THE PRINCIPLES OF FORENSIC BIOMECHANICS

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INTRODUCTION
Injury causation is a central issue in many personal injury lawsuits. To succeed in a personal injury suit, the plaintiff must prove that the forces applied to their body by the defendant’s action (or inaction) caused or materially contributed to their injury. In response to the plaintiff’s claim, the defendant can show that either the forces were insufficient to cause the plaintiff’s injury, or the forces applied during some other event or activity better explain the injury. Thus both the plaintiff and defendant require experts qualified to analyze injury causation. In this article, I describe the qualifications expected of an injury biomechanics expert and how the analyses of injury biomechanics are conducted.

QUALIFICATIONS
Over the last decade, some courts have limited accident reconstruction engineers from opining about injuries because they lack training in anatomy, physiology and injury mechanics. Medical doctors have similarly been limited from opining about biomechanics because they lack training in engineering mechanics, dynamics and tissue response. The resulting void has been filled by individuals who are trained in both engineering mechanics and tissue response. Based on event-related information generated by accident reconstruction engineers and injury diagnoses provided by medical doctors, the injury biomechanist can calculate the forces applied to the body and compare these forces to the tolerance for specific diagnosed injuries.

BIOMECHANICAL ANALYSES
Biomechanical analyses of injury examine the causal relationship between a specific event or loading scenario and a specific set of diagnosed injuries. A summary of the injuries is drawn from the medical records and reports, and in the case of car crashes, data regarding the crash direction and severity is drawn from the collision reconstruction report. Thus biomechanical analyses rely on the evidence of other experts, and accurate reconstructions and diagnoses are needed for sound biomechanical analyses.

The biomechanical analysis of each injury in question consists of two main steps: mechanism and magnitude. To assess injury mechanism, the point of application and direction of the forces/moments applied to the body are first determined for each event in question. This information is then compared to the point of application and direction of the forces/moments required to cause each injury.

If the point of application and direction of the applied and required forces/moments do not match, then a mechanism for the diagnosed injury does not exist and the injury was not caused by the event in question. If, however, the point of application and direction of the applied and required forces/moments do match, then a mechanism for the diagnosed injury exists and the analysis proceeds to the magnitude step.

To perform the second step of a biomechanical analysis, the magnitude of the forces/moments applied to or through the injured tissue is calculated for each event in question. The magnitude of the applied force/moment is called the exposure, and the threshold force/moment, above which an injury occurs, is called the tolerance. The tolerance values are drawn from scientific studies published in the peer-reviewed literature. If the exposure is greater than or equal to the tolerance, then the injury is consistent with the event. Alternatively, if the exposure is less than the tolerance, then the injury is not related to the event in question.

Although the mechanism and magnitude analyses are relatively simple in theory, there are numerous factors that can complicate an injury biomechanics analysis. First, the medical diagnosis is sometimes unclear, particularly for soft-tissue injuries where the specific tissue injury responsible for the plaintiff’s symptoms is often not identified. Second, the forces/moments applied to the occupant may be difficult to calculate, either because of the nature of the event (e.g., rollover collisions) or the lack of scientific data. Third, the tolerance values for some diagnosed injuries or conditions (e.g., fibromyalgia or carpal tunnel syndrome) and the tolerance values for individuals with some pre-existing conditions are not known. And finally, there is considerable variation in the tolerance values for many injuries. Thus the quality of the diagnosis and the state of the science for a specific injury play a large role in the quality of the answer an injury biomechanist can provide regarding injury causation.

SUMMARY
Individuals with training in engineering mechanics and tissue response have the necessary qualifications to be qualified as an expert in injury biomechanics. A comparison of the plaintiff’s tissue exposure to the published injury tolerance of that tissue can help prove or refute the causal relationship between a specific diagnosed injury and the events alleged to have caused it.