

Does vertebroplasty at the upper instrumented and adjacent vertebrae prevent proximal junctional kyphosis and failure in adult spinal deformity surgery?

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Introduction

Proximal Junctional Kyphosis and Failure (PJK/PJF) remain prevalent mechanical complications following Adult Spinal Deformity (ASD) surgery. Prophylactic cement augmentation at the Upper Instrumented Vertebra (UIV) and UIV+1 has been advocated to reinforce the bone-implant interface and mitigate proximal failure, however its true effectiveness remains controversial. The purpose was to evaluate the impact of prophylactic vertebroplasty on PJK/PJF and determine whether its effect is modulated by bone quality and sagittal alignment.

Materials and Methods

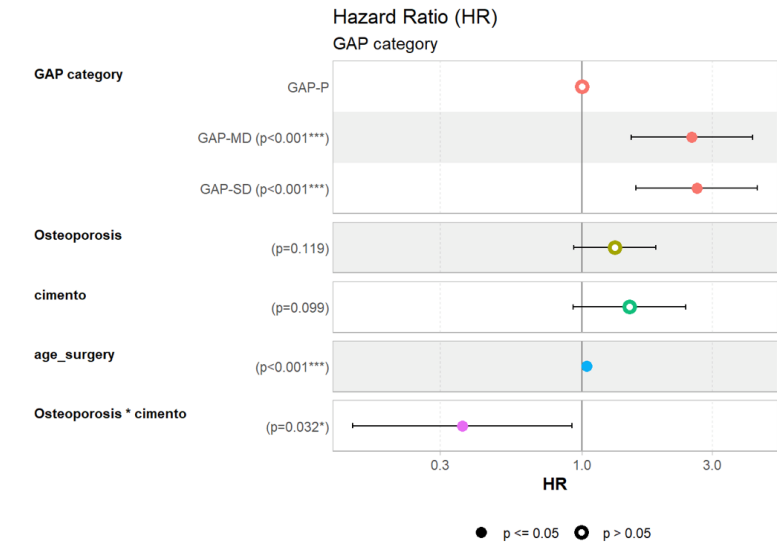
A retrospective multicenter register study included ASD patients >60 years, with lower thoracic UIV (T8-T12), fused to the pelvis. The primary endpoint was the incidence of PJK/PJF. Patients were grouped according to cement augmentation and osteoporosis (femoral T-score <-2.5). Multivariable regression and Cox proportional hazards models were performed to assess the influence of sagittal alignment, including the Global Alignment and Proportion (GAP) score and vertebral Pelvic Angles (T4PA-L1PA), age, interaction between osteoporosis and cement augmentation.

Results

Among 725 patients without osteoporosis, 82 underwent prophylactic cement augmentation and 643 non-cemented instrumentation. In this group, patients treated with cement were older (67±6 vs 61±14 years, p=0.005), more frequently female (90% vs 77%, p=0.006), and had a higher PJK/PJF rate (27% vs 13%, p<0.001) with increased risk over time (HR 2.73, p<0.001). Among 180 patients with osteoporosis, 42 had cement augmentation and 138 no cement. In this subgroup, age and gender distribution were comparable, incidence of PJK/PJF (12% vs 21%, p=0.2). Multivariate regression models showed that the risk of developing PJK/PJF over time was lower after cement augmentation in osteoporotic patients only (HR 0.24; p=0.01). Age at surgery was associated with increased risk (HR 1.05 per year; p<0.001). Postoperative malalignment was determinant: moderately and severely disproportioned GAP categories were at risk (HR 2.53, p=0.0004 and HR 2.64, p=0.0002). In models including T4PA-L1PA difference, each 1°-increase in mismatch was associated with a 5%-increase in PJF/PJK risk (HR 1.05, p<0.001). Patients within the T4PA-L1PA range [-3°;1°] had a lower risk (HR 0.34, p=0.002).

Conclusion

Prophylactic cement augmentation did not protect non-osteoporotic patients and was associated with increased PJK/PJF. A possible explanation is that the rigid cement core within healthy cancellous bone may cause peri-cemental trabecular microfailure, predisposing to proximal junctional collapse. In contrast, reduced PJK/PJF risk was observed only in osteoporotic patients. Postoperative sagittal alignment and age were strongly associated with failure, supporting the concept that PJK/PJF in elderly patients is primarily alignment driven.



Hazard Ratio (HR)

Mismatch [-3;1]

