D39 Vehicle Interior Surface Witness Marks Observed in the Analysis of Traffic Collisions

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The goal of this presentation is to exemplify how witness marks observed on vehicle interior surfaces can be used, together with the knowledge of vehicle collision type, to determine restraint use and injury causation.

This presentation will impact the forensic science community by demonstrating how physical evidence created during occupant impacts with interior vehicle structures during frontal, rear, lateral, or rollover collisions can be vital in correctly identifying seating position, restraint function, and cause of injury.

Human occupant motion within a vehicle as a result of the forces experienced during a collision will often result in forceful impacts between the occupant and vehicle interior (or exterior, if the occupant is ejected). The marks left on seat belt webbing and hardware (or lack thereof) is regularly utilized in analyzing restraint use and function. This presentation will focus on vehicle interior surface evidence from occupant interactions during motor vehicle collisions.

In collinear collisions, occupants generally move in a direction opposite the vehicle's velocity change vector (i.e., toward the impact location). Therefore, collision type (frontal, lateral, rear, or rollover) will determine where to look for telltale physical evidence. When two objects collide, forces are transferred between the two objects at the point of contact. The force applied to the human body from contacting the vehicle interior may cause injury. Likewise, the equal but opposite force applied by the occupant to the vehicle interior may cause disruption, damage, or failure of the impacted vehicle interior structures. The physical evidence (witness marks) often observed as a result of these interactions includes blood stains, tissue deposits, hair deposits, fractured glass, steering wheel rim deformation, seat back deformation, and plastic trim deformation, as well as scuffs, abrasions, and cracks on various vehicle interior surfaces.

Occupant motion within the vehicle interior will depend on dynamics, the occupant's initial position, and restraint design and use. Effective restraint designs mitigate injury risk through the reduction of impact force magnitude and distribution of those forces over a larger body area. Oftentimes, the presence and location of witness marks will aid in the determination of restraint use and restraint effectiveness.

In frontal crashes, the velocity change vector is directed from front to rear, so an occupant's initial (primary) motion will be toward the front interior surfaces. Interior surfaces offering evidence of contact by front seat occupants include the sun visor, windshield, A-pillar, steering wheel, dashboard, glove box, knee bolster, and center console. If airbags deploy, then the airbag fabric may also reveal evidence of occupant interaction. Rear seat occupants are exposed to impact with the front seat assemblies, B-pillar, or center console, depending on occupant seating position and the precise orientation of the velocity change vector.

In rear-end crashes, the velocity change vector is directed from rear to front, so the rear interior surfaces are among those potentially exposed to occupant impact. For front seat occupants, these surfaces include the front seat assembly and head restraint, the rear seat, the rear roof pillars, the rear cargo area, the rear window, and the rear roof header. For more severe impacts, potential contacts may also occur with cargo from the trunk or intrusion by the striking vehicle. Although their primary motion is not toward the front, rear seat occupants can be contacted by a front seat assembly if it collapses rearward into their space. For rear seat occupants, these surfaces include all those listed for the front seat occupants, except that the front seat assembly is a factor only if it collapses and intrudes into their occupant space.

In near-side or far-side lateral crashes, the occupant's primary motion will be toward the side of the impact. Interior surfaces to examine for potential contact evidence include, but are not limited to, the doors, window glass and window frame, roof pillars, center console, and deployed airbags.

The most common type of rollover collision is a barrel-type rollover. In barrel-type rollovers, the occupants tend to move in a direction away from the roll axis. In doing so, these occupants will also be moving toward, and eventually impact in a direction toward the ground in what are typically fairly low velocity events because the majority of the energy possessed by the vehicle continues along the roll trajectory. Consequently, depending on the number and orientation of ground contacts during a particular rollover crash and depending on the preservation of the occupant survival space, the interior surfaces available for occupant contact are many, and include those identified in front, rear, and side crashes. Although not limited to rollovers, contacts with the headliner are frequently observed in a rollover. Additional interior surfaces into which moving occupants come in contact during collisions include doors and door handles, center consoles, dome light covers, and deployed airbags.

In all types of crashes, seat belt use and structural integrity of the occupant compartment, which are foremost in occupant containment, have roles in the location, type, and significance of the physical evidence observed on the vehicle interior.

Vehicle Interior, Occupant Contact, Witness Marks