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Original Research Article

Screening of therapeutic potentials of proprioceptive exercises and topical glucosamine sulfate on pain and functional disability in knee osteoarthritis

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Abstract

Purpose: *To compare the effects of proprioceptive exercises and topical glucosamine sulfate on knee osteoarthritis in terms of reducing pain and functional disability.*
Methods: *A single-blinded randomized clinical trial (IRCT20220115053712N1) was conducted at Muhammad Physical Therapy Clinic and Rehabilitation Center, Multan, Pakistan, from November 2021 to April 2022. Eighty-four patients enrolled and were randomized into two groups; patients in Group A were treated with proprioceptive exercises while those in Group B were treated with topical glucosamine sulfate. The Numerical Pain Rating Scale (NPRS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scale were used to measure pain and functional activities at baseline, 9th and 18th sessions.*
Results: *The results showed that both interventions were effective, but more in Group A ($p < 0.05$). Group A also showed highly significant improvement in relieving the pains associated with osteoarthritis when compared to Group B ($p \leq 0.001$).*
Conclusion: *Proprioceptive exercises are more efficient than topical glucosamine sulfate for managing knee osteoarthritis, improving functional outcomes and lowering pain intensity.*

Keywords: *Osteoarthritis, Proprioceptive exercises, Topical glucosamine sulfate*

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INTRODUCTION

Osteoarthritis (OA) is a degenerative joint condition also called age-related arthritis or "wear and tear arthritis" [1]. Three signs and symptoms are prescribed by the European League to determine a case of rheumatism. The three signs are crepitus, restricted range of motion, and bony enlargement; and the three symptoms are non-stop pain, limited morning stiffness, and decreased functional activities [2]. People with OA have a poor quality of life in terms of physical activity, and cartilage degeneration occurs as a result of a sedentary

lifestyle [3,4]. Faster cartilage breakdown lessens the glycosaminoglycan content, leading to the weakening of joint mechanics and flexibility due to a sedentary lifestyle [4].

Overcoming noxious stimuli and improving functional activities is the primary approach to managing OA [5], and the first-line treatment involves non-pharmacological interventions [5]. Glucosamine is a normal glycosaminoglycan in the cartilage matrix and synovial fluid [6] which has anti-inflammatory activity, thus aiding relief from the symptoms [7]. Wear molecules become mediators of inflammation, and the pro-inflammatory cytokines, including IL-1, IL-6, and TNF, are secreted by molecules whenever collagen and proteoglycans decay. This further causes the release of matrix metalloproteinases (MMPs) and the suppression of the production of type-2 collagen [5]. Glucosamine affects the functions of various mediators of OA. Glucosamine is helpful in knee OA, by reducing the destruction of proteoglycans and suppressing the formation of degrading enzymes and inflammatory mediators. As glucosamine sulfate lessens the IL-1β in synovial fluid, it also blocks the actions of catabolic enzymes and enhances the cultured human chondrocytes to synthesize proteoglycans [7].

The perception or awareness of the position and movement of the body is called proprioception [8]. Mechanoreceptors are present in the skin, ligaments, tendons, joint capsules, and muscles to detect proprioceptive sensations. When movement occurs, the mechanoreceptors detect the stimulations which provide the proprioceptive sensations necessary for coordinating the Activities of Daily Livings (ADLs). Any injury or impairment lessens motor control [9]. The control of sensorimotor systems (muscle contraction and proprioceptive alertness), is necessary to produce a stable gait and maintain balance. The lack of quadriceps function disturbs the patients' balance and walking [8].

So it is believed that rehabilitation improves pain, ADLs, and the sensorimotor functions of patients. Recovery occurs due to proprioceptive therapy through the provocation of the articular mechanoreceptors. These exercises increase the muscle spindle sensations, as well as impact muscle strength and endurance. Intra-articular pressure increases the weight-bearing exercises, which causes the stimulations of Ruffini nerve endings, so the proprioceptive activity increases [10]. In this study, proprioceptive exercises and the topical drug (glucosamine sulfate) were applied to the knee of OA patients and compared for their effects in relieving the pains associated with osteoarthritis.

METHODS

A single-blinded randomized clinical trial (IRCT20220115053712N1), was conducted at Muhammad's Physical Therapy Clinic and Rehabilitation Center, Multan, Pakistan, from November 2021 to April 2022. Approval was received from the Ethical Committee of the Muhammad Institute of Medical and Allied Sciences, Multan, Pakistan (approval no. 2021/IRB/2/PT/02). The study protocol was in accordance with the declaration of Helsinki [11]. Using the Borkowf sample formula (Eq 1), the sample size was determined [12].

$$n=2\sigma^2 (Z1-\alpha+Z1-\beta)^2 / (\mu o-\mu\alpha)^2 \quad \ldots\ldots\ldots\ldots\ldots (1)$$

where σ^2 = variance, Z1-α = confidence level 95 %, Z1-β = power of test 90 %, μo= population means 1, μα = population mean 2.

A total of 84 subjects were randomly divided into Groups A and B.

Inclusion criteria

Patients with the Kellgren and Lawrence (K-L) grading system (grade 1-2-3 knee OA) were included in this trial [13]. Patients aged 45 - 70 years, either gender (male and female), with cartilage degeneration, local biomechanical factors (e.g., joint deformity, muscle weakness), nutritional factors, and postmenopausal women were also included.

Exclusion criteria

Patients with Kellgren and Lawrence grade 4, neurological disorders, knee replacement, rheumatoid arthritis, steroidal injection in the past 2 months, neuropathy, knee fractures, knee ligament or meniscus injury, diabetes mellitus > 10 years, metal implants in the knee were excluded from this study.

Treatments and assessment of parameters

The patients were assessed by radiological findings (x-rays) and by physical assessment. Group A was treated with proprioceptive exercises: standing on one leg, knee flexion and extension exercises (sitting position with a chair and theraband), walking on heel and toes (with eyes open and closed), half squat, side lunges, one-legged balance exercise with heating pad [14]. In contrast, Group -B was treated with topical glucosamine sulfate, ankle pumps, quads

strengthening, and calf stretching [15]. The workout plan was distributed over a six-week period, 3 times per week [16]. Exercise sessions lasted 30 min [14]. The dose of glucosamine sulfate gel was 250 mg [15]. Glucosamine sulfate was applied topically twice daily, 3 times per week for 6 weeks [16]. Patient's pain and functional disability were measured by the Numerical Pain Rating Scale (NPRS) [16] and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scale [17] on the baseline, 9th session (3rd week), and 18th session (6th week) of both the groups.

Statistical analysis

The Statistical Packages for Social Sciences (SPSS, version 23) was used to evaluate quantitative data. Significant value was taken at a probability (p) value less than 0.05. Unpaired t-test was used to determine differences between groups whilst a repeated measure of ANOVA was used to determine differences within groups.

RESULTS

Out of 86 subjects, 84 were selected as 2 of them dropped out from Group B. Group A was treated with proprioceptive exercises and showed significantly better results when assessed with WOMAC and NPRS scales than Group B, treated with topical glucosamine sulfate. The mean and standard deviation for the baseline measurements, 9th session, and 18th session for all the outcomes are described in Table 1 and Table 2.

Repeated measures of ANOVA revealed a significant enhancement of the outcomes within Group A (WOMAC pain p = 0.000), (WOMAC functional activities p ≤ 0.001) and (NPRS p < 0.001) showed highly significant outcomes compared to Group B (WOMAC pain p = 0.02), (WOMAC functional activities p = 0.04) and (NPRS p = 0.01). It showed the dominancy of Group A, interventions (proprioceptive exercises).

The unpaired t-test revealed significant improvement in the outcomes between Groups A and B. For the WOMAC pain (p = 0.000 and t = 1.9), WOMAC functional activities (p = 0.000 and t = 1.98) and for NPRS (p = 0.000 and t = 1.04). Demographic data and statistical analysis of data are shown in Table 1 and Table 2.

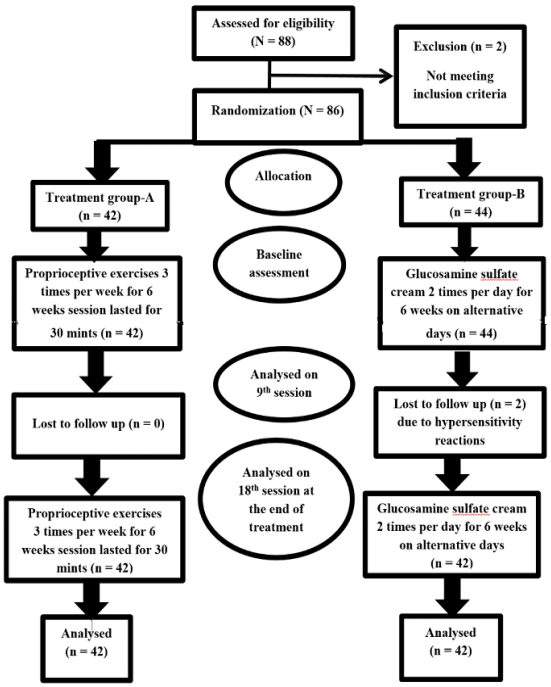

Figure 1: Consolidated Standards of Reporting Trials (CONSORT) flow diagram

Table 1: Demographic profile of patients (n = 84)

Parameter	Group A (%)	Group B (%)	Total, N (%)
Gender of participants			
Male	19 (45.23)	26 (61.90)	45 (53.57)
Female	23 (54.76)	16 (38.09)	39 (46.42)
Age of participants			
45-50	12 (28.57)	15 (35.71)	27 (32.14)
51-55	15 (35.71)	13 (30.95)	28 (33.33)
56-60	9 (21.42)	8 (19.04)	17 (20.23)
61-65	5 (11.90)	4 (9.52)	9 (10.71)
65-70	1 (2.38)	2(4.76)	3 (3.57)
K-L grades of OA			
K-L Grade 1	14 (33.33)	13 (30.95)	27 (32.14)
K-L Grade 2	18 (42.85)	21 (50)	39 (46.42)
K-L Grade 3	10 (23.80)	8 (19.04)	18 (21.42)

K-L grade: Kellgren *&* Lawrence grade

Table 2: Pairwise comparisons of mean differences for the outcomes of NPRS and WOMAC scales within the groups using repeated measures of ANOVA. (mean ± SD; n = 42)

Group	WOMAC Scale interpretation	Baseline	9th session	18th session	P-value
A	Pain	16.78±2.31	11.52±5.4	5.11±3.52	< 0.000
	Functional activities	57.33±21.9	34.59±23.71	12.69±8.94	≤ 0.001
	NPRS scale Interpretation				
	Pain	8.30±1.07	6.671±2.86	3.01±2.03	< 0.000
B	***WOMAC Scale interpretation***				
	Pain	16.16±2.75	13.85±3.94	10.34±2.40	0.02
	Functional activities	47.66±20.11	40.6±20.85	35.56±16.47	0.04
	NPRS scale Interpretation				
	Pain	7.85±1.69	6.09±1.30		0.01

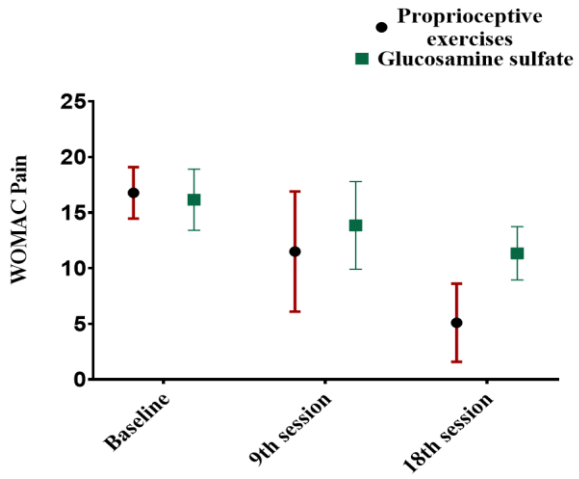

Figure 2: Scores results of WOMAC pain on the baseline, 9th session, and 18th session. Group A: Proprioceptive exercises, Group B: topical glucosamine sulfate

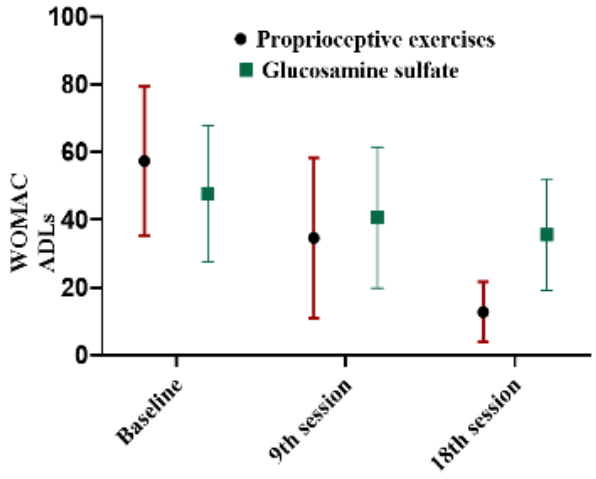

Figure 3: Scores results of WOMAC ADLs on the baseline, 9th session, and 18th session. Group A: Proprioceptive exercises, Group B: Topical glucosamine sulfate

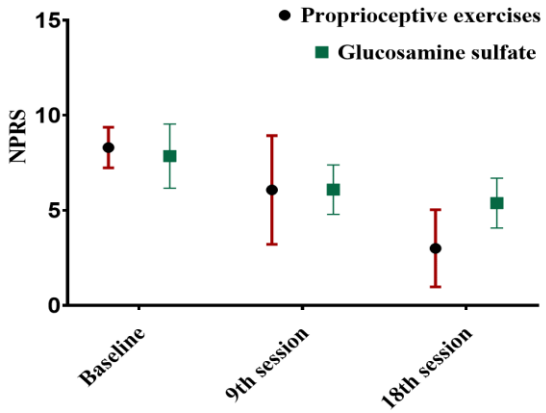

Figure 4: Scores results of NPRS on the baseline, 9th session, and 18th session. Group A: Proprioceptive exercises, Group -B: Topical glucosamine sulfate

DISCUSSION

This study evaluated the efficacy of proprioceptive exercises and topical glucosamine sulfate in patients with knee OA. When patients were given proprioceptive exercises, both outcomes (functional impairment and pain) were reduced to the greatest extent possible.

The research was previously undertaken on the impact of proprioceptive training on pain, stiffness, function, and functional test outcomes among patients with knee OA. Proprioceptive training successfully reduced pain and improved daily activities among patients with knee OA [15]. Some other studies compared the effects of isometric quadriceps exercise on proprioceptive exercise on pain, joint stiffness, and physical problems in patients with osteoarthritis of the knee. The results showed that both are effective, but proprioceptive exercises are more effective than isometrics quadriceps exercises [18]. The conclusion showed that proprioceptive exercises (Group A) were the most effective therapy used in the past, and must be used in the future.

Previous studies also provide evidence for the benefit of glucosamine sulfate in OA patients and highlighted the beneficial effects in OA patients [7,17]. One study was conducted on the effects of glucosamine on knee OA. The results showed that glucosamine was superior to placebo in the management of OA [7]. Another study compared the efficacy and safety of a new fixed-dose combination of glucosamine sulfate and chondroitin sulfate capsules to a fixed-dose combination of glucosamine hydrochloride and chondroitin sulfate capsules in patients with osteoarthritis of the knee. The findings revealed that a fixed-dose GS/CS combination was more effective [17].

Literature supports the individual effects of glucosamine sulfate and proprioceptive exercises. The effects of glucosamine sulfate cream and proprioceptive exercises are of great importance and must be implemented for future use. No study was published comparing proprioceptive exercises and topical glucosamine sulfate. So, this study looked at the comparison of both groups.

Limitation of the study

The study protocol was not for a lengthy period, (8 to 12 weeks), and hence this study was unable to observe the effects over a long period. Future research is needed to develop a long-term treatment procedure that can be used to test the products of long-term treatment durations.

CONCLUSION

In the management of OA (grades 1, 2, and 3), proprioceptive exercises and topical glucosamine sulfate are both effective, but the effects of proprioceptive exercises in reducing pain and functional disability are more when compared to topical glucosamine sulfate.

DECLARATIONS

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Ethical approval

Approval was obtained from the Ethical Committee of the Muhammad Institute of Medical and Allied Sciences, Multan, Pakistan (approval no. 2021/IRB/2/PT/02).

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

We declare that this work was performed by the authors named in this article, and all pertaining to claims relating to the content of this article will be borne by the authors. Hifza Arif designed the study and data collection. Hifza Arif interpreted the data and prepared the manuscript for publication. Hifza Arif, Nimra Arif, Noshaba Kanwal supervised the data collection. Humera Tahir analysed the data. Shaukat Hussain Munawar, Muhammad Omer Iqbal and Izhaan Akmal analysed the data and reviewed the manuscript.

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