Disperse Cement Filling in Vertebroplasty May Reduce Risk of Secondary Tissue Damage

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INTRODUCTION: There is an increased risk of fracture in untreated adjacent vertebrae after PMMA vertebroplasty (abstract by Tawackoli et al). The compact distribution of PMMA within the vertebrae caused stress concentrations in the bone tissue directly above and below the PMMA, which altered the load transfer to the adjacent vertebrae [1-3]. We hypothesized that a more dispersed fill of the vertebrae with an alternative cement (CORTOSS, Orthovita, Inc.) will provide a more uniform structural reinforcement, alleviating the high stresses and minimizing stress-riser effects. The objective of this study was to determine the effects of cement distribution patterns and material properties on vertebral mechanics.

METHODS: An untreated, PMMA and CORTOSS treated specimen specific finite element models of the same fractured vertebral body (L4, female, 90 years old) were generated from postoperative quantitative computed tomography (QCT) scans (Fig 1). The three-dimensional compact fill pattern of PMMA from another vertebra was extracted through multiple X-ray projections. Uniaxial compression was simulated with intervertebral discs and alternatively potting cement to replicate an *in-vitro* experimental setup as boundary conditions. Cement material properties were also varied.

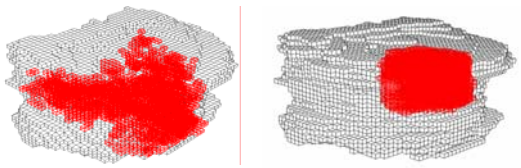

Fig 1: The dispersed fill pattern of CORTOSS (left) and compact fill pattern of PMMA (right) within the same vertebral body model.

RESULTS: The potting cement applied a uniform loading condition on the vertebral body, which resulted in the generation of stress-risers in the bone elements directly above and below the PMMA cement. Stress concentrations were absent in the CORTOSS treated model with either potting cement or intervertebral discs (Fig 2).

Vertebral stiffness augmentation under disc boundary conditions was higher with the dispersed cement fill pattern with CORTOSS than with a compact cement fill pattern with PMMA for the same volume of cement (Fig 3).

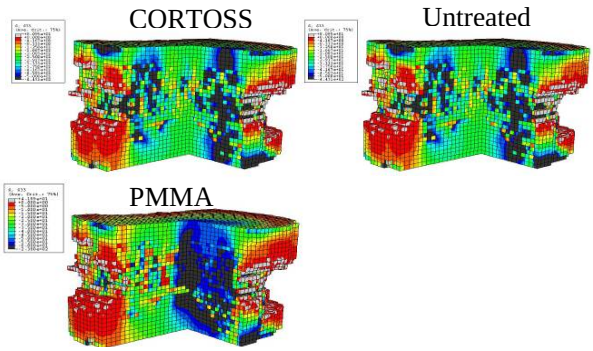

Fig 2: Stress distribution in the untreated, CORTOSS and PMMA treated models potted with PMMA. Higher stresses in blue.

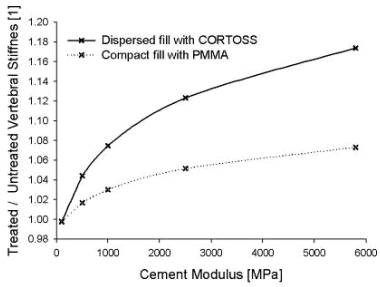

Fig 3: The effect of cement distribution patterns under different cement moduli.

DISCUSSION & CONCLUSION: The minimal intravertebral stress-risers with a dispersed cement fill may indicate a lowered risk of subsequent damage in the adjacent untreated vertebrae. The higher stiffness augmentation with a dispersed cement distribution pattern implies that a smaller cement volume fill would achieve the same level of augmentation than a compact fill, possibly reducing the risk of complications from cement leakages.

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