INTRODUCTION

Kyphoplasty is becoming an established treatment for painful osteoporotic vertebral fracture. The proposed benefit of the procedure lies in its potential to restore vertebral body shape, and hence to prevent or reverse deformity. However, whether kyphoplasty is superior to standard vertebroplasty in this respect, and whether it has other benefits in terms of improving the spine’s mechanical function, is uncertain. The aim of this study is to compare the effects of kyphoplasty and vertebroplasty on restoring vertebral body shape following fracture, and to evaluate whether kyphoplasty confers any short-term mechanical advantage when compared with vertebroplasty.

MATERIALS AND METHODS

Fifteen pairs of thoraco-lumbar “motion segments” were harvested from 11 cadaver spines (42–90 yrs). Specimens were compressed to failure in moderate flexion to induce vertebral fracture. Following fracture, one of each pair underwent vertebroplasty, the other kyphoplasty. Specimens were then creep loaded at 1.0kN for 2 hours to allow consolidation. At each stage of the experiment, motion segment stiffness in bending and compression was determined, and the distribution of compressive “stress” was measured in flexed and extended postures by pulling a pressure-sensitive needle through the mid-sagittal diameter of the disc whilst under 1.5kN load. Stress profiles indicated the intradiscal pressure (IDP), stress peaks in the posterior annulus (SP<sub>p</sub>), and neural arch compressive load-bearing (F<sub>n</sub>) (1). Lateral radiographs were taken at each stage of the experiment, and from these, vertebral deformity was assessed by measuring the change in vertebral wedge angle. Intra-observer and inter-observer reliability of wedge angle measurements were evaluated from the intraclass correlation coefficient (ICC). Repeated measures analysis of variance (ANOVA) was used to compare measurements following each intervention, with treatment group as a between-subjects factor. Where a significant main effect or interaction effect was found, post-hoc paired comparisons with appropriate Bonferroni adjustment were employed to identify where the differences arose.

RESULTS

Methods used to assess vertebral deformity were reproducible, with ICCs ranging from 0.96 to 0.98 for intra-observer error, and from 0.75 to 0.97 for inter-observer error. Vertebral wedge angle increased by 16% and 23% after fracture in the kyphoplasty and vertebroplasty groups respectively (p<0.001). Following augmentation, the wedge angle was reduced by kyphoplasty (p<0.001) but not by vertebroplasty (Figure 1).

DISCUSSION

Vertebral fracture was induced under conditions that simulated flexed postures in life. The load was removed at the first sign of failure. Nevertheless, damage was sufficient to increase the vertebral wedge angle by a significant amount and to produce marked changes in motion segment mechanics and spinal load-sharing. After fracture, there was a marked fall in stiffness and nucleus pressure (IDP). Decompression of the nucleus caused high stress peaks to arise in the annulus, and the loss of specimen height following fracture brought adjacent vertebrae closer together, increasing neural arch load bearing. Greater specimen height loss, as a result of fracture, induces greater mechanical changes (2), so restoration of vertebral height and shape might be expected to conferring some mechanical benefit. In the present study, kyphoplasty was more effective than vertebroplasty in restoring vertebral shape. However, this did not appear to influence the restoration of mechanical parameters. This may reflect the changes in wedge angle following fracture and subsequent kyphoplasty which, although statistically significant, were relatively small. These results suggest that kyphoplasty offers little mechanical benefit in the short term when wedge deformity is slight. However, patients suffering more severe fractures may obtain greater benefits with kyphoplasty.

REFERENCES


ACKNOWLEDGEMENT

Funded in the UK by Action Medical Research and the Hospital Saving Association Charitable Trust. Materials provided by Stryker and Kyphon