Optimizing Treatment Paths for Knee Osteoarthritis: A Comparative Evaluation of Joint Mobilization versus Proprioceptive Receptor Training Integrated with Conventional Physiotherapy Modalities

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Running title: Comparative Evaluation of Joint Mobilization and Proprioceptive Training in Knee Osteoarthritis

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ABSTRACT

Background and Purpose: The purpose of this study was to compare the effectiveness of Maitland's mobilization and Proprioceptive Receptor Training with commonly used conventional physiotherapy (UST & IFT) to improve pain and activities of daily living (ADL). **Methods:** Thirty patients age 50 to 80 years, presenting with unilateral knee osteoarthritis (OA) with Kellgren-Lawrence grade II-IV and ACR criteria, were randomized into two groups. The Group-A received Maitland's mobilization and conventional Physiotherapy and the Group-B received Proprioceptive Receptor Training and conventional Physiotherapy. Both groups received treatment 30 minutes per session, 5 times a week for 2 weeks. Data was obtained by Visual analogue Scales (VAS) for pain, The Western Ontario and McMaster Universities (WOMAC) and knee flexion range of motion (ROM) for ADL. **Results:** After 2 weeks of treatment, significant improvements in VAS, WOMAC scores, and ROM were observed in both groups. However, the statistical improvement was greater in Group received Maitland's mobilization than those who received proprioceptive receptor training with conventional physiotherapy. **Conclusion:** The results of the study show that proprioceptive receptor training combined with conventional physiotherapy is more effective than Maitland's mobilization with conventional physiotherapy in improving pain and ADL in patients with knee osteoarthritis. The improvement in patients who received Maitland's mobilization was greater than in those who received proprioceptive receptor training with conventional physiotherapy, and the difference was statistically highly significant.

Keywords: Knee Osteoarthritis, Proprioception Exercises, WOMAC scale, Range of Motion, Knee Pain.

INTRODUCTION

Osteoarthritis (OA) is a chronic, degenerative joint disorder characterized by progressive loss of articular cartilage, hypertrophic bone changes at joint margins, subchondral sclerosis, and alterations in the synovial membrane and joint capsule [1,2]. These pathological changes may lead to abnormalities in nerve excitability, altered vascular responses, and a range of clinical symptoms including pain, stiffness, swelling, and reduced joint mobility, all of which significantly impair patients' quality of life [3]. Knee OA is one of the most common forms of osteoarthritis, particularly prevalent among the elderly, with a higher incidence reported in women and in rural regions of Asia [4]. Individuals with knee OA experience difficulty performing daily activities such as walking, squatting, and stair climbing, which adversely affects their independence and functional capacity [5]. Pain is typically aggravated by weight-bearing activities and relieved by rest; however, stiffness and discomfort may also occur after periods of inactivity due to inflammation and degenerative progression [6]. In advanced stages, joint instability and crepitus are commonly observed [7]. Radiographic hallmarks of OA include joint space narrowing, osteophyte formation, subchondral sclerosis, and cyst formation [8]. Impaired proprioception is also frequently noted, leading to reduced joint stability and contributing to disease progression [9]. The primary goals of OA management are to reduce pain, improve joint mobility, enhance functional ability, and prevent further deterioration. Pharmacological options include paracetamol, NSAIDs, corticosteroid injections, and supplements such as glucosamine and chondroitin sulfate. Surgical interventions range from arthroscopic procedures to total knee arthroplasty [10]. Physiotherapy plays a vital role and typically incorporates electrotherapy, manual therapy, strengthening and stretching exercises, taping, massage, and hydrotherapy [11]. Proprioceptive training has gained increasing attention, with several studies supporting its effectiveness in improving knee joint function in OA patients [12].

Knee OA has a multifactorial etiology, influenced by mechanical loading, obesity, aging, genetic predisposition, and increased bone density. Additional risk factors include female gender, occupational strain, and previous joint trauma [4]. OA is classified as primary (idiopathic) or secondary, and its severity is commonly graded using the Kellgren and Lawrence system (Grade I–IV) [13]. Depending on the extent of involvement, OA may affect one (uni-compartmental), two (bi-compartmental), or all three (tri-compartmental) knee compartments [14].

Recent research on knee OA management has explored various therapeutic strategies to improve pain and functional outcomes. Allen et al. [15] compared physical therapy with internet-based exercise programs and found no significant differences in WOMAC improvements, indicating the need for optimized exercise interventions. Jahantigh Akbari et al. [16] emphasized the role of neuromuscular factors and their association with pain in OA patients. It has been reported that home-based exercise programs significantly enhanced the quality of life in OA patients [17]. Studies by Khan et al. (2018) It was also demonstrated that transcutaneous electrical nerve stimulation (TENS), when combined with physiotherapy modalities, effectively reduced pain and improved functionality [18,19]. Additionally, the benefits of quadriceps strengthening exercises and therapeutic ultrasound/interferential therapy are also evident in relieving symptoms of knee osteoarthritis [20,21]. Collectively, these findings underscore the importance of integrating multimodal physiotherapy approaches to enhance treatment outcomes in knee OA.

This study aimed to evaluate the effectiveness of combining joint mobilization and proprioceptive receptor training with standard physiotherapy in improving functional outcomes in patients with knee OA. Improvements were assessed using the Visual Analogue Scale (VAS) for pain and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) for functional performance.

METHODS

Patients

This comparative study included 30 patients with unilateral knee osteoarthritis (OA) who met the diagnostic criteria of the American College of Rheumatology and had radiographic confirmation of Kellgren–Lawrence grade II or III OA. All participants were between 50 and 80 years of age and had experienced symptoms for more than six months. The patients were from the same geographical region and provided informed written consent after being fully informed about the study procedures.

Selection of Patients

Patient selection was based on predefined inclusion and exclusion criteria. Individuals aged 50–80 years with unilateral knee OA of at least six months' duration and radiographic evidence of grade II or III OA were included. Patients were excluded if they had a history of surgery involving the knee, hip, or ankle; peripheral vascular disease; infections; limb length discrepancy; inflammatory arthropathies; recent corticosteroid injections; neurological or psychological conditions; balance impairments; joint instability; or uncontrolled medical conditions such as hypertension, diabetes, or cardiac disease. Musculoskeletal disorders that could interfere with exercise performance were also considered exclusionary. After screening, 30 eligible participants were randomly assigned to two groups of 15 each. Group A received Maitland's mobilization techniques using Grades II and III, including tibiofemoral anterior–posterior and patellofemoral glides, administered three times per session for two weeks. Group B received proprioceptive receptor training consisting of isometric quadriceps exercises, balance activities, toe and heel walking, and cross-body leg swings over a 10-day training period. Both groups also received conventional physiotherapy, including ultrasound therapy and interferential therapy, administered five days per week for two weeks. Patients were advised to avoid activities that could aggravate symptoms, such as squatting, kneeling, climbing stairs, using Indian toilets, and lifting heavy weights.

Efficacy Assessments

Efficacy was evaluated using standardized outcome measures collected on the first day of treatment (pre-test) and after two weeks (post-test). Pain intensity was assessed using the Visual Analogue Scale (VAS), while functional ability was measured using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Knee joint flexion range of motion (ROM) was measured with a goniometer to evaluate mobility. Improvements in pain, function, and mobility were determined by comparing changes in these clinical measures from baseline to post-treatment.

Ethics

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee of Haldia Institute of Health Sciences, Haldia, East Medinipur, West Bengal. All participants were thoroughly informed about the study procedures, potential risks, and anticipated benefits. Written informed consent was obtained from each participant prior to enrollment. Confidentiality and privacy of all patient data were strictly maintained throughout the study.

Statistical Analysis

Statistical analysis was performed using mean and standard deviation (SD) for all outcome variables. Within-group comparisons of pre- and post-treatment values were conducted using paired t-tests with a degree of freedom (df) of 14. Between-group comparisons of Group A and Group B were analyzed using independent (Fisher's) t-tests with a df of 28. Statistical significance was determined using p-values, with $p < 0.05$ considered indicative of a significant difference. The mean changes in VAS, WOMAC, and ROM scores were used to evaluate the magnitude of improvement within and between the groups.

RESULTS

Demographic Characteristics

The study sample comprised 30 total participants (N = 30), divided equally into two groups: Group A (N = 15) and Group B (N = 15). Both groups demonstrated homogeneity in terms of gender distribution, with each group consisting of 10 males (66.7%) and 5 females (33.3%). The mean age, height, and weight were comparable between the two groups. In Group A, the mean age was 63.60 ± 7.62 years, the mean height was 166.07 ± 8.50 cm, and the mean weight was 74.51 ± 8.99 kg. Similarly, in Group B, the mean age was 61.00 ± 7.69 years, the mean height was 165.87 ± 6.21 cm, and the mean weight was 72.48 ± 8.70 kg.

Assessment of Efficacy

Table 1 demonstrates significant changes in VAS, WOMAC and ROM of knee flexion scores in both group A and B after a two-week treatment. Group A had an average VAS score decrease from 6.20 ± 1.37 to 2.93 ± 1.53,

which indicated that the pain was significantly reduced. Likewise, Group B had a better pain decrease (VAS: 5.67 ± 1.23 to 1.40 ± 0.82). Functional status (assessed by the WOMAC index) was also significantly enhanced in both groups. The WOMAC score of group A dropped from 51.06 ± 13.78 to 34.73 ± 7.73, and that of group B decreased more significantly, from 44.0 ± 12.68 to 18.26 ± 6.68 during the same period. Knee flexion the ROM were significantly increased in both groups as well at followed-up, with Group A from 106.67 ± 9.02 to 116.67 ± 8.37 and Group B a more remarkable improvement from 105.87 ± 7.84 to 123.80 ± 7.95. These findings show that the two interventions appeared to be effective, with Group B showing overall greater improvements across all outcomes.

Comparison between the two groups at baseline and after treatment is shown in Table 2. Baseline data (VAS, WOMAC and knee flexion ROM) showed no significant difference between Group A and Group B before treatment, indicating that both groups were comparable at baseline. All outcome measures showed statistically significant changes after the treatments. After treatment, the post-treatment VAS score of Group B (1.40 ± 0.82) was significantly lower than that of Group A (2.93 ± 1.53), and the difference was statistically significant ($p = 0.002$). 18.26 ± 6.68 that was significantly higher than the pre-injection levels ($p < 0.0001$) and much better than the change observed in Group A, for which a highly significant improvement of WOMAC scores could only be recorded with mean post injection values of 34.73 ± 7.73 points we also got a highly significant difference between both groups B versus A) ($p < 0.0001$). Group B also significantly showed better knee flexion ROM (123.80 ± 7.95°) than Group A (116.67 ± 8.37°), $p = 0.024$). These results suggest that a proprioceptive receptor training programme in association with conventional physiotherapy (Group B) was found to be more effective than overall Maitland's mobilisation applied with conventional physiotherapy (Group A).

Table 1: Within the group comparison of VAS, WOMAC, and ROM scores at Pre- and Post-treatment

Assessment	Group	Pre-treatment (Mean ± SD)	Post-treatment (Mean ± SD)	P- value
VAS Score	Group A	6.20 ± 1.37	2.93 ± 1.53	0.0009***
	Group B	5.67 ± 1.23	1.40 ± 0.82	0.0026**
WOMAC Score	Group A	51.06 ± 13.78	34.73 ± 7.73	0.0025**
	Group B	44.0 ± 12.68	18.26 ± 6.68	0.00071**
Knee Flexion ROM	Group A	106.67± 9.02	116.67±8.37	0.0060**
	Group B	105.87 ± 7.84	123.80 ± 7.95	0.0027**

Table 2: Between groups comparison of VAS, WOMAC, and ROM scores at Pre- and Post-treatment

Assessment	Treatment Phase	Group A (Mean ± SD)	Group B (Mean ± SD)	P value
VAS Score	Pre-treatment	6.20 ± 1.37	5.67 ± 1.23	0.273
	Post-treatment	2.93 ± 1.53	1.40 ± 0.82	0.002**
WOMAC Score	Pre-treatment	51.06 ± 13.78	44.00 ± 12.68	0.155
	Post-treatment	34.73 ± 7.73	18.26 ± 6.68	< 0.0001***
Knee Flexion ROM	Pre-treatment	106.67± 9.02	105.87 ± 7.84	0.798
	Post-treatment	116.67±8.37	123.80 ± 7.95	0.024*

DISCUSSION

The findings of the present study demonstrate that both Maitland's Mobilization and Proprioceptive Receptor Training, when combined with conventional physiotherapy, significantly improved pain, functional ability, and knee joint mobility in patients with unilateral knee osteoarthritis. These results align with existing literature supporting multimodal physiotherapy approaches for enhancing clinical outcomes in knee OA.

Between-group comparisons revealed that participants receiving Proprioceptive Receptor Training achieved greater improvements in post-treatment VAS, WOMAC, and ROM scores compared to those treated with Maitland's Mobilization. This suggests that proprioceptive-based interventions may more effectively stimulate neuromuscular control, enhance joint stability, and improve sensorimotor function, thereby producing superior clinical benefits.

The statistically significant differences in outcomes ($p < 0.05$) further confirm the alternative hypothesis that the two interventions differ in effectiveness. The observed improvements can be attributed to the synergistic effects of conventional physiotherapy alongside the specific action of each technique: joint mobilization primarily enhances mechanical joint function and modulates pain, whereas proprioceptive training strengthens neuromuscular coordination and functional performance.

Overall, although both treatment approaches proved beneficial, Proprioceptive Receptor Training emerged as the more effective method for reducing pain and improving functional recovery in individuals with unilateral knee osteoarthritis.

LIMITATIONS

This study had several limitations that should be considered when interpreting the results. First, the sample size was relatively small, which may limit the generalizability of the findings. The short duration of the intervention and the absence of long-term follow-up restricted the ability to assess sustained benefits or relapse patterns. Additionally, variations in the severity of osteoarthritis among participants could have influenced treatment responses. Analgesic use was not controlled, which may have impacted pain-related outcome measures. Furthermore, both groups received conventional physiotherapy, making it difficult to isolate the independent effects of Maitland's Mobilization and Proprioceptive Receptor Training.

CONCLUSION

The findings of this study demonstrate that both Maitland's Mobilization and Proprioceptive Receptor Training, when combined with conventional physiotherapy (UST + IFT), significantly reduced pain and improved functional ability in patients with unilateral knee osteoarthritis over a two-week treatment period. However, analysis of the post-treatment values revealed that Proprioceptive Receptor Training produced greater improvements across all outcome measures, showing higher statistical significance compared to Maitland's Mobilization. Therefore, it may be concluded that Proprioceptive Receptor Training, in conjunction with conventional physiotherapy, offers superior clinical benefits and can be considered a more effective intervention for enhancing pain relief, functional performance, and activities of daily living in individuals with unilateral knee osteoarthritis.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Subhankar Patra: Conceptualization, data collection, administration of interventions, and preliminary drafting of the manuscript; Sugato Maity: Data collection, patient assessment, statistical data entry, and assistance in manuscript preparation; Oindrila Bhuniya: Literature review, data organization, preparation of tables and figures, and manuscript editing; Sushovan Mondal: Clinical supervision, patient screening, methodological guidance, and critical revision of the manuscript; Abanti Aich: Conceptualization, study design, overall supervision of the

research process, data analysis and interpretation, manuscript writing, final revision, and coordination of the entire project..

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