DIGITAL IMAGE CORRELATION OF CERVICAL VERTEBRAE IN COMPRESSION

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INTRODUCTION

Digital image correlation (DIC) is a non-contact optical technique that can be used to measure the full-field displacements of a surface with sub-pixel accuracy [1]. Measurements with DIC can provide more information than strain gauges, which measure strains at discrete points, or extensometers, which measure global displacements.

To measure displacements of an object with DIC, the object must have sufficient texture to allow tracking. It may be necessary to apply a synthetic pattern if an inherent surface pattern does not exist. For DIC, images are recorded during deformation. Using software, regions of interest are identified in the initial image. These same regions are then identified in each subsequent image using cross-correlation. From the position data, the strain of the surface can be calculated.

The purpose of this study was to measure full-field surface strains on isolated, cadaveric, cervical vertebrae using DIC. Results from a pilot specimen are presented.

METHODS

A cadaveric cervical vertebra specimen (C6 level) was obtained, and the posterior elements were removed. To distribute the load across the endplates, the specimen was potted in dental stone. The anterior surface of the bone was painted with a thin layer of white paint and then speckled with black paint using an airbrush; the speckles provided a pattern which could be tracked using DIC (Figure 1). A compressive load was applied quasi-statically using a materials testing machine (model 8874, Instron Corporation) until failure. The event was captured using two cameras (Phantom V9, Vision Research). The images were post-processed using commercial DIC software (2D StrainMaster, LaVision, Goettingen, Germany).

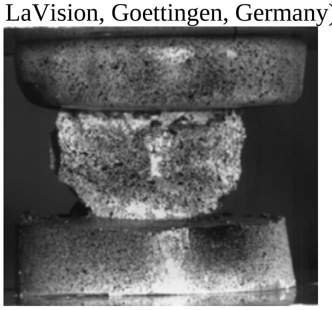

Figure 1: A cervical vertebra specimen potted in dental stone and painted with a speckle pattern

RESULTS AND DISCUSSION

The strain (Figure 2) and the displacement (Figure 3) in the y-direction were determined at a load of 2.4 kN, prior to failure initiation on the anterior surface.

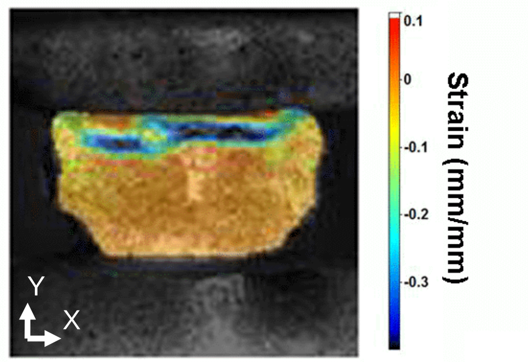

Figure 2: Strain in the y-direction calculated with DIC

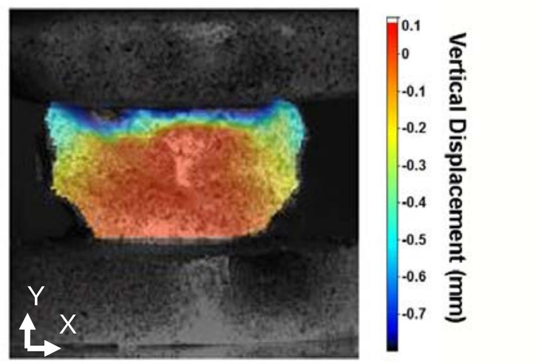

Figure 3: Displacement in the y-direction calculated with DIC

As the superior surface was compressed, high deformation and high compressive strains were observed at the interface between the potting and the bone. More displacement was observed on the lateral surfaces than in the centre of the vertebral body.

There are limitations to using DIC to measure bone strains. The method requires painting the bone which may affect the bone response. There is radial distortion due to the lenses that was corrected for in the images. However, this still may introduce error. Finally, the low resolution of the images made it difficult to detect deformation. In the future, we will capture higher resolution images of the object that will improve the resolution of the DIC measurements.

CONCLUSIONS

Digital image correlation can provide valuable information about deformations that are not possible to measure using other techniques. This method could be expanded to measure bone and disc deformation in spine segments. This full-field strain information can be used for validation of finite element models.

REFERENCES

1. Pan B, et al. *Optics and Lasers in Engineering*, **47**, 865-874, 2009.