**Introduction:** Vertebral compression fractures are estimated to affect 26% of women over age 50, causing pain, disability, and increased mortality risk [1]. An emerging surgical treatment is vertebroplasty, or injection of reinforcing acrylic bone cement into the vertebral body. Previous work has suggested that bone porosity can have a significant effect on the integrity of cement fixation in joint replacement [2], so the potential benefit of vertebroplasty surgery may also depend on a patient’s degree of osteoporosis. Other authors have investigated the relationship between bone density and mechanical behavior of vertebroplasty, but only using intact vertebræ [3] or vertebræ from an exclusively osteoporotic patient sample [4]. Our hypothesis was to test whether bone mineral density (BMD) can be used to predict improvements in mechanical strength of the vertebral body after cement injection over a range of normal and osteoporotic bone densities. A secondary hypothesis was to test whether the relationship between mechanical strength and BMD varied with volume of cement injected.

**Materials and Methods:** The spinal columns (T8-S1) of eight Caucasian female cadavers (age range 53 to 90, median age=62) were scanned for bone mineral density and T-score using a dual-energy x-ray absorptiometry (DEXA) scanner (GE Lunar Prodigy, GE Healthcare, Waukesha, WI) at a clinical osteoporosis screening facility. All forty lumbar vertebrae were dissected, the discs and soft tissues were excised and the posterior elements were removed to create isolated vertebral body specimens. The volume of each vertebral body was calculated by measuring the width, depth and height at each endplate and at the sagittal midplane with digital calipers. The areas of the vertebral endplates were calculated by tracing the endplates onto transparent acetate film, cutting out these traced areas and correlating the mass of each film with its area. The superior and inferior ends of each vertebral body were then potted in acrylic dental cement (Instant Tray Mix, Lang Dental, Wheeling, IL) in order to allow even load distribution on the endplates during mechanical testing. All vertebral bodies were wrapped in 0.9% NaCl saline-soaked gauze and stored at -20°C when not in use, and were subjected to exactly four cycles of freezing and thawing.

The five lumbar vertebræ from each cadaver were distributed into five experimental groups using a randomized block design. The first experimental group (control) received no cement treatment. The remaining four groups (0% fill, 4% fill, 12% fill and 24% fill) were first loaded asymmetrically in order to induce a wedge compression fracture. This wedge fracture was created by loading each specimen with a pin placed two-thirds of the way between the posterior and anterior walls of the vertebral body until yielding was observed on the load-displacement curve. These vertebral bodies were then injected with a dose of surgical grade acrylic bone cement containing 30% barium sulfate radiopaque filler (Spineplex, Stryker Interventional Pain, Kalamazoo, MI). The volume of cement injected for each specimen was determined based on the volume of the vertebral body and the experimental group to which it was assigned. The powder and pre-chilled liquid components of the cement were hand-mixed for 45±10 seconds before being poured into 5 mL syringes and injected into the vertebral body through 11-gauge bone biopsy needles. For every specimen, a needle was inserted into the vertebral body using a transpedicular approach through the left pedicle and were subjected to exactly four cycles of freezing and thawing.

**Results:** DEXA scanning showed that the eight cadavers represented a broad range of bone mineral densities with two normal subjects, two osteopenic subjects and four osteoporotic subjects (individual bone mineral densities of 0.342 to 1.411 g/cm², T-scores of -6.5 to +1.25). The control and 12% fill groups showed statistically significant positive correlations between yield strength and bone mineral density (p=0.005 and 0.007, respectively), while the 0%, 4% and 24% fill groups showed positive correlations that fell short of statistical significance (p=0.22, 0.10 and 0.13, respectively). When the slopes of the regression lines were compared among groups, the 12% fill slope was found to be statistically greater than the 0% or control groups (p=0.05).

**Discussion and Clinical Relevance:** Vertebroplasty has been reported to have high success rates in providing pain relief [5], but the procedure is not without risks. Serious adverse events associated with cement leakage have been reported including persistent pain, paralysis, loss of sensation and death. Another secondary complication is adjacent vertebrae fracture due to redistribution of loads following surgery. Use of smaller volumes of cement may therefore be desirable to reduce the risk for these potential adverse events. Our results suggest that there may be significant differences between osteoporotic and non-osteoporotic patients in terms of the relative improvement in strength that larger cement volumes can offer them. In our study, highly osteoporotic samples did not show as large an improvement in strength as non-osteoporotic samples when cement volume was increased. This study suggests that clinicians may be able to use DEXA to select an appropriate cement volume and to determine the expected improvement in mechanical stability after vertebroplasty for a specific patient based on his or her bone mineral density.

**References:**

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