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A COMPARATIVE STUDY OF MAITLAND MOBILISATION COMBINED WITH MULTIMODAL PHYSIOTHERAPY APPROACHES ON PAIN, FUNCTION AND QUALITY OF LIFE IN POSTMENOPAUSAL WOMEN WITH BILATERAL KNEE OSTEOARTHRITIS

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ABSTRACT

Background: Knee osteoarthritis is a common degenerative musculoskeletal disorder characterised by pain, joint stiffness, reduced range of motion and functional limitations. The condition is particularly prevalent among postmenopausal women due to hormonal changes and age-related degeneration. Multimodal physiotherapy approaches incorporating manual therapy, electrotherapy and therapeutic exercises are widely used for its management; however, limited evidence exists comparing the effectiveness of combination of these interventions in postmenopausal women with bilateral knee osteoarthritis. **Objective:** To compare the effectiveness of Maitland Mobilisation combined with Therapeutic Ultrasound, Isometric exercises, Dynamic Quads and Maitland Mobilisation combined with Interferential Current Therapy, Multiple-Angle Isometrics and Mini-squats in postmenopausal women with bilateral knee osteoarthritis. **Methods:** Sixty postmenopausal women aged 40-60 years diagnosed with bilateral knee osteoarthritis (Kellgren Lawrence grade II-III) were randomly allocated into two groups. Group A received Maitland Mobilisation with Therapeutic Ultrasound, Isometric exercises and Dynamic Quads whereas Group B received Maitland Mobilisation with Interferential Current Therapy, Multiple-Angle Isometrics and Mini-squats. Interventions were administered for three sessions per week for four weeks. Outcome measures included NPRS (Numeric Pain Rating Scale), Range of Motion (ROM), Manual Muscle Testing (MMT), WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) and WHOQOL-BREF (World Health Organization Quality of Life-BREF). **Results:** Both groups showed significant improvements in reduction of pain, increase in ROM, muscle strength, functional status and quality of life ($p < 0.05$). However, the interventions used in Group B demonstrated comparatively greater improvement in all the outcome measures. **Conclusion:** The findings highlight the clinical relevance and effectiveness of both multimodal physiotherapy approaches in the management of bilateral knee osteoarthritis in postmenopausal women. The protocol implemented in Group B produced comparatively superior outcomes.

KEYWORDS: Knee osteoarthritis, Postmenopausal Women, Maitland Mobilisation, Therapeutic ultrasound, Interferential Current Therapy, Isometric Exercise, Multiple-Angle Isometrics.

INTRODUCTION

Knee osteoarthritis (KOA) is one of the most common degenerative musculoskeletal disorders characterised by pain, reduced mobility and decrease in quality of life.[1] According to Osteoarthritis Research Society International (OARSI), Osteoarthritis (OA) begins with molecular alterations and subsequently progresses to anatomical and physiological changes, including cartilage degeneration, bone remodelling, osteophyte formation, joint inflammation and impairment of normal joint function.[2,3]

The decline in estrogen is associated with an increased risk of arthritis, particularly in postmenopausal women

(PMW). It is considered that estrogen lowers inflammation, prevents degenerative changes in chondrocytes and slows the progression of OA.[4,5] In addition, anatomical variations and age-related factors such as decreased muscle mass and altered biomechanics further contribute to the progression of OA.[6]

Multimodal physiotherapy approaches combining manual therapy, therapeutic exercise and electrotherapy have been shown to reduce discomfort, improve joint mobility and enhance functional ability. Physiotherapy interventions have also been reported to significantly improve pain management and quality of life.[7]

Maitland Mobilisation is a manual therapy technique that uses passive oscillatory movements through a graded system of mobilisation that allows the physiotherapist to control the amplitude, rhythm and treat the joint according to pain and stiffness.[8]

Therapeutic Ultrasound promotes non-thermal effects which include biologic repair of cartilage, improves fibrous tissue extensibility and elevates pain threshold as well as thermal effects such as increased blood flow and accelerate healing process.[9] Interferential current therapy causes sensory nerve stimulation without causing pain as well as targets deep-seated lesions.[10,11]

Isometric exercise is a static form of strengthening that leads to increased motor unit recruitment, firing frequency and activation of inhibited quadriceps muscles.[8,13] Multiple-angle isometrics enhances muscle fibre recruitment by generating tension at multiple points and providing a better functional range.[14]

The Dynamic Quads exercise is a controlled, non-weight bearing open kinetic chain movement that allows targeted activation of the quadriceps muscle group particularly during terminal extension when demand on vastus medialis oblique increases.[15] The Mini-Squats is a closed kinetic chain exercise involving femoral on tibial movement during which quadriceps generate an internal extension moment to counteract the external flexion moment created by gravity and ground reaction forces. The exercise works through coordinated action of hip, knee and ankle joint.[16]

Despite the high prevalence of KOA in postmenopausal women there is limited consensus on the optimal treatment protocol. This study aimed to compare the effects of two combined physiotherapy intervention protocols on pain, range of motion, muscle strength, functional status and quality of life to identify a more effective and resource-efficient treatment approach for this population.

MATERIALS AND METHODS

Study Design: Randomized controlled trial (RCT)
Study Setting: OPD of Department of Physiotherapy, Khalsa University, Amritsar
Study Population: Postmenopausal women radiologically diagnosed with bilateral knee osteoarthritis (Kellgren-Lawrence grade II-III)
Sampling Method: Simple Random Sampling

Sample Size: The sample size for this study was calculated using G*Power 3.1.9.7 software. Based on an effect size of 0.74, α= 0.05 and power =0.80, the analysis indicated a required sample size of 30 participants per group, resulting in a total sample of 60 participants for the trial.[17]

ELIGIBILITY CRITERIA

Inclusion criteria

- Postmenopausal women aged 40-60 years[18]
- Radiologically diagnosed bilateral knee osteoarthritis (Kellgren-Lawrence grade II-III) (radiograph obtained within six months of the outset of the study)[2,19]
- Persistent knee pain ≥ 3 months[18]

Exclusion criteria

- History of knee surgery or intra-articular injection within the last 6 months.[20]
- Advanced Knee osteoarthritis (Kellgren-Lawrence grade IV)[18]
- Neurological disorders affecting gait or balance[18]
- Systemic inflammatory disease[20]
- Acute trauma, fracture or ligamentous injury of the lower limb[20]
- Concurrent participation in another physiotherapy or exercise trial[20]

Variables

Independent Variables	Dependent Variables
Maitland Mobilisation	Pain
Therapeutic Ultrasound	Range of Motion
Interferential Current Therapy	Muscle Strength
Isometric Exercises	Functional Status
Multiple-Angle Isometrics	Quality of Life
Dynamic Quads	
Mini-Squats	

Instruments and tools

- Numeric Pain Rating Scale: The NPRS is a unidimensional tool used to measure pain intensity. An 11-point numeric scale with 0 representing one pain extreme (e.g., “no pain”) and 10 representing

the other pain extreme (e.g., "pain as bad as you can imagine" and "worst pain imaginable").[21]

- Universal Goniometer: It is the instrument used to measure knee joint range of motion (flexion and extension) in degrees. The design includes a body and two extensions called arms. It is designated as universal because of its versatility.[22]
- Manual Muscle Testing: Muscle strength grading, commonly referred to as Manual Muscle Testing (MMT) is an important clinical assessment method used to evaluate muscle strength by applying resistance during voluntary muscle contractions and the muscle strength is graded on a scale from 0 to 5, depending on the patient's ability to generate force.[23,24]
- Western Ontario and McMaster University Index: The WOMAC Index is a standardized questionnaire assessing pain, stiffness and physical function in knee osteoarthritis. It is widely used for assessing activities of daily living, functional mobility, gait, general health and quality of life in patients with knee osteoarthritis. The questionnaire consists of 24 items divided into three subscales: pain (5 items), stiffness (2 items) and physical function (17 items). Each item is scored using a five-point ordinal scale.[25]
- World Health Organization Quality of Life -BREF Questionnaire: The World Health Organization defines Quality of Life as an individual's perception of their position in life within the context of the culture and value systems in which they live. The WHOQOL- BREF is a shorter version of the WHOQOL-100 and serves as a practical tool to assess quality of life across physical, psychological, social and environmental domains.[26]

Outcome measures

Primary outcome measures

- Pain- measured by Numeric Pain Rating Scale
- Functional status- assessed using WOMAC Index
- Quality of life – assessed using WHOQOL-BREF

Secondary outcome measures

- Knee Joint Range of Motion – measured with Universal Goniometer
- Muscle strength – assessed using Manual Muscle Testing

Procedure

Informed consent of all the participants was taken. Baseline assessment was carried out. The participants were randomly allocated into two groups:

Group A: Participants received Maitland Mobilisation, Therapeutic Ultrasound, Isometric exercise and Dynamic Quads. (n=30)

Group B: Participants received Maitland Mobilisation, Interferential current therapy, Multiple-angle Isometrics and Mini-squats. (n=30)

Protocol: A total of 12 treatment sessions were administered three times per week over a period of four weeks in both groups.

Group A

1. Maitland Mobilisation

Patient Position – The patient was positioned in supine lying. For tibiofemoral mobilisation, the knee was maintained in slight flexion with a towel roll placed under the knee. For patellofemoral mobilisation, the knee was maintained in an extended or slightly flexed position.

Therapist Position: The therapist stood beside the treatment table. One hand stabilized the proximal segment while the other hand applied the mobilizing force to the tibia or patella depending on the glide being performed.

Procedure: Grade II and Grade III oscillatory glides were applied. For the tibiofemoral joint, anteroposterior (AP) and posteroanterior (PA) glides were applied. For the patellofemoral joint, caudal (inferior) and cephalic (superior) glides of the patella were performed.

Frequency and Dosage: Mobilisation was performed at a rate of approximately two oscillations per second. Each glide was given for two minutes.

2. Therapeutic Ultrasound

The patient was positioned in supine lying. The knee was supported in slight flexion with a towel roll beneath the knee. The therapist stood beside the treatment table operating the ultrasound unit. Ultrasound gel was applied over the treatment area. The ultrasound applicator was placed over the medial and lateral aspect of the knee joint and the transducer was moved in slow circular movements over the treatment area. Therapeutic ultrasound was administered using 1 MHz frequency, Pulsed mode and 0.8 W/cm^2 Intensity. Each session lasted for 5 minutes.

3. Isometric exercise

Participants performed three different isometric exercises:

a) Supine Straight Leg Raise (Isometric Hold): The participant lifted the affected limb approximately 10 cm from the table while keeping the knee fully extended and ankle dorsiflexed. The limb was held in this elevated position for 10 seconds after which the limb was slowly lowered back to the starting position. Other limb was flexed at hip and knee in neutral position for support. A rest period of 2 seconds was provided between repetitions. The movement was repeated 10 times to complete one set.

b) Side -Lying Leg Raise: In the side-lying position, the lower limb was resting on the table flexed at 90° at both the hip and knee while the affected limb was raised to approximately 10 cm above the resting

position. The elevate position was maintained for 10 seconds. A rest period of 2 seconds was provided between repetitions. The movement was repeated 10 times to complete one set.

c) Ball Squeeze Exercise: In the sitting position with both knees flexed to approximately 30°, a ball was placed between the knees. The participant was instructed to gently squeeze the ball by activating the adductor muscles and maintain the contraction for 10 seconds. The contraction was then gradually released. A rest period of 2 seconds was provided between repetitions. The movement was repeated 20 times to complete one set.

4. Dynamic Quads

The participant was positioned in high sitting on the treatment table with the hip and knee initially positioned in approximately 90° of flexion. From this starting position, they were instructed to actively extend the knee joint until full extension was achieved. During the movement, participants were encouraged to contract the quadriceps femoris muscle group concentrically to straighten the knee. Once full knee extension was reached, they were instructed to hold the position and then slowly lower the leg back to the starting position.

Progression Protocol of Dynamic Quads

Week	Exercise Protocol
Week 1	5 reps of dynamic quads
Week 2	10 reps of dynamic quads
Week 3	Resisted dynamic quads using 50%,75% and 100% of 10 RM weight with 10 reps
Week 4	Resisted dynamic quads using 50%,75% and 100% of 10 RM weight with 10 reps

Group B

1. Maitland Mobilisation

Patient Position – The patient was positioned in supine lying. For tibiofemoral mobilisation, the knee was maintained in slight flexion with a towel roll placed under the knee. For patellofemoral mobilisation, the knee was maintained in an extended or slightly flexed position.

Therapist Position: The therapist stood beside the treatment table. One hand stabilized the proximal segment while the other hand applied the mobilizing force to the tibia or patella depending on the glide being performed.

Procedure: Grade II and Grade III oscillatory glides were applied. For the tibiofemoral joint, anteroposterior (AP) and posteroanterior (PA) glides were applied. For the patellofemoral joint, caudal (inferior) and cephalic (superior) glides of the patella were performed.

Frequency and Dosage: Mobilisation was performed at a rate of approximately two oscillations per second. Each glide was given for two minutes.

2. Interferential Current Therapy

The patient was positioned in supine lying. The knee was supported in slight flexion with a towel roll beneath the knee. Four surface electrodes were placed around the knee joint in a quadripolar arrangement. The intensity of stimulation was adjusted according to the patient. Interferential current was delivered with the following parameters: isoplanar vector field with 6:6 sweep mode, carrier frequency of 4kHz, beat frequency of 100 Hz and sweep frequency of 150 Hz. Each treatment session lasted for 20 minutes.

3. Multiple-angle Isometric exercise

The participant was positioned in sitting on the treatment table with the hip and knee joint flexed at 90°. Participant was asked to extend the knee as far as possible against the resistance band at specific joint angles of 30°, 60° and 90° of knee flexion. At each angle, the participant maintained the contraction for 6 seconds. The exercise was performed for 3 sets of 10 reps at each angle.

4. Mini-Squats

The participant was positioned in standing with feet placed shoulder-width apart and the body upright. From the standing position, the participant slowly flexed the knees while keeping the feet flat on the floor and the trunk upright, then returned to the starting position in a controlled manner.

Progression Protocol of Mini Squats

Week	**Exercise Protocol**
Week 1	Up to 30° knee flexion for 5 reps
Week 2	Up to 45° knee flexion for 10 reps
Week 3	Resisted mini squats using 50%,75% and 100% of 10 RM weight held in both hands with 45° knee flexion for 5 reps
Week 4	Resisted mini squats using 50%,75% and 100% of 10 RM weight held in both hands with 45° knee flexion for 10 reps

Statistical analysis

The statistical analysis was carried out using IBM SPSS (Statistical Package for the Social Sciences) software. Both descriptive and inferential statistical methods were used to analyse the data. Descriptive statistics including mean and standard deviation were used to analyse the baseline characteristics and outcome measures of the participants in both groups. Paired t-test was used to compare the pre-intervention and post-intervention scores within each group. Independent t-test was applied to evaluate the difference in post-intervention outcomes between Group A and Group B. The level of statistical significance was set at $p \leq 0.05$.

RESULTS

Table 1: Baseline characteristics of participants in Group A and Group B.

Variable	Group A Mean ± SD	Group B Mean ± SD	t value	p value
Age (years)	50.47 ± 1.93	50.93 ± 2.02	-0.91	0.363
Height (m)	1.57 ± 0.02	1.60 ± 0.03	-0.98	0.327
Weight (kg)	70.27 ± 4.02	70.01 ± 4.29	0.24	0.814
BMI (kg/m²)	28.37 ± 1.77	28.22 ± 1.99	0.31	0.754

Data are expressed as mean ± standard deviation (SD). Table 1 presents the descriptive analysis of baseline characteristics of the participants in Group A and Group B. The mean age of participants in Group A was 50.47 ± 1.93 years, whereas in Group B it was 50.93 ± 2.02 years. The mean height of participants was 1.57 ± 0.02 m in Group A and 1.60 ± 0.03 m in Group B. The mean body weight was 70.27 ± 4.02 kg in Group A and 70.01 ± 4.29 kg in Group B. The mean BMI was 28.37 ± 1.77 kg/m² in Group A and 28.22 ± 1.99 kg/m² in Group B. Statistical analysis using an independent samples t-test revealed no significant differences between the two groups for any of the baseline variables ($p > 0.05$). This indicates that the participants in both groups were comparable and homogeneous before the intervention.

Table 2: Analysis of baseline and post intervention values within Group A.

Variable	Pre Mean ± SD	Post Mean ± SD	t value	p value
NPRS (Lt)	5.80 ± 0.70	3.40 ± 0.63	14.65	<0.001*
NPRS (Rt)	5.86 ± 0.69	3.46 ± 0.62	14.72	<0.001*
AROM Flexion (Lt) (°)	103.60 ± 7.28	114.10 ± 5.61	11.35	<0.001*
AROM Extension (Lt) (°)	-3.93 ± 1.34	-1.60 ± 0.50	10.1	<0.001*
AROM Flexion (Rt) (°)	103.73 ± 7.33	114.44 ± 5.65	11.49	<0.001*
AROM Extension (Rt) (°)	-3.96 ± 1.36	-1.50 ± 0.51	11.2	<0.001*
PROM Flexion (Lt) (°)	109.55 ± 6.30	120.20 ± 4.88	12.46	<0.001*
PROM Extension (Lt) (°)	-2.50 ± 0.50	-1.33 ± 0.48	13.1	<0.001*
PROM Flexion (Rt) (°)	109.65 ± 6.34	120.46 ± 4.92	12.60	<0.001*
PROM Extension (Rt) (°)	-2.50 ± 0.50	-1.23 ± 0.43	14.8	<0.001*
MMT (Lt)	3.43 ± 0.50	4.47 ± 0.51	10.89	<0.001*
MMT (Rt)	3.43 ± 0.50	4.47 ± 0.51	10.89	<0.001*
WOMAC	52.00 ± 9.13	37.33 ± 6.53	13.41	<0.001*
WHOQOL-BREF	57.90 ± 6.90	71.33 ± 5.29	11.76	<0.001*

(Note: * mark indicates that $p<0.05$)

Table 2 presents the within-group comparison of outcome measures before and after the intervention in Group A. Statistical analysis using a paired t-test revealed significant differences between pre- and post-intervention values ($p < 0.001$), indicating that the intervention produced significant improvements in pain, knee range of motion, muscle strength, functional status, and quality of life.

Table 3: Analysis of baseline and post intervention values within Group B.

Variable	Pre Mean ± SD	Post Mean ± SD	t value	p value
NPRS (Lt)	6.08 ± 0.72	2.28 ± 0.64	20.60	<0.001*
NPRS (Rt)	6.12 ± 0.70	2.32 ± 0.66	20.88	<0.001*
AROM Flexion (Lt) (°)	103.30 ± 7.88	118.90 ± 5.60	13.60	<0.001*
AROM Extension (Lt) (°)	-4.15 ± 1.56	0.00 ± 0.00	14.40	<0.001*
AROM Flexion (Rt) (°)	103.36 ± 7.94	119.10 ± 5.66	13.82	<0.001*
AROM Extension (Rt) (°)	-4.25 ± 1.60	0.00 ± 0.00	14.74	<0.001*
PROM Flexion (Lt) (°)	109.45 ± 7.68	124.90 ± 4.88	15.12	<0.001*
PROM Extension (Lt) (°)	-2.67 ± 0.47	0.00 ± 0.00	44.0	<0.001*
PROM Flexion (Rt) (°)	109.55 ± 7.72	125.10 ± 4.94	15.39	<0.001

PROM Extension (Rt) (°)	-2.67 ± 0.47	0.00 ± 0.00	44.0	<0.001*
MMT (Lt)	3.37 ± 0.49	4.97 ± 0.18	19.83	<0.001
MMT (Rt)	3.37 ± 0.49	4.97 ± 0.18	19.83	<0.001
WOMAC	51.20 ± 8.65	22.67 ± 5.50	18.94	<0.001
WHOQOL-BREF	57.33 ± 7.27	81.43 ± 5.49	16.88	<0.001

(Note: * mark indicates that p<0.05)

Table 3 presents the within-group comparison of baseline and post-intervention values in Group B. Statistical analysis using a paired t-test revealed significant differences between pre- and post-intervention values ($p < 0.001$), indicating that the intervention produced significant improvements in pain, knee range of motion, muscle strength, functional status, and quality of life.

Table 4: Analysis of baseline and post intervention values between Group A & Group B.

Variable	Group A Mean ± SD	Group B Mean ± SD	t value	p value
Pre-NPRS Pain (Lt)	5.80 ± 0.70	6.08 ± 0.72	-1.53	0.132
Post-NPRS Pain (Lt)	3.40 ± 0.62	2.28 ± 0.64	6.80	<0.001*
Pre-NPRS Pain (Rt)	5.86 ± 0.69	6.12 ± 0.70	-1.45	0.153
Post-NPRS Pain (Rt)	3.46 ± 0.64	2.32 ± 0.66	6.94	<0.001*
Pre-AROM Flexion (Lt) (°)	103.60 ± 7.28	103.30 ± 7.88	0.18	0.860
Post-AROM Flexion (Lt) (°)	114.10 ± 5.61	118.90 ± 5.60	-3.32	<0.001*
Pre-AROM Extension (Lt) (°)	-3.93 ± 1.34	-4.15 ± 1.56	0.83	0.41
Post-AROM Extension (Lt) (°)	-1.60 ± 0.50	0.00 ± 0.00	-17.5	<0.001*
Pre-AROM Flexion (Rt) (°)	103.73 ± 7.33	103.36 ± 7.94	0.19	0.852
Post-AROM Flexion (Rt) (°)	114.44 ± 5.65	119.10 ± 5.66	-3.21	<0.001*
Pre-AROM Extension (Rt) (°)	-3.96 ± 1.36	-4.25 ± 1.60	1.07	0.29
Post-AROM Extension (Rt) (°)	-1.50 ± 0.51	0.00 ± 0.00	-16.1	<0.001*
Pre-PROM Flexion (Lt) (°)	109.55 ± 6.30	109.45 ± 7.68	0.06	0.956
Post-PROM Flexion (Lt) (°)	120.20 ± 4.88	124.90 ± 4.88	-3.73	<0.001*
Pre-PROM Extension (Lt) (°)	-2.50 ± 0.50	-2.67 ± 0.47	1.33	0.19
Post-PROM Extension (Lt) (°)	-1.33 ± 0.48	0.00 ± 0.00	-15.1	<0.001*
Pre-PROM Flexion (Rt) (°)	109.65 ± 6.34	109.55 ± 7.72	0.06	0.956
Post-PROM Flexion (Rt) (°)	120.46 ± 4.92	125.10 ± 4.94	-3.65	<0.001*
Pre-PROM Extension (Rt) (°)	-2.50 ± 0.50	--2.67 ± 0.47	1.33	0.19
Post-PROM Extension (Rt) (°)	-1.23 ± 0.43	0.00 ± 0.00	-15.6	<0.001*
Pre-MMT (Lt)	3.43 ± 0.50	3.37 ± 0.49	0.47	0.605
Post-MMT (Lt)	4.47 ± 0.51	4.97 ± 0.18	-4.98	<0.001*
Pre-MMT (Rt)	3.43 ± 0.50	3.37 ± 0.49	0.47	0.605
Post-MMT (Rt)	4.47 ± 0.51	4.97 ± 0.18	-4.98	<0.001*
Pre-WOMAC	52.00 ± 9.13	51.20 ± 8.65	0.35	0.729
Post-WOMAC	37.33 ± 6.53	22.67 ± 5.50	9.41	<0.001*
Pre-WHOQOL-BREF	57.90 ± 6.90	57.33 ± 7.27	0.31	0.758
Post-WHOQOL-BREF	71.33 ± 5.29	81.43 ± 5.49	-7.21	<0.001*

(Note: * mark indicates that p<0.05)

Table 4 presents the comparison of baseline and post-intervention values between Group A and Group B. At baseline, there were no statistically significant differences between the two groups for any of the variables ($p > 0.05$), indicating that both groups were comparable before the intervention. Following the intervention, statistically significant differences were observed between the two groups in all the outcome measures ($p < 0.001$). Overall, the post-intervention results indicate that Group B demonstrated significantly greater improvements in pain reduction, knee range of motion, muscle strength, functional ability, and quality of life compared to Group A.

DISCUSSION

The present study was conducted to compare the effectiveness of two multimodal physiotherapy intervention protocols in postmenopausal women with bilateral knee osteoarthritis. The primary aim of the study was to determine whether Maitland Mobilisation combined with Therapeutic Ultrasound, Isometric Exercise and Dynamic Quads strengthening differed in effectiveness from Maitland Mobilisation combined with Interferential Current Therapy, Multiple-Angle Isometrics and Mini-Squats in reducing pain, improving range of motion, muscle strength, functional status and quality of life.

Knee osteoarthritis is one of the most prevalent musculoskeletal disorders affecting older adults, particularly postmenopausal women. Atasoy-Zeybek, Aysegul, et al. (2025) stated hormonal changes after menopause, particularly the decline in estrogen level, negatively affect cartilage health, increase inflammation and accelerate joint degeneration, making postmenopausal women more susceptible to knee osteoarthritis and associated symptoms such as pain, reduced mobility, muscle weakness and decreased functional independence.[5] Liu, Y-P., et al. (2018) reported that reduced ovarian function during menopause leads to decreased estrogen and serum estradiol (E2) levels. The role of inflammatory mediators such as interleukin-1 (IL-1) further contributes to disease progression.[27]

The findings of the present study demonstrated that both intervention protocols produced significant improvements in reducing pain intensity, improving knee joint range of motion, muscle strength, functional status and quality of life following the four-week intervention period. These results highlight the effectiveness of multimodal physiotherapy programs in the conservative management of knee osteoarthritis.

Maitland Mobilisation is widely recognized as an effective manual therapy technique for managing joint pain and stiffness. Bialosky, Joel E., et al. (2009) reported that the oscillatory joint mobilisation stimulates joint mechanoreceptors, which modulate pain through spinal inhibitory mechanisms, lead to pain reduction, relaxation of tissues and improved joint movement. Mobilisation also enhances synovial fluid distribution, improving cartilage nutrition and reducing mechanical stress on joint structures.[28] These findings align with previous studies demonstrating the effectiveness of manual therapy in knee osteoarthritis. Mutlu et al. (2018) found that joint mobilisation combined with exercise significantly improved pain, range of motion and functional ability.[30] Similarly Abdullah Al-Sheri et al. (2025) reported that Maitland Mobilisation with exercise produced greater improvements in pain relief and functional mobility.[29]

Therapeutic ultrasound has been widely used in physiotherapy for its mechanical and thermal effects on biological tissues. Zeng, C., et al (2014) stated pulsed ultrasound primarily produces non-thermal effects such as acoustic streaming and cavitation, which enhance cellular permeability, stimulate fibroblast activity and promote tissue repair. These physiological mechanisms contribute to reduced inflammation and improved healing within periarticular structures of the knee joint.[31] Previous systematic reviews have also reported positive effects of therapeutic ultrasound in knee osteoarthritis. Luo et al. (2024) demonstrated that ultrasound therapy significantly reduced pain and improved functional ability in patients with knee osteoarthritis, particularly when pulsed ultrasound was applied over several treatment sessions.[32]

Isometric Exercise allow muscle activation without joint movement, making them particularly suitable for individuals experiencing pain during dynamic movement. These exercises improve neuromuscular recruitment, increase motor unit activation and enhance muscle endurance without imposing excessive stress on the joint structures.[33,34] The findings of the present study are consistent with those reported by Huang et al. (2018) who demonstrated that isometric exercises significantly reduced pain and improved knee joint function in patients with knee osteoarthritis. The authors concluded it enhances joint stability and functional mobility, thereby contributing to improved clinical outcomes.[35]

Dynamic Quads is an open kinetic chain exercise that selectively activates the quadriceps muscle group, is particularly beneficial for individuals with higher body mass index or severe pain during weight-bearing activities.[15] The results of the present study are supported by the findings of Desai et al. (2022), who reported that open kinetic chain strengthening exercises significantly improved quadriceps strength and functional outcomes in individuals with knee osteoarthritis. These exercises allow controlled movement of the knee joint and facilitate targeted strengthening of the quadriceps muscle, particularly the vastus medialis oblique, which is important for patellar stabilization.[36]

Interferential Current Therapy is commonly used in physiotherapy for pain modulation. The intersecting medium-frequency currents generate a low-frequency amplitude-modulated current within deeper tissues, which stimulates sensory nerves and activates pain-inhibitory mechanisms.[11] Several studies have demonstrated its effectiveness in reducing pain in knee osteoarthritis. Ata et al. reported significant improvements in pain and functional performance following interferential current therapy in patients with knee osteoarthritis.[37]

Multiple-angle isometric training allows muscle activation across a broader range of motion, thereby improving functional strength and joint stability.[14] Parveen et al. (2024) demonstrated that multiple-angle isometric exercises resulted in greater improvements in pain reduction and functional performance compared with conventional isometric exercises in individuals with knee osteoarthritis. These findings support the rationale for incorporating multi-angle strengthening techniques into rehabilitation programs.[12]

Closed kinetic chain exercises involve weight-bearing movements where multiple joints and muscle groups work together to produce coordinated movement.[14] The findings of the present study are consistent with the results of Desai et al. (2022), who reported that closed

kinetic chain exercises such as mini-squats produced greater improvements in functional performance, dynamic balance and WOMAC scores in individuals with knee osteoarthritis. The authors explained that closed kinetic chain exercises improve proprioception, increase joint stability and enhance muscle coordination, which collectively contribute to improved functional outcomes.[36]

Despite the positive findings, the study has certain limitations. The sample size of the study was relatively small, with only sixty participants included, which may limit the generalizability of the findings to a larger population. The duration of the intervention was limited to four weeks; a longer intervention period might have produced greater improvements and provided better insights into the long-term effectiveness. The study included only postmenopausal women with bilateral knee osteoarthritis, which may limit the applicability of the findings to other populations such as males or individuals with unilateral knee osteoarthritis.

Future studies with larger sample sizes, both genders, longer intervention duration and longer follow-up periods are recommended to further validate the effectiveness of these interventions in individuals with knee osteoarthritis. The use of objective strength assessment tools such as hand-held dynamometry or isokinetic dynamometers may provide more accurate measurements of muscle strength and offer deeper insight into rehabilitation outcomes. Future research may explore different combinations of physiotherapy interventions, including advanced manual therapy techniques, neuromuscular training and balance exercises.

Overall, the results of the present study support the effectiveness of multimodal physiotherapy programs in managing knee osteoarthritis in postmenopausal women. S Therefore, the results of this study reinforce the role of physiotherapy as a cornerstone in the conservative management of knee osteoarthritis and support the use of comprehensive, multimodal rehabilitation protocols to achieve optimal clinical outcomes in this population.

ETHICAL APPROVAL

The study was approved by the Ethics Committee of Khalsa College, Amritsar. It is registered in Clinical Trial Registry of India, CTRI/2026/01/101761

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DECLARATION BY AUTHORS

The authors hereby declared that it was their original piece of research and had not been sent to any other journal for publication.

CONCLUSION

The study evaluated two intervention protocols in postmenopausal women with bilateral knee osteoarthritis: Group A received Maitland mobilisation with Therapeutic Ultrasound, Isometric Exercises and Dynamic Quads, while Group B received Maitland mobilisation with Interferential Current Therapy, Multiple-Angle Isometrics and Mini-Squats. Both protocols significantly reduced pain and improved knee range of motion, muscle strength, functional ability and quality of life. However, Group B demonstrated comparatively greater improvements, indicating superior functional outcomes.

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