

Clinical research progress of Chinese medicine in the treatment of residual pain after osteoporosis vertebral compression fractures surgery

Jiangjiang Lin^{1,a}, Longwang Tan^{2,b,*}

¹Shaanxi University of Chinese Medicine, Xianyang, Shaanxi, 712046, China

²Affiliated Hospital of Shaanxi University of Chinese Medicine, Xianyang, Shaanxi, 712000, China

^a315763079@qq.com, ^b1845626090@qq.com

*Corresponding author

Abstract: Postoperative residual pain after osteoporosis vertebral compression fracture (OVCF) is one of the most common complications in postoperative patients, which decrease surgical satisfaction and seriously affect patients' quality of life. In contrast, Chinese medicine therapy is an important therapeutic role in postoperative residual pain after OVCF. In this paper, we summarize and analyze the mechanism of postoperative residual pain and the clinical and experimental research progress of TCM treatment methods to explore the best treatment ideas for clinical workers.

Keywords: OVCF; residual pain; etiology; treatment; Chinese medicine; research progress

1. Introduction

Osteoporosis vertebral compression fracture (OVCF) is one of the common types of osteoporosis fractures, characterized by a systematic impairment of bone mass, strength and microarchitecture, leading to fragility fractures that seriously affect the quality of life and physical and mental health of the elderly^[1]. Previous studies have shown that prolonged bed rest and inactivity due to OVCF can increase the risk of pneumonia, decubitus ulcers, deep vein thrombosis and other diseases, or even threaten the life and health of patients^[2]. In recent years, with the development of minimally invasive techniques, percutaneous vertebroplasty (PVP) and percutaneous kyphoplasty (PKP) have become the gold standard for the treatment of OVCF, both of which can immediately relieve the pain caused by fractures, improve the functional activity of the spine, and reduce the occurrence of its complications^[3].

In clinical work follow-up and related reports we found that after surgical treatment, some patients still feel pain and persistent postoperative residual pain has become the most complicated problem in the postoperative management of OVCF patients because it can significantly reduce surgical satisfaction and quality of life^[4]. Postoperative residual pain after OVCF is common in our clinical work, and the relevant literature reports that the incidence of postoperative residual pain after OVCF is 1.8%-15.6%^[5]. In a related study we found that prolonged postoperative pain without relief creates a vicious cycle, i.e., low back pain leads to decreased activity, which in turn leads to continuous bone loss, thus increasing fragility and increasing the risk of re-fracture, and other consequences include loss of appetite, depression, and decreased quality of life^[6]. In my clinical work, I have found that Chinese medicine has a beneficial therapeutic effect on residual pain after OVCF. Take into account this, this paper will review the etiology, treatment and efficacy of Chinese and Western medicine for postoperative residual pain after OVCF, in order to provide an effective treatment plan for clinical workers.

2. Modern medical understanding of post-operative residual pain after OVCF

2.1. Bone Cement Leakage

Bone cement leakage is one of the main causes of residual pain after molding surgery. The possible mechanisms by which leakage of bone cement can cause postoperative pain after OVCF are: (1) extravasation of bone cement through the injured endplate to the pedicle or para vertebral vascular

system to compress nerve roots and blood vessels at the corresponding stage, or compression of the dropped bone mass by leaking bone cement leading to nerve compression and local ischemia, resulting in local pain with or without distal lumbosacral cramping and superficial skin sensory abnormalities^[7]; (2) leakage of bone cement to compress the spinal cord or local blood vessels inside and outside^[8]; (3) thoracic vertebral strengthening may lead to leakage of bone cement into the intervertebral foramen and stimulation of the corresponding intercostal nerve, resulting in localized fracture or radiating pain along the thoracic region^[9]; (4) if the bone cement leaks into the intervertebral disc, resulting in edema of the disc and its surrounding soft tissues and the release of a large amount of inflammatory substances to stimulate and irritate the disc, there will be swelling and pain in the low back^[10]; (5) The endplate of the adjacent vertebral body and the hard bone cement leaking into the intervertebral disc are strongly stimulated, resulting in an increase in ending pressure and disc weight-bearing, changing the vertebral body mechanical direction and eventually leading to a new fracture of the endplate of the adjacent vertebral body, resulting in new pain^[11].

2.2. Bone Cement Volume

Song Ge^[12] et al. showed that proper bone cement injection can restore the strength and stiffness of the vertebral body, which is related to bone density and not to the amount of bone cement injection, and that excessive bone cement injection can cause bone cement leakage and change the photomechanical changes of the adjacent vertebral body, leading to complications. Wang Yia^[13] et al. concluded that low injection force and 4 mL injection volumes can achieve the best treatment effect and reduce the occurrence of complications, while less than 2 mL or more than 8 mL may cause fracture non-union or risk of cement leakage. In conclusion, only the right amount of bone cement can achieve the best therapeutic effect, and too much or too little can increase the probability of complications (fracture non-union, cement leakage and re-fracture of adjacent vertebrae) and increase the possibility of postoperative residual pain.

2.3. Bone Cement Distribution

The unilateral distribution, underfilling and irregular distribution of bone cement is considered to be the main reasons for the lack of pain relief during vertebral body strengthening. Xiao Qinghua^[14] et al. believed that it is best to achieve a "head on the sky, foot on the ground" distribution of bone cement filling, i.e., the upper and lower endplates of adjacent vertebrae are filled with bone cement in order to obtain the initial strength of the vertebral body before fracture and achieve the photomechanical effect of vertebral body strengthening. Xie Hua et al^[15] concluded that unilateral distribution of bone cement across the midline of the vertebral body can achieve the same therapeutic effect as uniform distribution, while unilateral distribution of bone cement is the most likely to lead to unrelieved pain and residual pain. The possible reasons for this are related to unilateral distribution of bone cement leading to fracture instability, failure of local peripheral nerve to be destroyed, and shifting of pressure in the vertebral body to the contralateral side. Tang Guangman et al^[16], on the other hand, suggested that diffuse H-shaped distribution increases cement adhesion to the fracture surface, enhances vertebral stability, and reduces vertebral micromotion, whereas clumped O-shaped distribution predisposes to re-fracture of the vertebral body.

2.4. Bone Cement-Bone Interface Relationship

Krause^[17] demonstrated that the strength of the cement-bone interface depends on the strength of the bone cement and the porosity of the cancellous bone as well as the cleanliness of the fracture interface, and that compressed trabeculae, bone debris, and interstitial fluid affect the riveting relationship between the bone cement and the bone plane. Deep compression of the vertebral body or extrusion of extra-mural cancellous bone by the balloon leads to excessive extrusion of dense bone trabeculae, resulting in poor bone cement dispersion, which in turn leads to failure to form interlocking fracture ends and unstable stability of the vertebral body^[18]. It has also been shown that inadequate distribution of bone cement dispersion can easily lead to fracture instability, which is not conducive to riveting between the bone cement and cancellous bone and does not provide good filling and smooth mechanical support to the vertebral body, allowing rotation and displacement of the vertebral body^[19].

2.5. Bone Density

One study showed^[20] that the vertebral body reproduces the strength of a normal vertebral body

when the bone cement filling rate is 24%, and then when the density is less than approximately 0.7 g/cm², even if the patient's normal strength is restored, the higher the patient's risk of subsequent back pain and multi-stage vertebral compression fractures. The possible reasons for their occurrence are reduced bone density, sparse trabeculae, and increased brittleness of the bone, resulting in disruption of the vertebral mechanics and alteration of the gravitational line, leading to spinal deformities and multi-stage fractures of the vertebral body [21]. Yang Junsong et al [22] showed that multivertebral collapse due to low bone density can lead to destabilization of vertebral sagittal plane equilibrium and increased decompensation of the low back muscles, leading to strain on the back muscles; or residual pain in the low back can occur due to dense trabeculae due to vertebral compression, which affects the repositioning of the vertebral body and the diffusion of bone cement. Therefore, low bone density and osteoporosis are the main causes of postoperative residual pain in patients.

2.6. Infection

Infection is one of the main causes of postoperative residual pain after vertebroplasty, and its main clinical manifestation is sudden hyperthermia with increased pain after surgery. Infection causes postoperative residual pain mainly includes aseptic infection and bacterial infection, with aseptic infection being related to the inflammatory reaction caused by the bone cement and local ischemia or osteonecrosis of the vertebral bone-cement interface caused by the injection of the bone cement; bacterial infection is mainly due to the underlying disease in some patients and irregular aseptic operation during surgery or the patient's own infectious disease [23].

2.7. Proximal Vertebral Re-fracture

Proximal vertebral re-fracture is the main cause of unrelieved pain after PKP or PVP, and the incidence of proximal vertebral re-fracture within 1 year ranges from 8% to 52%, with approximately more than half of new fractures causing mild localized back pain symptoms [24]. In contrast, low bone density, larger balloon volume, cement volume, vertebral height recovery rate, and interpretative cement leakage were considered risk factors for proximal vertebral re-fracture in a clinical study [25]. Strauss [26] concluded that patients with preoperative segmental kyphosis >30 or patients with combined rheumatoid arthritis and cardiovascular disease were at the risk of re-fracture of the proximal vertebra is high, and re-fracture of the proximal vertebra causes increased pain in patients. In summary, proximal vertebral re-fracture is the main cause of postoperative residual pain, but the patient's underlying disease and surgical complications are risk factors for proximal vertebral re-fracture, so we should treat the underlying disease aggressively and improve surgical skills to reduce the incidence of complications and thus reduce the probability of postoperative residual pain.

2.8. Others

Other possible mechanisms leading to postoperative residual pain after PKP or PVP are: (i) lumbar dorsal myocarditis: Yan et al [27] showed that patients with lumbar dorsal myocarditis had poorer postoperative pain relief, demonstrating that lumbar dorsal myocarditis is a risk factor for postoperative residual pain in patients, which may be related to the low stiffness of the fascia and its ease of injury. (ii) Lumbar spine degeneration: patients had previous back pain disorders, such as lumbar spondylolisthesis, spinal stenosis, and lumbar disc herniation, which increase the occurrence of OVCF and change the structure of the spine and lead to poor postoperative pain relief [28]; (iii) Small joint injury: mechanical trauma and secondary inflammatory response due to small joint capsule or joint after fracture may lead to the occurrence of postoperative pain [4]. (iv) Disc Lesions: Vertebral body strengthening does not improve spinal alignment, restore disc biomechanics, or restore pre-fracture load transfer, leading to the development of residual pain [19]. (v) Paravertebral muscle fatty degeneration: long-term bed rest leads to fatty degeneration of the para vertebral muscles, which does not create strong support for the vertebral body, which in turn leads to progressive collapse of the vertebral body and insignificant pain relief [29]. (vi) Sagittal spine-pelvic imbalance destabilization: Liu Tao et al [30] concluded that sagittal-pelvic imbalance of the spine after lumbar spine surgery changes the vertebral body mechanics and increases the stimulation of local nerves, blood vessels, and soft tissues, which leads to long-term persistent lumbosacral pain.

3. Chinese Medicine understanding of residual low back pain after OVCF

The residual pain after OVCF does not have a name in Chinese medicine, but can be considered to be "dysesthesia", "lumbago" and "bone impotence" in Chinese medicine. The residual pain after OVCF is deficiency-based and solid-based, and is assigned to the scope of "pain if not honored, pain if not passed". The deficiency as the root refers to the deficiency of liver, spleen and kidney, which lead to the lack of a source of essential, blood and fluid production, resulting in the loss of nourishment of bones and ligaments, and pain without glory. The real is the standard refers to the deficiency of qi and blood or old age and deficiency of qi and blood, so that qi and blood stagnation, not pass is pass; trauma causes the body to consume qi and injure blood, deficiency of qi and blood, pushing weak; or trauma causes blood not to follow the meridian, overflowing outside the pulse, stagnation and impassability; old age and weakness, deficiency of kidney qi, fixation and pushing malfunction; or old age and thick blood, pulse channel loss, blood flow is not smooth, obstructing the movement of qi. In conclusion, the residual pain after OVCF is based on the deficiency of liver, spleen and kidney, and the deficiency of qi and blood stasis as the symptoms, so the treatment should be to tonify the kidney and strengthen the bones, dredge the liver and strengthen the spleen, activate blood and stop pain.

4. Chinese Medicine Therapy

4.1. Chinese Herbal Soup

Chinese medicine should take the principle of treating both the symptoms and the root cause of the disease, with the method of "codifying the kidney and strengthening the bones, draining the liver and strengthening the spleen, activating blood and relieving pain". According to Bu Bin et al ^[31], surgery can only relieve the pain caused by fracture, but not the pain caused by osteoporosis, which fails to treat the root of the disease, while various types of herbs in the formula of typifying the kidney and invigorating blood can significantly improve the bone metabolism level, enhance bone density, and significantly reduce the pain index and spinal dysfunction index of patients. Hu Jingnuan et al ^[32] also demonstrated that terrifying kidney and invigorating blood soup could improve patients' postoperative blood hypercoagulability, reduce blood viscosity, and increase vascular recovery and blood supply to local soft tissues and fracture sites, as well as that terrifying kidney and invigorating blood soup could also inhibit the release of inflammatory factors after fracture surgery and reduce inflammatory reactions, thus alleviating postoperative low back pain. Jiewen Zhang ^[33] postoperative adjuvant treatments with Jianbiao Tang can increase osteoblast activity, correct bone metabolism and osteoporosis, improve vertebral strength and anatomical structure, and relieve residual pain due to vertebral structure. Tang Baoming et al ^[34] divided the postoperative pain after OVCF into early, middle and late stages according to the three stages of fracture identification, and each stage was combined with the dialectical addition of Jin Kui Shen Qi Wan, which could promote the recovery of the injured spine, reduce the symptoms of postoperative residual pain within 1-2 consecutive years, restore the structure and function of the injured spine, improve osteoporosis, reduce the occurrence of complications and improve the life treatment of patients within 2-4 years.

4.2. Prepared Chinese Medicine

Rules and treatments of proprietary Chinese medicine are the same as those of Chinese medicine tonics, and this method is applicable to those who are intolerant of Chinese medicine topics. Kong Lingcheng et al ^[35] showed that strong bond drink granules improved the degree of osteoporosis, reduced the rate of bone conversion, promoted bone formation, improved the quality of life of patients, and improved low back pain and vertebral re-fracture. Fan Xinfu et al ^[36] showed that Lumbar Palsy Kang granules have the efficacy of fortifying the spleen and kidney, dredging the liver and Qi, activating blood circulation, resolving blood stasis, and relieving spasm and pain, and have good therapeutic effects on postoperative low back pain after OVCF due to muscle and soft tissue injury of the low back. Le Jin et al ^[37] showed that strong Tendon and Bone pill could restore the height of the anterior edge of the vertebral body, increase the density of the vertebral body, improve patients' pain sensation, and improve their daily self-care ability. Yan-Yan Zhang et al ^[38] showed that Xianling Bone Capsules could protect the gland, maintain estrogen levels, improve bone metabolism, increase density, improve vertebral compression ratio, Cobb angle, improve patients' functional impairment, and prolong the time of vertebral re-fracture occurrence. Liu Baoxin et al ^[39] showed that Chinese herbal poultices with the modified Eight Duan Jin Eighth Form could reduce bone loss, enhance the body's dynamic and

static balance, reduce the degree of low back pain, and decrease the probability of vertebral re-fracture.

4.3. External treatment with Chinese medicine

The external treatment method of Chinese medicine is to apply or paste the medicine on the skin surface, so that the medicinal properties can penetrate into the meridians from between the skin couples and either lift out or attack and disperse, thus achieving the effects of soothing the tendons, relieving pain, activating blood stasis and dispersing nodules. Zhang Zhen et al ^[40] applied Fuyuan cream acupoint paste with local herbal hot compresses at the acupoints of Kidney Yu and Dazhi to treat postoperative residual low back pain with a total efficiency of 97.1%, which could significantly improve patients' clinical symptoms and increase their bone density. Peng Nan et al ^[41] combined application of internal and external Chinese medicine with functional exercise can enhance vertebral stability, improve the blood supply, promote soft tissue recovery and elimination of inflammation, relieve muscle spasm, relieve pain, and effectively improve clinical efficacy. Zhao Hailing et al ^[42] applied Chinese medicine fumigation and Chinese medicine tonics with practical can improve local blood supply, relieve tissue spasm, and thus promote local metabolism, and significantly reduce postoperative pain, and the combined treatment obviously improves bone metabolism, promotes bone formation, avoids stimulation of surrounding soft tissues and blood vessels due to vertebral instability, and improves patients' postoperative quality of life.

4.4. Acupuncture, acupuncture knife

Acupuncture and acupuncture can enhance the body's positive energy, harmonize qi and blood, balance yin and yang, and promote regional blood supply; they can also relieve muscle spasm, release nerve compression symptoms, and relieve pain. Chen et al ^[43] concluded that the application of silver needles for early intervention treatment after surgery showed significant improvement in postoperative complications, distant pain and quality of life. Huang et al ^[44] pointed out that acupuncture can play an analgesic role by inhibiting nociceptive fiber conduction and promoting the secretion of small organic molecules similar to morphine through neurohumoral modulation, and it also proved that acupuncture can effectively relieve postoperative intercostal neuralgia and improve the quality of life of patients. Hou Xiaoyun et al ^[45] demonstrated that floating needle therapy effectively reduced the release of serum 5-HT and NPY pain factors, thus significantly improving residual intercostal pain after OVCF. Liang Dongbo et al ^[46] showed that small acupuncture treatment at muscle starting and ending points, joints, and ligaments could effectively relieve postoperative residual pain after OCVF due to soft tissue adhesions, joint degeneration, and disorders.

5. Summary

Postoperative residual pain after OVCF is a common postoperative complication of PKP or PVP for OVCF, which reduces surgical satisfaction and seriously affects the quality of life of patients. The main factors that cause postoperative pain after OVCF include cement-related, bone density, infection, and re-fracture of adjacent vertebrae, so this requires clinicians to prevent risk factors scientifically and reasonably during the perioperative period to reduce the occurrence of postoperative residual pain and other complications after OCVF. Chinese medicine, Chinese herbal external treatment, acupuncture, and acupuncture all have good therapeutic effects on postoperative residual pain after OVCF through different mechanisms of action, significantly improving osteoporosis, reducing the risk of vertebral re-fracture, and improving the quality of life of patients.

Currently, TCM has unique advantages in increasing bone density, improving local blood supply, restoring peripheral soft tissue damage, reducing inflammatory reactions and small joint disorders, etc. Therefore, when we develop a surgical plan for OVCF, we should develop an individualized, effective and stepwise treatment plan based on the patient's symptoms, signs, laboratory tests and imaging, together with the early intervention of TCM, to bring OVCF. The impact of postoperative residual pain on patients should be minimized. In contrast, the analgesic mechanism of TCM for postoperative residual pain after OVCF has not yet been clarified, so it can only be used for symptomatic treatment, but not for individualized treatment plans, and it is not possible to predict which groups will benefit from it, so scientific and high-quality clinical studies are still needed to guide the clinical application in order to achieve the best treatment effect. In addition, TCM has no effective method for symptoms such as nerve irritation and essence damage caused by cement leakage, uneven distribution of cement, and non-healing of cemented fracture interface, which can only relieve the symptoms but not the root cause

of the disease.

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