

# Outcomes and Factors in Cerebral Infarction Treated by Decompressive Craniectomy

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## Abstract

The objective of this analytic study was to investigate the outcome of patients suffering from ischemic strokes who were treated by decompressive craniectomy (DC) and factors associated with the unfavorable outcome. Data was conducted to investigate patients suffering from Middle cerebral artery (MCA) infarction who were treated with DC in Pranangkla hospital between January 1, 2007 and December 31, 2010. The medical records were reviewed and data collection age, sex, history of hypertension (HT), diabetes mellitus (DM), atrial fibrillation (AF), side of hemispheric infarction, preoperative Glasgow coma scale (GCS), pupil asymmetry, midline shift and Glasgow outcome scale (GOS). Fourteen patients were included in the present study. The overall mortality was 57.2 percent. There were high mortality in older age, lower preoperative GCS (3-6) and midline shift. Patients with lower GCS tended to have high risk of death after the operation.

In summary, preoperative GCS is a potential factor of survival in patients suffering from MCA infarction treated by decompressive craniectomy.

**Key words:** stroke, decompressive craniectomy, GCS, mortality

## Introduction

Stroke is the most common cause of death and adult disability worldwide.<sup>(1)</sup> The general term stroke describes the functional neurological injury. The cause of stroke can be either anoxic-ischemic, the result of vasogenic failure to supply sufficient oxygen and substrate to tissue, or hemorrhagic, the result of abnormal leakage of blood into or around central nervous system structures. In Thailand, stroke is the first and the third cause of death in females and

males of all age groups, respectively.<sup>(2,3)</sup> In 1983, one study conducted in Bangkok showed that the prevalence of stroke was 690/100,000 population (age over 20years).<sup>(4)</sup> Life-threatening, space-occupying brain edema occurs in 1-10 percent of patients with a supratentorial infarct and usually manifests itself between the second and the fifth day after stroke onset. However, up to a third of patients can have neurological deterioration within 24 hours of symptom onset.<sup>(5)</sup> The prognosis of malignant middle cere-

bral artery (MCA) infarction is poor and high mortality rate.<sup>(6,8)</sup> Despite medical treatments such as hyperventilation, mannitol, barbiturate coma, and hypothermia, mortality is estimated to be between 50 percent and 80 percent.<sup>(6,8)</sup> The main cause of death encountered in these patients is focal brain edema, with resultant compartmental shift and cerebral herniation.<sup>(8)</sup> Different predictors of fatal brain edema formation have been identified, such as major early CT brain hypodensity involving more than 50 percent of the MCA territory, other vascular territories and age. However, up to now no single prognostic factor with sufficient prognostic value has been identified.<sup>(5,9)</sup>

Decompressive craniectomy has been studied as a way to relieve the mass effect and tissue shifts related to mass lesions. Hemispheric craniectomy can relieve the pressure from swollen, brain tissue, preventing brain herniation and death.<sup>(5,9)</sup> Several studies with large MCA infarction have shown that decompressive surgery can reduce mortality to less than 50 percent.<sup>(8-12)</sup> Although mortality rates probably fall after decompressive surgery, it is unclear which groups of patients benefit most from the procedure.<sup>(5,9)</sup> Several studies have suggested that decompressive craniectomy reduces mortality in patients with malignant MCA infarction without increasing the number of severely disabled survivors.<sup>(5-10)</sup> Whereas most clinicians agree that the procedure is probably life-saving, no convincing data are available regarding outcome of survivors. The aim of this study was to investigate the outcome of patients suffering from ischemic strokes who were treated by decompressive craniectomy and factors associated with the unfavorable outcome.

## Methods

This analytic study was conducted at Pranangklaow hospital, Nonthaburi, Thailand. Data on patients suffering from MCA infarction who were treated with decompressive craniectomy (DC) in Pranangklaow hospital were collected between January 1, 2007 and December 31, 2010. Data reviewed from the medical records included in the analysis were age, sex, history of hypertension (HT), diabetes mellitus (DM), atrial fibrillation (AF), side of hemispheric infarction, preoperative Glasgow coma scale (GCS), pupil asymmetry, midline shift and Glasgow outcome scale (GOS). Comparisons were made between two groups of patients - survivors and non survivors.

Descriptive statistics were used and Fisher's exact test was used in the comparisons of the two groups and the present study was approved by the Ethic Committee of Pranangklaow hospital.

## Results

Before the surgery, CT brains were performed at the following times: a) immediately after hospital admission, b) when the patients deteriorated to a consciousness level of at least 2 on GCS, and /or pupil asymmetry appeared. Midline shift was evaluated from the last preoperative CT brain findings and based on horizontal displacement of septum pellucidum.

Indications for surgery were a deterioration of the level of consciousness and a space-occupying infarction on the CT brain. All patients with supratentorial massive cerebral infarction were treated with external decompression consisting of extensive craniectomy with removal of frontal, temporal, and parietal bone approximately 12 cm. in range. Neurological outcome

was assessed at discharge according to GOS (GOS 1-3 unfavorable outcome, GOS 4-5 favorable outcome).

Fourteen patients were included in the present study. There were 6 males and 8 females, aged from 31 to 78 years (mean 52.1 years). Acute massive cerebral infarction occurred in 9 right hemispheres and in 5 left ones. In all, 8, 4, 5 of patients presented with HT, DM and AF respectively.

Preoperatively, all 14 patients had developed cloudy consciousness (GCS become worse more than 2 from admitted at surgical department); GCS was 3 to 6 in 8 patients, 7 to 15 in 6 patients. Nine patients developed asymmetric pupils. CT brain demonstrated midline shift more than 10 m.m. in 11 patients. The characteristics of the 14 patients treated with decompressive craniectomy are shown in table 1.

The overall mortality was 57.2 percent. Favorable outcome was 21.4 percent and unfavorable outcome was 78.6 percent are shown in table 2

Preoperative GCS, older age and midline shift were associated with high mortality (table 1). Patients with lower preoperative GCS (3-6) tended to have higher mortality risk (100%). In addition, older age (>60yrs) tended to die more than younger group (80% vs. 44.4%). Patients with midline shift more than 10 m.m tended to die than other (0 cases vs. 8 cases).

### Discussion

The present study sought to identify clinical and radiographic factors that associated mortality among patients with large stroke undergoing DC intervention. Old age, preoperative GCS, and midline shift were associated with high mortality with large infarction. The over-

**Table 1** The patients characteristics and outcomes

Characteristic	Number of patients		p-value
	Survivors (n=6)	Non survivors (n=8)	
Age (yrs)			
< 60	5	4	0.3
> 60	1	4	
Sex			
Female	4	4	0.63
Male	2	4	
HT			
present	2	6	0.28
absent	4	2	
DM			
present	1	3	0.58
absent	5	5	
AF			
present	2	3	
absent	4	5	1.0
Hemisphere			
right	4	5	1.0
left	2	3	
GCS pre-op.			
3-6	0	8	<0.001
7-15	6	0	
Pupil unequal			
present	2	7	0.09
absent	4	1	
Midline shift (mm)			
< 10	3	0	0.06
> 10	3	8	

**Table 2** Neurological outcome (GOS).

GOS	Number of patient (n=14)	Percent
GOS 1 (death)	8	57.2
GOS 2 (vegetative)	1	7.1
GOS 3 (severe disability)	2	14.3
GOS 4 (moderate disability)	2	14.3
GOS 5 (good recovery)	1	7.1

all mortality was 8 of 14 patients (57.2%). Mortality was high in the patients with older age (4 of 5 patients), preoperative GCS 3 to 6 (8 of 8 patients) and midline shift more than 10 mm. (8 of 11 patients).

Although history of hypertension (HT) in this study showed high mortality than non-HT patients (75% and 33.3%). In this study, we did not find such association probably due to the limited number of study subjects, the association between clinical history of HT and brain swelling due to stroke is unclear and has not been described in prior studies. It seems likely that these disorders may be proxy measures of systemic disease and that may be related to chronic impairments in cerebral collateral flow and auto regulation.<sup>(8)</sup> History of systemic HT portended poor outcome, perhaps as a marker of increased vascular disease and greater risk of complications.<sup>(11)</sup>

Even though, the mortality rate was higher (4 of 5 patients) for those > 60 years of age compare with (4 of 9 patients) those < 60 years of age. The association was not statistically significant. It may be due to a small group of patients in the study. The impact of age on outcome has not been well studied in large hemispheric stroke. There are reports of poor functional outcome and increased mortality in older patients who underwent hemicraniectomy.<sup>(9,13-16)</sup> Older age may have an effect on the ability of the brain to compensate for a stroke. Older patients tend to have comorbid conditions that likely increase the risk of poor outcome and mortality. Conversely, younger patients may be expected to have better outcome, but a lack of cerebral atrophy may not allow them to tolerate massive brain edema as in older patients. In the systemic review of uncontrolled studies

on decompressive craniectomy, 80 percent of the patients older than 50 years were dead or remained severely disabled compare with 32 percent of patients aged 50 years or younger.<sup>(9)</sup>

It was found that older age, GCS and midline shift were an important factor of survival after DC. A consciousness level of GCS 3 to 6 or tentorial herniation may be too late to start DC. Drowsiness and pupillary asymmetry are thought to be the most consistent and specific sign of impending herniation. The CT brain should be taken as soon as possible when such conditions are found. Tentorial herniation is the primary neurological cause of death in the most studies.<sup>(13)</sup> If decompressive is carried out before the tentorial herniation develops, the outcome may be better. From neuroradiological studies it has been well recognized that “early visual radiolucency” in the CT brain is a negative outcome predictor. Von Khummer, et al demonstrated that large (>50%) or total hypodensity in MCA territory predicted fatal outcome in 85 percent of cases, with high specificity (94%) but moderate sensitivity (61%).<sup>(10,17)</sup> Based on Kriegger and colleagues, only CT brain involvement of >50 percent of MCA territory was found to predict fatal brain swelling.<sup>(18)</sup> Concurrent acute infarction in these territories contributed to poor outcome and was likely indicative of poor hemispheric collateral flow, large or more proximal vascular occlusion (such as the intracranial internal carotid artery), and greater volume of edematous brain tissue.<sup>(8,19)</sup> Prophylactic decompressive craniectomy may be carried out for such patients, especially young patients, in whom the homonymous low density area with mild edema appear over the whole MCA territory on CT brain 24 to 48 hours after onset.

Unfavorable outcome by GOS in this study was 78.6 percent. The poor outcome may be late detected for DC and older age.

The present study had some limitations; 1) its limited and number of cases design, whereas the abstraction of medical records often results in some misclassified or missing data; 2) as with most surgical trail, the nature of treatment under study prevented a fully blinded outcome assessment; 3) subgroup analyses on expected prognostic factors, such as age and treatment were not powered to show quantitative differences in treatment effect between groups; 4) no comparison (medication); could lead to the conclusion that DC is better than medication in patient with similar severity. Beneficial of this study, it showed unfavorable factors associated with a higher mortality such as older, lower preoperative GCS and midline shift. Information on such risk factors can help family and neurosurgeon to make decision on patient's prognosis. The choice of performing DC is on an individual patient with space-occupying hemispheric infarction and depends on the willingness to accept survival with moderate or severe disability.

It would be recommended that the clinician may suggest DC in patient with GCS higher than 6 and in patient with midline shift less than 10 mm., Because of potential reduction of death risk. However, the clinician would consult with individuals or patient's family to make a decision whether to undergo DC in patient with worse conditions.

In conclusion, older age, lower preoperative GCS, midline shift were negative factors in treatment of cerebral infarction by DC. Lower preoperative GCS was associated with high mortality. The decision to perform DC should be

made on an individual basis with any patient and family's consents.

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**บทคัดย่อ** ผลลัพธ์และปัจจัยพยากรณ์ในผู้ป่วยสมองขาดเลือดโดยการผ่าตัดเปิดกะโหลก

สกล สุขพรหม

กลุ่มงานศัลยกรรม โรงพยาบาลพระนั่งเกล้า นนทบุรี

*วารสารวิชาการสาธารณสุข* 2555; 21:129-34.

การศึกษาเชิงวิเคราะห์ เพื่อศึกษาผลการรักษาผู้ป่วยสมองขาดเลือดด้วยวิธีการผ่าตัดแบบเปิดกะโหลก และศึกษาปัจจัยที่สัมพันธ์กับกลุ่มผู้ป่วยที่มีผลการรักษาไม่พึงประสงค์ จากการเก็บข้อมูลผู้ป่วยสมองขาดเลือดได้รับการผ่าตัดแบบเปิดกะโหลกในโรงพยาบาลพระนั่งเกล้าระหว่างวันที่ 1 มกราคม 2550 ถึง 31 ธันวาคม 2553 โดยบันทึกข้อมูล เพศ อายุ ประวัติโรคความดันโลหิตสูง เบาหวาน หัวใจห้องบนเต้นเร็วแบบสั้นพลั่วข้างของสมองขาดเลือด คะแนนกลาสโกว์ก่อนผ่าตัด การตอบสนองของม่านตา การเคลื่อนที่ของแนว กึ่งกลางสมองในผลเอ็กซเรย์สมอง คะแนนผลลัพธ์กลาสโกว์หลังการรักษา ผลการศึกษาพบว่า ผู้ป่วยสมองขาดเลือดได้รับการผ่าตัดแบบเปิดกะโหลก 14 ราย เสียชีวิตร้อยละ 57.2 โดยผู้สูงอายุ คะแนนกลาสโกว์ก่อนผ่าตัดระดับต่ำ การเคลื่อนที่ของแนวกึ่งกลางสมองในผลเอ็กซเรย์สมอง มีอัตราเสียชีวิตสูง ผู้ป่วยที่มีคะแนนกลาสโกว์ก่อนผ่าตัดระดับต่ำมีความเสี่ยงในการเสียชีวิตหลังการผ่าตัดสูง

โดยสรุป คะแนนกลาสโกว์ก่อนผ่าตัดช่วยประเมินการรอดชีวิตหลังการผ่าตัดในผู้ป่วยสมองขาดเลือด ซึ่งได้รับการผ่าตัดแบบเปิดกะโหลก

**คำสำคัญ:** สมองขาดเลือด, การผ่าตัดแบบเปิดกะโหลก, คะแนนกลาสโกว์, การเสียชีวิต