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Forensic Medical Aspects of Bicycle Injury

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Abstract The scientific world literature on the problem has been studied, the most common clinical and morphological classifications of bicycle injuries have been analyzed, it has been established that bicycle injury is an independent type of road traffic accidents and makes up from 3 to 7% of all types of road traffic injuries, characterized by seasonality, age and time factors. The most common type of road traffic accident for cyclists is a collision with cars, in which a combined blunt trauma of several parts of the body forms on the body of the injured driver. In some cases, cyclists may experience injuries characteristic of this type of injury - strip-like abrasions, bruised and lacerated wounds on the front and inner surfaces of the thighs, lower leg, and fractures of the shin bones. However, this is not enough to substantiate the mechanism of injury. In addition, the prevalence of external injuries over internal injuries in bicycle injuries requires differentiating them from injuries associated with falls from a height. All this indicates the need for further study of the mechanism of damage and other forensic aspects of this injury with the development of diagnostic criteria for establishing the type of bicycle injury.

Keywords Bicycle injury, Types, Injuries, Mechanism, Diagnostics, Expertise

1. Actuality of the Problem

Road traffic injuries around the world remain a global health and social problem. Income indicators are higher (respectively 21.5 and 19.5 per 100,000 population). Road traffic accidents have become one of the leading causes of death and disability of people, mainly of the most working age. [1].

Nearly half (46%) of global road traffic deaths are among motorcyclists (23%), pedestrians (22%) and cyclists (4%) - referred to as "vulnerable road users". In a number of countries, these "vulnerable road users" account for up to 80% of road traffic deaths. However, the likelihood of dying on the road as a motorcyclist, cyclist or pedestrian varies by region: in the African Region, pedestrians and cyclists account for the highest proportion of deaths - 43% - of all road traffic deaths, while in the Southeast In Asia, these figures are relatively low. This reflects, in part, the level of safety measures introduced to protect different road users and the prevailing modes of travel in different regions. Globally, the share of deaths from bicycle injuries in the structure of road traffic accidents on average accounts for 4%. The highest rates of this injury are in the Western Pacific 7%, Africa 4%, Europe 4% and America 3%, Eastern Mediterranean 3% and Southeast Asia 3% [1,2].

Bicycling is growing in popularity in the world every year, as well as its use as a means of recreation and transportation, since the bicycle is simple, convenient, relatively inexpensive and affordable, but it can cause serious injuries. From a forensic point of view, it is important to establish the mechanism, severity, lifetime and duration of injury in persons affected by road traffic accidents with the participation of cyclists. In addition, in conditions of non-obviousness of the injury, it becomes necessary to differentiate this injury from other types of blunt injuries, and in case of fatal outcomes, to establish the main and immediate cause of death of the victims.

2. The Purpose of the Study

Study of forensic aspects of bicycle injuries and determination of the classifications of this type of injury.

3. Materials and Methods of Research

The scientific world literature on the problem has been studied. The most common clinical and morphological classifications of bicycle injury have been analyzed. For the mathematical processing of the data, the Student's method was applied. The arithmetic mean M, the mean error of the relative values m and the coefficient of reliability of the difference t are determined; used subprograms of the product Microsoft Excel 97, as well as Stat Plus 2007 Professional in the section for determining standard deviations and comparative samples.

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4. Research Results and Their Discussion

Bicycling injuries (BI) are injuries resulting from a bicycle accident on pedestrians and cyclists themselves. Most injuries are associated with high speed cycling. The most serious injuries and deaths are the result of collisions with other vehicles, mainly cars. Many authors refer to collisions of a bicycle with a car as an automobile, although collisions of cyclists with a car are predominant (81.8%). Most often, cyclists themselves are injured (79.5%) [3,4,5,6,7]. In addition, cyclists are more likely to die despite protective equipment than are drivers of other modes of transport. The mechanism of injury depends on many factors: the speed of the bicycle, rotation of the victim in a fall, impact on protruding parts of the bicycle, on a stationary obstacle, surrounding objects (when a body thrown off the bicycle hits them), parts of oncoming passing vehicles, road surface [8,9].

The most frequent road traffic accidents involving bicyclists occur in the city, where the concentration of this vehicle is very high. 75% of them occur at intersections, especially T-shaped ones. Roundabouts are also unsafe for cyclists. A significant proportion of accidents also occur on country roads. Many accidents happen in a residential area where cyclists feel safe [10].

The frequency of bicycle injuries is highest in spring and summer (from May to September). The frequency of occurrence by season is presented in **Figure 1.**

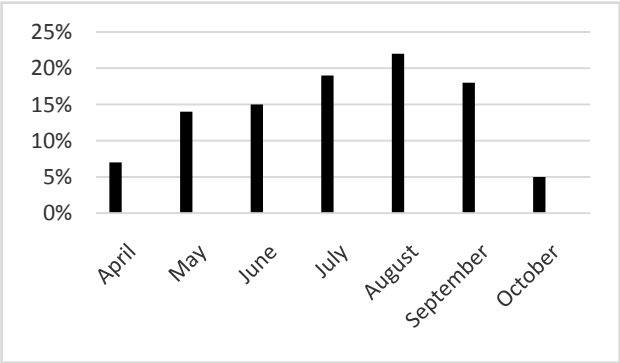

Figure 1. Distribution of detected cases of bicycle injuries by months

The largest number of accidents (50.8%) occurs in the evening (from 18.00 to 22.00). Most of the victims are adults, but 11% are children. Road traffic accidents involving cyclists under 14 years old account for about 38.6% of cases. In this case, a child on a bicycle, due to inexperience, makes mistakes, and the motorist often does not have enough time to prevent an accident. In Sweden, about half of the cyclists who are fatally injured are 65 years of age or older, and the most common mechanisms of injury were falls when getting on or off a bicycle (20%), as well as potholes or irregularities in the ground, the edge of the sidewalk and etc. (13%). In only 6% of cases, cyclists were injured in collisions with trucks or passenger vehicles. At the same time, half of the injured had fractures or dislocations, and 10% had concussion or more serious intracranial injuries [11,12,13].

Currently, many bicyclists continue to ride without a helmet, which can lead to death and other serious consequences as a result of head trauma [14,15,16,17]. There are 4 main mechanisms of damage in case of a bicycle injury: from hitting vehicles and obstacles, from hitting the road surface and other objects, from friction, from hitting a part of the bicycle [18]. At the same time, bruises and abrasions of the lower extremities are the most frequently formed injuries in cyclists (in 74.3% of victims) (t= 0,4215, p=0,02). However, in 90% of deaths, blunt trauma to multiple areas of the body is the cause of death.

Based on the literature data and reporting documents of forensic medical activity, the following types of cycling injuries can be distinguished: collisions of cyclists with other vehicles; collisions of cyclists with pedestrians or fixed obstacles; injuries to bicyclists as a result of falling from a bicycle while riding at high speed or on an uneven road, when descending a mountain; falls of cyclists from a bridge into ditches, reservoirs; exacerbation of diseases among drivers as a result of excessive load when using a bicycle. In collisions between a moving bicycle and pedestrians, damage to drivers occurs as a result of hitting a part of the moving vehicle and falling onto the road surface. Trauma in cyclists is characterized by bruising and abrasions, less often by fractures, with predominant localization in the lower extremities. However, falls in cyclists can injure the upper limbs, head and trunk. From impacts and friction from the protruding parts of the bicycle, strip-like abrasions and bruised wounds on the inner and front surfaces of the thighs and lower legs, closed or open fractures of one or both tibial bones are often formed, which distinguishes them from other types of blunt mechanical trauma.

When falling from a moving bicycle, the nature of damage from the impact of the cyclist's body on the road surface is determined by the place and direction of the traumatic force, as well as by a combination of two mechanisms - impact and friction. In this case, closed or open trauma to the abdominal organs from the influence of the bicycle steering wheel, for example, the iliac gland, can form [25,24].

In the event of injuries from impacts of bicycles on part of oncoming traffic or on stationary objects, damage to drivers and passengers is most diverse in terms of redistribution from superficial damage to soft tissues during tangential impacts to gross destruction of the skeleton and extensive ruptures of internal organs during direct (frontal) impact shaking the body. Collisions between a cyclist and a pedestrian are very rare, as are falls from a moving bicycle and collisions between two cyclists. Unfortunately, the mechanism of formation of this type of bicycle injury has not been studied at all.

These data indicate that the forensic medical aspects of bicycle injury have not been sufficiently studied. The information available in the literature is very scattered and fragmentary. To solve forensic problems, no diagnostic criteria have been developed for different types of bicycle injury. Bicycle injury differs from other transport injuries by

the prevalence of external injuries over internal ones, as well as a variety of injuries. In many types of cycling injuries, damage to several areas of the body is common in all cyclists. As noted above, bruises and abrasions of the lower extremities (in 74.3% of victims) are the most common injuries in cyclists with bicycle injuries, and skin sedimentation and compression of soft tissues are much deeper. In bicycle injuries, cyclists most often fall on the head area (86.9% of cases); therefore, the most common cause of death is multiple injuries to the head structure with the formation of severe brain contusion and fractures of the bones of the cranial vault (86.9%) [19,20,21].

One of the important issues in the forensic medical examination process related to bicycle injury is to determine the severity of both drivers and passengers and pedestrians who were injured in a road traffic accident involving bicycles. In this case, both the duration of the treatment of the victims and the outcomes of the trauma are important. The average length of hospital stay for these injuries is significantly longer than that for the rest of the injuries. If the average length of stay of patients with other types of trauma in trauma departments is on average 9.2 days, then in the treatment of wheel-and-bicycle trauma - 14.3 days [22,23]. These data should be taken into account to determine the severity of injury in non-fatal injury. Light injuries include abrasions, bruises, soft tissue bruises, small wounds on various parts of the victim's body. Isolated fractures of the bones of the hand, toes, clavicle and a number of other injuries that do not pose a threat to life can be classified as moderate. In case of combined injuries of the head, chest, abdomen and extremities with manifestations of brain contusion, injuries of internal organs, fractures of long tubular bones, the criteria for the severity of injuries are the danger to life. Thus, bicycle injury should be classified as an independent type - wheel-bicycle injury, since it has its own characteristic features and cannot be attributed to other types of transport injuries.

5. Conclusions

Bicycle injury is an independent type of road traffic accidents and accounts for 3 to 7% of all types of road traffic injuries, characterized by seasonality. Today, the most common type of road traffic accident for cyclists is a collision with cars, in which a combined blunt trauma of several parts of the body forms on the body of injured drivers. In some cases, cyclists may experience injuries characteristic of this type of injury - strip-like abrasions, bruised-lacerated wounds on the front inner surfaces of the thighs, lower leg and fractures of the lower leg bones. However, this is not enough to substantiate the mechanism of injury. In addition, the prevalence of external injuries over internal injuries in bicycle injuries requires differentiating them from injuries associated with falls from a height. All this indicates the need for further study of the mechanism of damage and other forensic aspects of this injury with the development of diagnostic criteria for establishing the type of bicycle injury.

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