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Percutaneous puncture of bone cement augmentation in the treatment of osteoporotic compressive fracture and bone non-union.

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Abstract

Objective: To observe and analyse the effect of percutaneous penetration of bone cement augmentation on the treatment of osteoporotic compressive fracture and bone non-union and explore its safety.
Methods: Subjects in the study were 60 cases of osteoporotic vertebral compression fractures with bone non-union in our hospital. All of these patients received treatment from May 2014 to May 2017 and underwent targeted puncture under local anesthesia and imaging surveillance with the bone end of non-union augmented with cemented bone. Visual Analogue Scale (VAS) and Activities of Daily Living (ADL) score were adopted to assess the patient's conditions in the day before surgery, the day after surgery, and the third, eighth and twelfth month after surgery and observe the effect of treatment.
Results: In this study, 40 patients, including 43 vertebral bodies, underwent successful operations and were observed intensively after surgery. Radiographic findings showed no leakage of cemented bone. Compared with patients' condition in the day before surgery, their VAS score comparatively decreased in the day after surgery, and the third, eighth and twelfth month after surgery of statistical significance. The VAS score of the twelfth month was much lower than that of the third month. For the ADL score, it turned out that the score in the third, eighth and twelfth month after surgery was apparently higher than that before surgery. In addition, after comparing the anterior and posterior vertebral height before and after surgery, we concluded that the results showed no statistical significance.
Conclusion: For the treatment of osteoporotic compression fracture and bone non-union, percutaneous targeted bone cement augmentation therapy can achieve relatively satisfactory results. Moreover, it is safe and reliable, and it is of great value to be popularized and applied.

Keywords: Percutaneous puncture, Bone cement, Osteoporosis, Compressive fracture, Bone non-union.

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Introduction

For patients with osteoporotic vertebral compression fractures, they usually suffered from unbearable pain, and it usually took several weeks even several months to remove the pain. Conservative treatments for osteoporotic vertebral compression fractures and bone non-union diseases included anti-osteoporosis drugs, analgesic drugs and bed rest and etc. [1]. Because many patients' healing ability was poor, osteoporotic vertebral compression fracture might easily lead to fracture non-union. The initiation of this situation was also an important factor of severe pain. Therefore, the key was how to fill the fracture end of the fracture to promote the effect of treatment. This study was carried out to investigate the effect of percutaneous penetration of bone cement for enhancing the treatment of osteoporotic compressive fracture and bone non-union, and the contents were shown below.

Materials and Methods

Materials

Subjects in the study were 60 cases of osteoporotic vertebral compression fractures with bone non-union in our hospital. All patients received treatment from May 2014 to May 2017. Inclusion criteria: patients were over 55 y old; the diagnosis of thoracolumbar compression fractures was confirmed by CT and MRI examinations; the course of disease was 6 months or longer; the result of osteoporosis was proved by the bone mineral density test [2]. Exclusion criteria: patients with spinal tumor fracture; patients without osteoporotic fracture; acute traumatic fracture patients; spinal fracture patients accompanied by neurological symptoms; surgical contraindication patients [3,4].

Patients in the study went to the hospital due to lumbar back or chest pain, and the pain was not relieved after conservative treatments. The pain had serious impact on their normal life and work. Patients' local tenderness and percussion pain of the waist and back were significant. By examining the X ray and

3D CT reconstruction and MRI, the fracture part of the fractured vertebra and the non-union of the vertebral body were clearly positioned [5,6]. There were 25 male patients and 15 female patients, and they were 58 to 70 y old with an average age of 62.5 ± 2.3 y old. Their courses of disease were 6 months to 24 months with an average of 8.6 ± 0.9 months. The fracture vertebral body was one and two, and the number of cases was 36 cases and 4 cases respectively. The vertebral compression of T10, T11 and T12 was five, twelve and four respectively; and the vertebral compression of L1, L2 and L4 was twelve, five and five respectively.

Methods

To let patients maintain a comfortable prone position, we strictly followed the preoperative three-dimensional CT results and clearly positioned the location of the vertebral fissure sign. We took the unilateral pedicle of the left or right side of the patient as the site of the puncture. The C type arm of X-ray machine should be adjusted properly. Each segment of the spine should be adjusted reasonably, to ensure the front and back margin of the vertebral body and the upper and lower margin in the "linear sign" state [7]. In the state of perspective, 10 points of pedicle projection should be selected as the direction of needle insertion. For local anesthesia, the needle should be inserted inside the vertebral body through the pedicle, and tilted to the middle sagittal section of the vertebral body. For the direction of the needle and the depth of the needle, the X-ray adjustment should be made to ensure that the puncture needle was penetrated in the fracture non-union area. After mixing up the bone cement, proper amount of bone cement needed to be injected through the work channel. After letting patients lie in bed for one day, they could get out of bed step by step with the protection of waist. During the perioperative period, anti-osteoporosis treatments were carried out, such as intramuscular injection of elcatonin injection and oral alendronate and etc. Six weeks was a course of treatment, and a close review of liver and kidney function and bone mineral density was made [8-10].

Outcome measures

VAS score was taken to assess patients' pain degree in the day before surgery, the day after surgery, and the third, eighth and twelfth month. The score was between 0-10 points, painless for 0 points, severe pain for 10 points, the lower the score, the lower the degree of the pain [11]. ADL was used to evaluate patients' ability for daily life in the day before surgery, the day after surgery, and the third, eighth and twelfth month. The daily living ability was evaluated by the Barthel index classification scoring method, with a score of 100. The gauge was mainly filled by patients themselves, and follow-up personnel needed to score closely [12]. In addition, radiographic evaluations included X-ray examination of the vertebral body in the fracture site from the positive and lateral side and measurements of vertebral height of the anterior, middle, and posterior vertebral column before and after the operation should be made to know about the change.

Statistical analysis

Relevant data were analysed and processed by SPSS 21.0 statistical software, the enumeration data were represented in the form of percentage and were checked by Chi-square test. Measurement data were expressed in the form of mean ± SD and was tested by t-test. The comparison between the situations before and after surgery should be analysed with one-way ANOVA and be represented by measurement data distributed by median versus skew. $P<0.05$ suggested that the differences had statistical significance.

Results

Comparison of patients' VAS scores before and after surgery

A total of 43 vertebral bodies were successfully operated on 60 patients in this study. The longest operation time was 60 min, the shortest was 25 min, and the average time was 48.6 ± 2.4 min. In each compressive fracture, the amount of bone cement injected into the vertebral body was between 2.3 ml-4.4 ml and the average amount was 3.5 ± 0.6 ml. There were no complications, such as bone cement leakage, nerve damage and pulmonary embolism and etc. As shown in Table 1, by comparing the VAS scores before and after the operation, we could see that the VAS scores at each time after surgery were significantly lower than those before surgery.

Table 1. *Comparison of patients' VAS scores before and after surgery.*

Time	The number of cases	VAS scores
The day before surgery	40	8 (7-9)
The day after surgery	40	3 (2-5)
The third month after surgery	40	3 (1-4)
The eighth month after surgery	40	2 (2-3)
The twelfth month after surgery	40	2 (1-3)

Comparison of patients' ADL scores before and after surgery

As shown in Table 2, by comparing the ADL scores before and after the operation, we could see that the ADL scores in the third, eighth and twelfth month after surgery were significantly higher than those before surgery, and the differences were clearly.

Table 2. *Comparison of patients' ADL scores before and after surgery.*

Time	The number of cases	ADL scores
The day before surgery	40	39.6 ± 7.5
The day after surgery	40	42.9 ± 15.3

The third month after surgery	40	68.8 ± 7.2
The eighth month after surgery	40	76.9 ± 5.3
The twelfth month after surgery	40	80.2 ± 6.6

Comparison of patients' anterior and middle height of the vertebral body before and after surgery

As shown in Table 3, by comparing patients' anterior and middle height of the vertebral body in first day, the third, eighth and twelfth month after surgery, we could see that the results had no significant differences, so the statistical significance did not exist.

Table 3. *Comparison of patients' anterior and middle height of the vertebral body before and after surgery.*

Time	The number of cases	Anterior height of the vertebral body (cm)	Middle height of the vertebral body (cm)
The day before surgery	40	2.0 ± 0.2	2.3 ± 0.2
The day after surgery	40	2.1 ± 0.3	2.3 ± 0.3
The third month after surgery	40	2.0 ± 0.4	2.3 ± 0.4
The eighth month after surgery	40	1.9 ± 0.3	2.2 ± 0.2
The twelfth month after surgery	40	1.9 ± 0.4	2.1 ± 0.5

Discussion

There were many factors that could cause osteoporotic vertebral compression fracture and bone non-union. Studies have shown that it could be caused by malnutrition and the formation of micro hemorrhage and thrombosis, or the rupture of blood vessels and biomechanical problems [13]. However, the universal and specific cause was still not clear. Vascular damage may lead to intraosseous vacuum, which further lead to secondary osteonecrosis, resulting in intraosseous vacuum clefts. In recent years, with the appearance of many clinical studies, it has been generally accepted that the pain factors leading to osteoporotic vertebral compression fracture and bone non-union included the following aspects [14-16]. Firstly, it was caused by incomplete healing of the fractured vertebral body and progressive collapse of the vertebral body. Secondly, it was because spinal deformity caused a change in the way that spine moved, especially in the case that resulted in severe kyphosis in the thoracolumbar spine. Finally, it was because the injured vertebra did not heal well, thus it resulted in soft tissue filling of the vertebral body.

Research showed that adopting cement vertebral augmentation for the treatment of post-traumatic chronic osteoporotic vertebral compression was an improved method for chronic compression fractures and its concerning symptoms and it could help prevent and control the vertebral compression, collapse and kyphosis problems significantly, and then relieved the painful feelings [17]. The main factors included: Bone cement had the characteristics of improving bone rigidity and strength, and through applying bone cement strengthening measures, it could effectively reduce the pain caused by bone deformation and the micro stimulation of fracture site; More heat and free radicals were formed during bone cement polymerization, which destroyed sensitive nerve endings in the stroma and helped relieve pain; with the method of targeted site puncture, the working sleeve could be accurately implanted in the fracture non-union fracture, and the purpose of obtaining the filling of the bone cement into the fracture was achieved, thereby enhancing the stability of the fracture [18].

Percutaneous kyphoplasty had wide application in the case of osteoporotic vertebral compression fracture and bone non-union with vacuum fracture sign. Its primary objective was to achieve the direct input of the work sleeve in the fracture of non-union under the support of X-ray and CT, and avoided penetrating the needle into the fracture of the healed bone. The bone cement could be fully filled in the fissures of the fracture non-union without hurting normal bone formation, thereby the fixation effect could be strengthened and good results could be achieved. When penetrating needle into the fracture accurately, it was necessary to make a detailed reading of the imaging data and make an assessment to determine the vacuum's location, size and direction of the fissure before surgery. During the puncture, the needle must be inserted strictly in accordance with the angle measured before the insertion. The guide wire should be inserted after entering the fracture. If you had a significant sensation that there was a cavity in the bone, it meant that you have reached the inside of the fracture [19]. During the period of bone cement implantation, the bone cement dispersion process must be closely observed. Bone cement was filled along the vacuum gap to prevent the cement from leaking [20].

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