FORENSIC BIOMECHANICS -- THE SCIENCE OF INJURY CAUSATION

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Human injury is complicated. If we lived our lives inside a protective bubble, then one day experienced an incident, it might be relatively simple to ascribe any injuries to the traumatic event. But that is typically not the case. As an aging nation, our bodies experience mechanical trauma every day - from work, sports, recreation and potential incidents. The question then arises whether forces and accelerations acting on the body as a result of a traumatic incident, such as an automobile collision, slip and fall, or recreational accident, were the direct and ultimate cause of injuries. Answering that question is the unique role of the forensic biomechanist and is typically beyond the expertise of most medical doctors.

Biomechanics is the study of injury causation by measuring forces acting on and within the human body using methods of mechanics, to determine whether such forces exceed known thresholds of injury. As such, a biomechanist possesses expertise in the fields of both mechanics and human anatomy. Biomechanists and medical doctors serve complementary roles in the medico-legal system. Medical doctors have specific knowledge to diagnose and treat a patient, but the science of biomechanics is not taught in medical school. Therefore, a biomechanist is required, based on their specialized education, training and experience, to serve as the necessary 'bridge' between medicine and engineering by calculating the forces acting on the body as a result of a claimed incident and thereby explaining the diagnosed injuries in terms of mechanical causation.

In a motor vehicle accident case, a biomechanist will assist the trier of fact by relating the impact forces and motions of the vehicles (automobiles, trucks, motorcycles, bicycles or pedestrians) to the resultant motion of occupants or other persons involved (kinematics), and forces they experience (kinetics) due to often multiple impacts within the vehicle interior or ground, then relate those forces to explain the mechanical causation of their medically diagnosed injuries.

For example, in a rear-end collision, both the target vehicle and occupant(s) will be accelerated forward. However, since the human body is more elastic than a car, the occupants and automobile will experience different impact durations. The vehicle will move forward more quickly than the occupants, who will initially be thrown rearward relative to the vehicle, potentially impacting components of the vehicle interior. Resultant injuries may include whiplash, lumbar disc herniation, or even traumatic brain injury, depending on the magnitude of the impact.

Motorcycle, bicycle and pedestrian involved accidents can be substantially more complex, since the vehicles and operators tend to become separated and travel independently to their final rest positions. . In Florida and many other states, motorcyclists have the right to choose whether or not to wear a helmet. Research on the biomechanics of helmet protection shows that while helmets are effective at reducing the risk of penetrating head injury due to skull

fracture, helmets do not offer adequate protection against traumatic brain injury, which may occur whether the rider is helmeted or not.

Given the inter-dependency between the accident reconstruction and biomechanical analysis, it is clearly beneficial if the biomechanist is also certified in automobile and motorcycle crash investigation, accident reconstruction and analysis. This advanced knowledge facilitates collaboration with and understanding of the techniques performed by an accident reconstructionist or, if necessary, allows the biomechanist to perform the complete analysis, beginning with the vehicle collision and continuing through biomechanical injury causation. There are benefits to either approach, but more importantly, opposing counsel is unable to challenge the reliability of one's opinions based upon the opinions generated by another expert if the biomechanist is qualified in both fields and can verify results independently.

Forensic biomechanics is also key to the analysis of cases involving slips, trips and falls, which are claimed in all manners of environments, including workspaces, shopping arenas, restaurants, etc. Slips may occur whenever the coefficient of friction (CoF) between one's footwear and the flooring surface is too low, often due to the presence of a foreseeable foreign substance, such as a fluid. Conversely, a trip may occur whenever the CoF between the footwear and flooring is too great, or unexpected, such as a transition between different surfaces.

Unprotected falls can and do generate inordinate forces on the human body caused by acceleration due to gravity. For example, a simple fall from approximately 3 feet can generate an impact velocity of 10 miles per hour! But, more important is how quickly the human body comes to rest upon impact. It has been shown that a simple fall from only 12 inches onto a hard surface, such as concrete, can generate more than 1000 pounds of force on the human head, which is sufficient to cause fatal injury.

In conclusion, a forensic biomechanical analysis may be pertinent to the success of a variety of cases, including: motor vehicle accidents (involving automobiles, trucks, motorcycles, bicycles and pedestrians), recreational accidents (including boats, jet skis, ATVs, etc.), sports injuries / helmet protection as well as slips, trips and falls. The opinions formulated by forensic biomechanists regarding the quantitative accelerations and forces necessary to result in injury are uniquely biomechanical opinions, and no other area of science or medicine is as appropriate to offer such opinions. Neither mechanical engineering nor physics include the prerequisite background concerning human body tissue properties and human anatomy. Similarly, medical training does not provide the necessary understanding of biomechanical principles to identify qualitative relationships between physical trauma and human tissue injury. Thus, a forensic biomechanist serves the legal system by quantifying the forces associated with an incident and comparing those forces against scientifically accepted thresholds of injury thereby explaining the medical diagnosis.

Ultimately, the success of any expert lies in their ability to convey often complex matters to a jury. Based on over 20 years of experience as an expert, during which time Dr. Lloyd has provided testimony at trial or in deposition more than 80 occasions, he has become highly proficient in using methods that express complex matters in simplistic terms for the purpose of educating the jury as to the facts of a case.