

DOES KYPHOPLASTY REDUCE POTENTIAL FOR EXTRA-VERTEBRAL AND INTRA-VASCULAR POLYMETHYLMETHACRYLATE LEAKAGE WHEN COMPARED TO VERTEBROPLASTY?

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Introduction: *Vertebroplasty* involves injection of polymethylmethacrylate (PMMA) under high pressure into a fractured vertebral body in an attempt to restore stability and reduce pain. During vertebroplasty, local PMMA leakage is common, with post-vertebroplasty CT scans showing extra-vertebral cement in up to 65% of levels treated (Cortet *et al.* J Rheum, 1999). Clinically significant cases of epidural or foraminal PMMA leakage have been reported. In addition, during vertebroplasty PMMA may enter the vasculature and pulmonary embolism of PMMA has been reported. *Kyphoplasty* involves the inflation of a balloon tamp in a fractured vertebral body in an attempt to restore vertebral body height, while creating a cavity to be filled with PMMA. Proponents of this technique claim that the cavity created allows for low-pressure placement of thicker PMMA into the fractured vertebra thus reducing the risk of extra-vertebral PMMA leakage. This study tested the hypothesis that with kyphoplasty there is less potential for PMMA leakage and systemic exposure than with vertebroplasty.

Methods: During 11 consecutive kyphoplasty procedures for osteopenic vertebral compression fractures, intra-vertebral contrast studies were performed. Seven thoracic and 4 lumbar level fractures were studied. The mean patient age was 75 yrs and the mean duration of fracture pain was 3.2 months. During the procedure, 5cc of Omnipaque 180 were injected after positioning an 11-gauge trochar within the vertebral body (mimicking injection during vertebroplasty). Dynamic continuous fluoroscopic images (Siemens OEC) were obtained during contrast injection. The dye was then flushed with sterile saline. We then proceeded with the kyphoplasty procedure and after bilateral balloon tamp inflation and tamp removal, contrast was injected into the cavity created (mimicking PMMA injection during kyphoplasty). Extra-vertebral leakage of contrast was scored based on extent of fill of the inferior vena cava (IVC), epidural vessels and direct extension of contrast beyond the walls of the vertebral body (0-6 total points).

During kyphoplasty procedures, the authors had observed compaction of bone around the void created by the balloon tamp that might play a role in decreasing leakage of PMMA. In order to assess this, two human cadavers were treated with kyphoplasty procedures at multiple levels of the thoracolumbar spine. Spinal CT scans were performed and the treated levels were evaluated for change in bony architecture within the vertebral body after balloon inflation and void creation with kyphoplasty.

Results: With contrast injection at the vertebroplasty stage, immediate extra-vertebral/vascular spread of contrast was noted. With kyphoplasty, the injected contrast tended to fill the intra-vertebral cavity with occasional extra-vertebral spillage. The mean extra-vertebral contrast scores were 3.9 and 0.6 ($p < 0.001$) for vertebroplasty and kyphoplasty respectively. In all 11 vertebroplasty studies, fill of the IVC was seen and was graded as "marked" in 9 of 11 studies. With kyphoplasty, IVC contrast was seen in 4 of 11 studies and was graded as "mild" in all 4. Epidural vessel fill was present in all 11 vertebroplasty studies and in 3 kyphoplasty studies. Direct extension of contrast through the vertebral walls was seen in 4 vertebroplasty and no kyphoplasty studies.

CT scanning of the cadaver vertebra after kyphoplasty revealed a dense rim of compacted cancellous bone surrounding the cavity created by balloon inflation.

Discussion: In this study, significantly less vascular fill and local leakage of contrast was seen after kyphoplasty when compared to vertebroplasty. The compacted rim of bone noted around the kyphoplasty cavity may act as a dam, reducing leakage of contrast. Of particular concern was the significant fill of the IVC and epidural vessels with contrast during vertebroplasty. Although extra-vertebral leakage of contrast may not correlate precisely with PMMA leakage, we believe that this study proposes a reasonable model for evaluating the relative safety of these procedures. In fact PMMA monomer is soluble, and may indeed have similar vascular fill to the contrast used in this study. We believe that the findings in this study have implications for PMMA extravasation and systemic monomer exposure for the two procedures.