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Short Communication

Biomechanical Analysis of Injury Patterns in Pedestrian-Vehicle Collisions

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DESCRIPTION

Pedestrian-vehicle collisions represent a significant portion of road traffic injuries and fatalities wide-reaching. Understanding the biomechanical analysis of injury patterns in these collisions is critical for improving pedestrian safety and developing effective prevention strategies. This analysis involves examining how the forces exerted during a collision impact the human body and result in specific injury patterns. Several factors influence these patterns, including the type of vehicle, speed of impact, pedestrian position and posture, and the biomechanics of the human body [1].

Vehicle type and speed

The type of vehicle involved in a collision significantly affects the injury patterns observed in pedestrians. For instance, collisions involving larger vehicles like trucks or SUVs tend to result in more severe injuries compared to smaller passenger cars. This is due to the higher front profile and greater mass of larger vehicles, which can cause more substantial force transfer to the pedestrian during impact. Additionally, the speed at which the vehicle is traveling at the time of the collision is a critical factor [2]. Higher speeds result in greater kinetic energy, leading to more severe injuries. Studies have shown that the probability of fatal injury increases exponentially with the speed of the vehicle [3].

Pedestrian position and posture

The position and posture of the pedestrian at the time of impact also play a key role in determining injury patterns. Pedestrians may be standing, walking, running, or even sitting when struck, and each posture presents different vulnerabilities. For example, a standing pedestrian is likely to experience different injuries compared to a pedestrian who is crouching or bending over [4]. Moreover, the direction of the impact (frontal, lateral, or rear) affects how the forces are distributed across the body. Frontal impacts often result in head, chest, and lower limb injuries, while lateral impacts are more likely to cause pelvic and thoracic injuries due to the side-on collision force [5].

Biomechanical response of the human body

The human body's biomechanical response to collision forces is complex and varies depending on the region of the body impacted. The lower extremities, including the legs and knees, are often the first points of contact in a pedestrian-vehicle collision. This initial impact can cause fractures to the tibia, fibula, and femur, as well as ligament injuries to the knee joint. The type and severity of these injuries depend on the force and angle of impact [6].

Following the initial contact with the lower extremities, the upper body is propelled onto the hood or windshield of the vehicle. This secondary impact can result in severe injuries to the head, thorax, and abdomen. Head injuries, including concussions, skull fractures, and Traumatic Brain Injuries (TBI), are common and often life-threatening. The thorax and abdomen may sustain rib fractures, lung contusions, and damage to internal organs such as the liver and spleen [7].

Injury patterns and safety measures

Analyzing injury patterns helps in the development of safety measures and technologies aimed at protecting pedestrians. For example, vehicle design modifications, such as energy-absorbing bumpers, pedestrian airbags, and active hood mechanisms, can mitigate the severity of injuries [8]. These technologies are designed to reduce the force of impact and provide cushioning to the pedestrian's body, thereby decreasing the likelihood of severe injuries [9].

Furthermore, advancements in biomechanical modeling and crash simulation techniques have improved the understanding of injury mechanisms in pedestrian-vehicle collisions. Finite Element Models (FEM) of the human body and vehicle components allow researchers to simulate collisions and analyze the resulting injury patterns in a controlled environment. These

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models are valuable for designing safer vehicles and developing protective gear for pedestrians [10].

CONCLUSION

The biomechanical analysis of injury patterns in pedestrian-vehicle collisions is vital for enhancing pedestrian safety and reducing fatalities. By understanding how various factors such as vehicle type, speed, pedestrian posture, and biomechanical response influence injury outcomes, researchers and engineers can develop effective safety measures and technologies. Continued research and advancements in biomechanical modeling and simulation will further improve our ability to protect pedestrians and save lives in road traffic accidents.

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