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Factors Contributing to Patient Outcome after Decompressive Craniectomy in Traumatic and Non-Traumatic Cases

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A B S T R A C T

Background: Decompressive craniectomy is an invasive procedure performed to reduce intracranial pressure. Inconsistent research results regarding the effectiveness of decompressive craniectomy are caused by various factors that are believed to play a role in patient outcomes after decompressive craniectomy. This study aims to determine the factors that play a role in patient outcomes after decompressive craniectomy in traumatic cases and in non-traumatic cases. **Methods:** This study is an analytic observational study with a cross-sectional approach. A total of 40 secondary data from postoperative decompressive craniectomy patients were included in this study. Data analysis was performed using SPSS version 25 with univariate, bivariate, and multivariate analysis. **Results:** Age and gender factors were not associated with patient outcomes after decompressive craniectomy in traumatic and non-traumatic cases. Clinical factors, initial GCS, and preoperative pupil diameter were shown to be unrelated to patient outcomes after decompressive craniectomy in traumatic cases. The time interval factor between trauma and decompressive craniectomy was also shown to be unrelated to patient outcomes after decompressive craniectomy in both traumatic and non-traumatic cases. The presence of comorbidities was also shown to be unrelated to patient outcomes after decompressive craniectomy in both traumatic and non-traumatic cases. Clinical factors and initial GCS showed a relationship with patient outcomes after decompressive craniectomy in non-traumatic cases. **Conclusion:** Age, gender, initial GCS, pupil diameter, the time interval of trauma and decompressive craniectomy surgery, and comorbidities are not associated with patient outcomes after decompressive craniectomy. In non-traumatic cases, only initial GCS was associated with patient outcomes after decompressive craniectomy.

1. Introduction

Intracranial pressure disorder is a serious health problem that has been encountered in the last 2 decades. Several studies have shown an almost 6-fold increase in cases of intracranial pressure disorders in the last 2 decades. This intracranial pressure disorder is caused by trauma and non-trauma. Traumatic brain injury is a cause of intracranial disorders due to trauma, and stroke is a cause of intracranial disorders due to non-trauma. Decompressive craniectomy is an invasive procedure performed to reduce intracranial pressure. Various studies have shown the effectiveness of decompressive craniectomy in the treatment of increased intracranial pressure due to traumatic or non-traumatic. Other studies show contradictions with previous studies, where other studies state that there is no significant difference between decompressive craniectomy and medical therapy in dealing with increased intracranial disorders. Inconsistent research results regarding the effectiveness of decompressive craniectomy are caused by various factors that are believed to play a role in patient outcomes after decompressive craniectomy.[1-6]

Another study showed that there is a role for the age of patients who underwent decompressive craniectomy, where the older the age, the worse the patient's outcome after decompressive craniectomy. Other studies have suggested a role for intracranial pressure, traumatic or non-traumatic. The study states that non-traumatic cases, especially hemorrhagic strokes, have poor patient outcomes after decompressive craniectomy. Other studies show that the patient's initial clinical factor, GCS (Glasgow Coma Scale), plays a major role in patient outcomes after decompressive craniectomy. Various risk factors are believed to play a major role in the success of decompressive craniectomy.[7-11] This study is an observational study that aims to scientifically determine the factors that play a role in patient outcomes after decompressive craniectomy. This study describes in detail the risk factors in traumatic cases and in non-traumatic cases.

2. Methods

This study is an analytic observational study with a cross-sectional approach. This study uses secondary data sourced from medical record data at Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia. A total of 40 secondary data from postoperative decompressive craniectomy patients were included in this study. The research subjects included in this study met the inclusion criteria in the form of postoperative decompressive craniectomy patients and complete medical record data. This study was approved by the medical and health research ethics committee at Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia (No. 168/kepkrsmh/2022).

Various risk factor variables, starting from the patient's sociodemography and clinical features, became the test parameters in this study. Data analysis of various test variables was performed using SPSS version 25 software. Univariate analysis was performed to present the distribution of data frequencies for each variable. Bivariate analysis using the chi-square test was used to determine the relationship between variables and patient outcomes after decompressive craniectomy. Multivariate analysis using logistic regression was performed to determine the adjusted p-value, which showed the relationship between various variables and patient outcomes after decompressive craniectomy, $p < 0.05$.

3. Results

Table 1 shows a comparison between variables related to patient outcomes after decompressive craniectomy in traumatic cases. Age and gender factors were not related to patient outcomes after decompressive craniectomy in traumatic cases, $p > 0.05$. Clinical factors, initial GCS, and preoperative pupil diameter were shown to be unrelated to patient outcomes after decompressive craniectomy in traumatic cases. The time interval factor between trauma and decompressive craniectomy was also shown to be unrelated to patient outcomes after decompressive craniectomy in traumatic cases. The presence of comorbidities was also shown to be unrelated to patient outcomes after decompressive craniectomy in traumatic cases.

Table 1. Comparison between variables related to patient outcomes after decompressive craniectomy in traumatic cases.

Variable	Outcomes		Adjusted p-value
	Poor (GOS 1-3)	Favorable (GOS 4-5)	
Age			
12-25 years	1 (50)	4 (28.6)	0.504*
26-45 ears	1 (50.0)	4 (28.6)	
46-65 years	0 (0)	6 (42.9)	
Gender			
Woman	2 (100)	11 (78.6)	1,000*
Man	0 (0)	3 (21.4)	
Initial GCS			
3-8	1 (50)	1 (7.1)	0.218*
9-12	1 (50.0)	11 (78.6)	
13-15	0 (0)	2 (14.3)	
Preoperative pupillary abnormalities			
6 – 10 mm	1 (50.0)	1 (7.1)	0.242*
No abnormalities	1 (50.0)	13 (92.9)	
The interval between trauma/symptom onset and decompressive craniectomy			
6-24 hours	2 (13.3)	13 (92.9)	1.000*
24 hours to 7 days	0 (0)	1 (7.1)	
Associated disease			
COVID-19	0 (0)	1 (100)	1,000*
Other	2 (100)	0 (0)	
None	0 (0)	13 (92.9)	

*Logistic regression test, p<0.05.

Table 2 shows a comparison between variables related to the outcome after decompressive craniectomy patients in non-traumatic cases. Age and gender factors were not related to patient outcomes after decompressive craniectomy in non-traumatic cases, p>0.05. Clinical factors and initial GCS showed a relationship with patient outcomes after decompressive craniectomy in non-traumatic cases. The time interval factor between trauma and decompressive craniectomy was also shown to be unrelated to patient outcomes after decompressive craniectomy in non-traumatic cases. The presence of comorbidities was also shown to be unrelated to patient outcomes after decompressive craniectomy in non-traumatic cases.

Table 2. Comparison between variables related to patient outcomes after decompressive craniectomy in non-traumatic cases.

Variable	Outcomes		p-value
	Poor (GOS 1-3)	Favorable (GOS 4-5)	
Age			
12-25 years	4 (44.4)	7 (46.7)	0.513*
26-45 years	3 (33.3)	7 (46.7)	
46-65 years	2 (22.2)	1(6.7)	
Gender			
Woman	4 (44.4)	8 (53.3)	1.000*
Man	5 (55.6)	7 (46.7)	
Initial GCS			
3- 8	5 (55.6)	2 (13.3)	0.048*
9-12	4 (44.4)	9 (60.0)	
13-15	0 (0)	4 (26.7)	
The interval between trauma/symptom onset and decompressive craniectomy			
6-24 hours	2 (13.3)	13 (92.9)	0.400*
24 hours to 7 days	0 (0)	1 (7.1)	
Postoperative complications			
Prolonged ventilation (more than 21 days for at least 6 hours a day)	2 (22.2)	1(6.7)	0.337*
Respiratory infection	2 (22.2)	1(6.7)	
Sepsis	1 (11.1)	1(6.7)	
None	4 (44.4)	12 (80.0)	
Associated disease			
Hypertension	4 (44.4)	7 (63.6)	
Diabetes mellitus	0 (0)	1(6.7)	
COVID-19	0 (0)	1(6.7)	0.486*
Hypertension + diabetes mellitus	2 (22.2)	2 (13.3)	
Hypertension + COVID-19	1 (11.2)	0 (0)	
Others	1 (11.1)	0 (0)	
	1 (11.1)	4 (26.7)	

*Logistic regression test, p<0.05.

4. Discussion

Trauma refers to physical injuries that occur suddenly and have a severity that requires immediate medical assistance. Injuries due to trauma can be caused by collisions with blunt objects, sharps, and burns. In patients undergoing decompressive craniectomy, the injuries are generally head injuries. In this study, the majority of patients who underwent decompressive craniectomy due to trauma were aged 46-65 years (37.5%). In line with this study, other studies reported that the majority of patients who underwent decompressive craniectomy due to trauma were over 40 years old (35%). Other studies also reported that the average age of patients who underwent a decompressive craniectomy procedure due to trauma was 38.95 ± 17.09 years, with an age range of 15 to 80 years.[12-14]

The majority of patients who underwent decompressive craniectomy due to trauma were male (81.3%). In line with this study, another study found that the majority of patients who underwent decompressive craniectomy due to trauma were male (67%). Another study reported that 89.8% of patients who underwent decompressive craniectomy due to trauma were male. This can be caused because men are more active outside the home and use motorized vehicles more often to carry out their activities, so they are more likely to experience head trauma.[15-17]

Some researchers found that the initial GCS score was a determining factor for the outcome of decompressive craniectomy, whereby patients with a low initial GCS score predicted a poor outcome. GCS (Glasgow Coma Scale) is a neurological scale used to objectively assess a person's level of consciousness. In this study, it was found that the majority of trauma patients who underwent decompressive craniectomy procedures had an initial GCS of 9-12, and the initial GCS in this study did not affect the outcome of patients who underwent decompressive craniectomy. Another study evaluating the results of decompressive craniectomy retrospectively from 2005 to 2011 in 60 patients with severe head injuries who had refractory intracranial hypertension reported that an initial GCS (Glasgow Coma Scale) score lower than 5 was statistically associated with a high mortality rate.[12] However, other studies reported that factors such as age, initial GCS, and type of craniectomy had no significant effect on the outcome of TBI patients undergoing decompressive craniectomy.[18-20]

In addition, some researchers found that pupil abnormalities are also a determining factor in the outcome of decompressive craniectomy, where patients who have pupil abnormalities are predicted to have a poor outcome. However, in this study, the majority of patients did not have pupillary abnormalities, and all patients had no postoperative complications. Another variable studied was the interval between trauma and decompressive craniectomy. The highest interval was 6-24 hours, and only 1 patient had an interval > 24 hours, and no patient had an interval > 7 days. This means that the head trauma patients in this study received fast treatment. Another study found that time from injury to admission to neurosurgery ($p=0.007$) was a risk factor for outcome after decompressive craniectomy in 62 head-injured patients.[21]

The outcome of this study was the Glasgow Outcome Scale (GOS) which was divided into poor (GOS 1-3) and good (GOS 4-5) and was evaluated 6 months after undergoing decompressive craniectomy. In this study, there was no relationship between age, sex, initial GCS, pupil abnormalities, interval, and after craniectomy complications with poor GOS outcomes in trauma patients undergoing decompressive craniectomy, so all variables assessed in this study were not factors that could influence outcomes decompressive craniectomy patients at Dr. Mohammad Hoesin General Hospital Palembang.

In this study, comorbidities were only found in 2 patients who underwent decompressive craniectomy, where both patients had poor GOS outcomes and were statistically significant as factors influencing decompressive craniectomy outcomes in this study. However, this relationship was found in the bivariate analysis, while in the multivariate analysis, these variables were not statistically significant. This could be because, in the multivariate analysis, the relationship between a variable and GOS outcome was also associated with other variables. For example, severe initial GCS and the presence of comorbidities could affect the poor outcome of GOS, but in this study, patients who had comorbidities turned out to have mild or conversely, patients with severe initial GCS did not have comorbidities, so that in the end these two variables were not associated with poor outcomes after decompressive craniectomy.[22]

In this study, the factors influencing the GOS outcome 6 months after decompressive craniectomy was also assessed in non-trauma patients. Non-trauma is an injury or disability to the body that is not caused by external physical force or pressure. Non-traumatic head injuries can be caused by a lack of oxygen supply, metabolic abnormalities, aneurysms, cardiac arrest, tumors, poisoning, and others. Ischemic stroke is one of the leading causes of death and disability in non-trauma patients worldwide. With a decompressive craniectomy, part of the skull bone tissue is removed to provide access for the edematous brain tissue to herniate out, thereby preventing damage to neurons in other parts of the brain.[20-22]

In this study, the majority of patients who underwent non-traumatic decompressive craniectomy were aged 26-45 years (45.8%). Other studies reported that the age range of patients undergoing non-traumatic decompressive craniectomy ranged from 16-79 years. While other studies reported that the average age of patients who underwent non-traumatic decompressive craniectomy procedures was 62.7 ± 13.9 years.[18-20]

There are as many males as females (50%) undergoing non-traumatic decompressive craniectomy. In line with this study, other studies reported that the sex of non-traumatic decompressive craniectomy patients was almost the same between males and females. In this study, there was no relationship between age and gender with GOS outcomes in decompressive craniectomy patients, so these two variables did not affect GOS outcomes in decompressive craniectomy patients. Other variables such as pupillary abnormalities, the interval between symptom onset and decompressive craniectomy, complications, and comorbidities also did not affect the outcome of GOS in decompressive craniectomy patients in this study. However, in this study, it was found that the majority of trauma patients undergoing decompressive craniectomy procedures had an initial GCS of 9-12, and the initial GCS in this study affected the outcome of patients undergoing decompressive craniectomy where patients with severe initial GCS (3-8) had significant outcomes poor GOS (1-3) compared patients with mild and moderate initial GCS.[23]

5. Conclusion

Age, gender, initial GCS, pupil diameter, the time interval of trauma and decompressive craniectomy surgery, and comorbidities were not associated with patient outcomes after decompressive craniectomy. In non-traumatic cases, only initial GCS was associated with patient outcomes after decompressive craniectomy.

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