DIRECTED INJECTION OF VERTEBROPLASTIC CEMENT AT THE SITE OF A LYtic METASTATIC LESION RESTORES STRENGTH WITH MINIMUM INJECTION VOLUME

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INTRODUCTION
Metastatic disease in the thoracolumbar spine represents a large and growing problem which can lead to pain, pathologic fracture, and neurologic compromise. The utilization of polymethylmethacrylate (PMMA) for percutaneous vertebral stabilization has gained popularity. Most of the biomechanical and outcomes data addresses the use of vertebroplasty (VP) and kyphoplasty procedures for osteoporotic fractures [1,2]. Use of these procedures for metastatic disease enjoys a long clinical history, but the outcomes and complications are notably higher than in osteoporosis [3,4]. Newer formulations of PMMA used in advanced systems such as the Perimeter system (DePuy, Raynham, MA) may allow carefully controlled, anatomically directed PMMA application with far greater control. However, The relative benefits of these newer, proprietary systems have not been demonstrated. Proposed benefits of directed void reconstruction, as opposed to anterior vertebral body fill include:

Tumor lysis
Decreased risk of later tumor growth with canal compromise
The ability to use less total PMMA
Decreased impact on adjacent segment mechanics, and therefore, a decreased adjacent segment fracture risk.

Purpose: To examine and compare the biomechanical effectiveness of the cement augmentation (vertebroplasty) and directed PMMA injection using the Perimeter system.

METHODS
Specimen Preparation:
32 test segments harvested from 6 old osteoporotic (age 74 ±14, mean BMD 0.7±0.17) cadaveric thoracolumbar (T5-S1) spines.
Each specimen consisted of one full vertebra and 2 adjacent hemi-vertebrae.
Lytic lesions with peripiedicular cortical disruption were created in ALL specimens (Figure 1).
Adipose tissue packaged into these lesions simulated tumor bulk.
Specimens were randomly divided into 3 treatment groups:

- Lesion alone served as a control.
- Standard VP (anterior PMMA augmentation from cranial to caudal endplate).
- Directed peripiedicular augmentation using Perimeter into the lytic lesion.

Figure 1: Simulated isolate peripiedicular lytic lesion

Biomechanical Assessment:
Specimens were loaded using a material-testing machine (MTS Bionix 858, Eden Prairie, MN) and an embedded bilateral cable system passing through the posterior third of the vertebral body to simulate load bearing associated with the mass of the body through the approximate center of rotation of the spine (Figure 2).

Linear and angular vertebral body collapse was tracked using iLEDs markers in conjunction with an Optotrak 3020 motion tracking system.

RESULTS

Image Analysis:
CT scans of each specimen were used to measure vertebra cross sectional area (CSA) along the inferior endplate, mid-body and superior endplate.
Average vertebral height (from markers data) and average CSA were used to approximate vertebral body volume.

Statistical Analyses:
ANOVAs with post-hoc Bonferroni Correction were used to compare treatment groups.
Linear regression model was used to study the effects of different parameters on failure load.

DISCUSSION
Compression fractures generated in this study were reproducible and did not alter sagittal balance.
Fractures resulted in increased loss of height in the anterior aspect of the specimen.
No measurable differences in terms of fractur mechanics were observed between the side of the simulated lesion (i.e. ipsilateral or contralateral).
Both standard and directed (Perimeter) vertebroplasty increased failure load
This trend was only significant for the standard vertebroplasty.
The cement required to achieve fracture fixation was substantially less for the Perimeter group in which focal lesions were directly filled.
Findings suggest that:

- An optimum threshold cement injection volume may exist, at which vertebral body strength is improved with minimum cement volume.
- Fixation by Perimeter vertebroplasty at the site of a peripiedicular lytic lesion can achieve similar augmentation to vertebroplastic cement with an anterior fill, while requiring roughly half the vertebroplastic cement injection volume.
- Although data support the use of focal void filling as a viable treatment option. Additional investigation to evaluate the clinical outcomes of this practice are needed to further support this work.

REFERENCES