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*Original Article*

# Effect of percutaneous kyphoplasty in the treatment of elderly patients with osteoporotic thoracolumbar compression fractures

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**Abstract:** Objective: To study the clinical efficacy, blood loss, pain and Oswestry disability index (ODI) scores of elderly patients with osteoporotic thoracolumbar compression fractures under the treatment of percutaneous kyphoplasty (PKP). Methods: Eighty elderly patients with osteoporotic thoracolumbar vertebral compression fractures were divided into two groups by a random number table method with 40 cases in each group. The control group received percutaneous vertebroplasty and the study group was treated with PKP. The clinical efficacy and blood loss of the two treatments were compared. The visual analogue scale (VAS), vertebral body height, Cobb angle, posterior edge height, midline height, anterior edge height, ODI score and Basel index (BI) score of the two groups were compared. Results: The healing rate of the study group increased significantly after treatment ($P < 0.05$). Besides, in the study group, the operation time was significantly shortened, the blood loss during surgery significantly reduced, and the VAS score significantly reduced compared with those of the control group ($P < 0.05$). The vertebral height, Cobb angle, posterior edge height, midline height, and anterior edge height of the study group were significantly better than those of the control group ($P < 0.05$). The ODI score of the study group was significantly reduced, and the BI index score was significantly increased compared with those of the control group ($P < 0.05$). Conclusion: PKP had achieved good clinical results in treating elderly patients with osteoporotic thoracolumbar vertebral compression fractures, which reduced blood loss and relieved pain. PKP also improved the front edge height of the vertebral body and correct kyphosis of the vertebral body, and reduced the ODI score and improved the BI score.

**Keywords:** Percutaneous kyphoplasty, osteoporotic thoracolumbar compression fractures in the elderly, clinical efficacy, blood loss, pain, ODI index score

## Introduction

Osteoporotic thoracolumbar compression fractures are considered as one of the most common clinical orthopedic diseases. As the older population in China grows dramatically, the number of elderly people diagnosed with osteoporotic thoracolumbar compression fractures is increasing annually. For the changes of bone mineral density, osteoporosis is a common disease among the elderly, and it easily results in osteoporotic thoracolumbar compression fractures. Some elderly patients resort to ineffective conservative treatment, while others use medical treatment with low-efficacy and bad prognosis. Apart from that, the high cost of traditional surgical treatment does not guarantee ideal therapeutic effects. Elderly patients with osteoporotic thoracolumbar compression fractures suffer from severe lower back and chest pain, which generates complications like kyphosis that undermine the spinal stability and seriously affect the life quality of patients. Also, long-term medical therapy can cause multiple complications. Studies illustrate how percutaneous kyphoplasty (PKP) and percutaneous vertebroplasty belong to the same minimally invasive technique. Based on percutaneous vertebroplasty, bone cement is injected by PKP into the vertebral body through the vertebral pedicle, thus enhancing the strength and stability of the vertebral body and improving therapeutic effects [4-6]. On the other hand, percutaneous vertebroplasty injects bone cement into the injured vertebrae directly. The streng-

th and hardness of the vertebral body is promoted by the hardening bone cement and the supporting ability is reinforced, restoring the height and strength. This method reduces the sensitivity of nerves to pain mainly by the thermal effect of the bone cement [7]. However, percutaneous vertebroplasty results in poor effects of restoring patients' injured vertebrae to its normal height and easily leads to malformation fixations. The bone cement injection often can cause bone cement leakage, hence reducing the therapeutic effects. PKP creates a relatively closed space through vertebral augmentation by injecting contrast medium. This bone cement injection method helps lower the possibility of bone cement leakage and restore the normal height and reduction of the vertebral body by balloon dilation, hence maintaining the persistent stability of the spine [8-10]. Therefore, this study aimed to investigate the effects of percutaneous kyphoplasty (PKP) on the clinical efficacy, blood loss, pain and Oswestry disability index (ODI) index scores of elderly patients with osteoporotic thoracolumbar compression fractures.

## Materials and methods

### *General data*

From February 2015 to May 2018, 80 elderly patients with osteoporotic thoracolumbar vertebral compression fractures treated in our hospital were selected. The patients were divided into two groups, a control group and a study group with 40 cases in each based on a random number table method. The control group included 22 males and 18 females aged 60 to 75 years old with weight ranging from 44 to 75 kg, the average age being 65.75±5.86 years old and the average weight being 62.35±3.26 kg. Among the control group, there were 13 cases of L1 lesions, 13 cases of L2 lesions and 14 cases of T12 lesions. The study group included 23 males and 17 females aged 60 to 80 years old with weight ranging from 44 to 77 kg, the average age being 66.35±6.12 years old and the average weight being 63.24±4.25 kg. Among the study group, there were 14 cases of L1 lesions, 15 cases of L2 lesions and 11 cases of T12 lesions. There was no significant difference in general clinical information in terms of age, gender and other data between the two groups ($P > 0.05$). The study was approved by the Ethics Committee in our hospital and informed consent was given by all the patients. Inclusion criteria: patients over 60 years old; patients with a bone mineral density lower than 0.72 g/cm$^2$ presented by L2-L4 vertebra density and a T value lower than -2.5 SD (osteoporosis); patients diagnosed with thoracolumbar vertebral compression fractures based on clinical manifestations and the frontal and lateral X-ray examination of the thoracolumbar spine [5-7]; patients with lumbago. Exclusion criteria: patients complicated with diseases of other tissues and organs (such as liver and kidney); patients with acute infections; patients with vertebral tuberculosis; patients with coagulation disorders; patients with pathologic thoracolumbar compression fractures; patients with poor compliance; or patients with incomplete clinical data.

### *Methods*

*Treatment methods:* The control group: patients received percutaneous vertebroplasty. Under the examinations of MRI, CT, etc., patients' vertebral pedicle and fractures were located. Punctures on both sides of the vertebral body were performed, and the operations were completed under the guidance of a fluoroscopy machine. The needle core was removed when the puncture needle was inserted into the 1/3 vertebral body; the methyl methacrylate bone cement was then injected, and 6 to 7 sticks of bone cement were extracted. After the extracted bone cement solidified, the puncture needle was removed, the patients were bandaged up, and the body position and use of antibacterial drugs were enhanced. Patients' vital signs were monitored in real-time, and sit-up training was provided according to patients' recovery conditions. The study group: patients received PKP. Patients laid down in the prone position. A C-arm fluoroscopy perspective and pedicle projection were used, and the puncture point was marked. Patients were under local anesthesia and the vertebral pedicle was punctured. With the correct guidance of the needle point's direction, the anterior 1/3 of the injured vertebra was punctured. The needle core was removed, the dilated balloon was inserted, the contrast medium was injected, and the compressed vertebral body

**Table 1.** Comparison of the clinical efficacy [rate (%), n=40]

| Groups | Excellent | Fair | Poor | Excellent rate |
|---|---|---|---|---|
| Control group | 10 (25.00) | 19 (47.50) | 11 (27.50) | 29 (72.50) |
| Study group | 27 (67.50)* | 11 (27.50) | 2 (5.00)* | 38 (95.00)* |
| $X^2$ | 14.532 | 3.413 | 7.440 | 7.440 |
| *P* | 0.000 | 0.065 | 0.006 | 0.006 |

Note: Compared with the control group, *$P < 0.05$.

**Table 2.** Comparison of the operation time, the blood loss and the VAS score between the two groups ($\bar{x} \pm s$, n=40)

| Groups | Operation time (min) | Intraoperative blood loss (mL) | VAS score |
|---|---|---|---|
| Control group | 106.24±15.24 | 312.02±36.24 | 6.98±1.03 |
| Study group | 55.21±10.29* | 97.54±17.58* | 4.21±1.01* |
| *t* | 17.551 | 33.677 | 12.144 |
| *P* | 0.000 | 0.000 | 0.000 |

Note: Compared with the control group, *$P < 0.05$.

was decompressed. The operation was stopped if the vertebral plate ruptured. The bone cement was injected into the channel until the anticipated balloon dilatation capacity was reached. The dose of lumbar vertebra was 4 to 6 mL and the dose of thoracic vertebra was 3 to 4 mL. The injection was stopped if bone cement leakage occurred. The puncture needle was removed before the bone cement solidified, and anti-inflammatory drugs were given after bandaging. If patients showed no obvious abnormality 8 hours after the operation, a basic amount of exercises were given.

*Criteria for the clinical efficacy:* The healing rate of the two groups were compared. Patients that were marked as excellent had healed fractures, normalized compressed vertebral body and were free of pressing pain, swelling pain and mobility dysfunction. Patients that were marked as fair had over 3/5 compressed vertebral body recovery and significant alleviation of pressing pain, swelling pain and mobility dysfunction. Patients that were marked as poor if they had no signs of compressed vertebral body recovery and no significant changes of pressing pain, swelling pain and mobility dysfunction. Excellent rate (%) = (excellent + fair)/ total number ×100%.

*Observation indexes:* Observation indexes such as the operation time and blood loss during surgery were compared. The visual analogue scale (VAS) was on a scale of 1 to 10, the larger the number, the higher the pain level [12]. The vertebral body height, Cobb angle, posterior edge height, midline height, anterior edge height in the two groups were compared.

*ODI and BIscores:* The ODI score of the two groups was compared. Ten entries were included (6 items per entry). On a scale of 1 to 5 (per item), the larger the number, the more severe the patients' dysfunction [13]. The BI score was used to evaluate patients' postoperative mobility. On a scale of 0 to 100, the larger the number, the better the patients' mobility [14].

*Statistical analysis*

Statistical analysis was conducted using the SPSS 21.0. The measurement data that were in accordance with a normal distribution were presented by $\bar{x} \pm s$, and analyzed with independent sample t-test in two-group comparison and one-way variance analysis in multiple-group comparisons. The enumeration data were tested by $X^2$. $P < 0.05$ was considered statistically significant.

## Results

*Comparison of the clinical efficacy*

The healing rate of patients in the study group increased significantly in comparison with the control group ($P < 0.05$, **Table 1**).

*Comparison of operation time, blood loss during surgery and VAS score*

The study group had a significantly shortened operation time, significantly reduced blood loss during surgery and VAS score in comparison with the control group ($P < 0.05$, **Table 2**).

*Comparison of the related indexes between the two groups*

The vertebral height, Cobb angle, posterior edge height, midline height, and anterior edge height of the study group were all significant-

**Table 3.** Comparison of the related indexes between the two groups ($\bar{x} \pm s$, n=40)

| Groups | Vertebral height ($\times 10^{-2}$) | Cobb angle (°) | Posterior edge height (mm) | Midline height (mm) | Anterior edge height (mm) |
|---|---|---|---|---|---|
| Control group | 67.58±3.25 | 16.29±1.26 | 21.36±1.58 | 12.13±1.25 | 12.21±1.25 |
| Study group | 79.65±3.24* | 11.25±1.52* | 23.68±3.21* | 14.98±1.57* | 15.32±1.57* |
| *t* | 16.634 | 16.145 | 4.101 | 8.982 | 9.801 |
| *P* | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Note: Compared with the control group, *$P < 0.05$.

**Table 4.** Comparison of the ODI score and BI score between the two groups ($\bar{x} \pm s$, n=40)

| Groups | ODI score | BI score |
|---|---|---|
| Control group | 35.87±6.25 | 75.25±9.62 |
| Study group | 23.26±3.29* | 93.26±8.21* |
| *T* | 11.292 | 9.006 |
| *P* | 0.000 | 0.000 |

Note: Compared with the control group, *$P < 0.05$.

ly better than those of the control group ($P < 0.05$, **Table 3**).

*Comparison of the ODI score and BI score*

The study group saw a significantly reduced ODI score, while the BI score significantly increased ($P < 0.05$, **Table 4**).

## Discussion

The incidence of osteoporotic thoracolumbar compression fractures among the elderly increases annually. In recent years, the probability of elderly people being diagnosed with osteoporotic thoracolumbar compression fractures caused by osteoporosis is increasing dramatically. Several main features of osteoporosis are osteopenia, the reduction of bone trabecular structure and the increase of bone fragility. One of the most common fracture types is thoracolumbar vertebral compression fracture, which has negative influences on the quality of life of patients. Studies have shown that patients treated with traditional conservative treatments require chronic bedrest and may suffer from accelerated bone loss. Patients treated with surgeries using pedicle screw fixation techniques fail to maintain vertebral compressive strength. This treatment also influences the interface quality of bones and pedicle screws [15, 16]. With the development of new therapy techniques, PKP provides new directions for the treatment of elderly patients with osteoporotic thoracolumbar compression fractures. It mainly promotes the vertebral body to be restored by balloon dilatation. Osteoporosis lowers the bone mineral density, but balloon dilatation extrudes surrounding bone tissues, creates a relatively closed space, augments space for bone cement filling and prompts the solidification of the supporting vertebral body [17]. Studies have demonstrated that traditional treatments like manual reduction and bedrest require longer treatment times and have poor prognosis. Percutaneous vertebroplasty results in relatively poor therapeutic effects by injecting the bone cement directly into the patients' vertebral body. PKP injects the bone cement only after balloon dilatation, which gives good therapeutic effects of vertebral reduction. Additionally, on the safety performance level, PKP is better than percutaneous vertebroplasty [18-20].

Our study shows that, the excellent healing rate of patients in the study group increased significantly compared with the patients in the control group. This suggests that in treating elderly patients with osteoporotic thoracolumbar compression fracture, the therapeutic effects of PKP have significant advantages over percutaneous vertebroplasty. Studies have indicated that PKP requires less surgery time and causes less blood loss during surgery [21-23]. This study demonstrated that the operation time in the study group was significantly shortened and the blood loss during surgery was significantly reduced compared with the control group. Based on the above mentioned indexes, PKP significantly shortens surgery time and blood loss for the elderly patients with osteoporotic thoracolumbar compression fractures. Previous studies have also proved that increasing the strength and restoring the height and strength of the vertebral body for

the elderly patients with osteoporotic thoracolumbar compression fractures contributes to improving patients' symptoms and alleviating their physiological trauma [24, 25]. The findings of the study indicate that the vertebral height, cobb angle, posterior edge height, midline height, and anterior edge height of the study group were significantly better than those of the control group. Thus, PKP contributes more to restoring the vertebral body and enhancing its strength for the elderly patients with osteoporotic thoracolumbar compression fractures. All these results were similar to previous studies [26, 27]. This study also suggested that the VAS score of the study group significantly reduced compared with the other group. PKP effectively alleviated the pain level for the elderly patients with osteoporotic thoracolumbar compression fractures. In addition to PKP's therapeutic effects and patients' index improvement, CT and MRI examination should be reinforced in fractured vertebral body relocation; the bone cement injection technique needs improving to lower the incidence of bone cement leakage; antiosteoporosis drug should be used in treatment during the perioperative period to improve patients' bone metabolism. Meanwhile, compared with the control group, the ODI score of the study group significantly reduced, and the BI score significantly increased. This also resonates with the results documented in related literature [28-30], indicating that PKP effectively improves clinical symptoms and postoperative mobility for the elderly patients with osteoporotic thoracolumbar compression fractures. These may be attributed to the fact that PKP treatment can relieve pain through vertebral body decompression and spinal remodeling.

In summary, positive therapeutic effects were examined in the application of PKP in elderly patients with osteoporotic thoracolumbar compression fractures. It contributes to patients' thoracolumbar function recovery, dysfunction and pain level relief, anterior edge height improvement and percutaneous kyphoplasty deformities correction. However, there may be bias in this study due to its small sample size and other external factors, thus further studies are needed to explore more accurately.

## Disclosure of conflict of interest

None.

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