The Role of the Injury Biomechanist in Personal Injury and Accident Reconstruction

What is an Injury Biomechanist?

Injury biomechanists are scientists or engineers who have a unique background in aspects of both mechanical engineering and human biology, which includes training in:

- physics and mathematics;
- human anatomy and physiology;
- failure testing of biological tissue; and,
- injury mechanisms.

This unique theoretical and experimental background enables the injury biomechanist to understand fundamental engineering principles as they relate to tissue properties. Injury biomechanists also understand the biological principles surrounding tissue growth, development, and strength and have the specific training required to interpret these factors with regard to the principles of engineering.

The ability to interrelate engineering and biological concepts uniquely positions an injury biomechanist to study, understand and effectively communicate the mechanisms of injury and their likelihood.

What Types of Injuries are Investigated?

Injury biomechanists can provide assistance in all cases where injuries are reported to occur, such as:

- sports or recreational injuries;
- motor vehicle collisions;
- slips, trips and falls;
- product failure; and,
- occupational injury.

Injury biomechanists are capable of understanding injuries to all parts of the human body, including the:

- spine;
- skull and brain;
- extremities;
- ribs and chest;
- skin and connective tissues; and,
- internal organs.

Injury Biomechanists Span Two Key Disciplines

Historically, the discussion of injury in claims investigation has been composed of two main disciplines, engineering and medicine.

Accident reconstruction engineers have been trained to examine collisions and use the observed physical evidence to deduce the magnitude, direction and duration of the forces that were involved. In the past, these engineers have been allowed to provide opinions on the likelihood of injury from collisions. While the engineer may be familiar with the severity and dynamics of the collision, they do not have the background or training to discuss forces as they relate to injury. As a result, an increasing number of reconstruction engineers have not been permitted to relate forces to injury in court.

In contrast, medical doctors have been trained to identify, diagnose, and treat injuries to optimize patient health. Based on their understanding of a sustained injury, doctors have been allowed to provide expert testimony regarding how an injury occurred. However, most doctors do not possess proper biomechanical training and therefore would not be qualified to act as experts in relating forces to injury. Although a doctor may have clinical experience with a particular type of injury and may be able to provide anecdotal evidence, few are trained to determine the specific mechanism and the necessary forces involved in the causation of an injury.

The inability of the engineering and medical communities to communicate across disciplines poses a dilemma for those in the insurance community involved in cases where an individual has sustained an injury. Who do you hire when an engineer can speak about forces but not their relationship to the injury and a medical doctor can speak about the presence or extent of injury but not whether the forces involved were sufficient for causation?

An injury biomechanist has both the engineering training and the understanding of injury to be qualified to discuss the force-injury relationship and can therefore provide the necessary expertise in determining causation.

What do Injury Biomechanists Do?

Assess the Location and Severity of the Injury

First, it is necessary to review if and where an injury has occurred. In order to perform this review, the following documentation is sought:

- Ambulance Call Report;
- Emergency Room Record;
- diagnostic imaging reports including X-ray, CT scan, or MRI;
- photographs of the injury;
- consultation reports from medical specialists (orthopaedists, neurosurgeons)
- reports from other physicians (general practitioners, family doctors);
- Independent Medical Examinations;
- rehabilitative reports (physiotherapists, occupational therapists, kinesiologists); and,
- witness reports.

Typically, the most useful documentation originates closer to the date of loss. Often, multiple medical records are available prior to and after the incident of interest. It is always beneficial to have a complete medical history as it may highlight a previous injury or underlying pathology that would affect the likelihood of an injury being present.

Relate the Injury to the Likely Forces and Motions Involved

Based upon the location and extent of the injury, the injury biomechanist can provide insight into the directionality and type of forces and motions involved in creating the observed injury. For example, bones fracture in a predictable pattern depending upon whether they are pulled, crushed, bent or twisted. Additionally, biological tissues are 'viscoelastic', meaning they are sensitive to the speed at which force is applied to them. As joints are made up of several tissues which fail at different rates, the specific tissue that is injured can provide insight into the rate of force application. Also, certain tissues are more likely to be injured due to a single load application while others are more prone to fatigue induced injury.

Determine Adequate Thresholds

Once the injured tissue and the mechanism of injury are identified, the injury biomechanist can relate known tissue tolerances, determined experimentally, to the particular incident of interest. Given the nature of injury in humans, this is not a trivial task. Clearly, it would not be ethical to take healthy human beings and injure them in an infinite number of ways in order to develop comprehensive tissue thresholds for every conceivable injury mechanism. For this reason, data regarding tissue thresholds is commonly based upon experiments conducted with animals or cadavers.

Often, computer (numerical) models are employed in an attempt to better represent the structural and material properties of living humans. However, these models are only as strong as the experimental evidence on which they are based.

An injury biomechanist's training in mechanics, physiology, and anatomy provides the background necessary to relate tolerances determined from animal, cadaver

and computer models to the actual tolerances of living humans.

Assess Safety Margin and Injury Risk

Once the injury biomechanist has determined the exposure magnitude, the tissue at risk and the appropriate threshold for injury, they can determine the risk of injury. In simple terms, when a particular exposure exceeds the threshold of a tissue, an injury occurs.

Where do Injury Biomechanists Fit?

The easy answer is anywhere and everywhere that a comparison is needed between an event and an injury. Injury biomechanists can function both as an independent source of information and as a critical addition to a team of investigators.

With personal injury cases, injurious events often occur for which there are no witnesses and reliable information is limited. However, there is often a significant amount of medical documentation available. In this scenario, an injury biomechanist may be the primary investigator relied upon to provide an accurate picture of what event(s) occurred to result in the documented injury.

Some examples of personal injury questions that can be answered by an injury biomechanist are:

- Did an individual slip due to inadequate flooring or did they trip?
- Is a water injury the result of diving, horseplay, or a fall?
- Was a cyclist wearing a helmet? Was it fastened properly? Was it appropriate for the activity?

Injury biomechanists also act as critical team members in accident reconstruction cases. While trained reconstructionists can often answer questions related to restraint usage, examination of the restraints and loading patterns are not always conclusive. However, the presence and pattern of occupant injury can be very indicative of restraint usage and effectiveness. In cases where vehicle evidence may be less than conclusive, a qualified injury biomechanics expert can provide additional information as to how the observed injury occurred that may allow a conclusion to be reached.

Apart from issues surrounding restraint usage, several other examples of accident reconstruction questions that can be answered by an injury biomechanist are:

- Is the reported injury an existing condition (such as disc degeneration) or is it trauma related to a collision?
- Is there a previous history of motor vehicle collisions? How much has each collision contributed to the currently claimed injuries?
- How much did each impact in a multiple-vehicle collision contribute to an injury?

Communication is Key

As with any professional activity within the forensic arena, effective communication of the results of an investigation is paramount. A well trained biomechanist should be able to relay their findings to their clients in a clear and concise manner, a critical quality when interpreting medical and engineering jargon.

Furthermore, these results need to be obtained and presented accurately and without bias in order to allow clients to make fully informed decisions regarding claims. This includes the communication of all findings, good and bad, in order to ensure that decisions can be made with confidence.

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