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Percutaneous Vertebroplasty of the Entire Thoracic and Lumbar Vertebrae for Vertebral Compression Fractures Related to Chronic Glucocorticosteriod Use: Case Report and Review of Literature

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Glucocorticosteroid-induced osteoporosis is the most frequent of all secondary types of osteoporosis, and can increase the risk of vertebral compression fractures (VCFs). There are promising additions to current medical treatment for appropriately selected osteoporotic patients. Few studies have reported on the efficiency of percutaneous vertebroplasty (PVP) or kyphoplasty for whole thoracic and lumbar glucocorticosteroid-induced osteoporotic vertebral compression fractures. We report a case of a 67-year-old man with intractable pain caused by successional VCFs treated by PVP.

Index terms: *Percutaneous vertebroplasty; Entire thoracic and lumber vertebra; Osteoporotic vertebral compression fractures; Steroids*

INTRODUCTION

Percutaneous vertebroplasty (PVP) or kyphoplasty (PKP) have been shown to be safe and effective procedures for the treatment of both primary and glucocorticosteroid-induced osteoporosis (GIOP). Nevertheless, there are only a few reports on the application of PVP or PKP for the treatment of glucocorticosteroid-induced osteoporotic vertebral compression fractures (GIOPVCFs) along the entire thoracic-lumbar length of the vertebral column. Here, we present a rare case where a GIOP patient, who suffered from a cluster of spontaneous vertebral fractures in a 27-month period, was relieved of sustained pain and had an improved quality of life following four successive rounds of PVP operations with 17 cement augmented vertebral bodies.

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CASE REPORT

A 67-year-old man had been living with rheumatoid arthritis and pulmonary fibrosis and regularly took glucocorticoids for more than 20 years. He was subsequently diagnosed with GIOP with a hip bone mineral density test score of -4.0. Alendronate, supplemental calcium, and vitamin D were prescribed as prophylactic treatment for GIOP. This patient has suffered three rounds of GIOPVCFs and experienced significant pain relief and improvements in his daily life following three rounds of PVP with 12 augmented vertebral bodies from the sixth thoracic to the fifth lumbar vertebrae since April 2008. In July 2010, he returned to our hospital presenting with serious chest and back pain confining him to bed, with no significant reasons for the pain. Radiography and magnetic resonance imaging (MRI) were performed to assess the recurrence

of severe pain and revealed stable vertebroplasty changes within augmented vertebral bodies from the sixth thoracic to the fifth lumbar vertebral bodies and new osteoporotic vertebral compression fractures on the first to fifth thoracic vertebral bodies. The patient was treated conservatively with medication and bed rest. However, the patient's symptoms failed to subside during the hospitalization. Because we were concerned about both his chronic pulmonary fibrosis and the likelihood of delayed side effects if conservative management did not work, we reluctantly decided that PVP was the treatment of choice. After written informed consent was obtained from the patient and his family, a fourth round of PVP was performed on the first to fifth thoracic vertebral bodies using 11-gauge bone puncture needles (Cook, Inc., Bloomington, IN, USA) under digital subtraction angiography (Axiom Zee Biplane, Siemens Healthcare, Erlangen, Germany) guidance. The treatment provided prompt pain relief as well as functional improvement. The volumes of bone cement (polymethyl methacrylate, PMMA) (Simplex P; Howmedica Osteonics, Kalamazoo, MI, USA) used were as follows: 1.5 mL were injected at the first thoracic vertebra, 2 mL were injected at the second thoracic vertebra, 1.5 mL were injected at the third thoracic vertebra, 1 mL was injected at the fourth thoracic vertebra, and 1.5 mL at the fifth thoracic vertebra.

From April 2008 to May 2008, the patient had experienced multiple vertebral compression fractures on three separate occasions: 1) the sixth thoracic and twelfth thoracic vertebral bodies; volumes of bone cement used were 1.5 mL for the sixth thoracic body and 3.5 mL for the twelfth thoracic vertebral body; 2) first lumbar and third to fifth lumbar vertebral bodies; volumes of bone cement used were 3 mL, 3 mL, 2.5 mL, and 3.5 mL, respectively; and 3) seventh to eleventh thoracic and second lumbar vertebral bodies; volumes of bone cement used were 2.5 mL, 2 mL, 2.5 mL, 2.5 mL, 3 mL, and 3.5 mL, respectively. Within a two-year period he underwent four PVP operations with 17 cement augmented vertebral bodies from the first thoracic to fifth lumbar vertebrae (Fig. 1, Table 1). The average interval between each PVP operation was 206.7 days (range, 20–791 days).

DISCUSSION

As the population ages, an increasing proportion of people are suffering from primary osteoporosis and GIOP that commonly results in vertebral fractures. These fractures not only reduce the patient's quality of life, but can also lead to multiple comorbidities such as functional limitations, depression, disability, height loss, spinal instability, and kyphotic deformity associated with impaired lung capacity. Unfortunately, conservative treatment strategies, such as analgesia, bed rest, and physical therapy, and other surgical options do not appear to effectively manage the disease (1, 2). Although the surgical treatment of spine deformities can be very challenging due to the frequently poor bone quality and to the patient's expectations regarding the improvement of chronic pain, which need to be clarified upfront, percutaneous vertebroplasty has become an interesting treatment option to improve functionality and quality of life and for the management of acute pain resulting from vertebral fractures, based on recent clinical results, especially for elderly patients (3-5).

A review of the literature from January 1, 1995, to December 1, 2013, was conducted for relevant studies about PVP or PKP regarding glucocorticosteroid-induced osteoporotic vertebral compression fractures in the PubMed database. One hundred and seventeen patients with GIOPVCFs treated by PVP or PKP were included in the 11 eligible studies (3-13). Fifty of 117 (42.8%) patients sustained refractures after vertebropalsty and received repeated vertebroplasty procedures, of which 24 and 26 patients underwent PKP and PVP procedures, respectively. Almost all the refractures occurred within one year after the PKP or PVP procedure and 41.8% were adjacent level refractures while 58.2% were remote level refractures. Therefore, studies have debated whether there is a correlation between the use of the vertebroplasty technique and the recurrence of new fractures in GIOP or primary osteoporosis patients (3, 8, 9, 14, 15). Although the mechanism by which future fractures may occur after the procedure is unclear, it is postulated that vertebroplasty and kyphoplasty might shift the normal load transmission through the spine, predisposing it to fracture (7). Harrop et al. (3) and Syed et al. (8) reported that patients presenting on oral steroid therapy at their initial vertebroplasty are almost twice as likely to have symptomatic refractures as primary osteoporosis patients are during follow-up. However, others have suggested that the refractures were simply the result of the natural progression of osteoporosis and vertebroplasty did not increase the risk of new fractures (16-18). Lindsay et al. (16) found the annual incidence of a vertebral compression fracture (VCF) in postmenopausal women without prior VCF was 3.6%. If the patient

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Table 1. Clinical Data of Patient in Four PVP Operations

Operation Times	Operation Date	Fracture Segments	Cement Filling Volume (mL)	VAS Pre-Operation	VAS 24 h Post-Operation	Intraoperative Complication
1st	2008/04/21	T6, T12	1.5, 3.5	7	2	No
2nd	2008/05/07	L1, L3, L4, L5	3, 3, 2.5, 3.5	8	3	No
3rd	2008/05/27	T7, T8, T9, T10, T11, L2	2.5, 2, 2.5, 2.5, 3, 3.5	7	3	No
4th	2010/07/27	T1, T2, T3, T4, T5	1.5, 2, 1.5, 1, 1.5	9	4	No

Note.— L = lumbar, PVP = percutaneous vertebroplasty, T = thoracic, VAS = Visual Analogue Scale

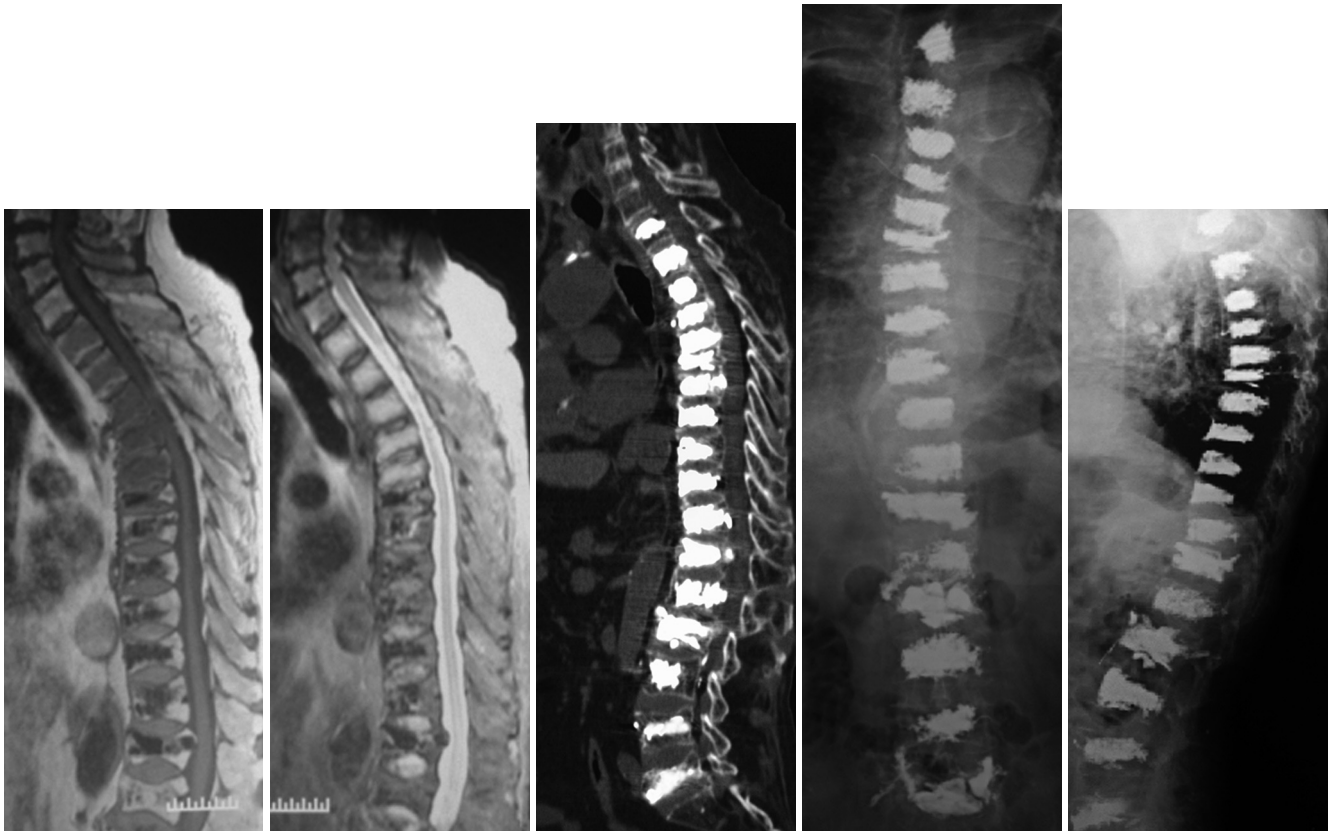

Fig. 1. Images illustrating pre-vertebroplasty MR and post-vertebroplasty CT and X-ray.
A, B. Last T2-weighted, T1-weighted sagittal magnetic resonance images demonstrating newly developed compression fractures on first to fifth thoracic vertebral bodies. **C.** Sagittal reformatted CT image showed 17 cement-augmented vertebral bodies from first to fifth thoracic vertebrae and good distribution of bone cement. **D, E.** Last thoracolumbar spinal radiographs of anteroposterior and lateral projections.

presented with one VCF on baseline imaging studies, then there was a 19.2% incidence rate of subsequent vertebral compression over the ensuing year. This incidence increased to 24% if there were two or more VCFs present on the initial radiograph (16). Recent data from the VERTOS II trial (17), randomizing painful VCFs to conservative treatment or PVP, showed the incidence of new VCF between the two groups was not different at 12 months follow-up, and the only risk factor identified for new VCFs was the number of baseline VCFs. Although the principle of applying PVP or PKP to not more than three levels or not more than 8 mL of bone cement at a time was adhered to in order to prevent complications resulting from cement, air, and fat emboli due to too many levels of cement being injected at a time (19-22). PVP was performed on the first to fifth thoracic vertebra bodies in a single session with a total of 8 mL bone cement, as the smaller upper thoracic vertebrae require less bone cement. As consequence of the more serious degree of osteoporosis in GIOP patients, more prudence is needed during the puncture process of PVP for GIOPVCFs, and the puncture needle can be placed into the target vertebra with merely a small amount of thrust. In view of the findings presented here, we demonstrate that, in specific cases, repeated PVP can be an effective treatment modality for

recurring osteoporotic vertebral compression fractures and GIOPVCFs, although it may be necessary to perform multiple rounds of PVP, provided successive surgeries are beneficial to the patient.

There is increasing evidence to suggest the possibility of PMMA chemotoxic accumulation inside the patient's body, whether from successive treatment via PVP or extensive vertebral restoration in a single PVP procedure. Aebli et al. (23) and Uemura et al. (24) both found that PaO_2 decreases and $PaCO_2$ increases as the number of treated vertebral bodies in single PVP increases. In our patient, we compared the major clinical biochemical indicators before and 48 hours after surgery, and identified no significant changes in this patient's electrolyte, hepatorenal, and hematopoietic functions; indicating that the accumulated PMMA does not cause a negative effect in this patient. However, we did observe both PaO_2 and SaO_2 increases to almost the normal range after PVP, when the operation was performed on the thoracic vertebrae. This change may be related to the pain relief and pulmonary improvement after PVP.

From the examination of this unique case study and the review of the literature, we conclude that PVP is a safe, effective, and feasible procedure for selected patients subjected to repeat and/or multiple thoracic-lumbar GIOPVCFs, bringing significant pain relief and improvement in the quality of life for the patient. However, long-term, large cohort, and randomized controlled studies are required to conclusively define the clinical application of vertebroplasty for serious multiple glucocorticosteroid-induced osteoporotic vertebral compression fractures.

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