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ANALYSIS OF THE SEVERITY OF TRAUMATIC INJURIES RESULTED FROM TRAFFIC ACCIDENTS AND THEIR LOCATION ON THE VICTIMS' BODY - CASE REPORT

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Abstract: *Introduction.* Traffic accidents represent one of the most common causes of violent deaths in legal medicine. Traumatic injuries resulting from them can directly contribute to the cause of death and their location on the victims' body may indicate the position the victims occupied in the vehicle.

Case report. We analyzed the case of a 71-year-old man who was involved in a traffic accident and died eight days after being hospitalized. The victim's autopsy was performed at the Institute of Legal Medicine Timisoara. Subsequently, in this case the police asked for a new forensic report to establish the severity of the traumatic injuries and their role in the thanatogenerating process and the position the victim occupied in the vehicle. The autopsy established that the cause of death was vertebro-medullary trauma involving the cervical and thoracic spine with fractures of vertebral bodies involving the spinal cord, in a polytrauma with a craniocerebral component and a thoracic component. The new forensic report maintained the conclusions of the autopsy report and established by analyzing the location of the traumatic injuries on the victim's body that the victim might have been in the driver's seat.

Conclusions. Deaths from traffic accidents represent for a forensic expert a subject of great interest. The main aims are to establish the cause of death and the role the traumatic injuries play in the thanatogenerating process. Moreover, the type of traumatic injuries and their location on the victim's body may suggest the position the victim occupied in the vehicle.

Keywords: traffic accidents, traumatic injury, spinal injury, position occupied in the vehicle.

INTRODUCTION

Road traffic injuries constitute a major public health and development crisis [1]. According to the Global status report on road safety 2018 launched by World Health Organization (WHO) the number of annual road traffic deaths has reached 1.35 million [2]. Based on WHO data, deaths from road traffic injuries account for around 25% of all deaths from injury [3]. Road traffic accidents represent the 8th leading cause of death and is projected to rise to the top five by 2030 [4].

Each year 127000 people die from road crashes in the WHO European Region.[5] United Nations Economic Commission for Europe (UNECE) data show that in 2019 around 98500 people died as a result of road traffic accidents with an average of 270 persons dying each day from road traffic accidents in the region [6]. In the European Union countries, road deaths in 2021 were reduced collectively by an unprecedented 13% compared to 2019. The highest road mortality was in Romania and Bulgaria with 92 and 81 road deaths per million inhabitants respectively [7].

Over 50% of the global mortality due to road traffic injury occurs among young adults aged between 15 and 44 years [3]. Road traffic injuries are not a major cause of death for the elderly but, relative to their proportion of the overall population, older people are often overrepresented in traffic fatalities [1]. In the European Region more than 27000 traffic deaths per year occur among elderly people [8]. According to Muresan *et al.*, there is an increase in the number of cases for

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pedestrians starting with the age group 41-50, reaching a maximum in the 61-70 age group [9].

Although all types of road users are at risk of being injured or killed in a road traffic accident, there are notable differences in fatality rates between women and men, with men accounting for 74% of all road traffic fatalities in the 40 UNECE states reporting in 2019.[6] A comprehensive review of studies in low-income and middle-income countries found that, in terms of involvement in road traffic crashes, there was a consistent predominance of males over females, males were involved in a mean of 80% of crashes and 87% of drivers were male [10].

As stated by the Illustrated Glossary for Transport Statistics, by definition a person killed in a traffic accident is any person killed immediately or dying within 30 days as a result of an injury accident, excluding suicides [11]. In Romania, forensic autopsies are mandatory in cases of violent or suspicious deaths and when the cause of death is unknown [12]. This applies to all road related deaths, disregarding the period of time from the accident until the victims' death.

Figure 1. The police on-site research report which presents the victim's car found in a ditch

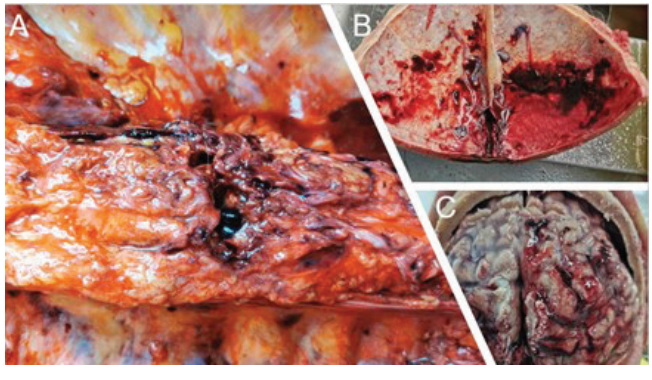

Figure 2. Autopsy findings - traumatic injuries. A. Fractured thoracic intervertebral bodies T10-T11. B. Skull cap with subdural hematoma and subdural hemorrhage. C. Brain with subarachnoid hemorrhage.

Regarding the mortality in traffic accidents, according to studies, cranio-cerebral trauma represents 33.58%, vertebro-medullary trauma 8.09%, thoracic trauma 2.89% and singular abdominal trauma 1.73% and the topographic distribution shows axial regions implicated in 79.19% of cases and limbs 20.80% [13].

Forensic pathologists sometimes need to determine seating positions of automobile occupants after road traffic accidents as accurately as possible. [14] When attempting to assess an occupant's seating position within a vehicle, autopsy findings should be interpreted with caution and only in conjunction with documentation from the crash scene [15].

The aim of the present study is to bring into attention that spinal injuries resulted from traffic accidents, even though are rare, should not be neglected because of their lethal potential. Moreover, we want to assess all the traumatic injuries presented by the victim, knowing that spinal injuries often are accompanied by other injuries, especially involving the cephalic extremity and thorax. By analyzing the location on the victim's body of these traumatic injuries, we want to establish whether the victim's injuries are consistent with the position he occupied in the vehicle.

CASE REPORT

Case History

We analyzed the case of a 71-year-old man who was involved in a traffic accident on 18th of January 2021. From the police report we found out that the victim was driving his car and was hit from behind by another car, the second driver not keeping the proper distance between cars while driving. The police on-site research report stated that the victim's car was found in a ditch and that he was in the driver's seat (Fig. 1).

The victim was taken with the ambulance to the nearest hospital where he was admitted.

On admission the patient had an influenced general state, he was a quadriplegic and, while being conscious, he was not cooperating well. The doctors performed a whole-body Computer Tomography (CT) scan which revealed fractured cervical and thoracic vertebral bodies (C7 and T10), right pleurisy and pulmonary contusions. They also performed a Nuclear Magnetic Resonance (NMR) examination which revealed fractured cervical and thoracic vertebral bodies (C7 and T10), fractured spinous processes, spinal epidural hematoma (C6-T6) with compression on the spinal cord and enlarged intervertebral space (T10-T11). The doctors

proposed to perform surgery for the spinal lesions, but the patient refused. He remained hospitalized at this hospital until 21st of January when he was transferred to a hospital in Timisoara, his discharge diagnosis being: vertebro-medullary trauma involving the cervical and thoracic spine affecting the spinal cord due to a traffic accident, fracture of vertebral bodies (C6 and T10), fractures of spinous processes C5-C6, epidural hematoma C6-T6, right pleurisy, right pulmonary contusions.

When arriving at the hospital in Timisoara, the medical staff noted he was a tetraplegic with posterior medullary syndrome, anesthesia below T5 level, had an unfit rigid cervical collar, was conscious but uncooperative, with psycho-motor agitation, with a start of alcohol withdrawal, yet hemodynamic and respiratory stable. It is mentioned that the patient is known as a chronic alcohol user. They performed a thoracic CT scan which revealed that the right pleurisy was stable, so the thoracic surgeon decided not to evacuate it due to the instability of the spinal fractures and since the patient was respiratory stable. The patient agreed with the surgery to stabilize the spinal fractures, but he changed his mind soon after and refused all medical treatment. His medical state deteriorated so a team of medical doctors decided to perform emergency surgery on the 22nd of January, reducing the spinal fractures with a metal rod and screws through lateral masses and pedicles in both sides, using a posterior cervical approach C7-T5 and evacuating the spinal hematoma. After surgery he was admitted in the Intensive Care Unit (ICU) where he was intubated and mechanically ventilated. They tried to remove the intubation, but the patient deteriorated so they decided to perform a pulmonary echography which revealed an increased pleural collection. They performed a thoracocentesis and evacuated the hematoma. On 25th of January the patient presented with hemodynamic instability and after cardio-pulmonary resuscitation he died at 10 o'clock that day.

Forensic Autopsy

In this case, according to Romanian law, a forensic autopsy was mandatory, which was performed on 27th of January 2021, 2 days after the victim's death. The questions that needed to be answered where about the nature and cause of death, the traumatic injuries on the victim's body, the mechanisms by which the traumatic injuries where produced, the object that produced the injuries, the traumatic injuries that had a thanatogenerating role and if there was a connection between the traffic accident and the traumatic injuries that led to the victim's death. On the external examination of the body, we discovered minor traumatic injuries such as bruises and excoriations on his limbs. We also noted the presence of a postoperative wound on the back of his body, involving the cervical and thoracic areas, which was sutured and had a drainage tube at the right external end. The internal examination of the body revealed traumatic injuries from the accident and associated pathologies. We noticed cranio-cerebral trauma with hemorrhagic infiltration to the scalp, small-sized subdural hematoma, subdural hemorrhage, and subarachnoid hemorrhage. The cervical and thoracic spine was fractured between the 6th and 7th cervical vertebral bodies and between the 10th and 11th thoracic vertebral bodies, the latter involving the spinal cord and having a dehiscence between the fractured vertebral bodies, with hemorrhagic infiltrates in the adjacent tissues. The thoracic trauma consisted in rib fractures, sternal fracture, pulmonary contusions and bilateral hemothorax (Fig. 2).

The victim presented associated pathologies such as cardiomegaly, myocardial fibrosis, micronodular liver cirrhosis, aortic atherosclerosis, splenomegaly, kidney cysts and chronic nephritis. We collected fragments of organs for histopathological exam which confirmed our macroscopic diagnosis. The autopsy report established that the victim's death was a violent one and that the cause of death was vertebro-medullary trauma involving the cervical and thoracic spine with fractures of vertebral bodies involving the spinal cord, while being a part of a complex polytrauma with craniocerebral component (subdural hematoma, subdural hemorrhage, and subarachnoid hemorrhage) and thoracic component (rib fractures, sternal fracture, pulmonary contusions and hemothorax). The traumatic injuries of the victim were a result of the traffic accident from 18th of January 2021.

New Forensic Report

A year and a half later, we received a request from the police for a new forensic report in which to establish the severity of the traumatic injuries presented by the victim, their role in the thanatogenerating process and the position the victim occupied in the vehicle. Moreover, we had to answer to questions regarding the moment of transfer of the victim from one hospital to another, implying that his medical state either deteriorated during the transfer, because of the transfer or his traumatic injuries were not severe enough to lead to his death. In addition, while analyzing the case, we also had to consider that the patient refused the proposed surgery at both hospitals at which he was admitted. Furthermore, we had to analyze if the associated pathologies had any role in the process of death, keeping in mind that the victim was a chronic alcohol user. One of the questions we had to

answer to stood out because it insinuated that the victim's traumatic injuries were not severe enough to cause his death because they spared his superior and inferior limbs. The board of forensic experts that conceived the new forensic report analyzed the case and established that the traumatic injuries sustained by the victim in the traffic accident were severe, causing vertebro-medullary trauma that affected both the cervical and the thoracic spine, while also involving the cephalic extremity with craniocerebral trauma (subdural hematoma, subdural hemorrhage and subarachnoid hemorrhage) and thoracic trauma (rib fractures, sternal fracture, pulmonary contusions and hemothorax). The traumatic injuries that were diagnosed in the hospital and discovered during the forensic autopsy represented the cause of death, having the defining role in the thanatogenerating process. With reference to the moment of the victim's transfer from one hospital to another, the new forensic report explained that regarding the severity and the instability of the fractured vertebral bodies the victim needed to be stable enough to tolerate the transport, keeping in mind that there is a 150 km distance between the two hospitals. It was also established by analyzing the location of the traumatic injuries on the victim's body correlated with the information provided by the police on-site research report, that the victim might have been in the driver seat.

DISCUSSION

Traffic accidents are a real concern of public health due to the important number of road related deaths they cause; for example, in 2012, 3600 individuals died in traffic accidents in Germany [16].

In this study, we presented the case of a 71-year-old male, who was implicated in a traffic accident as a driver and then died eight days after being hospitalized, the traumatic injuries he sustained in the accident having a decisive role in the thanatogenerating process. The cause of death was represented by vertebro-medullary trauma involving both the cervical and the thoracic spine, with fractures of vertebral bodies (C6-C7 and T10-T11), affecting the spinal cord.

Knowing that spinal trauma typically occurs in complex injury mechanisms, vertebral fractures are frequently accompanied by other injuries, as stated by Hasler *et al.* who found that 12.5% of victims had concomitant injuries in the head, and 18.8%, 5.1%, 25.6%, and 3.2% had injuries in the chest, abdomen, extremities, and pelvis, respectively [17]. The case we presented is not an exception and corresponds with the findings of Hasler *et al.*, since the traumatic injuries that the victim presented form a complex polytrauma with craniocerebral component and thoracic component, in addition to the vertebro-medullary trauma.

Regarding the investigation of injury patterns among car occupants, few driver-specific and passenger-specific patterns of injury could be identified [15]. In the case we presented, according to the police on-site research report, the victim was found in the driver's seat. What makes it even harder is the fact that same body regions, i.e. head and thorax, are most affected in both drivers and front seat passengers, and that these injuries are often fatal [14].

Pigolkin *et al.* observed in his study that drivers frequently suffer bending-extension fractures of the cervical vertebrae (in 2-4 cervical vertebrae), while front-seat passengers suffer most frequently fractures of the 4-6 vertebrae [18]. In contrast with these findings, in our case we observed that the fractured vertebral bodies were in fact C6-C7. Moreover, we also found an associated thoracic spine injury, involving the 10-11 thoracic vertebral bodies. This was in accordance with Winslow 3rd *et al.*, which discovered that occupants with a cervical fracture were more likely to have additional fractures in the thoracolumbar spine [19]. According to Muller *et al.*, among front-seat occupants who were diagnosed with a cervical spine fracture, 9% of them had additional fracture in thoracic spine [16]. In our study we observed the presence of both cervical and thoracic spine injuries in addition to thoracic trauma (sternal fracture, ribs fractures, hemothorax, pulmonary contusions), injury pattern that is consistent with the position the victim occupied in the vehicle - driver.

The main medico-legal issues that emerged from the presented case primarily concerned the recognition of the thanatogenerating role of the victim's traumatic injuries. According to studies, regarding the distribution of injuries from traffic accidents by body regions, lower limbs, and upper limbs (with a 16.4% each), head (16.2%) and thorax (15%) are regions more often injured. Even though spine only represents 8.7% of the injuries as distribution by region, spinal injuries are very often severe and responsible for death. Regarding the severity of the injuries, on the first place is head (52.3%), followed by thorax and abdomen (34.2% and 8.6%), and the spinal injuries (3.6%) [20]. For this specific case we presented, the autopsy report as well as the new forensic report concluded that the traumatic injuries the victim suffered were severe enough to cause his death.

Furthermore, the presence of multiple rib fractures associated with a coexistent thoracic spine fracture adds more instability for the spine injuries and

increases morbidity [21]. Our case is consistent with these findings seeing that he also had thoracic trauma with a sternal fracture, rib fractures, pulmonary contusions and hemothorax.

Concomitant injuries to other organs increase morbidity and mortality after a traffic accident. In the study of Rao *et al.*, thoracic and lumbar spine injuries most frequently associate extraspinal injuries; chest injuries being most associated, followed by head, lower extremity, abdominal, and pelvic injuries [22]. In the case we presented, in addition to the spinal trauma, the victim also presented with external traumatic injuries to his limbs, craniocerebral trauma and chest trauma. The victim did not present any traumatic injuries to the abdomen or pelvis.

CONCLUSIONS

Deaths from traffic accidents represent for a forensic expert a subject of great interest, regarding the important number of road related deaths. The main aims are to establish what is the cause of death and if the traumatic injuries resulted from the accident play any role in the thanatogenerating process. Despite all the improvements in safety of vehicles, car accidents still represent a major cause for vertebral fractures. Although spinal injuries are not frequent, there is a need to draw attention to these types of injuries, because injuries of the spine, vertebral bodies and spinal cord pose a threatening risk to life. Moreover, concomitant injuries to other organs increase morbidity and mortality after a traffic accident. In addition, forensic pathologists also need to determine seating positions of automobile occupants after road traffic accidents based on the pattern injury.

Conflict of interest

The authors declare that there is no conflict of interest. The authors are responsible for the content and writing of the paper.

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