

# Use of Digital Image Correlation for Validation of Surface Strain in Specimen-specific Vertebral Finite Element Models

Hannah Gustafson, Peter Cripton

University of British Columbia

## Abstract

*Finite element (FE) models of the spine are typically validated to be similar to the experimental response of specimens with anatomical variation, such as varying sizes and degrees of degeneration. To account for this variation, specimen-specific models can be developed. The purpose of this study was to compare the strain predicted by specimen-specific FE models of vertebrae under compressive loading with the strain measured experimentally using digital image correlation (DIC), a non-contact optical method for determining strain. A secondary purpose was to compare the DIC measured strain with the strain gauge on the bone to verify the use of DIC for obtaining full field strain. DIC has not been used to investigate cadaveric vertebrae previously.*

*Fresh-frozen human cadaveric vertebrae ( $n = 3$ , C6, T1, T1) from two donors were obtained. A high resolution CT scan of each bone was taken and the bone was segmented from the CT images to create geometric models. For the FE model, heterogeneous Young's moduli were assigned to each of the trabecular elements. A displacement function was applied at the center of gravity of the potting based on the experiment. For the experiment, the vertebrae were potted and tested in a materials testing machine. The bone was loaded dynamically to failure at a rate of 0.5 m/s. The minimum principal strains from the experiment and FE model were compared qualitatively and quantitatively. The coefficients of determination for the quantitative comparisons were between 0.18 and 0.47. During the loading, the error between the DIC measured strain and strain gauge was on average 123 microstrain or 7.2% of the maximum strain.*

*The qualitative similarity shows the potential of the specimen-specific models to predict surface strain, but further refinement of the models is needed. Use of DIC provides an accurate, unique dataset for validation of specimen-specific models.*