Factors Influencing the Outcome of Decompressive Craniectomy Used in the Treatment of Severe Traumatic Brain Injury

Kriengsak Limpastan MD*, Thunya Norasetthada MD*,
Wanarak Watcharasaksilp MD*, Tanat Vaniyapong MD*

** Neurosurgery Unit, Department of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand*

Objective: *To evaluate risk factors that influences the outcome of decompressive craniectomy (DC) in severe traumatic brain injury patients.*

Material and Method: *The authors' retrospective review of data collected from 826 severe traumatic brain injury patients admitted to the Chiang Mai University Hospital between January 1, 2006 and December 31, 2008. During this period, 159 of 826 patients (19.25%) underwent DC and the craniectomy size was not smaller than a fronto-temporo-parietal or a bifrontal bone flap. Data collected included demographics, pre- and post-operative Glasgow coma scores (GCS), timing of surgery, complications, and Glasgow outcome score (GOS) at discharge and six months after surgery. At our institution, patients are managed using the Brain Trauma Foundation guidelines.*

Results: *One hundred fifty nine patients were identified, 130 (81.76%) male and 29 (18.23%) female. One hundred twenty two patients were operated within the first 24 hours after admission. Overall mortality rate was 44.65%. The survival group was younger (30.73 years vs. 43.46 years, $p<0.001$) and had a higher pre-craniectomy GCS (6 vs. 5, $p = 0.002$). Of the 88 survivors, favorable outcome was achieved in 21 patients (13.20%) at discharge and increased to 38 patients (23.89%) at six months after surgery. Those with favorable outcome were younger (25.43 years vs. 38.35 years, $p = 0.001$) and had a higher pre-craniectomy GCS ($p = 0.013$).*

Conclusion: *Younger age group patients and higher pre-operative GCS are two factors that influence the outcome of DC. Early decompressive craniectomy in patients with higher GCS may result in better functional outcomes.*

Keywords: *Decompressive craniectomy, Severe traumatic brain injury, Factors influencing the outcome*

J Med Assoc Thai 2013; 96 (6): 678-82
Full text. e-Journal: *http://jmat.mat.or.th*

Traumatic brain injury (TBI) is a major cause of death and disability throughout the world, especially in developing countries. The treatment of TBI has been refined in recent years, and the brain trauma foundation (BFT) guidelines[1] have aided the development of new management techniques. These guidelines outline decompressive craniectomy as a surgical management option for refractory increased intracranial pressure (IICP). Previous reports have demonstrated that intracranial hypertension, functional outcome, and mortality may be improved by decompressive craniectomy[2,3]. However, this surgical procedure remains controversial because of the lack of clearly defined indications in the literature. The authors report the outcome of the severe TBI patients who underwent DC and an analysis of the factors that may influence outcomes.

Correspondence to:
Limpastan K, Neurosurgery Unit. Department of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai 50200, Thailand.
Phone: 053-945-532-4
E-mail: kriengsak@neurosurgerycmu.com

Material and Method

A retrospective review of medical records was completed on all patients who underwent decompressive craniectomy (DC) for severe TBI admitted at Chiang Mai University Hospital between January 1, 2006 and December 31, 2008. Inclusion criteria were, 1) all patients who sustained severe traumatic brain injury (GCS <8), and who underwent decompressive craniectomy; and, 2) the size of the craniectomy was not smaller than a fronto-temporo-parietal bone flap or a bifrontal bone flap. BTF guidelines are used at our institution for management of severe TBI. One hundred fifty nine patients met these criteria. Of these, 122 patients had the indication for surgical removal of the lesions such as subdural hematoma, brain contusion, and intracerebral hematoma, and a DC was performed due to mark brain

swelling within the first 24 hours after admission. Thirty-seven patients were operated on after the first 24 hours, usually because of worsening neurological status, enlarging surgical lesions, or uncontrollable ICP. The DC was completed on the side correlating with the high-pressure lesion, 59 patients on the right side and 81 patients on the left side, with 19 patients receiving bilateral DCs. This is shown in Table 1.

Medical records were reviewed, noting specifically gender, age, cause of injury, admission GCS, pre-craniectomy GCS, timing of craniectomy, post-craniectomy complications, and GOS at discharge and six months after the procedure. The Glasgow outcome score (GOS) was used to analyze functional outcome, with moderate disability and good recovery defined as a favorable outcome; severe disability and vegetative state were defined as an unfavorable outcome. Differences between groups were tested with the Student's test for continuous data, and the Chi-square x^2 test for dichotomous variables. P-value was set at 0.05 for statistically significant. The Faculty of Medicine, Chiang Mai University's ethics committee approved this study.

Results

During the three-year period between January1, 2006 and December 31, 2008, 826 severe TBI patients were admitted. Of these 159 patients received DC (19.25%), 130 were male and 29 female (mean age of 36.42 years, range 1-80 years). The major cause of injury was a traffic accident (121 cases, 76.10%). The decompressive craniectomy was performed within the first 24 hours following admission on 122 patients and 37 patients were operated on after the first 24 hours. The length of hospital stay ranged from 1 to 99 days (mean = 13.94). Seventy-one patients died of those 64 were operated on in the first 24 hours after admission (64 of 71 patients, 90.14%). The overall mortality rate at discharge was 44.65% (71 of 159 patients) as shown in Table 1. The patients who scored a pre-operative GCS of 6 and higher had a significantly lower mortality when compared with those who scored 5 or lower (35.42% vs. 58.74%, p = 0.004). As shown in Table 2. Those who survived were significantly younger (mean age 30.73 vs. 43.46 years, p<0.001) and had a higher pre-operative GCS (GCS.6 vs. 5, p = 0.002), as shown in Table 2. At discharge, 67 (42.14%) patients had an unfavorable outcome, whereas 21 patients (13.20%) had a favorable outcome. The favorable outcome group were significant younger than the unfavorable outcome and dead group (mean age 25.43 vs. 38.35, p = 0.001) as shown in Table 3. The favorable outcome group increased to 38 patients at six months after surgery (23.89%). Among the patients who were operated on within 24 hours, the patients who scored pre-operative GCS of 6 to 8 also got a significantly better outcome than those who scored pre-operative of 5 and lower at discharge and six months after surgery (p = 0.013), as shown in Table 3. The most common post-operative complications were pneumonia (29.56%), and other infections as shown in Table 4.

Discussion

DC has long been in use as a treatment option for refractory intracranial hypertension following TBI. The benefit of lowering the intracranial pressure by DC is clear, but the clinical outcome is still questionable[4]. Mortality rates reported range from 11% to 54%[3,5-8]. In the present study, DC was performed in 19.24% (159 patients) of the patients who were admitted with severe traumatic brain injury. We experienced an overall mortality rate of 44.65% (71 of 159 patients). This high mortality rate may be due to 80.28% of the deceased group (57 of 71 patients) had non-responsive pupillary light reflex on admission. In the deceased group, 64 of 71 patients

Table 1. Baseline characteristics and result

Characteristics	n (%)
Gender	
Male	130 (81.76)
Female	29 (18.24)
Age (year)	
Mean (SD)	36.42 (17.98)
Range	1-80
Cause of injury	
Traffic accident	121 (76.10)
Body assault	11 (6.92)
Falling	12 (7.54)
Penetrating injury	1 (0.63)
Unspecified	14 (8.81)
Side of craniectomy	
Right	59 (37.11)
Left	81 (50.94)
Both	19 (11.95)
Timing of DC (hours)	
≤24	122 (76.73)
>24	37 (23.27)
Result	
Alive	88 (55.35)
Dead	71 (44.65)

Table 2. Factors associated with survival after DC

Characteristics	Survive, n = 88 (%)	Dead, n = 71 (%)	p-value
Gender			
Male	75 (57.69)	55 (42.31)	0.208
Female	13 (44.83)	16 (55.17)	
Age (year)			
Mean(SD)	30.73 (15.30)	43.46 (18.64)	<0.001
GCS pre operation			
≤5	26 (41.26)	37 (58.74)	0.004
6-8	62 (64.58)	34 (35.42)	
Median (P25, P75)	6 (5, 7)	5 (4, 5)	0.002
Timing of DC			
≤24 hour	58 (47.54)	64 (52.46)	<0.001
>24 hour	30 (81.08)	7 (18.92)	

Table 3. Overall outcome of the patients

Outcome	Favorable, n (%)	Unfavorable, n (%)	Dead, n (%)	p-value
At discharge (159)	21 (13.20)	67 (42.14)	71 (44.66)	
Age, mean (SD) year	25.43 (11.93)	38.35 (17.97)		0.001
Range	13-53	1-80		
At 6 month (79)	38 (48.10)	25 (31.64)	16 (20.26)	Loss follow-up 9 cases
Outcome of DC within 24 hr at discharge				
Pre-op GCS ≤5 (50)	13 (26.00)	3 (6.00)	34 (68.00)	0.013
Pre-op GCS 6-8 (72)	30 (41.67)	12 (16.67)	30 (41.67)	
Outcome of DC within 24 hr at 6 month				
Pre-op GCS ≤5	1 (6.67)	10 (66.67)	4 (26.67)	0.013
Pre-op GCS 6-8	5 (14.71)	8 (23.53)	21 (61.76)	

Table 4. Complications

Variable	n (%)
Complication	
Pneumonia	47 (29.56)
UTI	4 (2.51)
Meningitis (ventriculitis)	1 (0.62)
Rebleeding	6 (3.77)
Infraction	15 (9.44)
Others (post traumatic seizure, sepsis, lung atelectasis, rhabdomyolysis, hypovolumic,shock, pressure sore, acute renal failure)	73 (45.92)
No	13 (8.18)

(90.14%) underwent DC within the first 24 hours following admission. The high mortality rate in this group may have been a result of more severity of injury and more marked brain swelling which mandated early DC after removal of the focal surgical lesions. The pre-operative GCS also influenced the mortality rate, patients with pre-operative GCS of 5 or lower had a mortality rate of 58.74% (37 of 63 patients), while a pre-operative GCS of 6 to 8 had a mortality rate of 35.42% (34 of 96 patients). Among the patients who were operated on within first 24 hours, the patients who have pre-operative GCS of 6 and better had a higher rate of favorable outcomes compared with the patients who had pre-operative GCS of 5 and lower (30 of 72 patients, 41.67% vs. 13 of 50 patients, 26.0%, p = 0.013). As shown in Table 3. This may encourage earlier DC in those patients with a higher GCS to obtain better outcomes. Previous studies have reported a wide range of favorable functional outcomes of 16% to 61%[8,9]. In the present study favorable outcomes at discharge were 13.20% (21/159), and poor outcomes 42.13% (67/159). However, the favorable outcome group increased to 23.89% at six months after the surgery. This wide range of outcomes is most likely secondary to the wide clinical variation in the patients who underwent DC[10]. Younger age groups have been

associated with a good outcome in many reported studies[10-15]. The present study confirmed that good outcomes resulted in the younger age group (mean age of 25.43 years), whereas the older group (mean age of 38.35 years) experienced increased poor outcomes.

The chief limitation of our study is that it was retrospective. If time to event data available in the future, the survival analysis may be result more useful conclusion.

Conclusion

Several factors influence the outcome of decompressive craniectomy for the treatment of severe traumatic brain injury. The present study suggests that the following factors influence the outcome:

1) Age of the patient, the younger age group achieved better results.

2) Pre-operative GCS affected outcome, a higher pre-operative GCS gave a better outcome.

3) Early decompressive craniectomy in the patients who have higher GCS may yield an improved functional outcome.

Potential conflicts of interest

None.

References

1. Bullock MR, Povlishock JT. Guidelines for the management of severe traumatic brain injury. Editor's Commentary. J Neurotrauma 2007; 24 (Suppl 1): 2.
2. Aarabi B, Hesdorffer DC, Ahn ES, Aresco C, Scalea TM, Eisenberg HM. Outcome following decompressive craniectomy for malignant swelling due to severe head injury. J Neurosurg 2006; 104: 469-79.
3. Polin RS, Shaffrey ME, Bogaev CA, Tisdale N, Germanson T, Bocchicchio B, et al. Decompressive bifrontal craniectomy in the treatment of severe refractory posttraumatic cerebral edema. Neurosurgery 1997; 41: 84-92.
4. Winter CD, Adamides A, Rosenfeld JV. The role of decompressive craniectomy in the management of traumatic brain injury: a critical review. J Clin Neurosci 2005; 12: 619-23.
5. Gaab MR, Rittierodt M, Lorenz M, Heissler HE. Traumatic brain swelling and operative decompression: a prospective investigation. Acta Neurochir Suppl (Wien) 1990; 51: 326-8.
6. Guerra WK, Gaab MR, Dietz H, Mueller JU, Piek J, Fritsch MJ. Surgical decompression for traumatic brain swelling: indications and results. J Neurosurg 1999; 90: 187-96.
7. Kunze E, Meixensberger J, Janka M, Sorensen N, Roosen K. Decompressive craniectomy in patients with uncontrollable intracranial hypertension. Acta Neurochir Suppl 1998; 71: 16-8.
8. Ucar T, Akyuz M, Kazan S, Tuncer R. Role of decompressive surgery in the management of severe head injuries: prognostic factors and patient selection. J Neurotrauma 2005; 22: 1311-8.
9. Timofeev I, Hutchinson PJ. Outcome after surgical decompression of severe traumatic brain injury. Injury 2006; 37: 1125-32.
10. Williams RF, Magnotti LJ, Croce MA, Hargraves BB, Fischer PE, Schroeppel TJ, et al. Impact of decompressive craniectomy on functional outcome after severe traumatic brain injury. J Trauma 2009; 66: 1570-4.
11. Makino H, Yamaura A. Assessment of outcome following large decompressive craniectomy in management of serious cerebral contusion. A review of 207 cases. Acta Neurochir Suppl (Wien) 1979; 28: 193-4.
12. Meier U, Zeilinger FS, Henzka O. The use of decompressive craniectomy for the management of severe head injuries. Acta Neurochir Suppl 2000; 76: 475-8.
13. Olivecrona M, Rodling-Wahlstrom M, Naredi S, Koskinen LO. Effective ICP reduction by decompressive craniectomy in patients with severe traumatic brain injury treated by an ICP-targeted therapy. J Neurotrauma 2007; 24: 927-35.
14. Pompucci A, De Bonis P, Pettorini B, Petrella G, Di Chirico A, Anile C. Decompressive craniectomy for traumatic brain injury: patient age and outcome. J Neurotrauma 2007; 24: 1182-8.
15. Schneider GH, Bardt T, Lanksch WR, Unterberg A. Decompressive craniectomy following traumatic brain injury: ICP, CPP and neurological outcome. Acta Neurochir Suppl 2002; 81: 77-9.

ปัจจัยที่มีผลต่อการรักษาผู้ป่วยบาดเจ็บที่ศีรษะขั้นรุนแรงด้วยวิธีการผ่าตัดเอากะโหลกศีรษะออก

เกรียงศักดิ์ ลิ้มพัสถาน , ธัญญา นรเศรษฐ์ธาดา, วนรักษ์ วัชระศักดิ์ศิลป์, ธนัฐ วานิยะพงศ์

วัตถุประสงค์: *ผลการรักษาผู้ป่วยบาดเจ็บศีรษะขั้นรุนแรงด้วยการผ่าตัดเอากะโหลกศีรษะออก ที่มีรายงานในต่างประเทศแสดงผลการรักษาที่แตกต่างกันมาก ตามแต่บริบทของแต่ละประเทศ คณะผู้ศึกษาจึงได้ทำการศึกษาผลของการรักษาด้วยวิธีนี้รวมถึงปัจจัยต่าง ๆ ที่ส่งผลต่อการรักษาด้วยวิธีนี้ในประเทศไทย*

วัสดุและวิธีการ: *ศึกษาข้อมูลย้อนหลังของผู้ป่วยบาดเจ็บที่ศีรษะขั้นรุนแรง 826 ราย ที่มารับการรักษาที่คณะแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ในช่วงเวลาตั้งแต่ วันที่ 1 มกราคม พ.ศ. 2549 ถึง วันที่ 31 ธันวาคม พ.ศ. 2551 ซึ่งมีผู้ป่วยที่ได้รับการผ่าตัดด้วยวิธีเอากะโหลกออกทั้งสิ้น 159 ราย โดยขนาดกะโหลกที่เปิดไว้มีขนาดไม่น้อยกว่า fronto-temporo-parietal หรือ bifrontal bone flap โดยทำการเก็บข้อมูลทั่วไป GCS ก่อนและหลังผ่าตัด ระยะเวลาที่มาถึงก่อนผ่าตัด GOS ขณะจำหน่ายออกจากโรงพยาบาล และที่เวลา 6 เดือนหลังการผ่าตัด*

ผลการศึกษา: *กลุ่มที่รอดชีวิตมีอายุเฉลี่ยน้อยกว่า (30.73 ปี vs. 43.46 ปี, p<0.001) และ GCS ก่อนการผ่าตัดที่สูงกว่ากลุ่มที่เสียชีวิตอย่างมีนัยสำคัญทางสถิติ (GCS 6 vs. 5, p = 0.002). ผู้ป่วย 21 ราย (13.20%) มีผลการรักษาที่ดีขณะจำหน่ายออกจากโรงพยาบาล และเพิ่มขึ้นเป็น 38 ราย (23.89%) ที่ระยะเวลา 6 เดือน โดยในกลุ่มที่ได้ผลดีมีอายุเฉลี่ยต่ำกว่า (25.43 ปี vs. 38.35 ปี, p = 0.001) และมี GCS ก่อนผ่าตัดที่ดีกว่า (p = 0.013)*

สรุป: *ผู้ป่วยที่มีอายุน้อยและมี GCS ก่อนผ่าตัดที่ดีกว่า เป็นปัจจัยสำคัญที่ส่งผลดีต่อการรักษาด้วยวิธีนี้การผ่าตัดในผู้ป่วยที่ GCS ที่ดีกว่าน่าจะส่งผลดีต่อการรักษา*