

Forensic Medical Assessment of Injuries to the Musculoskeletal System Structures in Children Injured in Automobile Collisions

Ilkhom Gulomovich Juraev¹, Sait Indiaminovich Indiaminov^{2,*}

¹Department of Traumatology and Orthopedics, Samarkand State Medical University, Samarkand, Republic of Uzbekistan

²Republican Scientific and Practical Center of Forensic Medicine, Ministry of Health of the Republic of Uzbekistan, Tashkent, Republic of Uzbekistan

Abstract The results of forensic medical examinations and case materials regarding 140 children who died in car accidents were studied and analyzed. Among the deceased, there were 91 boys and 49 girls. In terms of age distribution, there were 53 cases aged 6-7 years, 41 cases aged 8-10 years, 37 cases aged 11-14 years, and 9 cases aged 15-17 years. In children pedestrians, injuries to the upper thoracic and lower thoracic vertebrae (distraction and rotational) are frequently observed in the structure of spinal cord injuries, sometimes accompanied by detachment of the vertebral column and spinal cord in the area of fractures. This condition indicates that such characteristics of injuries to these structures occurred in the 1st phase (thoracolumbar spinal trauma) and 2nd phase (cervical spinal trauma) of automobile trauma. For this type of automobile trauma, the most characteristic are diaphyseal fractures of the femur and tibia bones in pedestrian children, which mostly present as comminuted fractures and, in some cases, as bumper fractures. Femoral fractures are more common in children aged 6-12 years and with a height of less than 140.0 ± 3.0 cm, while tibia fractures are more likely to occur in children older than 12-14 years with a height greater than 140.0 ± 3.0 cm. The localization of fractures in the lower third of the tibia bones may not always correspond to the level of contact injuries on the skin due to the anatomical and physiological characteristics of bone structure in this part - the fragility of the growth zone.

Keywords Automobile trauma, Pedestrian children, Limb bone fractures, Morphology, Mechanism, Expert assessment

1. Introduction

In many regions, a complex situation persists to this day with child mortality and disability due to severe multiple traumas caused by various circumstances. These conditions continuously attract the attention of researchers in the medical and social spheres. Comprehensive study and analysis of child mortality indicators, timely identification of death circumstances, and taking necessary measures to prevent them constitute one of the most important issues of national importance in medicine [Andreeva T.M., Ogryzko E.V., Redko I.A. Traumatism in the Russian Federation at the beginning of the new millennium // Bulletin of Traumatology and Orthopedics named after N.N. Priorov. - 2007. - No. 2. - P. 59-63; Anisimov V.S. Classification of pediatric traumatism. What should it be? // Orthopedics, traumatology, and prosthetics. - Moscow, 2006. No. 1. - P.63-65].

The highest number of road traffic incidents is represented by automobile traumas [Fetisov V.A., Smirnin S.A., Nesterov A.V., Khabova Z.S., 2014; Leonov S.V., Pinchuk P.V., 2016]. However, forensic medical aspects of automobile traumas in children of different ages, especially in children over 5-6 years old who independently navigate the streets, are insufficiently studied [Porodenko V.A., Anuprienko S.A., 2014; Savenkova E.N. et al., 2015; Andreykin A.B. Features of thoracic vertebral injuries in childhood under vertical load / A.B. Andreykin // Current issues of mechanical injuries]. Some studies have focused on examining the nature of injuries in child passengers in car cabins during road traffic incidents (Hamdane H., Serre T., et al., 2014).

Objective. Identifying the characteristics of musculoskeletal system injury formation in pedestrian children injured in road traffic accidents.

2. Materials and Methods

The results of forensic medical examinations and case materials concerning 140 children who died in collisions with moving vehicles have been studied and analyzed. Among the deceased, there were 91 boys and 49 girls.

* Corresponding author:

sayit.indiaminov@bk.ru (Sait Indiaminovich Indiaminov)

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Regarding age distribution, there were 53 cases aged 6-7 years, 41 cases aged 8-10 years, 37 cases aged 11-14 years, and 9 cases aged 15-17 years. Most often, collisions involving pedestrian children were with modern passenger cars - Daewoo-uz (85 cases). In 18 cases, collisions with pedestrian children occurred with older model cars (VAZ-2106, IJ-Moskvich). In 33 cases, pedestrian children were injured in collisions with Daewoo Damas vans (15), passenger cars (13), and trucks (5), with the vehicle types and models unspecified in the remaining 4 cases. The majority of injured children died at the scene of the incident (112), while 28 children died in medical institutions.

During the study, the nature, localization, frequency, and extent of tissue and organ injuries in the injured children were thoroughly analyzed. The length of the pedestrian children's bodies was measured. The main and immediate causes of death in fatal cases of injuries were determined based on corpse examination, considering medical records data and forensic histological examinations. In some cases, forensic medical methods of examining organ and tissue injuries were conducted. When studying the characteristics of injury formation on the bodies of pedestrian children and assessing their mechanism, the structural features and parameters of external body parts of vehicles were taken into account. The average and minimum errors (Mm), t-criteria, and reliability coefficient (R) were determined. The "Statistica for Windows 7.0" software package was used for statistical data processing.

3. Results and Discussion

The research revealed that in this type of automobile trauma (AT) among pedestrian children, cranial-cerebral trauma (CCT) occurred in 78% of cases, combined trauma (CT) of the chest in 40.6%, CT of the abdomen in 50.2%, spinal cord trauma (SCT) in 25.7%, and limb bone fractures in 55%. Isolated CCT was noted in only 16 observations. In 93 cases, CCT was combined with trauma to more than two parts of the body, most commonly with chest, abdominal, and limb trauma. CCT was characterized by extensive and massive injuries. In 81 out of 109 cases of CCT, fractures of the vault and base bones were observed, with frontal, temporal, and parietal bone fractures predominating.

Spinal cord injuries (SCI) were identified in 36 (25.7%) out of 140 cases, isolated in 1 case, and combined with trauma to other parts of the body in the remaining 35 deceased. With SCI, injuries to the cervical and thoracic regions were more frequently noted — 27 and 19 cases, respectively, with lumbar spine fractures in isolated 1 case, and combined cervical and thoracic SCI were noted in 12 cases. The structure of SCI predominantly included injuries to the upper cervical region — occipital-cervical trauma (OCT) — in 21 out of 27 cases and injuries to the lower cervical vertebrae (C3 and C4) in 6 cases. In the thoracic region, fractures of the upper thoracic vertebrae (Th-Th4) were most commonly observed (7 cases), with corresponding damage to the structure of these parts of the spinal cord. Fractures of the lower thoracic vertebrae (Th10-Th11) were found only in 2 cases. Thoracic vertebral fractures had a distraction and rotational characteristics. In most cases (24 out of 36) with SCI, complete detachment of the spinal cord was found in the area of spinal fractures.

Table 1 presents data on the frequency and localization of limb bone fractures in pedestrian children, as well as data from correlation-regression analysis ($R=0.991-0.995$) of diaphyseal fractures of the femur and tibia.

As seen from the table, fractures in the middle third of the femur and tibia diaphysis were more frequently observed in pedestrian children ($R=0.991-0.995$), while fractures in the lower third of these bones were relatively rare. Femur bone fractures were mainly observed in children with a height below 140.0 ± 3.0 cm, aged 6 to 12 years. Meanwhile, fractures of the tibia bones were more commonly observed in children older than 12-14 years, with a height exceeding 140.0 ± 3.0 cm, and predominantly presented as comminuted fractures.

4. Conclusions

1. In pedestrian children who died as a result of automobile trauma, the most common occurrence is combined trauma, with predominant injuries to the head (78%), chest (46.4%), abdomen (50.2%), and limbs (55%). Studying the nature of injuries to these body regions can serve as the basis for assessing the mechanism of trauma.

Table 1. Localization of limb bone fractures in pedestrian children with automobile trauma

No	Localization and number of fractures									Total
	Structures	Right				Left				
		Diaphyseal				Diaphyseal				
		Total	Upper third	Middle third	Lower third	Bcero	Upper third	Middle third	Lower third	
1.	Humerus bones	5	3	2	-	7	2	5	-	12
2.	Forearm bones	2	-	1	1	1	-	-	1	3
3.	Femur bones	19	3	14	2	16	4	10	2	35
4.	Tibia bones	10	1	7	2	19	1	14	4	29
Total		36	5	24	5	43	7	29	7	79

2. In pedestrian children, injuries to the upper thoracic and lower thoracic vertebrae (distraction and rotational) are frequently observed in the structure of spinal cord injuries, sometimes accompanied by detachment of the vertebral column and spinal cord in the area of fractures. This condition indicates that such characteristics of injuries to these structures occurred in the 1st phase (thoracolumbar spinal trauma) and 2nd phase (cervical spinal trauma) of automobile trauma.
3. For this type of automobile trauma, the most characteristic are the formation of diaphyseal fractures of the femur and tibia bones in pedestrian children, which mostly present as comminuted fractures, and in some cases as bumper fractures. Femoral fractures are more common in children aged 6-12 years and with a height of less than 140.0 ± 3.0 cm, while tibia fractures are more likely to occur in children older than 12-14 years with a height greater than 140.0 ± 3.0 cm.
4. The localization of fractures in the lower third of the tibia bones may not always correspond to the level of contact injuries on the skin, which is due to the anatomical and physiological characteristics of bone structure in this part - the fragility of the growth zone.
5. The provided data should be taken into account in the process of forensic medical diagnostics and in the provision of medical care to injured pedestrian children.

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