



Vertebroplasty in Vertebral Compression Fractures: Single Institute Experience with 49 Cases

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Summary

Objective: Percutaneous vertebroplasty (PVP) is the preferred treatment option for vertebral compression fractures (VCF). In this study, the efficacy and complications of PVP were investigated among 49 patients with VCF.

Methods: Forty-nine patients with VCF due to osteoporosis, trauma, osteolytic bone tumors, metastases or leukemia who were admitted to our hospital between 2012 and 2015 and treated with PVP were included in the study. In patients' preoperative and postoperative evaluation, a visual analogue scale (VAS) was used to assess back and leg pain, preoperative routine lumbar vertebral radiography was used for fracture morphology, lumbar magnetic resonance imaging was performed, and the segmental kyphotic angle, vertebral corpus compression rate, polymethylmethacrylate (PMMA) cement volume, and diffusion of PMMA were recorded.

Results: Preoperative and postoperative VAS scores were 8.6 ± 0.9 vs. 1.13 ± 1.1 ($p < 0.01$). The approximate compression rate was 24.72 ± 13.99 %, the ratio of approximate restoration height was 3.47 ± 5.36 , and the mean kyphosis angle was 7.35 ± 6.81 °. The mean pre- and postoperative values of vertebral height were 1.83 ± 0.39 cm vs 1.88 ± 0.36 cm ($P < .01$).

Conclusion: In this study, preoperative pain in patients with VCF prominently diminished in the postoperative early and late phase. After PVP, vertebral height showed a subtle increase.

Key words: Compression fracture, osteoporosis, vertebral, vertebroplasty

Vertebra Kompresyon Fraktürlerinde Vertebroplasti 49 Olgu ile Tek Merkez Çalışması Özet

Amaç: Vertebra kompresyon fraktürlerinin (VKF) tedavi seçenekleri arasında perkutan yolla vertebroplasti (PVP) tercih edilen bir yöntemdir. Bu çalışmada VKF'si olan 49 hastada PVP'nin etkinliği ve komplikasyonları araştırıldı.

Gereç ve yöntem: Hastanemize 2012-2015 tarihleri arasında osteoporoz ve travmaya ikincil kompresyon fraktürleri gibi benign, osteolitik kemik tümörleri, farklı metastazlar, lösemi gibi malign nedenlerle başvuran 49 hasta, PVP ile tedavi edildi. Hastaların preoperatif ve postoperatif değerlendirmesinde bel ve bacak ağrısı için visual analog skala (VAS), kırık morfolojisi için preoperatif rutin ayakta lumbal vertebra grafileri, lumbal magnetik rezonans görüntüleme (MRG) tetkikleri, segmental kifotik açı ve vertebra korpusunun kompresyon oranı, enjekte edilen polimetil metakrilat (PMMA) sement volumü ve yayılımı kayıt altına alındı.

Sonuç: Preoperatif ve postoperatif VAS skorları 8.60 ± 0.90 ve 1.13 ± 1.10 ($p<0.01$) Ortalama kompresyon oranı 24.72 ± 13.99 , ortalama restorasyon yüksekliği oranı ise 3.47 ± 5.36 , kifoza açısı ortalaması ise 7.35 ± 6.81 idi. Preoperatif ve postoperatif vertebra yükseklik ortalaması ise 1.83 ± 0.39 ve 1.88 ± 0.36 $p<0.01$ idi. Bu çalışmada VKF olan hastalarda, preoperatif ağrı, postoperatif erken ve geç dönemlerde belirgin olarak azaldı. PVP sonrası kırık vertebra yükseklik ortalamasında hafif artış saptandı.

Anahtar Kelimeler: Kompresyon fraktürü, osteoporoz, vertebra, vertebroplasti

INTRODUCTION

Percutaneous vertebroplasty is widely used for the treatment of painful compression fractures caused by benign or malignant diseases. Numerous clinical and radiologic studies have been published. However, the effect of vertebroplasty is controversial in patients who do not respond to medical therapy such as bed rest, braces, and analgesics (1). Osteoporosis is one of the most common causes of vertebral compression fractures (2). Fracture risk increases due to progressive bone mineral loss in osteoporosis. It has been stated that 100 million patients worldwide are at risk for fracture because of osteoporosis, 1, 5 million people have fractures in the United States of America every year, and 50% of these fractures are observed in the vertebra (3,4).

Percutaneous vertebroplasty was first performed in France in 1987 for the treatment of aggressive vertebral hemangioma. It has been improved and used to reduce pain, increase quality of life and functional capacity, and restore height of vertebra in vertebral compression fractures (5). In recent years percutaneous balloon kyphoplasty, a modification of percutaneous vertebroplasty has been performed. In this technique an inflatable balloon tamp is placed into the collapsed vertebra prior to cement injection and height of the vertebra is restored. Kyphoplasty is related with low rate of cement leakage compared with vertebroplasty (6,7).

In the current study, preoperative and postoperative symptoms, radiological findings, complications of PVP, and

recovery rates of patients with vertebral compression fractures were evaluated.

MATERIAL AND METHODS

In this study, 49 patients with vertebral compression fractures due to benign or malignant reasons who underwent PVP between 2012- 2015 were included in the study. Patients who had spinal cord and thecal sac compression, hemorrhagic problems, and a history of allergic reaction to vertebroplasty materials were excluded. Unilateral PVP was performed at 65 levels to 49 patients for the treatment of vertebral compression fractures. Physical and neurologic examinations and pain scores were verified. Preoperatively, all patients underwent lateral and anteroposterior standing lumbosacral radiographs and lumbar magnetic resonance imaging (MRI) to evaluate the compressed vertebra.

PVP procedures were performed to all patients under local anesthesia with sedation. The transpedicular route was used for all interventions using C-arm fluoroscopes. A Jamshidi needle was inserted from the left or right side in the anterior 1/3 of the vertebrae corpus. The distribution of injected PMMA cement in the vertebral body was observed in lateral and anteroposterior views (Fig. 1).

Age, sex, preoperative and postoperative visual analogue scale (VAS) scores, and mean injury time of patients were analyzed. For every effected level, rates of preoperative and postoperative compression and height restoration, and the amount of injected PMMA cement were recorded. Compression and restoration rates were calculated using the height of the compressed, caudal or cranial

adjacent vertebral body and the mean height of the vertebral body was measured (8). Postoperative X-rays were performed 24 hours after the surgery (Fig. 2).

STATISTICAL ANALYSIS

The Statistical Program for the Social Services version 16.0 (SPSS Inc, Chicago,

IL, USA) was used for analysis of data. The paired samples t-test was used for statistical analysis of VAS scores. The mean value was described as mean \pm standard deviation. Statistical significance was accepted as $P < 0.05$.



Figure 1: Bilateral distribution of cement in vertebroplasty with unipedicular approach.

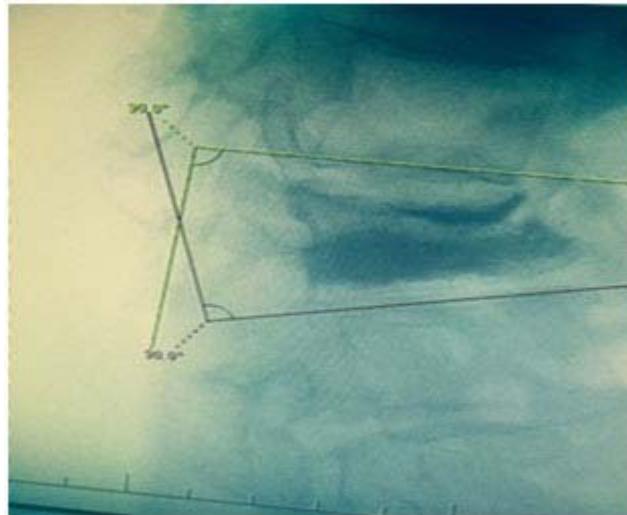


Figure 2: Restoration of compressed vertebra in the postoperative period (24 hours after the surgery)

RESULTS

In this study, fluoroscopy was used to observe the distribution of injected PMMA cement in the lumbar or thoracic vertebral body safely and transpedicular approach (Fig. 1). All patients underwent unilateral transpedicular PVP. Among the 49 patients, 37 were female and 12 were male. The mean age was 78.16 years. The mean preoperative pain duration was 0-7 days for 12 patients, 7-15 days for 9 patients, 15-30 days for 17 patients, and >30 days for 10 patients (Table 1). The causes of vertebral compression fractures were spontaneous fractures due to osteoporosis in 22 patients, falling or slipping in 20 patients, traffic accident in 3 patients, and malignancy in 4 patients. One patient had prostate malignancy, one had bladder malignancy, one had leukemia, and one had renal malignancy.

A total of 49 patients underwent PVP at 65 levels. PVP was performed to one level in 34 patients, two levels in 11 patients, and three levels in 3 patients (Table 2). The mean amount of injected PMMA cement was 4.46 ± 1.54 mL. Intraoperative cement leakage was observed in 4 cases; into the intra-discal space in two cases, posterior leakage in one case, and vascular leakage around the vertebrae via the segmental vein in one case. Therefore PVP procedure completed. Also, we determined one

pulmonary embolism and one reversible spinal compression among all the patients. The patient with leukemia who underwent PVP had tachypnea after discharge from hospital; he was readmitted and was diagnosed as having a pulmonary embolism. Low-molecular-weight heparin (LMWH, subcutaneous enoxaparin 0.3 mg/kg) was given for the treatment. In our study, four patients aged over 70 years stayed in the hospital more than 24 hours after the surgery, two of whom were mobilized using a wheelchair and the other two patients were mobilized with supervision.

The mean preoperative VAS score was 8.16 ± 0.90 and 1.08 ± 1.10 24 hours after surgery. The vertebral compression rate, vertebral body restoration rate, and kyphosis angle were calculated preoperatively and postoperatively.

In our study, the mean compression rate was 24.72 ± 13.99 , the mean restoration rate was 3.47 ± 5.36 , and the mean kyphosis angle was $7.35 \pm 6.81^\circ$. The mean vertebral height was 1.83 ± 0.39 cm preoperatively and 1.88 ± 0.36 cm postoperatively ($P < 0.01$).

In the two years of follow-up, two new osteoporotic fractures at different vertebra levels occurred in two patients. The surgical procedures were successful for the other patients.

Table 1.Demographic data of percutaneous vertebroplasty.

Number of patients	49
Mean Age	78.16
Female/ /Male (%)	3.08
Etiology	
Osteoporosis	22
Fall from height	17
Traffic accident	3
Slipping	3
Malignancy & systemic diseases	4
ASA classification	
I	7
II	37
III	5
Mean pain duration (week)	3-16
Mean VAS (preoperative)	8.60±0.90
Mean VAS (postoperative)	1.13±1.10
Mean Follow-up period (month)	4
PMMA CEMENT volume (ml)	4.46±1.54
Mean compression rate (%)	24.72±13.99
Preoperative-vertebral mean height (cm)	1.83±0.39
Postoperative-vertebral mean height (cm)	1.88±0.36
The correction rate of kyphosis (%)	7.35±6.81
The rate of height restoration (%)	3.47±5.36

Table 2.The vertebra levels of the patients treated with PVP

Level	The number of patient
T11	4
T12	18
L1	21
L2	9
L3	7
L4	6

DISCUSSION

Vertebral compression fractures are usually caused by osteoporosis, primary or metastatic bone diseases, multiple myeloma, and aggressive vertebral hemangiomas (6,9). In our study, 22 patients had vertebral compression fractures due to osteoporosis, 23 due to trauma, and 4 due to malignant or systemic diseases.

Vertebral compression fractures are usually caused by postmenopausal osteoporosis in elderly woman (2,10). In our study, the mean age was 78.16 years and the ratio of woman and man was 3.08%. The patients reported low back pain and limitation of low back movements. Karaman et al reported the mean pain duration as 15.7 months; however, in our study, the mean pain duration was 1-15 days for 22 patients, and 15 days-4 months for 27 patients (11).

The initial treatment for vertebral compression fractures is bed rest, non-steroidal anti-inflammatory agents, narcotic analgesics, and orthotic devices. However, some patients fail to benefit from these treatment modalities in 1 to 3 months. In these patients, PVP is the correct treatment choice (12-14).

Vertebral compression fractures commonly occur at the thoracolumbar junction (15). In our study, there were 18 vertebral compression fractures at T12 and 21 at L1.

In addition to conservative treatment, minimally invasive surgical procedures have been performed for patients with vertebral compression fractures (16). These treatment techniques are vertebroplasty, kyphoplasty, radiofrequency ablation, cryoablation, and microwave ablation. In our cases, vertebroplasty was preferred over kyphoplasty because it was more cost-effective.

It has been stated that percutaneous vertebroplasty induces pain when stabilizing fractured vertebrae, which causes thermal necrosis and a thermal and chemical effect on interosseous and periosteal nerve fibers at the fracture area (17-19). Cotten et al. reported that patients who had vertebral compression fracture due to myeloma and metastatic tumors and underwent vertebroplasty had induced pain at postoperative 6-72 hours, partially or totally (6). They also stated that at the 6th month follow-up, pain intensity and clinical recovery had not changed. Weill et al. reported that pain decreased in 73% of patients with spinal metastasis who had PVP, and they observed no radiologic improvement at the 11th month follow-up

(9). PVP is usually performed for the treatment of osteoporotic vertebral fractures; nevertheless, it can be used for the treatment of vertebral fractures due to primary or metastatic bone diseases and aggressive vertebral hemangiomas (9). In our cases, the mean VAS decreased from 8.16 preoperatively to 1.08 on the first day postoperatively. The pain-free period has been long lasting.

Another procedure for the treatment of VCF is percutaneous kyphoplasty (PKP). Pain and disability associated with VCF are treated effectively by augmentation of compressed vertebrae. Vertebral height restoration and kyphosis angle improvement are also provided by this procedure. Santiago et al. compared outcomes of these two techniques and reported no significant differences in pain relief, improvement in functional capacity, and cement leakage. PKP is not preferred by patients because of its high price (20). It is more useful for new and single-level fractures (21).

Yilmaz et al. performed 113 PKP and 11 PVP to their patients (2). The authors reported vertebral stabilization development, pain relief in both groups, and restoration of vertebral height and improvement in vertebral alignment in the kyphoplasty group, which they assigned to the inadequate number of patients in vertebroplasty group. In our study, the mean compression rate was 24.72 ± 13.99 , the mean restoration rate was 3.47 ± 5.36 , and the mean kyphosis angle was $7.35 \pm 6.81^\circ$. The mean vertebral height was 1.83 ± 0.39 cm preoperatively and 1.88 ± 0.36 cm postoperatively ($P < 0.01$). All these outcomes were similar to those that Yilmaz et al. reported. Restoration of vertebral height was provided using PKP according to many studies, but we also observed restoration of vertebral height with PVP.

PVP can be performed unilaterally or bilaterally. Tohmeh et al. performed unipedicular vertebroplasty and observed

adequate vertebral strength using PMMA lower than 5cc and similar outcomes with bipedicular vertebroplasty (22). Bozkurt et al. (23) compared 296 patients with osteoporotic vertebral fractures who underwent PVP and PKP procedures. The authors randomized the patients into three groups; bipedicular kyphoplasty, unipedicular kyphoplasty, and unipedicular vertebroplasty. VAS, Oswestry Disability Index (ODI), and height restoration were used to evaluate clinical recovery. No significant difference was determined between the groups. They also stated that no studies had compared bipedicular kyphoplasty, unipedicular kyphoplasty, and unipedicular vertebroplasty clinically. Their results indicated that all three groups achieved significant vertebral height restoration. Furthermore, bipedicular kyphoplasty was statistically significantly more successful in height restoration compared with the other groups. Pedicelli et al. preferred a unilateral procedure for 250 patients with VCF despite the cardiotoxic effect in the elderly and cardiopulmonary risk, and aggressive vertebral collapse reported by some authors (5). In our study, the mean age was high, and the medical situation according to the American Society of Anesthesiology (ASA) score was 2 in 37 patients and ASA 3 in 5 patients. Unipedicular procedures were preferred in our study because of surgery and radiation exposure duration, cost-effectiveness of surgery, and pedicular cannulation risk.

The systemic complication rate after PVP has been reported as 6-7% (24) and cement extravasation rate as 20-65%. (25-27) Zhang et al. reported 52.7% cement leakage due to unilateral PVP, and 28.1% due to bilateral PVP (27). In our study, all patients underwent unilateral PVP. Cement leakage was observed intraoperatively in 4 patients. The cement leakage was observed into the intradiscal space in two patients, vascular leakage around the vertebrae via segmental vein in one patient, and posterior leakage in one patient (18.5%).

We observed fewer cement leakages in our patients compared with the literature. Pulmonary embolisms due to cement leakage, infection, and neural injury have been reported lower than 1% (28-30). We observed one pulmonary embolism and one reversible spinal compression among all our patients. An increased incidence of thrombosis has been reported in patients with cancer compared with the general population; therefore, LMWH should be used for 3 to 6 months after the surgical procedure and anticoagulant treatment should be continued indefinitely or until cure for cancer is achieved for patients with pulmonary embolism and history of cancer. New fractures may occur in adjacent vertebra due to unbalanced load distribution in patients with multiple level osteopenia because the corpses of vertebra gain strength with increasing vertebrae resistance. Mazzatini et al. investigated the long-term outcomes of PVP and reported an average of 27.8% new vertebral fractures in 115 patients (31). Tseng et al. observed 58.5-63.8% adjacent vertebral fractures among 852 patients after performing 1131 PVPs (29). Both author groups reported that patients who had new vertebral fractures after PVP were older and had more vertebral compression fractures before surgery. They also reported that new vertebral fractures were not related with sex or cement quantity. In our study, the mean age was 78.16, the ratio of women to men was 3.08, and 14 patients had vertebral compression fractures at more than one level (28.5%). Furthermore, 2 patients (4.08%) with new adjacent vertebral fractures underwent PVP. Frankel et al. reported a 25% rate of new vertebral compression fractures after PKP during 3-month follow-up (32). Morvin et al. found no significant difference in the number of new vertebral fractures between PKP and PVP groups (33). In our study, we preferred fluoroscopy because it is cost-effective, safe, and fast.

In conclusion PVP is a safe, effective, cost-effective, and minimally invasive surgical procedure. When performed carefully, the complication rate is low and it is performed as a daily procedure.

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