

중증 대뇌동맥 경색 환자에서 두개감압술 후의 기능적 예후

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Functional Outcomes of Patients with Severe MCA Infarction after Decompressive Craniectomy

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Objective: To compare the functional outcomes between surgical treatment and conservative medical treatment for severe middle cerebral artery (MCA) infarction.**Method:** This is comparative analysis of prospectively documented data with 25 patients have malignant MCA infarction. Ten patients in Group A (male 7, female 3) received surgical treatment such as decompressive craniectomy, and fifteen patients in Group B (male 10, female 5) received conservative medical treatment. We defined MCA infarction as "severe" when it concerned both the deep and superficial areas of the MCA or when the Functional Independence Measure (FIM) was lower to 75 on admission to our department. Functional status was measured using modified Rankin Scale (mRS), FIM, Motricity Index (MI) and Trunk Control Test (TCT). All evaluations were measured at baseline and 90 days after stroke.**Results:** Mean age were 55.0 ± 8.6 and 58.7 ± 12.3 in Group A and B. Rt. MCA infarction were 4 in Group A and 5 in Group B. Lt. MCA infarction were 5 in Group A and 10 in Group B. Baseline functional status between two groups was not significantly different. Each group showed functional improvement according to the time. When compared changes between two groups, arm Motricity Index, K-MMSE, mRS and FIM were no significant difference between two groups. Leg segments of MI and TCT was significantly improved in Group A more than B at 90 days after baseline evaluation ($p < 0.05$).**Conclusion:** Decompressive craniectomy improved motor function of affected leg and trunk in patients with severe MCA infarction more than conservative medical treatment alone. (*Brain & NeuroRehabilitation* 2014; 7: 48-53)**Key Words:** cerebrovascular disease, decompressive craniectomy, functional outcome, stroke

Introduction

The treatment of life-threatening, space-occupying brain edema after massive cerebral infarction is still a controversial issue in neurology and neurosurgery. Such massive hemispheric infarctions occur in 1% to 10% of patients with a supratentorial infarction.¹ Mandon et al. defined middle cerebral artery (MCA) infarction as "severe" when

it concerned both the deep and superficial areas of the MCA or when the Functional Independence Measure (FIM) was lower to 75 on admission.² The term "malignant cerebral infarction in the middle cerebral artery" was first used by Hacke et al. in 1996.³ This term refers to a massive cerebral infarction in the MCA, responsible for a high early mortality rate because of cerebral edema and the risk of brain herniation. Several conservative treatment strategies, such as sedation, hyperventilation, steroids, barbiturates, and osmotic therapy with glycerol, mannitol, or hydroxyethyl starch, have been proposed to reduce the development of brain edema and intracranial pressure. So far, though, insufficient evidence of efficacy from randomized clinical trials is available to support any of these therapeutic

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strategies.⁴⁻⁶ Several reports suggest that these therapies may be ineffective or even detrimental.⁶⁻⁹ Because of the limitations of medical therapies, decompressive craniectomy has been proposed for patients with space-occupying hemispheric infarction. The disappointing outcomes of medical treatment resulted in the expansion of decompressive craniectomy, which demonstrates a significant survival benefit, since the mortality rate for malignant MCA infarction, which was 67 to 80% with traditional medical treatment, is now 0 to 34% with the use of decompressive craniectomy.⁸⁻¹³ The functional outcomes following decompressive craniectomy reported in scientific literature remain open to interpretation, and doubts about the benefits of this treatment in terms of functional outcomes and quality of life persist.² A recent pooled analysis of the 3 European randomized controlled trials by Vahedi et al proved that hemicraniectomy is a life-saving procedure and can result in a favorable functional outcome when offered early to younger patients (less than 60 years of age).¹¹ Most studies were based on the mRS to evaluate the long term effect of decompressive craniectomy on functional outcome. There was less data of short term effect. In this prospective, clinical, open (but primary end point blinded) study, we assess the efficacy of decompressive craniectomy on functional outcomes with variable scales such as Korean Mini Mental State Examination (K-MMSE), Motricity Index (MI), Trunk Control Test (TCT), modified Rankin Scale (mRS) and FIM at baseline to 90 days by comparison with medical treatment.

Methods

Between January 2009 and June 2011, 316 patients suffering from severe MCA infarction were managed in our Regional Cardiocerebrovascular Center who had been referred to department of rehabilitation medicine after the acute treatment. Inclusion criteria included both the deep and superficial areas of the MCA; FIM was lower to 75; Diffusion-weighted imaging (DWI) infarct volume > 145 cm³. Exclusion criteria included prior stroke history; FIM exceed 75 or more; anterior cerebral artery or posterior cerebral artery stroke occurs; combined with cerebellum or pontine stroke; dementia or cognitive impairment

which may interfere with other functional measurement; serious illness disability; unstable medical conditions. Indications of decompressive craniectomy in our Regional Cardiocerebrovascular Center were age 18~70 years; NIHSS score >18 for lesions of the nondominant hemisphere and >20 for lesions of the dominant hemisphere; decrease in the level of consciousness to a score of 1 on item 1a of the NIHSS; Computed tomography documented unilateral MCA infarction; including at least 2/3 of the territory and including at least part of the basal ganglia; onset of symptoms within 48 hours before a possible surgical intervention; possibility to start surgery within 6 hours; informed consent by the patient or legal representative. After acute treatment, all subjects were applied rehabilitation to 90 days.

To compare the degree of functional improvement between two groups, we prospectively assessed K-MBI, mRS, FIM, MI and TCT at baseline, 90 days after the stroke.

1) Statistical analysis

All statistical analyses were performed using statistical package for the social sciences for windows SPSS version 18.0K (SPSS Korea, Seoul, Korea) for Windows. An independent t-test was done to compare the differences in the measured values (K-MMSE, mRS, FIM, MI and TCT) between two groups. Paired t-test was used to compare the parameters between baseline and 90 days in each group. Differences were considered significant when the p-value was less than 0.05.

Results

According to the definition of severe MCA infarction; invade the surface and depth simultaneously, the stroke volume showed 145 cm³ or more in MRI, and 75 point or less in FIM, the total numbers of patients were 25. All patients fulfilled all eligibility criteria (Fig. 1). Ten patients (7 males, 3 females) received decompressive craniectomy, 15 patients (10 males, 5 females) received only medical treatment. In the surgically treated group, Rt. MCA infarction for 5, Lt. MCA infarction for 5, mean stroke volume was 166.1 ± 33.2 cm³. In the conservatively treated group, Rt. MCA infarction for 5, Lt. MCA

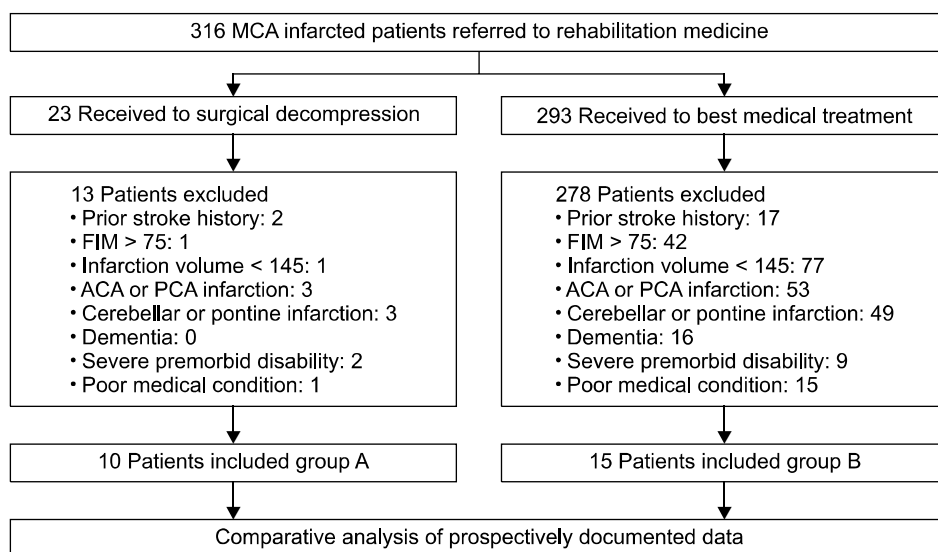


Fig. 1. Flow chart of patient group assignment and treatment.

Table 1. Demographic Characteristics of Patients

	Group A (n = 10)	Group B (n = 15)
Age (yrs)	52.4 ± 11.5	57.9 ± 12.4
Sex (male/female)	(7/3)	(10/5)
Hemisphere (right/left)	(5/5)	(5/10)
Infarction volume (cm ³)	166.1 ± 33.2	150.1 ± 4.0
NIHSS	19.3 ± 2.3	16.5 ± 3.7
Interval from onset to baseline evaluation (days)	23.1 ± 11.6	17.7 ± 8.0
Cigarette smoking	3 (30%)	6 (40%)
Hypertension	5 (50%)	8 (53%)
Diabetes	2 (20%)	4 (27%)
Hypercholesterolemia	1 (10%)	1 (7%)
Atrial fibrillation	2 (20%)	1 (7%)

Values are mean ± SD. Group A: Patients with decompressive craniectomy, Group B: Patients without decompressive craniectomy, NIHSS: National Institute of Health Stroke Scale.

infarction for 10, mean stroke volume was 150.1 ± 4.0 cm³. The clinical characteristics were not significantly different between the two groups (Table 1). The complications such as inhalation pneumonia, venous thromboembolic complication, seizure, depression, urinary tract infection, gastric ulcer between the two groups did not show significant differences (Table 2). There is no significant difference between the two groups for the baseline functional assessment ($p > 0.05$, Table 3).

Each groups showed significant improvement of K-MMSE, mRS, FIM and MI arm score for the periods of baseline to 90 days after the stroke. But, there were no significant differences in improvement of K-MMSE, mRS, FIM and MI arm score between two groups ($p >$

Table 2. Safty Outcomes of Patients

	From baseline to 90 days follow up	
	Group A, n (%)	Group B, n (%)
Inhalation pneumonia	3 (30)	1 (7)
Venous thromboembolism	0 (0)	0 (0)
Seizure	1 (10)	1 (7)
Depression	3 (30)	2 (13)
Urinary tract infection	4 (40)	5 (33)
Gastric ulcer	0 (0)	1 (7)

Group A: Patients with decompressive craniectomy, Group B: Patients without decompressive craniectomy.

0.05, Table 4). Compared with the conservatively treated group, the surgically treated group showed statistically significant improvement in Motricity index leg score and

Table 3. Change of Functional Status on Each Group

	Group A			Group B		
	Baseline	90 days	p-value	Baseline	90 days	p-value
K-MMSE	8.9 ± 11.4	12.0 ± 10.9	0.008**	9.0 ± 8.8	11.7 ± 8.6	0.000**
mRS	4.3 ± 0.9	3.2 ± 1.3	0.000**	4.0 ± 0.7	3.3 ± 1.0	0.000**
FIM	39.1 ± 21.8	62.8 ± 27.2	0.000**	41.0 ± 17.1	62.0 ± 19.4	0.000**
MI arm	14.7 ± 22.4	26.8 ± 27.9	0.016*	21.5 ± 27.6	31.9 ± 31.0	0.002**
MI leg	19.3 ± 21.9	49.9 ± 15.9	0.000**	28.9 ± 21.6	44.1 ± 21.8	0.000**
MI side	17.0 ± 21.8	38.4 ± 21.4	0.001**	25.2 ± 23.5	38.0 ± 23.9	0.000**
TCT	33.5 ± 32.4	73.1 ± 21.1	0.000**	47.8 ± 30.1	72.0 ± 32.0	0.000**

Values are mean ± SD. Group A: Patients with decompressive craniectomy, Group B: Patients without decompressive craniectomy, K-MMSE: Korean-mini mental state examination, mRS: Modified Rankin scale, FIM: Functional independence measure, MI: Motricity index, TCT: Trunk control test. * $p < 0.05$, ** $p < 0.01$

Table 4. Comparison of Mean Changes between Two Groups

	Baseline to 90 days		
	Group A	Group B	p-value
ΔK-MMSE	3.1 ± 4.5	2.7 ± 3.4	0.82
ΔmRS	1.0 ± 0.8	2.7 ± 3.4	0.39
ΔFIM	25.2 ± 9.2	20.5 ± 10.1	0.25
ΔMI arm	11.9 ± 16.2	10.4 ± 13.3	0.80
ΔMI leg	31.0 ± 14.6	15.2 ± 13.5	0.01*
ΔMI side	21.5 ± 12.3	12.8 ± 10.3	0.07
ΔTCT	40.9 ± 16.7	24.2 ± 19.2	0.04*

Values are mean ± SD. Group A: Patients with decompressive craniectomy, Group B: Patients without decompressive craniectomy, K-MMSE: Korean-mini mental state examination, mRS: Modified Rankin scale, FIM: Functional independence measure, MI: Motricity index, TCT: Trunk control test.

TCT ($p < 0.05$, Fig. 2, 3). At period of baseline to 90 days after the treatment, the surgically treated group showed improving tendency of Motricity index side score compared with the conservatively treated group, but there was no statistical significant difference between the two groups ($p = 0.074$, Fig. 2, 3).

Discussion

The prognosis of these space-occupying or malignant MCA infarctions is poor, with case fatality rates in intensive care-based series of nearly 80%.³ No medical treatment has been proven effective.⁴⁻⁶ Decompressive surgery, reduces mortality rate about 30% in patients with malignant MCA infarction without increasing the number of severely disabled survivors.^{12,14-16} Our Regional Cardio-

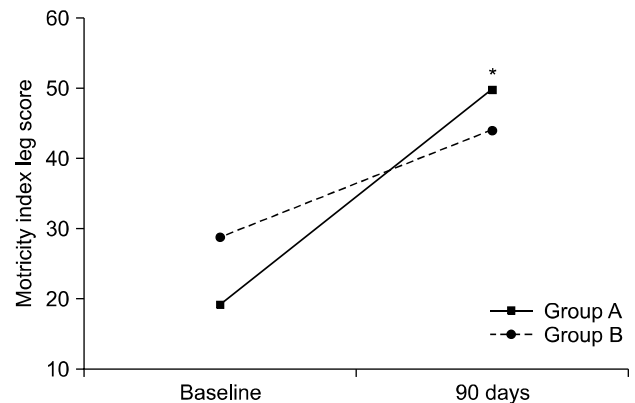


Fig. 2. Change of Trunk Control Test in both groups. Group A: Patients with decompressive craniectomy. Group B: Patients without decompressive craniectomy. * $p < 0.05$.

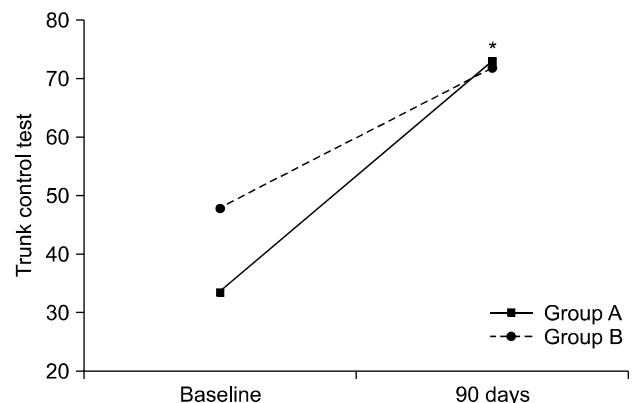


Fig. 3. Change of Motricity Index leg score in both groups. Group A: Patients with decompressive craniectomy. Group B: Patients without decompressive craniectomy. * $p < 0.05$.

cerebrovascular Center's mortality rate from January 2009 to June 2011 showed about 28%, there was similar to other studies.

In this study, for 25 patients of severe MCA infarction, 10 patients with decompressive craniectomy and 15 patients with medical treatment only, assessed the degree of functional recovery for the period of 90 days after the onset. In addition, by measuring TCT, Motricity index arm, leg, side score, patients were measured the functional improvement. As a result, for TCT, 90 days after the onset, both group showed statistically significant improvement. And when comparing both groups at 90 days, patients with decompressive craniectomy showed more favorable improvement. For Motricity index arm score, the degree of improvement for paralysis of the upper extremity after the severe stroke between the two groups did not show significant difference. For Motricity index leg score, 90 days after the stroke, both groups showed significant improvement, confirming that decompressive craniectomy in severe MCA infarction could improve early functional recovery. This result is in accordance with DESTINY study, mRS improvement is caused by the leg functional recovery.¹⁷

The efficacy of decompressive surgery's functional outcomes was hypothesized that interruption of the vicious circle of extensive edema, which by elevation of ICP causes ischemia of neighboring brain tissue and further infarction.¹⁸ This may then increase cerebral perfusion pressure and optimize retrograde perfusion of leptomeningeal collateral vessels, thus allowing functionally compromised but viable brain to survive.¹⁹ Decompressive surgery undertaken within 48 hour of stroke onset reduces mortality and increases the number of patients with a favourable functional outcome after malignant hemispheric infarction.^{1,14,16} The main evidence for a benefit of decompressive craniectomy has come from the pooled analysis of DECIMAL, DESTINY and HAMLET.^{12,17,20} In DESTINY trial, after decompressive surgery, the probability of survival increased from 22% to 71%, the probability of survival with an mRS score ≤ 4 increased from 24% to 75%, and the probability of survival with an mRS score ≤ 3 almost doubled.¹⁷ At the same time, very severe disability (mRS = 5) was not increased.¹⁷ The DECIMAL trial reported great benefit from the early decompressive hemicraniectomy on survival and better functional outcome as defined by the mRS score distribution at 6 and 12 months of follow-up after

craniectomy.¹² But, the previous studies only reported mRS and modified Barthel index, therefore lacks the functional recovery of patients. In addition, the degree of functional recovery was only examined for 6 to 12 months, lacking prior to 6 months period of the degree of early recovery.

According to the van der Worp et al.,²¹ the age for decompressive craniectomy performance, did not show significant difference even after early decompressive craniectomy for the group of patients with the age of 60 years or older. In addition, for females over 70 years or older showed reduction in mortality rate, but could not prove functional recovery, thus decompressive craniectomy is not being recommended.²¹ In this study, 6 patients were above 60 years of age, and among them 3 were more than 70 years of age. But the number of group was too few to compare the degree of the functional improvement between the groups.

This study has several limitations. First, the study was conducted with a small number of patients, and did not compare the difference in the degree of improvement by separating Rt. MCA infarction and Lt. MCA infarction. In addition, only measured the functional improvement for the period of 90 days after the stroke, thus have limitation on long-term prognosis. Also needs further research on functional improvement after decompressive craniectomy for the patients over the age of 60, and needs to conduct the research with more patients for a longer period of time. Second, we could not make randomized patients selection because of acute severe MCA infarcted patients were managed by neurosurgeon first.

Conclusion

We compared functional outcomes of decompressive craniectomy for severe MCA infarction with the conservative treatment. And as a result, patients with decompressive craniectomy showed significant improvement of leg and trunk function at 90 days after the treatment. In view of these results, it is therefore considered that decompressive craniectomy could be give beneficial effect to functional outcomes and improving leg and trunk function of severe MCA infarcted patients.

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