Shaw Chiropractic Group

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

Biomechanics Information Every Attorney Should Know: Part 1

At a recent lunch with some attorney friends, we were discussing the misleading comments encountered when reviewing the defense requested biomechanics reports. This was a very big problem over a decade ago prompting me to go back to university and earn a master's degree in biomechanical trauma. Fortunately, soon after completing the program the defense practice of using the "for hire" biomechanics services diminished. Well, that's not the case anymore and I've seen an uptick in the number of files crossing my desk for review. So, I decided to revisit the topic and present a summary of data that every attorney should know if they are to respond effectively to these reports or to examine these experts when they offer testimony.

I started writing this newsletter during a break at a recent conference. By the time I was done writing it was almost 12 pages long! Since no one, including me, wants to read a two page newsletter I am breaking it down into shorter sections that are more digestible. Each of the sections will be emailed to you one week apart so that you are not overwhelmed. The sections include:

1. Commonly Used Biomechanics Terminology
2. Non-Occupant Factors to Consider
3. Occupant Factors to Consider
4. Misleading Statements in Biomechanics Reports

The shortened newsletters will still be 2+ pages but hopefully you will find each of them interesting enough to keep reading. For those of you who are more adventurous or hungry for this information I will be posting the complete newsletter series to my website at www.shawchiropractic.com/attorney/newsletters/ .

Commonly Used Biomechanics Terminology

Everything starts with some understanding of the general terminology that is used in the reports so that you can discriminate between proper use and improper use of the jargon. It is a boring subject but important enough that I have included some of the more important terminology as it relates to the physics surrounding motor vehicle collisions (MVC). I have taken some liberty with the definitions to make it a little more relatable but to maintain the intended of the terms.

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- **Velocity ("v"):** For lay purposes, velocity is speed (change in distance divided by time i.e. meters per second "m/s" or miles per hour "mph")
- **Acceleration ("α"):** Acceleration is the rate of change of velocity with respect to time ($\Delta v/\Delta t$, often measured as meters per second squared "m/s^2" and represented as the symbol "g". 1g is the earth's gravity at 9.8 m/s^2)
- **Elastic versus Plastic Collisions:** These are concepts used to describe the transfer of energy and are very significant, particularly in low speed collisions. They are commonly referred to in the lay community as Bounce and Crush respectively. They are expressed using the principle of restitution which is reported in values between 0 and 1 as the coefficient of restitution (expressed as "e"). A purely elastic collision has 100% of the energy transferred as acceleration and has a value of 1. A purely plastic collision has 100% of its energy transferred in crush and is expressed as a 0. In other words, in lower speed impacts, more damage means less acceleration and less damage means more acceleration. Many will recall the commonly used example of collisions between billiard balls versus clay balls for demonstrative purposes representing elastic and plastic collisions respectively.
- **Forces:** A force is a push or pull upon an object resulting from the object's interaction with another object. Examples of contact forces include frictional forces, tensional forces, normal forces, air resistance forces, and applied forces.
- **Vector:** A vector quantity is a quantity that is described by both magnitude and direction. Examples of vector include displacement, velocity, acceleration, and force. Typically, in motor vehicle collisions vectors are usually described by lay people as directional descriptions (i.e. rear-end, right frontal offset, t-bone, side swipe)
- **Scalar:** A scalar quantity is a quantity that is described by its magnitude (i.e. 5 meters, 3 miles)
- **Mass:** Is the quantity of matter in a body regardless of its volume or of any forces acting on it. The term should not be confused with weight, which is the measure of the force of gravity acting on a body. Despite the distinction, mass in the typical biomechanics report formulas is usually represented as the vehicle weights (i.e. 1500kg or 4500lbs).
- **Delta (Δ):** Simply represents change (i.e. ΔV = change in velocity, 7mph minus 3mph = ΔV of 4mph)
- **Momentum:** Refers to the quantity of motion of an object. Momentum can be defined as "mass in motion." In the accident reconstruction world it is used in Newton's first law of Inertia and the conservation of momentum.
- **Bullet versus Target Vehicle**: The bullet vehicle is the striking vehicle and the target vehicle is the vehicle that is struck.

- **Closing Velocity/Speed**: The closing speed (aka approach velocity) is the speed at which vehicles approach each other just prior to impact.
- **Separation Velocity/Speed:** This is the velocity at which vehicles separate immediately after impact
- **Principle Direction of Force:** (AKA PDOF) From Newton's Third Law. The direction of action of the change in momentum is the principal direction of force**.** From a practical point, it's the direction of impact.
- **Viscoelasticity:** Viscoelasticity is the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation. As it relates to the body's connective tissues, it relates to stress and strain. It also relates to creep. To make this practical in medical terms, it has to do with the ability of a connective tissues to be stretched and return to its pre-stretched state and is time dependent. As an example, let's look at stretching a piece of silly putty. If done slowly the tissue will slowly stretch and retain its "structural integrity". However, if the silly putty is rapidly stretched it will break into two pieces.
- **Conservation of Momentum vs Conservation of Energy Methods:** These represent the 2 main methods of reconstructing an accident. It should be noted that the momentum approach, when used in low speed collisions, must consider the coefficient of restitution as described earlier.
- **Coordinate System:** This describes the orthogonal axis system. The Society of Automotive Engineers (SAE) describes the positive X, Y and Z axis as forward, rightward and downward respectively. So, when a report says the occupants head moved in a positive X axis they are saying that the head moved forward. Similarly, a negative Y axis for the head means the head moved upwards
- **Linear versus Angular Displacement and Acceleration:** Linear relates to a straight line between 2 points while angular relates to a non-linear connection between 2 points. For simplicity purposes, if the time it takes to go from point A to point B remains constant, the shorter linear acceleration will be less than the longer angular acceleration. The significance of this is best appreciated when looking at the head in a rear-end impact during which the head does not move linearly over the neck but rather moves is an angular motion. This results in accelerations far greater than the torso, seat or vehicle
- **Barrier Equivalent Velocity:** Is the speed of a vehicle into a fixed rigid barrier that would result in the same MAGNITUDE of crush as is observed in a "subject vehicle". This is often misused by reporting BEV as Delta V and the reverse. Also, BEV is improperly reported as an "impact speed" in car-to-car crashes without regard for car-to-barrier considerations. Remember that BEV is done in a controlled environment by a vehicle striking an immovable barrier and recording the crush/damage to the subject vehicle. This is very different than 2 vehicles of different masses and restitution values striking each other.

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The complete 4 part Biomechanics newsletter series can be seen and downloaded from our website at www.shawchiropractic.com/attorney/newsletters/