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Original article

FORENSIC ASPECT OF CEREBRAL CONTUSIONS

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Abstract

Introduction. Contusions are injuries of the brain dominantly incurred by blunt-force trauma in the head (blow, impact, fall). Proper analysis of the cerebral contusions within all head injuries and data case gives us complete view of the event and enables us to choose the right direction in the investigation. The aim of this investigation was to perform a forensic medical analysis of cases with brain injury (cerebral contusions) incurred by blunt-force trauma, and to compare results with a prior extensive research done at the Institute of Forensic Medicine, Skopje.

Methods. A total of 76 cases with cerebral contusions incurred by blunt-force trauma were included. The following data were analyzed: gender, age, event, skull fractures, type of fracture, localisation of contusions and toxicological analysis. The basic descriptive processing included the above information-variables taken from the written reports of the performed autopsies. The data are displayed graphically with the use of Microsoft Excel 2007. Results. Male was the dominant gender in the analyzed cases (86%), with mean age of 51 years. Traffic accidents were the main factor for these injuries (76%). Skull fractures were found in 67% of cases. The dominant cerebral lobes were the temporal and the frontal lobe, and the contrecoup contusions were found in 55% of cases.

Conclusions. The experience gained during the processing and analysis of these brain injuries answers the most complicated questions, and contributes to the health-care especially in dealing with the diagnosis and treatment of cerebral contusions.

Key words: cerebral contusions, forensic medicine

Introduction

Brain injuries are the leading cause of death in North America in individuals aged 1 to 45. The incidence of brain injuries in the USA is 538,2 in population of 100 000 [1], Europe has incidence of 235 in 100 000, and Australia 322 in 100 000 [2-3].

Brain contusions are dominantly caused by blunt-force

trauma in the head (blow, collision or fall). The contusion appearance can vary from small spot-like or linear hemorrhage to enormous tissue destruction and hemorrhage. The hemorrhage is usually spread out through the gray matter, but in more extensive injuries it can also be seen in the white matter. The most common and often localization is on the side where the force has acted (coup), but in a large number of cases it can be seen on the opposite side (contrecoup) [4-5].

Several questions are raised in the area of forensic medical expertise when we talk about craniocerebral injuries and brain contusions as part of them: is death a result of head injury, what is the mechanism of injury, is it a murder, suicide or an accident, are there additional or personal factors that contribute to the injuries. The correct analysis of brain contusions and the analysis of head injuries along with the operative data about the incident give a complete image of the event and point out to the right direction in the investigation. The aim of this study was to perform a forensic expertise in cases with brain contusions inflicted by blunt-force trauma and to compare results with the previous extensive study conducted at the Institute of Forensic Medicine in Skopje [6].

Materials and methods

A total of 76 cases with brain contusions inflicted by blunt-force trauma were analyzed. All of the autopsies were performed at the Institute of Forensic Medicine, and the data was obtained from the autopsy reports. The following data was obtained: gender, age, type of event (traffic accident, murder, suicide, and accident), presence or absence of skull fractures, type of fracture (linear, impulsive or combined, linear and impulsive), localization of contusions, toxicology reports considering alcohol, medicaments, and drugs in the blood and urine. In all of these cases the presence of coup and contrecoup contusions was analyzed.

The processing included variables that were obtained from the autopsy reports. The display of the data is presented in figures using the Microsoft Excel 2007.

Results

From the total of 76 cases, 86% were males and 14% females. The mean age was 51 years, ranging from 4 to 86 years.

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According to the type of event the cases were divided in four groups: traffic accidents, murder, suicide, and accident. The traffic accidents were dominant in the analyzed cases, followed by accidents, and murders. There were no cases of suicide with brain contusions (Figure 1).

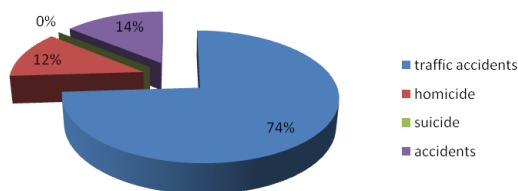


Fig. 1. Type of circumstances

The analysis of skull fractures showed presence of fractures in 67% of the analyzed cases. Concerning the type of fracture, the predominant one was linear fracture, followed by impressive fracture, multifragmentary fracture, and combined (linear and impressive) (Figure 2).

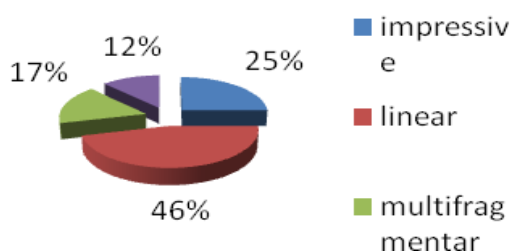


Fig. 2. Type of fractures

Temporal and frontal lobes were dominant when analyzing the anatomical localization of brain contusions. The less inflicted were the left parietal lobe (7%) and the left occipital lobe (9%) (Figure 3).

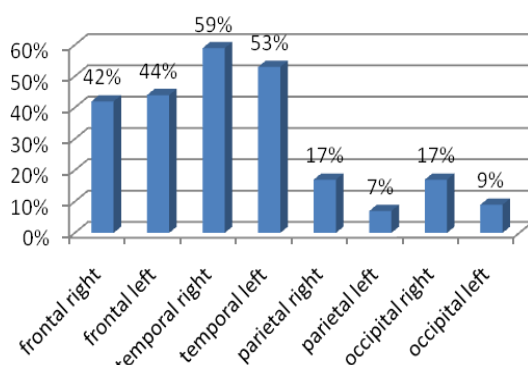


Fig. 3. Localization of contusions

With regard to the type of contusions, the findings of isolated coup or contrecoup on the opposite side were similar (Figure 4).

According to the direction of the action of the force, only in a small number of cases the force acted in a straight-line, both in the coronal and in the sagittal suture. The straight-line force accounted for 13% and the diagonal

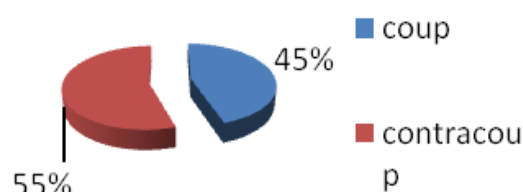


Fig. 4. Coup and contra coup contusions

action of force for 87%, of which the most common was temporal-occipital diagonal direction.

The toxicology analysis was performed in 55% of the cases. 88% of the analyzed cases showed presence of 0-0.5 gr %, and 12 % showed levels above the permitted limit. 19% of all cases were screened for psychoactive substances, and only one case was positive for opiates. 40% were screened for medicaments; one case was positive for barbiturates, and 19.35 were positive for benzodiazepines.

Discussion

The contusions in the brain cortex are the most often structural lesion [7]. Their pathophysiology is complex and multifactorial, but in general they are marked as hemorrhage and tears of the tissue in places where brain shifts occur relative to the skull. They can occur on the same side where the force have acted but also on the opposite side. The mechanical injuries occur in three different ways: blow, collision or fall. In general, even though it is not a rule, if there are contusions on the place of the direct action of the force they are due to a blow; if there are contusions on the opposite side they are due to fall or collision. However, this claim should not be accepted as a rule because there are always exceptions [4-5].

Brain injuries are very frequent cause of death in the world, especially in the young population, and most commonly occur in traffic accidents, murders and accidents, and they least occur as a result of a suicide [5]. The forensic medical expertise of these types of injuries includes analysis of all of their characteristics, with the aim to get the answers that differ from case to case. In this study, although based on 76 cases, we wanted to compare data found in the contemporary literature, and the data that we got from a large study conducted at our Institute and was related to craniocerebral injuries.

The brain injury rate is highest in children aged 1-4 years and in adolescents aged 15-24 years, and there is another peak found in the population aged over 65 years. It is more often found in males than in females with the ratio 2 to 1 and even 2.8 to 1 [8-10]. The mean age of our subjects was 51, that is 48% in the group between 21 and 60 years, and compared to the previous study it can be seen that [6] the same group had been represented with 60%. The males predominated with 6:1 ratio; however, this data has to be taken with caution due to the small

number of examinees. These injuries are inflicted most commonly in traffic accidents, murders, and accidents and the least in suicides [5,6]. This was also confirmed with our findings, where traffic accidents dominated in 3:1 ratio, compared to the other events. This corresponds with the fact that most of the injuries inflicted during traffic accidents are in the head, and the main cause of death is central nervous system injuries [6, 10].

Skull fractures are almost always associated with this type of injury [4-6]. In our study skull fractures were present in two thirds of the analyzed cases, with the linear fracture as a dominant one. The force needed to inflict bone fracture causes sufficient deformation of the skull and consequently brain surface injuries, thus skull fractures and contusions walk hand in hand. The contusions that are seen on the very same spot of the fracture or follow the fracture line are called fracture contusions. The localization of the fracture contusions does not always correspond with the spot where the force acted, unless there is an impressive fracture with an underlying contusion [11]. The number and the localization of contusions are not dependent on the type of fracture, but rather on the localization of the action of the object on the head and the intensity of the force. Thus, the greater the intensity of the force that acted, the greater the injuries will be. Contusions associated with skull fractures are more extensive and localized in more different brain lobes. The frontal and temporal lobes were the most frequent localizations of the brain contusions in our cases. This finding was in agreement with other studies [6,11] where it has been reported that ventral and lateral localization of the brain injuries is far less common than frontal and temporal localization. This can be easily explained with the bigger exposition of those brain lobes to the action of the force as well as with the uneven surface of the base of the skull in those regions.

The contrecoup contusions were represented with 55%, indicating that most of the examinees were injured in traffic accidents where the dominant mechanism is acceleration-deceleration and there is constant disproportion at brain shifting in the skull. The results coincide with the results of another extensive study conducted at our Institute [6]. However, the mechanism of formation of these contusions, that is the direction of the action of the force in the head and the circumstances under which the injuries occurred should be taken into consideration. Considering that most of our examinees were injured in traffic accidents, it could be expected that the counter-coup injuries would be dominant since they were inflicted with the acceleration-deceleration mechanism. Diagonal direction was the dominant one showing that in traffic accidents there is an action of different forces in

different directions, and a very small percent of them is straight-line.

When analyzing alcohol concentrations in our cases, we found that only 12% of the total number of analyzed cases had ethyl alcohol concentrations above the permitted level. However, we cannot consider this data relevant since 45% of all cases did not undergo toxicology analysis because they had been hospitalized longer than 24 hours before death.

Conclusion

The forensic medical expertise of brain contusions as part of craniocerebral injuries is of great importance when fixing the puzzle of an individual case. The experience gained during processing of these injuries gives us answers to the most complicated questions, but also gives contribution to the health in general especially to those who diagnose and treat these conditions.

Conflict of interest statement. None declared.

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