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Effect of Mindfulness Behavioral Training Combined with Exercise Intervention on Postoperative Functional Recovery and Quality of Life in Elderly Patients with Lumbar Spine Fractures

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Abstract: Objective: To investigate the positive effect of mindfulness training and exercise therapy on functional recovery and quality of life in elderly patients with fractures of the lower back. **Methods:** Collection of medical records of patients with lumbar vertebral fractures in Suzhou Municipal Hospital (North District), 60 patients underwent percutaneous vertebroplasty (PVP/PKP), they were divided into control and experimental groups according to a random number table, 30 people per group; In addition to traditional care method, Also intervened with behavioural awareness training and exercise therapy, By comparing the Oswestry dysfunction index score (ODI), visual simulation score (VAS), ability of daily living score (ADL), quality of life score (SF-36), To evaluate the effectiveness of the intervention.**Results:** Before the intervention, the ODI, VAS, ADL, and SF-36 scores were basically the same, with no significant difference (P>0.05). After treatment, the ODI and VAS scores of the experimental group and the control group were significantly lower, and the experimental group was significantly lower than the control group (P<0.05); the ADL scores of the experimental group were significantly higher than those of the control group (P<0.05); their SF-36 quality of life scores in all dimensions were significantly higher (P<0.05). **Conclusion:** Through the rehabilitation treatment method combining mindfulness behavior training and exercise intervention, it can effectively promote the functional recovery of osteoporotic lumbar fractures in the elderly, thus reducing their pain and improving their quality of life.

Keywords: Mindfulness Training; Exercise Intervention; Osteoporosis; Fracture of Lumbar Vertebrae; Functional Recovery; Quality of Life

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Introduction

At present, my country is gradually entering an aging society, and the incidence of osteoporosis (OP) increases with age. It has become one of the chronic diseases that seriously threaten the health of the middle-aged and elderly people[1]. With the increase of age, the degree of osteoporosis will continue to increase, which will lead to a continuous increase in the incidence of osteoporotic fractures[2]. Therefore, the elderly have become a high-risk group for fractures. The spine is the most common site of osteoporotic fractures (OPF), and osteoporotic vertebral compression fractures (OVCF) are the most

common type of OPF. Clinical diagnosis and treatment need to be based on imaging to determine the severity of the injury. If the injury is relatively mild, conservative treatment can be used, taking the form of bed rest or brace protection combined with drug treatment; for patients with a higher degree of injury, surgical treatment is required, and vertebroplasty (PVP/PKP) can be performed after the patient's condition stabilizes[3]. Surgical treatment is only the first step in solving the problem, helping patients relieve pain and repair the structure, while rehabilitation treatment is required for functional recovery. Many patients lack understanding of postoperative rehabilitation, which leads to poor postoperative functional recovery and reduced self-care ability, which in turn affects the quality of life of themselves and their families. Therefore, how to help patients with lumbar fractures reduce postoperative pain and improve their quality of life has become a hot topic in postoperative rehabilitation. Early exercise training is particularly important for osteoporotic patients after fracture surgery, which can reduce bone loss and promote early recovery from trauma[4]. Studies have found that mindfulness training can also relieve stress to a limited extent for pain relief, and has an effectiveness comparable to that of first-line drugs[5], which helps patients complete postoperative rehabilitation training more actively[6]. For patients, this can help patients reduce the pressure of postoperative rehabilitation, help patients adjust their mentality, and ensure better completion of rehabilitation training. Based on this, this study combined mindfulness behavioral training with exercise therapy intervention to explore its effects on functional recovery and quality of life in elderly patients after lumbar fracture surgery.

1.Materials and methods

1.1 Clinical data

This study selected 60 patients who visited the Department of Orthopedics of Suzhou Municipal Hospital (North District) from July 2022 to March 2023 and were diagnosed with lumbar fractures through physical examination and imaging. Inclusion criteria included: (1) met the diagnostic criteria for osteoporosis in the "Guidelines for the Diagnosis and Treatment of Osteoporosis"; (2) all patients met the indications for surgical treatment; (3) currently had single-segment vertebral lesions; (4) were over 60 years old; (5) had complete clinical data and signed informed consent. Exclusion criteria included: (1) had serious underlying diseases, organ dysfunction or malignant tumors; (2) had multi-segment vertebral fractures; (3) had incomplete posterior vertebral wall damage and kyphosis; (4) had spinal cord injury or lower limb neurological symptoms; (5) had vertebral re-fracture or bone cement leakage during surgery; (6) had cognitive, mental or language communication disorders. The patients were divided into a control group and an experimental group according to the random number table method, with 30 cases in each group. The baseline data of the two groups of patients are shown in Table 1. There was no statistical difference in the age of the two groups of experimental subjects (P>0.05), and the surgical method was not an influencing factor. This study complies with ethical principles and has been approved by the Ethics Committee (KL901173).

Table 1 Comparison of general information of the two groups of patients ($\bar{x} \pm s$)

Group	n	Gender		Age (years)	Surgical method	
		Male	Female		PVP	PKP
Experimental Group	30	18 (60%)	12 (40%)	67.50±4.38	17 (56.7%)	13 (43.3%)
Control group	30	17 (56.7%)	13 (43.3%)	67.70±3.35	14 (46.7%)	16 (53.3%)
x^2/t		0.069		-0.199	0.601	
P		0.793		0.843	0.438	

1.2 Methods

1.2.1 Control group

In this trial, patients with lumbar fractures in the control group were given routine care (including anti-osteoporosis treatment for 2 months), health education was provided to patients before and after surgery, and patients were informed of the precautions after lumbar fracture surgery after discharge, and were asked to come back for follow-up examinations on schedule.

1.2.2 Experimental group

The experimental group received two months of mindfulness behavioral training and exercise intervention on the basis of routine care.

Mindfulness behavioral training program: Before the patient left the hospital, the purpose, main content, key points and precautions of mindfulness training were explained to the patient so that the patient could smoothly carry out the next training. (1) Breathing training (weeks 1-2): When you are calm, lie on your back or sit, suppress your thoughts, stay relaxed, pay attention to the feeling of breathing, feel the fluctuations in your abdomen, and take deep breaths; (2) Relaxation training (weeks 3-4): Based on breathing training, the patient sits, closes his eyes and takes deep breaths, gradually relaxing the muscles from the head to the abdomen and then to the legs. Each session lasts for 10 minutes; (3) Five senses training (weeks 5-6): Use the five senses to perceive the world, cultivate the ability to capture information through the five senses of vision, touch, taste, hearing, and smell, do not judge everything around you, only focus on the five senses, and keep the mind in the present state; (4) Life training (weeks 7-8): The patient tries to bring mindfulness into various activities in daily life, constantly practice in daily life, internalize it, and gradually form his own pattern.

Exercise intervention plan: Preoperative and postoperative exercise prescriptions were given to the 10 patients in the experimental group, and the patients were given movement guidance. Since all the patients in this trial were elderly patients with lumbar fractures and had varying degrees of osteoporosis, relatively simple and easy-to-complete movements were selected in the formulation of the exercise prescription to avoid psychological burden on the patients, which made it difficult for them to persist. (1) Lower limb muscle strength training: ① Straight leg raising training: The patient lies on his back and lifts one leg off the bed to form a 30-degree angle with the bed surface. Each movement should last for 10 seconds, with both legs alternating, 15 times/set, 3-5 sets/day; ② Side leg raising training: The patient lies on his side, with his upper body parallel to the bedside, and straightens the upper leg and lifts it upward to form a 30-50 degree angle with the bed surface. Each movement lasts for 10 seconds, with both legs alternating, 15 times/set, 3-5 sets/day; (2) Back muscle training: The patient lies on his back, flexes his hips and knees, so that the headrest, elbows and feet follow the bed, the buttocks are tightened and raised, the trunk is in a straight line, and the waist, back, thighs and calves are all off the bed surface. The patient should rise and fall slowly each time, lift to the highest point as much as possible, and hold for 20-30 seconds. After each movement, rest for 3-5 seconds, 5-10 times/set, 2-3 sets/day. If the patient can complete the exercise smoothly, the elbow support can be removed, leaving only the headrest and heels on the bed. Other training requirements are the same as above. (3) Balance training: ① Standing with two feet apart: The patient stands upright with his feet apart, one hand supporting the wall or the handrail, and the other hand naturally lowered. Slowly move the right foot in front of the left foot so that both legs are on the same horizontal line, and continue for 15-20 seconds; alternate between the left and right sides, 10 times/group, 2-3 groups/day; ② Standing on one foot: The patient stands in place, with his feet as wide as his shoulders, one hand supporting the wall or the handrail, and the other hand naturally lowered. Slowly lift one side of the calf and hold for 10 -20 seconds, alternate between the left and right sides, 10 times/group, 2-3 groups/day; ③ Walking on tiptoes: The patient stands with his feet as wide as his shoulders, his hands naturally hanging on both sides of the body, lifts his heels and uses the forefoot for support and walks forward 5 meters at a normal walking speed, then turns around and returns to the starting point at the same speed. One round trip is one group, 3-5 groups/day.

The lower limb strength training in the above exercise prescription can be performed before surgery. Instruct patients to proceed step by step during the training, ensure safety, and avoid holding their breath. If dizziness, nausea, chest tightness, shortness of breath, etc. occur during the training, stop the exercise immediately.

1.3 Evaluation indicators

(1) Oswestry Disability Index (ODI) score[7]: Oswestry Disability Index (ODI) score is the most widely used functional scoring table for lumbar spine diseases and can be used for comparison before and after treatment. ODI score consists of 10 questions, each with 5 points, and the total score ranges from 0-50 points. The higher the patient's score, the more severe the functional disability; (2) Visual Analogue Scale (VAS) score[8]: Visual Analogue Scale (VAS) refers to the patient's subjective feeling based on the pain score from 0 to 10 points. The higher the score, the more severe the pain: 0-2 points indicate mild

pain; 2-4 points indicate mild pain; 4-6 points indicate moderate pain; 6-8 points indicate severe pain; 8-10 points indicate severe pain. If the VAS score decreases after the intervention, it means that the intervention is effective; otherwise, it means that it is ineffective; (3) Activities of Daily Living (ADL) score[9]: Daily living ability (ADL) refers to the necessary activities that humans perform every day to meet their daily needs. Currently, ADL is scored clinically using the Barthel Index Scale, which includes 10 aspects, 10 points for each aspect, and a total score of 100 points. 100 points indicates normal; 61-99 points indicate mild dependence; 41-60 points indicate moderate dependence; and less than 40 points indicate severe dependence. The Barthel index has the advantages of simplicity, accuracy, and high sensitivity, and has been widely used in clinical practice. (4) Quality of life score: The SF-36 summary scale is used[10]. This scale is a universal scale for measuring the health and quality of life of people of different ages and diseases. It includes four dimensions: postoperative physical function, social role, emotional state, and vitality[11] (Table 2). Each dimension has 10 small items, each item has 10 points, and the total score is 100. The higher the score, the higher the quality of life. Because this scale is sensitive to changes, many studies have used this scale to evaluate the effect of treatment.

Table 2 Specific content of each score

Indicators	Specific details
ODI	Intensity of pain, self-care, lifting, walking, sitting, standing, sleeping, sex life, social life, travel
ADL	Eating, bathing, washing face independently, dressing, controlling bowel movements, using the toilet, transferring from bed to chair, walking, and climbing stairs
SF-36	Physical functions, social roles, emotional states, vitality

1.4 Statistical methods

SPSS 26.0 software was used to analyze the data. All experimental data that conformed to normal distribution were expressed as mean±standard deviation ($\bar{x} \pm s$). Independent sample t test and chi-square test were used for comparison between the two groups, and paired t test was used for comparison within the group. P<0.05 indicated that the difference was statistically significant.

2 Results

2.1 Comparison of ODI and VAS scores before and after intervention between the experimental group and the control group (Table 3)

Before the intervention, there was no significant difference in ODI and VAS scores between the two groups (P>0.05); after two months of mindfulness behavioral training and exercise therapy intervention, the ODI and VAS scores of both groups decreased compared with before the intervention, and the ODI and VAS scores of the experimental group were lower than those of the control group, and the difference was statistically significant (P<0.05).

2.2 Comparison of ADL scores before and after intervention between the experimental group and the control group (Table 4)

Before the intervention, there was no significant difference in the ADL scores of the two groups (P>0.05); after two months of mindfulness behavioral training and exercise therapy intervention, the ADL scores of both groups were significantly improved, and the scores of patients in the experimental group were higher than those in the control group, and the difference was statistically significant (P<0.05).

2.3 Comparison of SF-36 scores in each dimension between the experimental group and the control group before and after intervention (Table 5)

Before the intervention, there was no significant difference in the scores of each dimension of SF-36 between the two groups (P>0.05); after two months of mindfulness behavioral training and exercise therapy intervention, the scores of each dimension of SF-36 between the two groups were significantly improved, and the scores of patients in the experimental group were higher than those in the control group, and the difference was statistically significant (P<0.05).

Table 3 Comparison of ODI scores and VAS scores before and after intervention between the experimental group and the control group ($\bar{x} \pm s$, points)

Group	n	ODI		VAS	
		Before	After	Before	After
Experimental Group	30	41.60±5.95	31.80±6.25*	7.00±1.05	2.60±1.70*
Control group	30	41.05±5.87	35.60±5.41*	7.10±0.88	4.20±1.79*
t		0.360	2.518	0.400	3.550
P		0.720	0.015	0.691	0.001

Compared with the same group before intervention, *P<0.05

Table 4 Comparison of ADL scores between the experimental group and the control group before and after intervention ($\bar{x} \pm s$, points)

Group	n	ADL	
		Before	After
Experimental Group	30	35.09±7.82	70.00±6.67*
Control group	30	35.30±7.89	65.50±5.80*
t		0.104	2.788
P		0.918	0.007

Compared with the same group before intervention, *P<0.05

Table 5 Comparison of SF-36 scores in each dimension between the experimental group and the control group before and after intervention($\bar{x} \pm s$, points)

Group	n	Physical Function		Social Role		Emotional state		Vitality	
		Before	After	Before	After	Before	After	Before	After
Experimental Group	30	64.12±9.34	90.34±9.77*	65.79±10.67	89.41±9.68*	60.78±11.23	88.97±10.67*	60.94±10.26	86.11±10.37*
Control group	30	63.92±8.32	82.65±9.45*	66.78±10.23	83.47±10.37*	60.12±10.78	80.79±11.03*	60.31±9.88	78.32±11.23*
t		0.088	3.009	0.367	2.293	0.232	2.920	0.242	2.791
P		0.931	0.003	0.715	0.025	0.817	0.005	0.809	0.007

Compared with the same group before intervention, *P<0.05

3.Discussion

As the aging process of society continues to intensify, the incidence of osteoporosis (OP) will increase with age. Osteoporotic fractures are caused by osteoporosis and are more common in the upper limbs, spine, and hips. In addition, fractures will aggravate osteoporosis again, leading to an increased risk of secondary fractures[12]. After percutaneous vertebroplasty, not only drugs are needed for anti-osteoporosis treatment, but functional rehabilitation training is also necessary to consolidate the effect of surgical treatment.

The results of this study showed that after 2 months of intervention, the ODI score and VAS score of the experimental group were lower than those of the control group, indicating that mindfulness behavioral training combined with exercise intervention can improve lumbar dysfunction and relieve pain after osteoporotic lumbar fracture surgery; at the same time, the results of the study showed that after the intervention, the ADL score and the scores of each dimension of SF-36 in the

experimental group were significantly higher than those in the control group, suggesting that the intervention of mindfulness behavioral training combined with exercise therapy can help patients restore normal activity functions, enable them to return to a normal social environment, and thus improve their quality of life.

Patients with lumbar fractures usually have lumbar pain and limited mobility. Elderly patients with lumbar fractures usually undergo surgical treatment, which can repair the fracture site, improve the spinal sequence to restore it to normal, improve the stability of the spine, reduce the pressure on the peripheral nerves, thereby reducing the patient's pain symptoms and further promoting the repair of nerve function[13]. Before surgery, most patients are anxious about the surgical trauma and results. After surgery, patients are anxious about persistent pain, lesion characterization, wound healing, functional recovery, quality of life and other issues. In this trial, after 2 months of mindfulness behavioral training, the experimental group not only had a decrease in VAS scores, but also had a significant increase in the scores of the two dimensions of physical function and emotional state in the SF-36 score compared with the control group. This shows that mindfulness training can relieve pain and effectively help patients improve negative emotions and reduce fear of the disease. Chen et al. helped patients maintain a good mentality through psychological intervention, and participated more actively in early rehabilitation training, promoting patients' functional recovery and accelerating their return to society[14].

Studies have shown that mindfulness training can adjust the body's basal metabolism, regulate the autonomic nervous system, and thus improve sensory sensitivity[15]. In addition, some experiments have shown that mindfulness practice can improve the body's immunity. After conducting mindfulness training on patients with hemiplegia after stroke, it was found that mindfulness training can effectively help patients improve their acceptance of the disease, reduce their cognitive stress, and reduce their painful experience[16]. In this experiment, mindfulness training can enable patients to have a clearer understanding of their fractures and the negative effects they bring, and to focus on the current feelings in continuous practice, using this self-awareness method to deal with the anxiety and fear generated in their hearts. Lumbar dysfunction is a common symptom of osteoporotic lumbar fractures. ODI score is a common indicator of lumbar dysfunction. In this experiment, we conducted 2-month lumbar and lower limb muscle strength training on postoperative patients. The results showed that the patients who underwent lumbar muscle training after fracture surgery had lower ODI scores and VAS scores than the control group, and the recovery of lumbar function and pain relief were more obvious than those in the control group ($P<0.05$). In addition, the results showed that in terms of ADL, the experimental group performed better than the control group in walking and going up and down stairs, indicating that muscle strength training helps improve patients' joint function and daily living ability. Chiang CH et al.[17] found that the ODI scores of patients who underwent lumbar muscle training were significantly higher than those of other patients after 6 months. This suggests that lumbar muscle training after vertebroplasty can help improve lumbar function in patients with osteoporotic lumbar fractures, which is consistent with the findings of Chen BL et al.[18]. In addition, a study by Zhu et al.[19] pointed out that if effective early functional exercise is not performed after vertebroplasty for osteoporotic lumbar fractures, disuse atrophy of the lower back muscles will occur. Functional back muscle training can promote the growth of skeletal muscle volume and increase blood supply, relieve local muscle tissue and nerve root edema, thereby improving neuromuscular control, reducing muscle atrophy due to disuse, making the waist muscles stronger, forming a strong peripheral support, maintaining the mechanical stability of the spine, reducing the load on the lumbar spine, and promoting the recovery of damaged tissues[20].

Balance ability is an important indicator for measuring the degree of recovery of motor function and is of great significance for elderly patients with lumbar fractures. A large number of literatures show that even if exercise intervention does not significantly increase bone mass, it can improve the balance of the elderly, thereby reducing the risk of falls and fractures. Decreased balance ability and decreased lower limb muscle strength are important causes of falls[21]. Balance disorders in the elderly are closely related to the decline of vision, vestibular function and proprioception. When designing the exercise program, this trial specifically strengthened the balance ability and lower limb muscle strength training of elderly patients. Lower limb muscle strength loss caused by bed rest after osteoporotic lumbar fracture surgery is more likely to cause patients to fall when walking after surgery. Therefore, it is not only necessary to conduct lower limb muscle strength training for patients after surgery, but also to guide patients to perform muscle strength training while they are bedridden before surgery

to help them maintain muscle strength. Studies have shown that personalized progressive exercise prescriptions can help patients strengthen their lower limb muscle strength and improve their lower limb stability, which can better prevent falls in the elderly[22], promote patients to better participate in family and social activities, and improve their quality of life.

In summary, the rehabilitation treatment method combining mindfulness behavioral training and exercise therapy can effectively promote the functional recovery of osteoporotic lumbar fractures in the elderly, thereby alleviating the pain of patients and improving their quality of life.

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Conflict of Interests

The author(s)declare(s) that there is no conflict of interest regarding the publication of this paper.

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