BIOMECHANICS OF TRAUMA

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Trauma is a major health problem in the developed as well as the developing countries of the world. In the United States, for example, traumatic injuries are the fourth leading cause of death surpassed only by heart disease, cancer and stroke. Trauma resulting from highway accidents is the principal component of this health problem. Approximately 3.2 million Americans were injured in motor-vehicle crashes in 1982. Of these, approximately 1.4 million were treated in emergency rooms and 350.000 were hospitalized. In the same year, over 50.000 person-years of work were lost by injured persons and the resulting GNP loss to the economy is overwhelming. Of course, the pain and suffering of the victims and their families can not be quantified but are just as important. A clear understanding of the biomechanics involved in the processes causing trauma, in trauma management, in recovery, in physical therapy, in rehabilitation and in the design of motor-vehicles, will help minimize trauma as a major health problem worldwide.

What is biomechanics and how can it help to minimize trauma? One can define biomechanics as mechanics applied to biology, in particular, to human biology. Considering both mechanics and biology are very broad fields, one immediately realizes the very large number of topics which can be studied and investigated. Some of these topics remain untouched or are in their early stages of development. Research areas and topics in biomechanics can be viewed in a wide spectrum ranging from microscopic scale dealing with individual cells to macroscopic scale dealing with large organisms, man being the center of attraction. Considering the human body is our main interest and concern within this wide spectrum, we can identify four divisions of research.

The first division deals with the study and determination of the mechanical properties of biological materials starting with individual cells, going through various soft and hard tissues and ending up with organs and complex body systems. The second division is concerned with analyses of response of the human body to physiological forces. This division includes topics such as locomotion, respiration, circulation and microcirculation. Analyses of responses of the human body replaced parts and assistive devices constitute the third division. Both internal and external prosthetic and orthotic devices and biomechanical compatibility of these devices make up the major research areas in the third division. In the fourth and the last division we consider analyses of responses of the human body to forces whose origins are external to the body. In this division all kinds of steady-state, transient, and random types of force and pressure applications can be cited. The nature of forces can be further classified as impact and impulsive type. An impact type of force requires contact of a particular body segment with an external object of with another body segment, whereas impulsive force on a body segment is caused by purely inertial type of loading without a contact with an external object. It is to the first and the last divisions of research areas in biomechanics mentioned above that one must turn one's attention to seek answers to such questions as the mechanisms of human impact injury, specifications of injury thresholds, and design data for vehicle equipment to protect the occupant during impact situations.

The application of biomechanics to the design of motor-vehicles assists in estimating the potential for various types and severities of injuries to vehicle occupants in impact or acceleration environments. The successful utilization of biomechanics in vehicle design is dependent on the following factors: (1) a clear understanding of the types and levels of trauma caused in specific impact conditions, (2) an understanding of the injury mechanisms in order to analyze and measure the mechanical forces inducing injury, (3) the development of a scale or index to predict injury levels from measured mechanical responses, (4) the

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development of an anthropomorphic model, or mechanical surrogate of the human body, which will provide the appropriate responses in impact environments, and (5) the development of realistic mathematical models in both a local and a global sense to understand the biodynamic response of the human body subjected to vehicular crash conditions.

In conclusion, no matter how successfully the forenamed items are applied the bottom line for safety is still one's common sense in knowing the capabilities of one's vehicle and conditions of the road and weather along with the understanding that one should obey all the traffic regulations and utilize the restraint system present on the vehicle.