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Original Article

Traumatic Brain Injury and the Importance of Neurosurgical Care: 10-year Retrospective Study on Cadavers

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Abstract

Objective: Traumatic brain injury (TBI) due to transport accidents is a serious cause of death and disability. In every case, however, quick response and a proper health care are required.

Materials and methods: We collected 10-year data retrospectively from the laboratory of forensic science and toxicology in Montana, Bulgaria with the intention to show the importance of neurosurgical care in the traumatology and its connection to mortality rate.

Results: 124 cadavers were included with significant male predominance. The data analysis shows that the mortality rate at the hospitals without neurosurgical facilities and the mortality at the scene of the accident is the same for traffic brain injuries. Furthermore, we found that the age has no correlation with the mortality rate.

Conclusion: Road injuries are the most common type of brain injury. We believe that the outcome of these TBIs depends on the availability of a neurosurgical unit.

Keywords

cadavers, healthcare, neurosurgery, trauma, traumatic brain injury

INTRODUCTION

Traumatic brain injury (TBI) is a serious condition and one of the top ten causes of death.[1] It is divided into categories based on many characteristics, e.g. open and closed traumas, single or multiple injuries, based on its location on the skull, and type of fracture. In terms of the classification of severity, TBI can be classified as mild, moderate or severe. Whatever the classification, however, no one could deny the importance of rapid and adequate management of the TBIs.

And because of the above mentioned, the authors aimed to support the fact that a neurosurgical facility is of paramount importance for the successful management of TBIs by studying the tenth-leading cause of all deaths globally (road injury) in cadavers.

MATERIALS AND METHODS

According to the recent guidelines the most proper management of these kinds of brain trauma is provided by level one trauma centres. These centres consist of a neurosurgical department, intensive care unit and a computer tomography unit, at least, but such centres are not always easily accessible. In order to support the importance of neurosurgical care, the authors investigated retrospectively the database of the Laboratory of Forensic Science and Toxicology in Stamen Iliev Hospital in Montana, Bulgaria, comparing the mortality rates at the hospital with the mortality rates at the scene of accident. The laboratory investigates cadavers and cases from a few regions - Montana, Vidin and Lom, but cadavers are always examined by one and the same doctor. These hospitals are regional, but they do not have a neurosurgical department (**Fig. 1**).

For this reason, the authors searched the 2007-to-2016 archives of cadavers for brain traumas due to road traffic accidents and divided them into groups by characteristics. The main category, however, is the one providing information about whether individuals have received medical care and where they died. We did not investigate the rest of TBIs and the detailed medical reports since the latter are property of other departments and are located in different hospitals, all the more so that the study's aim was not to show the clinical reports of these cadavers while they were alive, but the importance of the neurosurgical department. However, we did investigate the observational and autopsy findings from the reports of the laboratory.

Afterwards, we filtered the data and analyzed only TBIs from transport accidents using JASP 0.8.0.5. statistical program, performing a t-paired test, correlation and linear regression analysis. The t-paired or student t-test is one of the simplest and more accurate analyses to assess whether the mean of two samples is zero. In the current analysis we used it to compare whether the mortality rate at the hospital and the mortality rate at the scene of accident are identical.

We used the correlation analysis to show the strength of a relationship between two variables, while the linear regression analysis shows the variable response. In the current study we used these analyses to determine whether the age of the subjects had any correlation with the mortality rate.

RESULTS

The total number of autopsies between 2007 and 2016 in the hospital was 1227. Of these, 232 were traumatic brain injuries 124 of which (53.45%) (26 women and 98 men) were TBIs resulting from road transport accidents. The ratio of male to female was 3.8 to 1. The mean age of the males for the entire study was 48.13 years, while the mean age of the females was 59.77. We found that the mean age of the men in the study tended to decrease, while the mean age of the women tended to increase (**Fig. 2**).

The mean age of men admitted to the Hospital of Montana was 45.12 years, while that of women - 55.65 years. The mean age of men that have died at the scene of accident was 45.09 years, and that of women - 25.98 years.

In Vidin, there were two males who died at the scene of accident (mean age 25.6 years); the mean age of the males that have died in the hospital was 19.8 years. There was no female sample from Vidin.

And finally, only one female of 83 years of age died in the hospital of Lom, while the mean age of the males was 32.8 years. And no one of these died at scene of the accident.

We found no mild brain traumas after evaluation of the protocols of the Laboratory of Forensic Science and Toxicology. The greater part of the sample, more often males, had been tested positive for alcohol consumption. Sixty-seven out of 124 subjects had open (penetrating) injury, while the other 57 – closed (blunt) TBIs. The majority had fractures of the facial bones, skull base, frontal and occipital bones (**Table 1**).

The incidence of the TBIs, of the transport accidents injuries and the total number of autopsies per year are presented in **Fig. 3**. And as is seen, in the last few years the transport accidents have been the majority of the TBIs, while the total number of TBIs is steadily decreasing. On the other hand, the general prevalence of autopsies has a convex shape over the last ten years with decreasing curve which will be available for observation in future studies.

And finally, according to our findings on mortality rate, 7 (out of 12 patients) died in the hospital of Vidin, 8 (out of 8) died in the hospital of Lom, and 38 (out of 104) died in the hospital of Montana. The rest of the cadavers died at the scene of accident. We performed a t-test to find the difference of mortality rate between the groups of patients dying 'at hospital' and those dying 'at the scene of accident' for each city (in general 6 groups). The results (**Table 2**) showed that the mortality rate at a hospital without neurosurgical facility and that at the scene of accident for TBI from transport accidents is identical.

A major part of the subjects who died in the hospitals had polytraumatism, all of them had brain edema and all had brain hematoma, for which they would have required neurosurgical care (**Table 3**). Moreover, the majority of those individuals received intensive and/or surgical care for their injuries, suggesting only that for neurotrauma there should be a neurosurgical facility available.

Furthermore, we found that age did not play any role in the mortality at hospitals nor for the mortality at the scene of accident (**Fig. 4**), which is in support of what we said above.

DISCUSSION

Severe traumatic brain injury is one of the most common causes of death worldwide.[1-3] It has been estimated that TBI affects about 200 people per 100.000 or about 10 million worldwide.[3,4] On the other hand, road accidents are one of the most frequent sources of severe neurotrauma

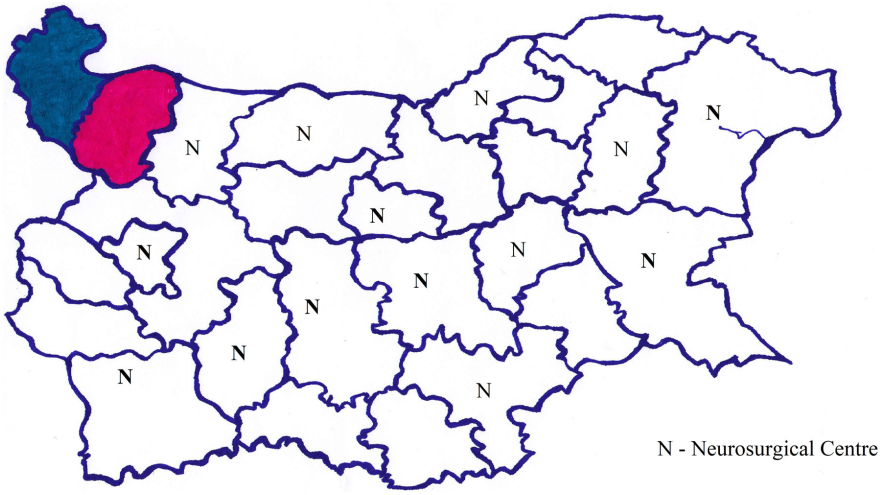

Figure 1. Neurosurgical centres in Bulgaria.

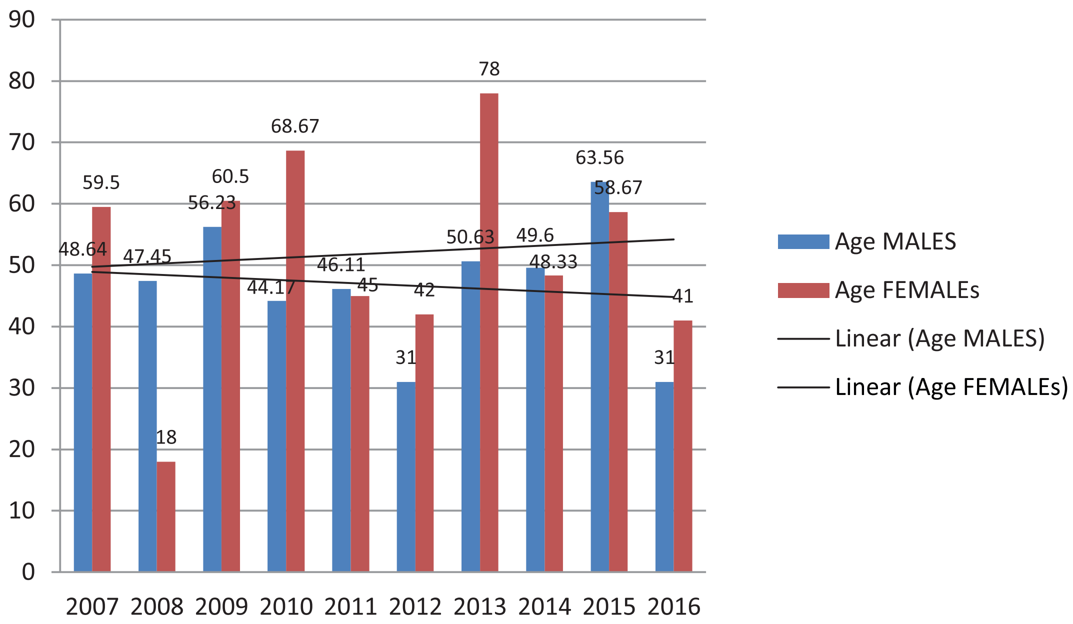

Figure 2. Mean age (years) of the participants.

and deaths and account for two thirds of all TBIs.[3,5] The incidence of the road neurotrauma is believed to be higher among young males, as it is believed to be the incidence of the general TBI.[5-7] Reports from USA[8] and China[9] show males to females ratio of 1.5:1 and 2.5:1, respectively for the brain injuries, which is consistent with the finding that males are affected more often. Our findings studying the cadavers retrospectively showed that twice as many men as women sustain TBIs, which is in support of the finding that males get affected more frequently and constitute the majority of deaths from these injuries.

Two major factors can account for traffic accidents: the road environment factors and the ‘human’ factors. In the latter category are included high speed, mobile phone use, drug and alcohol consumption.[10] Alcohol overdose is linked to increased rates of traffic accidents, as well as higher mortality rate among the injured subjects.[11] In the current study a great part of the subjects had used alcohol, not only increasing their risk ratio for injury, but also for fatality.

Adeleye et al.[12] reports that the most commonly injured regions are the maxillofacial region, followed by different bone fractures and chest injuries. Markogiannakis et al.[13] showed that the most frequently involved extracranial injuries in traffic car accidents are chest injuries, extremities fractures and spine injuries. Our findings after the autopsy

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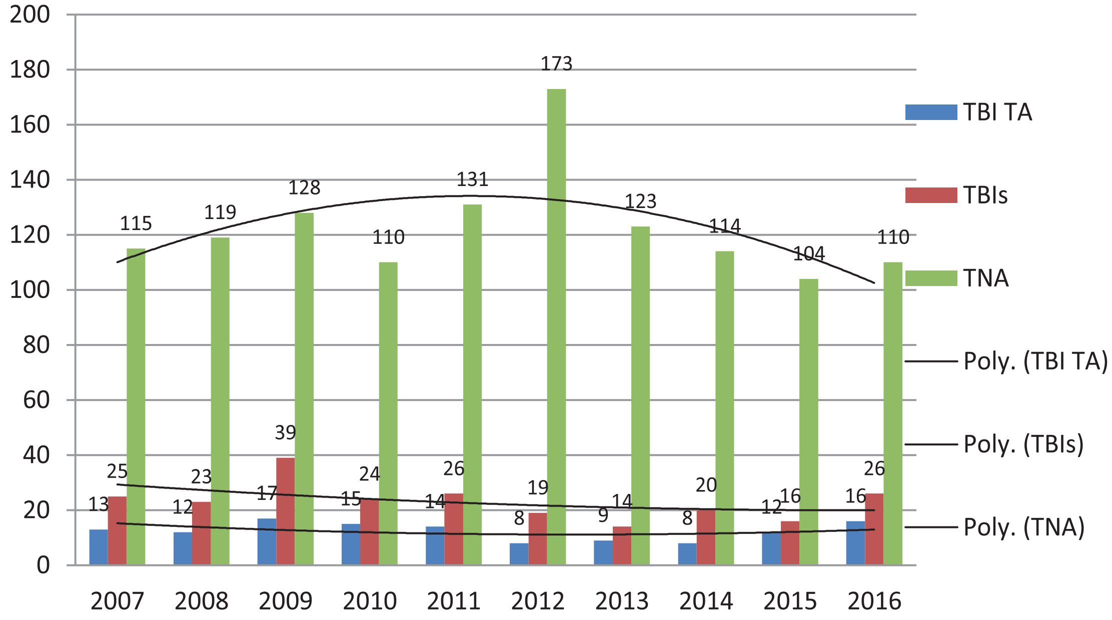

Figure 3. Incidence of the road traumatic brain injuries.

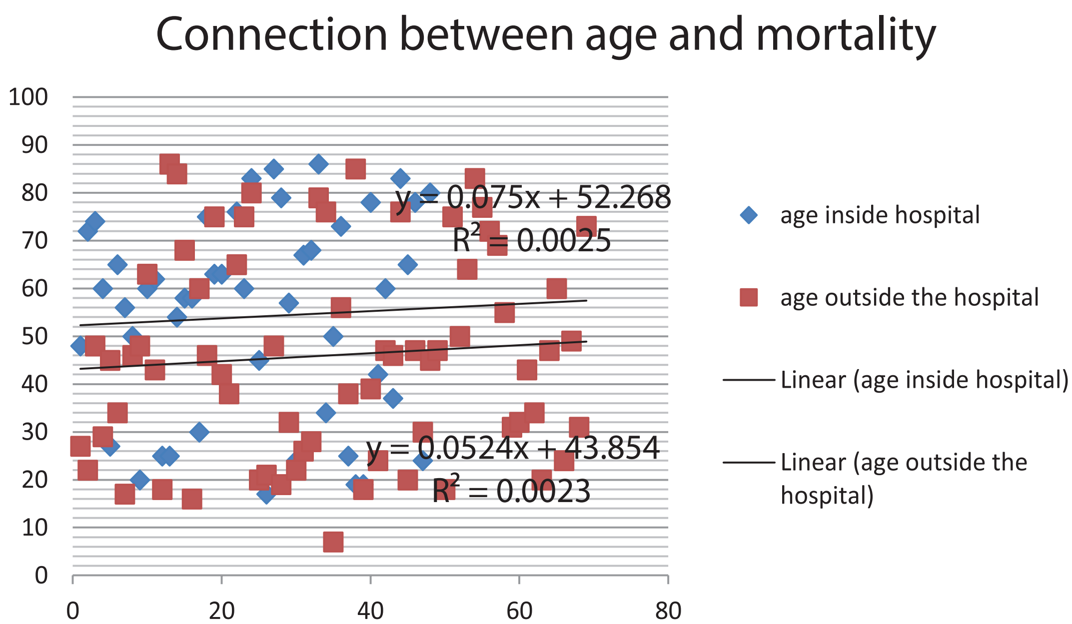

Figure 4. Correlation between age and mortality.

revealed the same types of extracranial injuries, suggesting that car traffic incidents are often the cause of polytraumatism.

The management of the neurotrauma is very complex. Recent guidelines[14] suggest the adherence of multiple methods to its management, with one key factor - neurosurgical care. And despite the fact that the TBI mortality rate is dependable on many factors such as age, condition (mild, moderate, severe), transportation, co-morbidities and clinical center[15-18], the final outcome is strongly connected to the guidelines' treatment. Prabhakaran et al.[17] report that the mortality rate of TBIs decreases if patients are directly transferred to level one trauma centres. Moreover, the healthcare adjustment of the TBIs to the world guidelines lead to decreased mortality[15], as well as the monitoring of the intracranial pressure in intensive care unit (ICU), when there are neurosurgical care unit[16,19].

Accurate management of the injury is highly required in order to prevent further damage. And in this respect, the trauma center at which the patient is treated has a major

Table 1. Skull trauma – location

Location	Males (n)	Females (n)	Total number of patients
Frontal bone	28	11	39
Parieto-temporal	6	2	8
Occipital bone	27	8	35
Parietal bone	10	1	11
Temporal bone	14	6	20
Skull base	49	9	58
Calvaria	22	3	25
Facial bones	53	19	72
Temporo-occipital	10	1	11
Sphenoid bone	5	2	7
Fronto-parietal	8	0	8
Temporo-parieto-occipital	2	0	2
Parieto-occipital	2	1	3
Mastoid process	1	1	2
Fronto-temporal	14	10	24
Fronto-temporo-occipital	0	1	1

n: number of patients

Table 2. Paired t-test on the mortality

Paired Sample t-test				
		t	df	p
Vidin hospital	At the scene of accident	1.000	1	0.500
Lom hospital	At the scene of accident	1.000	1	0.500
Montana hospital	At the scene of accident	-1.000	1	0.500

Significant results when $p < 0.05$

Table 3. Clinical findings in subjects who died in hospital

Type of injury	Males (n)	Females (n)
Brain hematoma	41	11
Brain edema	41	11
Brain ventrical hemorrhage	6	2
Hemothorax / hydrothorax / pneumothorax	25	8
Extremity fractures	15	4
Hepatic rupture	11	4
Pelvic fractures	6	3
Brain herniation	1	1
Spine fractures	10	1
Aortic rupture	1	0
Spleen rupture	1	0
Diaphragm rupture	1	0
Sternum fractures	1	0
Clavicle fractures	1	1
Chest wall fractures	28	8

n: number of patients

role to play for the outcome. Current guidelines for management of neurotraumas suggest that the patients should be transferred as fast as possible to a level one trauma centre[14], meaning that the center offers at least the three basic services: intensive care unit, neurosurgical unit and computer tomography[20-22]. Basic purposes of these centres are reduction of delays, of inadequate health care and preventable fatal outcomes.[23] The mortality rate of level I trauma centres is believed to be twice lower than the others.[20,24,25] In this regard, Young et al.[26] compared the outcome of subjects with TBI directed to Level I trauma Centre and non-Level I Centre. The patients directed to Level I Trauma Centre had shorter stay at ICU. Moreover, in the non-level I trauma centre there were observed more unexpected fatal outcomes in the first 24 hours or increased 24-hour mortality. Similar outcomes were observed by Sampalis et al.[27] in a comparative study, where the group transferred to non-level I Trauma Centre had an increased stay in the ICU. The subjects among the 'transferred' group with severe brain injury were also more prone to die compared to those directed into Level I trauma Centre.

Furthermore, Sharma et al.[6] investigated the access of the injured to trauma and non-trauma centres. According to his study, there is a significant difference among the patients reaching both centres, mainly in their demographic data. The demand of neurosurgical care, however, remains the same. In his study, comparing the two sites, the quality of care of the non-trauma centres is more prone to be insufficient than the trauma centre's care. This is supported by DuBose et al.[28], where the patients admitted to trauma center level I had better outcome, and Brown et al.[29], where the patients transferred to such center had better functional independence and independent expression. Furthermore, the delay of the neurosurgical care has also an impact on the mortality of the traumatic brain injuries.[7,20,30]

In order to improve the health care of TBIs in Bulgaria, and worldwide, there should be more fully equipped level I trauma centres with experienced personnel in neurotrauma management. The latter, however, according to Okeyere-Dede[31] is insufficient. In Africa, there is one neurosurgeon per 10000000 population, while in Europe there are on average 102 neurosurgeons providing services to

10000000 people. Dewan et al.[32] suggests that about 22626 neurosurgeons should be trained in order to meet the required needs of neurosurgical care. In our study, we have pointed to 14 out of 28 regions that provide neurosurgical services. The data of the study showed that except for one, the mortality rate there is as high as the mortality on the road, suggesting that such centres and neurosurgeons are of utmost importance for the successful management of TBIs and that prioritizing, rapid management, prognostic scales etc. are irrelevant when the basic requirements are not met.

CONCLUSION

Traumatic brain injury is a deadly condition requiring more than rapid management. Its therapy, however, should be provided in centres with proper settings, otherwise it is inadequate. In this study, we investigated cadavers who suffered traumatic brain injury from road accident and we found that the mortality rate at centres without neurosurgical facilities is identical with the mortality rate on the road. The cost of trauma centres is very high, so until they are equally distributed, "prevention should be the best therapy".

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Черепно-мозговая травма и значение нейрохирургической помощи: 10-летнее ретроспективное исследование трупов

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Абстракт

Цель: Черепно-мозговая травма (ЧМТ) в результате транспортных происшествий является серьёзной причиной смерти и инвалидности. Однако быстрое реагирование и соответствующее медицинское обслуживание требуются в любом случае.

Материалы и методы: Мы ретроспективно собрали данные за 10 лет из лаборатории судебно-медицинской экспертизы и токсикологии в Монтане, Болгария, чтобы продемонстрировать важность нейрохирургической помощи в травматологии и её связь с показателями смертности.

Результаты: Были включены 124 трупа, среди которых преобладали мужские. Анализ данных показывает, что в процентном отношении смертность в больницах без нейрохирургической помощи и смертность на месте происшествия одинаков для травм головного мозга в результате дорожно-транспортных происшествий. Кроме того, мы обнаружили, что отсутствует корреляция между возрастом и смертностью.

Выводы: Травмы в результате дорожно-транспортных происшествий являются наиболее распространённым видом травмы головного мозга. Мы считаем, что исход этих ЧМТ зависит от наличия отделения нейрохирургии.

Ключевые слова

Черепно-мозговые травмы, нейрохирургия, здравоохранение, травмы, трупы

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