) were older than 70 years of age, and 38(65.5%) were younger than 70 years of age. In the conservative care group, 51 patients(69.9%) were older than 70 years of age, and

Table 2. Demographic characteristics of patients

Characteristic	Group		Total	*p*-value
	Conservative care	Craniectomy		
Sex				
male	36 (49.3)	35 (60.3)	71 (54.2)	0.208
female	37 (50.7)	23 (39.7)	60 (45.8)	
Age (years)				
mean ± SD	72.64 ± 9.35	62.10 ± 12.36	67.98 ± 11.96	< 0.001
< 70	22 (30.1)	38 (65.5)	60 (45.8)	< 0.001
≧ 70	51 (69.9)	20 (34.5)	71 (54.2)	
Site				
Rt	46 (63.0)	39 (67.2)	85 (64.9)	0.615
Lt	27 (37.0)	19 (32.8)	46 (35.1)	
DM				
absence	61 (83.6)	43 (74.1)	104 (79.4)	0.185
presence	12 (16.4)	15 (25.9)	27 (20.6)	
HTN				
absence	34 (46.6)	32 (55.2)	66 (50.4)	0.328
presence	39 (53.4)	26 (44.8)	65 (49.6)	
Af				
absence	41 (56.2)	41 (70.7)	82 (62.6)	0.088
presence	32 (43.8)	17 (29.3)	49 (37.4)	
Ischemic heart disease				
absence	54 (74.0)	46 (79.3)	100 (76.3)	0.475
presence	19 (26.0)	12 (20.7)	31 (23.7)	
Hemorrhage transformation				
absence	57 (78.1)	42 (72.4)	99 (75.6)	0.453
presence	16 (21.9)	16 (27.6)	32 (24.4)	
Old infarction				
absence	60 (82.2)	41 (70.7)	101 (77.1)	0.120
presence	13 (17.8)	17 (29.3)	30 (22.9)	
Midline shifting				
< 10 mm	47 (64.4)	29 (50.0)	76 (58.0)	0.098
≧ 10 mm	26 (35.6)	29 (50.0)	55 (42.0)	
Total	73 (55.7)	58 (44.3)	131 (100.0)	

Rt = Right; Lt = Left; DM = Diabetes Mellitus; HTN = Hypertension; Af = Atrial fibrillation

Table 3. Mean NIHSS score

	Age		Total	*p*-value
	< 70	≧ 70		
Mean NIHSS score				
Conservative care	16.2	16.5	16.4	0.184
Craniectomy	16.8	17.7	17.1	

NIHSS = National Institutes of Health Stroke Scale

22(30.1%) were younger than 70 years of age.

The dominant hemisphere was affected in 46 cases and the non-dominant hemisphere in 85 cases. Forty-nine patients(37.4%) had a history of atrial fibrillation, 27(20.6%) had diabetes mellitus, 65(49.6%) had hypertension, 31(23.7%) had ischemic heart disease and 30(22.9%) had an old infarction. Thirty-two patients(24.4%) had a hemorrhagic transformation during the treatment period (Table 2).

The mean NIHSS score for all patients was 16.7. However, there were some imbalances in the patients' characteristics. The mean initial NIHSS score in the craniectomy group was 17.1 and that in the conservative care group was 16.4. However, this discrepancy was not statistically significant (Table 3).

Treatment modality and prognosis

A total of 58 patients received decompressive craniectomy. There were no surgical complications directly related to this procedure. In 17 patients of these patients, surgery failed to improve uncal herniation and they died within the one month of operation. And 28 patients died within six months of operation. Thus, the one-month mortality rate was 29.3%, and the six-month mortality rate was 48.3% in the craniectomy group. Favorable functional outcome at six months after surgery was noted in 19 patients(63.3%) in this group.

Seventy-three patients underwent conservative care. Their one-month mortality rate was 58.9%, and six-month mortality rate was 71.2%. There were eight patients(38.1%) with favorable functional outcome.

One-month and six-month mortality rates showed a statistically significant difference between the treatment modalities of craniectomy and conservative care ($p < 0.001$, $p = 0.007$). These treatment modalities, however, were not statistically different for the six-month functional outcome ($p = 0.076$) (Table 4).

Differences due to age

In patients older than 70 years of age, the craniectomy group had a 30.0% one-month mortality rate,

Table 4. Comparison of outcome between two groups

Outcome	Group		Total	*p*-value
	Conservative care	Craniectomy		
Mortality in 1 month				
alive	30 (41.1)	41 (70.7)	71 (54.2)	< 0.001
death	43 (58.9)	17 (29.3)	60 (45.8)	
Mortality in 6 months				
alive	21 (28.8)	30 (51.7)	51 (38.9)	0.007
death	52 (71.2)	28 (48.3)	80 (61.1)	
Functional outcome*				
favorable†	8 (38.1)	19 (63.3)	27 (52.9)	0.076
poor‡	13 (61.9)	11 (36.7)	24 (47.1)	

* survivors at 6 months after surgery; † zero to three in mRS score; ‡ four to six in mRS score

Table 5. The relation between treatment modality and prognosis

Outcome	< 70			≧ 70		
	Group			Group		
	Conservative care	Craniectomy	*p*-value	Conservative care	Craniectomy	*p*-value
Mortality in 1 month						
alive	10 (45.5)	27 (71.1)	0.049	20 (39.2)	14 (70.0)	0.020
death	12 (54.5)	11 (28.9)		31 (60.8)	6 (30.0)	
Mortality in 6 months						
alive	8 (36.4)	22 (57.9)	0.108	13 (25.5)	8 (40.0)	0.228
death	14 (63.6)	16 (42.1)		38 (74.5)	12 (60.0)	
Functional outcome*						
favorable†	5 (62.5)	15 (68.2)	1.000	3 (23.1)	4 (50.0)	0.346
poor‡	3 (37.5)	7 (31.8)		10 (76.9)	4 (50.0)	

* survivors at 6 months after surgery; † zero to three in mRS score; ‡ four to six in mRS score

Table 6. Predictors of six-month mortality

Variable	OR	95% CI	*p*-value
Sex (female vs. male)	3.24	(1.41 - 7.45)	0.006
Age (≧ 70 vs. < 70)	1.91	(0.82 - 4.47)	0.137
Site (Lt vs. Rt)	1.71	(0.74 - 3.92)	0.206
NIHSS (under cut-off vs. not less than cut-off)	2.40	(1.01 - 5.71)	0.047
Midline shifting (≧ 10 mm vs. < 10 mm)	3.33	(1.39 - 7.99)	0.007
Group (craniectomy vs. conservative care)	0.37	(0.16 - 0.87)	0.023

OR = Odds Ratio; CI = Confidence Interval; Lt = Left; Rt = Right

Table 7. Predictors of favorable functional outcome at six months after operation

Variable	OR	95% CI	*p*-value
Age (≧ 70 vs. < 70)	0.22	(0.04 - 1.18)	0.077
Site (Lt vs. Rt)	0.13	(0.02 - 0.84)	0.032
Midline shifting (≧ 10 mm vs. < 10 mm)	0.07	(0.01 - 0.42)	0.004
NIHSS (under cut-off vs. not less than cut-off)	0.29	(0.05 - 1.82)	0.184
Group (craniectomy vs. conservative care)	4.28	(0.75 - 24.55)	0.103

NIHSS = National Institutes of Health Stroke Scale

while the conservative care group had a 60.8% one-month mortality rate. The six-month mortality rates were 60.0% and 74.5% for each group, respectively. We confirmed that 50.0% (four cases) and 23.1% (three cases) of patients yielded a favorable functional outcome in the craniectomy group and conservative care group, respectively.

For patients younger than 70 years of age, the craniectomy group showed a 28.9% one-month mortality rate, while the conservative care group showed a 54.5% one-month mortality rate. The six-month mortality rates were 42.1% and 63.6% for each group, respectively. There were 68.2%(15 cases) and 62.5% (five cases) patients with favorable functional outcome in the craniectomy group and conservative care group, respectively.

For patients both older than 70 and younger than 70 years of age, the mortality rates (one-month, six-month) were lower and the favorable functional outcome was higher in the craniectomy group compared to the conservative care group (Table 5).

Finally, age was not statistically significant among all patients with respect to the six-month mortality rate and the favorable functional outcome ($p = 0.137$, $p = 0.077$) (Table 6, Table 7).

Dominant hemisphere

Right to left hemisphere ratio was 85(64.9%) : 46(35.1%) (Table 2). Between the two hemisphere, there was no statistically significant difference for six-month mortality rate ($p = 0.206$, Table 6). However, the functional outcome after six months was significant ($p = 0.032$) (Table 7).

Midline shift

The mean midline shift for all patients was 7.34 mm. When 10 mm was chosen as a cut-off point, midline shifting at the septum pellucidum level was significantly different with the six-month mortality rate and favorable functional outcome ($p = 0.007$, $p = 0.004$) (Table 6, Table 7).

Pre-operative NIHSS scores

The cut-off value for NIHSS scores was set up differently, depending on the location of the infarction site. The cut-off value was 18 points for a right-sided infarct, and 20 points for left-sided infarct. Eighty-four(64.1%) were lower than cut-off value, and 47 (35.9%) were higher. There was significant difference of NIHSS score in six-month mortality rate ($p = 0.047$, Table 6). But, no significant difference in functional outcome at six months after operation ($p = 0.184$, Table 7).

DISCUSSION

Decompressive craniectomy with duroplasty was been performed in patients with malignant brain edema caused by an infarction or trauma. The aim of the procedure was to decrease the mass effect of the edema, preventing brain herniation, secondary injury to the brain and death.[1)22)25)]

Treatment modality and prognosis

According to previous research regarding malignant infarctions, patients clinically presenting with severe hemispheric stroke syndrome, including hemiplegia, forced eye and head deviation, and progressive deterioration of consciousness within the first two days, have poor prognoses with mortality rates as high as 80%. Non-randomized studies found that decompressive surgery reduces these mortality rates and increases favorable functional outcomes in patients with large hemispheric infarctions when compared to conservative treatments. Schwab et al.[20)] reported that 73% of patients survived (mortality rate of 27%), whereas Sasaki et al.[19)] and Carter et al.[2)] documented the mortality rate of 33% and 0%, respectively.

Recently, three European randomized controlled trials (the French DECIMAL trial, the German DESTINY trial, and the Dutch HAMLET trial)[7)10)23)] demonstrated that decompressive craniectomy reduced the mortality rate by 49% at one year after stroke when compared with conservative care at the same time (78% in the craniectomy group, 29% in the conservative care group). And favorable functional outcome (zero to three in mRS) increased by 22% due to surgery (43% in the craniectomy group, 21% in the conservative care group).[6-8)10)11)15)23)]

In our study, the one-month mortality rate was 29.3% in the craniectomy group and 58.9% in the conservative care group. Six-month mortality rates were 48.3% and 71.2%, respectively. The favorable functional outcome was 63.3% in the craniectomy group and 38.1% in the conservative care group. Craniectomy reduced the mortality rate by 29.6% at one-month, 22.9% at six-months after surgery and increased the favorable functional outcome by 25.2% when compared with conservative care. Additionally, the mortality rates were significantly different ($p < 0.001$, $p = 0.007$) between two group (Table 4). This study reaffirms that hemicraniectomy for malignant

MCA infarction is a life-saving treatment.

Differences due to age

Recently, three trials published their pooled analysis of 93 patients,[7)10)23)] all less than 61 years of age, indicating that hemicraniectomy reduced the mortality rate by 49% at one year after stroke when compared with optimal medical treatments. This confirms the results from previous non-randomized studies and case reports that were analyzed in this review.[6-8)10)11)15)23)] The question remains as to whether similar results would be expected in an elderly population as the incidence of stroke increases with old age. Jüttler et al.[9)] suggested that about 50% of all patients with malignant MCA infarcts are older than 60 years of age.

In the present study, 27 patients were younger than 60 years of age, while 104(79.4%) were older than 60 years. However, 60 patients(45.8%) were under 70 years of age and 71(54.2%) were older than 70 years of age. For this reason, we segregated the patients with malignant MCA infarction into two group with a determining cut-off point of 70 years of age in order to balance the groups more equally (Table 8).

In previous reports, age was a key factor in determining who would benefit from decompressive surgery after malignant cerebral infarction, and some investigators have reported poorer outcomes in elderly patients. Preexisting disabilities and severe comorbid conditions are also important factors that increase poor outcomes, and both are more prominent in elderly patients.[13)17)21)22)]

We have shown that patients older than 70 years have higher mortality rates (both at one month and six months after surgery) and lower favorable functional outcomes compared with the patients under the age of 70 years. When comparing patients older than 70 years of age who received craniectomy to patients of the same age who received conservative care, the mortality rate was 30.8%, a 14.5% of rate reduction, while the favorable functional outcome rate increased by 26.9% in the former group. In the patients younger than 70 years of age, these results were similar.

Among all patients, age was not statistically significant for six-month mortality rate ($p = 0.137$, Table 6). In other words, no significant difference was observed between patients younger than 70 years of age and those older than 70 years of age in terms of mortality rate. We conclude that age itself has little effect on prognosis. Therefore, elderly patients with malignant infarctions will have better outcomes with decompressive craniectomy compared to conservative care only.

Preexisting factors

Preexisting factors that are also predictors of poor survival (diabetes mellitus, hypertension, atrial fibrillation, ischemic heart disease, a previous history of stroke and hemorrhagic transformation) did not significantly influence mortality rates or functional outcomes in our study. We assume that this was caused by the relatively small number of patients (n = 131) that were included in this study, in comparison to the larger numbers that have been included in other stroke reports.[2)3-5)11)12)14)17)25)26)]

Dominant hemisphere

Offering life-saving treatment for large dominant hemispheric infarcts is controversial, mainly because

Table 8. Distribution of patients with malignant MCA infarction by age

Age (years)	Group		Total	*p*-value
	Conservative care	Craniectomy		
< 60	6 (8.2)	21 (36.2)	27 (20.6)	< 0.001
≧ 60	67 (91.8)	37 (63.8)	104 (79.4)	
< 70	22 (30.1)	38 (65.5)	60 (45.8)	< 0.001
≧ 70	51 (69.9)	20 (34.5)	71 (54.2)	
Total	73 (55.7)	58 (44.3)	131 (100.0)	

surgery may leave patients with an unacceptable quality of life. The hemispheric location of the infarct did not have prognostic relevance in our study, as demonstrated by other series. Gupta et al.[6] reviewed the functional outcomes of 27 patients with decompression of the dominant hemisphere and 111 patients who had non-dominant infarcts and found that the outcomes were similar. In the study by Kilincer et al.,[12] half of the patients had a dominant hemispheric infarction with global aphasia pre-operatively, and six of seven patients in the good outcome group had a dominant hemispheric infarction and most of the patients showed considerable improvements in their aphasia.

In our study, the hemispheric location of the infarct had no effect on mortality rates but did have an effect on the functional outcomes. The larger the infarction was in size, the more the brain stem was compressed, indicating that mortality is more influenced by the size of infarct rather than the hemispheric location. Therefore, we believe that the location of the infarction should not be an exclusive criterion for surgery.

Pre-operative NIHSS scores

The NIHSS score is commonly obtained in acute stroke patients. A score of zero indicates no clinically relevant neurological abnormalities. If a patient scores more than 20, it usually indicates a dense paralysis with impaired consciousness.[2] NIHSS score $\geqq 20$ for left-sided infarctions, or $\geqq 18$ for right-sided infarctions may predict which patients will develop malignant edema and/or have a poor outcome.[18] Lam et al.[16] concluded that a NIHSS score of > 22 is predictive of high mortality.

In our study, patients who presented with NIHSS score of $\geqq 20$ for left hemispheric infarction, or $\geqq 18$ for the right hemispheric infarction in the presurgical exam demonstrated a tendency toward poor outcomes. The NIHSS score was significantly related to mortality rates but not to the functional outcomes.

Limitation

There are several limitations in our study. Although we present important data about decompressive surgery, it is a non-randomized retrospective study with results that need to be confirmed by larger randomized trials. Additionally, our follow-up period of six months is rather short, thus a longer follow-up evaluation is necessary.

CONCLUSIONS

Decompressive craniectomy is a life-saving procedure for patients with malignant cerebral infarctions, but the selection of patients for surgery remains controversial.

From our results, pre-operative midline shifts $\geqq 10$ mm, pre-operative NIHSS scores $\geqq 20$ for left, or $\geqq 18$ for right hemispheric infarctions were positive predictors of a poor outcome. The hemispheric location of the infarct should not be an exclusive criterion when deciding to perform this operation.

Additionally, factors other than age should be considered and treatment should be individualized, as decompressive craniectomy in patients with malignant MCA infarction is effective regardless of age. Age alone cannot be a contraindication for undergoing decompressive craniectomy, and elderly patients with malignant infarction also need aggressive treatments such as decompressive surgery.

DESTINY II (DEcompressive Surgery for the Treatment of malignant INfarction of the middle cerebral arterY II),[9] a randomized trial including patients 61 years of age and older, is ongoing and has already recruited 45 patients. The results of this trial are expected to directly influence the decision making for these patients.

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