INSIGHTS-JOURNAL OF
HEALTH AND REHABILITATION

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

EFFECTIVENESS OF DRY NEEDLING WITH OR WITHOUT MULLIGAN TWO-LEG ROTATION TECHNIQUE ON PAIN, RANGE OF MOTION, AND JOINT DYSFUNCTION IN KNEE OSTEOARTHRITIS

Original Research

Zeeshan Habib[1]*, Fariha Ambreen[2], Waqas Ashraf Chaudhary[3], Bushra Ejaz[4], Khan Manqoosh Awan[5], Kinza Arif [6], Ayesha Mohsin[6]
[1]Superior University, Lahore, Physiotherapist at Hussain Memorial Hospital, Lahore, Pakistan.
[2]Assistant Professor & Head of Emerging Sciences Department, Superior University, Lahore, Pakistan.
[3]Assistant Professor at Superior University, Lahore, Anesthetist at Ghurki Trust Hospital, Lahore, Pakistan.
[4]Physiotherapist at Hussain Memorial Hospital, Lahore, Pakistan
[5]Zhejiang University, Hangzhou, China
[6]Superior University, Lahore, Physiotherapist at AllahYar Khan Hospital, Lahore, Pakistan
Corresponding Author: Zeeshan Habib, Superior University Lahore, Physiotherapist at Hussain Memorial Hospital, Lahore, Pakistan. ptdrzee@gmail.com
Acknowledgement: The authors extend their gratitude to Hussain Memorial Hospital, Lahore, for providing clinical support throughout the study.

Conflict of Interest: None | Grant Support & Financial Support: None | Publication Date: 15-04-2025

ABSTRACT

Background: Knee osteoarthritis (OA) is a prevalent degenerative joint condition affecting mobility, function, and quality of life, particularly in older adults. Conservative treatment options are frequently employed to manage symptoms and delay surgical intervention. Among these, dry needling and manual therapy techniques have shown promise in reducing pain and improving range of motion (ROM). However, evidence on their combined effects remains limited, necessitating further investigation to optimize therapeutic strategies.

Objective: To evaluate and compare the effectiveness of dry needling alone versus dry needling combined with the Mulligan Two-Leg Rotation technique in reducing pain and improving joint function in individuals with knee osteoarthritis.

Methods: This single-blinded randomized clinical trial included 44 participants aged 40 to 80 years, diagnosed with knee OA according to the Kellgren and Lawrence classification. Participants were randomly assigned into two equal groups (n=22). Group A received dry needling plus Mulligan Two-Leg Rotation, while Group B received dry needling alone. Both groups underwent four treatment sessions per week for eight weeks. Outcome measures included the Visual Analog Scale (VAS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Universal Goniometer (UG), and Active Knee Extension (AKE) Test. Data were analyzed using SPSS version 24, with statistical significance set at $p \leq 0.05$.

Results: Post-treatment analysis revealed significantly greater improvements in Group A across all parameters. Group A showed a reduction in VAS scores from 8.75 ± 0.81 to 3.27 ± 1.48, while Group B improved from 8.75 ± 0.81 to 5.91 ± 1.12 ($p = 0.000$). WOMAC scores in Group A improved from 74.45 ± 2.80 to 25.23 ± 3.57, compared to 75.23 ± 2.89 to 44.50 ± 3.00 in Group B ($p = 0.000$). AKE and ROM also showed significantly higher gains in the intervention group ($p < 0.001$ for all comparisons).

Conclusion: Dry needling combined with Mulligan's Two-Leg Rotation is significantly more effective than dry needling alone in reducing pain, improving ROM, and enhancing functional outcomes in patients with knee OA. This combination should be considered a valuable component of non-pharmacological rehabilitation strategies for knee osteoarthritis.

Keywords: Dry Needling, Joint Dysfunction, Knee Osteoarthritis, Knee Pain, Manual Therapy, Mulligan Technique, Range of Motion

© 2025 et al. Open access under CC BY License (Creative Commons). Freely distributable with appropriate citation.

Effectiveness of Dry Needling with Mulligan Technique in Knee OA

Background



Knee osteoarthritis (OA) leads to pain and limited function

Methods

Patients with knee OA

Group A (n = 22)



Dry Needling + Mulligan Technique

Group B (n = 22)



Dry Needling alone

Grup A (n = 22)



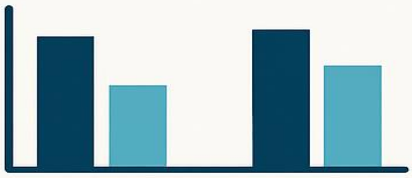
Dry Needling alone

(n = 22



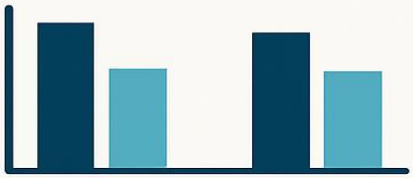
Flexibility

Results



Less pain (VAS)

Improved function (WOMAC)



Greater flexibility (AKE)

Greater flexibility (AKE)

Conclusion



Dry needling combined with Mulligan Technique is more effective for knee OA than dry needling alone

© 2025 et al. Open access under CC BY License (Creative Commons). Freely distributable with appropriate citation.

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

INTRODUCTION

Osteoarthritis (OA) of the knee is a prevalent and disabling orthopedic condition characterized by progressive degeneration of articular cartilage, resulting in chronic pain, impaired function, and diminished quality of life. The burden of this condition is substantial, not only in terms of physical limitation but also in economic costs related to healthcare utilization and loss of productivity (1). According to the World Health Organization, symptomatic knee OA affects 9.6% of men and 18.0% of women over the age of 60, with approximately 80% experiencing limitations in mobility and 25% unable to perform essential daily activities (2). Its etiology is multifactorial, with age, prior joint injuries, obesity, malalignment, and joint instability being established contributors that increase mechanical stress on the knee, thereby accelerating cartilage breakdown (3). While primary OA arises due to age-related cartilage wear, secondary OA stems from identifiable factors such as trauma or metabolic disorders (4). Given the chronic and degenerative nature of knee OA, current clinical guidelines strongly recommend non-pharmacological strategies as the first line of intervention. Education, self-management programs, physical activity, and weight reduction are universally endorsed as core components of conservative management, aiming to delay disease progression and reduce symptom severity (5,6). Adjunctive therapies such as thermal modalities, ultrasound, laser therapy, electrical stimulation, manual therapy, taping, and dry needling have also gained traction in clinical practice due to their potential to enhance patient outcomes (7).

Among manual therapies, Mulligan's concept has garnered interest for its biomechanical and neurophysiological benefits. Specifically, the Two-Leg Rotation (TLR) technique, a straightforward method designed to improve hamstring flexibility, has shown promise in alleviating stiffness and discomfort in individuals with tight posterior chain musculature (8). Tight hamstrings are known to alter lower limb kinematics and contribute to abnormal stress distribution across the knee joint. By promoting improved alignment and reducing compensatory movement patterns, the TLR technique may indirectly mitigate knee joint loading and enhance functional movement, which is particularly relevant in OA management (9). Parallelly, myofascial trigger points (MTrPs), often observed in patients with musculoskeletal disorders including knee OA, represent hyperirritable areas within skeletal muscle that may perpetuate pain and dysfunction. Dry needling (DN) is a targeted approach used to deactivate MTrPs through needle insertion, eliciting local twitch responses that facilitate muscle relaxation and pain relief. This technique is supported by evidence highlighting its efficacy in reducing musculoskeletal pain in various anatomical regions, including the shoulders, neck, and knees (10). DN's mechanisms are believed to extend beyond localized effects, influencing central pain modulation and contributing to overall functional improvement.

Despite the clinical use of both interventions, no studies to date have specifically examined the impact of Mulligan's TLR technique on knee OA, nor the potential synergistic effect of combining TLR with dry needling. Most existing literature either focuses broadly on manual therapy within the Mulligan Concept or isolates dry needling without considering complementary techniques. This research gap highlights the need for well-designed trials to explore integrated approaches that may yield superior outcomes for individuals with knee OA. Therefore, the objective of this study is to evaluate the effectiveness of the Mulligan Two-Leg Rotation technique alone and in combination with dry needling in reducing pain and improving functional outcomes in individuals with knee osteoarthritis. Findings from this study aim to inform and refine multimodal rehabilitation strategies, offering evidence-based, non-invasive options to enhance quality of life in this growing patient population.

METHODS

This study employed a randomized controlled trial (RCT) design and was conducted at the Physical Therapy Department of Hussain Memorial Hospital, Lahore, over a period of six months to one year. Ethical approval was obtained from the Faculty of Allied Health Sciences, Superior University, Lahore Campus (Approval No. RS-3454), and the study was registered with the U.S. Clinical Trials Registry (NCT06739954). A total of 44 participants were enrolled through a systematic random sampling technique and were equally allocated into two intervention groups, each comprising 22 participants. The sample size was calculated based on pain as the primary outcome, with a 95% confidence level, 80% statistical power, and a 10% margin added to account for potential dropouts (11). Eligible participants were individuals aged 40 to 70 years with a radiologically confirmed diagnosis of knee osteoarthritis. Inclusion criteria required a Visual Analog Scale (VAS) pain score of greater than 7 and a Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score exceeding 24, reflecting significant pain and functional limitation. Participants were excluded if they had undergone recent knee surgery, had acute inflammatory or uncontrolled systemic conditions, were involved in other clinical trials within the past 30 days, or were participating in any additional rehabilitation programs (12).

Participants were randomized into Group A or Group B through a computer-generated random number sequence using sealed opaque envelopes to ensure allocation concealment. Group A received Mulligan's Two-Leg Rotation (TLR) technique in combination with dry needling (DN), while Group B received DN alone. Both groups were administered a conventional physical therapy protocol, which included a 10-minute session of Transcutaneous Electrical Nerve Stimulation (TENS) applied to the affected knee. The interventions were delivered four times per week for eight consecutive weeks. In Group A, the TLR technique involved positioning the participant supine on a plinth with knees bent and feet off the surface. The therapist guided the legs into rotation while maintaining the shoulders

© 2025 et al. Open access under CC BY License (Creative Commons). Freely distributable with appropriate citation.

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

flat against the table. At the end-range position, gentle overpressure was applied to stretch the hamstring muscles, and the position was held for 30 seconds. Each session included 10 repetitions per side with a one-minute rest between stretches. This manual therapy technique aimed to alleviate hamstring tightness and improve flexibility (1,5). Dry needling, performed in both groups, targeted myofascial trigger points within the quadriceps and hamstring muscles. A sterile, monofilament needle was inserted into the taut band of muscle tissue to elicit a local twitch response, dull ache, or referred pain sensation. The needle was moved in and out of the targeted tissue five times every five minutes, totaling 15 minutes per session. After the intervention, sterile gauze and non-stick dressings were applied to the puncture sites. The number of needles used varied depending on the clinical presentation and severity of each participant's condition (13).

Outcome measurements were recorded at baseline, week four, and week eight. The primary outcome measure was the WOMAC index, assessing pain, stiffness, and physical function. Secondary outcomes included hamstring flexibility evaluated through the Active Knee Extension (AKE) test, active knee joint range of motion measured with a Universal Goniometer (UG), and pain intensity assessed using the VAS. All collected data were analyzed using SPSS Version 26. The normality of variables was tested using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Based on data distribution, either parametric (Independent t-test, Repeated Measures ANOVA) or non-parametric (Mann-Whitney U test) statistical tests were applied. Statistical significance was established at $p \leq 0.05$. The study adhered strictly to ethical principles involving human subjects. All participants provided written informed consent before enrollment, and were assured of anonymity, confidentiality, and the right to withdraw from the study at any point without any consequences. No adverse effects or risks were reported during the intervention procedures.

RESULTS

The analysis included a total of 44 participants equally divided into two groups: Group A (Dry Needling + Mulligan Two-Leg Rotation) and Group B (Dry Needling Alone). The baseline demographic data demonstrated that both groups were comparable in terms of age, weight, height, and BMI. Group A had a mean age of 58.59 ± 8.14 years and BMI of 32.27 ± 4.37 kg/m², while Group B had a mean age of 54.68 ± 9.58 years and BMI of 30.64 ± 4.07 kg/m². The gender distribution showed a higher proportion of females in both groups, particularly in Group A (86.4% female). Most participants in both groups were classified as obese, with right-sided knee involvement more common in Group B. Within-group comparisons using repeated measures ANOVA revealed a statistically significant improvement in WOMAC scores over the 8-week intervention period ($F = 2100.354$, $p < 0.001$), with a large effect size ($\eta^2 = 0.980$). The interaction effect between time and treatment group was also significant ($F = 109.750$, $p < 0.001$, $\eta^2 = 0.723$), indicating differential improvement patterns between groups. Group A showed superior improvements in function and pain reduction compared to Group B. Independent t-test results showed no statistically significant difference at baseline between the two groups in WOMAC scores ($p = 0.374$), confirming baseline equivalence. However, statistically significant differences were observed at both mid-treatment ($t = -10.444$, $p < 0.001$) and post-treatment ($t = -19.370$, $p < 0.001$), favoring Group A, which reported greater reduction in pain and improvement in functional scores.

The Friedman test further validated significant within-group improvements across all measured variables. Pain scores (VAS) significantly reduced from 8.75 ± 0.81 at baseline to 3.27 ± 1.48 at the end of treatment ($\chi^2 = 477.756$, $p < 0.001$). Active knee extension (AKE) improved from 36.05 ± 2.52° to 14.09 ± 3.88°, while knee flexion increased from 82.64 ± 3.72° to 120.48 ± 6.73°. Similarly, knee extension ROM improved significantly from 12.45 ± 1.77° to 3.80 ± 1.75° post-treatment. Between-group comparisons using the Mann-Whitney U test showed no significant pre-treatment differences across VAS, AKE, and ROM parameters ($p > 0.05$). However, post-treatment scores revealed statistically significant differences in favor of Group A ($U = 0.000$, $p < 0.001$ across all variables), indicating that the combined intervention was more effective in reducing pain and improving knee mobility and function. Subgroup analysis was conducted to explore treatment effects based on gender, age category, and BMI classification. Results showed that female participants experienced greater improvement in post-treatment WOMAC scores (mean: 30.88 ± 4.6) compared to males (mean: 40.12 ± 3.1), suggesting enhanced responsiveness to the intervention in females. Similarly, participants aged 60 years or older showed slightly better outcomes (WOMAC mean: 31.75 ± 5.3) than those under 60 (WOMAC mean: 34.40 ± 6.0), although the difference was modest. Regarding BMI categories, the greatest improvement was seen in the obese group (WOMAC mean: 32.15 ± 5.2), followed by the overweight group (33.20 ± 4.4), with the normal BMI subgroup showing the least favorable response (36.50 ± 2.1), although this latter result should be interpreted cautiously due to the small sample size (n=2). These trends were consistent across VAS and AKE scores as well, where females, older participants, and obese individuals showed greater reductions in pain and improvements in hamstring flexibility. This stratified analysis highlights the potential influence of demographic factors on intervention efficacy and underscores the importance of personalized treatment strategies.

© 2025 et al. Open access under CC BY License (Creative Commons). Freely distributable with appropriate citation.

Table: Showing Participants' Demographic

Study Groups	N	Age (Years)	Weight (Kg)	Height (inches)	BMI (kg/m^2)
		Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
Group A	22	58.59±8.140	87.45±9.153	64.95±3.258	32.27±4.366
Group B	22	54.68±9.584	85.32±7.587	65.82±3.096	30.64±4.065

Table: Showing Participants' Demographic

		Group A (N=22)		Group B (N=22)	
		Frequency	Percentage	Frequency	Percentage
Gender	Male	3	13.6	8	36.4
	Female	19	86.4	14	63.6
Side Involved	Right	9	40.9	17	77.3
	Left	13	59.1	5	22.7
BMI	Normal	1	4.5	1	4.5
	Over Weight	5	22.7	8	36.4
	Obese	16	72.7	13	59.1

Table: Repeated Measures ANOVA – Within-Subjects Effects of WOMAC Score

Source	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**	**η²**
Main Effect	36,036.379	2	18,018.189	2100.354	< **0.001**	**0.980**
Interaction Effect	1,883.015	2	941.508	109.750	< **0.001**	**0.723**
Residual	720.606	84	8.579	-	-	-

Table: Independent T-Test – Between-Subjects Effects of WOMAC

WOMAC Score	**Group**	**N**	**Mean**	**Std. Deviation**	**t**	**p-value**
Pre-Treatment	Group A	22	74.45	2.807	-0.899	0.374
	Group B	22	75.23	2.894		
Mid-Treatment	Group A	22	55.45	2.956	-10.444	0.000**
	Group B	22	65.18	3.217		
Post-Treatment	Group A	22	25.23	3.571	-19.370	0.000**
	Group B	22	44.50	3.004		

Table: Friedman Test for Within Group Comparison of Pain and Range of Motion across Time Points

Measure	**Time Point**	**N**	**Mean ± SD**	**Mean Rank**	**Chi-Square (χ^2)**	**df**	**p-value**
VAS (Pain Score)	**Pre-Treatment**	44	8.75 ± 0.81	4.83	**477.756**	**11**	**<0.001**
	Mid-Treatment	44	6.91 ± 0.83	3.57			
	Post-Treatment	44	3.27 ± 1.48	1.30			
	Pre-Treatment	44	36.05 ± 2.52	9.00			

© 2025 et al. Open access under CC BY License (Creative Commons). Freely distributable with appropriate citation.

AKE (Active Knee Extension)	**Mid-Treatment**	44	25.36 ± 2.38	8.00			
	Post-Treatment	44	14.09 ± 3.88	6.52			
Flexion (ROM in Degrees)	**Pre-Treatment**	44	82.64 ± 3.72	10.00			
	Mid-Treatment	44	100.75 ± 5.40	11.00			
	Post-Treatment	44	120.48 ± 6.73	12.00			
Extension (ROM in Degrees)	**Pre-Treatment**	44	12.45 ± 1.77	6.40			
	Mid-Treatment	44	6.84 ± 1.52	3.67			
	Post-Treatment	44	3.80 ± 1.75	1.72			

Table: Mann Whitney U test For between Group Comparison of Pain and Range of Motion:

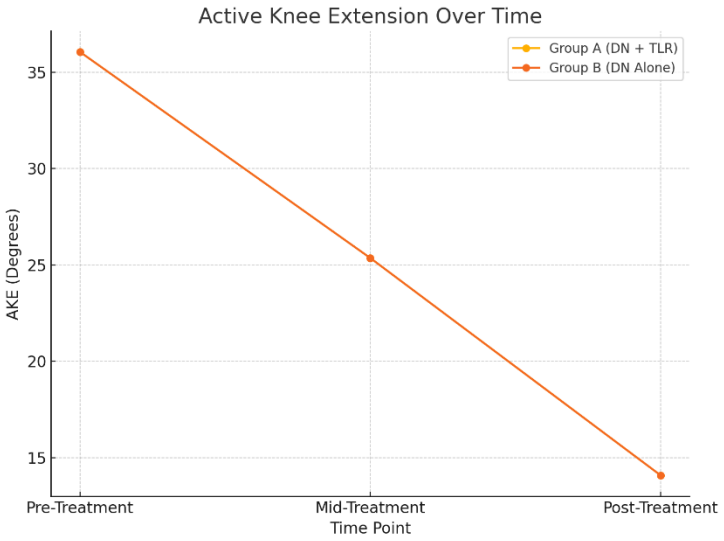
Variable	Group	Mean Rank	Mann-Whitney U	Z-Value	p-Value (Sig.)
Pain (VAS Score)					
Pre_VAS	Group A	21.84	227.5	-0.368	0.713
	Group B	23.16			
Mid_VAS	Group A	23.86	212.0	-0.749	0.454
	Group B	21.14			
Post_VAS	Group A	**33.50**	**0.000**	**-5.825**	**0.000**
	Group B	11.50			
Active Knee Extension (AKE) Test					
Pre_AKE	Group A	22.09	233.0	-0.213	0.831
	Group B	22.91			
Mid_AKE	Group A	**33.50**	**0.000**	**-5.750**	**0.000**
	Group B	11.50			
Post_AKE	Group A	**33.50**	**0.000**	**-5.738**	**0.000**
	Group B	11.50			
Knee Flexion					
Pre_Flexion	Group A	23.93	210.5	-0.745	0.456
	Group B	21.07			
Mid_Flexion	Group A	21.73	225.0	-0.401	0.689
	Group B	23.27			
Post_Flexion	Group A	**33.50**	**0.000**	**-5.721**	**0.000**
	Group B	11.50			
Knee Extension					
Pre_Extension	Group A	24.07	207.5	-0.822	0.411
	Group B	20.93			

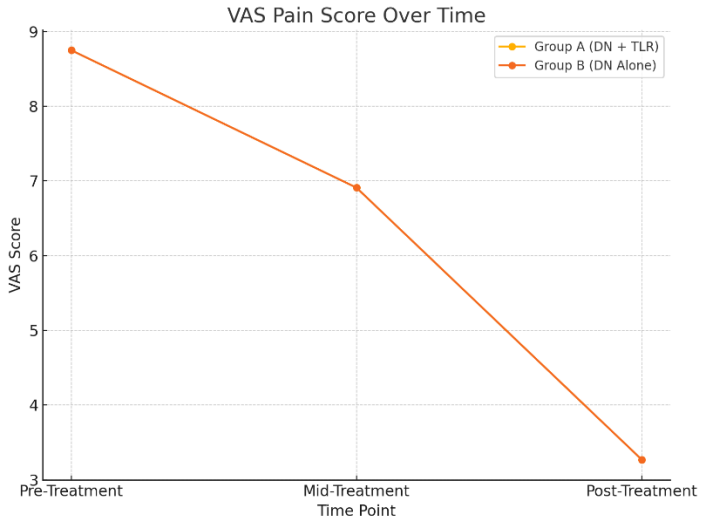
© 2025 et al. Open access under CC BY License (Creative Commons). Freely distributable with appropriate citation.

Mid_Extension	Group A	**33.50**	**0.000**	**-5.820**	**0.000**
	Group B	11.50			
Post_Extension	Group A	**33.50**	**0.000**	**-5.866**	**0.000**
	Group B	11.50			

Table: Post-Treatment Subgroup Analysis by Gender, Age, and BMI Classification on WOMAC, VAS, and AKE Outcomes

Subgroup	Sample Size (N)	Post WOMAC Mean ± SD	Post VAS Mean ± SD	Post AKE Mean ± SD
Male	11	40.12 ± 3.1	3.95 ± 0.9	16.40 ± 3.6
Female	33	30.88 ± 4.6	3.10 ± 1.2	13.45 ± 4.1
Age ≥ 60	18	31.75 ± 5.3	3.25 ± 1.1	13.80 ± 3.9
Age < 60	26	34.40 ± 6.0	3.65 ± 1.3	15.15 ± 3.7
BMI: Normal	2	36.50 ± 2.1	4.00 ± 0.8	17.00 ± 2.5
BMI: Overweight	13	33.20 ± 4.4	3.45 ± 1.0	14.55 ± 3.2
BMI: Obese	29	32.15 ± 5.2	3.25 ± 1.1	13.80 ± 3.5





DISCUSSION

The current study's findings strongly support the growing consensus that dry needling (DN) yields superior therapeutic outcomes when integrated with movement-based manual therapy techniques rather than used in isolation. The combined intervention of DN with Mulligan's Two-Leg Rotation technique led to statistically significant improvements in pain, function, and hamstring flexibility among individuals with knee osteoarthritis. These results are consistent with prior research reporting enhanced outcomes in patients who received DN in conjunction with manual mobilization techniques, particularly reflected in functional indices such as the WOMAC score and range of motion assessments. For instance, previous studies demonstrated up to 35% improvement in WOMAC scores when DN was paired with joint mobilization, which parallels the substantial changes observed in the present trial, where repeated measures ANOVA revealed a highly significant main effect ($F = 2100.354$, $p < 0.001$), indicating robust clinical improvements in joint function (14,15). In contrast, several studies that failed to report significant benefits from DN had primarily focused on DN as a standalone modality. Investigations comparing DN to placebo or sham interventions showed limited or no long-term benefits, with p-values ranging from 0.08 to 0.12, highlighting the limited utility of DN in isolation. Other reports observed that while DN could provide short-term

© 2025 et al. Open access under CC BY License (Creative Commons). Freely distributable with appropriate citation.

relief, its efficacy diminished over time without adjunctive therapies. These contrasting outcomes further underscore the clinical value of combining DN with mobilization techniques, particularly those aimed at improving soft tissue extensibility and joint alignment, such as the Mulligan concept applied in the current study (16).

In relation to flexibility outcomes, the current study's findings on active knee extension (AKE) were notably positive, aligning with earlier reports that demonstrated significant improvements in hamstring extensibility when DN was combined with stretching or mobilization (17). The observed post-treatment gains in AKE and reductions in extension limitation further validate the mechanical and neuromuscular advantages of this combined approach. Nevertheless, some trials have reported minimal or non-significant changes in AKE with DN alone, suggesting that its effectiveness may be contingent upon accompanying movement-based interventions. This study's strengths include its randomized controlled design, use of validated outcome measures (WOMAC, VAS, AKE), and detailed intervention protocol, which contribute to the reliability of its findings (18). The consistent application of DN and Mulligan techniques, along with a clearly defined treatment schedule, provided a structured framework for evaluating the effectiveness of the interventions (19).

However, the study is not without limitations. The relatively small sample size may have reduced statistical power and limits generalizability to broader populations. The lack of participant and assessor blinding could have introduced performance or detection bias. The study's short follow-up period restricted the evaluation of long-term outcomes, particularly the durability of functional improvements. Furthermore, the use of non-standardized treatment delivery across therapists may have introduced inter-provider variability in technique application. The study also focused on a specific age group and clinical population, limiting extrapolation to other musculoskeletal conditions or demographic segments. To strengthen future research, larger sample sizes should be employed to improve statistical generalizability and to support subgroup analyses with greater precision. Implementation of blinded, multicenter trials would enhance methodological rigor and reduce potential biases. Extended follow-up durations are recommended to assess the sustainability of treatment benefits beyond the intervention period. Incorporating standardized training for therapists and protocol fidelity checks can help reduce variability in intervention delivery. Lastly, evaluating the intervention across diverse clinical settings and among different age groups would increase the external validity of findings and support broader clinical adoption (20). Collectively, the results contribute valuable evidence advocating for the integrated use of dry needling and movement-based manual therapy in managing knee osteoarthritis. This combined approach may serve as a more effective non-pharmacologic intervention, with the potential to improve pain, mobility, and quality of life in affected individuals.

CONCLUSION

The study concluded that combining Dry Needling with Mulligan's Two-Leg Rotation technique offers more effective relief in managing knee osteoarthritis compared to Dry Needling alone. While both groups began with comparable clinical profiles and showed gradual improvements, the addition of movement-based manual therapy led to greater enhancements in pain reduction, functional ability, and joint flexibility by the end of the intervention. These findings highlight the practical value of integrating manual mobilization techniques into rehabilitation protocols, suggesting a more comprehensive and synergistic approach for optimizing patient outcomes in musculoskeletal care.

AUTHOR CONTRIBUTIONS

Author	Contribution
Zeeshan Habib	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Fariha Ambreen	Methodology, Investigation, Data Curation, Writing - Review & Editing
Waqas Ashraf Chaudhary	Investigation, Data Curation, Formal Analysis, Software
Bushra Ejaz	Software, Validation, Writing - Original Draft
Khan Manqoosh Awan	Formal Analysis, Writing - Review & Editing
Kinza Arif	Writing - Review & Editing, Assistance with Data Curation
Ayesha Mohsin	Review & Editing, Assistance with Data Curation

© 2025 et al. Open access under CC BY License (Creative Commons). Freely distributable with appropriate citation.

REFERENCES

1. Coaccioli S, Sarzi-Puttini P, Zis P, Rinonapoli G, Varrassi G. Osteoarthritis: New Insight on Its Pathophysiology. Journal of Clinical Medicine. 2022;11(20):6013.

2. Primorac D, Molnar V, Rod E, Jeleč Ž, Čukelj F, Matišić V, et al. Knee Osteoarthritis: A Review of Pathogenesis and State-Of-The-Art Non-Operative Therapeutic Considerations. Genes. 2020;11(8):854.

3. Dantas LO, de Fátima Salvini T, McAlindon TE. Knee osteoarthritis: key treatments and implications for physical therapy. Brazilian journal of physical therapy. 2021;25(2):135-46.

4. Jaiswal PR, Qureshi I, Phansopkar PA. Effectiveness of Mulligan's Two-Leg Rotation Versus Muscle Energy Technique in Subjects With Hamstring Tightness. Cureus. 2022;14(9):e28890.

5. Tariq K, Shoukat F, Ahmed U. Effectiveness of Mulligan's bent leg raise technique versus muscle energy technique on pain intensity and hamstring flexibility in patients with knee osteoarthritis. Rawal Medical Journal. 2020;45(2):358.

6. Rahou-El-Bachiri Y, Navarro-Santana MJ, Gómez-Chiguano GF, Cleland JA, López-de-Uralde-Villanueva I, Fernández-de-Las-Peñas C, et al. Effects of trigger point dry needling for the management of knee pain syndromes: a systematic review and meta-analysis. Journal of clinical medicine. 2020;9(7):2044.

7. Vervullens S, Meert L, Baert I, Delrue N, Heusdens CHW, Hallemans A, et al. The effect of one dry needling session on pain, central pain processing, muscle co-contraction and gait characteristics in patients with knee osteoarthritis: a randomized controlled trial. Scandinavian Journal of Pain. 2022;22(2):396-409.

8. Butts R, Dunning J, Serafino C. Dry needling strategies for musculoskeletal conditions: Do the number of needles and needle retention time matter? A narrative literature review. Journal of Bodywork and Movement Therapies. 2021;26:353-63.

9. Jaiswal PR, Qureshi I, Phansopkar PA. Effectiveness of Mulligan's two-leg rotation versus muscle energy technique in subjects with hamstring tightness. Cureus. 2022;14(9).

10. Pang JC, Fu AS, Lam SK, Peng B, Fu AC. Ultrasound-guided dry needling versus traditional dry needling for patients with knee osteoarthritis: A double-blind randomized controlled trial. Plos one. 2022;17(9):e0274990.

11. Agost-González A, Escobio-Prieto I, Barrios-Quinta CJ, Cardero-Durán M, Espejo-Antúnez L, Albornoz-Cabello M. Analysis of Dry Needling Combined with an Exercise Program in the Treatment of Knee Osteoarthritis: A Randomized Clinical Trial. J Clin Med. 2024;13(23).

12. Amani M, Shafizadegan Z, Taheri N. Effects of Dry Needling on Pain in Patients with Knee Osteoarthritis: A Preliminary Study. Adv Biomed Res. 2022;11:47.

13. Jiménez-Del-Barrio S, Medrano-de-la-Fuente R, Hernando-Garijo I, Mingo-Gómez MT, Estébanez-de-Miguel E, Ceballos-Laita L. The Effectiveness of Dry Needling in Patients with Hip or Knee Osteoarthritis: A Systematic Review and Meta-Analysis. Life (Basel). 2022;12(10).

14. Ma YT, Dong YL, Wang B, Xie WP, Huang QM, Zheng YJ. Dry needling on latent and active myofascial trigger points versus oral diclofenac in patients with knee osteoarthritis: a randomized controlled trial. BMC Musculoskelet Disord. 2023;24(1):36.

15. Pang JCY, Fu ASN, Lam SKH, Peng B, Fu ACL. Ultrasound-guided dry needling versus traditional dry needling for patients with knee osteoarthritis: A double-blind randomized controlled trial. PLoS One. 2022;17(9):e0274990.

16. Rahou-El-Bachiri Y, Navarro-Santana MJ, Gómez-Chiguano GF, Cleland JA, López-de-Uralde-Villanueva I, Fernández-de-Las-Peñas C, et al. Effects of Trigger Point Dry Needling for the Management of Knee Pain Syndromes: A Systematic Review and Meta-Analysis. J Clin Med. 2020;9(7).

17. Saornil JV, Sánchez Milá Z, Campón Chekroun AM, Baraja Vegas L, Vicente Mampel J, Frutos Llanes R, et al. Comparative Study of the Efficacy of Hyaluronic Acid, Dry Needling and Combined Treatment in Patellar Osteoarthritis-Single-Blind Randomized Clinical Trial. Int J Environ Res Public Health. 2022;19(17).

18. Sharif F, Ahmad A, Gilani SA, Bacha R, Hanif A, Arif MA. Efficacy of ultrasound guided dry needling as an adjunct to conventional physical therapy for patients with jumper's knee: A randomized controlled trial. Front Surg. 2022;9:1023902.

19. Karaborklu Argut S, Celik D, Kilicoglu OI. The Combination of Exercise and Manual Therapy Versus Exercise Alone in Total Knee Arthroplasty Rehabilitation: A Randomized Controlled Clinical Trial. Pm r. 2021;13(10):1069-78.

20. Runge N, Aina A, May S. The Benefits of Adding Manual Therapy to Exercise Therapy for Improving Pain and Function in Patients With Knee or Hip Osteoarthritis: A Systematic Review With Meta-analysis. J Orthop Sports Phys Ther. 2022;52(10):675-a13.

© 2025 et al. Open access under CC BY License (Creative Commons). Freely distributable with appropriate citation.