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

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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 aim 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 traumatic brain injury 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

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

Поєднані 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, госпіталізованих у період з 2016 по 2020 рр., 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 років і старше 70 років, де відзначалися найменший рівень черепно-мозкової травми. Показник різко підвищувався, досягаючи максимуму у віці 20–29 років 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, поєднані травми, променева діагностика

Traumatic brain injury (TBI) 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 [6, 7]. 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 [10].

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 indicators found in the representatives of the female half of the population, it can be said in all age groups [1, 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 [12]. 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 [8].

A characteristic feature of combined injuries is simultaneous damage to vital organs along with brain damage [11, 13]. Here it should be noted the presence of traumatic shock, blood loss, disorders in the nervous system 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 [9, 14].

**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 surgical clinic of the 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 people with traumatic brain injuries hospitalized between 2016 and 2020.

Computed tomography (CT), ultrasound and X-ray were performed to detection of pathological changes in brain. 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 effectiveness 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. Without exception, all patients were examined by doctors of other specialties, including an internist, a psychiatrist, an ophthalmologist, an otolaryngologist, as well as a urologist and a 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)" [3].

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

**Results of the study and their discussion.** The distribution of patients by age and sex is presented in the form of tabular data (Table 1).

Table 1

**Distribution of patients based on age and gender**

| Age groups | | | | | | Pearson Chi-Square Tests | | |
|---|---|---|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent | χ2 | df | p |
| Gender | Male | 233 | 77.9 | 77.9 | 77.9 | 2.066 | 4 | 0.724 |
| | Female | 66 | 22.1 | 22.1 | 100.0 | | | |
| Age | < 20 | 26 | 8.7 | 8.7 | 8.7 | 32.135 | 24 | 0.124 |
| | 20–29 | 83 | 27.8 | 27.8 | 36.5 | | | |
| | 30–39 | 50 | 16.7 | 16.7 | 53.2 | | | |
| | 40–49 | 63 | 21.1 | 21.1 | 74.2 | | | |
| | 50–59 | 45 | 15.1 | 15.1 | 89.3 | | | |
| | 60v69 | 20 | 6.7 | 6.7 | 96.0 | | | |
| | >=70 | 12 | 4.0 | 4.0 | 100.0 | | | |
| | Total | 299 | 100.0 | 100.0 | | | | |

Male (77.9 %), mostly of working age, predominated among the victims. Patients of similar age prevailed among 22.1 % of injured women.

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. 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 indicators (age and sex, the presence of pathology according to the results of X-ray, ultrasound and CT) were not detected (Table 2).

Table 2

**Results of imaging evaluation of TBI**

| | | qroup | | | | | | | | | | Pearson Chi-Square Tests | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TBI | | TBI + extremity fracture | | TBI + chest trauma | | TBI + abdominal injuries | | TBI + concomitant injuries | | | | |
| | | Count | % | Count | % | Count | % | Count | % | Count | % | χ2 | 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 ($\chi2$=5,509, Df=4, significance level p=0,064).

This fact indirectly, due to the large number of deaths, may indicate the effectiveness 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 ($\chi2$=6.233, Df=4, significance level p=0.044).

So, in the patients studied by X-ray, the pathological changes were detected in 2 (2.7 %) cases of favorable outcomes, but in all cases (170 (100.0 %)), when patients had complications, as well as all cases (56 (100.0%) of fatal outcomes.

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 [7, 11].

In our study the maximum incidents rate was detected at the age of 20–29 years and 40–49 years. Chikhladze N, et al in their work revealed that patients aged 25-44 years were more represented in the number of TBI-related hospitalizations and the older age was found to be an independent predictor of poor hospitalization outcomes and highest case fatality rates from TBI-related hospitalizations. The authors noted that complex computed tomography should be performed in all patients with TBI, which is an important aspect of the management and care of TBI [2]. According to our results, X-ray was more effective in detection of pathological findings depends on outcomes.

It is necessary to emphasize the high level of traumatic brain injuries among people of the most able-bodied age ($\chi2$=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.

Pastor IS, et al, found that patients with TBI and concomitant chest trauma had a higher mortality rate than those without chest trauma: patients with associated trauma, such as vertebro-medullary or thoracic trauma, were more likely to die after a few days of hospitalization (p=0.007) [9]. In our work the partially similar results were obtained: complications in the form of chest damage were characterized by a relatively more severe course of the injury.

The use of very effective and informative high-tech methods of radiation imaging, including CT and magnetic resonance imaging (MRI), 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.

So, Hallock H, et al (2023) noted, that repeated concussions are associated with an increased risk of several neurologic diseases and long-term cognitive deficits, which needs to improve standardized guidelines for the assessment and management of traumatic injuries. However, current concussion management guidelines lack procedures for timely detection of pathological changes [4].

In the other study, the authors revealed that inpatient brain MRI in TBI patients is associated with lower inpatient mortality. They presented the evidence depends on multivariate regression analysis (adjusted OR 0.32, 95 % CI 0.12-0.86), and emphasized the necessary of using MRI in patients with TBI to prevent fatal outcomes [6]. But with increased hospital resource utilization (compared to X-ray, which demonstrated statistical significance in our study) and likelihood of non-home discharge.

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. During CT scans of patients with combined TBI + chest trauma, pathology was detected in 98.1 % of cases. In patients with isolated TBI, pathological changes were noted in 100.0 % of cases,

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).

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