

Analysis of the Clinical Effect of Pedicle Screw Fixation Combined with Surgical Methods in Patients with Severe Osteoporosis and Compression Vertebral Fractures

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Abstract: *Objective:* To explore the therapeutic effect of pedicle screw fixation combined with surgical methods in patients with severe osteoporosis and compression vertebral fractures (OVCF). *Methods:* Eighty-two patients with severe osteoporosis and OVCF admitted to our hospital from January 2023 to January 2024 were selected as study subjects. They were randomly divided into a control group ($n = 41$) receiving conventional conservative treatment and an observation group ($n = 41$) undergoing pedicle screw fixation combined with vertebroplasty. The treatment effects and overall patient satisfaction rates were compared between the two groups three months after surgery. *Results:* The total effective rate of the observation group was 97.56% (40/41), significantly higher than the 70.73% (29/41) of the control group ($P < 0.05$). Additionally, the overall satisfaction rate of the observation group was significantly higher than that of the control group ($P < 0.05$). *Conclusion:* Pedicle screw fixation combined with vertebroplasty is significantly effective in treating severe OVCF, with higher patient satisfaction, and is worthy of promotion.

Keywords: Pedicle screw internal fixation; Severe OVCF; Bone cement; Vertebroplasty

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1. Introduction

Patients with severe osteoporosis (OP) are at a high risk of fractures due to decreased bone mineral density, particularly compression vertebral fractures (OVCF), which severely impact their quality of life and may lead to chronic pain and functional impairment. With the increasing aging population, the incidence of OVCF continues to rise, making it a significant health concern for the elderly. Traditional conservative treatments, such as pharmacotherapy and brace fixation, can alleviate symptoms to some extent but have limited efficacy in improving fracture stability and long-term prognosis^[1]. In recent years, advancements in spinal surgery have led

to the widespread adoption of pedicle screw fixation combined with vertebroplasty. This approach has become an essential treatment option for OVCF due to its ability to provide immediate stability and pain relief. Pedicle screw fixation enhances spinal stability by implanting screws into the vertebrae, while vertebroplasty restores vertebral height and strength by injecting bone cement. The combination of these techniques aims to achieve biomechanical reconstruction of the fractured vertebrae and rapid pain relief. To further clarify the actual clinical efficacy of this treatment approach, this study selected 82 patients with severe OVCF admitted to our hospital in recent years. They were randomly assigned to a control group receiving conventional conservative treatment and an observation group undergoing pedicle screw fixation combined with vertebroplasty, with 41 patients in each group. The treatment outcomes were compared, and the findings are reported as follows.

2. Materials and methods

2.1. General information

Eighty-two patients with severe OVCF admitted to our hospital from January 2023 to January 2024 were selected as study subjects. They were randomly divided into a control group ($n = 41$) receiving conventional conservative treatment and an observation group ($n = 41$) undergoing pedicle screw fixation combined with vertebroplasty. In the observation group, there were 11 males and 30 females, aged between 63 and 83 years, with an average age of 73.13 ± 3.17 years. Fracture locations included 17 lumbar vertebrae and 24 thoracic vertebrae. In the control group, there were 10 males and 31 females, aged between 62 and 82 years, with an average age of 72.97 ± 2.89 years. Fracture locations included 16 lumbar vertebrae and 25 thoracic vertebrae. There were no statistically significant differences in general information between the two groups, making them comparable ($P > 0.05$). All patients signed informed consent forms.

2.2. Methods

2.2.1. Control group treatment

The control group received conventional conservative treatment. Patients were required to rest in a supine position on a hard bed. Calcium and vitamin D supplements were provided to enhance bone density and promote bone health. Nonsteroidal anti-inflammatory drugs (NSAIDs) were administered to relieve pain and control inflammation, while opioids were used as needed for pain management. Additionally, bisphosphonates were prescribed to inhibit bone resorption and slow the progression of osteoporosis. Depending on the patient's condition and hormone levels, selective estrogen receptor modulators (SERMs) or estrogen replacement therapy (ERT) were applied individually to reduce the risk of further fractures.

In terms of physical therapy, treatments such as thermotherapy, electrical stimulation, and ultrasound therapy were employed to relieve muscle spasms, improve local blood circulation, and promote fracture healing. Functional exercises were also an essential part of conservative treatment. Patients were guided to perform progressive back muscle and core muscle exercises to enhance spinal stability and support, reducing the risk of further vertebral collapse. Additionally, depending on the patient's condition, spinal braces were used to limit spinal movement and reduce vertebral load.

2.2.2. Observation group treatment

The observation group was treated with pedicle screw fixation combined with vertebroplasty. Preoperatively, a detailed analysis of the patient's imaging data was conducted to determine the exact location and morphology of

the fractured vertebrae, allowing for an individualized surgical plan. During surgery, the patient was placed in a prone position under general anesthesia. With the assistance of a C-arm X-ray machine, the pedicle and vertebral body were precisely located. A small incision was made to expose the pedicle, and specialized instruments were used for pedicle drilling and tapping. The pedicle screws were then precisely implanted, ensuring their firm anchorage within the vertebral body and pedicle. This step was critical for the success of the procedure, as it provided a solid foundation for the subsequent vertebroplasty and helped restore and maintain the physiological curvature of the spine. Next, a working channel was inserted into the vertebral body via the guidewire at the end of the pedicle screw. Vertebroplasty was then performed using balloon dilation or direct injection of bone cement. In the balloon dilation method, a cavity was created within the vertebral body to restore its height, after which the balloon was removed, leaving an empty space. Bone cement was then injected into this cavity to enhance vertebral stability and strength. Postoperatively, the medication regimen and physical therapy were the same as those for the control group.

2.3. Observation indicators

The study compared the treatment efficacy and overall patient satisfaction between the two groups. The criteria for evaluating treatment efficacy were as follows:

- (1) Significantly effective: After three months of treatment, medical imaging confirmed bony union, substantial recovery of injured vertebrae, absence of scoliosis, and complete resolution of pain symptoms at the affected site.
- (2) Effective: After three months of treatment, there was a noticeable improvement in pain symptoms, and medical imaging showed a near-bony union with mild scoliosis.
- (3) Ineffective: No improvement was observed after three months of treatment, or there was a recurrence of fracture.

The overall response rate was calculated using the formula: Overall response rate = (Significant efficacy + Effective) / Total cases $\times$ 100%.

Patient satisfaction was assessed through a survey questionnaire that included options for “Very satisfied,” “Satisfied,” “Neutral,” and “Dissatisfied.” Patients selected one option based on their personal experience three months after treatment. The overall satisfaction rate was calculated using the formula: Overall satisfaction rate = (Very satisfied + Satisfied) / Total cases $\times$ 100%.

2.4. Statistical analysis

Data were processed using SPSS22.0 software. Measurement data were represented using parentheses “()” and analyzed by the *t*-test. Count data were expressed as [*n* (%)] and analyzed using the chi-square test (χ^2). Statistical significance was indicated when $P < 0.05$.

3. Results

3.1. Treatment efficacy

The overall treatment efficacy in the observation group was significantly higher than that in the control group ($P < 0.05$). See **Table 1** for details.

Table 1. Comparison of the total treatment effective rate between two groups of patients

Group	Total cases (<i>n</i>)	Significantly effective	Effective	Ineffective	Total effective rate (%)
Observation group	41	23	17	1	97.56
Control group	41	8	21	12	70.73
χ^2					11.0613
<i>P</i>					0.0009

3.2. Satisfaction rate

The total satisfaction rate of the observation group was significantly higher than that of the control group, with $P < 0.05$. See **Table 2**.

Table 2. Comparison of total satisfaction rates between two groups of patients

Group	Total cases (<i>n</i>)	Very satisfied	Satisfied	Neutral	Dissatisfied	Total satisfaction rate (%)
Observation group	41	24	15	1	1	95.12
Control group	41	9	17	6	9	63.41
χ^2						12.5412
<i>P</i>						0.0004

4. Discussion and conclusion

4.1. Causes and characteristics of OVCF

Osteoporosis is a skeletal disease characterized by reduced bone mass and microstructural deterioration, leading to increased bone fragility and, consequently, a higher risk of fractures [2]. In elderly individuals, the natural decline in bone density, coupled with prolonged bone loss, makes vertebrae susceptible to compressive changes even under minor external forces. These fractures typically involve the anterior part of the vertebral body, resulting in a reduction in vertebral height and kyphotic deformity, commonly referred to as “wedge-shaped” or “biconcave” deformities. Additionally, OVCF is characterized by acute pain, which is often associated with changes in body position and worsens under weight-bearing conditions, severely affecting patients’ daily lives and mobility.

The primary population affected by OVCF consists of elderly individuals, particularly postmenopausal women, who experience significant bone density loss due to decreased estrogen levels, thereby increasing fracture risk. Other high-risk factors for OVCF include hyperthyroidism, hyperparathyroidism, prolonged use of glucocorticoids, and unhealthy lifestyle habits. These factors not only contribute to osteoporosis but also disrupt normal bone metabolism and repair processes, leading to fractures. Due to the significant decrease in bone density and support capacity in these patients, even minor injuries can trigger fractures.

4.2. Dangers of severe OVCF

OVCF commonly manifests as anterior vertebral compression along with severe osteoporotic changes, making it difficult to restore the vertebrae to their original shape and function. In the early stages of fracture, patients may experience acute pain, usually related to microdamage within the vertebral body. As the fracture worsens, the pain

may become chronic, associated with vertebral compression deformity and loss of spinal stability ^[3]. The pain caused by this condition not only restricts movement but also significantly reduces the patient's quality of life, making walking difficult and even affecting self-care abilities.

Following the onset of OVCF, spinal kyphosis, or hunchback, often develops, which not only affects physical appearance but also reduces thoracic volume, negatively impacting lung function and leading to symptoms such as respiratory difficulties and shortness of breath. Additionally, spinal deformities can increase abdominal pressure, affecting digestive function and causing a decrease in appetite and constipation. These physiological changes, combined with prolonged pain, make patients more susceptible to mental health disorders such as depression and anxiety, exacerbating their sense of loneliness and further disrupting both their own and their family's daily lives ^[4].

Beyond the physical and psychological impact, severe OVCF also imposes a significant financial burden on families. Patients often require prolonged treatment, increasing their economic strain. In severe cases, patients may experience a marked decline in self-care abilities, necessitating care from family members or professional caregivers. This places immense pressure on the patient's family and further contributes to the patient's psychological burden, potentially leading to serious emotional distress such as depression and suicidal thoughts. Ultimately, OVCF poses a severe threat to both the physical and mental well-being of patients and their families.

4.3. Treatment of severe OVCF

4.3.1. Conservative treatment

For patients with severe osteoporosis combined with compression vertebral fractures, conservative treatment is a commonly used approach. This method involves the combined application of physiotherapy and medication to relieve pain, improve function, and reduce the risk of recurrent fractures. The expected outcome of conservative treatment is to provide immediate pain control while achieving long-term disease management by promoting bone health and enhancing vertebral stability ^[5]. Pharmacological therapy is an essential component of conservative treatment, aiming to alleviate pain and inflammation while improving bone density and quality. NSAIDs and opioids are widely used for pain management, acting directly on pain receptors and the central nervous system to reduce the patient's perception of pain. Additionally, calcium and vitamin supplementation, along with bed rest, help facilitate gradual fracture healing. However, this treatment approach requires a long recovery period, and after fracture healing, varying degrees of spinal deformity often occur.

4.3.2. Pedicle screw fixation combined with vertebroplasty

Pedicle screw fixation combined with vertebroplasty is a newly emerging minimally invasive treatment in recent years. Considering that most patients are elderly and have poor surgical tolerance, they are often unable to undergo major surgical procedures. Consequently, this type of minimally invasive surgery, characterized by its rapid efficacy and minimal trauma, has gained widespread adoption. The key aspect of this treatment technique involves inserting pedicle screws to stabilize the damaged vertebral body and injecting bone cement into the vertebral canal to reconstruct its structure and strength. The placement of pedicle screws is based on precise surgical planning and positioning, requiring a preoperative evaluation using the patient's medical imaging data to develop a specific surgical plan—this step is critical to the success of the surgery ^[6]. Vertebroplasty involves creating a cavity within the vertebral canal before injecting bone cement, which not only restores spinal height but also enhances the spine's compressive and supportive strength, reducing the risk of refracture and improving spinal stability. Additionally, this procedure effectively alleviates patient discomfort by reconstructing the spinal

structure, relieving compression on the spinal cord and nerve tissues. The surgery significantly lowers the risk of spinal deformity and maximally restores the original spinal morphology. Although pedicle screw fixation combined with vertebroplasty has demonstrated remarkable efficacy in treating severe OVCF, ensuring surgical safety and effectiveness requires thorough preoperative evaluation and postoperative management. Potential intraoperative complications, such as bone cement leakage, pedicle screw loosening or infection, and refracture, must be prevented through meticulous surgical technique, standardized postoperative rehabilitation plans, and anti-osteoporosis treatment. In this study, one patient in the observation group experienced pedicle screw loosening and subsequent refracture due to inadequate postoperative management. This highlights the need for strengthened rehabilitation management in the later stages of treatment. Upon patient discharge, it is essential to provide relevant knowledge education to both patients and their families, guiding them on daily care. This not only accelerates postoperative recovery but also enhances the long-term effectiveness of the surgery.

The results of this study indicate that the overall effective rate of treatment in the observation group, which underwent pedicle screw fixation combined with vertebroplasty, was 97.56%, significantly higher than the 70.73% in the control group ($P < 0.05$). Furthermore, the overall satisfaction rate of patients in the observation group was also significantly higher than that of the control group ($P < 0.05$). These findings suggest that pedicle screw fixation combined with vertebroplasty is highly effective in treating severe OVCF, leading to greater patient satisfaction. Therefore, it is a valuable clinical treatment option for severe OVCF patients and warrants wider application.

Disclosure statement

The authors declare no conflict of interest.

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