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New Progress in Research on the Synergistic Effect of Surgery and Drugs in the Treatment of Osteoporotic Vertebral Fractures

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[Abstract] Osteoporotic vertebral fracture (OVCF) is a common orthopedic condition in the elderly. Its high morbidity, disability, and risk of refracture have garnered significant research attention. In recent years, the combined surgical and medical treatment model has fully embodied the dual strategy of "structural repair + etiological intervention," significantly improving patient outcomes. Related research has also achieved breakthroughs in surgical technique innovation, optimized drug combination regimens, and long-term management. This review will analyze the clinical efficacy of surgical treatment, medical therapy, and their combination, starting with OVCF, to provide a basis for the clinical treatment of OVCF.

[Keywords] Osteoporotic vertebral fracture. Elderly population. Orthopedic disease. Surgical treatment. Medical therapy. Outcome quality.

Introduction

As the global population ages, the number of osteoporosis patients is on the rise. Osteoporosis is a systemic bone metabolic disease characterized by the destruction of bone structure and weakening of strength, which leads to increased bone fragility and increased risk of fractures[1]. Osteoporotic vertebral fracture (OVCF) is one of the most serious complications of osteoporosis, and its incidence is rapidly increasing. It is estimated that the number of OVCF patients in my country will reach 80 million by 2030[2]. OVCF has a high incidence and disability rate. After the fracture, the patient's reduced activity leads to muscle atrophy, further bone loss, and a high incidence of re-fracture, which increases the burden on patients and their families. With the advent of vertebral augmentation surgery, the treatment of OVCF has made

significant progress. Percutaneous vertebroplasty (PVP)/percutaneous kyphoplasty (PKP) has the advantages of less trauma, low risk, fast recovery and fewer complications. It is currently the most effective minimally invasive spinal technology for the treatment of OVCF. However, PVP/PKP surgery has certain limitations, such as the inability to completely relieve back pain and restore thoracic and lumbar spine function, and the high risk of secondary and multi-segment vertebral compression fractures [3]. Anti-osteoporosis drugs mainly include basic supplements, anti-bone resorption drugs, bone formation-promoting drugs, and Chinese patent medicines, but the effect of single drug treatment is limited, and bone density decreases rapidly after drug withdrawal [4]. This review will take OVCF as the starting point to analyze the clinical application effects of surgical treatment, drug treatment, and the combination of the two. The review is as follows.

1 Application of surgical treatment in OVCF

1.1 Vertebral augmentation (PKP/PVP)

PVP/PKP is still the mainstream minimally invasive surgical method for treating OVCF. Bone cement is injected into the vertebral body through percutaneous puncture to quickly stabilize the fracture end and relieve the patient's pain. Xu Hua et al. [5] studied 41 patients (55 vertebrae) with thoracolumbar OVCF combined with adjacent vertebrae wedge-shaped changes. All patients were treated with PVP/PKP. The effects of the surgery on the patients' Cobb angle, pain and ODI index were analyzed. The results showed that PVP/PKP treatment can significantly relieve the pain of thoracolumbar OVCF patients with adjacent vertebrae wedge-shaped changes, help improve the patient's motor function, and is an effective method for treating this type of fracture. Wang Fang et al. [6] studied 60 patients with OVCF. According to different treatment methods, they were divided into PVP group and PKP group. Each group received corresponding surgical treatment. The results showed that the modified approach PVP and modified approach PKP treatment of OVCF can achieve good results, and the modified approach PVP has the advantages of less intraoperative bleeding, less bone cement injection and lower bone cement leakage rate. Xiao Zhonghua et al. [7] studied 62 patients with severe OVCF and divided them into two groups according to different surgical methods. 30 patients in the control group were treated with PVP surgery, and 32 patients in the observation group were treated with PKP surgery. The safety of different surgeries was analyzed. The results showed that compared with PVP, PKP was more effective in treating severe OVCF in reducing pain and vertebral compression, improving lumbar spine mobility, and reducing complications and accelerating postoperative recovery.

In recent years, with the continuous development of medical technology, the application of robot-assisted vertebral augmentation and O-arm navigation technology has further improved surgical accuracy and reduced intraoperative radiation exposure and complication risks. For example, robot-assisted surgery can reduce the rate of

bone cement leakage and the incidence of postoperative re-fracture, and the surgery is suitable for complex cases such as spinal deformities [8]. Jiang Yu et al. [9] took 78 patients with OVCF as subjects and divided them into a robot group and a freehand group of 36 cases according to the puncture method. They further analyzed the effects of using intuitive image positioning robot assistance and freehand puncture under C-arm X-ray fluoroscopy. The results showed that the intuitive image positioning robot can safely and effectively assist in completing the surgical process, with the advantages of less intraoperative bleeding and fewer fluoroscopy times.

1.2 Other innovative techniques

(1) Angled puncture vertebroplasty. This surgery uses an angled injector to achieve multiple, multi-point injection of bone cement, promote the full diffusion of the cement in the vertebral body, enhance biological support, and reduce the incidence of vertebral refracture. Shi Jing et al. [10] took 100 patients with OVCF as subjects and divided them into two groups of 50 cases each according to the random number table method. The control group was given PKP treatment, and the observation group was given percutaneous angled vertebroplasty. The results showed that compared with PKP surgery, PVCP surgery can reduce the number of intraoperative fluoroscopy, shorten the operation and hospitalization time, help reduce the body's stress response, and the surgery is safer. (2) Mesh bone filler combined with PKP surgery. This surgery is mostly used for patients with vertebral fracture nonunion, which can improve the quality of reduction and reduce the risk of bone cement leakage and displacement. Wei Shuchao et al. [11] studied 128 elderly patients with OVCF and divided them into PKP group and mesh bag group according to the surgical method, with 64 patients in each group. Each group received corresponding surgical intervention. The results showed that both bone filling mesh bag pyramidal plasty and PKP surgery could promote the recovery of lumbar spine function in patients and did not affect the surgical process. However, the incidence of complications of bone filling mesh bag pyramidal plasty was lower.

2 Clinical effects of drug treatment on OVCF

2.1 Anti-bone resorption drugs

(1) Bisphosphonates. The representative drug is zoledronic acid, which reduces bone resorption by inhibiting osteoclast activity. Intravenous drip of 5 mg/year can significantly reduce the risk of fractures and relieve bone pain. Feng Haihui et al. [12] studied 68 patients with OVCF and randomly divided them into two groups of 34 cases each by envelope method. The control group was treated with percutaneous vertebroplasty, and the observation group was treated with zoledronic acid. The results showed that this treatment method helped improve the patient's spinal kyphosis and pain, increase bone density, reduce the incidence of vertebral refracture, and has a high safety of treatment. (2) Desmodium. Subcutaneous injection of

denosumab 60 mg/6 months can inhibit osteoclast differentiation and can be used for patients with poor compliance [13]. Huang Zhipeng et al. [14] studied 102 elderly female patients with thoracolumbar compression fractures and divided them into a control group and a treatment group according to whether they received denosumab treatment. The control group was treated with oral calcium carbonate D3 tablets and alfacalcidol soft capsules, while the treatment group was treated with denosumab. The results showed that denosumab combined with PKP surgery can improve clinical efficacy, alleviate clinical symptoms, increase bone density, and reduce the incidence of vertebral re-fracture. (3) Calcitonin. This drug has an analgesic effect and is suitable for short-term use within 3 months after surgery. Meng Lingzhi et al. [15] took 160 OVCF patients as subjects and divided them into two groups of 80 cases each using a random number table method. Group A was treated with PKP, and Group B was treated with subcutaneous injection of salmon calcitonin. The results showed that salmon calcitonin combined with PKP can relieve postoperative pain symptoms of OVCF patients and improve thoracic and lumbar spine mobility.

2.2 Bone formation promoting drugs

(1) Teriparatide. Subcutaneous injection of 20 μg per day for a course of no more than 24 months. This drug is the only approved bone formation promoting drug that can significantly increase bone density and reduce the risk of vertebral fractures. Chen Yanchao et al. [16] studied 92 patients with OVCF and divided them into two groups of 46 cases each according to the random number table method. Both groups underwent PVP surgery. The control group was given intravenous zoledronic acid injection, and the observation group was given subcutaneous injection of teriparatide. The results showed that adjuvant treatment with teriparatide can improve the serum bone metabolism level of OVCF patients, improve patient recovery and quality of life, relieve patient pain, and reduce the incidence of adverse reactions. (2) Romosozumab. This drug is a new type of monoclonal antibody that increases bone formation and reduces bone resorption by inhibiting sclerostin, thereby reducing the risk of new vertebral fractures [17]. However, this drug is still in the clinical research stage, and its effect still needs further research and discussion.

2.3 Traditional Chinese Medicine Adjuvant Treatment

In recent years, with the continuous development of medical technology, traditional Chinese medicine has been widely used in clinical practice and has played an important role. Among them, traditional Chinese medicine such as Quanduanbanguidanqi capsule can increase lumbar bone mass and improve spinal bone density, playing an important role in the prevention and treatment of osteoporotic vertebral fractures. Ding Xu et al. [18] took 79 elderly patients with OVCF as subjects. The control group of 39 patients received PKP treatment and got out of bed with a thoracolumbar brace 2 days after surgery. The brace was removed 1 month after surgery. The observation group of 40 patients received combined

treatment with Huoxue Yigutang. The results showed that Huoxue Yigutang adjuvant treatment for elderly patients with OVCF who underwent PKP treatment could relieve postoperative pain, promote bone healing and lumbar function recovery, improve blood circulation, and reduce inflammation.

3 Synergistic mechanism of surgery combined with drug treatment for OVCF

From the above analysis results, it can be seen that both surgical treatment and drug treatment can achieve good results in OVCF patients, but different treatment methods have their own advantages and disadvantages. Although surgery can stabilize the fractured vertebra, if the fundamental problem of osteoporosis is not solved, the risk of new fractures is as high as 50.0%. Therefore, anti-osteoporosis treatment should be started immediately after surgery, and strong bone resorption inhibitors such as zoledronic acid or bone formation-promoting drugs should be given priority, combined with calcium and vitamin D supplements. At the same time, after the fracture end is stabilized by surgery, drugs can improve bone metabolism and increase bone density, forming a “treating both the symptoms and the root cause” effect. Drugs complement the rapid analgesic effect of surgery by inhibiting bone resorption and reducing the release of pain mediators. In addition, surgery combined with drug treatment can promote functional recovery and improve the patient’s ability to take care of themselves. Qin Yaozong [19] used 86 OVCF patients as subjects and divided them into two groups of 43 cases each using a random number table method. The control group was treated with PVP, and the observation group was treated with bone melon extract. The results showed that bone melon extract combined with PVP can improve the bone density and vertebral function of OVCF patients, reduce pain, improve bone metabolism indicators and cytokines, regulate calcium and phosphorus metabolism, and the treatment safety is relatively high. Lei Yaozhen et al. [20] randomly divided 100 OVCF patients into two groups. The control group underwent kyphoplasty, and the observation group was treated with denosumab. The results showed that denosumab can effectively improve bone metabolism, relieve clinical symptoms, and reduce the incidence of re-fracture in OVCF patients after surgery.

4 Summary

In summary, OVCF surgery and drug synergistic treatment can significantly improve clinical efficacy, help relieve patient pain, improve patient function, reduce the risk of re-fracture, improve bone density and quality of life, and has high quality and safety, thereby giving full play to the advantages of different intervention measures, and most patients can benefit from it. In order to further improve the treatment effect of OVCF patients, we will actively explore degradable and bone regeneration-promoting materials in the future, reduce the risk of bone cement leakage, and promote long-term vertebral stability. Integrate patient imaging, bone metabolism markers and genetic data to construct an individualized surgical plan prediction model to optimize the puncture path and bone cement dosage. At the same time, further deepen the

exploration of the mechanism of drug synergistic treatment, use the big data platform to analyze the effects of different drug combinations, and thus obtain the optimal treatment plan.

Reference

[1] Zhang Zhenlin, Yue Hua. Analysis of key points of the diagnosis and treatment guidelines for primary osteoporosis (2022 edition) [J]. Journal of Internal Medicine Critical Care, 2024, 30 (4): 289-293.

[2] Bone Metabolism Expert Group of the Chinese Journal of Osteoporosis, Zhang Mengmeng, Ma Qianqian, et al. Expert consensus on the clinical application of bone metabolism biochemical indicators (2023 revised edition) [J]. Chinese Journal of Osteoporosis, 2023, 29 (4): 469-476.

[3]Xiang Q Q，Chu B，Lu M Q，et al.Risk–benefit ratio of percutaneous kyphoplasty and percutaneous vertebroplasty in patients with newly diagnosed multiple myeloma with vertebral fracture: a single-center retrospective study[J].Annals of Hematology，2023，102（6）:1513-1522.

[4]Du W，Li W，Kang L，et al.Percutaneous Kyphoplasty combined with different anti-osteoporosis drugs for the treatment of osteoporotic vertebral compression fractures[J].Pakistan Journal of Medical Sciences，2025，41（4）：1013-1018.

[5] Xu Hua, Fan Tianyou, Li Xiaofeng, et al. Analysis of the efficacy of PVP/PKP in the treatment of thoracolumbar osteoporotic vertebral compression fractures combined with adjacent vertebral wedge deformation [J]. Chinese Journal of Bone and Joint Injury, 2024, 39 (11): 1190-1193.

[6] Wang Fang, Li Jinglong, Pan Yalin. Comparison of the efficacy of two modified approaches for vertebroplasty in the treatment of osteoporotic vertebral compression fractures[J]. Journal of Clinical Orthopaedics, 2024, 27 (6):761-764.

[7] Xiao Zhonghua, Xin Wenying. Analysis of the efficacy and safety of PVP and PKP in the treatment of severe osteoporotic vertebral compression fractures [J]. Journal of Cervical and Lumbar Pain, 2024, 45 (5): 880-885.

[8]Xue H, Liu W, Li R, et al.Advantages of robot-assisted PKP under local anesthesia in the treatment of OVCF: a retrospective, non-randomized, controlled, clinical study[J].Frontiers in Surgery, 2024, 11:1445461.

[9] Jiang Yu, Li Weishi, Chen Zhongqiang, et al. Intuitive image-guided robot-assisted percutaneous kyphoplasty for the treatment of osteoporotic vertebral compression fractures[J]. Chinese Journal of Orthopaedics, 2024, 44(12):803-810.

[10] Shi Jing, Zhou Xiang, Yang Rongzhi, et al. Study on the efficacy and safety of percutaneous vertebroplasty for the treatment of single osteoporotic vertebral compression fractures[J]. Hainan Medicine, 2024, 35(1):71-75.

[11] Wei Shuchao, Liu Jing, Zhang Shouling, et al. Effect of bone-filled mesh bag vertebroplasty on bone cement leakage after surgery for elderly patients with osteoporotic thoracolumbar compression fractures [J]. Sichuan Journal of Physiological Sciences, 2024, 46(4):785-787.

[12] Feng Haihui, Lai Muyong. Observation on the effect of zoledronic acid -assisted percutaneous vertebroplasty in the treatment of osteoporotic thoracolumbar compression fractures[J]. Chinese Journal of Drug Abuse Prevention and Treatment, 2024, 30(12):2275-2276.

[13] Liu P, Hu J, Zhang W, et al. Robot -assisted versus fluoroscopy-assisted kyphoplasty in treatment of severe osteoporotic vertebral compression fractures in the old patients: a retrospective study[J]. BMC Musculoskeletal Disorders, 2025, 26 (1): 1-9.

[1 4] Huang Zhipeng, Song Mengying, Zhao Xiaolin, et al. Observation on the effect of denosumab combined with percutaneous kyphoplasty in the treatment of osteoporotic vertebral compression fractures in elderly women [J]. Practical Geriatrics, 2024, 38 (12): 1238-1241.

[15] Meng Lingzhi, Leng Ao, Guo Mingming, et al. Clinical efficacy of salmon calcitonin combined with percutaneous balloon kyphoplasty in the treatment of acute symptomatic osteoporotic vertebral compression fractures [J]. Traumatology and Critical Care Medicine, 2023, 11 (3): 158-161.

[16] Chen Yanchao, Wei Xuechang, Gao Chunzhi, et al. Comparison of the effects of teriparatide and zoledronic acid injection in postoperative rehabilitation of patients with osteoporotic vertebral compression fractures [J]. Chinese Journal of Drug Abuse Prevention and Treatment, 2023, 29 (2): 320-323.

[17]Mun H W，Lee J J，Shin H C，et al.Comparative Analysis of Romosozumab Versus Vertebroplasty With Denosumab: Efficacy，Safety，and Secondary Bone Mineral Density Outcomes[J].Neurospine，2025，22（1）：69-77.

[18] Ding Xu, He Wencheng, Zhao Yi. Effects of Huoxue Yigu Decoction assisted vertebral kyphoplasty on bone healing and postoperative lumbar function recovery in elderly patients with osteoporotic thoracolumbar fractures [J]. International Journal of Traditional Chinese Medicine, 2023, 45 (7): 823-828.

[19] Qin Yaozong. Effects of bone melon extract combined with PVP on bone mineral density and vertebral function recovery in patients with osteoporotic vertebral compression fractures [J]. Journal of Aerospace Medicine, 2024, 35 (7): 824-827.

[20] Lei Yaozhen, Li Tao, Wang Pan, et al. Effects of denosumab on bone metabolism indicators and clinical effects in patients with osteoporotic vertebral compression fractures after surgery [J]. Chinese Journal of Drugs and Clinics, 2023, 23 (7): 446-449.