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Research Article

Effectiveness of Mulligan's Mobilization with Movement On Pain Pressure Threshold and Functional Ability in Subjects with Knee Osteoarthritis

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Abstract: Osteoarthritis (OA) is a degenerative condition mainly due to wear and tear occurring during ageing. Knee osteoarthritis shall be classified as primary or secondary osteoarthritis depending upon its aetiology. This study aims to determine the effectiveness of Mulligan's Mobilization with Movement (MWM) on pain pressure threshold and functional ability in subjects with knee osteoarthritis. 40 patients with knee osteoarthritis were allotted into two groups, i.e., Group A (experimental) and Group B (control). Group A subjects were subjected to Mulligan's MWM along with conventional physiotherapy, and Group B subjects were subjected to conventional physiotherapy alone for 3 sessions per week for a period of 4 weeks. The outcome measures were the PPT (pain pressure threshold) and WOMAC (Western Ontario and McMaster Universities Osteoarthritis) scale. For PPT, the post-test values of the experimental group were the median (interquartile range) 10(10-10), mean rank of 30.50, and the sum of ranks of 610.00. The post-test values of the control group were median (interquartile range) 5 (4-5.75), mean rank 10.50, and the sum of ranks 210. 00. For WOMAC, the post-test values of the experimental group were median (interquartile range) 30 (29–30.7), mean rank 10.50, and the sum of ranks 210.00. The post-test values of the control group were median (interquartile range) 44 (42-45), mean rank 30.50, and the sum of ranks 610.00. The post-test Mann-Whitney U value was < .001; the P value was < .001, which shows that there is a statistically significant difference in post-test values of PPT and WOMAC between experimental and control groups. The study concluded that applying MWM significantly improves the pain pressure threshold and functional ability in subjects with knee osteoarthritis.

Keywords: knee osteoarthritis, MWM (Mobilization with Movement), PPT: Pain pressure threshold; WOMAC (Western Ontario and McMaster Universities Osteoarthritis) scale

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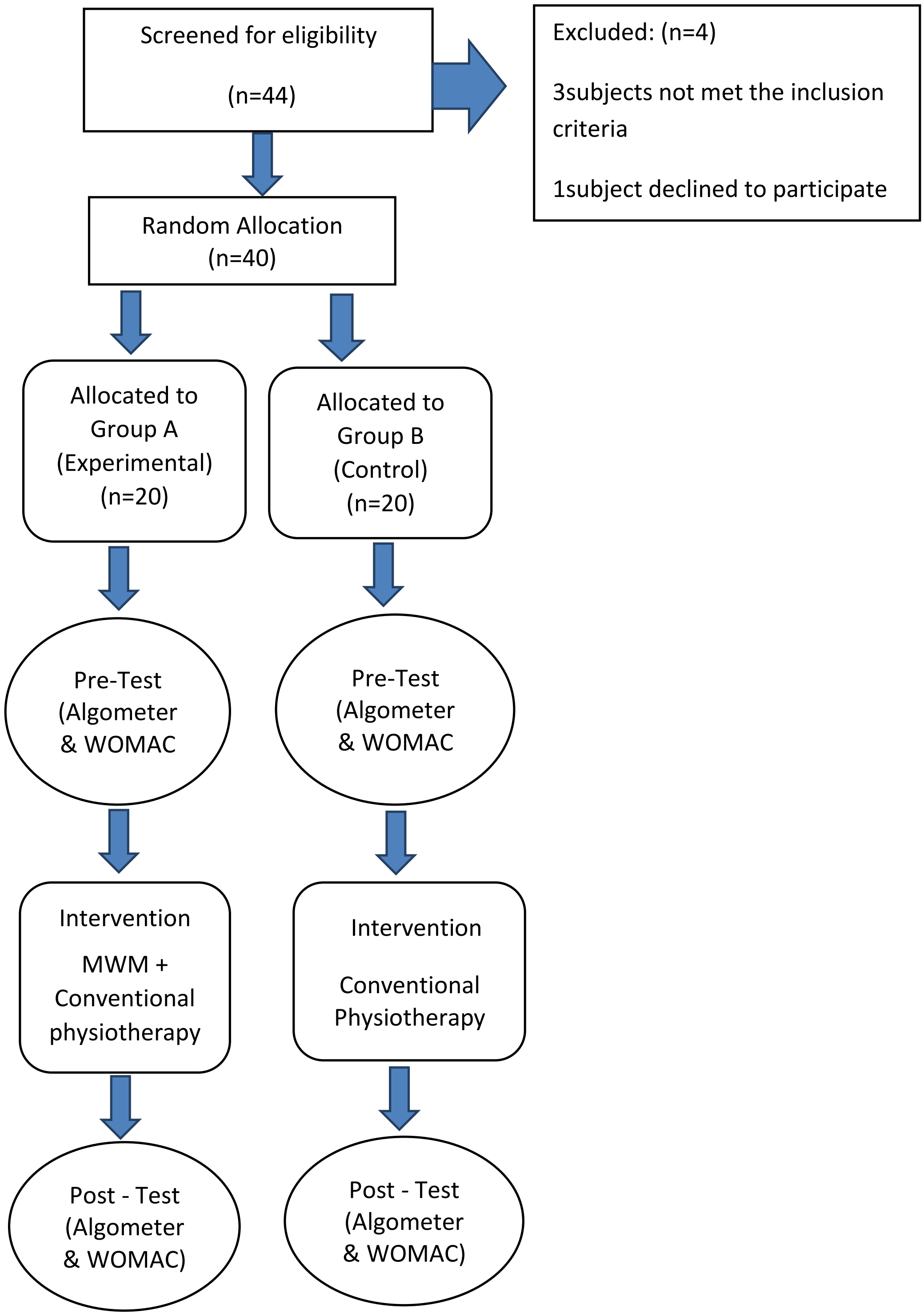
1. INTRODUCTION

Osteoarthritis (OA) is a degenerative condition that is mainly due to the wear and tear occurring during the process of ageing. A wide variety of pathological changes occur in osteoarthritis, including softening, ulceration, disintegration, and loss of the articular cartilage; hypertrophy of bone at the margins; subchondral sclerosis, and biochemical and morphological alterations of the synovial membrane and joint capsule. [1,2,3] The most common clinical features are pain, especially after prolonged weight-bearing and physical activity; stiffness after a prolonged period of inactivity, and once started moving the limb, the movement will be better. [2] Osteoarthritis is also known as a degenerative joint disorder that affects most of the joints of the human body, such as the hands, feet, spine, and large weight-bearing joints, such as the hips and knees. [1,2] Osteoarthritis is the most common and frequent disease, with a prevalence of 22% to 39% in India. [1,3] Osteoarthritis occurs more in women than men, and the prevalence increases with age. [1,2,5] Among women over 65 years of age, radiological evidence of osteoarthritis was found in 70% of women, with 45% of women having clinical symptoms of osteoarthritis. [2,4,5] The major reason for the impairment in mobility in women is osteoarthritis. Osteoarthritis of the knee shall be classified as primary or secondary, depending upon its aetiology. [6] Primary knee Osteoarthritis is the consequence of the degeneration of the articular cartilage for an unknown reason, and it may result from the wear and tear of the articular cartilage due to ageing. [1,2] Secondary osteoarthritis is secondary to some other disease conditions like obesity, joint deformity, previous injury, joint instability, metabolic diseases, joint stiffness, etc. [4.] Common clinical symptoms of knee osteoarthritis include knee pain that is gradual in onset and worsens with activity; morning stiffness or pain and stiffness after a prolonged period of rest, knee stiffness and swelling; crepitus during the joint movement; painful difficulty in squatting in an Indian toilet; and painful difficulty in ascending and descending stairs. Traditional methods of treatment for knee osteoarthritis, including physiotherapy, are commonly used. Surgical treatment is recommended if there is no progress with conventional treatment methods. The intervention strategies for osteoarthritis are multi-dimensional. The intervention consists of pharmacological and non-pharmacological components. The pharmacological treatment, especially the non-steroidal anti-inflammatory drugs, causes various side effects that mainly affect the gastrointestinal tract simultaneously; they are merely decreasing the pain temporarily. [7, 8]. The non-pharmacological treatment consists of exercise therapy, manual therapy, electrotherapy, thermal therapy, body weight optimization, etc. [9,10,11.] Mobilization with movement (MWM), a type of manual therapy with hypoalgesic effects, increases joint ROM, enhances muscle function, and treats specific pathologies. [12]. MWM is very effective in treating conditions like shoulder impingement, tennis elbow, etc. [13-18] There need to be more studies to determine the long-term effect of MWM in patients with knee osteoarthritis. Hence, this study aims to determine the effectiveness of Mulligan's Mobilization with Movement (MWM) on pain pressure threshold and functional ability in subjects with knee osteoarthritis.

2. METHODOLOGY



Flow Diagram: Methodology

2.1. *Methodology*

An orthopaedic surgeon has screened 44 subjects with knee osteoarthritis. Three participants did not fulfil the inclusion criteria, and one was unwilling to participate. Therefore, 40 subjects met the inclusion criteria, and informed consent was obtained.

2.2. *Ethical committee approval*

Ethical clearance obtained from the institutional ethical committee of Bethany Navajeevan College of Physiotherapy, Ref. No. BNCP/F/02/2022 All procedures performed in this study were performed according to the ethical standards in the 1964 Declaration of Helsinki, as revised in 2013. Accordingly, permission has been obtained to gather the data for conducting and publishing the study.

2.3. *Study design*

Pretest-posttest experimental study.

2.4. *Study setting*

The outpatient department of Bethany Navajeevan College of Physiotherapy, Thiruvananthapuram

2.5. Sampling design

Simple random sampling using the fish bowl draw method

2.6. Study duration: *6 months.*

2.7. Inclusion criteria

Diagnosed case of knee osteoarthritis, both men and women, age group 40 to 65 years, unilateral knee osteoarthritis, in case of bilateral knee OA dominant side, Kellgren and Lawrence grade ≥3, criteria of American College of Rheumatology for Knee OA.

2.8. Exclusion criteria

Knee or lower limb surgery had received an intra-articular corticosteroid or hyaluronic acid injection within the past 6 months, reported current or past (within 4 weeks) oral corticosteroid use, had inflammatory or neurological disorders, had altered sensation around their knee, cognitive difficulties, or any contraindication to manual therapy.

2.9. Procedure

The patients were randomly allocated into two groups, i.e., Group A and Group B. Group A was the experimental group and Group B was the control group. Pre-test was conducted on PPT and WOMAC scale for both Group A and Group B. After a brief demonstration, Group A (Experimental group) was subjected to Mulligan's MWMS and conventional physiotherapy 3 sessions per week for a period of 4 weeks. After a brief demonstration, Group B (Control group) was subjected to conventional physiotherapy alone for 3 sessions per week for a period of 4 weeks. Conventional physiotherapy consists of Ultrasound therapy, strengthening exercises: Quadriceps strengthening exercises: Isometric quadriceps exercise, Terminal knee extension, Partial wall supported squats, High sitting knee extension with weight cuff; Stretching exercises: calf, Hamstring, and quadriceps stretch. Post-test was conducted on PPT and WOMAC scale for both Group A and Group B.

2.10. Technique of Mobilization with movement[19]

2.10.1. Lateral glide MWM for flexion

The patient lies prone with the knee flexed close to the limitation. The distal femur is stabilised laterally with one hand. Glide the tibia laterally using the belt. While the glide is sustained, the therapist passively moves the knee into flexion from the starting position and returns to the starting position. Full, active, pain-free flexion is complemented by over-pressure from the therapist (Fig.1).

2.10.2. Lateral glide MWM for extension

The patient lies prone with the knee extended close to the limitation. The distal femur is stabilised laterally with one hand. Glide the tibia laterally using the belt. While the glide is sustained, the therapist passively moves the knee into extension from the starting position and returns to the starting position. A full, active, pain-free extension is complemented by over-pressure from the therapist (Fig.1).

Fig.1: Lateral glide MWM of the knee for flexion and extension: Position of the patient is prone lying with the knee flexed close to the limitation for improving the knee flexion range of motion and knee extended close to the limitation to improve the knee extension range of motion. The distal femur is stabilized laterally, and the belt applies lateral glide to the tibia. While the glide is sustained, the therapist moves the knee into flexion or extension depends on the required range of motion

2.10.3. Medial glide MWM for flexion

The patient lies prone with the knee flexed close to the limitation. The distal femur is stabilised medially with one hand. Glide the tibia medially using the belt. While the glide is sustained, the therapist passively moves the knee into flexion from the starting position and returns to the starting position. Full, active, pain-free flexion is complemented by overpressure from the therapist (Fig. 2).

2.10.4. Medial glide MWM for extension

The patient lies prone with the knee extended close to the limitation. The distal femur is stabilised medially with one hand. Glide the tibia medially using the belt. While the glide is sustained, the therapist passively moves the knee into extension from the starting position and returns to the starting position. The full, active, pain-free extension is complemented by over-pressure from the therapist (Fig. 2).

Fig.2: Medial glide MWM of the knee for flexion and extension: Position of the patient is prone lying with the knee flexed close to the limitation for improving the knee flexion range of motion and the knee extended close to the limitation to improve the knee extension range of motion. The distal femur is stabilized medially, and the medial glide is applied to the tibia using the belt. While the glide is sustained, the therapist moves the Knee into flexion or extension depending on the required range of motion.

2.10.5. *Tibial internal rotation in weight-bearing*

The patient stands with the affected knee flexed and the foot resting on a chair. The proximal tibia is mobilised into the internal rotation direction with the patient's hands. While the internal rotation is sustained, the patient actively moves the knee by 'squatting' into flexion from the starting position of partial flexion and then returns. Full, active, pain-free flexion is complemented by self-generated over-pressure (Fig. 3).

Fig.3: Tibial internal rotation in weight-bearing: The patient keeps the affected leg on the chair with the knee flexed, and internal rotation is applied to the proximal tibia with the patient's hand and while this internal rotation is sustained, the patient moves the knee into flexionMWM has been given 10 repetitions with 3 sets per session

2.11. *Conventional physiotherapy* [20,21]

2.11.1. *Isometric quadriceps exercise*

The participant is positioned in a long sitting position with the knee extended. The therapist instructs the participant to isometrically contract the quadriceps muscles bilaterally as vigorously as possible without reproducing pain. Per session, 3 sets of 10 repetitions have been performed.

2.11.2. *Terminal knee extension with weight cuff*

The participant is initially positioned in a long sitting position on the treatment table. Next, the target limb is flexed over a bolster. A weight cuff was applied to the ankle as tolerated. Next, the contralateral limb's knee is flexed so the foot rests comfortably in a foot-flat position on the table. The therapist instructs the participant to extend the knee of the target limb to full extension, and then slowly lower it until the foot returns to rest on the table. Per session, 3 sets of 10 repetitions have been performed.

2.11.3. *Partial squats*

Partial squats were performed with the patient's back against the wall. Per session, 3 sets of 10 repetitions have been performed.

2.11.4. Hamstrings strengthening

In a standing position, knee flexion/hip extension against a resistive band was performed. Per session, 3 sets of 10 repetitions were performed.

2.11.5. Calf stretching

The patient stands on the step with heels unsupported. Then, using minimal support, they lower their body weight so heels drop below horizontal, and a stretch is felt in the calf muscles. The stretching was performed in 3 repetitions with a holding time of 30 seconds per session.

2.11.6. Hamstring stretching

The patient is positioned in a long sitting position. The affected leg is kept straight, and the patient attempts to reach toward the toes keeping the low back in a neutral position until a stretch is felt. The stretching was performed in 3 repetitions with a holding time of 30 seconds per session.

2.11.7. Quadriceps stretching

The patient is positioned prone and bends the affected knee into flexion. Then, they can use the other leg to push resistance. The stretching was performed in 3 repetitions with a holding time of 30 seconds per session.

2.11.8. Ultrasound therapy[21]

Ultrasound therapy was given in continuous mode with a frequency of 1 MHz and 0.8 W/cm power. Ultrasound was applied to the medial and lateral parts of the knee in circular movements with the probe at right angles to ensure maximum energy absorption with an acoustic ultrasound gel. The duration of each session was 5 minutes. HMS Digisonic 2018 model ultrasound machine was used.

2.12. Outcome measures

2.12.1 PPT (Pain pressure threshold)[22]

A digital algometer has been used to measure the pain pressure threshold. The patients were positioned in supine lying position. The therapist stabilized the knee with one hand and palpated and identified the tenderest point of the medial joint line of the knee with the other hand. The tip of the algometer was placed perpendicular to the tender point. The therapist applied pressure. The point at which the sensation of pressure felt by the patient changed into pain was noted and recorded. The unit of measurement was in kilogram (Kg) (fig.4)

Fig.4: Measurement of pain pressure threshold by digital algometer: Patient lies in a supine position on the couch. The therapist places the tip of the algometer perpendicular to the tender point in the medial knee joint line and applies pressure. The point at which the pressure change into pain is noted and recorded

2.12.2 WOMAC (Western Ontario and McMaster Universities Osteoarthritis) scale[23]

The Western Ontario and McMaster Universities Arthritis Index (WOMAC) is widely used to evaluate Knee Osteoarthritis. It is a self-administered questionnaire consisting of 24 items divided into 3 subscales Pain (5 items), Stiffness (2 items), and Physical Function (17 items). Each subscale has been categorized into 4 subdivisions, i.e., 0= none; 1= mild; 2= moderate; 3= severe; 4= extreme. Thus, the maximum score of pain is 20, stiffness is 8, and that of physical function is 68The total score has been taken for the calculation. Max. total score is 96(20+8+68).

3. STATISTICAL ANALYSIS

The results were recorded and analyzed statistically using spss. The difference within the group has been analyzed with Wilcoxon signed rank test. The difference between groups has been analyzed with the Mann-Whitney U test.

4. RESULTS

40 subjects fulfilling the inclusion criteria were included in this study. They were divided into groups, Group A (Experimental group) and Group B (Control group), with 20 subjects in each group.

Table 1: Demographic data

Variable		Experimental Group (Group A) (MWM + Conventional Physiotherapy)	Control Group (Group B) (Conventional Physiotherapy)	P value
Age (Mean & S.D.)		52.5±3.0	51.8±2.5	.902
BMI (Mean & S.D.)		29.8±2.7	30.2±2.6	.849
Gender	Men	10	9	
	Women	10	11	.752

S.D.: Standard Deviation; *BMI: Body Mass Index; *MWM: Mobilization with Movement; Values are Mean± S.D(n=40); Age p value .902; BMI p value .849; Gender p value .752

Table 1: shows the demographic data of the subjects. The demographic data shows equal distribution of the demographic data, i.e., the Age, BMI, and gender are equally distributed among the experimental and the control group. In the experimental group, the mean age was 52.5±3.0, the mean BMI was 29.8±2.7, and Gender distribution was 10(50%) men and 10 (50%) women; in the control group, the mean age was 51.8±2.5, the mean BMI was 30.2±2.6, Gender distribution was 9(45%) men and 11(55%) women. The p-value of Age is .902, BMI is .849, and Gender is .752, which shows no significant difference between the distribution of Age, BMI, and Gender among the experimental and the control group.

Table 2: Within-group comparison of PPT AND WOMAC in the Experimental Group

Variable	Time Point	No. of Samples(n)	Median	Inter Quartile Range (IQR)	Mean Rank	Sum of Ranks	Z value	*P* value*
PPT	Pre-test	20	2.5	2-3	10.50	210.00	-3.970	<.001
	Post-test	20	10	10-10				
WOMAC	Pre-test	20	66	64-68	10.50	210.00	-3.934	<.001
	Post-test	20	30	29-30.7				

Analysed by Wilcoxon signed ranks test, PPT: Pain pressure threshold; WOMAC: Western Ontario and McMaster Universities Osteoarthritis (WOMAC) scale; Values are Median (IQR) (n=40); PPT p value <.001; WOMAC p value <.001

Table No. 2 shows the experimental group's pre and post-test values of PPT and WOMAC. The pain pressure threshold and functional ability were measured before and after the application of the intervention in the experimental group. There was a significant difference between the pre and post-test values of PPT and WOMAC in the experimental group. There was an increase in the score of PPT after the application of the intervention, and there was a decrease in the value of the WOMAC after the application of the intervention in the experimental group. Thus, this table shows an improvement in pain pressure threshold and functional ability in OA knee patients after applying MWMS with conventional physiotherapy. While analysing PPT, in the pre-test, the median was 2.5, and the interquartile ranges were: 2-3. In the post-test, the median was 10, and the interquartile ranges were 10-10. The pre vs post-test mean rank was 10.50, the sum of ranks was 210.00, Z value was -3.970, and the P value was <.001, which shows a statistically significant difference between the pre and post-test values of PPT in the experimental group. Also, the result shows that the post-test value of PPT is higher than the pre-test value of PPT in the experimental group. While analysing WOMAC, in the pre-test, the median was 66, and the interquartile ranges were: 64-68. In the post-test, the median was 30, and the interquartile ranges were: 29-30.7. The pre vs. post-test mean rank was 10.50, the sum of ranks was 210.00, Z value was -3.934, and the P value was <.001, which shows that there is a statistically significant difference between the pre and post-test values of WOMAC in the experimental group. Also, the result shows that WOMAC's post-test value is lower than WOMAC's pre-test value in the experimental group.

Table 3: Within-group comparison of PPT AND WOMAC in the Control Group

Variable	Time Point	No. of Samples(n)	Median	Inter Quartile Range (IQR)	Mean Rank	Sum of Ranks	Z value	*P* value*
PPT	Pre-test	20	3	2-3.75	10.50	210.00	-4.233	<.001
	Post-test	20	5	4-5.75				
WOMAC	Pre-test	20	65.5	64-68	10.50	210.00	-3.924	<.001
	Post-test	20	44.0	42-45				

Analysed by Wilcoxon signed ranks test, PPT: Pain pressure threshold; WOMAC: Western Ontario and McMaster Universities Osteoarthritis (WOMAC) scale; Values are Median (IQR) (n=40); PPT p value <.001; WOMAC p value <.001

Table No. 3 shows the pre and post-test values of PPT and WOMAC in the control group. The pain pressure threshold and functional ability were measured before and after the application of the intervention in the control group. There was a significant difference between the pre and post-test values of PPT and WOMAC in the control group. There was an increase in the PPT score after the intervention's application, and there was a decrease in the value of the WOMAC after the application of the intervention in the control group. Thus, this table shows an improvement in pain pressure threshold and functional ability in OA knee patients after applying conventional physiotherapy alone. While analysing PPT, in the pre-test, the median was 3, and the inter quartile ranges were: 2-3.75. In the post-test, the Median was 5, and the inter quartile ranges were 4-5.75. The pre vs post-test mean rank was 10.50, the sum of ranks was 210.0, Z value was -4.233, and the P value was <.001, which shows a statistically significant difference between the pre and post-test values of PPT in the control group. Also, the result shows that the post-test value of PPT is higher than the pre-test value of PPT in the control group. While analysing WOMAC, in the pre-test, the median was 65.5, and the inter quartile ranges were: 64-68. In the post-test, the median was 44, and the inter quartile ranges were: 42-45. The pre vs post-test mean rank was 10.50, the sum of ranks was 210.00, Z value was 3.924, and the P value was <.001 which shows that there is a statistically significant difference between the pre and post-test values of WOMAC in the control group. Also, the result shows that WOMAC's post-test value is lower than WOMAC's pre-test value in the control group.

Table 4: Comparison of PPT between the Experimental group and Control group.

PPT		No. of Samples(n)	Median (Inter Quartile Range)	Mean Rank	Sum of Ranks	*U* value	*Z* value	*P* value*
Time Point	Group							
Pre	Exp	20	2.5 (2-3)	18.72	374.50	164.500	-1.034	.301
	Cont.	20	3 (2-3.75)	22.28	445.50			
Post	Exp	20	10(10-10)	30.50	610.00	< .001	-5.576	<.001
	Cont.	***20***	***5(4-5.75)***	***10.50***	***210.00***			

****Analysed by Mann-Whitney U test, Exp=Experimental group, Cont.=Control group, PPT: Pain pressure threshold; Values are Median (IQR) (n=40); PPT p value <.001***

Table 4: shows the comparison of pre and post-test values of PPT between the experimental group and the control group. There is no significant difference between the pre-test values of PPT in the experimental and control groups. However, when comparing the post-test values of PPT, there was a greater difference between the experimental and control groups. In addition, there was a greater increase in the post-test score of PPT in the experimental group than in the control group. Thus, this table shows that there is a significant increase in pain pressure threshold in OA knee patients after the application of MWM with conventional physiotherapy than those treated with conventional physiotherapy alone. The pre-test values of the experimental group were Median (interquartile range) 2.5 (2-3), mean rank 18.72, and the sum of ranks 374.50. The pre-test values of the control group were median (interquartile range) 3 (2-3.75), mean rank 22.28, sum or rank445.50. The pre-test Mann-Whitney *U* value was 164.500; the *Z* value was -1.034, *and the P* value was .301, which shows no significant difference in pre-test values of PPT between experimental and control groups. The post-test values of the experimental group were, median (interquartile range) 10(10-10), mean rank 30.50, and the sum of ranks 610.00. The post-test values of the control group were, median (interquartile range) 5(4-5.75), mean rank 10.50, and a sum of ranks 210.00. The post-test Mann-Whitney *U* value was < .001, *the Z* value was -5.576; *the P* value was < .001, which shows a statistically significant difference in post-test values of PPT between experimental and control groups. Also, the result shows that the post-test value of PPT in the experimental group is higher than the post-test value of PPT in the control group.

Table 5: Comparison of WOMAC between the Experimental group and Control group.

WOMAC		No. samples(n)	Median (Inter Quartile Range)	Mean Rank	Sum of Ranks	*U* value	*Z* value	*P* value*
Time Point	Group							
Pre	Exp	20	66 (64-68)	20.50	410.00	200.000	< .001	1.000
	Cont.	20	65.5 (64-68)	20.50	410.00			
Post	Exp	20	30(29-30.7)	10.50	210.00	< .001	-5.447	<.001
	Cont.	20	44(42-45)	30.50	610.00			

****Analysed by Mann-Whitney U test, Exp=Experimental group, Cont.=Control group, WOMAC: Western Ontario and McMasterUniversities Osteoarthritis (WOMAC) scale; Values are Median (IQR) (n=40); WOMAC p value <.001***

Table 5: shows the comparison of pre and post-test values of WOMAC between the experimental group and control group. There is no significant difference between the pre-test values of WOMAC in the experimental and control group. However, when comparing the post-test values of WOMAC, there was a greater difference between the experimental and control group. There was a greater decrease in the post-test score of WOMAC in the experimental group than in the control group. Thus, this table shows a significant decrease in WOMAC score in OA knee patients after applying MWM with conventional physiotherapy than those treated with conventional physiotherapy alone. The pre-test values of the experimental group were, Median(interquartile range) 66 (64-68), mean rank 20.50, and the sum of ranks 410.00. The pre-test values of the control group were, Median (interquartile range) 65.5 (64-68), mean rank 20.50, and sum or rank 410.00. The pre-test Mann-Whitney *U* value was 200.000; the *Z* value was < .001, *and the P* value was 1.000, which shows no significant difference in pre-test values of WOMAC between experimental and control groups. The post-test values of the experimental group were median (interquartile range) 30 (29-30.7), mean rank 10.50, and the sum of ranks 210.00. The post-test values of the control group were, median (interquartile range) 44 (42-45), mean rank 30.50, and the sum of ranks 610.00. The post-test Mann-Whitney *U* value was < .001, *the Z* value was -5.447; *P* value was < .001, which shows that there is a statistically significant difference in post-test values of WOMAC between experimental and control groups.

Also, the result shows that the post-test value of WOMAC in the experimental group is lower than the post-test value of WOMAC in the control group.

5. DISCUSSION

Based on the statistical analysis, our study's result shows that MWM can improve the pain pressure threshold and functional ability in subjects with knee osteoarthritis. Various kinds of literature support the result of the present study. Gupta et al. conducted a study that concluded that the application of MWM significantly reduced pain and improved functional ability and knee joint proprioception in subjects with knee osteoarthritis [23]. During the application of MWM, squeezing out of the synovial fluid occurs during compression, and imbibing of the synovial fluid occurs during distraction, which distributes nutrition to the articular cartilage. [24]. Also, mobilisation decreases the viscosity of the synovial fluid, thereby facilitating the imbibing of the synovial fluid by the articular cartilage and subsequent nutrition. Lalnunpuii et al. concluded that MWM significantly decreases pain and increases the range of motion and functional capacity in women with knee osteoarthritis [25]. Manipulation decreases pain in joints and periarticular structures by stimulating joint receptors. It reduces pain perception by blocking pain impulses through the gate control mechanism and producing reflexive muscle relaxation. Gating pain impulses occurs when the movement of the periarticular tissue being manipulated stimulates fast-conducting large-diameter proprioceptive nerve fibres that block the transmission of slow-conducting small-diameter pain fibres, thus minimising the transmission of pain impulses to the brain. Reducing pain has a secondary effect on muscle relaxation and improved motor control [19,26]. The study conducted by Rao et al. also concluded that the application of MWM significantly reduces pain and improves functional mobility in knee osteoarthritis patients [27.] Kaya Mutlu et al. concluded that MWM significantly reduces the pain and improves the quadriceps muscle strength, range of motion of knee joint, and functional ability in subjects with osteoarthritis of the knee. The possible mechanism is the resultant inhibition of the nociceptors because of MWM [28]. Also, MWM has a psychological effect that reduces the fear of movement [29]. Varma et al. conducted a study concluding that MWM reduces pain and significantly improves range of motion and functional ability. [30] Bhagat et al. concluded that MWM significantly decreases the pain and improves the functional ability in patients with knee osteoarthritis, and the possible mechanism for pain reduction in knee osteoarthritis is based on the theory of Mulligan, which says that the pain and dysfunction are due to the micromal-alignment that occurs because of the positional fault. [31] The application of MWM corrects any positional faults and brings about the joint's normal kinematics and kinetics, thereby decreasing the pain [32,33]. Pawar et al. conducted a study that concluded that MWM significantly reduces pain in subjects with knee osteoarthritis [34] Saddam Hussain Shaik et al. conducted a study and concluded that MWM significantly reduces the pain and improves the quadriceps peak torque, which may be the result of the reflex relaxation of the muscles around the joint [35] Mahmooda et al. concluded that MWM significantly reduces pain and increases the range of motion in subjects with knee osteoarthritis[36]. Various research studies proved that the application of ultrasound assisted in the formation of hyaline cartilage and repaired the defects in the articular cartilage, thus playing a major role in delaying the progression of osteoarthritis. [37] Strengthening of the muscles around the knee joint increases the stability of the knee joint, decreases pain, stiffness, and compressive load, and improves shock absorption function and functional ability. [38.39] Stretching exercises increase the range of motion and, thus, function. Still, there is no clinically significant decrease in the pain. As Mulligan's MWMS technique corrects the micromalalignment, due to the positional fault and other mechanisms, it yields a clinically significant improvement in patients with knee osteoarthritis.

6. LIMITATIONS AND RECOMMENDATIONS

The sample size is small, which may lead to bias. Hence, further study is recommended with a large sample size. The soft tissue component is not addressed in this study; hence, further study will be conducted to see the combined effect of MWM and soft tissue techniques in the OA knee. Knee range of motion and muscle strength is not included in outcome measures; hence, further study will be conducted using this outcome measure

7. CONCLUSION

The current study aims to determine the effectiveness of Mulligan's Mobilisation with Movement (MWM) on pain pressure threshold and functional ability in subjects with knee osteoarthritis. Based on the statistical analysis, the result of this study shows that the application of MWM significantly improves the pain pressure threshold and functional ability in subjects with knee osteoarthritis.

- ***Abbreviations***

MWM: Mobilization with movement; PPT: Pain Pressure Threshold; WOMAC: Western Ontario and McMaster Universities Osteoarthritis scale; BMI: Body Mass Index; OA: Osteoarthritis; IQR: Inter Quartile Range; S.D.: Standard Deviation

8. AUTHORS CONTRIBUTION STATEMENT

Mr. J Andrews Milton conceptualised and designed the study and gathered and analysed the data. Dr.S.Subbiah gave the necessary inputs towards designing the study and the manuscript. All authors read and approved the final version of the manuscript.

9. CONFLICT OF INTEREST

Conflict of interest declared none.

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