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Preliminary Results of the Effect of Prophylactic Vertebroplasty on the Incidence of Proximal Junctional Complications After Posterior Spinal Fusion to the Low Thoracic Spine

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Abstract

Study Design: Prospective cohort study.

Objective: To evaluate, in adults undergoing posterior spinal fusions, 1) the effect of prophylactic vertebroplasty on the incidence of proximal junctional kyphosis (PJK) and proximal junctional failure (PJF), and 2) the difference in outcomes between those who did and did not develop PJK or PJF.

Summary of Background Data: Proximal junctional kyphosis occurs in 20% to 39% of adults after posterior spinal fusions; a subset develops PJF.

Methods: From 2005 through 2008, we treated 41 consecutive patients (40 years old or more) with spinal deformity with 2-level prophylactic vertebroplasty (at the upper instrumented vertebrae and the supra-adjacent vertebrae) during posterior spinal fusion. The 38 patients with 24 months' follow-up formed our study group. We measured patient outcomes with the Scoliosis Research Society−24 questionnaire, the Oswestry Disability Index, and the 12-item Short Form Survey. All patients completed each assessment preoperatively, and 89% or more did so postoperatively. We compared postoperative and final follow-up radiographs to identify the PJK incidence (ie, a PJK angle change of 10° or more), and analyzed the PJK, PJF, and non-PJK/PJF groups for outcome scores with Student *t* test and chi-square test (significance, $p < .05$).

Results: Three patients (8%) developed PJK and 2 (5%) developed PJF, markedly lower incidences than those previously reported. At final follow-up, patients with PJK or PJF reported statistically significant lower pain and satisfaction Scoliosis Research Society−24 scores than did patients in the non-PJK/PJF group, but there were no significant differences in Scoliosis Research Society−24 mental health or function scores between groups. All patients had significant improved Oswestry Disability Index and 12-item Short Form Survey scores.

Conclusions: Prophylactic vertebroplasty in long posterior spinal fusions for adult spinal deformity resulted in a low incidence of PJF and PJK, with only small differences in outcome scores between those who did and did not develop PJK and PJF.

Keywords: Adult spinal deformity; Posterior spinal fusion; Proximal junctional kyphosis; Proximal junctional failure; Vertebroplasty; Complications

Introduction

Proximal junctional kyphosis (PJK), defined as a positive sagittal imbalance in the spinal segments immediately cephalad to the proximal instrumented levels, is a well-known complication of long spinal fusion surgeries. A small number of such patients develop proximal junctional failure (PJF), requiring revision surgery [1,2]. Some authors have speculated that PJK is caused by a disruption of the muscular and ligamentous support around the vertebrae and by increased mechanical stress at the proximal junction,

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because of the transition from a fixed to a mobile spine [2-4]. Overall, the cause of PJK is not well understood and is likely multifactorial.

Most previous studies have focused on PJK in adolescents [1,3-8]. The 3 largest studies of PJK in adults reported on fusions to the upper thoracic spine, found a PJK incidence of 20% to 39%, and indicated conflicting results with regard to risk factors for its development [9-11]. One small study focused on adults with fusion to the lower thoracic spine; it found a 27% incidence (4 of 22 patients) of PJF resulting from PJK, which indicates that PJF and PJK are also major problems in the lower thoracic spine [12]. Because mechanical stress at the proximal junction is believed to contribute to the development of PJK and PJF, we hypothesized that prophylactic vertebroplasty would reduce the incidence of PJK and PJF.

Vertebroplasty, the injection of polymethylmethacrylate bone cement into the vertebral body [13], was first reported in 1987 for the treatment of painful spinal hemangiomas [14]. Since then, it has been adapted to treat other vertebral body abnormalities such as metastasis and multiple myeloma. Currently, the procedure is most widely used for reducing pain associated with vertebral compression fractures [15]. However, to our knowledge, this is the first report of vertebroplasty used prophylactically for the prevention of PJK or PJF.

Our goals were to evaluate, in adults undergoing posterior spinal fusions, 1) the effect of prophylactic vertebroplasty on the incidence of PJK and PJF, and 2) the difference in outcomes between those who developed PJK or PJF and those who did not.

Methods

Patient population

From 2005 through 2008, we recruited 41 consenting consecutive patients with adult spinal deformity for our study. Inclusion criteria were age 40 years or older, fusion extending at least 5 vertebral levels that crossed the thoracolumbar junction and ended in the distal thoracic spine (T9−T12), and a dual-energy X-ray absorptiometry scan with a t score of -1 or less or suboptimal pedicle screw purchase. Of the 41 patients, 2 died of causes unrelated to the initial surgery (Parkinson disease and myocardial infarction); neither of those 2 had PJK or PJF at the time of the final follow-up. One patient did not complete the 2-year follow-up.

The 38 patients (4 men and 34 women; average age, 64.4 years; range, 41−80 years; all white) with 2-year follow-up formed our study group. The average body mass index was 26.7 kg/m^2 (range, 17.1−53.4 kg/m^2). Preoperative diagnoses were scoliosis (14 patients), kyphoscoliosis (19 patients), and lumbar flat back syndrome (5 patients). For 24 patients, this procedure was a revision of a previous spinal fusion surgery. The average follow-up was 32.3 months (range, 24−48 months).

For analysis purposes, we divided the patients into 3 groups: those who developed PJK (PJK group), those who developed PJF (PJF group), and those who developed neither (non-PJK/PJF group). There were no significant differences in age, follow-up, gender, body mass index, osteotomy usage, or surgical approaches among the 3 groups (Table 1).

Operative procedure

All patients underwent posterior arthrodesis (Fig. 1) via a standard open midline approach and instrumentation with bilateral pedicle screws (EXPEDIUM or Moss Miami screws; DePuy Spine, Raynham, MA) at the proximal 2 levels. After exposure and instrumentation, all patients underwent prophylactic vertebroplasty at the upper instrumented vertebral level (UIV) and at the supra-adjacent vertebral level (UIV+1). With regard to our choice of the UIV, T10 and T11 were the most common cephalad upper instrumented levels; we chose these levels based on the preoperative imaging and deemed them to be neutral and stable in the coronal and sagittal planes. All patients had the major curve (sagittal or coronal) in the lumbar spine, which made it feasible to stop in the lower thoracic spine.

First, we removed the pedicle screws at the UIV to prepare for the cement injection. We prepared the UIV+1 pedicles using a 2.5-mm drill introduced through the pedicle and into the vertebral body, and then carefully evaluated the pedicle holes for any breach using a blunt ball-tip probe. We used

Table 1
Demographics of PJK, PJF, and non-PJK/PJF groups.

Parameter	PJK group (n=3)	PJF group (n=2)	Non-PJK/PJF group (n=33)	p
Follow-up, months	27.7 (5.5)	30 (2.8)	32.9 (6.8)	.389
Age at operation, years	67.7 (2.3)	65 (8.5)	64.1 (8.7)	.784
Gender				.713
Men	0	0	4	
Women	3	2	29	
Body mass index, kg/m^2	25.2 (10.0)	21.9 (1.1)	27.1 (7.4)	.592
Number of instrumented vertebrae	9 (1.0)	10 (0)	9 (1.0)	.408
Upper instrumented vertebrae				.173
T8	0	0	1	
T9	0	1	1	
T10	2	1	24	
T11	1	0	7	
Pedicle subtraction osteotomy?				.427
Yes	0	1	8	
No	3	1	25	
Pelvic fixation?				.583
Yes	3	2	27	
No	0	0	6	
Approach				.231
Posterior only	1	2	24	
Posterior and anterior	2	0	9	

PJK, proximal junctional kyphosis; PJF, proximal junctional failure.
Numbers in parentheses are standard deviations.