

I.Sh. Magerrambeyli
Azerbaijan Medical University, Baku, Azerbaijan

EFFICIENCY OF RADIODIAGNOSIS METHODS IN DETECTING STRUCTURAL CHANGES IN TISSUES ASSOCIATED WITH TRAUMATIC BRAIN INJURY

e-mail: mic_amu@mail.ru

Combined craniocerebral injuries, which occupy one of the first places among peacetime injuries and are the most characteristic of road traffic accidents, can reach 70–92 % in terms of prevalence. The purpose of the study was to compare the studied clinical diagnostic parameters associated with various forms of traumatic brain injury. To achieve this goal, a prospective comparative study of 299 people with traumatic brain injuries hospitalized in the period from 2016 to 2020 was conducted, and the complex use of clinical and instrumental methods of research in various forms of isolated and combined injuries was performed. Pronounced deviations in the prevalence of traumatic brain injury are detected at the age of up to 20 years and older than 70 years, and where the lowest level of TBI was noted, the rate increased, reaching a maximum at the age of 20–29 years and 40–49 years. The results of radiodiagnosis testify to the effectiveness of X-ray when used in patients with various post-traumatic complications ($\chi^2=6.233$, $df=2$, $p=0.044$).

Key words: traumatic brain injury, age-gender characteristics, concomitant injuries, radiodiagnosis

І.Ш. Магеррамбейлі

ЕФЕКТИВНІСТЬ МЕТОДІВ ПРОМЕНЕВОЇ ДІАГНОСТИКИ У ВИЯВЛЕННІ СТРУКТУРНИХ ЗМІН У ТКАНИНАХ, АСОЦІЙОВАНИХ ІЗ ЧЕРЕПНО-МОЗКОВОЮ ТРАВМОЮ

Комбіновані черепно-мозкові ушкодження, що займають одне з перших місць серед травм мирного часу і є найбільш характерними для дорожньо-транспортних пригод, можуть досягати за рівнем поширеності 70–92 %. Метою дослідження було порівняння досліджуваних клініко-діагностичних параметрів, асоційованих з різними формами черепно-мозкової травми. Для досягнення поставленої мети було проведено проспективне порівняльне дослідження 299 осіб із черепно-мозковими травмами, які були госпіталізовані в період з 2016 по 2020 роки, та виконано комплексне використання клінічних та інструментальних методів дослідження при різних формах ізольованих та поєднаних ушкоджень. Виражені відхилення у показниках рівня поширеності черепно-мозкової травми виявляються у віці до 20 і старше 70 років, і де відзначалися найменший рівень черепно-мозкових травм. Показник різко підвищувався, досягаючи максимуму у віці 20–29 та 40–49 років. Результати променевої діагностики свідчать про ефективність рентгенодіагностики при його застосуванні у пацієнтів з різними посттравматичними ускладненнями ($\chi^2=6,233$, $df=2$, $p=0,044$).

Ключові слова: черепно-мозкова травма, віково-статеві ознаки, комбановані травми, променева діагностика

Traumatic brain injury is still an unresolved and important medical and social problem, due to the steady increase in its prevalence and the increase against this background in the frequency of occurrence and severity of neurological trauma [7, 8]. According to experts, this is due to technological progress in production, the intensification of traffic and the growth of traffic accidents, despite modern automation and computerization of street traffic. This remains a problem even despite the implementation of large-scale preventive measures aimed at identifying the causes and reducing the level of the most frequent road and domestic injuries [11].

At the same time, it is important to note some age-sex distinctive features in people most often subject to traumatic injuries, where, according to various authors, the proportion of males aged 20–39 years can vary between 70–95 %, more precisely, the prevalence of TBI in men significantly exceeds the indices found in the representatives of the female half of the population, it can be said in all age groups [5].

Pre-hospital mortality among victims with severe forms of traumatic brain injury before hospitalization, that is, at the scene and during transportation to a specialized clinic, can reach 50 %. And this fact should always be the focus of emergency medicine, because it deals with the provision of timely and effective medical care at the scene of a traffic accident and thus reducing the number of deaths, especially in victims with concomitant traumatic brain injury [13, 15]. Combined craniocerebral injuries or the so-called polytrauma, which occupies one of the first places among other injuries and is the most characteristic category for road traffic injuries with atypical clinical course and extracranial injuries. They reach 70–92 % of the total number of all suffered injuries in terms of prevalence and severity of the course [3].

A characteristic feature of combined injuries is simultaneous damage to vital organs along with brain damage [4]. Here it should be noted the presence of traumatic shock, blood loss, disorders in the nervous system [1, 10, 12] and in the functional state of some internal organs, the musculoskeletal system. And all this can be accompanied by the development of serious pathological syndromes [2, 6, 9].

The purpose of the study was to compare the studied clinical diagnostic parameters associated with various forms of traumatic brain injury.

Material and methods. To achieve this purpose, a comparative study of patients was carried out and a complex use of clinical and instrumental research methods was carried out to develop and apply a clinical diagnostic algorithm for various forms of isolated and combined traumatic brain injuries.

The material for the study was collected in the Educational-Surgical Clinic of Azerbaijan Medical University, which is one of the medical centers in Baku city for providing emergency care to victims with severe isolated and combined craniocerebral injuries; patients are delivered to the clinic by ambulance teams. The studies included data on the treatment of 299 persons with traumatic brain injuries hospitalized between 2016 and 2020. Computed tomography (CT) has a higher resolution than traditional ultrasound and radiography, in the study of structural changes in the brain. This gave grounds to introduce into the objectives of this study a comparative analysis of the frequency of use and the efficacy of these methods of radiation diagnostics.

The inclusion criteria for the study were as follows: victims with a verified diagnosis of TBI; age over 18; patients without concomitant somatic pathology; patients with laboratory and instrumental parameters without pronounced deviations, which reflects the general normal state of the body.

Exclusion criteria: victims with severe somatic pathology, in particular, with hepatic, renal and severe cardiovascular insufficiency; age up to 18 years.

All patients were examined by physicians of other specialties, including internist, psychiatrist, ophthalmologist, otolaryngologist, as well as urologist and pulmonologist in the presence of corresponding combined traumatic injuries. The studies were carried out with the written consent of the patients, observing the norms of biomedical ethics, according to the Declaration of Helsinki "Ethical Principles of Medical Research Involving Humans", developed by the World Medical Association, "Universal Declaration on Bioethics and Human Rights (UNESCO)".

The obtained data were statistically processed using the Microsoft Excel and Statistica 7.0 software package. The indices are presented as mean values and mean error ($M \pm m$). Statistical significance of differences between samples was determined using the Student's t-test and using non-parametric Kruskal-Wallis Test (ANOVA) and Mann-Whitney methods. A p-value of <0.05 was considered statistically significant.

Results of the study and their discussion. When analyzing gender characteristics of patients observed we revealed that male /female ratio showed predominance of males, mostly of working age (233 (77.9 %) and 66 (22.1 %), respectively, $\chi^2=2.066$, $df=4$, $p=0.724$).

The greatest deviations in the prevalence of traumatic brain injury are detected in the youngest and oldest age groups, that is, up to 20 years of age and in the group that included victims over the age of 70 years and where the lowest level of TBI was noted. In subsequent age groups, this indicator increased, reaching a maximum at the age of 20–29 years and 40–49 years, and stabilized in the age group over 49 years.

More patients with traumatic injuries of the bones of the skull and soft tissues are at a young age, that is, the age of 20–29 years, where the frequency of occurrence of injuries was 27.8 %. Cases of identification of injured persons, whose age was 40–49 years, amounted to 21.1 %. The lowest rates were recorded for the head injury rate, which was recorded in the oldest age group, i.e. 70 years and older ($\chi^2=32.135$, $df=24$, $p=0.124$). The proportion of elderly and senile patients decreases in the structure of traumatic brain injury over the entire period of our observations.

According to the results of a comprehensive analysis of statistically significant differences in a number of clinical diagnostic indices (age and gender, the presence of pathology according to the results of X-ray, ultrasound (US) and CT) were not detected (Table 1).

Table 1

The results of imaging evaluation of TBI

		group										Pearson Chi-Square Tests		
		TBI		TBI+extremity fracture		TBI+chest trauma		TBI+abdominal injuries		TBI+concomitant injuries				
		Count	%	Count	%	Count	%	Count	%	Count	%	χ^2	p	df
X-ray	didn't have	0	0.0	1	1.1	1	1.9	0	0.0	0	0.0	2.411	0.661	4
	had	90	100.0	94	98.9	52	98.1	24	100.0	37	100.0			
US	didn't have	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	-	-	-
	had	90	100.0	95	100.0	53	100.0	24	100.0	37	100.0			
CT	didn't have	0	0.0	3	3.2	1	1.9	0	0.0	0	0.0	4.553	0.336	4
	had	90	100.0	92	96.8	52	98.1	24	100.0	37	100.0			

In the course of studies during CT scans with combined TBI+chest trauma, pathology was detected only in 98.1 % of cases. In patients with isolated TBI, pathological changes were noted in 100 % of cases, which may indicate the presence of certain difficulties in the optimal diagnosis and objectification of various forms of the studied traumatic injuries in clinical practice.

When analyzing the results of CT scans performed in 295 individuals, we detected pathological changes in 97.3 % of cases with a favorable outcome, in 100 % of cases with complications, and in 96.4 % of cases with a fatal outcome. This fact indirectly, due to the large number of deaths, may indicate the efficacy and accuracy of X-ray diagnostics when used in patients with signs of complications, in particular, complications in the form of chest damage against the background of a relatively more severe course of the injury ($\chi^2=6.233$, $df=2$, $p=0.044$) (Table 2).

Table 2

Diagnostic imaging findings for outcomes in patients with TBI

imaging procedures		Outcome								
		Improvement		Complications		Mortality		Pearson Chi-Square Tests		
		Count	%	Count	%	Count	%	χ^2	df	p
X-ray X-Ray	didn't have	2	2.7	0	0.0	0	0.0	6.233	2	0.044
	had	71	97.3	170	100.0	56	100.0			
US	didn't have	0	0.0	0	0.0	0	0.0	-	-	-
	Had	73	100.0	170	100.0	56	100.0			
CT	didn't have	2	2.7	0	0.0	2	3.6	5.509	2	0.064
	Had	71	97.3	170	100.0	54	96.4			

On the other hand, a high percentage of detected pathological changes of traumatic origin, registered on the basis of ultrasound and radiography data in patients with improvement in post-traumatic condition and with a fatal outcome, in a certain sense confirms the ease of visualization of TBI using these methods of radiation diagnostics. Thus, we can testify to an increase in traumatism in middle age, that is, people of working age are prone to craniocerebral injuries. This fact requires special attention, since it has a very important social and economic significance for any state, due to the high level of disability of the most active part of the population.

Traumatic brain injuries lead to an increase in disability and in some cases even disability. The epidemiology of disability, in our opinion and the conclusions of some foreign authors, will have a negative trend in the future due to an increase in the number of such injuries.

Kureshi N, et al (2021), analyzing causes and age of patients with TBI in relation to rate, revealed that an increasing incidence of major TBI over a 16-year period was associated with fall-related TBI. The authors noted the importance of TBI prevention by reducing falls, especially in older adults [7].

At the same time, it is necessary to emphasize the high level of traumatic brain injuries among people of the most able-bodied age ($\chi^2=32.135$, $df=2$, $p=0.044$). It is possible to eliminate such a possible dynamic by conducting deep comprehensive studies to further study the features of the occurrence and development of traumatic brain injuries and their complications [14].

The use of very effective and informative high-tech methods of radiation imaging, including computed tomography and magnetic resonance imaging, according to our research and the results of other scientific works, is very limited at the initial stages of providing emergency medical care to patients with severe traumatic injuries, most often due to for economic and technical problems, which will depend on the equipment and professional level of specialized resuscitation and surgical teams [8].

It is considered that magnetic resonance imaging has higher sensitivity than computed tomography for certain types of traumatic brain injury. Despite this, magnetic resonance imaging in most cases allows to expand the possibilities of visualizing traumatic brain injuries, especially in the subacute period, when clinical data do not correspond to the CT picture, and especially in patients in a coma, with craniospinal injuries. At the same time, due to the high spatial resolution, small damage and hemorrhages can be detected during research. But in acute cases, CT is slightly more preferable, since trauma patients are usually unstable and require follow-up. So, it is currently believed that computed tomography is the main method for quickly diagnosing most traumatic brain injuries, including those requiring immediate intervention. However, if a favorable CT picture is observed with obvious disorders of the neurological status, magnetic resonance imaging is recommended.

Lee, H., et al (2021) studying the data of 340,090 hospitalized TBI patients with and without brain MRI (2012–2014) by multivariate regression analysis presented the first evidence that inpatient brain MRI in TBI patients is associated with lower inpatient mortality, but with increased hospital resource utilization.

The authors found out that the MRI group had a lower unadjusted mortality rate of 0.75 % compared to 2.54 % in the non-MRI group [8].

All of the above makes the issue of reducing the incidence of serious complications and secondary brain lesions relevant and today predetermines the importance of finding and implementing affordable and optimal diagnostic methods and subsequent management of people with traumatic brain injuries.

Conclusions

1. Pronounced deviations in the prevalence of traumatic brain injury are detected at the age of up to 20 years and older than 70 years, and where the lowest level of TBI was noted, the rate increased, reaching a maximum at the age of 20–29 years and 40–49 years.

2. The results of radiodiagnosis testify to the effectiveness of X-ray when used in patients with various post-traumatic complications ($\chi^2=6.233$, $df=2$, $p=0.044$).

References

1. Cruz-Haces M, Tang J, Acosta G, Fernandez J, Shi R. Pathological correlations between traumatic brain injury and chronic neurodegenerative diseases. *Transl Neurodegener.* 2017; 6: 20. <https://doi.org/10.1186/s40035-017-0088-2>.
2. Dams-O'Connor K, Juengst SB, Bogner J, Chiaravalloti ND, Corrigan JD, Giacino JT, et al. Traumatic brain injury as a chronic disease: insights from the United States Traumatic Brain Injury Model Systems Research Program. *Lancet Neurol.* 2023 Jun;22(6):517–528. doi: 10.1016/S1474-4422(23)00065-0.
3. Guo S, Han R, Chen F, Ji P, Liu J, Zhai Y, et al. Epidemiological characteristics for patients with traumatic brain injury and the nomogram model for poor prognosis: an 18-year hospital-based study. *Front. Neurol.* 2023; 14:1138217. doi: 10.3389/fneur.2023.1138217
4. Izzy S, Chen PM, Tahir Z, Grashow R, Radmanesh F, Cote DJ, et al. Association of Traumatic Brain Injury With the Risk of Developing Chronic Cardiovascular, Endocrine, Neurological, and Psychiatric Disorders. *JAMA Netw Open.* 2022 Apr 1;5(4):e229478. doi: 10.1001/jamanetworkopen.2022.9478.
5. Klukowska-Rötzler J, Buerzle A, Exadaktylos AK, Niemann S, Bürgi F, Jakob DA. Sex differences in sledging injuries: a retrospective 10-season study from a Swiss level 1 trauma centre. *BMJ Open Sport Exerc Med.* 2023 Jun 22;9(2):e001615. doi: 10.1136/bmjsem-2023-001615.
6. Kong LZ, Zhang RL, Hu SH, Lai JB. Military traumatic brain injury: a challenge straddling neurology and psychiatry. *Mil Med Res.* 2022 Jan 6;9(1):2. doi: 10.1186/s40779-021-00363-y.
7. Kureshi N, Erdogan M, Thibault-Halman G, Fenerty L, Green RS, Clarke DB. Long-Term Trends in the Epidemiology of Major Traumatic Brain Injury. *J Community Health.* 2021 Dec;46(6):1197–1203. doi: 10.1007/s10900-021-01005-z.
8. Lee H, Yang Y, Xu J, Ware JB, Liu B. Use of Magnetic Resonance Imaging in Acute Traumatic Brain Injury Patients is Associated with Lower Inpatient Mortality. *Journal of clinical imaging science.* 2021;11: 53. https://doi.org/10.25259/JCIS_148_2021
9. Nelson LD, Temkin NR, Barber J, Brett BL, Okonkwo DO, McCrea MA, et al. Functional Recovery, Symptoms, and Quality of Life 1 to 5 Years After Traumatic Brain Injury. *JAMA Netw Open.* 2023 Mar 1;6(3):e233660. doi: 10.1001/jamanetworkopen.2023.3660.
10. Peterson K, Veazie S, Bourne D, Anderson J. Association Between Traumatic Brain Injury and Dementia in Veterans: A Rapid Systematic Review. *J Head Trauma Rehabil.* 2020 May/Jun;35(3):198–208. doi: 10.1097/HTR.0000000000000549.
11. Picetti E, Catena F, Abu-Zidan F, Ansaloni L, Armonda RA, Bala M, et al. Early management of isolated severe traumatic brain injury patients in a hospital without neurosurgical capabilities: a consensus and clinical recommendations of the World Society of Emergency Surgery (WSES). *World J Emerg Surg.* 2023 Jan 9;18(1):5. doi: 10.1186/s13017-022-00468-2. Erratum in: *World J Emerg Surg.* 2023 Apr 6;18(1):29.
12. Pushko OO, Lytvynenko NV. Peculiarities of neurocognitive status of patients in the acute ischemic stroke phase of different hemispheric localization. *World of Medicine and Biology.* 2020; 2(72):099–103. DOI: 10.26724/2079-8334-2020-2-72-99-10
13. Sanae H, Tetsuhisa K, Tomotaka S, Yuko N, Hiroshi O, Takeshi Sh. Association of Pre-Hospital Helicopter Transport with Reduced Mortality in Traumatic Brain Injury in Japan: A Nationwide Retrospective Cohort Study. *Journal of Neurotrauma.* Jan 2022.76-85. <http://doi.org/10.1089/neu.2021.0181>
14. Sang, X. Z., Wang, C. Q., Chen, W., Rong, H., & Hou, L. J. (2023). An exhaustive analysis of post-traumatic brain injury dementia using bibliometric methodologies. *Frontiers in neurology*, 14, 1165059. <https://doi.org/10.3389/fneur.2023.1165059>
15. Sivco P, Plancikova D, Melichova J, Rusnak M, Hereitova I, Beranek V, et al. Traumatic brain injury related deaths in residents and non-residents of 30 European countries: a cross-sectional study. *Sci Rep.* 2023; 13: 7610. <https://doi.org/10.1038/s41598-023-34560-7>

Стаття надійшла 3.11.2022 р.