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Risk Factors Analysis on Traumatic Brain Injury Prognosis

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Key words: traumatic brain injury; prognosis; risk factors

Objective To investigate the independent risk factors of traumatic brain injury (TBI) prognosis.

Methods A retrospective analysis was performed in 885 hospitalized TBI patients from January 1, 2003 to January 1, 2010 in the First Affiliated Hospital of Medical College of Xi'an Jiaotong University. Single-factor and logistic regression analysis were conducted to evaluate the association of different variables with TBI outcome.

Results The single-factor analysis revealed significant association between several variables and TBI outcome, including age (P=0.044 for the age group 40-60, P<0.001 for the age group ≥60), complications (P<0.001), cerebrospinal fluid leakage (P<0.001), Glasgow Coma Scale (GCS) (P<0.001), pupillary light reflex (P<0.001), shock (P<0.001), associated extra-cranial lesions (P=0.01), subdural hematoma (P<0.001), cerebral contusion (P<0.001), diffuse axonal injury (P<0.001), and subarachnoid hemorrhage (P<0.001), suggesting the influence of those factors on the prognosis of TBI. Furthermore, logistic regression analysis identified age, GCS score, pupillary light reflex, subdural hematoma, and subarachnoid hemorrhage as independent risk factors of TBI prognosis.

Conclusion Age, GCS score, papillary light reflex, subdural hematoma, and subarachnoid hemorrhage may be risk factors influencing the prognosis of TBI. Paying attention to those factors might improve the outcome of TBI in clinical treatment.

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TRAUMATIC brain injury (TBI) is a type of acquired brain injury, caused by a sudden trauma which damages the brain.[1] It is one of the main causes of mortality and morbidity in persons aged 40 years or younger in both developed and developing countries. Although being a preventable disease, TBI is still associated with high morbidity, presenting a significant health, social, and economic concern worldwide.[2] Epidemiological data show that the incidence of TBI is more than 100 per 10 million in China, almost rising to the level in western counties (150-200 per 10 million).[3] Given the severity of the health problem posed by TBI, understanding of the factors affecting the prognosis of TBI would be conducive to improving the disease outcome. In the present study, we retrospectively analyzed the data of 885 TBI patients treated in one neurosurgery unit to

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identify the risk factors of TBI prognosis.

PATIENTS AND METHODS

Patient collection

In the present study, we collected 885 inpatients with TBI treated in the Department of Neurosurgery (First Affiliated Hospital of Medical College of Xi'an Jiaotong University) from January 1, 2003 to January 1, 2010.

Data collection

Clinical, epidemiological, and observation variables were recorded within the first 6 hours of trauma for analysis. The variables included age, sex, seizure, shock (any recorded episode of systolic blood pressure ≤90 mm Hg), complications (other diseases occurring during hospitalization), cerebrospinal fluid leakage, epidural hematoma, subdural hematoma, cerebral contusion, diffuse axonal injury (including brain stem damage), subarachnoid hemorrhage, and associated extra-cranial lesions. Pupillary light reflex was also recorded within the first 6 hours of trauma, which was classified into five types: undeterminable if reactivity could not be assessed due to direct facial trauma or previous ocular injury; normal if both pupils were reactive and of equal size; non-reactive unilateral mydriasis or non-reactive bilateral mydriasis; and bilateral inequality means the pupil diameters on the two sides were different but pupillary light reflex exists. As a commonly used measure of injury severity, Glasgow Coma Scale (GCS) scores were also recorded. GCS has been proven to be a prognostic indicator of cognitive recovery and functional outcome and is also predictive of later parenchymal change.[4] According to GCS score, we divided the patients into three types: severe head injury when 3≤GCS score≤8, moderate TBI when 9≤GCS score≤12, and mild TBI when 13≤GCS score≤15.

When the patients were discharged, another GCS assessment was performed. According to the GCS scores and clinical manifestations upon discharge, final outcome was graded as cure, improvement, no cure, and death. Cure and improvement were interpreted as favorable outcomes while no cure and death, on the other hand, were unfavorable outcomes.

Statistical analysis

All the variables were coded as qualitative and introduced into a database for statistical analysis. A descriptive analysis was performed on the entire patient sample using frequency distributions and percentages for qualitative variables.

The χ^2 test (with Yates correction when indicated) and the Fisher exact test were used to compare categorical qualitative variables. Firstly single-factor analysis was applied on the above-mentioned 14 variables. Then we conducted multivariate logistic regression analysis using forward selection (entry criterion: P<0.05) stepwise method to identify independent risk factors for TBI prognosis. The association between variables and prognosis was considered statistically significant when the P value was under 0.05. Statistical analyses were performed with the Statistical Analysis Software (SAS) system statistical package (SAS Institute, Inc., Cary, NC, USA).

RESULTS

The included patients were composed of 668 male cases and 217 female cases, aged from 1 month to 88 years.

Single-factor analysis results

Based on GCS score and clinical manifestations, 751 TBI patients were classified as cured or improved, while the other 134 were either not cured or dead.

Nearly all the studied variables were shown significantly associated with the outcome, including age (P=0.044 for the age group 40-60, P<0.001 for the age group ≥60), complications (P<0.001), cerebrospinal fluid leakage (P<0.001), GCS score (P<0.001), pupillary light reflex (P<0.001), shock (P<0.001), associated extra-cranial lesions (P=0.01), subdural hematoma (P<0.001), cerebral contusion (P<0.001), diffuse axonal injury (P<0.001), and subarachnoid hemorrhage (P<0.001). Such association with TBI outcome was not found in the other variables, i.e. sex, seizure, and epidural hematoma (Table 1).

Logistic regression analysis results

In order to eliminate the influence of confounding factors, we conducted multi-factor logistic regression analysis. There was 1 degree of freedom in all cases.

Based on the result of multi-factor analysis, we conclude that five variables (age, GCS score, papillary light reflex, subdural hematoma, and subarachnoid hemorrhage) may be significantly associated with the prognosis of TBI. This association persisted after controlling for potential confounders (Table 2), suggesting that those five variables may be independent risk factors affecting the prognosis of TBI.

Table 1. Single-factor analysis for risk factors of the prognosis of 885 patients with TBI

Variables	Outcome		OR (95%CI)	*P*
	Favorable (*n*=751)	Unfavorable (*n*=134)		
Age				
≤40	460	61	Ref	
40-60	199	41	1.55 (1.01, 2.39)	0.044
≥60	92	32	2.62 (1.62, 4.25)	<0.001
Sex				
Female	186	31	Ref	
Male	565	103	1.09 (0.71, 1.69)	0.686
Complications				
No	708	103	Ref	
Yes	43	31	4.99 (2.99, 8.22)	<0.001
Cerebrospinal fluid leakage				
No	694	128	Ref	
Yes	57	6	0.57 (0.24, 1.35)	<0.001
GCS score				
3-8	94	117	Ref	
9-12	139	10	0.058 (0.028, 0.12)	<0.001
13-15	518	7	0.01 (0.005, 0.024)	<0.001
Pupillary light reflex				
Normal	666	44	Ref	
Non-reactive bilateral mydriasis	14	60	64.87 (33.63, 125.11)	<0.001
Non-reactive unilateral mydriasis	28	11	5.95 (2.78, 12.73)	<0.001
Bilateral inequality	26	15	8.73 (4.32, 17.67)	<0.001
Undeterminable	17	4	3.56 (1.15, 11.04)	0.028
Seizure				
No	725	127	Ref	
Yes	26	7	1.54 (0.65, 3.62)	0.325
Shock				
No	735	120	Ref	
Yes	16	14	5.36 (2.55, 11.26)	<0.001
Associated extra-cranial lesions				
No	558	85	Ref	
Yes	193	49	1.67 (1.13, 2.46)	0.01
Epidural hematoma				
No	620	119	Ref	
Yes	131	15	0.60 (0.34, 1.05)	0.075
Subdural hematoma				
No	626	68	Ref	
Yes	125	66	4.86 (3.29, 7.17)	<0.001
Cerebral contusion				
No	498	67	Ref	
Yes	253	67	1.97 (1.36, 2.85)	<0.001
Diffuse axonal injury				
No	724	103	Ref	
Yes	27	31	8.07 (4.63, 14.07)	<0.001
Subarachnoid hemorrhage				
No	569	56	Ref	
Yes	182	78	4.35 (2.97, 6.38)	<0.001

TBI, traumatic brain injury; Ref, reference; GCS, Glasgow Coma Scale.

Table 2. Logistic regression analysis for risk factors of TBI prognosis

Variables	S.E.	OR (95% CI)	*P*
Age			
≤40		Ref	
40-60	0.39	1.25 (0.67, 2.31)	0.49
≥60	1.13	3.06 (1.48, 6.31)	0.002
GCS score			
13-15		Ref	
9-12	0.05	0.12 (0.05, 0.25)	<0.001
3-8	0.01	0.03 (0.01, 0.08)	<0.001
Pupillary light reflex			
Normal		Ref	
Non-reactive bilateral mydriasis	3.89	9.88 (4.56, 21.41)	<0.001
Non-reactive unilateral mydriasis	0.95	1.98 (0.77, 5.08)	0.15
Bilateral inequality	0.9	2.09 (0.89, 4.88)	0.09
Undeterminable	1.59	2.3 (0.59, 8.92)	0.23
Subdural hematoma	0.54	1.86 (1.05, 3.29)	0.03
Subarachnoid hemorrhage	0.01	0.03 (0.01, 0.08)	<0.001

DISCUSSION

TBI is a leading cause of death and disability around the globe and presents a major worldwide problem in many aspects.[5] In children and young adults, it is one of the major causes of disability and brain damage due to trauma.[1] To improve the knowledge of the clinical course and outcome of TBI, large databases have been set up in main trauma centers throughout the world. We observed in the present study that there are much more male patients, with the male to female ratio being about 3.4∶1, similar with the gender composition reported by Mauritzl et al.[6]

Identification of risk factors of TBI prognosis could facilitate reliable prediction of TBI outcome and provide a theoretical basis for the improvement of TBI prognosis. Single-factor analysis in this study revealed that the age group older than 60 had the most significant association with unfavorable outcomes among the three age groups, followed by the group of 40-60 years old. In the study conducted by Brown et al,[7] the highest rates of mortality and hospitalization due to TBI were in people over 65 years old. The mortality rate of TBI was reported to be dependent on GCS score and pupillary light reflex during admission, as well as on the presence of coexisting trauma to other parts of the body and secondary brain injury.[8] Similar results were observed in our study. Mild and moderate TBI (GCS scores ranging from 9 to 15) was found to be more strongly associated with favorable outcome than severe head injury. Pupillary light reflex was identified as a good prognostic indicator for TBI, as non-reactive bilateral mydriasis showed the worst prognosis, followed by unequal pupils and unilateral mydriasis. Presence of subdural hematoma, cerebral contusion, diffuse axonal injury, and subarachnoid hemorrhage were found significantly associated with unfavorable outcomes. No significant association was found between the outcome of TBI and the other three variables in this study, i.e. sex, concurrent seizure, and presence of epidural hematoma. The results of logistic regression analysis further suggest that age, GCS score, papillary light reflex, subdural hematoma, and subarachnoid hemorrhage may be independent risk factors affecting the prognosis of TBI. Based on those findings, we recommend paying attention on the above mentioned features, and providing timely treatment for patients presenting any of those risk factors to ensure more favorable outcomes.

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