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Research Article

Efficacy Evaluation of Modified Siwu Decoction to Treat Osteoporosis in Patients with Poststroke Hemiplegia by Using the Magnetic Resonance Imaging Features

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This study was focused on the clinical efficacy and safety of magnetic resonance imaging (MRI)-based Siwu decoction for poststroke hemiplegia complicated with osteoporosis. 120 patients with poststroke hemiplegia and osteoporosis were divided into an observation group (modified Siwu decoction based on the treatment scheme of control group, 60 cases) and a control group (conventional drugs in neurology + neurology-based rehabilitation training treatment of muscle enhancement surgery, 60 cases). They all underwent MRI scans. The results showed that the bone mineral density (BMD) of lumbar spine, ipsilateral femoral neck, and ipsilateral patella in the observation group was higher than that in the control group 180 days after treatment ($P < 0.05$). MRI showed restricted diffusion and edema in the left frontoparietal cortex and subcortical white matter. The levels of 25-hydroxy-vitamin D (25-OH-VD) and bone gla-containing protein (BGP) in the observation group 180 days after treatment were higher, and the type I collagen n-terminal propeptide (PINP) and type I collagen cross-linked C-terminal telopeptide (β-CTX) were lower ($P < 0.05$). The visual analogue scale (VAS) score of the observation group at 180 days after treatment was lower, while the quality of life score was higher ($P < 0.05$). The median cell count in the observation group at 180 days after treatment was less, while the lymphocytes showed a higher level ($P < 0.05$). In conclusion, the Siwu decoction could effectively improve the bone metabolism of patients with poststroke hemiplegia and osteoporosis, promote the proliferation and differentiation of osteocytes, and improve the BMD and quality of life of patients.

1. Introduction

Stroke, also known as cerebrovascular accident, is a local brain dysfunction caused by acute cerebrovascular disease. Its clinical symptoms persist for more than 24 hours and are characterized by high morbidity, mortality, disability, and recurrence [1, 2]. Stroke is common in people aged 50 and older, and clinically manifests as symptoms and signs of transient or permanent brain dysfunction. It usually manifests as sudden weakness, clumsiness, heaviness, or numbness on one side of the limbs, numbness on one side of the face or skewed corners of the mouth, slurred speech accompanied by disturbance of consciousness or convulsions, etc. [3, 4]. It ranks first in the cause of death of urban residents [5]. The most serious consequence of cerebral stroke is hemiplegia, which will lead to long-term bed rest, greatly reduce the amount of exercise, and disrupt the balance of bone resorption and bone formation in the human body, which is prone to disuse osteoporosis [6, 7]. Disuse osteoporosis caused by poststroke hemiplegia is a type of secondary osteoporosis. If not treated in time, it will cause more pain to patients and cause a series of complications such as kidney stones, pathological fractures, and heterotopic ossification [8].

The clinical treatment principles for patients with disuse osteoporosis are to increase calcium intake, reduce calcium excretion, guide the deposition of calcium salts at the target site, and improve bone strength. Common treatment options include surgery, physical therapy, and drug therapy [9, 10]. The use of internal fixation can better help patients to get out of bed as soon as possible and avoid the aggravation of osteoporosis caused by long-term bed rest, but the effectiveness is not high [11]. Guiding patients to perform appropriate physiological exercise can stimulate the increase of bone mass, reduce the fracture rate, and improve the body's agility. Physical therapy includes ultraviolet therapy, high-frequency electrotherapy, and specific frequency vibration stimulation to promote bone growth in patients [12]. In terms of drug treatment, bone resorption and bone metabolism balance can be improved by supplementing calcium and other drugs, such as calcium gluconate, calcigard, alfacalcidol, sodium alendronate, calcitonin, and compound estrogen [13]. Siwu Decoction is a classic traditional Chinese medicine (TCM) for nourishing and nourishing blood. It is composed of four herbs: angelica sinensis, ligusticum wallichii, rehmannia glutinosa, and radix paeoniae alba. It is mainly used for the treatment of Chong-Ren deficiency, irregular menstrual flow, umbilical-abdominal pain, metrorrhagia, and fetal uneasiness during pregnancy [14].

With the development of imaging technology, clinical imaging examinations are often used to evaluate disuse osteoporosis caused by post-stroke hemiplegia, including X-ray films, quantitative ultrasound, quantitative computed tomography (CT), and magnetic resonance imaging (MRI) [15–17]. X-ray films can clearly show the osteoporosis in patients with advanced disuse osteoporosis (at least 30% of bone mass has been lost), which is simple, easy to operate, and low in cost, but has little significance for the diagnosis of early osteoporosis. Quantitative ultrasound can clearly display the mechanical strength, bone mineral density (BMD), and elastic structure of patients' bones. It is an economical, simple, and non-radioactive detection method, but there is a certain rate of missed diagnosis and misdiagnosis. Quantitative CT can detect changes in bone mineral content in patients early by measuring cortical bone and cancellous bone, so as to predict the degree of the patient's disease. As a new non-invasive imaging technology, MRI is widely used in clinical medical disease assessment, and has the advantages of high resolution, multi-parameter, and high accuracy. The manifestations of osteoporosis on MRI images are usually marked xanthosis of the vertebral body, and high signal intensity on T1-weighted and T2-weighted images. When a fracture occurs, the edema in the vertebral body shows long T1 and long T2 signals, and the edema signal is not good in the background of high signal intensity on T2 weighted imaging (T2WI) of osteoporosis [18].

To sum up, post-stroke hemiplegia and osteoporosis will have a very serious impact on patients, and even life-threatening if not treated early. 120 patients with post-stroke hemiplegia complicated with osteoporosis random were divided into observation group and control group, and all underwent MRI imaging scans. It compared the X-ray measurement indicators, bone metabolism indicators, visual analog pain score, and clinical efficacy of the two groups of patients to deeply understand the clinical efficacy and safety of the modified Siwu Decoction treatment on post-stroke hemiplegia patients with osteoporosis.

2. Materials and Methods

2.1. Research Objects. A total of 120 patients with post-stroke hemiplegia and osteoporosis who were treated in our hospital from October 2020 to May 2022 were selected as the research objects. The informed consents are obtained from all patients and their families and this study was approved by ethics committee of hospital.

2.1.1. Inclusion Criteria. (i) Patients with symptoms of hemiplegia on one limb; (ii) Patients with Fug1-Meyer motor function score of the hemiplegic limb less than 50; (iii) patients with stable vital signs within two days; (iv) patients with good nutritional status; and (v) patients who were conscious and able to cooperate with treatment.

2.1.2. Exclusion Criteria. (i) Patients with Glasgow coma scale (GCS) less than 8 points; (ii) patients who had received thrombolytic therapy; (iii) patients with limb hemiplegia caused by other factors; (iv) patients with severe heart, lung, kidney, and other major organ insufficiency; (v) patients with hemiplegia in all four limbs; and (vi) patients who had used glucocorticoids and immunosuppressants.

2.2. Treatment Schemes. The patients were randomly divided into 60 cases in the observation group and 60 cases in the control group. The patients in control group received conventional drug therapy in neurology and rehabilitation training based on neuromuscular stimulation. It mainly included rhythmic initiation, compound isotonic exercise, repetitive contraction technique, hold-relax technique, and hold-relax-active movement. Each treatment time was generally 1 hour, 2 times a day, and 5 days a week. The patients in observation group were given modified Siwu Decoction on the basis of treatment scheme of the control group. Recipe was as follows: angelica sinensis 10 g, ligusticum wallichii 10 g, peach kernel 10 g, rhizoma zingiberis preparata 10 g, astragalus membranaceus 30 g, leonurus japonicus 15 g, radix rehmanniae recens 15 g, rehmannia glutinosa 15 g, radix paeoniae rubra 15 g, radix paeoniae alba 15 g, radix angelicae 10 g, teasel 30 g, rubia cordifolia 15 g, honeysuckle rattan 20 g, and white flower patrinia 15 g. It should be taken with decoction in water, 1 dose per day, orally in 3 doses for 3 to 6 days.

2.3. MRI Scan. The MRI system was used. The patient was required to keep a supine position with the feet inside the coil. Scanning parameters were set as follows: the time of

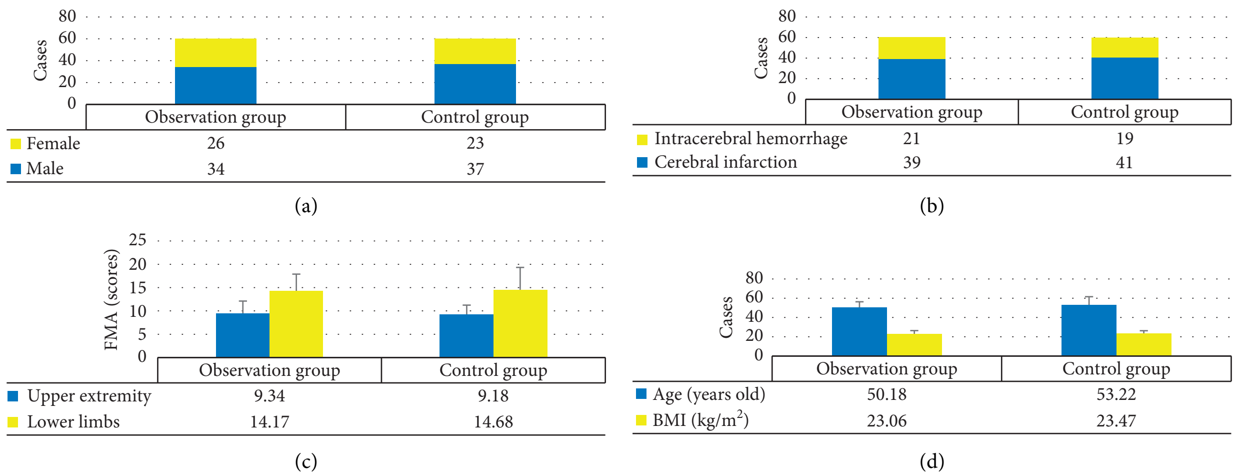


Figure 1: Comparison of general data between the two groups before treatment. (a)~(d) show the comparisons of gender, numbers of patients with cerebral infarction and cerebral hemorrhage, FMA score, and age and BMI, respectively.

echo (TE) = 4.65 ms, the time of repetition (TR) = 12.5 ms, layer thickness = 0.8 mm, layer spacing = 0.15 mm, matrix = 325 × 256, and flip angle = 30°. On average, three images were collected per scan. The acquired images were sent to the workstation for processing.

2.4. Observation Indicators. The bone mineral density (BMD) of the lumbar spine, ipsilateral femoral neck, ipsilateral patella, and ipsilateral forearm was measured on the first day of admission, 60 days after treatment, and 180 days after treatment.

6 mL of fasting venous blood was collected in the morning on the 1st day after admission and 60th and 180th day after treatment and we coagulated it naturally at 25°C for 15 minutes. The blood samples were centrifuged at 3500 rpm for 20 minutes, and the supernatant was transferred to a 1 mL centrifuge tube and stored at low temperature.

Safety was observed by comparing the changes of blood routine, liver function (including alanine aminotransferase (ALT) and aspartate aminotransferase (AST)) and renal function (including serum creatinine (Scr) and urea) before and after treatment in the two groups.

The changes of bone metabolism indicators in the two groups of patients were measured, including 25-hydroxy-vitamin D (25-OH-VD), bone gla-containing protein (BGP), type I collagen n-terminal propeptide (PINP), and type I collagen cross-linked C-terminal telopeptide (β-CTX) levels.

The pain level of the patients was assessed using a visual analog scale (VAS). The World Health Organization Quality of Life Scale (WHOQOL-100) was adopted to evaluate patients' life treatment before and after treatment. According to the clinical symptoms, the clinical efficacy was evaluated and divided into markedly effective (clinical symptoms and signs completely disappeared), effective (clinical symptoms and signs were alleviated), and ineffective (clinical symptoms and signs did not improve or worsened). In addition, the effective rate of treatment was calculated.

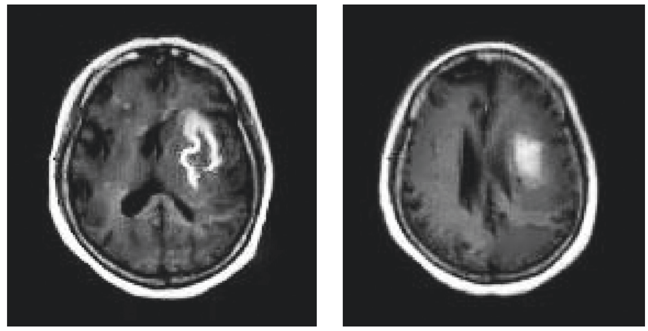
2.5. Statistical Methods. The data processing in this work was analyzed by SPSS 19.0 statistical software, the measurement data was expressed as mean ± standard deviation ($\overline{x} \pm s$), and the count data was expressed as percentage (%). Pairwise comparisons were made using one-way ANOVA. The difference was statistically significant at $P < 0.05$.

3. Results

3.1. Comparison of General Data of Two Groups. As shown in Figure 1, there was no significant difference in gender, number of patients with cerebral infarction, number of patients with cerebral hemorrhage, FMA score, age, and body mass index (BMI) between the observation group and the control group ($P > 0.05$).

3.2. Case Data. Figure 2 shows the brain MRI images of a 63-year-old female patient. Physical examination showed that the heart rate was 67 times/min, and the blood pressure was 208/156 mmHg. She was comatose with eyes open, unresponsive, cataracts on the right side of both pupils, 1.5 mm, 1 mm on the left, with presence of light reflexes. The low breath sounded in both lungs, no rales, low heart sounds, no murmurs, and soft abdomen. The right limb can move voluntarily, and the mobility was worse than that of the left. The right Pap's sign was positive and the left was negative.

3.3. Comparison of BMD. As shown in Figure 3, there was no significant difference in BMD of the lumbar spine, ipsilateral femoral neck, and ipsilateral patella between the two groups on the first day of admission and 60 days after treatment ($P > 0.05$). The BMD of the lumbar spine, ipsilateral femoral neck, and ipsilateral patella at 180 days after treatment in the two groups were significantly higher than those on the first day of admission, and the differences were statistically significant ($P < 0.05$). The BMD of



(a) (b)

Figure 2: MRI image data of patient. (a) There were irregularly shaped near-oval high-density shadows in the left corona radiata-basal ganglia region; (b) there were long T1 isometric T2 signals inside the lesion in the left corona radiata-basal ganglia region.

lumbar spine, ipsilateral femoral neck, and ipsilateral patella in the observation group at 180 days after treatment were significantly higher in contrast to the BMD values in the control group, and the differences were statistically significant ($P < 0.05$). There was no significant difference in the BMD of the affected side forearm 180 days after treatment between the two groups ($P > 0.05$).

3.4. Comparison of Bone Metabolism Indicators. As illustrated in Figure 4, the levels of 25-OH-VD and BGP 180 days after treatment in the two groups were significantly higher than those on the first day of admission, while PINP and β-CTX were significantly lower than those on the first day of admission, and the differences were statistically significant ($P < 0.05$). The levels of 25-OH-VD and BGP in the observation group at 180 days after treatment were significantly higher than those in the control group, while PINP and β-CTX were significantly lower than those in the control group, and the differences were statistically significant ($P < 0.05$).

3.5. Comparison of Pain Scores. As shown in Figure 5, the VAS scores 180 days after treatment in the two groups were significantly lower than those on the first day of admission, and the difference was statistically significant ($P < 0.05$). The VAS score 180 days after treatment in the observation group (0.55 ± 0.14) was significantly lower than that in the control group (2.27 ± 0.49), and the difference was statistically significant ($P < 0.05$).

3.6. Comparison of Quality of Life Scores. As demonstrated in Figure 6, the quality of life scores of the two groups of patients 180 days after treatment were significantly higher than those on the first day of admission, and the difference was statistically significant ($P < 0.05$). The quality of life score 180 days after treatment in the observation group was significantly higher than that in the control group, and the difference was statistically significant ($P < 0.05$).

3.7. Comparison of Blood Routine Indexes. The median cell count of the two groups of patients 180 days after treatment was significantly lower than that on the first day of admission, while the level of lymphocytes was significantly higher than that on the first day of admission, and the difference was statistically significant ($P < 0.05$). The median cell count of the observation group at 180 days after treatment was significantly lower than that of the control group, while the level of lymphocytes was significantly higher than that of the control group, and the difference was statistically significant ($P < 0.05$). However, there was no significant difference in the erythrocyte volume and platelet count between the two groups on the first day of admission, 60 days after treatment, and 180 days after treatment ($P > 0.05$). The specific results are demonstrated in Figure 7.

3.8. Comparison of Clinical Efficacy. In Figure 8, we compared the clinical efficacy between two groups of patients. After treatment, 42 cases were markedly effective, 11 cases were effective, and 7 cases were ineffective in the observation group; in the control group, 27 cases were markedly effective, 20 cases were effective, and 13 cases were ineffective. It suggested that the total effective rate (88.33%) of the observation group was significantly higher than that of the control group (78.33%), and the difference was statistically significant ($P < 0.05$).

4. Discussion

Poststroke hemiplegia osteoporosis is a type of disuse osteoporosis. The main pathological mechanism is that, in the process of bone metabolism, there are problems in bone resorption and new bone formation, resulting in abnormal calcium and phosphorus metabolism in the human body, decreased BMD, and many clinical symptoms [19, 20]. Therefore, how to improve the bone metabolism pathway of the patient's body and improve the patient's BMD is the focus of current clinical treatment. This work used the random number table method to divide 120 patients with poststroke hemiplegia complicated with osteoporosis into 60 patients in the observation group (on the basis of the control group, they were given Siwu decoction) and 60 patients in

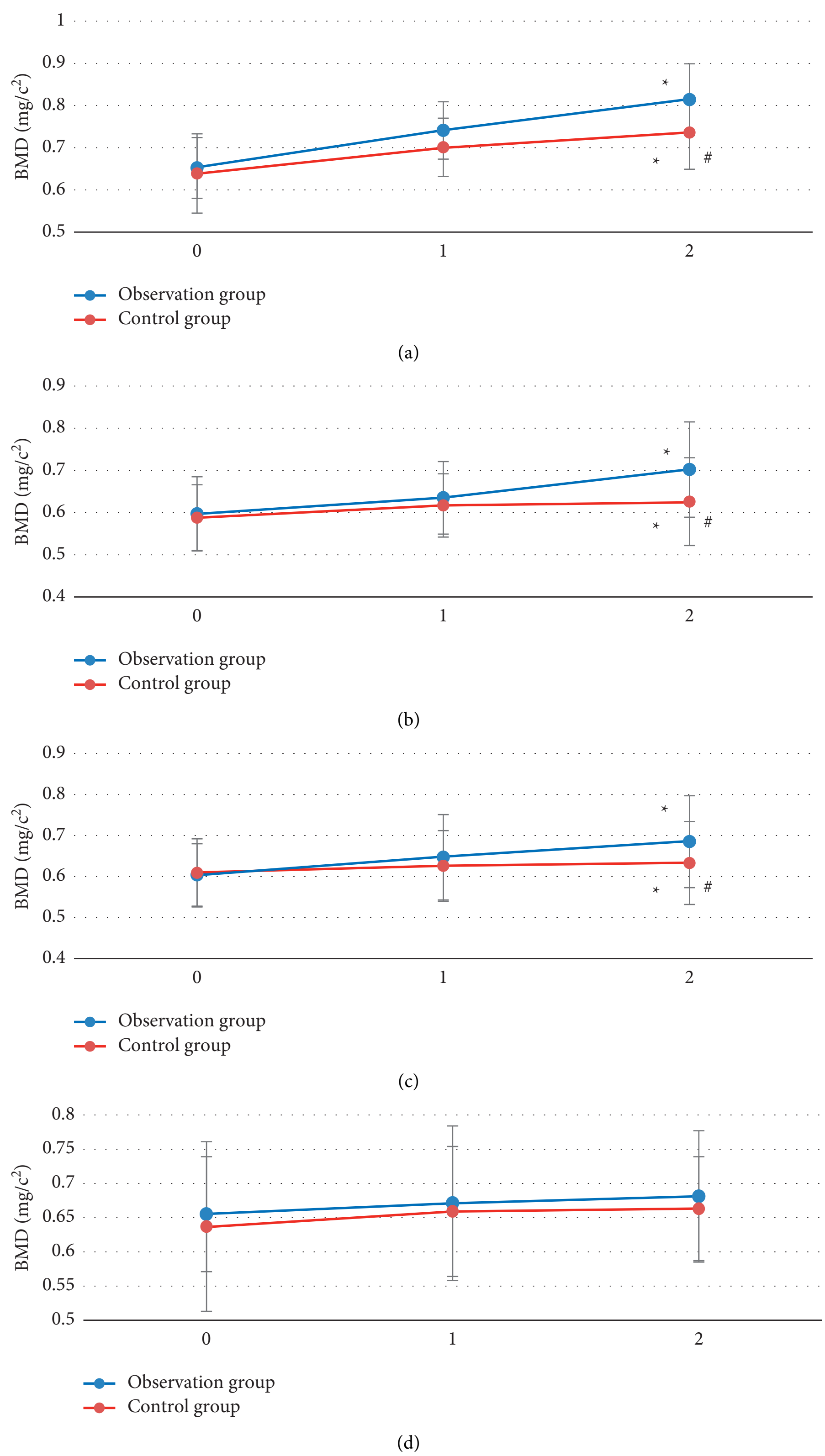


FIGURE 3: Comparison of BMD before and after treatment in the two groups. (a) The BMD in the lumbar spine; (b) the BMD in ipsilateral femoral neck; (c) the BMD in ipsilateral patella; and (d) the BMD in affected forearm. 1–3 refer to the first day of admission, the 60th day after treatment, and the 180th day after treatment, respectively. *Compared with the first day of admission, $P < 0.05$; #compared with control group, $P < 0.05$.

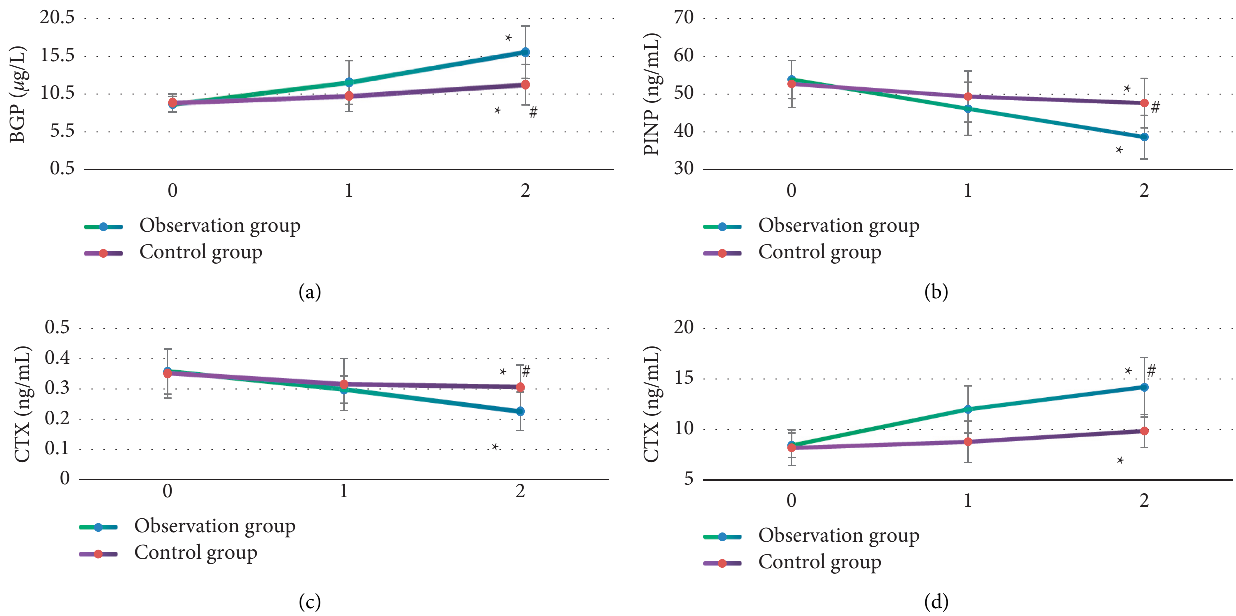


Figure 4: Comparison of bone metabolism indicators between the two groups before and after treatment. (a)~(d) show the comparisons of BGP, PINP, β-CTX, and 25-OH-VD, respectively. 1–3 refer to the first day of admission, the 60th day after treatment, and the 180th day after treatment, respectively. *Compared with the first day of admission, $P < 0.05$; #compared with control group, $P < 0.05$.

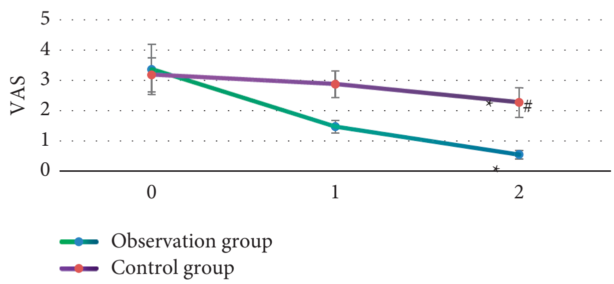


Figure 5: Comparison of pain scores in the two groups before and after treatment. 1–3 refer to the first day of admission, the 60th day after treatment, and the 180th day after treatment, respectively. *Compared with the first day of admission, $P < 0.05$; #compared with control group, $P < 0.05$.

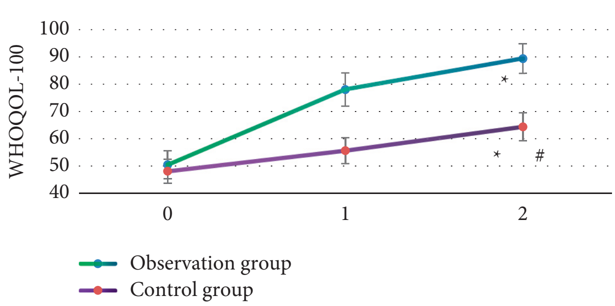


Figure 6: Comparison of quality of life scores between the two groups before and after treatment. 1–3 refer to the first day of admission, the 60th day after treatment, and the 180th day after treatment, respectively. *Compared with the first day of admission, $P < 0.05$; #compared with control group, $P < 0.05$.

the control group (neural Internal medicine routine drug treatment and neuromuscular promotion-based rehabilitation training treatment), and all underwent MRI imaging scans. First, the basic data of the two groups of patients were compared, and it was found that there were no statistically significant differences in gender, number of patients with cerebral infarction, number of patients with cerebral hemorrhage, FMA score, age, and BMI between the observation group and the control group ($P > 0.05$). Such results ensure the feasibility of follow-up studies. From brain MRI images, patients with poststroke hemiplegia osteoporosis have limited diffusion and edema in the left frontoparietal cortex and subcortical white matter.

Then, the BMD changes of the two groups of patients before and after treatment were compared. It was found that the BMD values of the lumbar spine, ipsilateral femoral neck, and ipsilateral patella of the observation group at 180 days after treatment were significantly higher than those of the control group, showing statistically significant differences ($P < 0.05$). BMD can reflect the bone strength of patients and help physicians to detect the signs of osteoporosis more accurately. The results indicated that the Siwu Decoction formula can effectively improve the BMD of patients with poststroke hemiplegia osteoporosis, improve bone strength, and help patients recover more [21]. 25-OH-VD is the main form of vitamin D in the human body, which is mainly synthesized by human skin after ultraviolet radiation. A small portion of it comes from food or supplements and has an important role in the human skeleton. BGP is an active polypeptide synthesized and secreted by osteoblasts and plays an important role in regulating bone metabolism, and its level reflects osteoblast activity [22, 23]. In this work, the analysis of bone metabolism indicators showed that the 25-

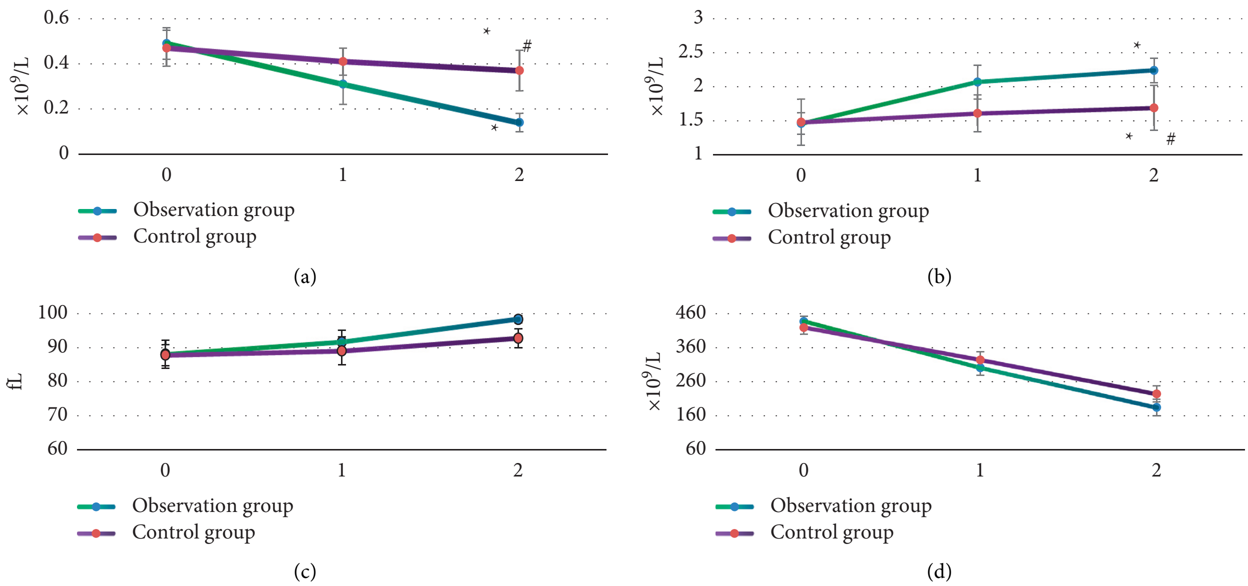


Figure 7: Comparison of blood routine indicators before and after treatment in two groups. (a)~(d) show the comparisons of median cell count, lymphocyte level, erythrocyte volume, and platelet count, respectively. 1–3 refer to the first day of admission, the 60th day after treatment, and the 180th day after treatment, respectively. *Compared with the first day of admission, $P > 0.05$; #compared with control group, $P < 0.05$.

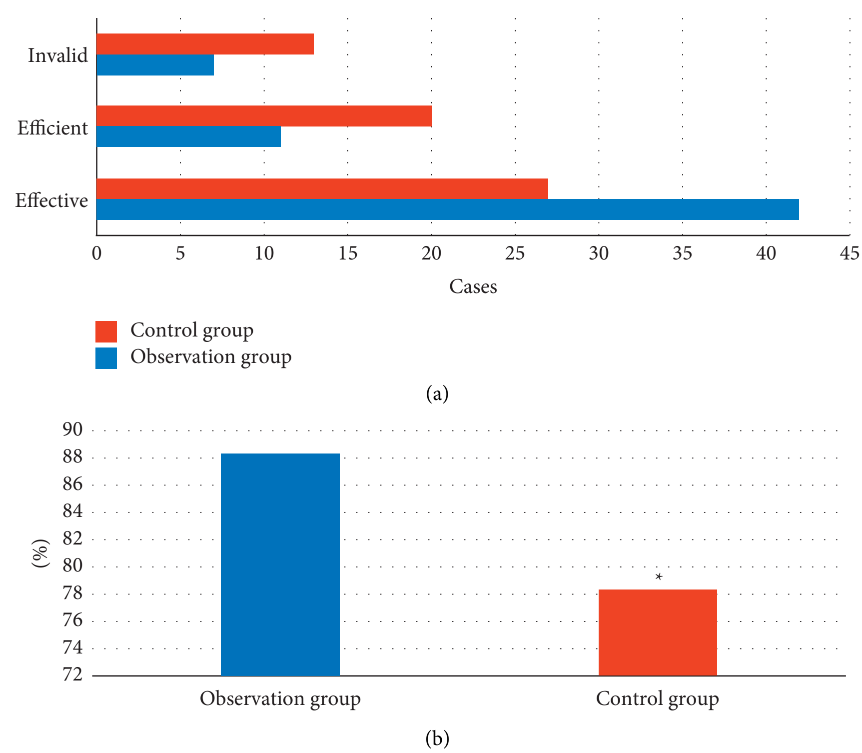


Figure 8: Comparison of clinical efficacy between the two groups. (a) The numbers of markedly effective, effective, and ineffective cases. (b) The total effective rate of treatment. *Compared with control group, $P < 0.05$.

OH-VD and BGP of the observation group were significantly higher than those of the control group at 180 days after treatment, with statistically significant differences ($P < 0.05$). This indicates that the Siwu decoction can treat poststroke hemiplegia osteoporosis patients by increasing the levels of 25-OH-VD and BGP and improving bone metabolism. In addition, the PINP and β-CTX of the observation group 180 days after treatment were significantly lower than those of the control group, and the differences were statistically significant ($P < 0.05$). Such results are similar to the results of He et al. [24]. The content of PINP in serum reflects the ability of osteoblasts to synthesize collagen and has high specificity and sensitivity in predicting the occurrence of osteoporosis, evaluating bone mass, and monitoring the efficacy of antiosteoporosis. The level of β-CTX reflects the bone resorption activity of osteoclasts and is an important biochemical marker of bone resorption, indicating that the Siwu decoction has a regulatory effect on bone metabolism and promotes the proliferation and differentiation of osteocytes and the efficiency of bone formation [25].

In addition, it was found that the VAS score of the observation group 180 days after treatment was significantly lower than that of the control group, and the difference was statistically significant ($P < 0.05$). This shows that the Siwu decoction not only has a significant clinical effect, but also can relieve the pain of patients with poststroke hemiplegia osteoporosis, so it is safe. The quality of life score 180 days after treatment in the observation group was significantly higher than that in the control group, showing statistically significant difference ($P < 0.05$). Such results are similar to the findings of Shapiro et al. [18]. This indicates that the Siwu decoction can effectively improve the quality of life and prognosis of patients with poststroke hemiplegia and osteoporosis. From the blood routine indicators, the median cell count of the observation group 180 days after treatment was significantly lower than that of the control group, while the level of lymphocytes was significantly higher than that of the control group ($P < 0.05$). It shows that the Siwu decoction can reduce the number of intermediate cells in patients, increase the volume of red blood cells, and elevate the level of lymphocytes. From the perspective of clinical efficacy, the total effective rate (88.33%) of the observation group was significantly higher than that of the control group (78.33%), and the difference was statistically significant ($P < 0.05$). This indicates that the Siwu decoction has significant curative effect in the treatment of patients with poststroke hemiplegia and osteoporosis, showing high clinical application value.

5. Conclusion

In this study, the modified Siwu decoction was applied in the treatment of poststroke hemiplegia patients with osteoporosis. It was finally found that Siwu decoction can effectively improve bone metabolism in patients with poststroke hemiplegia and osteoporosis, promote the proliferation and differentiation of bone cells, and improve the BMD and quality of life of patients. However, the patients selected in this work all came from the same hospital, and the long-term follow-up time was short, so no longer-term patient prognosis data were obtained. Therefore, in the following research, it would include stroke patients with osteoporosis in different hospitals as the research object and further analyze the clinical application value of traditional Chinese medicine Siwu decoction. All in all, the results of this work could provide a reference for the nursing treatment of poststroke hemiplegia complicated with osteoporosis.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Authors' Contributions

Jing Wang and Xiuyun Liu contributed equally to this work.

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