STUDY ON THE TREATMENT RESULTS OF DECOMPRESSIVE CRANIECTOMY IN SEVERE TRAUMATIC BRAIN INJURY WITHOUT MASS LESION

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Abstract

Objectives: To evaluate the treatment results of severe traumatic brain injury without intracranial hematoma by decompressive craniectomy. ***Methods:*** An uncontrolled intervention study on 45 patients with severe traumatic brain injury, no intracranial hematoma, high intracranial pressure above 20 mmHg, unresponsive to medical therapy, and operated decompressive craniectomy at Viet Duc University Hospital from May 2017 to December 2022. Research variables: Age, gender, cause of the accident, preoperative GCS, pulse and blood pressure before surgery, and CT images before and 3 months after surgery. Comparing treatment results between groups. ***Results:*** 45 patients were studied, including 42 males and 3 females; the oldest age was 78, and the lowest was 6 years old; traffic accidents accounted for the majority of 86.7%; daily-life accidents was 8.9%; GCS before surgery: 3 - 5 points (55.6%), GCS: 6 - 8 points (44.4%); GCS = 8 points (8.9%). The mean ICP was: 40.09 ± 10.37 mmHg. Results when patients were discharged: 9 patients were dead and 36 patients were alive. ***Conclusion:*** In the treatment results of decompression craniectomy on patients with a severe traumatic brain injury without intracranial hematoma, the mortality rate, vegetative state, and severe sequelae are still high.

Keywords: Decompression craniectomy; Traumatic brain injury without intracranial hematoma; Intracranial pressure.

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INTRODUCTION

Traumatic brain injury was defined as severe when the Glasgow Coma Scale score ≤ 8 after initial emergency treatment, accounting for 28.3% of total traumatic brain injuries, with a mortality rate and severe sequelae of 36.6 - 80% [1]. According to the statistics of Viet Duc University Hospital, during 3 years (1995 - 1997), the mortality rate from traumatic brain injury accounted for 93% of the total number of deaths due to accidents and accounted for 3/4 of all deaths in the whole hospital. In 2005, the mortality rate due to severe traumatic brain injury was 64.3% [2, 3]. In 2003, the Intensive Care Unit at Military Central Hospital 108 treated 147 cases of severe traumatic brain injury, with 80% mortality and disability [4]. In the US, there are 1.6 million patients with traumatic brain injury annually, including 52,000 deaths, 90,000 cases with lifelong sequelae, and currently about 2% of the population (5.3 million people) living with sequelae of traumatic brain injury [5].

Increased intracranial pressure in severe traumatic brain injury, which causes decreased cerebral perfusion pressure and decreased oxygen supply to brain tissue, is the main cause of brain damage secondary to death or severe sequelae [5].

Indications for surgery to relieve brain compression, as well as surgical techniques, the timing of surgery, and prognostic factors in patients with severe traumatic brain injury are not yet agreed. Especially for patients with severe traumatic brain injury but small hematoma or no intracranial hematoma, mainly cerebral contusion and cerebral edema, despite intensive resuscitation treatment but unable to control the increase in intracranial pressure skull [6]. Therefore, we conducted this study: *To study the treatment results of decompressive craniectomy in patients with severe traumatic brain injury without intracranial hematoma.*

MATERIALS AND METHODS

1. Subjects

45 patients with severe traumatic brain injury who underwent decompressive craniectomy at the Center for Neurosurgery at Viet Duc University Hospital from May 2017 to December 2022

* *Inclusion criteria:* Patients who were diagnosed with severe traumatic brain injury before surgery (GCS score: 3 - 8); CT scans showed no intracranial hematoma or hematoma less than 20 grams; Measure intracranial pressure with Integra's

Camino instrument (intraparenchymal or intraventricular) with ICP > 20 mmHg after active medical therapy and indications for decompression craniectomy.

* *Exclusion criteria:* Decompression craniectomy without measuring ICP, no continuous ICP monitoring, no surgery; Hematoma and decompression craniectomy with hematoma > 20 grams, weak body, have many medical diseases associated with affecting anesthesia, resuscitation and evaluation of postoperative results*;* Patients who had a state of traumatic shock, multi-trauma patients with many serious injuries in addition to skull associated with traumatic brain injury; Patients who underwent surgery to release the brain compression elsewhere and transferred to Viet Duc University Hospital for further treatment; Patients with surgical release of brain compression in other cranial pathologies; Patients and family members do not agree to participate in research cooperation.

2. Methods

* *Study design*: A prospective descriptive study with no control intervention.

* *Sample size:* Use the following formula to calculate sample size:

$$n \geq \left(\frac{Z_{1-\alpha/2}}{d} \right)^2 \times p \times (1-p)$$

n: The number of patients with severe severe traumatic brain injury requiring decompressive craniotomy surgery to be included in the study.

$\mathbf{Z}_{1-\alpha/2}$: Limit value calculated from the normal distribution corresponding to the two-sided statistical significance level of the assigned error α. Statistical significance level α = 0.05, so $\mathbf{Z}_{1-\alpha/2}$ = 1,96.

d: The allowable error when estimating the mortality rate after surgery for severe traumatic brain injury, d = 0.126.

p: The mortality rate in patients with severe traumatic brain injury who underwent decompressive craniotomy. According to the study of Yuan Q. et al (2013), a 5-year study with n = 164, has a postoperative mortality rate of 22%. Using that ratio we have p = 0.22 and 1 - p = 0.78.

Substitute the formula:

$$n \geq \left(\frac{1.96}{0,126} \right)^2 \times 0,22 \times (1-0,22) \rightarrow n \geq 41,5$$

The minimum study subjects were 42 patients. In this study, we performed 45 cases (n = 45).

* *Research process:*

An uncontrolled intervention study on 45 patients with severe traumatic

brain injury was treated at Viet Duc University Hospital. All patients underwent clinical examination, CT scan, intracranial pressure (ICP) measurement, and cerebral perfusion pressure measurement. Patients are indicated for surgery based on perception, lesion image on CT and intracranial pressure. If the intracranial pressure < 20 mmHg or is under control, the patient is resuscitated in the neurologic ICU. If intracranial pressure ≥ 20 mmHg, ICP cannot be controlled, decompressing craniectomy. Research indicators include Clinical status, GCS, pupils, breathing, pulse, and blood pressure. Computed tomography image: Intracranial lesions such as hematoma, cerebral contusion, subarachnoid hemorrhage, cerebral edema, midline shift, basilar collapse, collapse, and fundus obliteration. Treatment surgery: Incision, skull opening area, and dural patch. Results: Assessed when the patient is discharged and after 3, 6, and 12 months based on the GOS table.

* *Data processing:* According to statistical algorithms, using SPSS software.

RESULTS AND DISCUSSION

During 5 years, our study was conducted on 45 patients who met the criteria, including 42 males and 3 females, the oldest age was 78, and the lowest was 6 years old. Traffic accidents accounted for the majority of 86.7%, and accidents in daily life were 8.9%.

Table 1: Results when the patient was discharged from the hospital.

Result	Number of patients (n)	Ratio (%)
Living	36	80
Dead	9	20
Total	45	100

There were 9 patients (20%) died immediately after discharge, and 36 patients (80%) survived. Fatal cases are usually patients with severe clinical manifestations such as a low GCS score, bilateral pupillary dilation, loss of light reflexes and often death in the first days after surgery. The cases of intracranial pressure increased very high, and brain edema did not patch the dura. After surgery, the state of increased intracranial pressure still occurred, and then the patient died. The mortality rate in our study was lower than that of Yuan (2012)

[7], with 22% of patients who died after decompression craniectomy in 164 patients with severe traumatic brain injury.

Table 2: Results 3 months after surgery (n = 45).

Result	Number of patients (n)	Ratio (%)
Good (GOS 4, 5)	14	31,1
Bad (GOS 1, 2, 3)	31	68,9
Total	45	100

There are 31 patients (68.9%) with bad GOS results (1 - 3), 14 patients (31.1%) with good GOS (4 - 5), in which, 11 patients with GOS score 5 (30.6%). Our study results were lower than those of Yuan (2017) [7] with 164 patients with severe traumatic brain injury undergoing decompression craniectomy, the mortality rate, vegetative survival, and severe sequelae were 58%, and good recovery result was 42%.

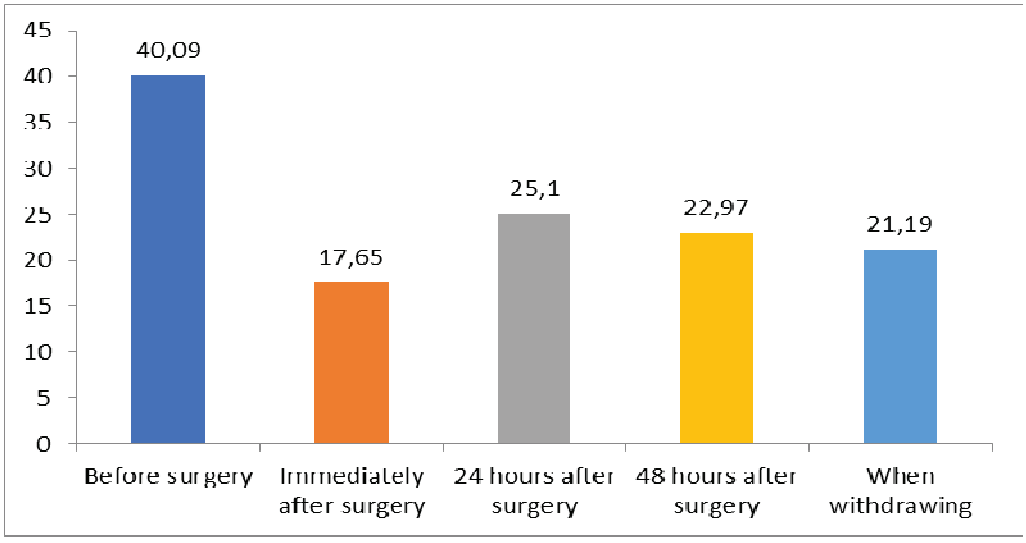

Figure 1. Average intracranial pressure chart over time (n = 31).

The mean intracranial pressure before surgery was 40.09 ± 10.37 mmHg. Right after surgery, the intracranial pressure decreased to 17.65 ± 13.32 mmHg. The average intracranial pressure at the time immediately after surgery 24h, 48h tended to increase higher than the intracranial pressure at the time immediately after surgery, but the increase was not much. The highest increase at 24h was 25.10 ± 14.70 mmHg.

Table 3: Effectiveness in reducing intracranial pressure after surgery compared to before surgery (n = 31).

Time	Intracranial pressure (mmHg)	Decreased intracranial pressure compared to pre-surgery	Rate of reduction in intracranial pressure compared with preoperative	p
Before surgery (1)	40.09 ± 10.37			
Immediately after surgery (2)	17.65 ± 13.32	23.26 ± 12.83	57.39%	< 0.001
24 hours after surgery (3)	25.10 ± 14.70	15.81 ± 14.88	46.29%	< 0.001
48 hours after surgery (4)	22.97 ± 6.90	16.83 ± 11.93	38.21%	< 0.001
When withdrawing (5)	20.32 ± 15.49	20.58 ± 16.81	49.59%	< 0.001

f: Wilcoxon Signed Ranks test

p^{1-2}: Paired comparison of intracranial pressure immediately after surgery and before surgery.

p^{1-3}: Paired comparison of intracranial pressure 24 hours after surgery with preoperative pressure.

p^{1-4}: Paired comparison of intracranial pressure 48 hours after surgery and before surgery.

p^{1-5}: Paired comparison of intracranial pressure during withdrawal with pre-surgery.

The effect of reducing intracranial pressure immediately after surgery and 24h, 48h after surgery was reduced compared to preoperative intracranial pressure, and this reduction was very significant when compared in pairs ($p < 0.001$). After 24 and 48 hours of surgery, intracranial pressure increases slightly and then gradually decreases and is usually maintained and controlled with relatively stable medical resuscitation until the device is removed. Therefore, close monitoring of intracranial pressure after surgery is necessary, especially in the first 48 hours, to promptly detect increased intracranial pressure to prescribe appropriate treatment such as using a hypertonic solution such as mannitol 20%, NaCl 3%, 10% hypertonic saline, or hyperventilation to combat cerebral edema. In addition, it is necessary to combine monitoring of intracranial pressure and other clinical symptoms such as mental status, characteristics of craniofacial defects, pupillary signs as well as other focal neurological signs to promptly Detecting the cause of

increased intracranial pressure, distinguishing the cause due to cerebral edema and bleeding complications after surgery is very necessary. The reduction of intracranial pressure after surgery has helped increase cerebral venous pressure to maintain adequate oxygen supply to the brain, limit irreversible secondary damage, and reduce mortality and postoperative sequelae. Daboussi A. et al. (2009) conducted monitoring of intracranial pressure on 26 patients with traumatic brain injury before, immediately after surgery and 48 hours after decompressive craniectomy. Immediately after surgery, intracranial pressure decreased from 37 ± 17 to 20 ± 13 mmHg, and the cerebral perfusion rate increased from 23 ± 15 to 31 ± 13 cm/s. The authors found that these parameters continued to remain stable during the first 48 hours after surgery [8].

Bor-Seng-Shu E. et al. (2012) reviewed the overview of decompressive craniectomy on severe traumatic brain injury from 20 studies from January 1995 to December 2010 with n = 479, with an evaluation of intracranial pressure and cerebral venous pressure showed that the average intracranial pressure decreased immediately after surgery was 17.59 mmHg ($p < 0.00001$), 24 hours after surgery was 14.27 mmHg ($p < 0.00001$) and 48 hours after surgery was 12.69 mmHg ($p < 0.0001$). Intracranial pressure decreased immediately after surgery and lasted for more than 48 hours after surgery, leading to an average increase in cerebral venous pressure after surgery of 7.37 mmHg ($p < 0.0001$). In the study, 8 - 20% of cases did not reduce intracranial pressure after surgery, and these cases often had a bad outcome after treatment [9].

CONCLUSION

Decompressive craniectomy should be indicated for patients with severe traumatic brain injury whose CT scan shows small hematomas or no intracranial hematomas, mainly brain contusions, and cerebral edema, despite intensive resuscitation treatment, but cannot control the increase of intracranial pressure..

- Results at the time of discharge: 9 patients died (20%), 36 patients survived (80%), good GOS score (4, 5) was seen in 14 patients (31.1%), bad GOS score (1, 2, 3) was seen in 31 patients (68.9%).

- Decompressive craniectomy effectively reduces intracranial pressure. The effect of reducing intracranial pressure is obvious and statistically significant, with $p < 0.001$.

- Intracranial pressure decreased, and the effectiveness of intracranial pressure reduction was maintained in the days after surgery until the device was removed and controlled by post-operative medical treatment.

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