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ORIGINAL

Analysis of clinical features of high-energy pediatric cranial trauma: A comparative study

Análisis de las características clínicas de los traumatismos craneoencefálicos pediátricos de alta energía: Un estudio comparativo

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Abstract

Objective: The aim of this study is to analyze and characterize the clinical features associated with high-energy pediatric cranial trauma.

Materials and methods: This retrospective study was conducted on high-energy pediatric cranial trauma patients who presented to Şanlıurfa Balıklıgöl State Hospital in Turkey between 2012 and 2014. For the purpose of this study, patients were divided into two groups based on their treatment strategy: non-operative (Group 1) and operative (Group 2).

Results: The study population consisted of 50 individuals. Regarding the cause of trauma, 46% of incidents were due to falls, while 54% were due to road accidents. There was no significant difference in age between groups (p=0.168). However, the distribution of males differed significantly between the groups (p<0.001). The Glasgow Come Scale (GCS) score averaged significantly higher in Group 1 (13±2.26) than in Group 2 (7.74±2.52) (p<0.001). The incidence of linear fractures was significantly higher in Group 1 (52%) than in Group 2 (19%) (p=0.014). On the other hand, subdural hematomas were significantly more prevalent in Group 2 (68%) compared to Group 1 (5%) (p<0.001). There was a higher incidence of liver and spleen injuries in Group 2 but the differences was not statistically significant (p>0.05 for each opne). Lung injuries were significantly more common in Group 2 (77%) than in Group 1 (37%) (p=0.004). Mortality rates did not significantly differ between the two groups (5% in Group 1 vs 10% in Group 2, p=0.577). In this study found a robust inverse correlation between GCS and numbers of organ injured (p<0.001, r= -0.696).

Conclusions: The findings underscore the importance of comprehensive understanding and careful management, considering the associated thoracoabdominal injuries.

Key words: Cranial trauma, multi-organ injury, subdural hematoma, abdominal trauma, lung injury.

Resumen

Objetivo: El objetivo de este estudio es analizar y caracterizar los rasgos clínicos asociados a los traumatismos craneoencefálicos pediátricos de alta energía.

Material y métodos: Este estudio retrospectivo se realizó en pacientes con traumatismo craneoencefálico pediátrico de alta energía que se presentaron en el Hospital Estatal de Şanlıurfa Balıklıgöl en Turquía entre 2012 y 2014. Para el propósito de este estudio, los pacientes se dividieron en dos grupos en función de su estrategia de tratamiento: no quirúrgico (Grupo 1) y quirúrgico (Grupo 2).

Resultados: La población de estudio consistió en 50 individuos. En cuanto a la causa del traumatismo, el 46% de los incidentes se debieron a caídas, mientras que el 54% se debieron a accidentes de tráfico. No hubo diferencias significativas en la edad entre los grupos (p=0,168). Sin embargo, la distribución de varones difería significativamente entre los grupos (p<0,001). La puntuación de la Escala Venosa de Glasgow (Glasgow Come Scale, GCS) fue significativamente mayor en el Grupo 1 (13±2,26) que en el Grupo 2 (7,74±2,52) (p<0,001). La incidencia de fracturas lineales fue significativamente mayor en el Grupo 1 (52%) que en el Grupo 2 (19%) (p=0,014). Por otro lado, los hematomas subdurales fueron significativamente más prevalentes en el Grupo 2 (68%) en comparación con el Grupo 1 (5%) (p<0,001). Hubo una mayor incidencia de lesiones hepáticas y esplénicas en el Grupo 2, pero las diferencias no fueron estadísticamente significativas (p>0,05 para cada opne). Las lesiones pulmonares fueron significativamente más frecuentes en el Grupo 2 (77%) que en el Grupo 1 (37%) (p=0,004). Las tasas de mortalidad no difirieron significativamente entre los dos grupos (5% en el Grupo 1 frente a 10% en el Grupo 2, p=0,577). En este estudio se encontró una sólida correlación inversa entre la GCS y el número de órganos lesionados (p<0,001, r= -0,696).

Conclusiones: Los hallazgos subrayan la importancia de una comprensión integral y un manejo cuidadoso, teniendo en cuenta las lesiones toracoabdominales asociadas.

Palabras clave: Traumatismo craneal, lesión multiorgánica, hematoma subdural, traumatismo abdominal, lesión pulmonar.

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Introduction

Trauma is a leading cause of morbidity and mortality in the pediatric population globally, with cranial trauma being of particular concern due to the potential for long-term cognitive, behavioral, and physical impairments. High-energy pediatric cranial trauma, resulting from incidents such as road accidents or significant falls, necessitates a comprehensive understanding of the associated clinical features to inform effective management strategies and improve patient outcomes[1-3].

In addition to the immediate implications of cranial injury, the impact of such trauma often extends to other organ systems, a factor that complicates the management of these cases and can potentially increase the associated morbidity and mortality. The co-occurrence of abdominal and thoracic organ injuries alongside cranial trauma is a critical area of concern[4]. Therefore, characterizing the clinical features of high-energy cranial trauma in children, including the nature of the injuries and the correlation between Glasgow Coma Scale (GCS) scores and the extent of multi-organ injury, is a crucial element in advancing our understanding of this major public health issue[5,6].

The aim of this study is to analyze and characterize the clinical features associated with high-energy pediatric cranial trauma.

Materials and methods

This retrospective study was conducted on high-energy pediatric cranial trauma patients who presented to Şanlıurfa Balıklıgöl State Hospital in Turkey between 2012 and 2014. The study was initiated after obtaining approval from the institutional ethics committee (number 45-2023). The medical records of these patients were retrospectively reviewed to collect the necessary data for the study. The sample population consisted of 50 patients. For the purpose of this study, patients were divided into two groups based on their treatment strategy: non-operative (Group 1) and operative (Group 2). Each patient's profile was evaluated considering various factors. These factors included age, gender, the mechanism of trauma, Glasgow Coma Scale score at the time of admission, type of fractures, accompanying injuries to other organs, length of stay in the hospital, and duration of stay in the intensive care unit. The mortality rate was also calculated as part of the assessment. The collected data was subsequently analyzed to establish patterns, associations, and correlations between various factors and the patients' clinical outcomes.

Inclusion criteria

Patients under the age of 18, those with high-energy cranial trauma and those with consistent and accurate data in retrospective file scans were included to this study.

Exclusion criteria

Patients over the age of 18, neonates (due to highly variable laboratory parameters), patients with inconsistently recorded and irregular data, identified during the retrospective review,were excluded from the study.

Statistical analysis

The evaluation of patient data for this study was accomplished through the use of descriptive statistics, frequency calculations, and the examination of other relevant characteristics. Quantitative or continuous data were represented using means and standard deviations. To test the normality of continuous data, Shapiro-Wilk and Kolmogorov-Smirnov tests were administered. In cases where the data deviated from a normal distribution, non-parametric tests were applied in place of the Student's T-test, which is typically used for continuous and normally distributed variables. Chi-square tests were implemented for the analysis of categorical variables. Correlations between items were determined using the Pearson correlation test. The statistical software SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA), was employed for data analysis.

Results

The study population consisted of 50 individuals with a mean age of 8.58±5.61 years. The majority of the participants were male (70%). Regarding the cause of trauma, 46% of incidents were due to falls, while 54% were due to road accidents. The mean Glasgow Coma Scale (GCS) score upon admission was 9.74±3.52). Linear fractures were observed in 32% of cases, compression fractures in 26% of cases. Epidural hematoma was present in 32% of the cases, while subdural hematoma was observed in 44% of cases. The most prevalent type of injury was traumatic subarachnoid hemorrhage (SAH), occurring in 62% of the subjects. Regarding the management of cranial injury, 38% of the patients were treated non-operatively, while 62% underwent operative treatment. Regarding the time of surgery from admission, 78% of surgeries were conducted within the first 3 hours, 9% between 3-6 hours, another 9% between 6-12 hours, and only 3% took place after 12 hours. Associated abdominal trauma included injuries to the liver (42%), spleen (62%), pancreas (8%), and bowels (8%). Associated chest trauma, specifically to the lungs, was present in 62% of cases. In terms of thoracoabdominal injury management, 78% of injuries were managed non-operatively, whereas 22% required surgery. Both cranial and thoracoabdominal injuries that necessitated surgery were present in 22% of patients. The mortality rate in our study population was 8%. The mean length of stay (LOS) in the intensive care unit was 10.9 days (SD=9.67), and the overall mean duration of hospital stay was 18.2±12.90 days (**Table I**).

Table I: Characteristics of the patients.

	N	%
Age	8.58	5.61
Gender (M)	35	70%
Traume type		
Fall	23	46%
Accident	27	54%
GCS	9.74	3.52
Linear fracture	16	32%
Compression fracture	13	26%
Epidural hematoma	16	32%
Subdural hematoma	22	44%
Traumatic SAH	31	62%
Management of cranial injury		
Non-operative	19	38%
Operative	31	62%
Surgery time (from admission)		
0-3 hour	25	78%
3-6 hour	3	9%
6-12 hour	3	9%
>12 hour	1	3%
Associated abdominal trauma		
Liver	21	42%
Spleen	31	62%
Pankreas	4	8%
Bowels	4	8%
Associated chest trauma		
Lung	31	62%
Management of thoracoabdominal injury		
Non-operative	39	78%
Operative	11	22%
Both cranial and thoracoabdominal injury		
Operative	11	22%
Mortality	4	8%
Length of stay hospital		
Intensive care unit	10.9	9.67
Total	18.2	12.90

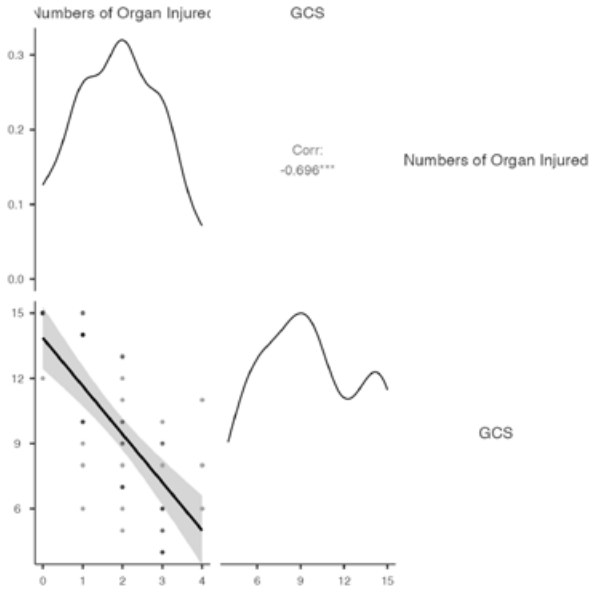
Table II: Comparison of the Non-operative and Operative management group.

	Group 1 (n=19)	Group 2 (n=31)	p-value
Age	7.17±5.39	9.44±5.66	0.168
Gender (M)	8 (42%)	27 (87%)	<0.001
Traume type			0.05
Fall	12 (63%)	11 (35%)	
Road accident	7 (37%)	20 (65%)	
GCS	13±2.26	7.74±2.52	<0.001
Linear fracture	10 (52%)	6 (19%)	0.014
Compression fracture	2 (10%)	11 (35%)	0.05
Epidural hematoma	4 (21%)	12 (39%)	0.194
Subdural hematoma	1 (5%)	21 (68%)	<0.001
Traumatic SAH	9 (48%)	22 (71%)	0.095
Associated abdominal trauma			
Liver	5 (26%)	16 (51%)	0.079
Spleen	9 (48%)	22 (71%)	0.095
Pankreas	2 (10%)	2 (7%)	0.606
Bowels	0 (0%)	4 (13%)	0.182
Associated chest trauma			
Lung	7 (37%)	24 (77%)	0.004
Management of thoracoabdominal injury		0.003	
Non-operative	19 (100%)	20 (65%)	
Operative	0 (0%)	11 (35%)	
Mortality	1 (5%)	3 (10%)	0.577
Length of stay hospital			
Intensive care unit	2.26±3.48	16.19±8.33	<0.001
Total	6.67±5.42	25.64±10.52	<0.001

There was no significant difference in age between groups (p=0.168). However, the distribution of males differed significantly between the groups (p<0.001) with Group 1 consisting of 42% males and Group 2 containing 87% males. The type of trauma, categorized as falls and road accidents, was significantly different between the groups (p=0.05). Falls were more prevalent in Group 1 (63%) compared to Group 2 (35%), whereas road accidents were more common in Group 2 (65%) than in Group 1 (37%). The GCS score averaged significantly higher in Group 1 (13±2.26) than in Group 2 (7.74±2.52) (p<0.001). The incidence of linear fractures was significantly higher in Group 1 (52%) than in Group 2 (19%) (p=0.014). On the other hand, subdural hematomas were significantly more prevalent in Group 2 (68%) compared to Group 1 (5%) (p<0.001). For associated abdominal and chest traumas, the two groups showed variation. There was a higher incidence of liver and spleen injuries in Group 2 but the differences was not statistically significant (p>0.05 for each opne). Lung injuries were significantly more common in Group 2 (77%) than in Group 1 (37%) (p=0.004). Management of thoracoabdominal injuries differed significantly between the two groups (p=0.003). Mortality rates did not significantly differ between the two groups (5% in Group 1 vs 10% in Group 2, p=0.577). However, the length of hospital stay, both in the intensive care unit and total duration, was significantly longer in Group 2 (ICU: 16.19±8.33 days, Total: 25.64±10.52 days) than in Group 1 (ICU: 2.26±3.48 days, Total: 6.67±5.42 days) (p<0.001, p<0.001, respectively) (**Table II**).

In this study found a robust inverse correlation between GCS and numbers of organ injured (p<0.001, r= -0.696) (**Figure 1**).

Figure 1: Corellation between GCS and number of organ injured.



Discussion

The present retrospective study was undertaken to investigate the clinical features of high-energy pediatric cranial trauma and to elucidate the correlations between various factors such as GCS scores, type of fractures, accompanying injuries, length of stay in the hospital, and clinical outcomes in a Turkish pediatric population. Our findings offer significant insights into this critical area of pediatric medicine, with broad implications for trauma management, prognosis, and public health.

Consistent with previous studies[7,8], our population revealed a male predominance (70%), reflecting a general trend in pediatric trauma literature. The reasons for this gender disparity require further exploration but might be attributed to differences in activity levels and risk-taking behaviors between genders. The finding that 54% of traumas were due to road accidents and 46% were due to falls is aligned with global trends. This underlines the importance of continued public health initiatives targeting road safety and fall prevention, particularly in the pediatric age group.

Our data highlighted significant variations between the non-operative (Group 1) and operative (Group 2) groups. As expected, GCS scores were significantly higher in the non-operative group, reflecting milder injury severity. The finding of a robust inverse correlation between GCS scores and the number of organs injured underscores the importance of GCS as a valuable prognostic indicator, not only for cranial injury but also for multi-organ involvement.

The distribution of fractures and hematomas between the groups can be understood in the context of the severity and nature of the trauma[9-11]. Linear fractures and higher GCS scores were more prevalent in the non-operative group, reflecting less severe injuries, whereas subdural hematomas, indicative of more significant injury, were more common in the operative group. The high prevalence of traumatic subarachnoid hemorrhage (62%) underscores the need for vigilance in diagnosis and potential challenges in management. This calls for future research to determine the optimal management strategies for this specific injury type.

In accordance with existing literature[12,13], subdural hematomas were found to be more prevalent in cases of high-energy trauma in our study as well. Additionally, it was observed that in high-energy trauma scenarios, the GCS score tends to be higher, and accompanying abdominal and thoracic traumas are more frequent. In such situations, abdominal injuries may be present, necessitating surgical intervention for management[13].

Our study also illustrated that associated abdominal and thoracic injuries were a common occurrence, consistent

with other studies that have identified the complexity of cranial trauma management due to the involvement of multiple organ systems. Though not statistically significant, there was a trend toward higher incidence of liver and spleen injuries in the operative group, possibly reflecting a more severe trauma profile. The significant difference in lung injuries between the groups emphasizes the importance of thorough assessment and cautious management of thoracoabdominal injuries.

The finding that mortality rates did not differ significantly between the groups might be seen as counterintuitive, but this could be influenced by the small sample size or perhaps indicative of effective trauma management. However, the longer hospital and ICU stays in the operative group provide a clear indication of the substantial resource implications and the additional care required for these more severely injured patients.

While our study offers valuable insights, several limitations must be acknowledged. The retrospective design may limit the generalizability of our findings, and the relatively small sample size may have affected the statistical power. Additionally, the study's single-center nature and the specific population characteristics might limit the application of findings to other settings.

In conclusions, in this study of high-energy pediatric cranial trauma, the correlation between GCS scores, trauma severity, and multi-organ injuries was examined, revealing complex relationships. The findings underscore the importance of comprehensive understanding and careful management, considering the associated thoracoabdominal injuries. The insights gathered from this research may contribute to enhancing treatment protocols and ultimately improving patient outcomes in pediatric trauma care.

Conflict of Interest

The authors declare that there is no conflict of interest.

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