CLM

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Narrative

Fender Benders and Side Impact Offenders

I. Understanding the Fundamentals **(20 minutes)**

A. Preservation of evidence

1. Physical Evidence

Scene and vehicle evidence is best obtained during site and vehicle inspections. Scene evidence includes tire marks, pavement gouges, grass furrows, and tree damage among other things. While tire marks only last a couple of days after an accident, pavement gouges can remain a much longer time and help establish where the undercarriage structures of the involved vehicles interacted with the pavement when impact occurred.

Vehicle evidence is specifically related to documentation of the damage. While most people are accustomed to photographs and measurements of damage, three-dimensional scan data has become more commonly used over the last couple of years. Scanning allows accident reconstructionists to accurately capture the entirety of the vehicle damage while not spending significant time on measuring damage during vehicle inspections.

2. Electronic Data

Electronic data recorders or EDRs were first installed on passenger vehicles manufactured by General Motors in the mid-1990s. As time went on other manufacturers, including Ford, Chrysler, and Toyota began to also install EDRs in their passenger vehicles. The initial reason EDRs were installed was to evaluate the performance of safety equipment (for example, airbags and seat belt pretensioners). As we approached the end of the 2000s, significantly more manufacturers began to install EDRs and they were increasingly recognized as providing critical information related to crash investigations. This importance came to a head in 2012 when requirements for EDRs were codified into law in Title 49, Part 563 of the Code of Federal Regulations, or just Part 563.

While Part 563 became effective for passenger cars manufactured after September 1, 2012, it did NOT require manufacturers to install EDRs in passenger vehicles. So many manufacturers started to adopt this technology (or a version of it), that Part 563 only requires adherence to its rules if the manufacturer is already recording data. From an accident reconstruction perspective, the most important regulation was the establishment of a common trigger threshold for front, rear, side, and rollover events. The threshold can be simply stated as “any impact event with a delta-V greater than 5 mph (in any one direction) must be recorded regardless of airbag deployment.” Conversely, the absence of a recorded event can be used to establish an upper bound on delta-V of 5 mph in any one direction for a given incident.

This discussion has been specifically with respect to recorded data in passenger vehicles, but many commercial vehicles record event data as well, though the amounts and types of data are more variable.

B. What is accident reconstruction?

Accident reconstruction is a scientific approach to determining what happened in a vehicle accident from all available sources of information. Those available sources of information include police and incident reports. Incident reports are generally company specific and provided forms for drivers to fill out when they are involved in an accident. By photographs, I specifically mean digital photographs like JPEGs. A lot of the time we get scanned copies of photographs and while we can still use those, when the photographs get scanned, we lose the resolution of the photographs which is very helpful in distinguishing damage. Repair estimates are important when we are not able to inspect a damaged vehicle because the provided photographs do not always show damaged internal components. Vehicle specification data includes vehicle weights and wheelbases.

1. Delta-V

When two vehicles collide, the transfer of momentum results in a change in velocity of both vehicles with the struck vehicle accelerating, or speeding up, and the striking vehicle decelerating, or slowing down. This change in velocity occurs over a relatively short period of time, typically a small fraction of a second. In the absence of intrusion into the occupant compartment, the vehicle’s change in velocity during the impact, referred to as the Delta V, is an effective indicator of the severity of the collision for the vehicle’s occupants.

2. Principal Direction of Force (PDOF)

Another term we’re going to discuss is Principal Direction of Force or PDOF. Simply put, PDOF is the angle created by the longitudinal and lateral delta-Vs experienced by the involved vehicle. In order to keep it easy, PDOF is referenced to a clock face with the vehicle placed at the center. If a vehicle experiences a frontal impact, the delta-V will be directly rearward or at 12 o’clock. Conversely, if a vehicle experiences a rear impact, the delta-V will be directly forward or at 6 o’clock. Reconstructing the collision in terms of vehicle speed, direction and location allows us to quantitatively describe the accident and gives insight into the collision severity. In the context of this panel, performing an accident reconstruction of a low-speed collision will yield delta-Vs for the vehicles as well as directionality of the forces.

C. Biomechanics

After quantifying the subject collision in terms of the vehicle kinematics and severity, we are now able to perform a biomechanical analysis. But what exactly does that mean? Mechanics is the branch of physics that studies how objects and structures respond to forces that are applied to them. Biomechanics is specifically the study of how biological materials respond to applied forces. So biomechanical engineers understand how the human body responds to mechanical forces, as well as the amount, and nature, of forces required to produce injury.

1. Injury Biomechanics

Biomechanics is used to understand and prevent injuries in many different arenas, such as automotive design, helmet and protective equipment design, as well as development of crash test dummies that are human-like in their motion in response to forces.

As lot of or parents in this audience will know recollections or 'the story of what happened' during a specific event can vary from person to person. As an example, there can be conflicting information about who spilled the yogurt on the floor or more to the point, whether someone was wearing their seat belt. For the latter example, we can use things like physical evidence on the belt to reveal the true story. Injuries can also tell a story. They provide physical evidence regarding mechanism of injury, the applied loads, and movements of a body prior to, and during, injury.

I. Fracture mechanics

(Hand panelist pieces of chalk - ask some to twist and other to bend the chalk, and also hit a piece of chalk with a "hammer") We can see that the different loading types yielded different fracture patterns. While chalk and bone aren't exactly the same, the same idea holds. Different loading paths result in different looking types of fractures. The type of fracture can tell us a lot about loading direction, loading type, and mechanism. This isn't only true for bone but also for abrasion patterns, bruising, internal injuries, and other types of fractures.

2. Application of Biomechanics

To analyze a specific accident scenario, biomechanists utilize physics to determine how a person moves during an accident. We also use understanding of the human body to determine if the forces resulting from a scenario are consistent with potential for a specific injury.

Investigation of collisions involves data collection and review, including photographs, accident reports, witness statements, and medical records, as well as, in an ideal world, inspection of the involved vehicles as well as exemplar vehicles with a surrogate occupant. The severity of the collision must be determined through an accident reconstruction analysis. As part of this reconstruction analysis, issues involving accident causation can also be explored. Afterwards, an investigation of the occupant kinematics and subsequent discussion of injury mechanisms can occur.

Overall questions we can answer, and will keep coming back to as we discuss our case studies, are: how severe was the subject collision, how were the alleged injuries caused, and are they related to the subject collision? Due to our short time we will not discuss issues regarding accident causation (ie liability) today.

D. Role of engineer versus treating physician

This analysis differs considerably from a physician's practice, which is focused on diagnosing and treating injuries and medical injuries, with little, if any, need to analyze the physical environment, human kinematics and mechanical loads associated with an even or injury.

II. Case Study: Fender Bender **(20 minutes)**

With background and degrees in mechanical engineering, a lot of biomechanists can perform straightforward accident reconstruction analyses, usually for collisions involving passenger vehicles in fore-aft crash alignment, or basically frontals and rear_ends.

A. Incident Details

The first case study involves a Hyundai Sonata and a Ford Taurus. The Ford impacted the rear of the Hyundai just prior to entering an intersection. Testimony indicated that prior to impact, the Hyundai had stopped due to traffic. The driver of the Hyundai, a 17-year-old female was the plaintiff and alleged injuries from the collision. This is a scenario that is very common and I'm sure most of you have experience working a similar case at some point in your career.

1. Vehicle Information

The Hyundai was not available for inspection due to it being in another rear-end collision following this incident and was totaled. However, we were provided photographs and a repair estimate. Looking closely, we saw displacement of the rear bumper cover and no visible crush damage apparent on the rear bumpers of the vehicle.

B. Reconstruction Analysis

1. IIHS Bumper Test

A vehicle's Delta-V can be bounded by quantitative comparison of damage in the subject collision to that sustained by the same model vehicle in a controlled crash test. The Insurance Institute for Highway Safety (IIHS) routinely conducts and reports on full-scale low-speed crash testing of various vehicles. After each test, the damage to the vehicle is documented. One of the test configurations is a rear full-overlap crash test involving a rear-end-leading vehicle into a contoured, bumper-like barrier.

2. Damage Comparison

The minimal damage to the Hyundai in the subject collision can be compared to more significant damage demonstrated and reported in the IIHS's rear bumper test of a Hyundai Sonata.

In that IIHS test, the Hyundai required replacement of the rear bumper cover and rear bumper energy absorber. Taken together, a physical damage comparison between the Hyundai in the IIHS test and the involved Hyundai in the subject collision show similar damage, including damages extending into bumper structures and the rear body panel.

C. Claimed Injuries

According to the available medical records, Ms. Jones was 17 years old, weighed approximately 125 pounds and was 5 feet 4 inches tall. Following the subject incident, she had complaints of back pain which resulted in a magnetic resonance imaging (MRI) study of her lumbar spine, a few months after the subject collision, which showed a disc bulge at the L4-L5 level and a disc herniation at the L5-S1 level.

1. Spine Anatomy and Function

The spine is made of 33 individual bones stacked one on top of the other, which provides the main support for your body, allowing you to stand upright, bend, and twist, while protecting the spinal cord from injury. The vertebrae are numbered and divided into regions: cervical, thoracic, lumbar, sacrum, and coccyx. Only the top 24 bones are moveable; the vertebrae of the sacrum and coccyx are fused.

The main function of the lumbar spine is to bear the weight of the body. The five lumbar vertebrae are numbered L1 to L5. These vertebrae are much larger in size to absorb the stress of lifting and carrying heavy objects. Within the spine, most vertebral bodies are separated by an intervertebral disc, making up one fourth of the spinal column's length. The intervertebral discs are fibrocartilaginous cushions serving as the spine's shock absorbing system. The discs are composed of two cartilage endplates, an annulus fibrosus surrounding an inner nucleus pulposus. The nucleus is a hydrated gel–like matter that resists compression.

The annulus fibrosus circumnavigates and contains the pressurized nucleus. We can think of the IVD as a jelly donut or even a tire. As the nucleus is compressed is exerts a hydrostatic pressure on the annular lamellae, thus the lamellae are loaded in tension as the disc experiences compressive loading. Under compression the annulus can bulge outward.

2. Intervertebral Disc Herniation

Annular tears are the first indication of disc herniation and a characterizing feature of disc degeneration. These tears, because of the high pressure within the nucleus, can allow nuclear material to enter into the annulus fibrosus thus characterizing a disc bulge. A disc herniation occurs when the nucleus pulposus tears its way completely through the annulus fibrosus. The presence of this nuclear material in the anterior epidural space can irritate neural structures, causing back and/or leg pain.

Biomechanical studies have shown that, in the absence of damage to adjacent bony structures, individual loading events do not result in disc bulges or herniations. Research has demonstrated that compressive loading to failure creates fractures in the vertebral endplates but not failure in the disc.

Within physiological ranges of motion of the spine, in the absence of damage to adjacent bony structures, intervertebral disc bulges and herniations have been produced experimentally only through repetitive application of compressive loading to the spine over thousands of cycles, through what is known in engineering terms as a fatigue process.

(Basketball analogy)

D. Occupant Kinematics in Rear End Impacts

Prior to a collision, a vehicle and its occupants are essentially traveling at the same speed and direction with respect to the ground. As collision forces change the velocity of the vehicle, its occupants initially tend to keep moving at their original speed in their original direction of travel. During the rear-impact, the Hyundai was accelerated forward.

The discrepancy that arises between the altered velocity of the vehicle and the maintained velocity of the occupants results in movement of the occupants relative to the vehicle interior. This movement continues until it is slowed and arrested via interaction with the restraints like seatbelts, interaction with interior vehicle structures, and voluntary bracing or muscular resistance to inertial motion.

1. Testing

Along with low-speed bumper tests, which we discussed above with regard to accident reconstruction, the IIHS also rates vehicle rear-impact crashworthiness for different vehicle makes and models by analyzing head restraint geometry and by testing head restraint performance in simulated rear impacts with an approximately 10-mile-per-hour delta-V rear impacts and measure head and neck injury metrics.

There are currently about 600 tests available through IIHS that include instrumented anthropomorphic test devices (ATDs, better known as crash test dummies). Which allow us to gain insight into the loading experienced by the ATD in a specific seat. I, and some colleagues, published a paper investigating the head and neck loading during these 600 tests and compared across vehicle type (sedan, van, pick up etc) and vehicle year.

The seat specific test can be used as an example of occupant kinematics in a driver's seat in a rear impact more severe than the subject collision. Based on the laws of physics that we discussed at the beginning of the presentation, as the Hyundai moved forward, Ms. Jones' body initially moved rearward relative to the interior of her vehicle, and her body loaded her padded seatback and head restraint. Following her initial rearward motion, Ms. Jones rebounded forward relative to the vehicle at a speed substantially less than that of her initial rearward motion. Any forward motion of her body that occurred during the rebound phase of the rear impact was limited by her use of the restraint system. After Ms. Jones' forward motion, she returned to approximately her original seated position within her vehicle.

In 2017, Exponent ran a crash test series on an outdoor crash rail that included, in part, four inline, fore-aft impacts. The closing speeds of the fore-aft tests ranged from about 4½ miles per hour to about 20 miles per hour. The video that I showed as an example of a slightly more severe impact than the subject collision, was that of test 4 here.

Not only is this another example of occupant kinematics in a driver's seat in a rear impact, this time more severe than the subject collision. But can also obtain occupant loading data, as measured with instrumented ATDs. We can see the ATD initially moved rearward relative to the vehicle interior and interacted with the cushioned seatback and padded head restraint before rebounding forward relative to the vehicle interior.

2. Spinal Loading

The loading generated in the lumbar spine of the target vehicle ATDs can be described in three principal phases. The first phase occurred immediately following impact as the ATD moved rearward with respect to the occupant compartment, with the head and torso maintaining alignment until the torso engaged with the padded seatback and began to decelerate leading to a tensile loading condition. Lumbar tension increased until the torso's forward motion was completely arrested by the torso belt, occurring slightly after maximum torso belt load. In the second phase, the ATD rebounded rearward into the padded seatback and then settled back into the seat. As the ATD translated rearward after seat belt engagement and moved into the padded seatback, the return of the striking vehicle ATD upper body weight onto the lumbar spine generated a compressive load. The final phase included a minor oscillation into tension as the ATD leaned against the seatback, with the frictional force of the seatback generating slight upward forces to the lap-belt-restrained pelvis.

The lumbar spine loads experience by Ms. Jones during the subject collision can be bounded from Exponent's testing. These both were many times less than those required to cause a lumbar compression fracture. A low back analysis was performed to compare the estimated compressive loading in Ms. Jones' lumbar spine during the subject accident to the loading experienced in the lumbar spine of a woman of approximately Ms. Jones' height and weight during daily activities. The results of this analysis demonstrate that the loads experienced in Ms. Jones' lower back in this rear-end crash were less than the loads a person of similar size and stature would experience during everyday activities such as bending over or running, and comparable to the loads experienced during walking.

So, were Ms. Jones lumbar spine injuries caused by or related to the subject incident? The simple answer, is no. As a biomechanist, I can say is Ms. Jones' lumbar spine pathologies, with the possible exception of transient strain, cannot reasonably be attributed to the subject collision and were less than those experienced during routine bending and lifting activities for a woman of her height and weight.

III. Litigating Low Speed Matters **(10 minutes)**

The first consideration is to examine the quality of the evidence. Ask yourself:

- Is it credible?
- Is it persuasive?
- Is it admissible?

Admissibility is a key component in any analysis.

Rules of Evidence Regarding Admissibility

Simply stated the rules surrounding the admissibility of evidence are to make sure that the evidence placed before a jury is reliable. Today, eyewitness testimony can be enhanced, corroborated or refuted by a technical data that comes in a myriad of forms: cell phone recordings, GPS data, emails, text messages, comments on social media sites and even Twitter. How then is a Judge supposed to deal with newly developed types of evidence that did not exist when the rules of evidence were formulated? The answer is that Judge will require that the party offering evidence lay a foundation which shows that the evidence is reliable before it is placed before the trier of fact.

The first step in establishing the proper foundation is authenticating the data. That is, the proponent must show that the evidence is what it is represented to be. For example, a witness may testify that she is familiar with the image taken from a drone and identify the items shown in the imagery. The evidence must also be relevant. That is, it must have a tendency to either prove or disprove a fact at issue in the case. Note that the evidence must not contain *hearsay* which is an out of court statement offered to prove the truth of the matter asserted. If the aforementioned drone imagery contained a soundtrack, the Judge may allow the image but preclude the statements that go along with the image. That is, allow the video to play with the sound turned down. Finally, the probative value of the evidence must outweigh any prejudicial effect.

Spoliation

The most critical aspect of any successful investigation is the preservation of evidence for use at trial. In *Landry v. Charlotte Motors Cars, LLC,* District Court of Appeal of Florida, Second District, 2017, the Court reiterated the severe sanctions for spoliation of evidence: "Generally speaking, sanctions may be appropriate when a party has spoliated, lost, or misplaced evidence. Spoliation is defined as "[t]he destruction, or significant and meaningful alteration of [evidence]," Vega v. CSCS Int'l, N.V., 795 So. 2d 164, 167 n.2 (Fla. 3d DCA 2001) (quoting Black's Law Dictionary 728 (5th ed. 1983)); or "the failure to preserve property for another's use as evidence in pending" or reasonably foreseeable litigation, id. (quoting Jay E. Rivlin, Note, Recognizing an Independent Tort Action will Spoil a Spoliator's Splendor, 26 Hofstra L.Rev. 1003, 1004 (1998)).

To guard against spoliation, ensure that your experts carefully observe legal protocols concerning the preservation of evidence when removing evidence from the scene, and during subsequent storage and testing. Written agreements should be obtained among all potentially interested parties whenever feasible prior alteration of evidence. Obtain a court protective order when agreement cannot be reached. Consult with legal counsel and your experts early on about this crucial issue - the credibility of your expert testimony can be weakened or destroyed by the mishandling of evidence.

Decisions concerning whether to retain experts depend on the size and scope of the issues presented in a case. If the decision is made to bring in an expert, consider doing it earlier rather than later. An expert can provide valuable insight on discovery requests, investigation and the framing of deposition questions.

When rebutting challenges, work with your expert to obtain his or her education, training, experience Obtain all relevant published papers, articles and studies that bear upon the issues at hand. The goal is to convince the trial judge that your expert is qualified, can speak to issues that are relevant in the case and will help the jury render a fair verdict.

IV. Conclusions/Questions from the audience **(10 minutes)**

On this panel, I discussed low speed motor vehicle collisions with allegations of acute injuries to the spine. These same methodologies can be used to address claimed injuries to the head, shoulder, knee – really almost any injury or pathology. As a biomechanist, I am using my education, training, experience and knowledge and published biomechanical studies to investigate whether impact forces generated loading of the nature and magnitude required to generate traumatic injury – that could be in the context of motor vehicle collisions, amusement park rides, slip/trip/fall events, and use of consumer products.