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Effect of Matrix rhythm therapy on pain, range of motion and balance in patients with knee osteoarthritis

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Abstract

Introduction: Osteoarthritis is a complex, multifactorial disease involving the interplay of mechanical, biochemical, and genetic factors. Knee Osteoarthritis (KOA) is a prevalent joint disorder characterized by cartilage degeneration and changes in the underlying bone. Matrix Rhythm Therapy (MRT) is a novel approach that utilizes rhythmic oscillations to influence cellular function and tissue repair. These oscillations are believed to stimulate cellular activity that improves circulation and promotes tissue healing.

Aim: Our study aimed to assess the effect of MRT on Pain, Range of Motion, and Balance in patients with KOA.

Materials and Method: 37 patients (N=37) diagnosed with KOA were recruited from the outpatient department of physiotherapy of D.Y. Patil Hospital. They were given Matrix therapy twice a week for two weeks. The outcomes used were Numerical Pain Rating Scale (NPRS), Range of motion (ROM) using a Universal Goniometer, and Bergs Balance Scale (BBS).

Results and Conclusion: Wilcoxon matched pair test was used to compare the pretest and post-test ($p<0.05$). The statistical analysis of pretest and post-test flexion range of motion was done using dependent T test ($p<0.05$). The comparison of the pretest and post-test balance assessment was done using dependent T test ($p<0.05$). There was a significant improvement in pain, range of motion and balance in individuals of KOA after administering the MRT. The findings suggest that the MRT is highly effective in managing symptoms of KOA and improving overall functional abilities.

Keywords: Matrix Rhythm Therapy; Knee Osteoarthritis; Numerical Pain Rating Scale; Bergs Balance Scale

1. Introduction

Osteoarthritis (OA) is a progressive disease in which the structures of the joint undergo pathological changes that may eventually lead to disability. Hyaline articular cartilage is lost with increasing thickness and sclerosis of the subchondral bony plate. There is outgrowth of osteophytes at the joint margins, stretching of articular capsule with synovitis, and weakness of muscles bridging the joint. [1,2] KOA, also known as degenerative joint disease, is typically the result of wear and tear of articular cartilage. There are numerous pathways that can lead to failure, but the initial step is often joint injury in the setting of a failure of protective mechanisms. [2] This multifaceted condition is caused by the interaction of genetic, biochemical and mechanical factors. The pathophysiology of OA of the knee involves cartilage degradation. Abnormalities in the anabolic and catabolic processes affect the specialized cartilage cells known as chondrocytes. The cells in cartilage called chondrocytes are responsible for the extracellular matrix's (ECM) formation

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and turnover. Cartilage breaks down as a result of the production of catabolic enzymes by the chondrocytes, which break down collagen and proteoglycans. The integrity and functionality of cartilage are disturbed by the breakdown of collagen and proteoglycans. [2,3] The typical thinning and erosion seen in OA results from this loss, which lowers the cartilage's capacity to endure mechanical stress and absorb shock. [4,5] The remodeling of subchondral bone results in osteophyte development, microcracks, and sclerosis, which changes joint biomechanics and produces pain. As the cartilage deteriorates, it experiences more mechanical stress. Increased bone remodeling results from this stimulation of osteoblasts, which makes new bone, and osteoclasts, which breaks down existing bone. The thickening and hardening of the bone due to enhanced bone production is known as subchondral bone sclerosis. As a result, the joint becomes more rigid and less able to absorb shock. Increased mechanical stress on cartilage can also result from obesity, joint instability, malalignment, and excessive joint use. This stress speeds up the deterioration of cartilage and increases the progression of OA. [5,6] Another symptom of osteoarthritis (OA) is synovitis. Synovial hypertrophy brought on by persistent inflammation can exacerbate joint discomfort and swelling.[2,3,4] This collagen network is weakened when collagen is broken down by extracellular matrix enzymes, which leads to cartilage degradation.[4,6,7] Many joint tissues, such as the synovium, subchondral bone, ligaments, and periarticular muscles, can cause pain in OA. Mechanical stress and inflammatory agents activate nociceptors. The central nervous system may become more sensitive to pain signals as a result of central sensitization brought on by chronic pain. This could increase pain perception and lead to chronic pain in OA patients. [4, 5, 7] The primary sign of osteoarthritis (OA) in the knee is pain, which is usually felt when walking, ascending stairs, or standing up from a seated posture. Joint stiffness is typical, especially when you get up in the morning or after periods of inactivity. Knee swelling can result from synovial inflammation, which can affect the surrounding soft tissues or just the joint itself. Increased exercise frequently makes swelling worse, and its intensity can change over time. [5,6] A grinding feeling inside the knee joint, which can be felt or heard when moving, is the hallmark of crepitus. It is caused by osteophytes and abnormalities in the articular surfaces. [5,6,7] Limitations in knee range of motion may result from progressive cartilage loss and joint deterioration. Functional movements including walking, squatting, and bending may be hampered by patients' inability to fully extend or flex their knees.[6,7,8] Following altered biomechanics, pain inhibition, and disuse, knee OA patients frequently have weakness in the muscles surrounding the knee joint. Further compromising joint stability and functional effectiveness is muscle weakening. [8,9] OA of the knee is typically graded radiologically using the Kellgren-Lawrence grading system,which ranges from 0 to 4: [2,6,8]

- Grade 0: No osteoarthritis, no joint space narrowing, and no osteophytes.
- Grade 1: Doubtful narrowing of joint space and possible osteophyte lipping.
- Grade 2: Definite osteophytes and possible narrowing of joint space.
- Grade 3: Moderate multiple osteophytes, definite narrowing of joint space, somesclerosis, and possible deformity of bone ends.
- Grade 4: Large osteophytes, marked narrowing of joint space, severe sclerosis, anddefinite deformity of bone ends.[2,6,8]

MRT was developed by German researcher and physician Dr. Ulrich Randoll. He found that at the cellular level, healthy tissue moves in a regular pattern, and that any disturbances to this rhythm can result in a number of musculoskeletal problems, including pain, stiffness, and restricted movement.

He developed MRT, a non-invasive technique that uses rhythmic mechanical oscillations to stimulate tissue at the cellular level, based on these findings. MRT uses a handheld device called the Matrix Mobil to provide mild mechanical oscillations to certain body parts. By simulating the natural rhythm of healthy tissue movement at predetermined frequencies and amplitudes, these oscillations are intended to restore normal rhythm and function. The typical frequency range used is 8–12 Hz as this is the range of frequencies seen in human tissue. In order to treat the root causes of musculoskeletal issues, these oscillations are considered to increase cellular activity, enhance circulation, and encourage tissue healing. [10] The mechanical oscillations boost cellular metabolism by penetrating the tissues. By encouraging cells to operate at their most efficient level, this stimulation aids in tissue regeneration and repair. The lymphatic and blood circulation is improved by the rhythmic vibrations. Through the removal of waste products from metabolism and the delivery of oxygen and nutrients, improved circulation aids in tissue healing and inflammation reduction. It aims to restore the natural rhythm of tissue motion. By resolving tissue rhythm abnormalities, the therapy improves overall function and mobility by relieving muscle discomfort, stiffness, and tension. The therapy's ability to relax muscles, reduce tension, and increase flexibility may lead to pain relief and an improvement in range of motion. MRT can reduce inflammation, reduce pain, and speed up the healing process for a variety of musculoskeletal conditions by affecting cellular activity, circulation, and tissue rhythm. [10,11] Some of the benefits include better tissue health, myofascial release, pain alleviation, enhanced cellular function, reduced edema, improved microcirculation, and increased joint mobility and flexibility.[11,13,14,15] The therapy can lower anxiety and stress levels. [12,13,15] Restoring tissues and cells to their native frequency is the goal of MRT, a relatively new form of treatment. Examining how it affects osteoarthritis in the knee may help determine whether it can be used as an alternative or complementary therapy. Understanding how MRT directly affects pain, balance, and function might help people with knee osteoarthritis with their demands, which could enhance their general well-being and quality of life.

2. Material and Methods

This observational study was conducted in the Physiotherapy department of tertiary health carecenter. The ethical approval was taken. The samples (N=37) between 35 to 60 years of age were recruited based on the inclusion and exclusion criteria over 6 months. A written informed consent was obtained from each individual. The NPRS was used to quantify and communicate the intensity of pain experienced. The ROM was measured using a Universal Goniometer. The BBS was used to provide comprehensive insights into dynamic balance. Baseline parameters for pain, ROM, and balance were taken. The subjects were given MRT twice a week for two weeks. Along with matrix therapy, patient was given the following exercises- aerobic exercises like walking, cycling, and strength training that included quadriceps (leg press, straight leg raise, and quadriceps setting exercises) hamstring and calf strengthening (hamstring curls and calf raises). Flexibility and range of motion exercises like supine heel slides, knee extension, balance and proprioception training, and single-leg standing. [16] After 2 weeks, post-intervention parameters for pain, ROM, and balance were reassessed. Statistical data obtained from the NRS, ROM and BBS was used to evaluate the pain, ROM, and balance. The results and conclusion were found.

2.1. Inclusion Criteria

- Individuals clinically diagnosed with grade 2 and grade 3 knee osteoarthritis.
- Individuals between 35-60 years of age.
- Both males and females.
- Individuals willing to participate in the study.

2.2. Exclusion Criteria

- Individuals with previous history of knee surgery (e.g., knee replacement,arthroscopic ligament surgeries).
- Individuals with a history of other significant musculoskeletal conditions affecting thelower limb.
- Individuals with any infective skin condition.

2.3. Outcome measures

2.3.1. Numeric Pain Rating Scale (NRS)

With 0 denoting no pain and 10 denoting the greatest pain felt, the NPRS is a popular pain assessment instrument that asks users to score their level of pain on a scale of 0 to 10. Patients are asked to select a number that most accurately reflects how much pain they are experiencing right now. Healthcare professionals use this scale to monitor changes in pain over time. Although the NPRS is useful for measuring pain severity, it ignores other facets of pain experience, such as the impact on one's emotions or ability to function. [16]

2.3.2. Berg Balance Scale (BBS)

A clinical test called the BBS is used to evaluate balance in those who have balance issues. It includes 14 components that assess both dynamic and static balance. Every component has a score between 0 and 4, with 56 being the highest possible total. Better balance is indicated by higher scores, which are divided into three fall risk categories: low (41–56), medium (21–40), and high (0–20). Because of its simplicity and dependability, the BBS is frequently utilized in therapeutic settings. [17]

2.3.3. Range of motion (ROM)

To measure range of motion (ROM) with a goniometer: Position the patient in prone position with the joint in the neutral position. Position the stationary arm on thigh and the moving arm on the leg with the fulcrum at the lateral femoral condyle. Note the goniometer's angle at the neutral position, which is typically 0 degrees, and record the beginning position. Ask that the patient to fully extend the joint's range of motion, then note the angle at the final position. To calculate the entire range of flexion motion (ROM), subtract the beginning angle from the end angle. [18]

3. Results

Table 1 Normality of change scores from pretest and posttest of all parameters by ShapiroWilk test

Parameters	Shapiro-Wilk	df	p-value (p<0.05)
Matrix Pain (Pretest-posttest)	0.9140	37	0.0070*
Matrix Flexion ROM (In degree) (Pretest-posttest)	0.9470	37	0.0750
Matrix Extension Lag (Pretest-posttest)	0.7210	37	0.0001*
BBS (Pretest-posttest)	0.9680	37	0.3690

3.1. Interpretation

The pretest and post-test analysis of pain and extension lag, show p- values of 0.007 and0.0001 respectively which is statistically significant (p<0.05). This shows that the post-intervention pain and extension lag shows a significant improvement. However, the post-intervention flexion range of motion and BBS scores do not show a significant difference as compared to pre-intervention values. (p>0.05)

Table 2 Comparison of pretest and posttest Matrix Pain scores by Wilcoxon matched paired test

Times	Mean	SD	Mean Diff.	SD Diff.	% of change	Z-value	p-value (p<0.05)
Pretest	5.68	1.00	4.95	1.08	87.14	5.3028	0.0001*
Posttest	0.73	0.84					

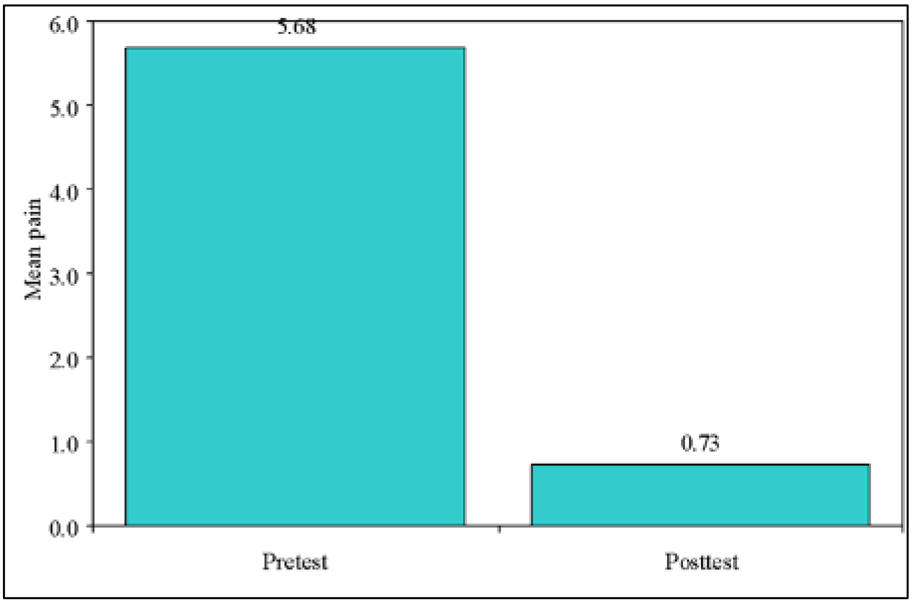

Figure 1 Comparison of pretest and post-test Matrix Pain scores

3.2. Interpretation

The statistical analysis for comparison of pretest and posttest pain scores by Wilcoxon matched pair test shows a mean difference of 4.95 and standard deviation of 1.08. The p-value for the pretest and posttest pain score is 0.0001 (p< 0.05) which is statistically significant.This implies that there is improvement in the post-intervention pain score.

Table 3 Comparison of pretest and posttest Matrix Flexion ROM scores by dependent T-test

Times	Mean	SD	Mean Diff.	SD Diff.	% of change	t-value	p-value (p<0.05)
Pretest	107.84	11.04	-16.97	7.94	-15.74	-13.0103	0.0001*
Posttest	124.81	7.13					

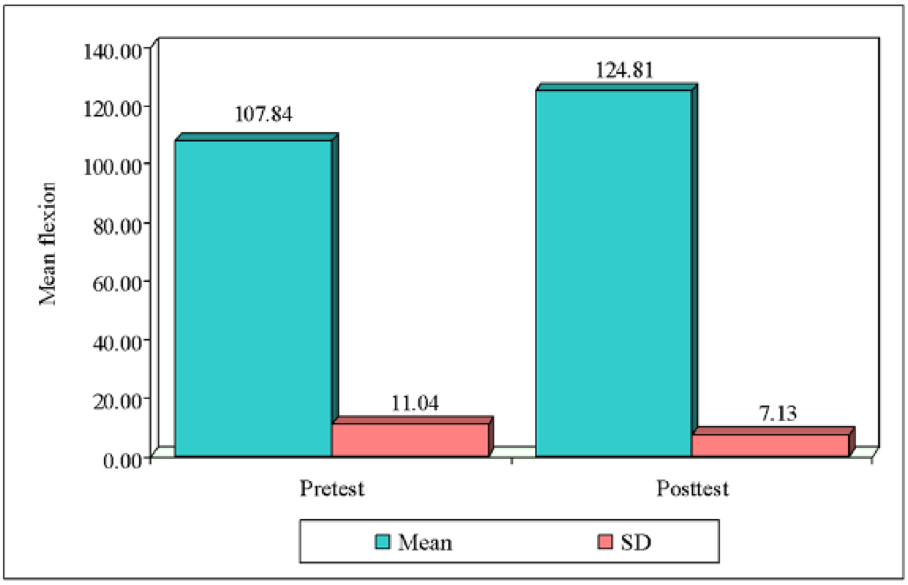

Figure 2 Comparison of pretest and post-test Matrix Flexion ROM scores by dependent T test

3.3. Interpretation

The analysis of pretest and posttest flexion ROM by dependent T-test shows a mean difference of 16.97 and a standard deviation of 7.94. The p-value for pretest and posttest flexion range of motion is 0.0001 ($p<0.05$). This suggests that a significant improvement was seen after MRT in flexion ROM (% change= 15.74)

Table 4 Comparison of pretest and post-test Matrix Extension Lag scores by Wilcoxon matched pairs test

Times	Mean	SD	Mean Diff.	SD Diff.	% of change	Z-value	p-value (p<0.05)
Pretest	3.14	4.67	2.97	4.30	94.83	5.3029	0.0001*
Posttest	0.16	0.73					

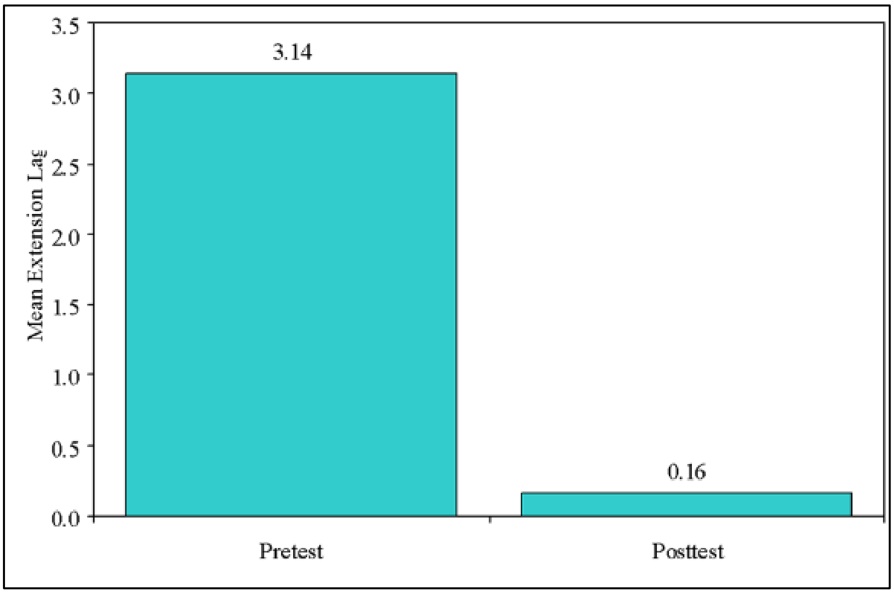

Figure 3 Comparison of pretest and post-test Matrix Extension Lag scores

3.4. Interpretation

The statistical analysis of the pretest and posttest extension lag by Wilcoxon matched pairs test shows a mean difference of 2.97 with a standard deviation of 4.30. The p-value for pretest and posttest for extension lag is 0.0001 ($p<0.05$). This shows that there is a significant improvement in the extension lag (% change =94.83) after MRT, thereby improving the knee ROM.

Table 5 Comparison of pretest and post-test BBS scores by dependent T test ||

Times	Mean	SD	Mean Diff.	SD Diff.	% of change	t-value	p-value (p<0.05)
Pretest	36.30	9.75	-16.68	8.07	-45.94	-12.5650	0.0001*
Posttest	52.97	7.40					

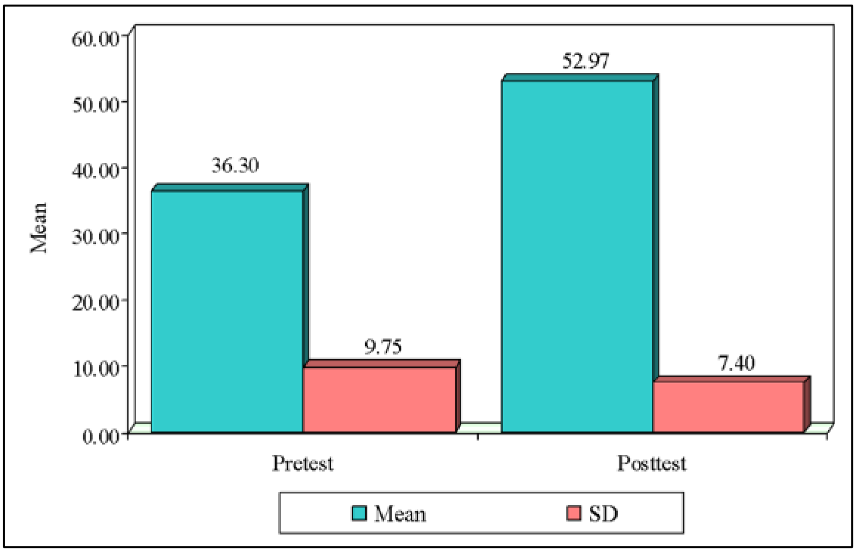

Figure 4 Comparison of pretest and posttest BBS scores

3.5. Interpretation

The statistical analysis of pretest and post-test BBS by dependent T-test shows a p-value of 0.0001 for BBS scores ($p<0.05$). This suggests that the balance improved after the application of MRT.

4. Discussion

A significant trend in the prevalence of KOA in our population may be seen in the age distribution of the patients. This is consistent with the known osteoarthritis epidemiology, which shows that as people age, the condition becomes more common as a result of the gradual joint deterioration.[1,2,3] The distribution of affected sides shows that the left and right knees are almost equally prevalent. Although biomechanical stress, stride patterns (an uneven distribution of stresses across the knees), and prior injuries may be responsible for this minor prevalence of right knee involvement, it also indicates that both knees are equally vulnerable to osteoarthritis. [2,3,9] There has been a noticeable decrease in pain, according to the comparison of pain levels before and after the intervention. The substantial decrease in pain ratings following the session demonstrates the many advantages of MRT in the treatment of KOA. By improving microcirculation and addressing other underlying mechanisms, it is possible to induce rhythmic oscillations at the cellular level. [11,12] By eliminating metabolic waste products and improving the delivery of oxygen and nutrients to tissues, improved blood flow can lessen pain and inflammation. MRT promotes cellular regeneration and repair by influencing the extracellular matrix and encouraging cell metabolism, reduction of muscle tension and spasm. [12,13] Targeting muscle tension and spasms by inducing rhythmic muscle contractions and relaxations results in reduced muscle stiffness and improved joint mobility, contributing to pain relief and decreased inflammatory response [11]. By improving lymphatic drainage, it helps to reduce knee joint edema and swelling. By treating adhesions in the soft tissues surrounding the knee, it improves tissue elasticity and flexibility. [11, 12, 13, 14] After the intervention, there was a noticeable improvement in the flexion range of motion. This improvement in range of motion demonstrates how MRT improves joint mobility and functional performance. [13, 14] Cellular metabolism is stimulated by MRT's mechanical oscillations. MRT reduces muscle tension and spasms through regular muscle oscillations. The impacted joints' range of motion can be greatly enhanced by this muscular relaxation. The MRT helps to release the fascial restrictions, which often cause limited ROM. [12, 13, 14]. By loosening these restrictions, the overall flexibility and mobility of the joint can be improved. By alleviating muscle tension and improving blood flow, MRT can reduce pain associated with restricted ROM. Decreased pain levels significantly increases flexion ROM enhancing the joint mobility. [11,13,14] The extension lag also demonstrated significant improvement. This indicates that the intervention effectively reduces extension lag, thereby enhancing knee joint stability. The clinical reasoning behind this improvement can be attributed to several physiological and biomechanical factors influenced by MRT. The factors include muscle and tendon relaxation, reduction in muscle spasms by rhythmic oscillations provided by MRT help in reducing muscle spasms and tension in the muscles surrounding the knee, particularly the quadriceps and hamstrings. Relaxed muscles are more capable of achieving full extension. The therapy may improve the elasticity of the tendons, allowing for better extension of the knee joint. The therapy aids in lymphatic drainage, reducing swelling and inflammation around the knee joint. [13,14] Reduced edema can lessen extension lag and allow for a wider knee ROM. Fascial adhesions that restrict knee extension can be released with MRT. It can enhance proprioception and neuromuscular control, achieving complete extension through improved coordination. [11, 12, 13] Patients with better proprioception are more aware of the knee joint position, which allows for better extension when engaging in activities. Reducing extension lag increases the ability to fully extend the knee joint, which is required for joint stability when weight bearing. This can lower the risk of falls and injuries while preventing excessive strain on the joint. [11, 12, 13, 14, 15] The significant improvement in BBS scores highlights its effectiveness in improving balance and stability. This indicates that MRT enhances balance and reduces the risk of falls in patients with KOA by reducing stiffness, reducing pain, increasing ROM and enhancing proprioception. [12, 13, 14, 15]

5. Conclusion

Our study demonstrates significant improvements in pain reduction, joint mobility (increasing the flexion ROM and decreasing the extension lag), and balance following MRT. The findings suggest that the MRT is highly effective in managing symptoms of KOA and improving overall functional abilities. This will help the therapists to add MRT along with the exercises in treating the patients with KOA, thereby accelerating the healing process and delaying the progression of degeneration.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors reported no potential conflict of interest

Statement of informed consent

Informed consent was obtained from all individual participants included in the study

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