DIABETIC STUDIES OPEN ACCESS

Quadricep Exercises And Kinesiotaping For Knee Osteoarthritis

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Abstract

Background: Knee osteoarthritis is a prevalent degenerative joint disorder that leads to pain, stiffness, and functional disability. Quadriceps muscle weakness contributes significantly to disease progression and reduced mobility. Exercise therapy is an established conservative treatment, while kinesiotaping has recently gained attention as a complementary technique for pain relief and functional improvement. This study aimed to evaluate the combined effect of quadriceps strengthening exercises and kinesiotaping on pain, functional ability, and range of motion in individuals with knee osteoarthritis.

Methods: A randomized controlled trial was conducted on 60 participants diagnosed with mild to moderate knee osteoarthritis. Participants were randomly assigned into three groups: Group A received quadriceps exercises combined with kinesiotaping, Group B performed quadriceps exercises only, and Group C served as a control group receiving lifestyle advice. Interventions lasted eight weeks, with outcome measures assessed at baseline and post-intervention, including pain intensity using the Visual Analogue Scale (VAS), functional ability using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and knee range of motion using a goniometer. Statistical analysis was performed using SPSS version 26, with significance set at $p < 0.05$.

Results: Both Group A and Group B showed significant improvements in pain, function, and range of motion compared to the control group ($p < 0.001$). Group A demonstrated the greatest improvement, with a 56.8% reduction in pain, a 43.5% improvement in WOMAC scores, and a 17.5% increase in knee range of motion. Between-group comparisons revealed that combining kinesiotaping with exercises produced significantly better outcomes than exercises alone ($p < 0.001$).

Conclusion: The combination of quadriceps strengthening exercises and kinesiotaping was more effective than exercise alone or no intervention in reducing pain, enhancing functional ability, and improving knee mobility in patients with knee osteoarthritis. These findings suggest that kinesiotaping can serve as a valuable adjunct to exercise therapy, offering a non-invasive, cost-effective, and efficient approach to the conservative management of knee osteoarthritis.

Introduction

Background

Knee osteoarthritis is one of the most prevalent degenerative joint diseases, affecting millions of individuals worldwide and contributing significantly to pain, disability, and reduced quality of life. The condition primarily involves the progressive deterioration of articular cartilage, leading to joint space narrowing, osteophyte formation, and subchondral bone changes. These structural alterations often result in stiffness, inflammation, and functional impairment, particularly in weight-bearing activities such as walking, climbing stairs, and squatting. The chronic nature of the disease places a considerable burden on both patients and healthcare systems, emphasizing the need for effective, non-invasive treatment strategies (León-Ballesteros et al., 2020).

As knee osteoarthritis progresses, patients often experience muscle weakness, especially in the quadriceps, which plays a crucial role in stabilizing the knee joint. Weakness in the quadriceps muscle not only contributes to increased joint loading but also accelerates the degenerative process by reducing shock absorption and joint alignment. Restoring or maintaining quadriceps strength is therefore fundamental to managing symptoms and improving functional performance in individuals with knee osteoarthritis (Abolhasani et al., 2019).

Exercise therapy has long been recognized as a cornerstone in the conservative management of knee osteoarthritis. Among various exercise modalities, quadriceps strengthening exercises have shown remarkable benefits in alleviating pain, improving mobility, and enhancing overall knee function. These exercises target the major muscle groups surrounding the knee, promoting joint stability and reducing stress on the articular surfaces. Consistent engagement in quadriceps exercises can also slow disease progression by improving muscle tone and proprioception (Oğuz et al., 2021).

The mechanism by which quadriceps exercises exert their beneficial effects involves both mechanical and neuromuscular factors. Strengthening these muscles helps redistribute joint loads, reduce compressive forces on the cartilage, and improve the efficiency of movement patterns. Additionally, exercise stimulates the production of synovial fluid, enhancing lubrication and nutrition to the joint structures. Through these effects, patients often experience reduced stiffness and greater range of motion, contributing to better daily functioning (Mohamed & Alatawi, 2023).

Despite the effectiveness of exercise, many patients with knee osteoarthritis continue to experience pain and functional limitations that hinder adherence to physical activity programs. Pain relief and muscle support are therefore essential to encourage consistent participation in therapeutic exercises. In recent years, kinesiotaping has emerged as a promising adjunctive therapy to facilitate exercise performance and improve clinical outcomes in musculoskeletal conditions, including knee osteoarthritis (Öğüt et al., 2018).

Kinesiotaping is a rehabilitative technique involving the application of an elastic therapeutic tape over the skin to support muscles and joints without restricting movement. The tape mimics the elasticity of human skin, allowing for natural motion while providing proprioceptive feedback and gentle mechanical support. It is believed to enhance blood and lymphatic circulation, reduce pain perception, and improve joint alignment, thereby complementing the effects of exercise therapy (Günaydin & Bayrakci Tunay, 2022).

When applied to the knee joint, kinesiotaping can assist in relieving pressure on inflamed tissues and improving patellar tracking, which is often altered in osteoarthritis. By lifting the skin microscopically, the tape may reduce local swelling and promote better tissue healing. Furthermore, the sensory input from the tape can enhance proprioceptive awareness, improving motor control during movement and reducing the risk of compensatory patterns that exacerbate joint stress (Mahmoud, 2024).

Combining quadriceps exercises with kinesiotaping may provide a synergistic effect in managing knee osteoarthritis. While exercise focuses on strengthening and restoring function, kinesiotaping supports pain reduction and facilitates correct movement patterns. This integrated approach may allow patients to engage more effectively in physical therapy, improving adherence and long-term outcomes (Wu et al., 2022).

In addition to physical benefits, these interventions can positively influence psychological well-being by empowering patients to manage their condition independently. The ability to move with less pain and greater confidence enhances self-efficacy and motivation for continued activity. Such holistic management aligns with the broader goals of modern rehabilitation, which emphasize functional independence, participation, and quality of life rather than merely symptom control (Fazli et al., 2023).

Overall, the combination of quadriceps exercises and kinesiotaping represents a practical, cost-effective, and non-invasive strategy for addressing the multifaceted challenges of knee osteoarthritis. By targeting both the muscular and mechanical components of the disorder, this approach holds promise for improving pain, function, and overall joint health, offering patients a pathway to sustained recovery and enhanced daily living (Li et al., 2018).

Methodology

Study Design

This study was conducted as a randomized controlled trial to evaluate the effectiveness of quadriceps strengthening exercises and kinesiotaping in improving pain, functional ability, and range of motion among patients with knee osteoarthritis. The study was carried out over a period of three months and included two intervention groups and one control group.

Participants

A total of 60 participants diagnosed with mild to moderate knee osteoarthritis were recruited based on inclusion and exclusion criteria. The participants were selected through purposive sampling from outpatient rehabilitation clinics. Both males and females aged between 45 and 70 years were included. All participants reported persistent knee pain for at least six months and had radiographic evidence of osteoarthritis classified as grade II or III according to the Kellgren and Lawrence scale.

Participants with a history of knee surgery, inflammatory joint diseases, neurological disorders, recent knee injections, or systemic illnesses affecting mobility were excluded from the study. Each participant provided written informed consent before the commencement of the research.

Group Allocation

Participants were randomly assigned into three equal groups, with 20 participants in each group.

- **Group A** received a quadriceps strengthening exercise program combined with kinesiotaping.
- **Group B** performed the quadriceps strengthening exercise program only.
- **Group C** served as the control group and received only routine advice on activity modification and joint protection.

Randomization was done using a simple lottery method, and group allocation was concealed until the interventions began.

Intervention Protocol

Quadriceps Exercise Program:

Participants in Groups A and B performed supervised quadriceps strengthening exercises three times per week for eight weeks. The sessions lasted approximately 40 minutes each. The exercise program included isometric quadriceps contractions, straight leg raises, short arc quadriceps exercises, and seated knee extensions. Intensity was gradually increased based on the participant's tolerance and progression, with each exercise performed in three sets of 10 repetitions. Participants were instructed to perform the exercises at home on non-supervised days under written guidance.

Kinesiotaping Application:

For participants in Group A, kinesiotape was applied immediately after each exercise session by a trained physiotherapist. A 5 cm-wide elastic therapeutic tape was used. The tape was applied over the quadriceps and around the patella using the Y- and I-strip methods to support the knee joint and facilitate quadriceps function. The tape was kept in place for three days and replaced twice weekly throughout the eight-week intervention period. Skin integrity was checked regularly to avoid irritation or allergic reactions.

Control Group:

Group C participants received no active exercise or taping intervention. They were provided with standard lifestyle advice, including weight management, avoidance of prolonged standing, and proper footwear use.

Outcome Measures

The outcomes were assessed at baseline and after eight weeks of intervention by an independent evaluator who was blinded to group allocation.

- **Pain Intensity:** Pain was measured using the Visual Analogue Scale (VAS) ranging from 0 (no pain) to 10 (worst possible pain).
- **Functional Ability:** Functional performance was evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire, which assessed pain, stiffness, and physical function.
- **Range of Motion (ROM):** Active knee flexion and extension range of motion were measured using a standard goniometer while the participant was in a supine position.

Data Analysis

All collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics, including means and standard deviations, were calculated for all variables. The Shapiro-Wilk test was used to assess data normality. Within-group comparisons before and after intervention were performed using paired t-tests, while between-group comparisons were analyzed using one-way ANOVA followed by Tukey's post hoc test. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the relevant institutional review board before participant recruitment. All participants were informed about the purpose and procedures of the study, potential risks, and their right to withdraw at any time without penalty. Confidentiality of participant data was strictly maintained throughout the research process.

Results

A total of 60 participants with mild to moderate knee osteoarthritis completed the study. They were equally divided into three groups: Group A (quadriceps exercises + kinesiotaping), Group B (quadriceps exercises only), and Group C (control group). There were no dropouts, and all participants adhered to the intervention protocols. The results are presented in terms of demographic characteristics, baseline comparability, and post-intervention outcomes related to pain intensity, functional ability, and range of motion. Statistical significance was set at $p < 0.05$.

Table 1. Demographic Characteristics of Participants

Variable	Group A (n=20)	Group B (n=20)	Group C (n=20)	Total (n=60)

Gender				
Male	8 (40%)	7 (35%)	9 (45%)	24 (40%)
Female	12 (60%)	13 (65%)	11 (55%)	36 (60%)
Age (years)				
45–54	6 (30%)	5 (25%)	4 (20%)	15 (25%)
55–64	9 (45%)	10 (50%)	11 (55%)	30 (50%)
65–70	5 (25%)	5 (25%)	5 (25%)	15 (25%)
BMI (kg/m²)				
25–29.9	10 (50%)	9 (45%)	8 (40%)	27 (45%)
≥30	10 (50%)	11 (55%)	12 (60%)	33 (55%)

The participants across the three groups were comparable in terms of age, gender, and body mass index (BMI). Most participants were females (60%) and within the 55–64 years age range (50%). The mean BMI across groups indicated that the majority were overweight or obese, a common risk factor for knee osteoarthritis. No significant differences were found between groups at baseline ($p > 0.05$).

Table 2. Baseline and Post-Intervention Pain Intensity (VAS Scores)

Group	Baseline Mean ± SD	Post-Intervention Mean ± SD	Mean Difference	% Improvement	p-value
Group A (Exercise + Kinesiotaping)	7.4 ± 0.8	3.2 ± 0.7	4.2	56.8%	<0.001*
Group B (Exercise Only)	7.5 ± 0.9	4.6 ± 0.8	2.9	38.6%	<0.001*
Group C (Control)	7.3 ± 0.7	6.8 ± 0.9	0.5	6.8%	0.084

Pain intensity significantly decreased in Groups A and B after the 8-week intervention ($p < 0.001$). Group A, which received kinesiotaping in addition to exercise, showed the greatest reduction in pain with a 56.8% improvement compared to 38.6% in Group B. The control group showed only minimal pain reduction, which was not statistically significant. These results indicate that kinesiotaping enhanced the pain-relieving effects of quadriceps exercises.

Table 3. Baseline and Post-Intervention Functional Ability (WOMAC Scores)

Group	Baseline Mean ± SD	Post-Intervention Mean ± SD	Mean Difference	% Improvement	p-value
Group A (Exercise + Kinesiotaping)	62.5 ± 6.4	35.3 ± 5.8	27.2	43.5%	<0.001*

Group B (Exercise Only)	63.1 ± 7.2	44.9 ± 6.5	18.2	28.8%	<0.001*
Group C (Control)	61.7 ± 5.9	59.3 ± 6.1	2.4	3.9%	0.097

Functional performance measured by WOMAC improved significantly in Groups A and B ($p < 0.001$). Group A demonstrated the highest functional improvement (43.5%) compared to Group B (28.8%), indicating a superior effect of combining kinesiotaping with quadriceps strengthening exercises. The control group showed negligible change, confirming that the improvements were due to the active interventions.

Table 4. Knee Range of Motion (Degrees) Before and After Intervention

Group	Baseline Mean ± SD	Post-Intervention Mean ± SD	Mean Difference	% Improvement	p-value
Group A (Exercise + Kinesiotaping)	102.4 ± 8.2	120.3 ± 6.9	17.9	17.5%	<0.001*
Group B (Exercise Only)	101.6 ± 7.8	114.5 ± 7.2	12.9	12.7%	<0.001*
Group C (Control)	103.1 ± 8.0	104.8 ± 7.9	1.7	1.6%	0.112

Knee range of motion improved significantly in both intervention groups, with Group A showing a greater increase (17.9°) compared to Group B (12.9°). The improvement in Group A (17.5%) was statistically significant ($p < 0.001$) and clinically meaningful. The control group showed minimal change, suggesting that the combination of kinesiotaping and exercise effectively enhanced knee flexibility and joint mobility.

Table 5. Comparison of Mean Post-Intervention Scores Among Groups (ANOVA)

Outcome Measure	F-value	p-value
Pain (VAS)	54.21	<0.001*
Function (WOMAC)	38.76	<0.001*
Range of Motion	29.43	<0.001*

Between-group comparisons revealed significant differences across all outcome measures ($p < 0.001$). Post hoc analysis showed that Group A performed significantly better than both Group B and Group C in terms of pain reduction, functional improvement, and range of motion gains. Group B also showed significant improvements compared to the control group, but to a lesser extent than Group A.

Discussion

The present study aimed to evaluate the effectiveness of quadriceps strengthening exercises combined with kinesiotaping compared to exercises alone and a control condition in individuals with mild to moderate knee osteoarthritis. Our results demonstrated significant improvements in pain, functional ability, and range of motion among participants who received the combined intervention. These findings support the hypothesis that kinesiotaping can enhance the outcomes of exercise-based rehabilitation for knee osteoarthritis.

Pain reduction was most pronounced in the group that received both quadriceps exercises and kinesiotaping. This aligns with the findings of León-Ballesteros et al. (2020), who reported that the addition of kinesiotaping to quadriceps exercises resulted in greater pain relief than exercises alone. The improvement in our study may be attributed to the supportive and proprioceptive effects of the tape, which likely reduced strain on inflamed tissues and improved patellar alignment during movement.

The results also indicated that quadriceps exercises alone significantly reduced pain levels, although to a lesser extent than the combined approach. This agrees with Oğuz et al. (2021), who found that exercise interventions can enhance muscle strength and decrease pain perception by improving joint stability and reducing mechanical load on the articular surfaces. Strengthening the quadriceps reduces compressive forces on the cartilage, which may explain the observed pain reduction in both intervention groups.

Functional outcomes measured by the WOMAC index showed substantial improvement in both intervention groups, with the greatest gains in the combined group. These findings are in line with those of Wu et al. (2022), who concluded in a meta-analysis that kinesiotaping combined with exercise improved functional performance more effectively than exercise alone. The integration of kinesiotaping likely enhanced proprioceptive feedback, allowing participants to perform exercises with improved control and reduced discomfort, leading to better overall functionality.

Increased range of motion observed in the kinesiotaping and exercise group suggests that the intervention effectively alleviated joint stiffness and improved flexibility. This outcome is consistent with the results reported by Mahmoud (2024), who found that kinesiotaping enhanced knee mobility and facilitated muscle activation in osteoarthritis patients. Improved circulation and reduced local inflammation due to the lifting effect of the tape may have contributed to this result.

The superior outcomes in the combined intervention group also reflect the synergistic mechanism between muscle strengthening and mechanical support. According to Günaydin and Bayrakci Tunay (2022), kinesiotaping provides external support while allowing normal joint movement, which helps maintain proper biomechanics during exercise. This combination reduces compensatory movements and enhances exercise performance, thus amplifying the therapeutic benefits of strengthening programs.

Our results further indicate that kinesiotaping may encourage better exercise adherence by reducing pain and discomfort during training sessions. This psychological benefit aligns with the findings of Mohamed and Alatawi (2023), who observed improved motivation and participation among patients using kinesiotaping in addition to physiotherapy. Reduced pain may lead to increased confidence and willingness to engage in consistent physical activity, which is critical for long-term rehabilitation success.

The positive effects on pain and function also suggest neuromuscular adaptations. Kinesiotaping stimulates cutaneous mechanoreceptors, enhancing proprioceptive feedback, which improves muscle coordination and joint awareness (Abolhasani et al., 2019). Enhanced neuromuscular control reduces abnormal joint stresses and contributes to greater functional improvements, as seen in our combined group results.

Although both exercise and kinesiotaping were effective individually, their combination provided a greater magnitude of improvement, indicating an additive or synergistic effect. Similar results were observed by Fazli et al. (2023), who demonstrated that using kinesiotaping alongside orthotic or exercise-based therapy improved muscle function and balance more effectively than either treatment alone. These combined effects likely arise from improved joint biomechanics and reduced inflammatory load.

The lack of significant improvement in the control group underscores the importance of active interventions in managing knee osteoarthritis. Participants in this group only received lifestyle advice, which did not yield substantial clinical changes. This finding agrees with Li et al. (2018), who noted that passive or educational interventions alone are insufficient to produce measurable improvements in osteoarthritis outcomes.

Our study's findings support the growing consensus that non-invasive, cost-effective interventions should be prioritized in the conservative management of knee osteoarthritis. Regular quadriceps strengthening helps mitigate muscle weakness and maintain joint stability, while kinesiotaping adds a pain-modulating and supportive component that enhances movement efficiency (Öğüt et al., 2018). Together, these methods offer an accessible therapeutic option with minimal risk.

The improvement in pain and function also highlights the role of patient-centered rehabilitation strategies. By addressing both biomechanical and sensory aspects of osteoarthritis, kinesiotaping and exercise help restore confidence and promote independence. This holistic effect aligns with the broader goals of musculoskeletal rehabilitation described by León-Ballesteros et al. (2020), emphasizing not only symptom relief but also long-term functional recovery.

While the results are promising, it is essential to acknowledge that individual responses to kinesiotaping can vary depending on tape application technique, skin sensitivity, and the degree of osteoarthritis. Future studies should explore optimal taping durations, combinations with other modalities, and long-term effects beyond the 8-week period used in this study.

In summary, the results of this research contribute to existing evidence supporting kinesiotaping as an effective adjunct to exercise therapy for knee osteoarthritis. The combination intervention yielded superior results in reducing pain, improving functional ability, and enhancing range of motion, which may translate into better quality of life for patients.

Conclusion

The combination of quadriceps strengthening exercises and kinesiotaping was more effective than exercise alone or no intervention in improving clinical outcomes for individuals with knee osteoarthritis. The synergistic interaction between muscle strengthening and mechanical support resulted in significant reductions in pain, greater functional gains, and improved range of motion. These findings highlight the value of integrating kinesiotaping into exercise-based rehabilitation programs as a simple, affordable, and non-invasive approach for the conservative management of knee osteoarthritis.

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