KYPHOPLASTY VS VERTEBROPLASTY
DIFFERENCES IN BIOMECHANICAL BEHAVIOR UNDER REPETITIVE LOADING CONDITIONS

Kim MJ (1,2), Lindsey DP (3), Hannibal M (1), Carragee EJ (1), Stevens KJ (1), Alamin TF (1)
(1) Stanford University, Palo Alto, CA, USA; (2) Hanyang University, Seoul, Korea; (3) VA Health Care System, Palo Alto, CA, USA

Introduction
Vertebroplasty and kyphoplasty are newer alternatives for the treatment of osteoporotic vertebral fractures. The resultant cement/bone construct will be repetitively loaded subsequent to the procedure; as such it is important to understand its behavior under such conditions. The purpose of this study is to investigate the effect of repetitive loading conditions on fractured vertebrae treated with either PMMA vertebro- or kyphoplasty.

Methods
Sixteen T8, T10 vertebral bodies (VBs) from eight elderly female cadavers (Age 75.0±9.9) were evaluated. All posterior elements including pedicles were removed to facilitate testing. The VBs were considered as paired specimens within a given donor. One of each pair was assigned to the kyphoplasty group (KP) and the other was assigned to the vertebroplasty group (VP). Prior to testing, bone mineral density was measured by ex-situ DEXA scanning. Before and after loading, VB heights and x-ray were checked to determine morphologic changes. VP and KP with PMMA were performed according to standard techniques.

Mechanical testing was performed using a servo-hydraulic materials testing system (858 Mini Bionix, MTS, Eden Prairie, MN). Based on prior biomechanical modeling in our laboratory of fractures created by repetitive loading conditions, all VP and KP specimens were preconditioned and then cyclically loaded at 2 Hz between 20% and 70% of the predicted ultimate compressive load and up to 100,000 cycles. Force and displacement data were recorded and analyzed to determine biomechanical differences between the two groups. X-ray changes were evaluated by two experts (1 radiologist, 1 spine surgeon) in a blinded fashion.

Results
Height was initially restored with KP, but vertebrae treated with KP showed significant height loss in the course of loading (p<0.001). The maximal strain was smaller (p<0.001) and the compression stiffness was greater (p<0.001) in VP during each loading cycle.

Discussion
The results of this study suggest that while vertebrae treated with VP do not seem morphologically or mechanically affected by subsequent repetitive loading conditions, those treated with KP are more likely to show progressive loss of height under these conditions. This finding is explained by the collapse of cancellous bone between the cement bolus and the vertebral endplate. The clinical significance of this finding is worrisome, and may be elucidated with a careful controlled clinical study with radiographic follow-up.

Acknowledgement The authors would like to thank the VA Rehab R&D Center, Palo Alto, CA and Gary Beaupré, Dennis Carter, and Scott Yerby for their support.