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Original Article

Effect of vertebroplasty with bone cement on osteoporotic compression fractures in elderly patients

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Abstract: Objective: To explore the effect of vertebroplasty with bone cement on elderly patients with osteoporotic compression fractures. Methods: A retrospective study was conducted on 130 patients with osteoporotic compression fractures treated at the Second Hospital of Hebei Medical University from January 2018 to January 2022. According to different treatment methods, 50 patients who underwent conservative treatment were included in a control group (CG), and 80 patients who underwent vertebroplasty were included in a research group (RG). The anterior vertebral height, kyphotic Cobb angle, and Oswestry Disability Index (ODI) score in both groups were observed before and after treatment. The Visual Analogue Scale (VAS) scores were compared between the two groups before and after treatment. The quality of life and efficacy were evaluated in both groups. Results: After treatment, the anterior vertebral height in the RG exhibited a significant increase compared to that before treatment, and both groups showed a significant decrease in the Cobb angle and ODI ($P<0.05$). Furthermore, the RG exhibited notably higher anterior vertebral height, and significantly lower Cobb angle and ODI than the CG after treatment ($P<0.05$). The post-treatment VAS score decreased significantly in both groups ($P<0.05$), and was lower in the RG than that in CG ($P<0.05$). After treatment, the quality of life scores improved significantly in both groups ($P<0.05$), but the RG demonstrated significantly higher scores in the role-emotional, physical functioning, social functioning, and general health (GH) dimensions compared to the CG ($P<0.05$). The total response rate in the CG was significantly lower than that in the RG ($P<0.05$). Age, course of disease, underlying disease, distribution of bone cement, and leakage of bone cement were found to be risk factors affecting the prognosis of patients. Logistic regression analysis showed that course of disease, distribution of bone cement, and leakage of bone cement were independent risk factors affecting prognosis. Conclusions: Vertebroplasty with bone cement is an effective treatment for elderly patients suffering from osteoporotic compression fractures. This intervention can improve anterior vertebral height, kyphotic Cobb angle, and ODI, while alleviating pain and enhancing the quality of life. Given its promising clinical outcomes, this treatment is highly recommended.

Keywords: Bone cement, vertebroplasty, osteoporosis, compression fracture, effect

Introduction

Osteoporosis is a prevalent skeletal disorder that manifests as a systemic condition typified by reduced bone mass, compromised microarchitecture of bone tissue, heightened bone fragility, and susceptibility to fractures [1, 2]. Elderly individuals with osteoporosis are at a significantly elevated risk of fracture, which can impair the quality of life, lead to disability, or even threaten patient life [3]. According to relevant surveys, the prevalence rate of osteoporosis among individuals aged 50 and above in China is approximately 19.2%. However, for those aged 65 and above, the prevalence rate increases to around 32.0%. Osteoporosis can develop at any age, but it is more prevalent among elderly patients [4]. Nevertheless, there is currently a lack of awareness and recognition of the risk of osteoporosis, resulting in low screening rates. According to a survey, the rate of awareness of osteoporosis among patients over the age of 50 is only 7.0%, and the rate of bone density detection is even lower, at 3.7% [5]. Osteoporosis is often accompanied by complications, such as fragility fractures, thoracic

vertebra deformation, spinal deformation, and compression fractures that can seriously affect daily life.

The primary area of stress on the spine is in the thoracolumbar region, making elderly patients with osteoporosis particularly susceptible to compression fractures of those vertebrae. These fractures can result in symptoms such as pain, swelling, functional impairment, and even deformity in severe cases [6]. Currently, conservative treatment, reduction and internal fixation, and vertebroplasty are available for the treatment of osteoporotic compression fractures. For elderly patients with osteoporosis, vertebroplasty is a preferable option since it causes less trauma, preserves spinal stability, and prevents further deterioration of spinal injury [7]. Vertebroplasty, also referred to as percutaneous vertebroplasty, is a minimally invasive surgical procedure that reinforces the vertebrae by injecting bone cement or artificial bone into the affected vertebrae [8]. This procedure can shorten the treatment time and reduce the incidence of complications. Previous studies [9] have demonstrated the efficacy of vertebroplasty in treating compression fractures in patients with osteoporosis and relieving pain, surpassing the efficacy of conventional treatment methods.

Therefore, this study was designed to explore the therapeutic effect of vertebroplasty with bone cement in elderly patients with compression fractures by comparing it with conservative treatment, aiming to provide a further reference for the clinical treatment of this disease.

Methods and materials

Clinical data

A retrospective study was conducted on 130 patients with osteoporotic compression fractures treated at the Second Hospital of Hebei Medical University from January 2018 to January 2022. Based on different treatment methods, 50 patients who underwent conservative treatment were included in a control group (CG), and 80 patients who underwent vertebroplasty during the same time period were included in a research group (RG). This research was approved by the Medical Ethics Committee of the Second Hospital of Hebei Medical University.

Inclusion and exclusion criteria

Inclusion criteria: patients who met the diagnostic criteria of osteoporosis [10] and had a confirmed diagnosis of vertebral compression fractures; patients who met the surgical indications and agreed to undergo surgery; patients with comprehensive clinical data.

Exclusion criteria: patients with surgical contraindications; patients with a history of lumbar surgery; patients with low compatibility and poor adherence; patients with end-stage malignant tumors or other diseases; patients with severe cardiovascular or cerebrovascular diseases or hematologic disorders; patients with mental disorders.

Therapeutic schemes

In the CG, patients were treated with conservative treatment. The patients received celecoxib (Pfizer Pharmaceuticals Limited, SFDA approval No. J20140072, specification: 0.2 g*18 capsules, once a day) and zoledronate sodium (Zhengda Tianqing Pharmaceutical Group Co., Ltd., SFDA approval No. H20041346, specification: 5 ml:4 mg). The patients were advised to maintain complete bed rest on a firm surface. Additionally, they were instructed to place a cylindrical soft pillow beneath the fracture site, ideally positioned approximately 10 cm above the bed. The patients were also encouraged to engage in upper and lower limb exercises to promote limb function. One week later, the patients were instructed to increase the functional exercises for the muscles of the back and waist. Two weeks later, the patients were instructed to engage in activities out of bed. The fracture recovery was observed after treatment.

In the RG, patients were treated with vertebroplasty with bone cement. Before surgery, routine checks were conducted to assess blood pressure and electrocardiogram. During the operation, each patient was placed in the prone position, and a thoracolumbar pad was utilized to facilitate hyperextension of patient's thoracolumbar vertebrae. C-arm fluoroscopy was used to determine the location of the fractured vertebra, followed by local anesthesia. Under fluoroscopy, a thinner trocar was inserted into the vertebral body and placed in the middle 2/3-3/4 of the anterior vertebral body. The

Table 1. Evaluation criteria for clinical response

Efficacy grade	Evaluative criteria
Markedly effective	After treatment, the pain disappeared, and the fractured bone healed completely.
Effective	After treatment, the pain improved, and the fractured bone healed basically.
Ineffective	After treatment, the pain did not improve or even worsen, and the fractured bone did not heal.

Table 2. Comparison of clinical data

Factor	Control group (n=50)	Research group (n=80)	χ^2	P
Age			0.249	0.618
≤73 years old	26	38		
>73 years old	24	42		
Gender			0.339	0.560
Male	27	39		
Female	23	41		
Course of disease			1.170	0.279
≤20 days	28	37		
>20 days	22	43		
Educational level			0.376	0.540
Below junior college	29	42		
Junior college and above	21	38		
Underlying disease			0.008	0.927
Yes	36	57		
No	14	23		
Living environment			0.765	0.382
Urban	32	45		
Rural	18	35		
Ethnicity			0.689	0.406
Han	36	52		
Other ethnicities	14	28		

pressure pump connector was connected with the bone cement-filling oral tube, and the air was evacuated. Afterwards, the bone cement was blended and injected into a tissue filler. The viscous bone cement was filled into the thoracolumbar vertebrae, diffusing and flowing along the loose areas and fracture gaps within the vertebral body until reaching the back of the vertebra, at which point the filling process ceased. The filling quantity of bone cement was determined by the scale of the filler. After 2-3 minutes, the bone cement was completely hardened. Then, the puncture needle was withdrawn, and compression, hemostasis and wound dressing were performed. After the surgery, patients were instructed to take functional training, and their recovery progress was assessed regularly.

Outcome measures

Main outcome measures: The therapeutic response was compared between the two groups. Total response rate = (markedly effective + effective)/total number of patients *100%. The evaluation criteria of treatment response are shown in **Table 1**. In both groups, lateral radiographs were utilized to detect the anterior vertebral height and kyphotic Cobb angle before and after treatment. Oswestry disability index (ODI) [11] was employed to evaluate patient dysfunction before and after treatment. The index comprises 10 items (self-care ability, walking, standing, sitting, etc.), with each rated on a scale of 0 to 10 points. A higher score indicates a greater degree of dysfunction.

Secondary outcome measures: Visual Analogue Scale (VAS) [12] was utilized to compare the pain in both groups before and after treatment, with a total score of 10 points. A higher score indicates a severer pain. The quality of life questionnaire (SF-36) [13] was used to evaluate the patients' quality of life before and after treatment. This questionnaire comprises four domains, namely role-emotional (RE), physical functioning (PF), social functioning (SF) and general health (GH), with a maximum score of 100 points. A higher score indicates a better quality of life.

Statistical methods

GraphPad Prism 8 was used for data visualization. SPSS 20.0 (SPSS Inc., Chicago, IL, USA) was used to analyze the collected data. For

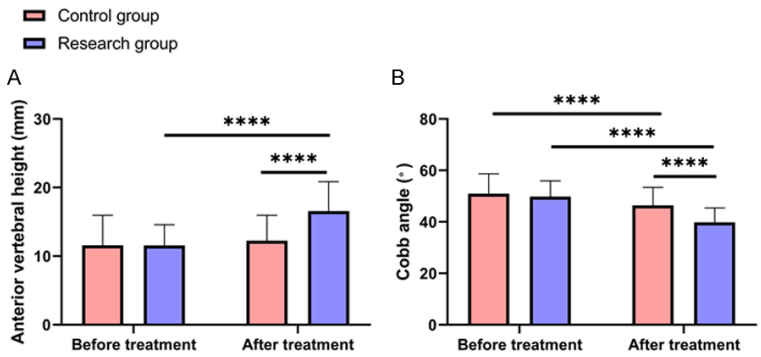

Figure 1. Comparison of anterior vertebral height and kyphotic Cobb angle before and after treatment. A. Changes in anterior vertebral height before and after treatment. B. Changes in Cobb angle before and after treatment. Note: **** means P<0.0001.

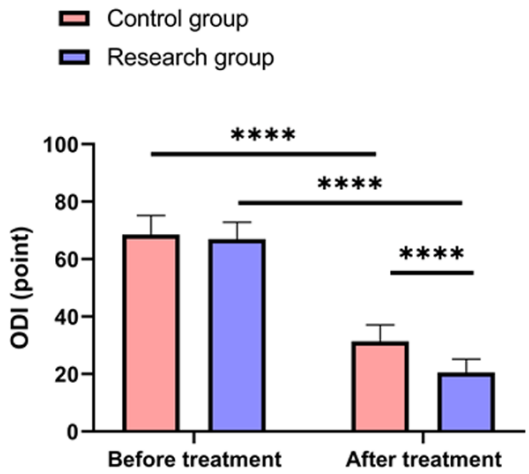

Figure 2. Comparison of ODI scores before and after treatment. Note: **** means P<0.0001. ODI: Oswestry Disability Index.

measured data, the independent sample t-test was used for inter-group comparison, and the paired t-test was used for intra-group comparison. Counted data were expressed as percentage (%) and tested by chi-square test, which was expressed as χ^2. Chi-square test was utilized for comparison of classified variables. Logistic test was used to analyze the risk factors affecting the prognosis of patients. Results were considered significant if P<0.05.

Results

Comparison of baseline data

There was no significant difference in age, gender, course of disease, educational level, living environment, or ethnicity between the two groups (P>0.05) (**Table 2**).

Comparison of anterior vertebral height and kyphotic Cobb angle before and after treatment

Before treatment, there were no significant differences in anterior vertebral height and Cobb angle between the two groups (P>0.05). After treatment, the anterior vertebral height in the RG was increased, and the Cobb angle was decreased in both groups (P<0.05). Furthermore, intergroup comparison showed that the anterior vertebral height in the RG was higher than that of the CG, and the Cobb angle in the RG was lower than that of the CG (P<0.05). See **Figure 1**.

Comparison of ODI scores before and after treatment

Before treatment, there was no significant difference in ODI between the two groups (P>0.05). After treatment, the ODI was significantly decreased in both groups (P<0.05), and intergroup comparison showed that the ODI in the RG was lower than that in the CG (P<0.05). See **Figure 2**.

Comparison of quality of life before and after treatment

Before treatment, there was no significant difference in quality of life between the two groups (P>0.05), but after treatment, the RE, PF, SF and GH in the RG were all higher than those of the CG (P<0.05). Intra-group comparison showed that RE, PF, SF, and GH were significantly increased in both groups after treatment (P<0.05) (**Figure 3**).

Comparison of VAS scores

Before treatment, there was no significant difference in VAS scores between the two groups (P>0.05), but after treatment, the VAS in the RG was lower than that of the CG (P<0.05). In addition, intra-group comparison showed that the

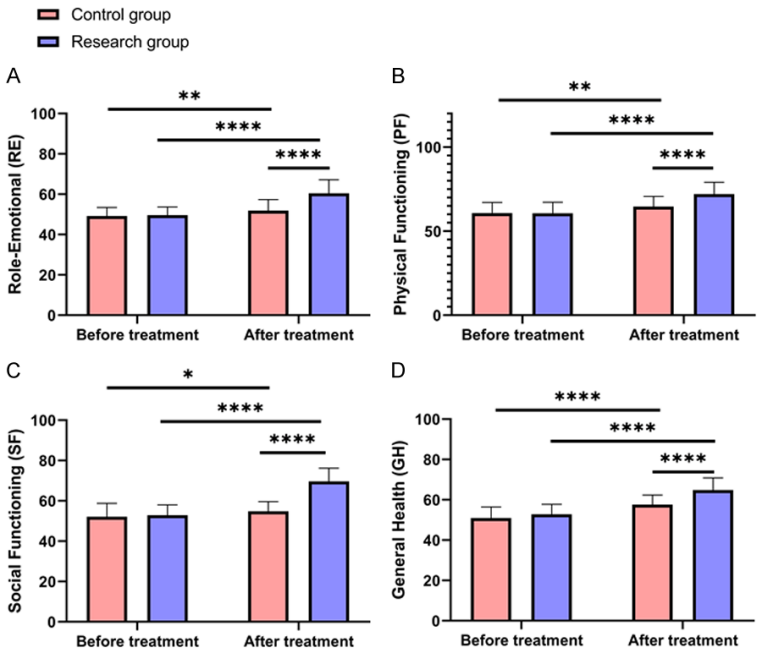

Figure 3. Comparison of quality of life before and after treatment. A. Changes in role-emotional before and after treatment. B. Changes in physical functioning before and after treatment. C. Changes in social functioning before and after treatment. D. Changes in general health before and after treatment. Note: * means P<0.05; ** means P<0.01; **** means P<0.0001.

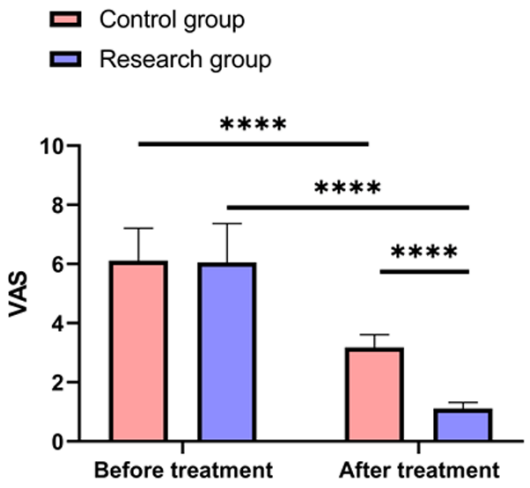

Figure 4. Comparison of VAS scores before and after treatment. Note: **** means P<0.0001. VAS: Visual Analogue Scale.

VAS score was significantly decreased in both groups after treatment (P<0.05) (**Figure 4**).

Comparison of treatment response

The total response rate of the CG was lower than that of the RG (P=0.002) (**Table 3**).

Analysis of prognostic factors

According to the remission of clinical symptoms, the patients were re-divided into a poor prognosis group (n=36) and a good prognosis group (n=94). Then, we compared the differences in clinical data between the two groups, and found that age, course of disease, underlying disease, distribution of bone cement and leakage of bone cement were risk factors affecting the prognosis of patients (**Table 4**). Indicators with differences in the above univariate analysis were taken and assigned (**Table 5**). Further logistic regression analysis showed that course of disease, distribution of bone cement, and leakage of bone cement were independent risk factors affecting the prognosis (**Table 6**).

Discussion

With the aging of China's elderly population, it is estimated to increase to 479 million by 2050. This demographic shift will consequently result in a yearly rise in the incidence of osteoporosis among the elderly [14, 15]. Relevant studies have reported that the prevalence of osteoporosis in China is at approximately 13%, but it has been progressively increasing in recent years [4]. Corresponding data surveys indicate that as of 2013, roughly 27.5 million individuals in Europe are afflicted with osteoporosis [16]. Clearly, osteoporosis has become a global public health concern. Elderly individuals with osteoporosis experience a decrease in bone mass, degenerative microstructure of bone tissue, and heightened bone fragility, leading to an elevated risk of fractures [17, 18]. Compression fractures, which frequently occur in the thoracolumbar region, affect the 11th and 12th thoracic vertebrae as well as the 1st and 2nd lumbar vertebrae [19, 20]. When an osteoporotic vertebra is subjected to indirect force, it can incur minor damage that ultimately leads to compression fractures in the patient. This condition significantly impacts the patients'

Table 3. Therapeutic response

Group	Markedly effective	Effective	Ineffective	Total reponse rate
Control group (n=50)	9 (18.00)	20 (40.00)	21 (42.00)	29 (58.00)
Research group (n=80)	25 (31.25)	41 (51.25)	14 (17.50)	66 (82.50)
χ^2				9.387
P				0.002

Table 4. Univariate analysis

Factor	Poor prognosis group (n=36)	Good prognosis group (n=94)	χ^2	P
Age			5.034	0.025
≤73 years old (n=64)	12	52		
>73 years old (n=66)	24	42		
Gender			1.650	0.199
Male (n=66)	15	51		
Female (n=64)	21	43		
Course of disease			12.45	<0.01
≤20 days (n=65)	9	56		
>20 days (n=65)	27	38		
Educational level			0.018	0.894
Below junior college (n=71)	20	51		
Junior college and above (n=59)	16	43		
Underlying disease			4.264	0.039
Yes (n=93)	21	72		
No (n=37)	15	22		
Distribution of bone cement			13.43	<0.001
Medial	14	69		
Lateral	22	25		
Leakage of bone cement			14.41	<0.001
Yes	22	24		
No	14	70		
Living environment			0.017	0.898
Urban (n=77)	21	56		
Rural (n=53)	15	38		
Ethnicity			0.467	0.494
Han (n=88)	26	62		
Other ethnicities (n=42)	10	32		

quality of life, causing symptoms such as radiation-induced pain, loss of appetite, insomnia, and breathing disorders, as well as affecting their mental health. Therefore, it is of great significance to continue research on the treatment of osteoporotic thoracolumbar compression fractures in the elderly.

In the past, treatment for compression fractures often involved reduction surgery and conservative treatment. However, both of these treatment methods have varying degrees of drawbacks. Reduction surgery requires a long operation time, and is associated with a high incidence of postoperative complications, poor prognosis, and unsatisfactory results. Although conservative therapy has certain therapeutic effects with a low incidence of adverse reactions, it is a time-consuming process and may result in other issues such as muscle atrophy. At present, vertebroplasty is considered a superior option for elderly patients with osteo-

Table 5. Assignment table

Factor	Assignment
Age	≤73 years old =0, >73 years old =1
Course of disease	≤20 days =0, >20 days =1
Underlying disease	No =0, Yes =1
Distribution of bone cement	Medial =0, lateral =1
Leakage of bone cement	No =0, Yes =1
Prognosis	Good prognosis =0, Poor prognosis =1

porosis due to its high safety, proven efficacy, low incidence of complications, and short hospitalization period [21]. Therefore, this study evaluated the therapeutic effect of vertebroplasty in elderly patients with osteoporotic compression fractures. Specifically, we monitored and compared anterior vertebral height, kyphotic Cobb angle, and ODI before and after treatment. The results showed that compared to before treatment, the anterior vertebral height in the RG was significantly increased after treatment, and the Cobb angle and ODI in both groups were significantly decreased. In addition, after treatment, the anterior vertebral height in the RG was significantly higher than that in the CG, and the Cobb angle and ODI were significantly lower than those of the CG. This suggests that the anterior vertebral height, Cobb angle, and ODI score can be significantly improved in elderly osteoporosis patients receiving vertebroplasty. A previous study by Ding et al. [22] also showed that the recovery value of vertebral height and Cobb angle of the patient after percutaneous vertebroplasty were significantly improved, and the patients recovered well with definite curative effect, which is similar to the results of this study. Furthermore, we analyzed and compared the VAS scores between the two groups. The results showed that the VAS score of the RG was significantly lower than that of the CG, indicating that vertebroplasty can significantly improve the clinical symptoms and relieve pain. Similarly, the study by Dong et al. [23] revealed that vertebroplasty was an effective method to relieve pain in patients with osteoporotic vertebral compression fractures. Vertebroplasty with bone cement can strengthen the injured site, increase stability, relieve pain, and effectively improve the treatment outcome.

The quality of life of patients was compared before and after treatment. The results revealed that compared to before treatment, RE, PF, SF and GH in both groups were significantly increased after treatment, and the RE, PF, SF, and GH in the RG were significantly higher than those in the CG. This indicated that the physiologic and psychological conditions of the patients were significantly ameliorated after vertebroplasty, which is reflected by the significantly improved the quality of life. This was similar to the research results of Jurczyszyn et al. [24].

At the end of the study, the efficacy in both groups was analyzed and compared. The results showed that the total response rate in the CG was significantly lower than that of the RG, indicating that vertebroplasty with bone cement could repair and fix the damaged vertebrae, restore spinal function, and achieve satisfactory treatment outcomes with minimal trauma. Analysis of factors affecting the prognosis showed that age, course of disease, underlying disease, distribution of bone cement, and leakage of bone cement were risk factors affecting the prognosis. Logistic regression analysis showed that course of disease, distribution of bone cement, and leakage of bone cement were independent risk factors affecting prognosis.

This study proved the clinical efficacy of vertebroplasty with bone cement in elderly patients with osteoporotic compression fractures. However, there are some limitations. First, this is a retrospective study with a limited sample size, which may compromise the experimental results. Second, patients could not be followed up in this study, so the long-term efficacy and prognosis of patients were not observed and compared. Therefore, we hope to carry out more experiments in the future to improve our research conclusions.

To sum up, vertebroplasty with bone cement is an effective treatment for elderly patients suffering from osteoporotic compression fractures. This intervention effectively improves anterior vertebral height, kyphotic Cobb angle, and ODI, while alleviating pain and enhancing the quality of life of the patients. Given its promising clinical outcome, this technique is highly recommended for clinical application.

Table 6. Multivariate analysis

	B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. of the EXP (B)	
							Lower limit	Upper limit
Age	-0.15	0.627	0.057	1	0.811	0.861	0.252	2.943
Course of disease	1.257	0.615	4.171	1	0.041	3.515	1.052	11.742
Underlying disease	-0.276	0.513	0.29	1	0.59	0.759	0.277	2.075
Distribution of bone cement	1.12	0.456	6.03	1	0.014	3.064	1.254	7.489
Leakage of bone cement	1.248	0.453	7.583	1	0.006	3.483	1.433	8.466

Disclosure of conflict of interest

None.

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