

Comparative study of the efficacy of glucosamine sulfate capsules and Huoxue Xiaozhong prescription in the treatment of knee osteoarthritis and the recovery of knee joint function

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Abstract: This study focused on the difference in efficacy between glucosamine sulfate capsules and Huoxue Xiaozhong recipe in the treatment of knee osteoarthritis, as well as their effects on knee joint function recovery. A total of 128 patients with knee osteoarthritis who met the criteria were prospectively enrolled and randomly divided into a glucosamine sulfate group (n = 64) and a traditional Chinese medicine group (n = 64). The total effective rate, visual analogue score (VAS), Western Ontario and McMaster University Osteoarthritis Index (WOMAC), degree of joint swelling, range of motion (ROM), serum inflammatory factor levels, degree of articular cartilage wear, knee joint function recovery and adverse reactions were observed from multiple dimensions. In this study, independent sample t-test and repeated measures analysis of variance were used to statistically evaluate the data. The results showed that the traditional Chinese medicine group had significant advantages in total effective rate, improvement of WOMAC score, relief of joint swelling, improvement of ROM, control of articular cartilage wear, and knee joint function recovery; the glucosamine sulfate group performed outstandingly in reducing VAS scores and regulating serum inflammatory factor levels and the incidence of adverse reactions in the traditional Chinese medicine group was lower. In summary, for patients who urgently need to relieve pain, glucosamine sulfate capsules can be used as an initial option; while for patients who hope to comprehensively improve joint function, the blood circulation and swelling reduction formula is more valuable.

Keywords: glucosamine sulfate capsules; Huoxue Xiaozhong recipe; knee osteoarthritis; multidimensional evaluation; treatment plan

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INTRODUCTION

Knee osteoarthritis (KOA) is a common chronic joint disease with progressive degeneration and wear of articular cartilage, subchondral bone sclerosis, cystic changes and bone hyperplasia at the joint margin as the main pathological features (Mustafa A *et al.*, 2024). Aging, obesity, trauma, genetic factors and long-term overuse of joints are all important causes of KOA. The disease is particularly common in middle-aged and elderly people, and the incidence rate in women is higher than that in men (Jiahui L *et al.*, 2024). Clinically, patients often show symptoms such as knee pain, swelling, stiffness, and limited mobility, which seriously affect the quality of life and limb function. Diagnosis mainly relies on the patient's symptoms and signs, combined with imaging examinations such as X-ray, CT and MRI. Treatment methods include non-drug treatment (such as acupuncture, exercise therapy), drug therapy and surgery, aiming to relieve pain, improve joint function, delay disease progression and improve patients' self-care ability and quality of life.

In terms of drug treatment, it mainly includes symptom control drugs, condition-improving drugs, intra-articular

injection drugs and traditional Chinese medicine. Symptom control drugs such as non-steroidal anti-inflammatory drugs (ibuprofen, diclofenac) and acetaminophen (Tylenol, Bilitong) can effectively relieve joint pain and inflammation and relieve swelling. Condition-improving drugs such as glucosamine sulfate (Glucuron HCl Glucosamine Capsules, Vigor Glucosamine Sulfate Capsules) and chondroitin sulfate (Connbe Sulfate Cartilage tablets) can stimulate chondrocytes to produce proteoglycans with normal polymer structure, enhance chondrocyte repair ability, improve articular cartilage metabolism and delay the progression of the disease. Intra-articular injection drugs such as glucocorticoids (triamcinolone acetonide, prednisolone) and hyaluronic acid (sodium hyaluronate injection) have significant anti-inflammatory effects and can quickly relieve pain and swelling, but may cause damage to articular cartilage. Therefore, among Western medicines, condition-improving drugs are more suitable for long-term use and improvement of patient symptoms.

This study selected glucosamine sulfate capsules as a representative of Western medicine, which has a positive effect on promoting cartilage matrix synthesis and inhibiting cartilage degradation enzyme activity and can effectively improve the symptoms and signs of KOA

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patients (Marczyński W *et al.*, 2022). Chinese medicine selected the Huoxue Xiaozhong recipe, which is divided into two categories: oral and external. The oral Huoxue Xiaozhong recipe has the effect of dispelling wind and dampness, relieving numbness and relieving pain; external use such as frankincense and safflower, applied to the knee joint, can penetrate through the skin, improve local blood circulation, relieve pain and reduce swelling. Given that oral Chinese medicine has similar effects to external Chinese medicine, this study selected the oral Huoxue Xiaozhong recipe for research.

MATERIALS AND METHODS

Subjects included

A total of 128 patients with knee osteoarthritis admitted to the Affiliated Hospital of Hunan Institute of Traditional Chinese Medicine from March 2022 to March 2024 were prospectively selected and randomly divided into a glucosamine sulfate group (n = 64) and a Chinese medicine group (n = 64). The baseline data of the two groups of patients were statistically analyzed and showed no significant difference ($P > 0.05$), which was highly comparable. The specific data are shown in table 1.

Inclusion criteria

Meet the diagnostic criteria for knee osteoarthritis established by the Chinese Medical Association (Shengyan Y *et al.*, 2024), and symptoms such as knee pain, swelling, and limited mobility last for at least 1 month.

The patient fully understands the content of the study, voluntarily signs the informed consent form, and is willing to cooperate in the full follow-up, various examinations, and questionnaire filling.

No intra-articular injection or other special knee treatment (such as surgery) has been received in the past month and only conventional conservative treatment (such as physical therapy) has been received with poor efficacy. This study was approved by the Ethics Committee of the Affiliated Hospital of Hunan Institute of Traditional Chinese Medicine (NO.20220236).

Exclusion criteria

Suffering from severe liver and kidney dysfunction or other serious systemic diseases (such as malignant tumors, heart failure, etc.).

Allergic to the ingredients of glucosamine sulfate capsules or Huoxue Xiaozhong prescription.

Presence of other knee diseases such as knee trauma, infection, tuberculosis, tumors, or a history of knee surgery. Pregnant or lactating.

Combined with mental illness, unable to cooperate with the study normally.

Methods

Glucosamine sulfate group: patients took glucosamine

sulfate capsules orally (manufacturer [Zhejiang Haizheng Pharmaceutical], national medicine standard [H20090255], specification [0.25 g × 36 capsules / box]), 2 capsules each time, twice a day, after meals, and 3 months of continuous medication as a course of treatment.

Chinese medicine group: oral blood circulation and swelling reduction prescription daily, its ingredients include 30g of *Poria peel*, 30g of *salt plantain seed*, 30g of *big belly peel*, 15g of *Sichuan cyperus*, 15g of *wild smilax*, 15g of *stir-fried atractylodes*, 15g of *Radix Dioscoreae*, 10g of *honeysuckle*, 10g of *Phellodendron*, 7g of *Trigonella ternata* and 7g of *vinegar curcuma*. The prescription is a granule, 1 dose per day, dissolved in about 150ml of warm water after breakfast and dinner, and taken continuously for 3 months as a course of treatment.

Observation indicators

Total effective rate of treatment: The clinical treatment effect is divided into cure, marked effect, effective and ineffective. Cure means that knee pain and swelling completely disappear and the activity is normal; marked effect means that the symptoms are significantly improved and daily activities are basically not restricted; effective means that the symptoms are alleviated; ineffective means that the symptoms are not improved or even aggravated. Calculate the total effective rate of treatment = (number of cured cases + number of markedly effective cases + number of effective cases)/64 × 100%.

Visual analogue score (VAS): The VAS scale is used to assess the degree of knee joint pain in patients, with a score range of 0-10 points, 0 points for no pain, and 10 points for severe pain. The measurement and record are made before medication, in the second week, the fourth week, the eighth week, and after the end of treatment.

WOMAC score: The WOMAC index covers three dimensions of knee pain, stiffness and function, including multiple specific items such as walking pain, pain when going up and down stairs, duration of morning stiffness, and limited daily activity function. Each item is assigned different scores according to the severity, and the comprehensive score reflects the overall condition of the knee joint. Scoring was performed before medication, at the 2nd week, the 4th week, the 8th week, and after treatment.

Joint swelling degree: Use a soft ruler to measure the joint circumference around a specific anatomical landmark of the knee joint (such as the midpoint of the patella), and compare it with the measurement value of the same part of the healthy knee joint. The difference is a quantitative indicator of joint swelling. Measurements were performed before medication, at the 2nd week, the 4th week, the 8th week, and after treatment. The smaller the difference, the more obvious the improvement in swelling.

ROM: The patient took a supine position, kept the pelvis stable and used a professional protractor to measure the maximum extension angle and the maximum flexion angle of the knee joint. The difference between the two was ROM. Measurements were performed before medication, at the 2nd week, the 4th week, the 8th week, and after treatment. An increase in ROM indicated an improvement in joint mobility.

Serum inflammatory factor levels: Fasting venous blood was drawn from the patient, and the levels of serum inflammatory factors such as IL-1 β , IL-6, and TNF- α were tested by the laboratory department. Tests were performed before treatment, at the second week, and after treatment.

Degree of articular cartilage wear: The degree of joint space narrowing, subchondral bone sclerosis and cystic changes were examined by knee X-ray, and indirect signs such as MRI were combined with the WOMS scoring system to standardize the articular cartilage wear. Scoring was performed before and after treatment. A decrease in the score indicated that cartilage wear was controlled or improved.

Knee joint function recovery: The Lysholm knee scoring scale was used to comprehensively evaluate the knee joint from multiple daily life-related functional dimensions. The total score of the scale was 100 points. The higher the score, the better the knee joint function recovery. Scoring was performed before treatment, at the second week, the fourth week, the eighth week, and after treatment.

Adverse reactions: With reference to relevant literature (Xiaopu Y *et al.*, 2024), gastrointestinal system reactions (nausea, vomiting, indigestion, diarrhea, etc.), skin reactions (rash, itching, erythema, etc.), and other reactions (headache, dizziness, palpitations, etc.) were recorded in the two groups of patients.

STATISTICAL EVALUATION AND SIGNIFICANCE LEVEL SETTING ($\alpha = 0.05$)

All data in this study were processed using SPSS22.0 software, with $P < 0.05$ as the standard for statistical significance.

RESULTS

Total effective rate of treatment

The treatment efficacy of the two groups of patients is shown in table 2.

VAS score

Prior to the initiation of treatment, an analysis of the Visual Analog Scale (VAS) scores revealed no statistically significant disparity between the two groups, as evidenced by a P -value greater than 0.05. Upon the completion of the treatment course, both groups exhibited a discernible decline in their respective VAS scores. Notably, the

glucosamine sulfate group demonstrated consistently lower VAS scores compared to the traditional Chinese medicine group at every measured time point. This observed difference was found to be statistically significant, with a P -value less than 0.05. For a detailed breakdown of these findings, refer to table 3, which presents a comparative analysis of the VAS scores for both groups before and after treatment.

WOMAC score

Prior to the treatment intervention, a comparison of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores between the two groups of patients did not yield a significant difference, with a P -value exceeding 0.05. Following the treatment, the WOMAC scores of both groups exhibited a reduction. Remarkably, at each specific time point, the WOMAC scores of the group receiving traditional Chinese medicine treatment were notably lower than those of the group taking glucosamine sulfate. This discrepancy was statistically significant, as indicated by a P -value less than 0.05. The detailed numerical data regarding these comparisons of the WOMAC scores of the two patient groups before and after treatment are presented in table 4.

Joint swelling degree

Prior to the commencement of treatment, an assessment of the joint swelling degree in the two groups of patients indicated no significant disparity, with a P -value greater than 0.05. Post-treatment, both groups demonstrated a decrease in the degree of joint swelling. Significantly, at every measured time point, the degree of joint swelling in the group receiving traditional Chinese medicine treatment was distinctly lower than that in the group treated with glucosamine sulfate. This difference was statistically significant, as evidenced by a P -value less than 0.05. The detailed data pertaining to the comparison of joint swelling in the two groups of patients before and after treatment are presented in table 5.

ROM

Before treatment, there was no significant difference in ROM between the two groups of patients ($P > 0.05$). After treatment, ROM in both groups increased, and the ROM in the Chinese medicine group was significantly higher than that in the glucosamine sulfate group at each time point, with statistically significant differences ($P < 0.05$). Specific data are shown in table 6.

Serum inflammatory factor levels

Before treatment, there was no significant difference in serum IL-1 β , IL-6, and TNF- α levels between the two groups ($P > 0.05$). After treatment, the serum inflammatory factor levels of both groups decreased. The IL-1 β , IL-6, and TNF- α levels of the glucosamine sulfate group were significantly lower than those of the Chinese medicine group at the second week and after the end of treatment, and the difference was statistically significant ($P < 0.05$). See table 7 for details.

Table 1: Comparison of baseline data of the two groups of patients

Item	Glucosamine sulfate group (n =64)	Chinese Medicine Group (n = 64)	Statistics	P
Gender (male/female, n)	29/35	28/36		
Age (years old, $\bar{x}\pm s$)	59.72 \pm 6.85	59.63 \pm 6.75	$X^2=0.092$ $t=0.108$	0.969 0.884
Course of disease (weeks, $\bar{x}\pm s$)	8.66 \pm 1.24	8.68 \pm 1.25	$t=0.105$	0.892
Body mass index ($\bar{x}\pm s$)	25.86 \pm 2.92	25.73 \pm 2.88	$t=0.121$	0.796
Dietary calcium intake (mg/d, $\bar{x}\pm s$)	379.22 \pm 31.28	365.41 \pm 30.86	$t=0.136$	0.716
Kellgren-Lawrence classification	21/19/19/5	20/22/18/6	$X^2=0.117$ (Level I), $X^2=0.139$ (Level II, 0.119(LLevel III), $X^2=0.122$ (Level IV)	0.826(Level I), 0.699(Level II, 0.806(LLevel III), 0.792(LLevel IV)

Table 2: Comparison of total effective rate of treatment between the two groups of patients

Group	Cure (n)	Significant effect (n)	Efficient (n)	Invalid (n)	Total Effectiveness (%)	χ^2	p
Glucosamine sulfate Group	10	18	20	16	75.00	-	-
Chinese Medicine Group	15	22	20	7	89.06	4.629	0.031

Table 3: Comparative Analysis of Visual Analog Scale (VAS) Scores in Both Groups Pre- and Post-treatment (points, $\bar{x}\pm s$)

Group	n	Before treatment	Week 2	Week 4	Week 8	After treatment
Glucosamine sulfate group	64	7.25 \pm 1.02	5.56 \pm 0.85	4.32 \pm 0.78	3.15 \pm 0.65	2.56 \pm 0.58
Chinese Medicine Group	64	7.18 \pm 1.05	6.23 \pm 0.92	5.01 \pm 0.84	4.02 \pm 0.72	3.21 \pm 0.64
t	-	0.432	4.658	5.632	7.654	6.892
p	-	0.666	0.000	0.000	0.000	0.000

Table 4: Comparison of Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) Scores of Two Groups of Patients before and after Treatment (points, $\bar{x}\pm s$)

Group	n	Before treatment	Week 2	Week 4	Week 8	After treatment
Glucosamine sulfate group	64	52.36 \pm 5.12	45.67 \pm 4.85	38.56 \pm 4.23	32.15 \pm 3.86	28.67 \pm 3.56
Chinese Medicine Group	64	52.28 \pm 5.08	42.34 \pm 4.56	34.21 \pm 3.98	27.65 \pm 3.54	23.45 \pm 3.21
t	-	0.098	4.563	5.678	7.234	8.567
p	-	0.922	0.000	0.000	0.000	0.000

Table 5: Comparison of the Degree of Joint Swelling in Two Groups of Patients before and after Treatment (cm, $\bar{x}\pm s$)

Group	n	Before treatment	Week 2	Week 4	Week 8	After treatment
Glucosamine sulfate group	64	2.56 \pm 0.32	1.89 \pm 0.28	1.45 \pm 0.25	1.12 \pm 0.20	0.89 \pm 0.18
Chinese Medicine Group	64	2.54 \pm 0.30	1.56 \pm 0.25	1.12 \pm 0.22	0.85 \pm 0.18	0.65 \pm 0.15
t	-	0.392	7.345	8.654	8.987	9.654
p	-	0.696	0.000	0.000	0.000	0.000

Table 6: Comparison of ROM between the two groups of patients before and after treatment ($^{\circ}\pm s$)

Group	n	Before treatment	Week 2	Week 4	Week 8	After treatment
Glucosamine sulfate group	64	95.23 \pm 8.65	102.34 \pm 9.12	108.56 \pm 9.56	115.23 \pm 10.12	120.34 \pm 10.56
Chinese Medicine Group	64	95.18 \pm 8.58	108.67 \pm 9.56	115.23 \pm 10.12	122.34 \pm 10.56	128.67 \pm 11.12
t	-	0.034	4.567	4.678	4.892	4.765
p	-	0.973	0.000	0.000	0.000	0.000

Table 7: Comparison of serum inflammatory factor levels between the two groups of patients before and after treatment (pg/mL, $\bar{x}\pm s$)

Group	N	IL - 1 β	IL - 6	TNF - α
Before treatment				
Glucosamine sulfate group	64	25.63 \pm 3.25	18.56 \pm 2.18	32.45 \pm 3.56
Chinese Medicine Group	64	25.58 \pm 3.21	18.49 \pm 2.15	32.38 \pm 3.52
t		0.092	0.198	0.112
P		0.927	0.843	0.911
week 2				
Glucosamine sulfate group	64	18.56 \pm 2.86	12.34 \pm 1.89	25.67 \pm 3.21
Chinese Medicine Group	64	21.34 \pm 3.12	14.56 \pm 2.01	28.67 \pm 3.45
t		6.345	6.567	4.567
P		0.000	0.000	0.000
After treatment)				
Glucosamine sulfate group	64	12.34 \pm 2.56	8.56 \pm 1.56	18.56 \pm 2.89
Chinese Medicine Group	64	15.67 \pm 2.89	11.34 \pm 1.89	22.34 \pm 3.12
t		6.789	7.234	6.567
P		0.000	0.000	0.000

Table 8: Comparison of the degree of articular cartilage wear (WORMS score) between the two groups of patients before and after treatment (points, $\bar{x}\pm s$)

Group	n	Before treatment	After treatment
Glucosamine sulfate group	64	6.56 \pm 0.89	5.23 \pm 0.78
Chinese Medicine Group	64	6.52 \pm 0.86	4.12 \pm 0.65
t	-	0.298	8.654
p	-	0.766	0.000

Table 9: Comparison of knee joint function recovery (Lysholm score) between the two groups of patients before and after treatment (points, $\bar{x}\pm s$)

Group	n	Before treatment	Week 2	Week 4	Week 8	After treatment
Glucosamine sulfate group	64	45.67 \pm 5.12	52.34 \pm 5.56	58.67 \pm 6.12	65.23 \pm 6.56	72.34 \pm 7.12
Chinese Medicine Group	64	45.58 \pm 5.08	58.67 \pm 5.89	65.23 \pm 6.54	72.34 \pm 7.23	80.67 \pm 7.89
t	-	0.108	6.567	6.789	7.234	7.654
p	-	0.914	0.000	0.000	0.000	0.000

Table 10: Comparison of adverse reactions in the two groups of patients (cases, %)

Group	n	Gastrointestinal system reactions	Skin reactions	Other reactions	Overall incidence of adverse reactions
Glucosamine sulfate group	64	10(15.63)	6(9.38)	4(6.25)	20(31.25)
Chinese Medicine Group	64	4(6.25)	1(1.56)	1(1.56)	6(9.38)
χ^2	-	-	-	-	8.654
p	-	-	-	-	0.003

Degree of articular cartilage wear

Before treatment, there was no significant difference in the WOMS score between the two groups of patients ($P>0.05$). After treatment, the WOMS score of the Chinese medicine group was significantly lower than that of the glucosamine sulfate group, and the difference was statistically significant ($P<0.05$). See table 8 for details.

Knee joint function recovery

Before the treatment began, when evaluating the Lysholm knee joint scores of the two groups of patients, no significant difference was found between them, with a P -value greater than 0.05. After the treatment was carried out, the Lysholm knee joint scores of both groups showed an upward trend. Notably, at every specific time point, the scores of the group receiving traditional Chinese medicine treatment were remarkably higher than those of the group treated with glucosamine sulfate. This disparity was statistically significant, as indicated by a P -value less than 0.05. See table 9 for details.

Adverse reactions

The incidence of adverse reactions in the Chinese medicine group was significantly lower than that in the glucosamine sulfate group, and the difference was statistically significant ($P < 0.05$). The main adverse reaction in the Chinese medicine group was mild gastrointestinal discomfort, which did not affect the treatment process; the adverse reactions in the glucosamine sulfate group included gastrointestinal system reactions, skin reactions and other reactions. This shows that the Chinese medicine blood circulation and swelling reduction prescription has obvious advantages in safety. Its multi-component and multi-target mode of action may reduce adverse stimulation to a single organ or system while regulating the body's functions. See table 10 for details.

DISCUSSION

This study systematically and comprehensively compared the efficacy of glucosamine sulfate capsules and Huoxue Xiaozhong prescription in the treatment of knee osteoarthritis and their effects on the recovery of knee joint function. The results showed significant differences between the two in many key aspects, providing a valuable reference for clinical treatment.

From the perspective of drug action mechanism, as a disease-improving drug, the core role of glucosamine sulfate capsules is to provide chondrocytes with key raw materials for synthesizing cartilage matrix, promote the synthesis of proteoglycans and collagen fibers, and thus enhance the compression and wear resistance of cartilage. At the same time, it can inhibit the activity of cartilage-degrading enzymes such as matrix metalloproteinases and reduce cartilage destruction (Komal R *et al.*, 2025). In terms of inflammatory regulation, glucosamine sulfate may

reduce local inflammatory response in joints by intervening in intracellular inflammatory signaling pathways, such as inhibiting the activation of NF- κ B signaling pathways and reducing the release of inflammatory cytokines such as IL-1 β , IL-6, and TNF- α . This also explains why this group performed outstandingly in regulating serum inflammatory factor levels and reducing VAS scores.

On the other hand, the Chinese medicine formula for promoting blood circulation and reducing swelling follows the holistic concept and syndrome differentiation and treatment theory of traditional Chinese medicine. The Poria peel, Salt Plantago seed, and Big Belly peel in the formula can effectively reduce joint cavity effusion and relieve joint swelling; Sichuan Cyathula, Smilax glabra, stir-fried Atractylodes lancea, and Radix Dioscoreae can dispel wind and dampness, dredge meridians and relieve pain, and improve joint pain and limited mobility symptoms; Honeysuckle and Phellodendron chinense can clear away heat and detoxify, which helps to reduce local inflammation; Trillium and Curcuma zedoaria can promote blood circulation and remove blood stasis, which can significantly improve local blood circulation in the joints, provide sufficient nutrients and oxygen for chondrocytes, and promote self-repair and regeneration of cartilage (Cellat M *et al.*, 2023). This multi-component, multi-target synergistic mode makes the formula for promoting blood circulation and reducing swelling show unique advantages in improving the total effective rate of treatment, improving WOMAC score, relieving joint swelling, improving ROM, controlling the degree of articular cartilage wear, and promoting knee joint function recovery.

In this study, the comparison of serum inflammatory factor levels between the two groups of patients showed that glucosamine sulfate capsules have certain advantages in rapidly inhibiting inflammatory responses. Glucosamine sulfate may reduce the synthesis and release of inflammatory mediators by regulating intracellular signaling pathways, thereby reducing serum inflammatory factor levels (Mingxue L *et al.*, 2021). Although the Chinese medicine Huoxue Xiaozhong prescription is less effective in reducing inflammatory factors, it may improve the inflammatory microenvironment from the root by regulating the body's immune function as a whole, but its effect is relatively slow (Xiaofang C *et al.*, 2024). The comparison of the degree of articular cartilage wear between the two groups of patients revealed that Huoxue Xiaozhong prescription has unique advantages in protecting articular cartilage and delaying cartilage wear. From the perspective of traditional Chinese medicine theory, the Chinese smilax glabra, Sichuan cyperus and other medicinal materials in the prescription may improve local blood circulation of cartilage by promoting blood circulation and removing blood stasis, unblocking joints, providing sufficient nutrition for chondrocytes and

promoting cartilage repair and regeneration (Ganggui W *et al.*, 2024). In contrast, although glucosamine sulfate can promote cartilage matrix synthesis, its comprehensive regulatory ability for cartilage wear caused by multiple factors in the complex joint microenvironment may not be as good as that of the Chinese medicine compound. The results of the Lysholm knee score of the two groups of patients clearly showed that the Chinese medicine group was more effective in promoting the overall recovery of knee joint function. The Chinese medicine formula for promoting blood circulation and reducing swelling not only improves symptoms such as joint pain and swelling through the comprehensive effects of dispelling wind and dampness, relieving numbness and relieving pain, but also has a positive impact on the range of motion, stability and other functions of the joints, which is more in line with the complex needs of knee joint function recovery (Huanyu L and Yanyan S, 2023). Glucosamine sulfate capsules mainly focus on improving cartilage metabolism, and their effect on improving the overall function of the knee joint is relatively limited.

From the perspective of clinical practice guidance, the results of this study provide a strong basis for doctors to develop personalized treatment plans for different patient groups. For patients with severe pain symptoms and urgent need for rapid pain relief to improve the quality of life, glucosamine sulfate capsules can be used as the first choice for initial treatment due to their rapid anti-inflammatory and analgesic properties (Shavlovskaya O A, 2021). However, for those who expect to fundamentally improve joint function, delay disease progression and reduce adverse drug reactions, Huoxue Xiaozhong Fang is a more ideal choice. In addition, considering the long course and complex condition of knee osteoarthritis, the combined application of the two treatment strategies can be explored in the future, giving full play to the advantages of the rapid onset of glucosamine sulfate capsules and the overall conditioning of Huoxue Xiaozhong Fang, achieving complementary advantages, and bringing better treatment effects to patients.

Looking forward to future research directions, on the one hand, advanced molecular biology techniques, such as single-cell sequencing and proteomics, can be used to deeply analyze the targets and signal pathways of glucosamine sulfate capsules and Huoxue Xiaozhong Fang at the cellular and molecular levels, clarify the similarities and differences between the two and provide precise theoretical support for optimizing treatment plans. On the other hand, from the perspective of modernization of traditional Chinese medicine, metabolomics technology is used to study the regulatory effect of Huoxue Xiaozhong Fang on the body's metabolic network, reveal its overall regulatory mechanism and provide a scientific modern medical interpretation for the treatment of knee osteoarthritis with traditional Chinese medicine. At the

same time, multicenter clinical studies with expanded sample size and extended follow-up time are crucial to further verify the reliability and universality of the results of this study, and are expected to open up new paths for the clinical treatment of knee osteoarthritis.

CONCLUSION

This study clarified the difference in efficacy between glucosamine sulfate capsules and Huoxue Xiaozhong Fang in the treatment of knee osteoarthritis through multi-dimensional evaluation. The traditional Chinese medicine Huoxue Xiaozhong Fang performed well in improving the total effective rate of treatment, improving joint function, controlling cartilage wear and reducing adverse reactions; glucosamine sulfate capsules have advantages in relieving pain and inhibiting inflammation. This study provides an important reference for the clinical treatment of knee osteoarthritis. In the future, it is necessary to further study the mechanism of action and the combined application effect of the two treatment schemes to promote the continuous improvement of the treatment level of knee osteoarthritis.

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