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ORIGINAL

Decompressive craniectomy as a treatment in patients with cranio-brain trauma at the central hospital of Maracay

Craniectomía descompresiva como tratamiento en pacientes con traumatismo craneoencefálico en el hospital central de Maracay

Daniel Aguiar[1], Miguel Flores[1], Claudia León[1], German Pinto[2], Mildred Lupi[3]

[1]Universidad Nacional Experimental Rómulo Gallegos, Facultad de Ciencias de la Salud. Maracay, Venezuela.
[2]Servicio Autónomo Docente Hospital Central de Maracay, Servicio de Neurocirugía, Docente Investigador. Maracay, Venezuela.
[3]Servicio Autónomo Docente Hospital Central de Maracay, Coordinadora de Investigación Docente Asociado. Maracay, Venezuela.

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Corresponding author: Miguel Flores

ABSTRACT

Introduction: traumatic brain injury (TBI) is defined as an anatomical and functional alteration of the brain due to violent changes in mechanical energy. It is considered a public health problem because it causes high mortality and disability.
Objective: to evaluate decompressive craniectomy (DC) as a treatment in patients with TBI at the Central Hospital of Maracay. January-July 2024.
Method: the study is descriptive, prospective and cross-sectional. Glasgow and Marshall coma scale, clinical characteristics and imaging findings were applied.
Results: 15 patients aged 49±23,5 years, 93 % male, were studied. The main cause of TBI was a motorcycle accident and another (53,3 %). Before CD, 80 % had moderate TBI, 66,66 % had normal pupils, 46,67 % entered II and 33,33 % were placed in IV on the Marshall scale. Subdural hematoma and epidural hematoma predominated with 26,67 % in each case. The midline deviation was 8,5±2,4 mm. The CD application time was 11±9,6 hours. After CD, 46,66 % and 26,67 % were classified as having moderate and mild TBI respectively. 40 % had normal pupils, 20 % died and 66,67 % were not admitted to the Intensive Care Unit. Although the results were favorable after CD, the differences did not show statistical significance (p≥0,05) so it is recommended to expand the sampling.
Conclusion: the results suggest that decompressive craniectomy is recommended as a treatment in patients with traumatic brain injury, with satisfactory results in ages 20-40 years and moderate and mild TBI on the Glasgow scale. However, in patients over 60 years of age and a Glasgow scale score of less than 9 points, the results may be unfavorable.

Keywords: Decompressive Craniectomy; Traumatic Brain Injury; Neurosurgery.

RESUMEN

Introducción: el traumatismo craneoencefálico (TCE) se define como una alteración anatómica y funcional del cerebro debido a cambios violentos de energía mecánica. Es considerado un problema de salud pública por ser la causa de alta mortalidad y discapacidad.
Objetivo: evaluar la craniectomía descompresiva (CD) como tratamiento en pacientes con TCE en el Hospital Central de Maracay. Enero-Julio 2024.

Método: el estudio es descriptivo, prospectivo y de corte transversal. Se aplicó escala de Glasgow y Marshall, características clínicas y hallazgos imagenológicos.
Resultados: se estudiaron 15 pacientes de 49±23,5 años, 93 % del sexo masculino. La causa principal del TCE fue el accidente de moto y otro (53,3 %). Antes de la CD 80 % tuvieron TCE moderado, 66,66 % pupila normal, 46,67 % entraron en II y 33,33 % se ubicaron en IV de la escala de Marshall. El hematoma subdural y el hematoma epidural predominaron con 26,67 % en cada caso. La desviación de la línea media fue de 8,5±2,4 mm. El tiempo de aplicación de la CD fue de 11±9,6 horas. Luego de la CD, 46,66 % y 26,67 % se clasificaron con TCE moderado y leve respectivamente. 40 % tenían pupilas normales, 20 % fallecieron y 66,67 % no ingresaron a la Unidad de Cuidados Intensivos. Aunque los resultados fueron favorables luego de la CD, las diferencias no arrojaron significancia estadística (p≥0,05) por lo que se recomienda ampliar el muestreo.
Conclusión: la craniectomía descompresiva es recomendable como tratamiento en pacientes con traumatismo craneoencefálico, con resultados satisfactorios en edades de 20-40 años y TCE moderado y leve en escala de Glasgow. Sin embargo, en pacientes mayores de 60 años y escala de Glasgow inferior a 9 puntos, los resultados pueden ser desfavorables.

Palabras clave: Craniectomía Descompresiva; Traumatismo Craneoencefálico; Neurocirugía.

INTRODUCTION

Traumatic brain injury (TBI) is considered a public health problem because it is the cause of high mortality and disability, so its therapeutic approach requires a timely and rapid assessment to initiate adequate treatment and avoid complications.[1] TBI is defined as an alteration that occurs in the brain, affecting its anatomy and functionality due to violent changes in mechanical energy.[2] About the etiology, there are various causes, including traffic accidents, which are frequent in young adults, while in pediatric patients, falls and abuse are the most frequent causes. Other causes described are related to direct trauma.[1]

The pathophysiology of TBI is somewhat complex, as it causes damage to the central nervous system through two different injury mechanisms, including primary injury, which is the direct result of the trauma that occurs immediately after the impact and causes functional and structural injuries, which may or may not be reversible, such as contusions, lacerations, fractures, bruises or diffuse axonal injury.[3] The second mechanism is secondary injury, which develops as a consequence of the primary injury as the result of a series of molecular events (neurotransmitter-mediated excitotoxicity, loss of electrolyte balance, mitochondrial dysfunction, inflammatory responses, apoptosis and ischemia).[4] On the other hand, tertiary injury can occur, which is the late manifestation of the damage caused by primary and secondary injuries that lead to apoptosis, necrosis, neurodegeneration and encephalomalacia.[5]

Likewise, patients with severe TBI can develop coagulopathy, which can be associated with an increased risk of hemorrhage expansion, which indicates a poor prognosis for the patient with a risk of death.[1] On the other hand, TBI can trigger a series of complications such as edema, intracranial hypertension, hyperemia, hemorrhages, and thrombosis that can progress to ischemia.[4]

The indication for surgical treatment of TBI is used to preserve the patient's life and avoid neurological sequelae, reducing intracranial hypertension (ICH).[1,6] DC consists of the surgical removal of a considerable part of the cranial vault, associated with a durotomy of the exposed area, to increase the volume of the cranial container and thus achieve a reduction in hypertension and/or alleviate the secondary mechanical compression produced by the displacement of structures.[7,8]

TBI is one of the leading causes of morbidity, mortality, and disability in people under 45 years of age.[2] It has been estimated that approximately 1,5 million people die annually from TBI, in addition to producing nearly 69 million disabled people worldwide, which is why DC is applied as a treatment under clinical indications and promptly.[9,10]

The incidence rate of TBI in Latin America is high and is associated with traffic accidents and violence, with countries such as Colombia, Brazil, Venezuela, Mexico, and El Salvador being the most affected.[2] For example, in Sao Paulo, Brazil, the incidence rate of TBI was found to be 360 per 100 000; figures that exceed the global incidence rate of 200 per 100 000 for developed countries.[2] In Mexico, the incidence rate was reported as 38,8 cases per 100 000 inhabitants, with a higher incidence among men aged 15 to 45.[1] In Venezuela, there is no updated official data on the incidence of TBI; however, it is presumed to be high, as it is a country with high numbers of traffic accidents and violent incidents. Therefore, there is a lack of statistical and epidemiological data that would allow us to understand the reality of TBI in the state of Aragua. There are no published studies on the outcome of TBI patients who undergo DC, nor are there any recent publications that have presented results on the benefits or consequences of early or late primary

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DC on survival and functional outcomes in TBI patients. Given the above, there is a research interest in assessing the benefits and consequences of DC as a treatment for TBI to optimize the care of patients with this condition.

METHOD

The study was conducted under the quantitative, biomedical, and clinical epidemiological paradigms. It is descriptive, prospective, field-based, non-experimental, and cross-sectional. The context of the study was the Autonomous Teaching Service of the Central Hospital of Maracay, located in the state of Aragua. The population and sample were represented by 15 patients diagnosed with TBI with valuable intracranial injury and with clinical criteria for DC. The following were considered inclusion criteria: 1.- Patients admitted within 24 hours of the TBI. 2.- Age between 13 and 85 years. 3.- Patients with traumatic brain injury, 4.- Patients with criteria for DC due to the presence of traumatic brain injury.

Procedure for collecting and processing information

To classify TBI as mild, moderate, or severe, the criteria published by the Royal College of Physicians and Surgeons of Glasgow were applied.11 In this sense, the Glasgow Scale was used, according to the score obtained, the TBI was classified as mild (14–15 points), moderate (9–13 points), and severe (3–8 points).[8]

In addition, in this study a technical sheet was applied for data collection that included all the study variables related to age, sex, clinical epidemiological history, Glasgow scale, imaging results, among others. From a bioethical point of view, the work complied with the criteria established in the Declaration of Helsinki in that each participant or representative was asked to sign an informed consent form.

The variables were analyzed using descriptive and inferential statistical analysis, for which a database was initially created in Microsoft Excel. The statistical program Epinfo 7.2.6.0 was used for the analysis of the quantitative and qualitative variables. For the association of qualitative variables, the chi-square test was applied considering a 95 % confidence level and a statistically significant p-value of ≤0,05. The results are expressed in tables for ease of understanding, analysis and discussion.

RESULTS

The average age of the patients included in the study was 49±23,5 years, mainly in the 20-40 age group (53,33 %), followed by the 61-80 age group (33,3 %). 93 % were male. Motorcycle accidents, other causes, and falls from height were the leading causes or reasons for TBI, with 53,33 %, 20 %, and 13,33 %, respectively (table 1).

Table 1. Distribution of patients studied according to age group, sex, and reason for traumatic brain injury. Maracay Central Hospital

Variable	Frequency	Percentage	Interval of Confidence at 95 %
Age group			
20-40 years	8	55,33	26,59 %-78,73 %
41-60 years	1	6,67	0,17 %-31,95 %
61-80 years	5	33,33	11,82 %-61,62 %
More than 80 years	1	6,67	0,17 %-31,95 %
Sex			
Feminine	1	7	0,1 %-31,95 %
Masculine	14	93	68,05 %-99,83 %
Cause of injury			
Motorcycle accidents	8	53,33	26,59 %-78,73 %
Being run over	1	6,67	0,17 %-31,95 %
Falling from a height	2	13,33	1,66 %-40,46 %
Falling at your own feet	1	6,67	0,17 %-31,95 %
Other	3	20,00	4,33 %-48,09 %

The results regarding the classification of TBI according to the Glasgow scale indicated that a high percentage of patients presented moderate TBI (80 %), while only two patients (13,33 %) had severe TBI. Likewise, 66,66 % presented normal pupils, followed by 20 % with mydriatic pupils. On the other hand, 46,67 % of the patients were placed on the Marshall II scale, and 33,33 % corresponded to level IV (table 2).

Table 2. Classification of traumatic brain injury according to the Glasgow scale, pupils, and Marshall scale on admission. Maracay Central Hospital

Variable	Frequency	Percentage	Interval of Confidence at 95 %
TBI classification according to the glasgow scale			
Mild	1	6,67	0,1 %-31,95 %
Moderate	12	80,00	51,91 %-96,67 %
Severe	2	13,33	1,66-40,46 %
Pupil			
Anisocorical	1	6,67	0,17 %-31,95 %
Mydriatic	3	20,00	4,33 %-48,09 %
Myotic	1	6,67	0,17 %-31,95 %
Normal	10	66,66	38,38 %-88,18 %
Marshal scale			
II	7	46,67	21,27 %-73,41 %
III	1	6,67	0,17 %-31,95 %
IV	5	33,33	11,82 %-61,62 %
VI	2	13,33	1,66 %-40,46 %

Among other clinical and imaging findings, 26,67 % of patients presented with epidural hematoma, 13,38 % had subdural hematoma, and 13,38 % had epidural hematoma. 73,33 % of the patients did not present a deviation of the midline. However, it was observed in 26,67 % of the cases, with an average of 8,5±2,4 mm (table 3).

Table 3. Clinical and imaging findings in patients with traumatic brain injury and midline shift on admission. Hospital Central de Maracay

Variable	Frequency	Percentage	Interval of Confidence at 95 %
Clinical-imaging findings			
Cont+hed+others	1	6,67	0,17 %-31,95 %
Edema+hsd	1	6,67	0,17 %-31,95 %
Hed	4	26,67	7,79 %-55,10 %
Hed+cont	1	6,67	0,17 %-31,95 %
Hed+others	2	13,38	1,66 %-40,46 %
Hsd	4	26,67	7,79 %-55,10 %
Hsd+others	1	6,67	0,17 %-31,95 %
Others	1	6,67	0,17 %-31,95 %
Mean line deviation >5cm			
Yes	4	26,67	7,79 %-55,10 %
No	11	73,33	44,90 %-92,21 %

The time taken to perform decompressive craniectomy from the moment the head injury occurred was, on average, 11,3±9,6 hours, with a minimum and maximum value of 2 and 32 hours, respectively. In 60 % of the patients, decompressive craniectomy was applied in less than 11 hours (table 4).

Table 4. Time of application of decompressive craniectomy in patients with traumatic brain injury. Maracay Central Hospital

Variable	Frequency	Percentage	Interval of Confidence at 95 %
Time and number of ours in the implementation of the CD			
Greater than 11 hours	5	33,33	11,82 %-61,62 %
Less than or equal to 11 hours	9	60,00	32,9 %-83,66 %
NR	1	6,67	0,17 %-31,95 %

The results of the clinical findings of the patients after decompressive craniectomy, according to the Glasgow scale, indicated that 46,66 % and 26,67 % had moderate and mild status, respectively. Likewise, it was observed that 26,67 % were classified as severe. About the pupils, mydriatic (40 %) and standard (40 %) were observed more frequently. 66,67 % of the patients were not admitted to the Intensive Care Unit (ICU). However, three (20

%) patients were admitted to the ICU, and two (13,3 %) had no recorded data. Of the three patients admitted to the ICU, one (1) did not leave, and one (1) left, and no record was obtained of the third. Only 20 % died, and 26,67 % suffered sequelae.

Comparison of the results of the patients before and after DC derived from the Glasgow scale showed differences in scores 14 and 15, from 6,67 % to 26,67 %, respectively, in each case. However, 2 (13,33 %) patients with 3 points after DC were also observed. Likewise, before the DC, the instances of TBI classified as moderate and severe totaled 93,3 %, and 6,67 % were mild cases. At the same time, after the DC, it was observed that the cases classified in the severe and moderate categories were fewer (73,34 %), with an increase in those classified as mild (26,67 %). However, the differences observed were not statistically significant (p≥0,05) (table 5).

Table 5. Comparison of the Glasgow Coma Scale of patients with traumatic brain injury before and after decompressive surgery. Maracay Central Hospital

Glasgow Coma Scale 15 points	At admission Frequency (%)	After the DC Frequency (%)
3	0	2 (13,33)
6	1 (6,67)	0
7	1 (6,67)	1 (6,67)
8	0	1 (6,67)
9	1 (6,67)	1 (6,67)
10	4 (26,67)	1 (6,67)
11	1 (6,67)	0
12	2 (13,33)	0
13	3 (20)	1 (6,67)
14	1 (6,67)	4 (26,67)
15	1 (6,67)	4 (26,67)
Total	15 (100)	15 (100)
Sum of frequencies		
Moderate-Severe	93,3	73,34
Mild	6,67	26,67
Chi-square for Glasgow Scale	62,5	p=0,2564

DISCUSSION

This study included 15 patients with TBI who underwent DC at the primary health center in Aragua. The average age was 49±23,5 years, unlike what was reported by Bagheri et al.[7], who obtained an average age of 36,09±15,89 years in the patients analyzed. Likewise, in the present study, the patients were mainly in the 20-40 age group (53,33 %), similar to León et al.'s survey, which found that 66,7 % of the patients were under 40 years of age. These data coincide with the overall figures Cruz López et al.[1] reported, in that TBI occurs in adolescents and young adults between the ages of 15 and 45.

93 % of the patients were male, similar to previous studies' evidence.[7,8,12] On the other hand, this research showed that motorcycle accidents (53,3 %), other causes (20 %), and falls from height (13,33 %) were among the leading causes or reasons for TBI. In this sense, it coincides with Siranka et al.[13], who reported that traffic accidents were the predominant mechanism of injury. At the same time, for León et al.[8], 33 % were admitted for traffic accidents, 37,5 % for falls from height, and 28,8 % for other or unknown causes.

The TBI on admission was mainly classified as moderate (80 %), with two cases of severe TBI (13,33 %). According to what was previously reported by León et al.[8], 37,5 % of the patients presented with moderate TBI, below the finding of the present study; however, unlike what was observed in this research, León et al.[8] reported a higher percentage of severe cases (45,8 %). For their part, Geyik et al.[12] found a high percentage of severe cases (78,5 %), 17,5 % moderate and 3,5 % mild cases. The differences between this study and previous research could be due to the etiology of the TBI. In this sense, Geyik et al.[12] and León et al.[8] observed that the leading cause of TBI was traffic accidents, while in this research, it was motorcycle accidents and other causes.

Concerning pupil size, which is another essential element in assessing a patient with TBI, it was found that a high percentage had normal pupils (66,66 %), and only 20 % had mydriatic pupils. Contrary to the results found here, León et al.[8] reported that 42,9 % of patients had anisocoria-mydriasis at admission. Likewise, in this investigation, 46,67 % of the patients were placed on the Marshall II scale and 33,33 % on the IV scale, while León et al.[8] observed that 21,7 %, 65,2 %, and 13 % were placed on the Marshall II, III and IV scale respectively.

The patients included in the study mainly presented with Epidural and Subdural Hematoma in 26,67 % of cases, followed by 13,33 % with Epidural Hematoma and others. The findings of this study differ from those of other investigations. For example, Geiyik et al.[12] reported intracerebral hematoma (31,5 %), subdural

hematoma (24,5 %), and subarachnoid hemorrhage (22,8 %). For their part, León et al.[8] reported 54,2 % acute subarachnoid hemorrhage and 33,3 % epidural hematoma. Additionally, only in 26,67 % of the cases was there deviation from the midline, with a mean of 8,5±2,4 mm, a result close to the 10 mm reported by Bagheri et al.[7]

In this investigation, the time taken to apply DC was 11,3±9,6 hours, with the additional data that in 60 % of the patients, it was used in less than 11 hours. León et al.[8] reported longer times, where 58,3 % of the patients had DC performed within 24 hours. Several studies have demonstrated excellent results when DC is practiced early.[14,15]

The Glasgow scale results after DC indicated that 46,66 % and 26,67 % presented a moderate and mild status, respectively, while 26,67 % were severe. León et al.[8] reported that six months after the DC, 14 patients were classified as having a poor prognosis and 10 patients as having a good prognosis according to the classification proposed by the researchers and the Glasgow scale. The increase in severe cases in this study could be related to the death of three of the four cases in this category.

Regarding the condition of the pupils, mydriatic (40 %) and standard (40 %) were found. Pupil alterations have been reported in other studies following DC, such as in the case of León et al.[8] who published that 7 out of 10 patients did not present with pupil alterations with a good Glasgow Coma Scale score, while in patients with a poor Glasgow Coma Scale score they observed pupil alterations in 9 out of 13 patients.

Another significant result is that 66,67 % of the patients after DC did not enter the ICU, and 80,0 % survived, suggesting that DC produced satisfactory results in a high percentage of patients, as reported in previous studies. For example, GeyiK et al.[12] reported that 10,5 % of patients fully recovered and were discharged. Similar to the results of this study, Srikanta et al.[13] found that a high percentage of patients achieved good surgical results (66,67 %). Likewise, Bagheri et al.[7] reported that 54,1 % had favorable and 45,9 % had unfavorable results.

The high percentage of patients who had favorable results in this study could be due to the fact that the majority of the patients were in the 20-40 age group and were admitted with a moderate Glasgow scale (9-13 points).

On the other hand, there was also an increase in the percentage of severe cases related to three patients (20 %) who died. In this sense, of the three patients, two of them were in the 61 to 80 age group with 3 and 9 points according to the Glasgow scale, while the third patient turned out to be young (21 years old) and had 6 points according to the Glasgow scale on admission. This finding coincides with that reported by Bagheri et al. seven, who observed that in patients over 60 years of age or with critical head injury, the results of DC can be worse.

The differences according to the Glasgow scale in patients before and after DC were not statistically significant ($p>0,05$). Similarly, the relationship between the study variables and the impact of DC on patients with TBI was not statistically significant. Although the data generally indicate that DC is a beneficial procedure for a high percentage of patients, as was also demonstrated in previous studies,[7,8,12,16,17] the lack of statistical significance could result from the low number of patients included in this study.

CONCLUSION

Decompressive craniectomy is a treatment that offers satisfactory results in patients with moderate head injuries and mild head injuries on the Glasgow scale aged between 20 and 40 years, with a poor prognosis in patients with head injuries over the age of 60 years, with a Glasgow scale of less than 9 points.

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CONTRIBUTION OF AUTHORSHIP

Conceptualization: Daniel Aguiar, Miguel Flores, Claudia León, German Pinto, Mildred Lupi.
Data curation: Daniel Aguiar, Miguel Flores, Claudia León, German Pinto, Mildred Lupi.
Formal analysis: Daniel Aguiar, Miguel Flores, Claudia León, German Pinto, Mildred Lupi.
Research: Daniel Aguiar, Miguel Flores, Claudia León, German Pinto, Mildred Lupi.
Methodology: Daniel Aguiar, Miguel Flores, Claudia León, Mildred Lupi.
Project administration: Daniel Aguiar, Miguel Flores, Claudia León.
Resources: Daniel Aguiar, Miguel Flores, Claudia León.
Software: Daniel Aguiar, Miguel Flores, Claudia León, Mildred Lupi.
Supervision: German Pinto, Mildred Lupi.
Validation: Daniel Aguiar, Miguel Flores, Claudia León, German Pinto, Mildred Lupi.
Visualization: Daniel Aguiar, Miguel Flores, Claudia León, German Pinto, Mildred Lupi.
Writing – original draft: Daniel Aguiar, Miguel Flores, Claudia León.
Writing – review and editing: Daniel Aguiar, Miguel Flores, Claudia León.