C3 Injury Patterns and Impact Sequence of a Multiple Rear-End Collision

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Attendees will be shown how errors were made while disregarding physical evidence in favor of witness statements that validate one con- clusion in the analysis of a multiple rear-end collision. This presentation will impact the forensic community by enlightening the forensic engineer to become more thorough in investigations of vehicle collisions.

INTRODUCTION: Motor vehicle collisions are often studied when an occupant's injury is not commensurate with the collision severity. The collision reconstructionist is used to determine collision severity, the restraint system engineer evaluates the performance of the safety system, and the biomechanical expert seeks to define the type and cause of injury. However, an overlap in the roll of these disciplines can occur during the collision analysis.

CASE STUDY: During morning rush hour traffic, a four vehicle, multiple rear-end collision occurred on a congested highway. Prior to the collision sequence, all vehicles were traveling in the same traffic lane. All the witnesses agreed the collision was initiated after the front vehicle, iden- tified as vehicle #4, slowed for traffic ahead. After vehicle #4 came to a stop, vehicle #3 stopped behind it without incident. Reacting to the change in conditions, vehicle #2 came to an abrupt stop behind vehicle #3. Unfortunately, vehicle #1 did not brake soon enough, and rear-ended vehicle #2. The force of this impact thrust vehicle #2 into the back of vehicle #3, and in turn, vehicle #3 impacted the back of vehicle #4.

Vehicle #4 and vehicle #3 sustained minimal damage, and the occu- pants did not suffer any significant injuries. Vehicle #2 sustained minor damage to the front, but major damage to the rear. Driver #2 sustained significant facial injuries including a LeFort fracture involving the left orbital bone, a dislocated left eye, a fractured nose, three fractured teeth, and a chin laceration. Vehicle #1 sustained major damage to the front. Remarkably, the four occupants of this vehicle, all wearing 3-point lap and shoulder belts, did not suffer any significant injuries.

This collision sequence is not unlike many studied before. Most of the responsibility falls on the driver of the rearmost vehicle due to failure to stop in time. Driver #2 was simply in the wrong place at the wrong time. The collision sequence in this case was not contested until the two occu- pants of vehicle #3 changed their story regarding the order of the impacts felt. The new version offered was that the vehicle was impacted twice in the rear by vehicle #2; first because vehicle #2 was unable to stop in time, and then a second time because vehicle #1 impacted the rear of vehicle #2. Given this alternate collision scenario, it appeared that driver #2 shared the responsibility of the collision with driver #1.

A biomechanical expert was retained by counsel for driver #1 to determine the more likely collision sequence. When this expert was hired, the vehicles were not available for inspection, but photographs of vehicles and property damage existed. The selection of the more likely collision sequence was made primarily by considering the cause of the injury to driver #2. Upon review of the medical records, this expert concluded the injuries suffered were those consistent with a frontal collision, and an analysis was undertaken to determine which interior surface caused the injury.

In his opinion, the facial injuries to driver #2 were severe enough to be associated with a fractured windshield, but since the windshield of vehicle #2 was not fractured, impact to the windshield was ruled out. Similarly, there was no evidence of steering column collapse or wheel rim deformation, so this expert ruled out a head strike to the steering assembly. What remained as a potential source of injury was the driver's airbag that had deployed in the collision sequence and whose fabric was covered with splattered blood. And, while inflation-induced injuries were rare in his opinion, this expert concluded the inflating airbag caused the facial injuries to the driver. Therefore, this expert concluded vehicle #2 first impacted the rear of vehicle #3, and then vehicle #1 subsequently impacted the rear of vehicle #2.

FURTHER ANALYSIS: This analysis is replete with inaccuracies. Many examples of significant physical evidence were disregarded. Only the witness statements which changed during the collision investigation support this conclusion. It is known that independent witnesses' statements often conflict, and this only confounds the analysis of some challenging collision reconstructions. However, the physical evidence can outweigh witness statements, and the thorough expert will be diligent in his search of witness marks.

Driver #2 was wearing his 3-point, lap and shoulder belt at the time of collision as evidenced by striations to the plastic coated latch plate, and the deployment of the buckle pretensioner. A significant amount of blood was deposited throughout the interior of vehicle #2. Blood stains appear on the seat upholstery, the center console, the head liner, the interior door panel, and the airbag fabric. However, the blood splattering on the airbag fabric does not reveal a pattern consistent with facial impact. This blood is evenly distributed over the entire circular panel, and the streaks of blood are not aligned symmetrically to indicate one wheel position at the time of deposit. Clearly the airbag was not the source of injury.

If all forward structures of the vehicle interior were dismissed as a source of injury to driver #2, how were the extensive facial fractures suf- fered? The most likely candidate was discovered during the inspection of the vehicle, before it was sold for salvage. When the right rear door was opened, a strong witness mark was

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observed to the rear surface of the right B-pillar, revealing tissue, hair, and blood, and associated upholstery tears. The location of this witness mark was adjacent to head restraint at the approximate height of the driver's head. If indeed this witness mark was the source of the severe facial injuries of driver #2, his head would not strike this surface in a frontal collision.

A blood stain on the inboard side of the driver's seat back had run a few inches on the upholstery before drying. However, this blood stain, which ran in response to gravity, did not have a vertical alignment with the seat back in the position as found at the inspection. The direction of the blood stain indicated the driver's seat back was further reclined when the blood had dried. This finding suggested a seat back failure.

Research indicated an FMVSS 301 movable barrier rear impact test was conducted on a vehicle similar to vehicle #2. A 4000 lb movable barrier impacted the test vehicle at 29 mph. The test vehicle attained a change in velocity of 16.4 mph, and sustained deformation very similar to the damage to the rear of vehicle #2. Review of the test video revealed some startling results.

The video shows that as the test vehicle is accelerated forward upon impact by the movable barrier, the test vehicle is thrust under the test dummy. The test dummy sinks into the driver's seat back. Then the seat back continues to recline such that the test dummy's upper torso rotates backward until the head is behind the left B-pillar. As the seat back con- tinues to deform, the test dummy's torso rotates until its head drops below the top of the left rear door belt line and disappears from view. After reviewing the results of the crash test video, the suspicion that the face of driver #2 struck the B-pillar was validated.

The opinion that driver #2 struck the left B-pillar was strongly opposed by the expert for driver #1. This expert suggested the presence of blood and tissue in that area was the result of medical personnel extricating the driver. This expert also suggested this area of the B-pillar was not exposed when the rear door was closed. However, the witness mark observed on the B-pillar is not concealed when the rear door is closed.

CONCLUSION: Oftentimes there is an overlap between the disci- plines of experts analyzing an accident vehicle. The presence of physical evidence in the vehicle interior can be consistent with the collision scenario and should be considered when formulating opinions of the collision dynamics. Errors may arise if physical evidence is disregarded when it contradicts witnesses' statements. Only after thorough investigation can a more complete analysis be achieved.

B-Pillar, LeFort, Multiple Vehicle

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