

## Original Article

# The study on the possible relationship between the residual bone cement in vertebral pedicle and the prognosis of osteoporotic vertebral compression fractures

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**Abstract:** Objective: To explore possible relationship between the residual bone cement in vertebral pedicle and the prognosis of osteoporotic vertebral compression fractures in patients who were treated with percutaneous vertebroplasty. Methods: A total of 100 patients admitted to our hospital from January 2013 to December 2016, who had low back pain in different degrees after treated with percutaneous vertebroplasty for osteoporotic vertebral compression fractures during one-year follow-up, were selected as subjects. Those patients were divided into the slight pain group (SlIP group) (0-3 points) and the severe pain group (SevP group) (4-10 points) according to the postoperative VAS scores, and each group included 50 cases. The pain degrees of the patients in two groups were assessed and compared using the visual analog scale (VAS), the CT scan was performed to the medial and lateral vertebral pedicle for marking bone cement residue (BCR) and the scores were compared. Meanwhile, Pearson methods were also performed to analyze the relationship between BCR scores and the VAS scores. And the recurrences and the hospitalization of patients were compared between these two groups. Results: Before operation, there is no significant difference in the VAS scores between two groups. After operation, the VAS score of SlIP group ( $2.23 \pm 0.87$ ) was significantly lower than that in the SevP group ( $4.48 \pm 0.91$ ) ( $P < 0.05$ ) and the difference was statistically significant. The BCR scores in medial and lateral vertebral pedicle in SlIP group ( $0.22 \pm 0.06$ ,  $0.26 \pm 0.08$ ) were significantly lower than those in SevP group ( $0.39 \pm 0.13$ ,  $0.46 \pm 0.17$ ) ( $P < 0.05$ ). And the BCR scores in medial and lateral vertebral pedicle were positively correlated with postoperative low back pain ( $r = 0.757$ ,  $0.773$ ,  $P = 0.011$ ,  $0.009$ ). The recurrence (2%) and hospitalization ( $7.58 \pm 2.54$  d) of patients in SlIP group were significantly lower than those in SevP group ( $P < 0.05$ ). Conclusion: After percutaneous vertebroplasty, the postoperative VAS scores and recurrences of fracture of osteoporotic vertebral compression fractures were low, the hospitalization of patients was short and the BCR scores in vertebral pedicle were positively correlated with postoperative low back pain. Therefore, we can improve the therapeutic effects and alleviate postoperative low back pain by clearing the BCR away.

**Keywords:** Osteoporotic vertebral compression fractures, bone cement, percutaneous vertebroplasty, postoperative low back pain

## Introduction

The osteoporotic vertebral compression fracture is a kind of common disease in clinical orthopedics. As a new therapeutic method, percutaneous vertebroplasty has been used extensively, which can get ideal results. Many researches showed that percutaneous vertebroplasty could quickly alleviate patients' pain and improve the biomechanical intensity of vertebral [1-3]. However, there are still some argu-

ments on the mid-term and long-term results of percutaneous vertebroplasty. Some studies showed that patients felt satisfied with the pain remission and had a high quality of life 6 months or so after operation [4]. Others showed that the long-term results of osteoporotic vertebral compression fracture treated with operation was equivalent to the conservative treatment [5]. Besides, there were some studies reporting that some patients suffered low back pain in different degrees after the vertebroplas-

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**Table 1.** Comparison of the general data between the two groups

Group	Gender (case) (male/female)	BD (T value)	Bone cement injection volume (mL)	BMI (kg/m <sup>2</sup> )	Age (years old)	Fracture site (case)				
						T11	T12	L1	L2	L3
SliP group	32/18	-3.0±1.4	4.0±0.4	24.3±2.7	73.2±5.4	5	13	16	10	6
SevP group	31/19	-3.1±1.6	4.1±0.5	24.1±2.3	74.6±4.9	4	12	17	9	8

ty so that the bed rest time and immobilized time were prolonged, thereby influencing the quality of life and the effects of operation [6]. The analysis on the reasons of low back pain after vertebroplasty is conducive not only to providing effective methods in the treatment, but also improving the rehabilitation and the life quality of patients [7]. Whether the different postoperative remission degree is related to the individual differences of the patients, the bone cement injection volume, the distribution of bone cement and other factors is still unclear so far. Most scholars thought that the bone cement injection volume had no significant relationship with analgesic effects. And there were few reports about the relationship between the bone cement residue (BCR) in vertebral pedicle and the remission of postoperative low back pain. For this purpose, this research aimed at providing experimental evidence for clinical treatments by analyzing the effects of BCR after percutaneous vertebroplasty in vertebral pedicle on the prognosis of osteoporotic vertebral compression fractures.

## Materials and methods

### Clinical data

One hundred patients who were successfully treated with percutaneous vertebroplasty in our hospital from January 2013 to December 2016 were selected to be the subjects of our research. During the one-year follow-up, the patients all showed osteoporotic vertebral compression fractures with different degrees of low back pain. Percutaneous vertebroplasty was performed by the same group of physicians. On the first day after operation, patients should lie in bed for one day. On the second day, patients should wear girdles to get out of the bed. Patients should avoid carrying heavy objects for three months. At the same time, they were treated with calcitonin, Salmon Calcitonin Nasal Spray calcium supplements and anti-osteoporotic treatment. Cefotiam was

used for anti-inflammatory treatment. All patients received pain education which would help them analyze the mechanisms, causes, possible positions, kinds and the effects on body of the low back pain. The ways to face the pain, the methods to relieve pain and other things were introduced.

**Inclusion criteria:** All the patients who conformed to the clinical diagnosis of osteoporosis according to two-photon bone density (BD) detection; patients who suffered from low back pain, obvious local percussion pain and tenderness; patients without symptoms of neurologic compression and local infection at the site of the puncture, coagulation disorders or other diseases; patients with good operation compliance; patients who could be followed up for a long period after operation; patients whose operations used polymethacrylate as the type of bone cement, whose fracture type was single vertebral compression fracture, whose centrum's degree of compression was less than 1/3 or whose upper and lower endplate and the posterior border of centrum were complete.

**Exclusion criteria:** Patients with incomplete collected clinical data, good BD or spinal nerve injury; patients whose causes of vertebral fracture were infection, tumors and so on; patients who suffered from high energy damage such as traffic accidents.

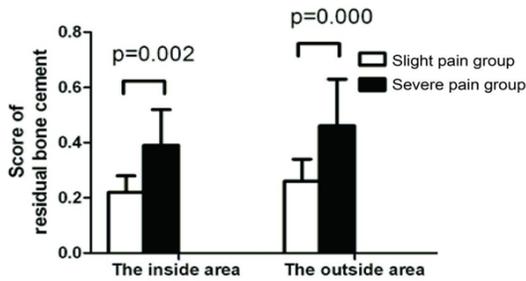
The patients were divided into the slight pain group (SliP group) (0-3 points, the slight pain could be endured and would not affect appetite and sleep) and the severe pain group (SevP group) (4-10 points, the severe pain could hardly be endured and would affect appetite and sleep) according to the postoperative visual analog scale (VAS) scores, and each group included 50 cases. There were 32 males and 18 females in the former group. The age ranged from 60 to 80 years old, with an average of  $73.2 \pm 5.4$  years old. There were 31 males and

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**Table 2.** Comparison of VAS scores before and after operation (n,  $\bar{x} \pm s$ )

	Cases	Before operation	After operation	T value	P value
SliP group	50	6.26±1.07	2.23±0.87* <sup>#</sup>	14.362	0.015
SevP group	50	6.31±1.11	4.48±0.91*	13.265	0.039

Notes: Compared with that before operation, \*P<0.05; compared with SevP group, <sup>#</sup>T=14.026, P=0.026.



**Figure 1.** Comparison between BCR scores of medial and lateral vertebral pedicle of patients.

19 females in the latter group. The age ranged from 61 to 82 years old, with an average of  $74.6 \pm 4.9$  years old. The general data of two groups were shown in **Table 1**. There was no statistically significant difference.

### Methods

The hospitalization and rates of refracture of all the patients during the follow-up period were collected and sorted out. The degrees of low back pain after the operation were assessed by VAS, including preoperative pain and postoperative pain after the follow-up period. We used 64-section CT to do spine scan check-ups for patients after operation. All the patients' CT images which were exclusive of metal artifact were collected to assess the BCR in vertebral pedicle. The assessment was done by two independent observers. If opinions of two observers were divided on the assessment, the views of the third observer would be regarded as the final result. Other clinical data of patients were kept concealed to them.

### Observation indexes

The VAS scores of two groups before and after operation were compared. The VAS scores judgment standard: The total number of scores was 10. A higher score indicated a more severe

pain level. The BCR scores of medial and lateral vertebral pedicle were compared. BCR judgment standard: If BCR was found in the medial and lateral side of the vertebral pedicle, the score was counted as one. If BCR was not found in the vertebral pedicle, the score was counted as zero. The rates of refracture and hospitalization of all the patients were compared and the relationship between the BCR scores of vertebral pedicle and low back pain after operation was analyzed.

### Statistical methods

All data were analyzed by SPSS 19.0 software. Quantitative data were all expressed as  $\bar{x} \pm s$ . Differences between the groups were tested by t test. Chi-square test was applied to compare the qualitative data. The relationship between the BCR scores of vertebral pedicle and low back pain after operation was analyzed by Pearson correlation analysis. There was statistical difference when  $P < 0.05$ .

### Results

#### *The comparison of VAS scores between two groups*

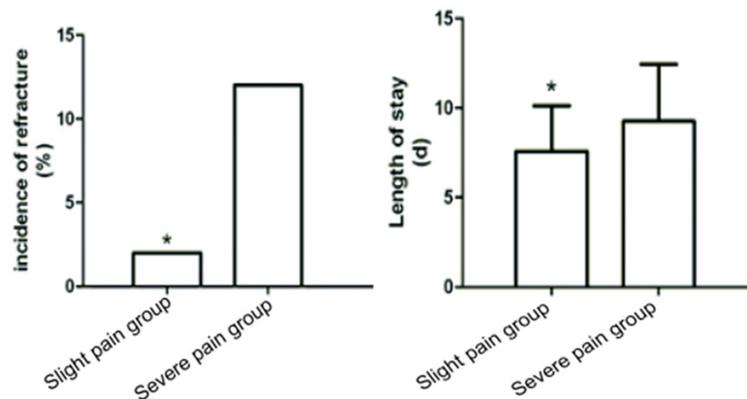
There was no significant difference in pre-operative VAS scores between the two groups. Compared with that before operation, postoperative VAS scores of patients in SevP group and SliP group significantly declined, the difference of which was of statistical significance ( $P=0.039$ ,  $P=0.015$ ). Furthermore, the VAS score of SliP group ( $2.23 \pm 0.87$ ) was significantly lower than that in the SevP group ( $4.48 \pm 0.91$ ) ( $P < 0.05$ ), the difference of which was of statistical significance ( $P=0.026$ ) (**Table 2**).

#### *BCR scores of medial and lateral vertebral pedicle*

According to standard of BCR scores, the BCR score in the medial vertebral pedicle of the patients in SevP group was  $0.39 \pm 0.13$  and the BCR score of lateral area was  $0.46 \pm 0.17$ . While the BCR score in the medial vertebral pedicle of the patients in SliP group was  $0.22 \pm 0.06$  and that of lateral area was  $0.26 \pm 0.08$ . The statistical analysis showed that compared

**Table 3.** Analysis of correlation between BCR scores of vertebral pedicle and postoperative low back pain

	VAS scores of postoperative low back pain	
	R value	P value
BCR scores of medial area	r=0.757	0.011
BCR scores of lateral area	r=0.773	0.009



**Figure 2.** Comparison of recurrences of fractures and hospitalization time of patients between two groups. \*P<0.05, compared with SevP group.

with SevP group, BCR scores of medial and lateral vertebral pedicle significantly decreased, the difference of which was of statistical significance (P=0.002, P=0.000) (Figure 1).

*Relationship between BCR scores of vertebral pedicle and postoperative low back pain*

The results of Pearson correlation analysis showed that the correlation coefficient between the BCR scores of medial and lateral vertebral pedicle and postoperative VAS scores was 0.757. There was a positive correlation between the BCR scores and the postoperative VAS scores, the differences of which were both of statistical significance (P<0.05) (Table 3).

*The comparison of recurrences of fracture and hospitalization of patients between two groups*

There was no symptom of neural compression resulting from bone cement extravasation. Only one occurred T12 compression fractures again in SliP group while there was six cases of adjacent vertebral body fracture in SevP group, as for recurrences of fracture, there was a significant difference between the two groups (P<0.05); compared with SevP group (9.26 ± 3.17 days), the hospitalization of SliP group

(7.58 ± 2.54 days) were significantly shorter, the difference of which was statistical significance (P<0.05) (Figure 2).

**Discussion**

Osteoporotic vertebral compression fractures were mostly in old age group. With the increasing aging population in China, the incidence rate was increasing year by year [8]. Percutaneous vertebroplasty, enhanced the intensity and stability of the vertebral body mainly through the infusion of bone cement to the lesion, which had certain therapeutic effects [9]. The possible mechanism was as follows: the injection of bone cement quickly increased the biomechanical strength of injured centrum, providing a good support for cortical bone [10, 11]. In the polymerization and curing reaction, bone cement could release energy, thereby destroying and cauterizing the sensory nerve endings at the injured site. The polymethylmethacrylate monomer left in bone cement had a toxic effect on sensory nerve endings. In this study, patients with percutaneous vertebroplasty were followed up for 1 year, showing that postoperative VAS scores were significantly lower than those of pre-operation, the difference of which was of statistical significance (P<0.05). Thus, compared with preoperative pain, relieving pain by the injection of bone cement could maintain for quite a long time, which was almost similar to previous research reports [12, 13]. However, some studies showed that the degrees of pain relief of percutaneous vertebroplasty were different and some patients still suffered from low back pain [14]. Therefore, in-depth studies of patients with low back pain were helpful in providing clinical guidance for the prevention and remission of low back pain after percutaneous vertebroplasty.

Bone cement, the biomaterials to fill the gap between bone and implant or bony cavity, is autopolymerizing itself [15]. Though the technique of bone cement has developed to some

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extent, there are some shortcomings. The distribution, quantity and other factors of bone cement have some relationships with the low back pain after percutaneous vertebroplasty [16, 17]. Some studies suggested that the more bone cement filled, the higher pressure produced in vertebra, which would easily lead to bone cement extravasation and further complications like low back pain [18-20]. On the other side, because of the low mechanical properties of bone cement, under the physiological load, bone cement would cause fractures of bone cement or even the ruptures of mud layers, thereby affecting the therapeutic effects and then causing the postoperative low back pain. Besides, the great heat produced during polymerization of bone cement may cause burn damage to bone bed and then result in the low back pain as well. Nevertheless, the relationship between the residual bone cement in vertebral pedicle and the pain after percutaneous vertebroplasty was not clear, while the relating studies was so limited. However, this study manifested that patients in both groups had no bone cement extravasation, while the SliP group had obviously lower postoperative VAS scores of low back pain than SevP group. Furthermore, the former had obviously lower BCR scores in medial and lateral vertebral pedicle than the latter, which proved a certain relationship between the BCR scores and postoperative low back pain. According to the results of Pearson correlation analysis, a significant positive correlation was observed between postoperative low back pain and the BCR scores in medial and lateral vertebral pedicle respectively. In addition, the results of this study also revealed that the recurrences of fracture and hospitalization of the SliP group were both significantly lower than the SevP group, which proved that the lower BCR score got, the worse patients' prognoses might occur. Meanwhile, it indicated that BCR score in vertebral pedicle possibly have relationship with the therapeutic effects of operation. Moreover, the possibility of the BCR in vertebral pedicle entering the circulation of blood has been brought out in some studies, resulting in dilating blood vessel, decreasing myocardial contraction and causing pulmonary embolism after entering the vein. If effective treatments were not taken, severe hypotension or even cardiac arrest would happen [21, 22].

In conclusion, the relationship between patients' prognoses and the BCR in medial and lateral vertebral pedicle after percutaneous vertebroplasty does exist. During the operation, the BCR in medial and lateral vertebral pedicle should be evacuated with great care, in order to alleviate or prevent the occurrence of postoperative low back pain, so as to improve patients' surgical outcomes and prognoses. However, there are some limitations still remaining in this study. As a retrospective study, some confounding factors are inevitable, for instance, no randomization in patients, the small sample size and the single-center study. The following studies should have multiple centers, large sample size and randomized controlled trial to further investigate the relationship between BCR in vertebral pedicle and the prognosis of percutaneous vertebroplasty.

### Disclosure of conflict of interest

None.

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