

“Comparative Effectiveness of Mulligan Mobilization with Movement Combined with Quadriceps Exercises Versus Shortwave Diathermy Combined with Quadriceps Exercises in Patients with Knee Osteoarthritis: A Pre–Post Experimental Study”.

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ABSTRACT

Background

Knee osteoarthritis (KOA) is a common musculoskeletal condition characterized by pain, stiffness and impaired physical function. Physiotherapy management commonly incorporates therapeutic exercise and physical or manual therapy interventions. Mulligan Mobilization with Movement (MWM) has been proposed as a technique for reducing pain and facilitating functional movement, whereas shortwave diathermy (SWD) is used as a therapeutic heating modality for symptomatic management.

Objective

To compare the effects of Mulligan Mobilization with Movement combined with quadriceps exercises and shortwave diathermy combined with quadriceps exercises on pain and knee function in individuals with knee osteoarthritis.

Methods

A pre-test/post-test comparative experimental study was conducted in the physiotherapy outpatient department of Career Institute of Medical Sciences, Bhopal. Twenty medically diagnosed participants with unilateral early knee osteoarthritis who fulfilled the study eligibility criteria were included through consecutive sampling and allocated into two groups of 10 participants each. Group A received Mulligan Rotation Mobilization with Movement combined with quadriceps exercises, whereas Group B received shortwave diathermy combined

with quadriceps exercises. Pain was assessed using the Visual Analogue Scale (VAS), and knee-related symptoms and function were assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Pre-intervention and post-intervention scores were compared using paired and unpaired *t*-tests as reported in the original dissertation.

Results

Both groups demonstrated statistically significant pre- to post-intervention improvements in pain and knee function. In Group A, the mean VAS score decreased from 7.2 to 2.4, while in Group B it decreased from 6.9 to 4.1. The reported paired *t*-values were 17.20 and 12.64, respectively. WOMAC scores decreased from 60.0 to 18.9 in Group A and from 55.9 to 35.1 in Group B, with reported paired *t*-values of 11.62 and 7.87, respectively. Between-group analysis of change scores demonstrated statistically significant differences for pain ($t = 5.525$) and knee function ($t = 6.331$).

Conclusion

Within the limitations of the small sample and short intervention period, both treatment approaches were associated with improvements in pain and knee function. The reported between-group findings favored the Mulligan MWM plus quadriceps exercise intervention over shortwave diathermy plus quadriceps exercise for the measured outcomes. Larger, adequately powered controlled trials with standardized intervention protocols and longer follow-up are required to confirm these findings.

Keywords: knee osteoarthritis; Mulligan Mobilization with Movement; shortwave diathermy; quadriceps exercise; pain; WOMAC; physiotherapy.

Introduction

Knee osteoarthritis (KOA) is a common chronic musculoskeletal condition characterized by progressive degeneration of the articular cartilage, changes in the subchondral bone, synovial involvement, pain, stiffness, and impairment of physical function. It is one of the major causes of disability among adults and can substantially affect mobility and quality of life.¹

The clinical presentation of knee osteoarthritis commonly includes knee pain, stiffness, reduced range of motion, muscle weakness, difficulty in walking, and limitations in activities of daily living. The severity of symptoms may vary among individuals and is influenced by structural, mechanical, and functional factors.²

Conservative physiotherapy management plays an important role in the treatment of knee osteoarthritis. Exercise therapy, particularly quadriceps strengthening, is commonly used to improve muscle strength, physical function, and symptoms in individuals with knee osteoarthritis.^{3,4} Exercise-based rehabilitation may also be combined with manual therapy or physical modalities according to the patient's clinical presentation.

Mulligan Mobilization with Movement (MWM) is a manual therapy approach in which a sustained accessory joint glide is applied while the patient performs an active physiological movement. The technique is intended to improve joint movement and reduce pain during functional activity. MWM has been investigated in patients with knee osteoarthritis, with systematic reviews reporting improvements in pain and physical function following its use.^{5,6}

The Mulligan concept proposes that an appropriate combination of accessory mobilization and active movement may produce an immediate or short-term improvement in pain-free movement. In knee osteoarthritis, MWM may therefore be used as an adjunct to therapeutic exercise to facilitate functional movement and reduce pain.

Shortwave diathermy (SWD) is a deep-heating physical modality that uses electromagnetic energy to produce therapeutic effects in tissues. It has been used in musculoskeletal conditions, including knee osteoarthritis, with the proposed effects including reduction of pain, improvement in tissue extensibility, and facilitation of physical function.^{7,8} However, studies investigating SWD have used different treatment parameters, and the magnitude of its clinical effects has varied across studies.

Previous evidence has examined manual therapy and physical modalities separately in the management of knee osteoarthritis.⁵⁻⁸ However, there is comparatively limited evidence directly comparing Mulligan MWM combined with quadriceps exercises with a deep-heating modality combined with quadriceps exercises. Therefore, comparing these treatment approaches may provide clinically relevant information regarding their effects on pain and knee-related functional disability.

The present study was therefore undertaken to compare the effectiveness of Mulligan Mobilization with Movement combined with quadriceps exercises versus shortwave diathermy combined with quadriceps exercises in patients with knee osteoarthritis. Pain was assessed using the Visual Analogue Scale (VAS), while knee-related functional status was assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

Aim

To compare the effects of Mulligan Mobilization with Movement combined with quadriceps exercises versus shortwave diathermy combined with quadriceps exercises on pain and knee function in patients with knee osteoarthritis.

Objectives

1. To determine the effect of Mulligan Mobilization with Movement combined with quadriceps exercises on pain and knee function.
2. To determine the effect of shortwave diathermy combined with quadriceps exercises on pain and knee function.
3. To compare the change in pain between the two intervention groups.
4. To compare the change in knee function between the two intervention groups.
- 5.

MATERIALS AND METHODS

Study Design

The dissertation describes the investigation as a **pre-test/post-test experimental study**. Participants were allocated into two groups, with Group A receiving MWM plus quadriceps exercises and Group B receiving shortwave diathermy plus quadriceps exercises.

Because the dissertation also states that participants were "randomly assigned" after consecutive sampling, the exact allocation procedure should be verified from the original study records before the manuscript is submitted.

Study Setting

The study was conducted in the Physiotherapy Outpatient Department of Career Institute of Medical Sciences (CIMS), Bhopal, Madhya Pradesh, India.

Participants

Twenty participants with medically directed unilateral early knee osteoarthritis were included.

The reported inclusion criteria were:

- unilateral early knee osteoarthritis;
- age 45–55 years;
- male participants.

The reported exclusion criteria included bilateral knee osteoarthritis, deformity or contracture, recent fracture, soft-tissue injury around the knee, limb-length discrepancy, obesity, metabolic disorders, hypermobility, hypersensitivity, extensive sensory loss, arterial insufficiency, previous knee surgery, arthroplasty and metal implantation.

Sampling and Group Allocation

Consecutive sampling was reported. Twenty eligible participants were subsequently divided into two groups of 10 participants each.

- **Group A (n = 10):** Mulligan Rotation MWM + quadriceps exercises
- **Group B (n = 10):** Shortwave diathermy + quadriceps exercises

The manuscript should report the precise method of allocation only after verification from the original study documentation.

Outcome Measures

Visual Analogue Scale

Pain intensity was assessed using the Visual Analogue Scale (VAS). The dissertation describes a 0–10 cm/0–100 mm scale with anchors representing absence of pain and severe pain.

Western Ontario and McMaster Universities Osteoarthritis Index

Knee-related symptoms and function were assessed using the WOMAC. The study used the five-point Likert format, with responses scored from 0 to 4. The instrument contains 24 items covering pain, stiffness and

physical function. Higher scores indicate greater symptom/disability burden in the scoring system described in the dissertation.

Intervention

Group A: Mulligan MWM + Quadriceps Exercises

Participants were positioned supine. The therapist applied the described rotational mobilization to the tibia relative to the femur while the participant actively performed knee flexion. Manual overpressure was applied at the end of active movement where indicated.

The dissertation reports six repetitions per set and three sets per session, with seven treatment sessions reported over a two-week period.

Quadriceps exercises consisted of:

1. Isometric quadriceps setting.
2. Straight-leg raising.
3. Knee extension from high sitting.
4. Knee flexion from high sitting.

The exercise descriptions and repetition schemes are provided in the original dissertation.

Group B: Shortwave Diathermy + Quadriceps Exercises

Group B received shortwave diathermy combined with the same quadriceps exercise programme. The dissertation identifies shortwave diathermy as the deep-heating modality used in the comparison group.

Important: The manuscript should include the exact SWD treatment parameters—frequency, mode, power/dose, applicator arrangement, treatment duration per session, tissue temperature/thermal sensation target and safety procedures. These parameters are not adequately presented in the extracted methodology and should be obtained from the original treatment records before submission.

Assessment Procedure

VAS and WOMAC were recorded before intervention and after the treatment period. The original dissertation states that post-intervention measurements were obtained following completion of the treatment programme.

Statistical Analysis

The dissertation reports paired *t*-tests for within-group comparisons and unpaired *t*-tests for comparisons between groups.

For a Scopus-level submission, the final statistical analysis should preferably be independently rechecked from the participant-level raw dataset. The manuscript should report:

- mean $\pm$ SD;
- mean change;
- 95% confidence intervals;
- between-group mean difference;
- exact p -values;
- effect sizes with confidence intervals;
- assumption testing for parametric analysis.

The present manuscript should **not invent these values** where they are not available in the dissertation.

RESULTS

Twenty participants were included, with 10 participants in each intervention group. The dissertation reports that participants underwent pre-intervention assessment using VAS and WOMAC followed by post-intervention reassessment.

Pain

In Group A, the mean VAS score decreased from **7.2 at baseline to 2.4 after intervention**, representing a reported mean reduction of 4.8 points. The paired t -value was 17.20.

In Group B, the mean VAS score decreased from **6.9 to 4.1**, representing a reported mean reduction of 2.8 points. The paired t -value was 12.64.

The reported between-group analysis of improvement in pain produced an unpaired t -value of **5.525**.

Table 1. Within- and between-group changes in VAS

Group	Pre-intervention mean	Post-intervention mean	Mean change	Reported test
MWM + quadriceps	7.2	2.4	4.8	Paired $t = 17.20$
SWD + quadriceps	6.9	4.1	2.8	Paired $t = 12.64$
Between-group comparison	—	—	Difference in change = 2.0	Unpaired $t = 5.525$

Knee Function

In Group A, the reported WOMAC mean score decreased from **60.0 to 18.9**, with a mean change of 41.1 and a paired t -value of 11.62.

In Group B, the reported WOMAC mean score decreased from **55.9 to 35.1**, with a mean change of 20.8 and a paired t -value of 7.87.

The reported between-group comparison produced an unpaired t -value of **6.331**, with a mean difference in improvement of approximately 20.3 points.

Table 2. Within- and between-group changes in WOMAC

Group	Pre-intervention mean	Post-intervention mean	Mean change	Reported test
MWM + quadriceps	60.0	18.9	41.1	Paired $t = 11.62$
SWD + quadriceps	55.9	35.1	20.8	Paired $t = 7.87$
Between-group comparison	—	—	Difference in change = 20.3	Unpaired $t = 6.331$

Figure 1. VAS Pain Score

Pre- and Post-treatment VAS Scores

Comparison of mean VAS pain scores before and after treatment in the MWM + quadriceps and SWD + quadriceps groups.

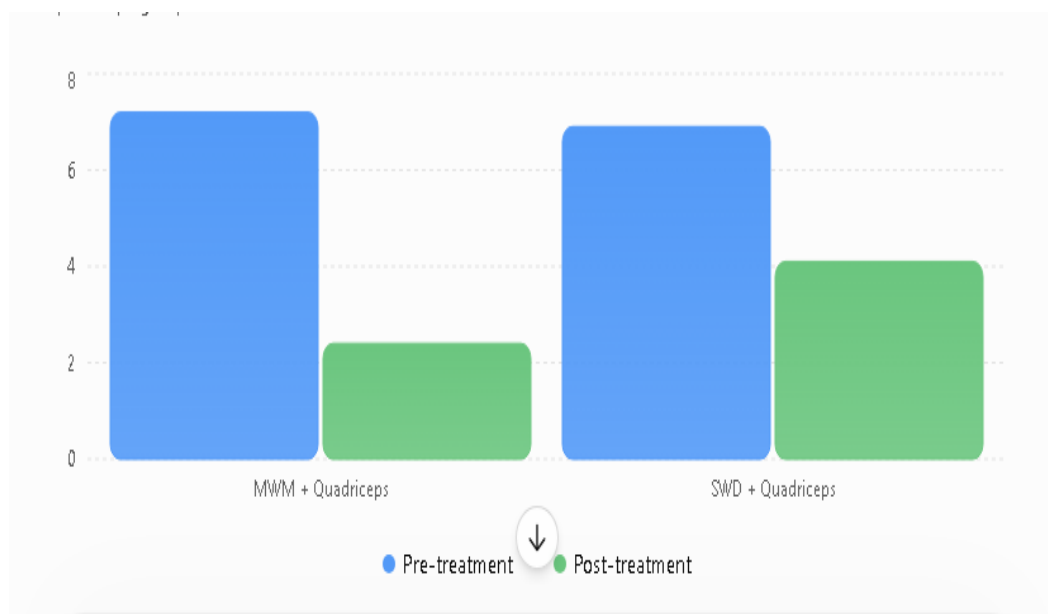
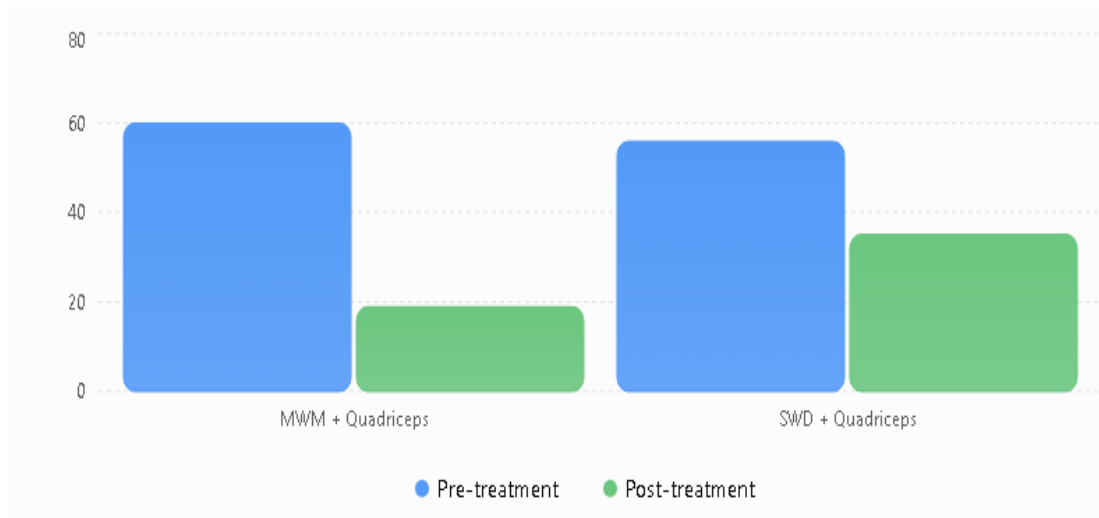


Figure 2. WOMAC Score

Pre- and Post-treatment WOMAC Scores

Comparison of mean WOMAC scores before and after treatment in the MWM + quadriceps and SWD + quadriceps groups.



DISCUSSION

Discussion

The present study compared the effectiveness of Mulligan Mobilization with Movement (MWM) combined with quadriceps exercises with shortwave diathermy (SWD) combined with quadriceps exercises in patients with knee osteoarthritis. The findings demonstrated improvement in both groups in terms of pain and knee-related functional status. However, the magnitude of improvement was greater in the MWM combined with quadriceps exercise group.

In the present study, pain assessed using the Visual Analogue Scale (VAS) decreased from 7.2 to 2.4 in the MWM group, with a mean improvement of 4.8 points. In comparison, the SWD group demonstrated a reduction from 6.9 to 4.1, representing a mean improvement of 2.8 points. The between-group analysis also demonstrated a statistically significant difference in change in pain scores, favouring the MWM intervention.

The improvement in pain observed following MWM is consistent with previous literature investigating mobilization with movement in knee osteoarthritis. Systematic reviews have reported beneficial effects of MWM on pain and physical function in individuals with knee osteoarthritis.^{5,6} More recent evidence has also reported significant improvements in pain and disability following MWM-based interventions, although differences in treatment protocols and study quality should be considered.⁹

A possible explanation for the reduction in pain following MWM is that the technique combines an accessory joint glide with active physiological movement. This may allow movement to be performed with reduced pain and may facilitate improvements in joint mechanics and functional movement. The current study, however, did not directly investigate the underlying mechanisms responsible for the observed improvement.

The present study also demonstrated improvement in WOMAC scores in both groups. The MWM group improved from a mean baseline score of 60 to 18.9 after treatment, representing a mean improvement of 41.1 points. The SWD group improved from 55.9 to 35.1, representing a mean improvement of 20.8 points. The between-group comparison demonstrated a statistically significant difference in functional improvement.

The improvement in functional status following MWM is in agreement with previous systematic reviews reporting beneficial effects of manual therapy and MWM on pain and disability in patients with knee

osteoarthritis.^{5,6} Manual therapy combined with exercise may provide additional benefits compared with exercise or physical modalities alone, although the magnitude of benefit may vary according to treatment dosage, patient characteristics, and outcome measures.¹⁰

Quadriceps exercises were provided to participants in both groups. Quadriceps strengthening is an established component of conservative rehabilitation for knee osteoarthritis and has been associated with improvements in pain and physical function.^{3,4} Therefore, the improvements observed in both groups may reflect, at least in part, the contribution of the exercise component of the intervention.

The SWD group also demonstrated improvement in pain and WOMAC scores. This finding is consistent with previous research investigating shortwave diathermy in knee osteoarthritis. Systematic reviews have reported improvements in pain and some functional outcomes following SWD, although considerable variation has been reported in treatment parameters and study methodology.^{7,8}

The comparatively greater improvement observed in the MWM group may indicate that combining manual therapy with active quadriceps exercise produced greater short-term changes in pain and function than combining SWD with the same exercise programme. However, this finding should be interpreted within the limitations of the present study, particularly the small sample size and short intervention period.

The results of the present study are also consistent with the broader evidence supporting conservative, exercise-based and manual therapy approaches for knee osteoarthritis. Current evidence suggests that physiotherapy interventions should generally be individualized according to symptoms, functional limitations, patient characteristics, and treatment response.¹¹

Overall, the findings suggest that MWM combined with quadriceps exercises may be a useful physiotherapy intervention for improving pain and self-reported functional status in patients with knee osteoarthritis. Nevertheless, larger studies with adequately reported intervention parameters, longer follow-up periods, and standardized methodology are required to determine whether the observed differences are maintained over time.

CLINICAL IMPLICATIONS

The study suggests that both MWM combined with quadriceps exercise and shortwave diathermy combined with quadriceps exercise may be associated with improvements in pain and knee-related function in individuals with early unilateral knee osteoarthritis.

The observed between-group differences provide a rationale for further adequately powered trials examining manual therapy combined with exercise versus physical-agent-based treatment combined with exercise.

LIMITATIONS

The principal limitations reported in the dissertation include:

1. Small sample size (**n = 20**).
2. Restricted age range of 45–55 years.
3. Male-only participants.
4. Short treatment period.

5. Lack of longer-term follow-up.
6. Limited range of outcome measures.
7. The study was conducted at a single clinical setting.

The dissertation itself recommends larger samples, broader age ranges, additional variables, more consistent outcome measures and different treatment durations.

For journal publication, additional limitations should also be transparently addressed, including uncertainty concerning the exact allocation procedure and incomplete reporting of the shortwave diathermy dosage parameters.

CONCLUSION

Both Mulligan Mobilization with Movement combined with quadriceps exercises and shortwave diathermy combined with quadriceps exercises were associated with significant improvements in pain and knee function in the studied participants with knee osteoarthritis.

The reported between-group analyses demonstrated greater improvement in the MWM plus quadriceps exercise group for both VAS pain and WOMAC scores. However, because of the small sample size, short treatment period, restricted participant characteristics and methodological reporting limitations, these findings should be considered preliminary.

Future studies should use larger samples, clearly documented randomization and allocation procedures, standardized intervention dosages, validated outcome measures, appropriate effect-size reporting and longer follow-up periods.

CONFLICT OF INTEREST

No conflicts of interest related to this study.

FUNDING

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