3-D graphical representation of the PMHS cervical spine during low-speed, rear-end impacts using a combination of CT scans and high-speed x-rays

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ABSTRACT

A novel method has been developed to graphically recreate the 3-D kinematics of the PMHS cervical spine subjected to low-speed, rear-end impacts. Several previous studies have investigated the kinematics of the cervical spine using high-speed x-ray systems. These kinematics have been classified using qualitative expressions such as hyperextension or S-shape and quantitative calculations of facet stretch using motion data obtained from implanted radio-opaque markers. The current study focuses on a new methodology to graphically recreate the 3-D motion of the cervical spine during a whiplash event using a combination of high speed x-ray kinematics data and CT segmentation of the cervical spine.

Each cervical vertebra of the PHMS was implanted with two 3 mm diameter radio-opaque markers, allowing for the kinematics of the cervical spine to be captured using high-speed x-rays. The PHMS was then subjected to a series of simulated low-speed rear-end impacts on a mini sled. Post testing, CT scans of each PMHS cervical spine were taken and segmented into individual vertebra including the implanted radio-opaque markers. Using a rigid body assumption, the motion of each vertebral body was simulated graphically by applying prescribed motion, based off of the high speed x-ray kinematics data, to each marker of the segmented rigid body model. Through these procedures, a graphical subject-specific 3-D model of each whiplash event was created, allowing for further investigation of whiplash kinematics.