

# Progress in Rehabilitation of Chronic Pain after Vertebroplasty of Osteoporotic Vertebral Compression Fracture

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**Abstract:** *Osteoporosis is one of the major chronic diseases affecting the elderly population, and vertebral compression fracture is among its most common complications. Vertebral augmentation is the conventional surgical treatment and can substantially relieve pain. However, because of factors such as the patient's underlying deficiency-and-blood-stasis constitution, injury to muscles and fascia, the surgical approach, the distribution or leakage of bone cement, and psychological factors, some patients still experience chronic postoperative pain or residual pain, which seriously affects quality of life. Therefore, rehabilitation after vertebral augmentation for osteoporotic vertebral compression fracture is critically important. Relevant studies have shown that both traditional Chinese medicine and Western medicine rehabilitation interventions can alleviate chronic postoperative pain. For example, traditional Chinese medicine can improve clinical symptoms through approaches such as nourishing yin, tonifying yang, and eliminating dampness, whereas Western medicine can relieve postoperative pain through the combination of analgesics and anti-osteoporosis drugs. This review summarizes the causes of chronic pain after vertebral augmentation for osteoporotic vertebral compression fractures and reviews research progress in traditional Chinese medicine rehabilitation and Western medicine rehabilitation.*

**Keywords:** Osteoporosis, Vertebral compression fracture, Vertebral augmentation, Chronic pain, Rehabilitation.

## 1. Introduction

Osteoporotic vertebral compression fracture (OVCF) is commonly treated surgically with vertebral augmentation, yet chronic postoperative pain still occurs [1]. Studies have shown that chronic pain after vertebral augmentation for OVCF is associated with multiple factors [2-5]. Current research has mainly focused on the causes of postoperative chronic pain and refracture, while postoperative rehabilitation has received comparatively less attention.

Available evidence indicates that early rehabilitation can alleviate chronic pain after vertebral augmentation for OVCF. These interventions mainly include internal and external treatments in traditional Chinese medicine, exercise rehabilitation, and psychological adjustment. The following sections summarize the causes of chronic pain after vertebral augmentation and the current progress in rehabilitation-based management.

## 2. Causes of Chronic Pain After Vertebral Augmentation

### 2.1 Traditional Chinese Medicine Perspective

In traditional Chinese medicine, chronic pain after vertebral augmentation for OVCF is related to the patient's constitution of deficiency and blood stasis. The Plain Questions states that "the kidney generates bone marrow and manifests in the body as bone," and traditional Chinese medicine therefore considers kidney deficiency to be the root cause of osteoporosis [6]. The Puji Formulae further notes that when the channels and collaterals are obstructed after an injury, blood stasis accumulates and produces swelling and pain [7]. Accordingly, many scholars regard deficiency of the zang-fu

organs and blood stasis as the basic mechanism underlying osteoporotic fracture [8].

Several studies have suggested that the principal syndrome patterns in osteoporotic fracture are deficiency of the liver and kidney and qi stagnation with blood stasis. Even after surgery, patients often remain in a state characterized by both deficiency and stasis, which may predispose them to chronic pain. From this perspective, postoperative pain persists because the body remains insufficiently nourished and the circulation of qi and blood is not fully restored.

### 2.2 Western Medicine Perspective

#### 2.2.1 Muscle and fascial injury

Although vertebral augmentation is minimally invasive, it still requires percutaneous puncture. If preoperative localization is suboptimal and puncture is not smooth, soft tissue, the erector spinae, and other muscles and fascia may be injured, thereby increasing postoperative pain. Prospective studies [9] have shown that patients without thoracolumbar fascial injury achieve better improvement in pain scores and disability indices than those with fascial injury.

Other studies [10] have reported that the severity of thoracolumbar fascial injury is positively associated with residual postoperative pain. Residual pain may also be related to erector spinae spasm. Increased muscle tension after vertebral compression can lead to spasm and ischemia, and intraoperative puncture may further aggravate this process [11].

#### 2.2.2 Surgical factors

Vertebral augmentation mainly includes percutaneous

vertebroplasty (PVP) and percutaneous kyphoplasty (PKP). Both procedures [12] can improve pain and function in patients with OVCF, but some differences remain. Several comparative studies [13] have shown that PKP may achieve greater improvement in pain score, Cobb angle, anterior vertebral height, and disability index than PVP.

At the same time, PKP may involve longer operative duration and more fluoroscopy exposure [14], and some reports [15] have suggested a higher likelihood of postoperative vertebral recollapse, possibly because of balloon-related factors. Accordingly, the choice of procedure should be individualized according to patient condition and operative indications.

### 2.2.3 Bone cement factors

The postoperative outcome of vertebral augmentation is also influenced by the distribution and leakage of bone cement. More homogeneous [16] cement distribution has been associated with a lower risk of recompression, whereas full contact of the cement with the upper and lower endplates may better restore vertebral strength, preserve vertebral height, and relieve pain [17].

However, excessive cement injection may cause paravertebral leakage, which can lead to nerve compression symptoms and may increase the risk of adjacent vertebral fracture [18]. Reported risk factors for cement leakage include cement volume, operative time, and multilevel fracture [19]. Thorough preoperative assessment and careful intraoperative control of cement volume are therefore important.

### 2.2.4 Psychological factors

Adverse psychological and emotional factors are important contributors to chronic pain after surgery for OVCF. Pain and psychological change interact closely: patients with osteoporosis frequently experience long-term pain and are prone to anxiety and depression, while fracture and surgery may further intensify negative emotions because of personal and family-related stressors [20].

Negative psychological states may amplify pain perception, whereas persistent pain may in turn worsen psychological distress, thereby creating a vicious cycle [21]. Studies suggest that positive coping, emotional adjustment, and psychological resilience can reduce pain-related suffering and improve adaptation to postoperative pain.

## 3. Rehabilitation Strategies for Chronic Pain After Vertebral Augmentation

### 3.1 Traditional Chinese Medicine Rehabilitation

#### 3.1.1 Internal therapies

Traditional Chinese medicine considers this condition to be rooted in deficiency and manifested in blood stasis. Therefore, treatment commonly aims to tonify the kidney, strengthen the bones, invigorate blood, and dispel stasis. Recent studies have also explored syndrome-based interventions involving the nourishment of yin, warming of yang, and elimination of

dampness.

Clinical reports suggest that prescriptions such as Bushen Huoxue Decoction [22], Shenggu Formula Granules, Zuogui Pill, Bushen Zhuyang Jiangu Formula, and Duhuo Jisheng Decoction may improve pain [23], bone mineral density, bone metabolism, and quality of life after surgery [24-26]. Overall, these findings indicate that internal traditional Chinese medicine interventions may relieve chronic postoperative pain, although treatment should be tailored to the patient's syndrome differentiation [27].

#### 3.1.2 External therapies

Acupuncture is a common external traditional Chinese medicine treatment for postoperative pain and may relieve symptoms by regulating qi, blood, yin, and yang. With the development of acupuncture-based practice, warming needle therapy, microneedle therapy, electroacupuncture, and acupotomy have received increasing attention.

Studies [28] have shown that warming needle therapy at acupoints such as Dazhui, Yaoyangguan, Shenshu, Mingmen, and Zusanli can improve low back pain [29], function, vertebral height, and bone mineral density [30]. Microneedle stimulation at bilateral Hegu points combined with celecoxib has also been reported to improve pain and function while reducing analgesic use [31-33].

Acupotomy may relieve pain by releasing local tissue adhesion, reducing muscle spasm and nerve compression [34], improving local circulation, and promoting the absorption of inflammation. Several studies [35,36] have found that acupotomy provides better relief of residual postoperative pain and lumbar dysfunction than celecoxib alone.

Other characteristic therapies of traditional Chinese medicine, including herbal fumigation, directional transdermal drug delivery, and herbal hot-compress treatment, have also shown potential benefits in reducing pain, shortening bed rest, improving bone mineral density, and enhancing recovery after vertebral augmentation [37].

#### 3.1.3 Traditional exercise therapies

Traditional exercise therapies such as Tai Chi, Baduanjin, Yijinjing, and modified Wuqinxi are designed to relax the tendons, activate the collaterals, and harmonize yin and yang. Modified forms of these exercises have been increasingly used in the rehabilitation of OVCF [38].

Available studies indicate that modified Wuqinxi and Baduanjin-based programs may increase bone mineral density, improve balance and function, reduce pain, and lower the risk of recurrent vertebral fracture [39]. Because most patients undergoing vertebral augmentation are elderly and often have postoperative functional limitation, exercise intensity and movement patterns should be individualized to avoid refracture [40].

### 3.2 Western Medicine Rehabilitation

#### 3.2.1 Pharmacological management

Although vertebral augmentation is minimally invasive, intraoperative puncture may still damage soft tissue, muscle, and thoracolumbar fascia and thereby contribute to postoperative pain. Current evidence suggests that postoperative treatment should not be limited to analgesia; anti-osteoporosis therapy is also essential.

Studies [41] comparing zoledronic acid, alendronate, celecoxib, parecoxib, salmon calcitonin, and denosumab have shown that combined analgesic and anti-osteoporosis regimens can improve pain, vertebral height restoration, bone metabolism, and bone mineral density [42,43]. Because patients remain osteoporotic after surgery, sustained anti-osteoporosis management is necessary, and chronic pain may gradually improve as bone quality improves [44,45].

### 3.2.2 Device-assisted physical therapy

Device-assisted rehabilitation in Western medicine mainly includes modalities such as low-frequency pulsed electromagnetic fields and whole-body vibration. These emerging physical therapies may improve bone metabolism and increase bone mineral density by altering bioelectrical activity or enhancing muscle strength [46,47].

Clinical reports suggest that whole-body vibration therapy can promote fracture healing, relieve pain, improve bone mineral density and bone metabolism, and enhance motor function after vertebral augmentation. However, because these devices require adjustment of treatment parameters and are relatively inconvenient for independent use, they are not usually considered the first-line rehabilitation option [48].

### 3.2.3 Exercise training

Modern rehabilitation programs increasingly emphasize back muscle strengthening, aerobic exercise, resistance training, and balance training. These interventions may help improve postoperative function and reduce the risk of recurrent fracture.

Studies [49,50] have shown that glute-bridge exercise, systematic low back muscle exercise, and structured postoperative back muscle training can reduce pain, improve mobility and disability scores, promote restoration of vertebral height, and help maintain spinal biomechanical stability.

Appropriate [51,52] exercise can also regulate endocrine function, improve bone metabolism, promote bone formation, increase bone mineral density, and reduce the risk of future fracture. Because patients remain osteoporotic after surgery, exercise should be moderate and carefully supervised. Back muscle training is relatively simple and may be considered the preferred exercise modality [53,54].

### 3.2.4 Psychological intervention

Anxiety, depression, and other forms of psychological stress may aggravate postoperative pain. Increasing evidence indicates that effective psychological intervention can improve recovery after vertebral augmentation for OVCF [56].

Studies have found that postoperative depression is a risk factor for poorer rehabilitation adherence and worse recovery. Psychological burden, low life satisfaction, and social or family stress may contribute to postoperative weakness, decreased function, and persistent pain.

Compared with routine care alone, psychological intervention has been associated with lower anxiety and depression scores, higher resilience scores, and better pain outcomes [57]. Narrative therapy, which emphasizes deeper communication with patients, has also been reported to relieve pain, reduce anxiety, and improve quality of life. Given that many patients are older adults with significant emotional vulnerability, psychological support before and after surgery should be regarded as an integral component of rehabilitation.

## 4. Conclusions and Future Perspectives

Chronic pain after vertebral augmentation for osteoporotic vertebral compression fractures may result from a combination of factors, including deficiency-and-blood-stasis constitution, muscle and fascial injury, surgical technique, the diffusion pattern or leakage of bone cement, and psychological distress. Evidence to date suggests that integrated rehabilitation strategies based on both traditional Chinese medicine and Western medicine can help relieve chronic postoperative pain.

Potentially useful approaches include oral herbal medicine, acupuncture-related therapies, traditional exercise programs, analgesics combined with anti-osteoporosis drugs, device-assisted rehabilitation, modern exercise training, and psychological intervention. Because the mental health of older adults influences both disease progression and recovery, future research should further investigate the relationship between psychological factors and postoperative pain in patients with osteoporosis. Such work may provide new directions for improving postoperative pain management and overall quality of life.

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