

SUCCESSFUL POSTEROLATERAL LUMBAR FUSION
USING SILICATE SUBSTITUTED CALCIUM PHOSPHATE
IN THE PRESENCE OF OSTEOPOROSIS, DIABETES,
OBESITY, AND NICOTINE USE:
A CASE SERIES

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Abstract

Spine fusion can be difficult to achieve in challenging patients, particularly those who are osteoporotic, obese, diabetic or smokers. Commercially available bone graft substitutes may contribute to a higher rate of fusion in these patients. We present a series of three "difficult fusers" who have had successful posterolateral lumbar fusion using silicate substituted calcium phosphate bone graft substitute (Actifuse™) in combination with locally obtained autograft bone. One patient achieved excellent clinical and radiographic results following multilevel lumbar fusion despite morbid obesity, osteoporosis, diabetes, and ongoing nicotine use. Two other patients had successful non-instrumented multilevel fusions despite longstanding osteoporosis. The purpose of presenting this series of patients is to demonstrate that silicate substituted calcium phosphate is an important contributor to solid spinal fusion in challenging patient populations.

Introduction

Decompressive surgery for degenerative disease of the lumbar spine often requires adjunctive fusion in order to stabilize the involved segments. Fusion rates are significantly lower for patients with one or more risk factors for fusion failure, including obesity, diabetes, osteoporosis, and nicotine use. One of the primary challenges to spine surgeons is achieving successful fusion in difficult patients, and this remains a strong motivator for surgical and medical device innovation.

The gold standard for biological enhancement of spine fusion has historically been iliac crest bone graft (ICBG), though commercially available bone graft substitutes now present an effective alternative without the morbidity of ICBG harvest. Silicate substituted calcium phosphate has been shown to enhance fusion by increasing osteoblast proliferation and differentiation in animal models. Early clinical studies suggest a rate of successful fusion that is equal to or greater than that of other commercially available bone graft substitutes (Eskander, 2006). In this series, 3 osteoporotic smokers were treated with decompression and posterolateral fusion with silicate substituted calcium phosphate bone graft substitute combined with locally obtained autograft bone for degenerative disease of the lumbar spine. Successful clinical fusion was obtained within 6 months and was maintained through 2 years post-surgery.

Case #1

MP is a 79 year old former smoker with a long history of lower back pain and more recent complaints of leg pain consistent with neurogenic claudication. She has osteoporosis and takes Evista® in addition to calcium and vitamin D. She had no neurologic deficits on physical examination. An MRI demonstrated multi-level lumbar spinal stenosis. Oral anti-inflammatory medications and transforaminal epidural steroid injections did not relieve her pain.

Surgery was scheduled, and the patient underwent complete laminectomy of L2, 3, 4, and 5 with posterior spinal fusion in situ from L2-5 using silicate substituted calcium phosphate bone graft substitute in addition to local bone graft.

Postoperatively, the patient has radiographic evidence of posterolateral fusion through 1 year follow-up (Figures 1, 2). She reports complete resolution of back and leg pain, and she has returned to full activity without restriction or limitation.



Figure 1. AP radiograph, 1 year post-op



Figure 2. Lateral radiograph, 1 year post-op

Case #2

KP is a 59 year old woman who presented with lower back and left leg pain following a fall that occurred 3 years earlier while working as a registered nurse. At that time, decompressive surgery without fusion was performed at the L3-5 levels, though was unsuccessful at relieving her pain. She has Type II diabetes mellitus that is controlled with oral medications, takes Premarin® for osteoporosis, and has a BMI of 44.5. She has a history of right total hip arthroplasty. She is a current smoker with a 30 pack year history. Physical exam was unremarkable; motor and sensory function was intact, and she had normal reflexes. Plain X-rays demonstrated a Grade I degenerative spondylolisthesis at L3-4 as well as degenerative disk disease at L2-3, L3-4, L4-5, and L5-S1. An MRI showed the expected postoperative changes consistent with decompressive surgery without evidence of recurrent disk herniation. An EMG study of the lower extremities was within normal limits.

After two transforaminal epidural steroid injections at L3 and L4 separated by 3 months, the patient reported minimal temporary pain relief. Spondylolisthesis at L3 and L4 was thought to be the cause of the patient's pain, and she was scheduled for surgery.

The patient underwent laminectomy of L3 and L4 with bilateral foraminotomies and interbody fusion of the L3-4 disk space using an allograft bone cage. Instrumented posterior segmental fixation was achieved from L3-4 using pedicle screws, as well as silicated calcium phosphate bone graft substitute mixed with the patient's local bone. The patient was discharged home after 3 nights in the hospital.

Postoperatively, the patient reports complete relief of her leg pain, and only mild residual lower back pain through 2 years of follow-up. She remains neurologically intact. A CT scan was obtained at 1-year, and demonstrated solid fusion (Figures 3, 4). At 2 years, AP and lateral X-rays of the lumbar spine demonstrated a solid fusion with no evidence of loosening or pseudarthrosis (Figures 5, 6). Despite the clinical and radiographic success of her spine fusion, she remains disabled due to aseptic loosening of her total hip arthroplasty, which has required revision surgery.



Figure 3. CT Sagittal view at 1 year post op



Figure 5. AP radiograph at 2 years post op



Figure 4. CT Coronal view at 1 year post op

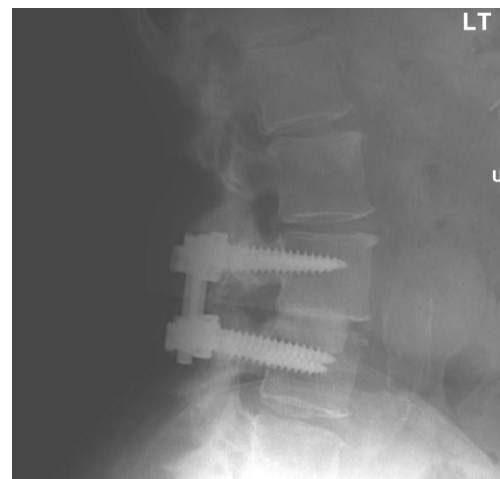


Figure 6. Lateral radiograph at 2 years post op

Case #3

JR is a 71 year old woman who presented with an 18-month history of lower back and left hip pain. She has osteoporosis. On physical exam, she was neurologically intact. A full evaluation ruled out hip pathology and oral medications have not decreased her pain. An MRI showed a large disk herniation at the L3-4 level with grade I degenerative spondylolisthesis at L4-5. The patient was taken to the operating room, and a discectomy was performed at L3-4 and L4-5, as well as posterior spinal fusion in situ from L3-5.

As early as 2 months post-op, this patient showed radiographic signs of early fusion without pain. Eighteen months after surgery, the patient is fused via radiographs (Figures 7, 8) and CT scan (Figure 9), remains asymptomatic, and has returned to full activity without restriction.



Figure 7. Lateral radiograph at 2 months post op

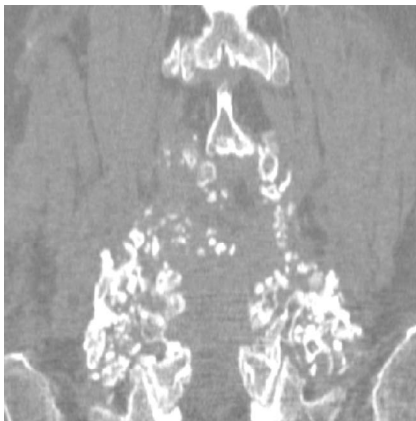


Figure 8. Coronal CT at 18 months post op



Figure 9. AP radiograph at 2 years post op

Discussion

The spine surgeon's task includes selecting an appropriate operative plan that will balance a high likelihood of clinical success with low morbidity at a reasonable cost. Iliac crest bone graft is historically effective, but contributes significant morbidity to the recovery period (Silber, 2003). The importance of added stability gained with instrumentation has been debated in light of increased cost and potential for adjacent segment disease. Commercially available products offer the promise of solid fusion without the drawbacks associated with these other methods. In particular, silicate substituted calcium phosphate (Actifuse™) has been shown to result in fusion rates equal to or greater than those of other commercially available bone graft substitutes.

Among female patients over the age of fifty undergoing spine surgery, more than half suffer from osteoporosis (Chin, 2007). Instrumentation is often employed as a stabilizing measure, but concerns over pedicle screw pullout from osteoporotic bone heighten the importance of timely and effective incorporation of graft. Not only is osteoporotic bone more prone to hardware failure, but the very nature of the disease presents a physiologic challenge to fusion. In an animal model, treatment with alendronate inhibited posterolateral spine fusion and the authors recommended that patients undergoing spine arthrodesis do not take alendronate until fusion is achieved (Huang 2005). A separate animal study concluded that, while alendronate did not inhibit fusion rate it did decrease fusion mass remodeling (Xue, 2005). In the three osteoporotic patients reported here (one instrumented, two in situ), intraoperative application of a bone graft substitute combined with locally obtained autograft bone was used with excellent results.

Nicotine is detrimental to spine fusion (Theiss, 2000). Commercially available bone morphogenetic proteins have been shown to improve the fusion rate in cigarette smokers undergoing single-level instrumented posterolateral lumbar fusion (Glassman, 2007). We present an active smoker and a former smoker in this series, both with successful spinal fusion using silicate substituted calcium phosphate bone graft substitute.

Obese and diabetic patients are prone to peri- and post-operative medical and wound complications (Glassman, 2003). The patient presented here in Case #2 was both a Type II diabetic and obese (BMI = 44.5), yet had a successful lumbar surgery without complications related to these diseases. Of note, this patient did have aseptic loosening of a total hip replacement less than one year following her spine surgery. Despite the failure of her hip arthroplasty, she achieved a very successful spine fusion over the same time period using local autograft and silicate substituted calcium phosphate bone graft substitute.

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