Shaw Chiropractic Group

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

Biomechanics Information Every Attorney Should Know: Part 3

Non-Occupant Factors to Consider

The last newsletter addressed the occupant factors related to injury potential. Occupant factors are those considerations that are determined by the occupant directly. This newsletter discusses the non-occupant factors. These are factors external to your client but that have impact on injury potential independent of the occupant variables. It is important to appreciate that both the occupant and non-occupant variables, while independent of each other, have a combined and likely cumulative effect on the occupants likelihood of sustaining an injury in any given traumatic event.

- **Seat Back Angle:** Improperly positioned seat backs may lead to greater injury potential. In rear-impact collisions, a seat back that is excessively inclined may lead to ramping of the neck over an otherwise properly adjusted head restraint. In a deceleration (negative acceleration) trauma, excessive seat back angle can result in submarining. Submarining occurs when the lap belt slides over the pelvis affecting the internal abdominal organs during the forward displacement of the lower torso.
- **Belted Versus Non-Belted**: Seat belts save lives. They also increase the likelihood of non-fatal injuries. Why? The seat belt functions as a fulcrum focusing the energy to specific regions of the spine (and extremities) rather than allowing the dispersion of the energy throughout the spine. A shoulder harness restraint, compared to a 4 point restraint system, can result in torsional forces being applied to the entire spine in the deceleration phase of an impact or during a side impact trauma. In a negative acceleration injury, during which the torso is stabilized by the pre-tensioning of the seat belt systems, the majority of the forces are focused at the cervical spine.
- **Road Conditions**: Road conditions make a difference due to its “coefficient of friction”. The coefficient of friction relates to how much resistance the road applies to the vehicle. The more friction the less likely the vehicle will rapidly accelerate and result in injury. Which collision do you think would result in greater acceleration? A rear end impact to a vehicle with bald tires stopped on a sheet of ice facing downhill or a Range Rover with off-road tread tires, facing uphill on newly paved asphalt? It’s a no brainer when you think of it.

- **Braking Status**: Will a car accelerate quicker if the driver has their foot firmly applied to the brake pedal or if there is no braking applied? Braking results in less acceleration and less injury potential. That said, some authors have suggested that in rear impact collisions, as the vehicle moves forward under the occupant and the seat back compresses, the relative position of the foot on the brake is separated sufficiently to result as if there is no breaking at all.
- **Improperly Adjusted Head Restraint**: Improperly adjusted head restraints can result in worsening of the neck injury. The topset and backset distances must be adjusted for the individual. Otherwise the head restraint geometry can increase injury potential. In fact, if the back of the head is greater than 2" from the restraint or the center of gravity is not in line with the restraint all the head restraint benefits are lost and, in fact, the result may be a worsening of the injuries sustained.
- **Impact Vector(s):** The principle direction of force (PDOF) will help determine the likelihood of injury. By far, rear end impacts are identified as the worst in the literature but other vectors have significant injury potential as well. Multiple impacts with overlapping PDOFs have not and cannot be researched and therefore are unique in their potential to result in injury. Some biomechanical experts will reconstruct each vector mechanism separately and then opine that the impacts individually could not cause an injury. However, your client was not involved in 2 separate impacts and therefore the separate analysis is invalid.
- **Vehicle Mass Differential:** Occupants in lesser mass vehicles have greater potential for injury versus being an occupant in a greater mass vehicle. An extreme example would be a bird flying into a car versus a car striking a bird. Relative vehicle mass matters (as does collision velocity, separation velocity and ΔV)
- **Lower Crash Velocity:** Injury potential **can** be greater in lower velocity collisions than in higher velocity collisions. You may ask yourself "how that could be possible?" You would think there is a linear relationship between impact speed and injury but that is not the case. With impacts that are relatively low speed (typically considered to be ΔV of less than 10mph), the amount of vehicle crush is below the level required to overcome the crumple zone of a vehicle or bumper system failure. Therefore, in low speed collisions with little or no vehicle damage, the coefficient of restitution, the bounce, shifts closer to 1.0 (on a scale of 0-1). That means that the energy transfer does not result in the vehicle sustaining significant (if any) property damage. Rather, the energy is transferred to the target vehicle in the form of acceleration. **It is acceleration that results in injury, not property damage**. So, while extremely low speed impacts may have little or no injury potential, as velocity increases and until the vehicle starts to crush, the injury potential increases. Once the vehicle starts to crush and demonstrate property damage, the acceleration and resulting injury potential will initially decrease until the impact velocity overcomes the crush and is then translated into acceleration. That may initially sound counterintuitive but if you think about it for a moment it makes a lot of sense. Let's look at an example. If you are sitting in a 30,000lb school bus that is struck by

an 1,800lb Smart car moving 10 MPH. Chances are that the Smart car will be almost totaled with extraordinary damage. Chances also are that the bus will not even move from the impact. That means that your body also won't move and that means that your body would not accelerate. Therefore, you would have no injury because if there is no acceleration there is no injury potential. Let's reverse the scenario and have the bus hit the smart car at the same speed of 10 mph. Again, the bus would likely sustain little or no damage and just keep on moving as if it hit a mosquito. However, the smart car would likely bounce off the bumper of the bus at a speed of slightly less than 10mph and it will reach that velocity in several thousandths of a second. Since the bumper systems are pretty good on a Smart car (made by Mercedes Benz of course) the related acceleration would be huge resulting in significant injury potential. The time it takes for the vehicle crush to occur on either vehicle results in a ΔT which is longer and, when applied to the acceleration formula, results in a lesser acceleration. That means that there may be lesser injury potential when there is crush (damage) versus no crush.

- **Multiple Impacts:** The first comment about this factor is that there is no scientific research that has addressed multiple impact collisions and the injury potential. This is probably because there are so many variables which cannot be controlled and an infinite number of the injury vectors and forces that may need to be considered. So, if a client of yours had a multiple impact collision there is no literature to refute the injury potential. Multiple impacts may include an impact resulting in a secondary impact to another vehicle or object. There are typically multiple PDOF considerations and nearly impossible to reproduce mathematically using accident reconstruction principles.

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