Characteristics of Traumatic Brain Injury Patients in Korean Military Hospitals During Non-War Years

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Received: November 29, 2020

Accepted: January 26, 2021

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Objective

Because of the specialty of the military medical system, there might be different characteristics of patients with traumatic brain injury (TBI) comparing to the patients in university hospitals. However, the characteristics of the soldiers' TBI has never been reported. Therefore, we tried to identify the different characteristics of TBI patients in military hospitals by comparing them of other hospitals.

Methods

We extracted the data of TBI patients from the databank of the Korean Multicenter TBI study. Patients, who were diagnosed with TBI and admitted to the ten institutions (including two military hospitals) between January 2016 and December 2018, were retrospectively enrolled. They are divided into 'Military' and 'Other' groups according to the admitted hospitals, and statistical comparisons were conducted on gathered information.

Results

Among 4601 enrolled patients, 133 patients were from two military hospitals and 4468 patients belong to the eight university hospitals. Military patients show significant younger age and male predominance. In general, they have fewer past histories and different trauma mechanisms - more sports-related and lesser traffic accident-related. They usually show higher initial Glasgow coma scale scores and better favorable outcomes - lower incidence of neurologic deterioration in mild TBIs and better modified Rankin Scale scores in moderate to severe TBIs.

Conclusions

Military hospitals usually take care of small numbers of patients who are young males with mild TBIs. Because of the different characteristics of group members and traumatic severity, the patients usually show favorable outcomes. Therefore, the optimized medical system is mandatory.

Keywords: Military; Mild traumatic brain injury; Traumatic brain injury; Young male

INTRODUCTION

In 1953, the Armed Forces Medical Command of Republic of Korea (ROK) was established. It provided medical service and welfare for the military service personnel⁶. Up to date, it offers several military hospitals distributed near corps and is able to handle the situation of potential mass casualties after wartime. Because of the huge gap between the numbers of the patients in wartime and those in non-wartime, military hospitals usually utilize the different medical systems according to the situations^{3,4,11}. During the non-war years (a confrontation with the North), military medical service usually takes care of small numbers of the patients; therefore, a few military hospitals are concentrated and equipped with the medical resources to treat the severe traumatic brain injury (TBI) patients. However, the characteristics of the military personnel's TBI in ROK during the non-war years has never been reported; and the majority of the literatures on military TBI are limited to the wartime situation such as combat injuries^{1,7,9}.

By the merest chance, two military hospitals (AFCH, Armed Forces Capital Hospital; and AFYH, Armed Forces Yangju Hospital) participated in the Korean multi-centered TBI (KMTBI) study for identifying the clinical features and analyzing risk factors for young TBI patients. They constructed a large databank which includes patients diagnosed with TBI for 3 consecutive years (2016~2018) in participants' hospitals. By using these data, we could identify the different characteristics of the military personnel's TBI comparing to those of the general populations. It might be helpful to understand the characteristics of military TBIs and to optimize the military medical systems in non-wartime situations.

MATERIALS AND METHODS

Patients and data acquisition

The data were extracted from the registered data bank system from the KMTBI study. Ten institutions (eight university hospitals and two military hospitals) are participated in the KMTBI study. The patients, who were admitted to the hospitals and diagnosed with definitive TBI from January 2016 to December 2018, were retrospectively enrolled. Patients, who were aged under 15 or who had poor medical records, were excluded. In this study, the data were registered online and were freely accessible to the research team of the institutions. The extracted data contained age, sex, past medical histories, mechanism of trauma, diagnosis, neurologic status including Glasgow coma scale (GCS) scores, treatment modality, and outcomes. The outcome was measured by the modified Rankin Scale scores on discharging date in mild TBI and at six-month in moderate to severe TBIs. In addition, the neurological

deterioration was defined when the GCS score decrement is larger than 2 points. The previous study was approved by the Institutional Review Board of the Human Research Center of each institution. The requirement for obtaining informed consent was omitted because it is a retrospective design.

In the current study, the patients were divided into "Military Hospital" group and "Other Hospital" group according to the institution that the patients are admitted to. In addition, patients were classified as mild (13-15) and moderate/severe TBIs (3-12) according to their GCS scores.

Statistical analysis

Baseline characteristics of military hospital groups were examined. Furthermore, comparison analyses between the groups were conducted by two steps; "mild" and "moderate/severe" TBIs according to the GCS scores. Continuous values were presented as mean and standard deviation, and they were compared by using independent t-test. Discontinuous variable data were presented as numbers and percentages, and they were compared by using Chi-square analysis. Statistical analyses were conducted using a standard software (version 23.0, SPSS, IBM, Chicago, IL, USA), and the significance was considered if $p < 0.05$.

RESULTS

Table 1 demonstrates the comparison of general demographics between military and other hospital groups. Total 133 patients (107 from AFCH and 26 from AFYH) were identified as the military personnel, and they were young and had male predominance with significances. They have less past medical histories including hypertension, diabetes, cardiologic disease, alcohol abuse, and antiplatelet agent medications. In terms of TBI mechanism, they significantly have more frequent association with sports and less association with traffic accidents. More than a half of the military personnel were transferred from other hospitals (55.3%). Regarding diagnosis, concussion and epidural hematoma were more frequent in military group, whereas acute and chronic subdural hematoma were highly occurred in other hospital groups. In military group, most of the patients had mild TBI (88.0%) with better initial GCS scores (14.40 ± 2.24). Consequently, the outcome of modified Rankin Scale (mRS) was favorable in military group.

Table 2 shows the results of comparison between the groups in 'mild TBI'. The GCS score is significantly higher in military group. Non-specific symptoms such as headache, dizziness, nausea and vomiting, and loss of consciousness are more frequently occurred in military group, and motor weakness is often observed in other hospital groups. Most of the military patients received conservative

Table 1. Comparison between the enrolled patients of military and other hospitals

Parameters	Military Hospitals (n=133)		Other hospitals (n=4468)		OR or MD	95% CI		p-value
Age	23.2	±7.688	61.11	±17.443	-37.905	-40.879	-34.931	0.000
Sex (male)	131	0.985	3075	0.688	29.672	7.333	120.071	0.000
Hypertension	5	0.038	1780	0.398	16.952	6.924	41.508	0.000
Diabetes	1	.8%	889	0.199	32.788	4.578	234.817	0.000
Cardiologic disease	3	0.023	399	0.089	4.249	1.347	13.409	0.002
Hepatic disease	1	.8%	108	0.024	3.270	0.453	23.602	0.149
Alcohol abuse	0	0	199	0.045				0.001
Smoking	49	0.368	695	0.156	0.316	0.220	0.453	0.000
Antiplatelet medication	1	.8%	438	0.098	14.346	2.001	102.857	0.000
Mechanism								0.000
Traffic accident	20	0.15	1280	0.286				
Sports-related	20	0.15	33	0.007				
Fall down	65	0.489	2145	0.48				
Assault	20	0.15	276	0.062				
Unknown	8	0.06	734	0.164				
Transfer	73	0.553	1436	0.326	0.391	0.276	0.554	0.000
Diagnosis								0.000
Concussion, Skull fx.	45	0.338	636	0.142				
EDH	19	0.143	374	0.084				
Acute SDH	27	0.203	1648	0.369				
Chronic SDH	6	0.045	603	0.135				
Contusion, ICH	14	0.105	622	0.139				
Traumatic SAH, IVH	20	0.15	526	0.118				
Others	2	0.016	59	0.013				
GCS score	14.4	±2.243	13.11	±3.389	1.293	0.694	1.891	0.000
Mild	117	0.88	3465	0.776				0.015
Moderate	5	0.038	394	0.088				
Severe	11	0.083	609	0.136				
mRS (3 or 6 months)	0.58	±1.298	1.26	±1.953	-0.680	-1.014	-0.345	0.000
0 or 1	126	0.947	3550	0.795				0.000
2 or more	7	0.053	918	0.205				

OR: Odds ratio, MD: Mean difference, CI: Confidential index, fx.: fracture, EDH: Epidural hematoma, SDH: Subdural hematoma, ICH: Intracerebral hemorrhage, SAH: Subarachnoid hemorrhage, IVH: Intraventricular hemorrhage, GCS: Glasgow coma scale, mRS: modified Rankin Scale.

treatment without surgical interventions, and the outcome (incidence of neurological deterioration, decrement in GCS score > 2) was more favorable. The mRS score is slightly higher in military personnel, and it is not significant.

Table 3 presents the results of comparison between the groups in 'moderate to severe TBIs'. Initial neurologic status according to the GCS score, mental status, symptoms, and signs have no significant differences between the groups. However, the military personnel significantly show favorable outcomes in 3 or 6-months mRS scores.

The TBI mechanism (A), initial diagnosis (B), initial GCS score and 6-month mRS score (C) are illustrated in Fig. 1.

DISCUSSION

Herein, we tried to figure out the different clinical features of military personnel's TBI comparing to the general populations. In general, the military personnel are significantly young and healthy (lower rate of having past medical histories) and show high male predominance. They showed better prognosis including lesser neurologic deterioration in mild TBIs ($p=0.004$) and lower mRS scores at 3 or 6 months in moderate to severe TBIs ($p=0.001$). From military medical perspective, military personnel's TBI should be optimized because of their lesser TBI events and better prognosis.

The TBI patients from military hospitals have never been re-

Table 2. Comparison between mild TBI patients of military and other hospitals

Parameters	Military Hospitals (n=117)		Other hospitals (n=3465)		OR or MD	95% CI		p-value
GCS score								0.001
13	0	0	341	0.113				
14	8	0.068	319	0.106				
15	109	0.932	2354	0.781				
Symptom								
Headache	97	0.829	2244	0.648	0.379	0.233	0.616	0.000
Dizziness	56	0.479	563	0.162	0.211	0.145	0.307	0.000
Nausea, vomiting	42	0.359	315	0.091	0.179	0.120	0.265	0.000
LOC	59	0.504	728	0.21	0.261	0.180	0.379	0.000
Aphasia, dysarthria	3	0.026	218	0.063	2.551	0.804	8.094	0.099
Motor weakness	2	0.017	511	0.147	9.947	2.450	40.378	0.000
Altered mentality	3	0.026	161	0.046	1.852	0.582	5.891	0.250
Amnesia	6	0.051	117	0.034	0.647	0.279	1.5	0.306
Treatment								0.003
Conservative	106	0.906	2621	0.756				
Burr-hole	6	0.051	560	0.162				
Open craniotomy	5	0.043	183	0.053				
Decompressive craniectomy	0	0	80	0.023				
Others	0	0	21	0.006				
Deterioration	0	0	121	0.035				0.004
3-month OPD f/up	61	0.521	1978	0.571	1.221	.844	1.766	0.288
Symptomatic	28	0.459	1093	0.544	1.405	.843	2.342	0.191
Asymptomatic	33	0.541	917	0.456				
mRS					1.478	.961	2.274	0.073
0	89	0.761	2365	0.683				
1 or more	28	0.239	1100	0.317				

R: Odds ratio, MD: Mean difference, CI: Confidential index, GCS: Glasgow coma scale, LOC: Loss of consciousness, OPD: Out-patient department, mRS: modified Rankin Scale.

ported due to the following reasons. First, the incidence of head trauma in the military corps is relatively low due to the limited social activities of the military personnel and their efforts for reducing a non-combat injury. Second, majority of military hospitals' members is consisted of short-term working military officers (3 to 5 years), and they rarely investigate or report the literatures. Third, due to the situation of prolonged confrontation against the North, the military remains tense and is separated from the society in terms of location as well as a scholastic exchange. Also, the process of the military medical investigation is quite complicated.

Characteristics of military TBIs during the non-war years

The result of the current study would be a good reference for the military doctors working in the military hospitals. In order to identify the clinical characteristics of the military TBI patients, the optimized military medical system can be equipped during this non-war years in ROK. They can place the medical resources in the

right place with the most efficient ways. Specifically, the most of the patients in military group are young male soldiers, and they show the clinical differences: lesser past medical diseases, higher incidence of sports-related trauma, lower incidence of traffic accidents, and lesser frequent diagnosis of chronic subdural hematoma^{12,13}. We conclude that the military hospital usually cares mild TBI patients, that the most of them is young male soldiers. Only 10% of the military patients had severe TBI, and others had favorable outcomes which means non-severe TBI (Table 1).

From the 'mild TBI' comparison (Table 2), we can draw a conclusion that the clinical manifestation, clinical courses, and outcomes of military mild TBI patients are related to 'young male' patients. The patients significantly complain bitterly of non-specific symptoms: headache, dizziness, nausea and vomiting, and loss of consciousness. A larger number of young patients might be related to the sensitive detection of increased intracranial pressure, and the symptoms can be frequently observed among the young age group. On contrary, 'motor weakness' is significantly highly observed

Table 3. Comparison between moderate to severe TBI patients of military and other hospitals

Parameters	Military Hospitals (n=16)		Other hospitals (n=1124)		OR or MD	95% CI		p-value
GCS score	6.63	±3.777	8.15	±3.732	-1.520	-4.121	1.080	0.252
Mild	0	0	121	0.108				0.132
Moderate	5	0.313	394	0.351				
Severe	11	0.688	609	0.542				
Level of consciousness								
Alert	0	0	79	0.07				0.133
Drowsy	2	0.125	335	0.298				
Stupor	8	0.5	416	0.37				
Coma	6	0.375	294	0.262				
Symptom & Signs								
Bilateral fixed pupils	6	0.375	207	0.184	0.376	0.135	1.047	0.052
Unilateral dilated pupil	3	0.188	83	0.074	0.346	0.097	1.237	0.143
Motor weakness	3	0.188	102	0.091	0.432	0.121	1.543	0.236
Unresponsiveness	0	0	18	0.016	0.986	0.979	0.993	0.610
Another major organ injury	5	0.313	221	0.197	0.538	0.185	1.566	0.248
Operation								0.522
Conservative Tx.	6	0.375	502	0.447				
Burr-hole trephination	0	0	90	0.08				
Open craniotomy	4	0.25	150	0.133				
Decompressive craniectomy	6	0.375	382	0.34				
Medical treatment								0.066
Conservative Tx.	14	0.875	888	0.79				
ICP monitoring	2	0.125	29	0.026				
Hypertonic saline	0	0	57	0.051				
Coma therapy	0	0	51	0.045				
Hypothermia	0	0	99	0.088				
Complication								
Medical	6	0.375	392	0.362	0.947	0.342	2.625	0.916
Surgical	3	0.188	90	0.08	0.381	0.097	1.501	0.152
mRS (3 or 6 months)	3.06	±2.435	4.06	±2.009	-0.997	-1.993	-0.002	0.049
0 or 1	9	0.563	206	0.183				0.001
2 or 3	0	0	205	0.182				
4 or 5	2	0.125	305	0.271				
6	5	0.313	408	0.363				

OR: Odds ratio, MD: Mean difference, CI: Confidential index, GCS: Glasgow coma scale, ICP: Intracranial pressure, mRS: modified Rankin Scale.

among other hospital groups: it might be related to the chronic subdural hemorrhage which frequently occurred in elderly patients¹⁰. Therefore, the treatment such as burr-hole trephination is more frequently conducted in other hospital groups. In terms of outcome, we can find that no military patients were deteriorated, which means that the military personnel in mild TBI have rarely been worsened to moderate or severe TBIs.

In moderate to severe TBIs (Table 3), the favorable clinical courses and outcome in military personnel are identified. The initial neurologic status, including GCS scores, level of consciousness, and neurological symptom and signs, have no differences between the groups. Treatment modality does not vary among the groups,

neither. However, the mRS score in military group is approximately 1 point higher than that in other hospital groups. Because more than a half of the military patients who had no symptoms or had mild symptoms (mRS 0 to 1) were treated, physicians should actively treat the patients.

Clinical implication of the study

We identify the low incidence of TBI in military personnel and small numbers of 'severe' patients which requires the human as well as medical resources for treating. In non-wartime years, the military hospitals in ROK divided their works and specialties for better efficacy. If we have TBI patients (especially, severe), they ini-

Fig. 1. Graphical plots of the trauma mechanisms (A), final diagnosis (B), and the initial GCS scores and final mRS outcomes (C).

tially visit the nearest military hospital and are transferred to the superior hospitals. Consequently, AFCH carries on providing the medical service as the supremacy hospital. In addition, AFYH is located on front lines and usually prepare for the potential combat injuries. Maybe this systematic difference leads to the higher transfer rates of military hospitals (55.3%). Instead, the medical command operates an all-time helicopter emergency transporting systems in order to assess and manage the patients better²⁾. The fastest transporting system may enable the better clinical outcomes. According to our results, two hospitals greatly manage the military TBI patients, and the outcomes are favorable.

Limitations

The present study has several limitations. First, the data were extracted from the databank system of KMTBI, and they did not include radiological images. Therefore, known prognostic factors observed in brain computed tomography (CT), such as poor Mar-

shall or Rotterdam CT scores, were omitted^{5,8)}. Second, the data were registered from each different hospital's reviewers, and there might be an inter-observer bias.

CONCLUSIONS

Military hospitals usually take care of young male soldiers with mild TBIs. Because of the different characteristics of group members and traumatic severity, the patients usually survive and show favorable outcomes. Therefore, the optimized treatment should be mandatory.

NOTES

Conflict of interest

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGEMENTS

The clinical data was obtained from the database of Korean Multi-centered Traumatic Brain Injury 2019 study (KMTBI-2019).

The authors appreciate to the 10 principal investigators of each institution: Seong-Jong Lee, Sang Hoon Yoon, Ki Seong Eom, Kyung-Jae Park, Sung-Kon Ha, Jin-gyu Choi, Kwang Wook Jo, Suk Hyung Kang, Jongyeon Kim, and Jong Hyun Kim.

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