

Clinical study

# Outcome of and prognostic factors for decompressive hemicraniectomy in malignant middle cerebral artery infarction

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## Abstract

Decompressive hemicraniectomy as an appropriate treatment for malignant middle cerebral artery (MCA) infarction is still a controversial issue. This study aimed to determine the survival rate and functional outcome, and factors associated with these, in patients with malignant MCA infarction. From January 2000 to December 2003, 60 patients with malignant MCA infarction were treated in our hospital. All patients in the study underwent a large ipsilateral craniectomy and duroplasty for decompression. The infarction territory was evaluated by either diffusion weighted magnetic resonance imaging or computed tomography. Clinical neurological presentation was evaluated using the Glasgow Coma Scale. Functional outcome was evaluated using the Barthel index (BI) and the Glasgow Outcome Scale (GOS) at follow-up 12 months later. Thirty-day mortality was 20% (12 patients) and 12-month mortality was 26.6%. The factors associated with higher mortality were age  $\geq 60$  years, involvement of more than one vascular territory, presence of signs indicating clinical herniation before surgery, and treatment more than 24 hours after ictus. The mean GOS score was  $3.3 \pm 1.7$ . The mean Barthel index was  $65.1 \pm 40.1$ . Twenty-nine (65.9%) patients had a favourable outcome (BI  $\geq 60$ ). The factors associated with favourable outcome were age  $< 60$  years and treatment within 24 hours of ictus, before clinical signs of herniation were noted. Decompressive hemicraniectomy should be performed in patients younger than 60 years within 24 hours of ictus before clinical signs of herniation develop. Age, timing of surgery and clinical signs of herniation are prognostic factors for mortality and functional outcome.

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**Keywords:** Decompressive hemicraniectomy; Infarction; Middle cerebral artery

## 1. Introduction

Life-threatening cerebral infarctions of the middle cerebral artery (MCA) account for 10–15% of all stroke patients.<sup>1,2</sup> Patients may have severe neurological deficits, with hemiplegia, head and gaze deviation towards the side of the infarction, and deterioration of consciousness. Brain oedema may subsequently be associated with tentorial brain herniation and death. In a number of clinical trials survival rates of 67–84% have been reported in

patients with malignant MCA infarction treated with decompressive hemicraniectomy compared with 20–30% in conservatively treated patients.<sup>3–15</sup> However, the effects of this treatment on functional outcome are equivocal. As young patients are particularly affected by malignant MCA infarction, in addition to reducing the death rate, lowering morbidity and improving quality of life are essential goals of decompressive hemicraniectomy. Thus, the aims of this study were: (i) to determine survival, prognosis and functional outcome; and (ii) to determine factors associated with survival and functional outcomes in a series of consecutive patients who underwent decompressive hemicraniectomy for the treatment of malignant MCA infarction.

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## 2. Materials and methods

### 2.1. Patient selection

From January 2000 to December 2003, 60 patients with malignant MCA infarction were treated in our hospital. The surgical inclusion criteria were: (i) infarction of >50% of the MCA territory as measured by computed tomography (CT) scan and/or magnetic resonance imaging (MRI), with an acute onset of corresponding clinical signs and symptoms; (ii) neuroradiological evidence of local brain swelling such as compression of the basal cisterns and effacement of sulci. Patients with any previous disabling neurological disease, coma, terminal illness, or secondary parenchyma haemorrhage were excluded.

### 2.2. Operative methods

All patients in the study underwent a large ipsilateral craniectomy and duroplasty for decompression. Intracranial pressure (ICP) was monitored by intraparenchymal insertion of a fiberoptic sensor (Codman, Johnson & Johnson, Piscataway, NJ, USA). If the postoperative ICP was more than 30 mmHg with medical treatment, further anterior temporal lobectomy was performed to reduce the ICP. The bone flap was frozen and stored until reimplantation 12 weeks after surgery.

### 2.3. Patient evaluation

Clinical status was recorded on admission and preoperatively using the Glasgow Coma Scale (GCS). The consciousness level of all patients was reassessed on the 7th postoperative day. Time spent in the intensive care unit (ICU) was also recorded. Surgical mortality was defined as patient death 30 days after ictus. Functional outcome was evaluated using the Barthel index (BI) and the Glasgow Outcome Scale (GOS) at follow-up 12 months later. A favourable outcome was defined as  $BI \geq 60$  (moderate disability to good recovery), and a poor outcome was defined as  $BI < 60$  (severe disability).

### 2.4. Statistical analysis

All numerical data are given as mean  $\pm$  standard deviation (SD). The following variables were considered for prognostic evaluation: sex, age, brain stem herniation signs, extent of infarction (MCA territory only versus more than MCA territory), laterality of infarction, and timing of surgery. Univariate analysis was carried out first. Comparison of mean values was performed using the Mann-Whitney *U*-test or  $\chi^2$  test. A probability value of 0.05 or less was considered to be significant. Logistic regression analysis was used to analyze the prognostic impact of pretreatment factors on the BI. A  $BI < 60$  was classified as an unfavourable outcome; otherwise a favourable outcome was assumed.

## 3. Results

### 3.1. Patient characteristics

The demographic data of patients are presented in Table 1; a total of 60 patients (39 men and 21 women) with a mean age of  $62.7 \pm 13.9$  years (range: 19–89) were included. In 41 patients only the MCA territory was affected, whereas in 19 the territory of the anterior cerebral artery was also involved. The mean preoperative GCS score was  $8.4 \pm 2.5$ . The mean time from symptom onset to decompressive hemicraniectomy was  $41.3 \pm 47.8$  h; 31 patients were treated within 24 h, and the other 29 patients were treated more than 24 h after ictus. Twenty (33.3%) patients had clinical signs of herniation before treatment.

### 3.2. Survival rates and prognostic factors

Forty-eight (80%) out of 60 operated patients survived after malignant MCA infarction. Thirty-day mortality was 20% (12 patients) and 12-month mortality was 26.6%. Thirty-four (56.7%) patients regained consciousness by the 7th day after ictus. The mean ICU stay was  $15.5 \pm 11.0$  days. Risk factors after univariate analysis were involvement of more than one vascular territory ( $p = 0.0036$ ) and clinical signs of herniation preoperatively ( $p = 0.0013$ ). There were no statistical differences with respect to timing of surgery and age (dichotomized:  $\geq 60$  years) in univariate analysis. Logistic regression analysis revealed that treatment more than 24 h after ictus ( $p = 0.0362$ ) and age  $> 60$  years ( $p = 0.0008$ ) were associ-

Table 1  
Baseline characteristics in 60 patients who underwent surgical decompression to treat malignant MCA infarction

Characteristic or variable	Value
Mean age (years)	$62.7 \pm 13.9$
Range (25th percentile, median, 75th percentile)	19–89 (53.5, 64.5, 73.0)
Mean GCS	$8.4 \pm 2.5$
Range (25th percentile, median, 75th percentile)	4–15 (7.0, 8.0, 10.0)
Sex (% female)	35.0%
Affected side (% right)	63.3%
Mean time to operation (h)	$41.3 \pm 47.8$
Range (25th percentile, median, 75th percentile)	1–216 (4.0, 22.0, 72.0)
Involvement of vascular territories (%)	
MCA	68.3%
MCA and ACA (ICA)	31.7%
Presence of clinical signs of herniation (%)	33.3%
Mean ICU stay after operation (days)	$15.5 \pm 11.0$
Range	4–60
Mean BI	$65.1 \pm 40.1$
$BI \geq 60$ (%)	65.9%
Mean GOS	$3.3 \pm 1.7$
$\geq 4$ (%)	48.3%

GCS, Glasgow Coma Scale; MCA, middle cerebral artery; ACA, anterior cerebral artery; ICA, internal carotid artery; BI, Barthel index; GOS, Glasgow Outcome Scale.

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