Conceptual design modification for reducing aortic strain in a left-lateral impact: A Design of Computer Experiments Study

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Aortic Injury (AI) leading to disruption of the aorta is an uncommon but highly lethal impact-induced trauma in modern society. More than 98% of automobile occupants with an aortic laceration die at the scene. The incident rate of AI is higher in lateral than in frontal automobile crashes. The primary objective of this study was to develop a suitable countermeasure to reduce B-pillar intrusion, which is deemed as a precursor to aortic strain and injury.

A lateral impact AI case was obtained from the Crash Injury Research and Engineering Network (CIREN) database. Based on incident report, the kinematics of the bullet and target vehicles were reconstructed using two finite element car models scaled and adjusted for the proper masses, location of center of gravity and wheel base. The relative position of the two vehicle models were then adjusted until the model-predicted deformations matched those measured experimentally. Eighteen simulations were carried out by increasing the stiffness of the B-pillar beam, adding a cross-beam within the door, affixing a side curtain airbag and varying the thickness of the sheet metal structures in the left side door. Deformation time histories of the side door structures including the B-pillar were used as inputs to the Wayne State Human Body FE Model to calculate the strains in the aorta. A main effects analysis was carried out using Minitab 15 to estimate the effectiveness of each design factor on aortic strain and compartmental intrusion.

It is evident from simulation results that aortic strain can be significantly decreased by reducing the B-pillar intrusion into the occupant compartment. It should also be noted that the current study did not consider the feasibility of manufacturing or the implication on performance and fuel economy due to increase in weight.