

# Fatigue Loading of Osteoporotic Vertebrae Post Vertebroplasty

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## Disclosures

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## Introduction

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- Vertebroplasty is a treatment option for osteoporotic compression fractures.<sup>1</sup>
- Most of the available literature has focussed on static testing regimes.<sup>2</sup>
- However, clinically the cement-bone construct is subjected to dynamic loads.
- The aim of the study was to investigate the effects of dynamic loading on the height of unaugmented vertebra and those having undergone vertebroplasty (VP).

1. TOHMEH A.G., J.M. MATHIS, D.C. FENTON, A.M. LEVINE, S.M. BELKOFF, Biomechanical efficacy of unipedicular versus bipedicular vertebroplasty for the management of osteoporotic compression fractures. *Spine (Phila Pa 1976)*, 1999, **24**(17), pp. 1772-1776
2. STEENS J., N. VERDONSCHOT, A.M.M AALSMA, A.J.F HOSMAN, The influence of Endplate-to-Endplate Cement Augmentation on Vertebral Strength and Stiffness in Vertebroplasty. *Spine (Phila Pa 1976)*, 2007, 32(15), pp. 419-422

## Materials and Methods

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- Thirty two vertebra (T5-L1) were harvested from four spines.
- MicroCT analysis of bone mineral density (BMD), vertebral dimensions and endplate area.
- Three groups were defined:
  1. Fractured but not augmented (control).
  2. Fractured and augmented with an estimated 15% fill.
  3. Fractured and augmented with an estimated 30% fill.

## Materials and Methods

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- Vertebrae from all groups were axially loaded to failure (using a specific loading protocol<sup>3</sup>) – Figure 1.
- PMMA cement was delivered via a bilateral transpedicular approach with a target fill of 15% or 30% based on vertebral body (VB) volume.
- All specimens underwent dynamic compression at 1 Hz for 22,000 cycles on a fatigue testing rig.
- Loading regimes were specimen specific based on BMD and endplate area.
- VB heights were recorded post dissection, post initial static fracture and post fatigue.

## Materials and Methods

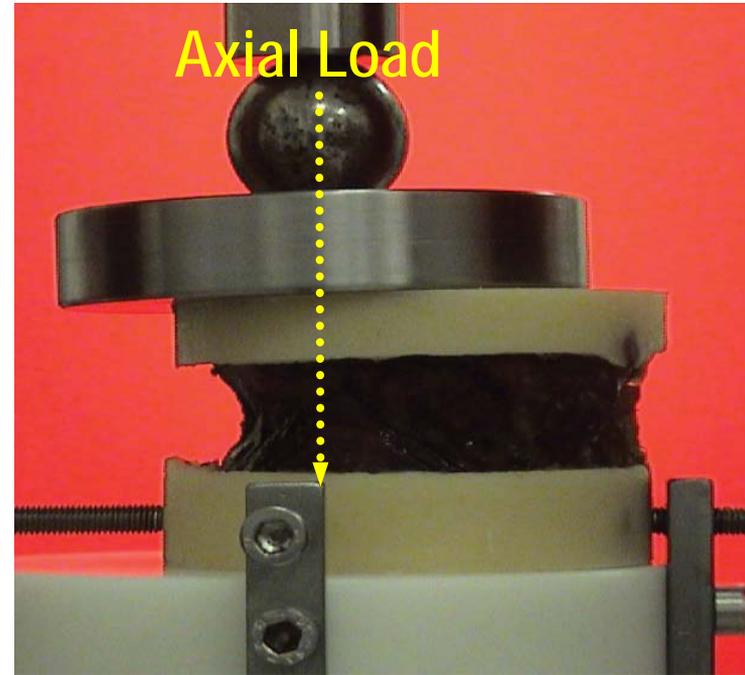
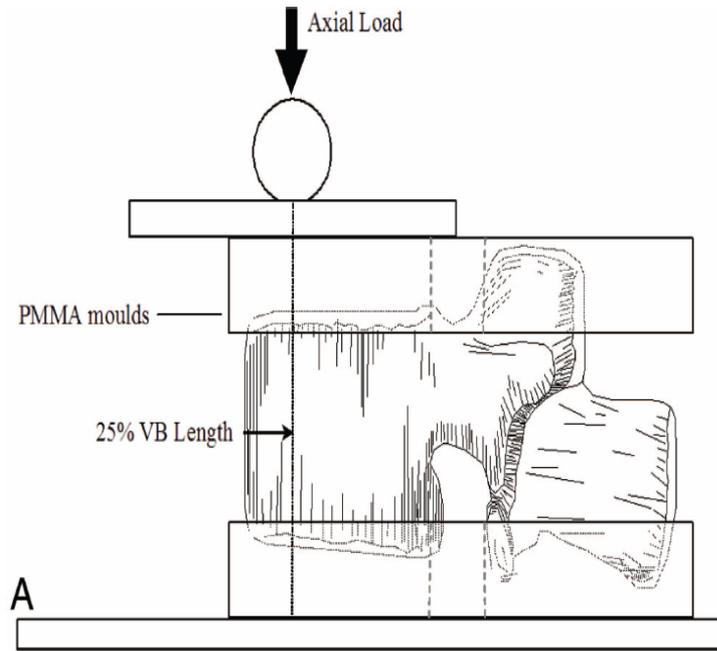


Figure 1

## Results

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- BMD analysis confirmed these were osteoporotic specimens (mean  $67 \pm 14$  mgHA/cm<sup>3</sup>).
- No difference between cohorts for either initial anterior VB height (two way ANOVA  $F = 0.18$ ,  $p = 0.91$ ) or BMD ( $F = 0.26$ ,  $p=0.85$ ).
- On initial fracture there was no significant difference found in terms of the yield load between cohorts ( $F = 3.4$ ,  $p = 0.06$ ).

## Results

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- There was a statistically significant reduction in the collapse of the anterior VB height post augmentation (ANOVA,  $F=6.0$ ,  $P=0.009$ ) with the main difference being between the height loss in the control group and groups 2 and 3.
- The difference in height loss between groups 2 and 3 was small although the 30% group showed a greater tendency to arrest the deformation.

## Discussion

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- Vertebroplasty arrests vertebral body deformation during a cyclic fatigue process.
- This cyclic process is more akin to normal physiological loads placed on the spine than static processes.
- Increasing cement volume decreased height loss.