

Biomechanics Information Every Attorney Should Know: Part 4

Misleading Statements in the Biomechanics Reports

This final newsletter in the Biomechanics newsletter series is directed towards the common misrepresentations that I have experienced in the biomechanics reports I have been asked to review over the past several decades. It is interesting as a reviewer to see reports that are generated from the same 3 or 4 companies with strikingly similar format, structure, content and references. Of course, the specific biomechanist is unique, as is their curriculum vitae, but most everything else seems to be derived from a template and the only real change is the vehicles, occupants and the description of the crash dynamics. In all fairness, there is no reason to change some information because it is the same from accident to accident. However, the misuse of research and repeated use of medical myths and falsehoods makes it seem more like a predetermined opinion. In their defense, many of them have been force fed specific literature and have bought it hook, line and sinker (perhaps the same can be said for me). It's no different than the doctor who listens to a pharmaceutical representative who presents only the literature findings that are favorable to their product. The difference with these biomechanical experts is that they are usually PhDs with very analytical minds. They should know better than to regurgitate limited "facts" presented to them. They have the capability and responsibility to know better and to look at the entire spectrum of data before opining resolutely about a fluid and dynamic injury mechanism population and patient base. In other words, the opinions expressed likely have either internal or external bias that tarnishes their work product. Hopefully, after having read this series you have the basis to determine if the reports provided to you by the biomechanical expert are representative of your client or if they are lacking the objectivity needed to be admitted into evidence. If the latter, you will have some of the tools needed to keep this evidence out and protect your client's interests.

- **“Within the Limits of Human Tolerance”:** When you see this statement realize that the concept of human tolerance is a moving target and different for every single person. Every single occupant factor described in this newsletter series plays a role in the determination of that individual's tolerance to injury. Also, realize that the determination of human tolerance is assessed in controlled environments that certainly are not representative of what happens in real world collisions. Furthermore, it is extremely important to appreciate that nearly every collision that takes place induces tissue strains and deformations that result from movements that do not consider coupling movements, non-physiologic motions, extremely rapid tissue

tensioning that requires consideration of the viscoelastic properties of the specific tissues on that specific occupant. Bottom line is that there is no such thing as a human tolerance that can be related to your individual client and the unique elements of their collision dynamics.

- **“Average Acceleration”**: Use of this statement is a pet peeve of mine. When I see PhD trained professionals intentionally misleading readers in their reports it pushes my buttons. Average acceleration tells you absolutely nothing about the potential for injury. The only thing that is important is the peak acceleration (or accelerations in multiple impact collisions). Let me explain why this average acceleration is misleading and I believe intentionally. If a peak acceleration of 10g is achieved over 10 seconds then the average acceleration is 1g, or the force of gravity. No reputable scientist or physician would argue that 10g acceleration doesn't have tremendous potential to cause injury. However, when the PhD biomechanical expert reports average acceleration they know exactly what they are doing and it's both disingenuous and deceitful. They know that the significance of average acceleration is non-existent and completely unrelated to injury potential. They also know that there is no way that they can calculate peak acceleration unless the occupant is instrumented at the time of the collision.
- **“Average Acceleration of the Vehicle”**: Not only are biomechanical experts misrepresenting injury potential when reporting the average acceleration but they further mislead the reader by trying to relate the average acceleration of the vehicle to the accelerations experienced by the individual body parts within the vehicle. It is a universally known in the injury mechanics universe that vehicle acceleration is not representative of occupant accelerations. Research has demonstrated that accelerations of the head can be far greater than that of the vehicle. There are many factors that contribute to this including the angular acceleration of the head rather than linear acceleration, the trunks rebound off the seatback, the heads rebound off the head restraint and the addition of ramping of the head if the restraint is in an unadjusted position. The point here is that average acceleration is meaningless and is not representative of the peak acceleration of the vehicle and certainly not representative of the peak occupant body part accelerations, which will always be at least equal to but likely greater than that of the vehicle.
- **Specific Velocities or Accelerations Rather than Ranges**: Some accident reconstructionists and biomechanists will report specific values for velocity and acceleration. You should know that the math related to reconstruction of a collision is best represented by garbage in – garbage out. Since the collisions being reconstructed are not instrumented with accelerometers, the best that a reconstructionist can do is input a range of potential values that result in a very wide range of results. They ethically should report the low range and high range of the potential values if they want to appear objective. Even then, the values are derived from research that is frequently controlled in a manner that is different than the real world collision and is speculative at best.

- **Improper Use of Research:** Many of the reports I review reference citations of research within the report with a long bibliography. The research is typically the same research that has been misapplied and refuted for years. Let's face it, no reader of these reports actually reads those studies or validates the research so it is assumed that the conclusions in the study are fact. Anyone who knows research knows that there are studies available to prove nearly any hypothesis but when critically dissected, very few studies can hold their own. I suggest everyone download this paper published in the reputable journal Spine which critiques many of the commonly cited studies. **A Review and Methodologic Critique of the Literature Refuting Whiplash Syndrome, SPINE Volume 24, number 1, pp86-96.**
(http://www.whiplashinfo.se/artiklar_debatt_forskning_asikter/A_Review_and_Methodologic_Critique.pdf)
- **Patient Reports Related to Direction of Bodily Movement:** Biomechanists like to suggest that your clients are liars or misrepresenting the facts because their description of their bodily movements is inconsistent with the collision mechanism. The most common example of this is with rear impact collisions during which the occupant says they moved forward. Well, the first and most important point is that they do in relation to space. However, relative to the vehicle the occupant's body is moving backward. Allow me to explain further. The sensation of moving forward or backward is related to your focus. If you are looking at the interior of the vehicle then your perspective will be that you are moving backward. If your focus is some object outside the vehicle your perception will be that you are moving forward. The truth is that in a rear end impact the occupant will always move forward because there is no way that the body can move in a direction opposite of the force applied.
- **The Impact Did Not Result in the Spine Reaching its Functional Range of Motion Limits:** The first thing you should know is that the legacy concept of whiplash being a hyperflexion/hyperextension injury is rarely the injury mechanism. Typically, the injury mechanism in cervical acceleration/deceleration events (CAD) has a total time frame of approximately 300ms or about 1/3rd of a second. However, the first 100ms is the period of time that most of the injuries in the cervical spine occur. This is because the overall gross range of motion of the cervical spine in the X axis is irrelevant. It is the specific motions of each vertebral segment that may result in injury. The first 100ms of a CAD injury result in a segmental movements that include relative flexion at some levels and relative extension at other levels. It also is associated with complicating axial loads (compression and tension) and translational loads which are non-physiologic. This 100ms time frame occurs before the head impacts the restraint. It is also before the muscles of the neck would contract due to the simple reflex arc associated with the stretch reflex that occurs when muscles and their tendons are quickly separated. This segmental injury mechanism has been well described in the literature and is often referred to as the S-shaped curve. For a good reference I would refer you to a study published by Panjabi who is among the most respected name in

biomechanics from the Yale Biomechanics laboratory titled Mechanism of whiplash injury Clin Biomech (Bristol, Avon). 1998 Jun;13(4-5):239-249

- **Comparing Activities of Daily Living (ADL) to Injury Mechanics:** Biomechanical experts frequently attempt to connect ADL related accelerations to the accelerations experienced by the occupant in a traumatic event. There have been several studies that have attempted to relate ADLs to traumatic events and nearly all refer back to a 1994 paper published by ME Allen titled Acceleration Perturbations of Daily Living: a Comparison to Whiplash Spine (Phila Pa 1976). 1994 Jun 1;19(11):1285-90. To review the challenges to this paper and other similar papers I refer you back to the methodological critique paper discussed in the “improper use of research” section of this newsletter. Bottom line is that the comparison is no different than comparing apples and oranges. ADL perturbations are normal movements that a patient is doing on their own volition. The ADL events are controlled by the instrumented, aware subjects unlike an MVC occupant that is often completely unaware of the impending impact. Furthermore, the forces applied in a MVC are typically coupled with non-physiologic motions. Translation (shear) may be coupled with rotation, lateral bending and extension compounding injury potential. These coupled physiologic and non-physiologic motions are not reproduced in any ADL perturbation. In fact, it would be unethical to try and reproduce these motions in a research setting due to the likelihood of severe injury and the resulting improbability of receiving IRB (internal review board) clearance.
- **Flexion/Extension of spine controlled by seatback or head restraint:** For both of these I refer you back to the sections that cover the S-Shaped curve and head restraint.
- **“Millions of Loading Cycles”:** You will observe that some biomechanics reviewers will indicate that the body’s tissues are capable of withstanding millions of loading cycles with little or minimal damage and that the MVC related loading is similar to that experienced by your client. It is true that connective tissues can withstand millions of cycles of normally encountered stress and strain. However, no honest scientist/physician would characterize the stresses and strains experienced in a MVC as normal. This brings us back to the concept of viscoelasticity discussed earlier in this newsletter. The very rapid stretching that occurs in a MVC challenges the viscoelastic characteristics of the connective tissues of the body. They are not in any way similar to the millions of loading cycles a tissue would otherwise withstand. The rapid stretch experienced in a MVC will often lead to failure or sub failure of the connective tissues.
- **“Normal movements”:** You will often see biomechanical experts state that the movements of the occupant were the same as normal movements that they do on a daily basis. The issue with this statement relates back to the physiologic versus non-physiologic movements discussed under other headings including the ADLs. While it is true that joints move within their normal planes, the speed of application of an external force, combined with multi-planar coupling effects and with the addition of non-physiologic movements such as compression, tension and shear, all result in an increased injury potential. This is

commonly seen in a general chiropractic practice with low back disc herniation injuries. It is commonly accepted that a common mechanism of disc herniation is from flexion, coupled with rotation and/or lateral bending and complicated by the addition of a rapidly applied external force in the form of a heavy object. Without the heavy object, and the speed of which it is lifted, the injury may not occur.

- **Property damage as an assessment of forces and vectors:** Property damage evaluation offers some insight into the PDOF and perhaps the magnitude but perhaps not. Property damage can be very misleading. Certainly, when a car is impacted in a broadside fashion, the sheet metal of a door and the amount of deformation is a relatively good indicator of impact. But what if the car is broadsided into the B-Pillar which is far more rigid than the sheet metal of the door? What if the car is struck directly into the “bumper”, which is specifically designed not to be damaged but rather transfer the forces? Is no damage or slight damage an indicator of injury potential? Probably not. Remember, shock attenuation systems are designed to protect the vehicle for insurance repair purposes and not to reduce occupant injury.
- **Reconstruction Assumptions Based Upon Pictures and/or Repair Estimates:** Be suspicious of reports that rely on data derived from improperly performed repair estimates or photos which do not include the proper angles, heights and exposures. We all know repair estimates are exactly that. They are estimates done by people that have their own interests in mind. The parts may not be OEM and therefore knockoff cheap parts. The “company” owned repair shop may have external influences that intentionally drive down the costs or are representative of volume discounted hourly rates for labor. As it relates to photos, these cannot be done informally. There are specific numbers of angles and heights that must be routinely taken as described by several agencies including ACTAR. Anything less makes the photo derived property damage assumptions to be invalid..
- **Comments about Disc Injury Potential:** I have recently seen biomechanical experts opine about what it takes to damage the intervertebral discs by citing literature demonstrating the most common forces resulting in disc injury and the number of cycles it would take to cause these disc injuries. Unfortunately for them they can’t put your client’s square peg disc into the reconstructionists round hole. What I mean by that is that by the time we reach age 3 we can already start developing disc issues on a microscopic level. These early evolutionary processes progress over years at varying rates depending on factors too numerous to list. There is no doubt that a person with a healthy disc has a lesser injury potential than a person with a severely degenerated disc. However, they still have injury potential. To suggest that every occupant with disc related complications from a MVC should be compared to an optimally healthy disc from a young healthy subject is ridiculous. After over three decades of clinical practice I can assure you that very few people are representative of the perfect disc specimen.



A MEDICAL-LEGAL NEWSLETTER FOR PERSONAL INJURY ATTORNEYS BY DR. STEVEN W. SHAW

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