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Retrospective Analysis of Prognostic Factors of Severe Traumatic Brain Injury in a University Hospital in Turkey

Türkiye'deki Bir Üniversite Hastanesinde Ağır Travmatik Beyin Hasarına Etkili Prognostik Faktörlerin Retrospektif Analizi

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ABSTRACT

AIM: To examine the use of prognostic factors such as age, Glasgow Coma Scale (GCS) score, pupil reactivity and computerized tomography (CT) findings for predicting the prognosis of severe traumatic brain injury (TBI) patients in Turkey.

MATERIAL and METHODS: We retrospectively evaluated TBI patients who were accepted to Akdeniz University Intensive Care Unit between 1 January 2007 and 31 December 2009. Patient data were collected from the hospital information system. Marshall CT classification was performed and CT findings were noted. The Glasgow outcome scale (GOS) score of patients was calculated according to their 6-months follow up.

RESULTS: A total of 101 patients with severe TBI were studied. The mean age of the patients was 34.7 ± 14.1 years. Of these, male patients (81.2%) were dominant and road accidents (83.2%) were the most common mechanism of TBI development. In addition, poor neurological outcome was detected in 58.4% of the patients and 29 patients (28.7%) died. The mechanism of injury ($p = 0.34$), gender ($p = 0.64$) or age ($p = 0.34$) did not lead to a difference in neurologic outcomes while the GCS score ($p = 0.01$), pupillary reactivity ($p = 0.000$), Marshall CT classification ($p = 0.01$) and the presence of traumatic subarachnoid haemorrhage ($p = 0.04$) affected the GOS scores.

CONCLUSION: In our study, GCS score, CT findings and pupil reactivity were prominent as prognostic factors, but a relationship between age and prognosis was not observed.

KEYWORDS: Traumatic brain injury, Prognostic factors, Outcome

ÖZ

AMAÇ: Ağır travmatik beyin hasarlı (TBH) hastaların prognozunu tahmin etmede kullanılan yaş, Glasgow Koma Skalası (GKS) skoru, pupil reaktivitesi, bilgisayarlı tomografi (BT) bulguları gibi prognostik faktörlerin Türkiye'deki kullanılabilirliğini incelemeyi amaçladık.

YÖNTEM ve GEREÇLER: Akdeniz Üniversitesi Hastanesi Anestezi Yoğun Bakımına, 1 Ocak 2007 - 31 Aralık 2009 tarihleri arasında kabul edilen TBH'li hastalar retrospektif olarak incelendi. Hasta verileri hastane bilgi sisteminden toplandı. Marshall BT sınıflaması yapıldı ve diğer BT bulguları kayıt altına alındı. Hastaların 6 ay sonraki takiplerine göre Glasgow sonuç ölçeği (GOS) skoru hesaplandı.

BULGULAR: Toplam 101 hastada ağır TBH tespit edildi. Hastaların yaş ortalaması 34,7 ± 14,1 idi. Erkek cinsiyet daha sık olarak saptandı (%81,2). Ağır TBH mekanizmalarından en sık trafik kazası görüldü (%83,2). Hastaların % 58,4'ünde kötü nörolojik sonuç tespit edilmiş ve 29 (%28,7) hasta ölmüştür. Hasar mekanizması ($p=0,34$), cinsiyet ($p=0,64$) ve yaş ($p=0,34$) nörolojik sonuçlar açısından bir fark yaratmaz iken GKS skoru ($p=0,01$), pupil reaktivitesi ($p=0,000$), Marshall BT sınıflaması ($p=0,01$) ve ayrıca travmatik subaraknoid hemoraji varlığı ($p=0,04$) GOS skorunu etkiledi.

SONUÇ: Çalışmamızda; GKS skoru, BT bulguları ve pupil reaktivitesi prognoza etkili faktörler olarak ön plana çıktı, ancak yaşın prognoza etkisi tespit edilemedi.

ANAHTAR SÖZCÜKLER: Travmatik beyin hasarı, Prognostik faktörler, Sonuç

INTRODUCTION

Traumatic brain injury (TBI) is a prevalent public health problem for the society in terms of its incidence and consequences. It is estimated that at least 10 million people worldwide pass away or are hospitalized annually due to TBI (8). In particular, young people experience TBI consequences that include severe psychological, social and economic problems. Severe TBI is the leading cause of death in the young adult population. In the United States, >50.000 people die annually due to TBI and >40% of survivors have functional disability (16). In Turkey, almost 700–800 thousand people suffer from TBI, of whom 250.000 are hospitalized annually (18).

Because of utilizing evidence-based guidelines in the management of patients, the mortality rates of severe TBI patients have decreased from 50% to 25% (2). Due to the possibility of long-term neurological effects in the prognostic markers of surviving patients, which are assessed accurately and meticulously, valuable information was ascertained about the prognosis of the patients. Previous studies indicated that age, the Glasgow Coma Scale (GCS) score, computed tomography (CT) findings and pupil reactivity were found to be effective for determining the prognosis of patients but gender and mechanism of injury were not (3, 10-12). These factors have been studied extensively in developed countries, but studies have been limited in developing and underdeveloped countries thus far (1, 14).

The objective of this study was to examine the availability of prognostic factors used for predicting the prognosis of severe TBI patients in Turkey and to guide clinicians in this regard.

METHODS

We evaluated TBI patients who were accepted to the Akdeniz University Intensive Care Unit (ICU) between 1 January 2007 and 31 December 2009. The Akdeniz University ICU has 24 beds and is a mixed tertiary ICU. Those TBI patients who were >18 years old and were followed and treated for >24 h in the ICU were included in this study. Patients who had a GCS score of >8, who were followed-up at another hospital for >48 h, and those who died within the first 24 h after having been accepted to the ICU were excluded from the study.

Age, gender, GCS score, pupil reactivity and the injury mechanism of patients were acquired from the hospital information system (HIS). Radiology reports of the patients that were obtained from HIS were also examined. Marshall CT classification (Table I) was performed and the presence of traumatic subarachnoid haemorrhage (tSAH), epidural hematoma (EDH) and subdural hematoma (SDH) were also recorded. Standard treatment, that was consistent with TBI guidelines, was applied to all patients and referrals to rehabilitation clinics were provided on time. The Glasgow Outcome Scale (GOS) score of the patients was calculated according to their 6-month follow-up and was divided into Good (score of 4–5) and Poor (score of 1–3) neurological outcome (Table II) (7).

For statistical evaluations, SPSS Statistics 21.0 (IBM Corp., Armonk, NY, USA) software was used. The results were expressed as mean ± standard deviation or as a number representing a percentage. For the comparison of categorical variables, the chi-square test was used and $p < 0.05$ was considered statistically significant.

RESULTS

A total of 170 TBI patients were accepted to the ICU between 1 January 2007 and 31 December 2009. Fifty-six patients had a GCS score of >8, 3 patients were followed up in another hospital for >48 h and 10 patients died within the first 24 h, resulting in a total of 69 patients who were excluded from this study. Therefore, 101 severe TBI patients were included in the study (Table III). The general characteristics of the study population are provided in Table IV, while Table V shows the relationship of the prognostic factors with the GOS.

Age

The mean age of the patients was 34.7 ± 14.1 years. The number of patients <60 years old was 95 (94%). No relationship was

Table I: Marshall Computed Tomography (CT) Classification

Class I	No visible intracranial pathology seen on CT scan
Class II	Cisterns are present with midline shift 0-5 mm and/or lesions densities present; no high or mixed density lesion >25 cc, may include bone fragments and foreign bodies
Class III	Cisterns compressed or absent with midline shift 0-5 mm; no high or mixed density lesion >25 mm
Class IV	Midline shift >5 mm; no high or mixed density lesion >25 cc.
Class V	Any lesion surgically evacuated.
Class VI	High or mixed density lesion >25 cc; not surgically evacuated.

Table II: Glasgow Outcome Scale

1. Death	Dead.
2. Persistent vegetative state	Severe damage with prolonged state of unresponsiveness and a lack of higher mental functions.
3. Severe disability	Severe injury with permanent need for help with daily living.
4. Moderate disability	No need for assistance in everyday life, employment is possible but may require special equipment.
5. Good recovery	Light damage with minor neurological and psychological deficits.

Table III: Patient Selection

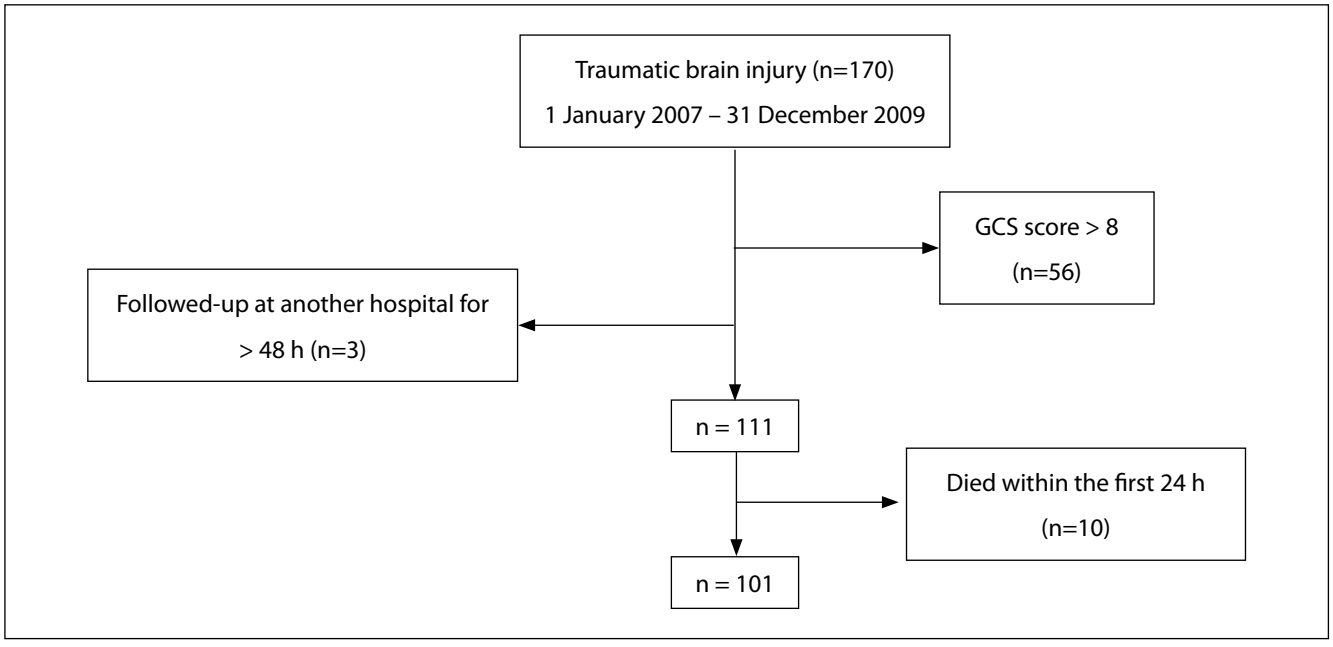

Table IV: The General Characteristics of Study Population

Mean age±SD	34.7±14.1	
Gender/(male) n (%)	82 (81.2)	
Mechanism of injury	Motorcycle Automobile Pedestrian Fall Other	38 (37.6%) 27 (26.7%) 19 (18.8%) 12 (11.9%) 5 (4.9%)
Pupil reactivity	Both reactive Uni-reactive None reactive	59 (58.4%) 24 (23.8%) 18 (17.8%)
GCS	3 4 5 6 7 8	9 (8.9%) 13 (12.9%) 15 (14.9%) 14 (13.9%) 23 (22.8%) 27 (26.7%)
Marshall CT classification	I II III IV V/VI	10 (9.9%) 22 (21.8%) 42 (41.6%) 10 (9.9%) 17 (16.8%)
CT findings	tSAH Epidural hematoma Subdural hematoma	60 (59.4%) 24 (23.8%) 40 (39.6%)
Mortality n (%)	29 (28.7)	
6-mo GOS	I II III IV V	29 (28.7%) 16 (15.8%) 14 (13.9%) 21 (20.8%) 21 (20.8%)

found between the GOS score and increasing age ($p > 0.05$). However, the mortality rate of patients aged ≥60 years was greater ($p < 0.05$).

Gender

Eighty two (81.2%) of the 101 patients who were exposed to TBI were male, while 19 (18.8%) were female. A total of 57.3% of male patients had a poor neurological outcome, compared with 63.1% of female patients ($p > 0.05$). The mortality rate was 29.2% for male patients and 26.3% for female patients ($p > 0.05$).

Mechanism of injury

According to the mechanism of injury data collected, 27 (26.7%) patients developed TBI from vehicular accidents, 38 (37.6%) from motorcycle accidents, 19 (18.8%) from pedestrian accidents, 12 (11.9%) from falling from height, 3 (2.9%) from explosion, 1 (0.9%) from assault and 1 (0.9%) from gun injury. Vehicular, motorcycle and pedestrian accidents were evaluated together as road accidents and they constituted 83.2% of the total number of patients. Moreover, while the number of patients who were >60 totalled six, the development of TBI as a result of falling was only applicable for one patient. No relationship was found between the mechanism of injury and GOS score ($p > 0.05$).

GCS

Severe TBI is defined by a GCS score of ≤8 in a patient. In our study, the mean GCS score was 6 ± 1.6. The GCS score of surviving patients was 6.4 ± 1.4, while the score for deceased patients was 5.1 ± 1.8 ($p < 0.05$). In this study, all patients with a GCS score of 3 died. When we examined patients who had a GCS score of 8, we found that 5 patients died, 3 survived with severe disabilities and 9 patients survived with

mild disabilities. In contrast, 10 patients achieved complete recovery. It was found that a low GCS score was associated with a poor neurological outcome ($p < 0.05$).

Pupil reactivity

In this study, we detected reactive pupils in 59 (58.4%) patients, uni-reactive pupils in 24 (23.8%) patients and non-reactive pupils in 18 (17.8%) patients. Moreover, 17 (94.4%) of the 18 patients who had non-reactive pupils died, whereas 7 (29.1%) of the 24 patients who had uni-reactive pupils died and another 10 had poor neurological outcome. Ultimately, the patients who had non-reactive or uni-reactive pupils had a worse GOS score ($p < 0.05$).

Table V: The Relationship of Prognostic Factors with GOS

	GOS		
Prognostic factors	**Bad (n=59)**	**Good (n=42)**	**p value**
Age groups			
18-30	27	20	0.34
31-40	16	9	
41-50	9	7	
51-60	2	5	
60+	5	1	
GCS			
3	9	0	0.01
4	9	4	
5	7	8	
6	11	3	
7	15	8	
8	8	19	
Pupil reactivity			
Both reactive	25	34	0.000
One reactive	17	7	
None reactive	17	1	
CT classification			
I	3	7	0.01
II	8	14	
III	27	15	
IV	7	3	
V/VI	14	3	
CT findings			
Epidural hematoma	14	10	0.99
Subdural hematoma	26	14	0.27
tSAH	40	20	0.04
Gender			
Female	12	7	0.64
Male	47	35	
Mechanism of injury			
Road accident	48	36	0.34
Fall	9	3	
Other	2	3	

CT findings

Intracranial abnormalities (CT class II–VI) were observed in 90.1% of 101 patients. Shift, EDH, SDH and tSAH were detected in 9.9%, 23.8%, 39.6% and 59.4% of the CT scans, respectively. There were fewer patient deaths and better neurological outcomes for CT class I and II. Alternatively, the situation was exactly the opposite for CT class III and higher ($p < 0.05$). While the presence of epidural and/or subdural hematoma in the patients did not affect the GOS score, worse neurological outcomes were encountered in patients who had tSAH ($p < 0.05$).

Poor neurological outcome was detected in 58.4% of patients, 29 patients (28.7%) died and morbidity was observed in 51 patients (50.5%).

DISCUSSION

Severe TBI affects the healthcare system by causing pathologies and complications. Governments are affected due to labour loss and economic burden, while patients and their families are burdened with the consequences of death and disability.

Because of advancements in the field of medicine and the guidelines for the approach to TBI patients since the 1990s, the mortality rate is steadily declining. As a result of the declining mortality rate, the number of patients with neurological sequels is increasing (2). The studies on ameliorating neurological outcomes by estimating the prognosis of patients with appropriate treatment approaches are increasing in number. Clinicians should take factors affecting prognosis into consideration and determine the approach with patients and their families using their experience to guide them. We examined the prognostic factors in Turkey, which were already studied extensively and have a largely accepted validity in developed countries.

Age–GOS

Severe TBI continues to be a problem affecting the youth population worldwide (12). It is important to note that in the present study, the percentage of the patients who were >60 years old totalled only 5.9%. This situation can be explained by youth motor vehicle accidents, which are the most common cause of severe TBI in Turkey. It has already been emphasized that older patients who experienced TBI had decreased GOS scores with worse neurological outcome and increased mortality rate than the younger patients (5, 12, 17). Although various threshold values between 30 and 60 years old were defined in the literature (12), such a threshold value was not detected in our study. No relationship was observed between age groups and GOS score ($p > 0.05$); however, a significant difference was observed for patients >60 years old in terms of the mortality rate ($p < 0.05$). A systemic review published in 2010 by Husson et al. found that nine studies supported increasing age with worse neurological outcome, while four studies observed no effect. In contrast, one study obtained better neurological outcomes and determined controversially that age was not a strong prognostic factor, contrary to common belief (6).

Gender–GOS

Given that the male population constitutes the majority of motor vehicle drivers worldwide as well as in Turkey, they were more readily exposed to TBI than females. In our study, men were exposed to TBI approximately four times more than women; however, similar to previous studies, no difference was observed between genders in terms of the GOS score ($p > 0.05$) (9, 12).

Mechanism of injury–GOS

Due to the necessary precautions being taken while driving motor vehicles and administering severe punishments for citizens failing to obey related laws, falling became the dominant cause of TBI in the United States (15). However, due to more lenient penalties and non-use of seat belts and helmets, road accidents are still the leading cause of TBI in Turkey (1). In our study, vehicular accidents were found to be the most frequent cause of TBIs, at 83.2%. While falls for patients >60 years old lead as the dominant cause of TBI in developed countries (4), our study demonstrates that the most common cause of TBI in Turkey remains road accidents for patients >60 years old in Turkey. Although road accidents resulted in better neurological outcome than falls (42.8% vs. 25%), the mechanism of TBI did not affect the mortality rate or GOS score ($p > 0.05$). In an IMPACT study, it was stated that road accidents had better outcomes than fall cases; however, it was not regarded as a prognostic factor. Simultaneously, this study supports the idea that it is irrevocable information from the public health perspective (3).

GCS–GOS

In the neurological examination of TBI patients, one of the most important tools is GCS score due to its extensive use and easy application. It is one of the best indicators for determining severity and mortality rates of TBI (11,19). However, brain stem responses cannot be directly evaluated with GCS scores. In addition, verbal and eye scores (intubated, aphasic or aphonic patients, facial and ocular injury) may not be evaluated accurately (16). Similar to the literature (6, 11, 13, 14), our study yielded an improvement in the GOS scores and detected parallels to the increasing GCS score ($p < 0.05$). The group with a GCS score of 3–5 had lower GOS scores, whereas the group having a GCS score of 6–8 had higher GOS scores ($p < 0.05$).

Pupil reactivity–GOS

Moderately enlarged pupils with low light reactivity are the first indicators of uncal herniation. With the establishment of tentorial herniation, pupils are dilated along with the loss of light reaction. Pupil examination is a very practical type of examination with proven reliability; however, it has limited use for patients who have orbital trauma. The relationship between non-reactive or uni-reactive pupils after TBI and poor neurological outcome was previously emphasized (11, 13). In our study, most patients with non-reactive pupils died, whereas patients who had uni-reactive pupils largely encountered poor neurological outcome ($p < 0.05$).

CT findings–GOS

CT is an indispensable radiological study in the evaluation of severe TBI patients because it can be easily utilized and quickly evaluated. Due to these advantages, it frequently takes precedence in prognostic studies. Despite the availability of various classification systems, the Marshall CT classification is most commonly used. In recent years, however, CT findings that are not included in this classification are also considered (6, 10, 14). In an IMPACT study, CT class III and IV were found to yield the worst neurological outcome and partial obliteration of the basal cisternae. Moreover, tSAH and the presence of midline shift in the patients were also found to be associated with poor outcomes. The study stated that the presence of epidural hematoma as a mass lesion was associated with a better neurological outcome than subdural hematoma (10). In our study, during the CT evaluation, the presence of pressure on the cisternae and/or shift as well as the presence of tSAH yielded a poor outcome ($p < 0.05$). However, we did not find any association between the presence of epidural and/or subdural hematoma with a poor outcome ($p > 0.05$).

Limitations

In evaluating the cognitive, motor and sensory dysfunctions occurring after TBI, only GOS was used and more detailed functional and neurophysiological tools were not utilized. In addition, our study is a uni-centred retrospective study.

CONCLUSIONS

For predicting the prognosis of severe TBI patients, many factors were evaluated to this point. Our study reflects conclusions similar to studies conducted in developed countries; GCS score, brain CT findings and pupil reactivity were prominent as effective factors, while the effect of age on the prognosis was not observed.

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