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Effects of Mulligan's Rotation Mobilization With Movement and taping on knee pain, foot posture and functional status in medial compartment knee Osteoarthritis.

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ABSTRACT

Mulligan's Mobilization With Movement (MWM) and taping techniques are known to be effective in reducing pain, increasing Knee range of motion and improving function in patients with Knee osteoarthritis (OA). This study specifically focussed on determining the effect of Mulligan's Rotation MWM and taping not only on local parameters at the site of application of the glide at the knee, but also distally at the foot. This Quasi experimental study was performed on a purposive sample of 54 individuals responding to Mulligan's Internal or External Rotation glide, in the age group of 50 to 70 years having Grade 2/3 medial compartment Knee OA on Kellgren and Lawrence classification for Knee OA.Outcome measures included the Visual Analogue Scale (VAS) for Knee pain, Navicular Height (NH), Foot Posture Index (FPI), Aggregated Locomotor Function (ALF) Score, Knee Range of motion (ROM) using goniometer, Tibial Torsion Angle and Quadriceps Angle (Q angle) using goniometer. Outcomes were assessed at baseline and 24 hours after application of the last treatment session. All participants underwent treatment sessions of therapist-applied MWM and taping daily for 4 consecutive days after the baseline assessment. Tape was removed prior to the post-intervention assessment.65% of patients responded to an Internal Rotation Mulligan glide in this study. Statistically significant improvements from baseline were seen in all outcome measures except the Q angle. Knee pain intensity reduced at rest, during lunging and during performance of most-offending movement post-treatment compared to the baseline ($p < 0.001$). Time required for performance of functional activities including locomotion, sit-to-stand and staircase ascending-descending was statistically significantly reduced post-treatment as demonstrated by a lowered ALF score ($p < 0.001$). Foot posture changes seen post-treatment included a statistically significant increase in the NH ($p < 0.001$) and a reduction in the FPI score ($p = 0.021$). A statistically significant reduction in the Tibial torsion angle was seen post-treatment compared to the baseline ($p < 0.031$). In this study conducted in patients with medial compartment Knee OA; Mulligan's Rotation MWM and taping were associated not only with reduced Knee pain, increased Knee range of motion and improved locomotor function; but also changes in foot posture.

Keywords: Knee, Osteoarthritis, Mobilization, Taping, Foot posture

INTRODUCTION

Osteoarthritis (OA) is a highly prevalent, chronic rheumatic disease commonly affecting the weight-bearing Knee joint of the lower extremity [1, 2]. In Knee OA, involvement of the medial tibiofemoral compartment is more commonly seen as compared to the lateral compartment [2].The clinical symptoms of knee OA include knee pain, swelling, joint stiffness, gradual limitation of range of motion (ROM) at the joint, instability and functional difficulties [3, 4]. Pain is often the predominant symptom in Knee OA and is the primary reason for seeking medical care [1]. Pain related to OA leads to impaired mobility, functional limitations and a reduced quality of life [4, 5]. The functional limitations seen are determined more by pain rather than the structural changes seen on radiographs [4]. Thus current therapeutic strategies in the management of OA primarily aim at reducing pain and improving function [3].

Common physiotherapy treatments recommended in the management of Knee OA include manual therapy, taping, exercise therapy, use of thermal agents, bracing, insoles and footwear modifications [6, 7]. Manual therapy is a clinical approach which utilizes skilled, specific hands-on techniques for the diagnosis and treatment of joint, neural and soft-tissue dysfunctions.

The Mulligan Concept of Mobilization with Movement (MWM) is a manual therapy technique which involves the application of a sustained passive glide to a painful or stiff joint by the therapist while the patient performs a concurrent active movement of the joint. The active movement performed by the patient is a previously impaired action (painful restricted movement or painful muscle contraction). The technique is indicated if its application enables the joint to move freely without pain or impediment [8, 9].

It has been postulated that MWM treatment techniques produce their effects by correcting positional faults of joints that occur following injuries or strains. Injury can theoretically result in a positional fault that alters joint kinematics and can be responsible for pain and decreased range of motion which should be resolved when the positional fault is corrected. The Mulligan concept enables clinical identification and treatment of positional faults [8,11].

MWM has several advantages over other passive manual therapy approaches as it involves the active participation of the patient to perform active movements of the affected joint along with the therapist-applied glide and the treatment is preferably performed in a weight-bearing position whenever possible. The Mulligan Concept approach also emphasizes on self-treatment and the application of glides during functional movements and movements which are most offending or difficult to perform by the patient. The use of taping has been advocated as an adjunct to the MWM technique to prolong the benefits of mobilization. The application of the tape enables the glide used for correction of the positional fault to be maintained [8,11].

The etiology of Knee OA is multifactorial involving both biochemical and biomechanical factors. The entire synovial joint as a whole is affected with structural changes occurring in the bone, articular cartilage, the synovium along with the soft-tissues in and around the joint [1]. In the mechanical factors, skeletal malalignment has been shown to play an important role in the development and progression of the disease [12, 13].

A skeletal malalignment is defined as an abnormal joint alignment or deformity which can result in pathology of structures within the neuro-musculoskeletal system. The pathology can occur at the site of the skeletal malalignment or at a distant site characterized by correlated or compensatory motions or postures if the sites are linked to each other in a closed kinetic chain [14]. Individuals with medial compartment knee OA often display Genu varum malalignment which increases the risk of development and progression of Knee OA [12,13]. Assessment of pelvic and lower extremity alignment along with foot posture assessment provide valuable information regarding the various correlated and compensatory motions and thus form an integral part of the examination in patients with Knee OA. Excessive subtalar pronation is one of the compensatory motions associated with Genu varum malalignment [14]. Studies demonstrate that people with medial compartment Knee OA have relatively pronated foot posture and demonstrate foot kinematic patterns that are indicative of a less mobile everted type foot compared to controls [15,16].

It is unclear whether the foot posture changes in patients with Knee OA are a cause or consequence of the disease.[15] Numerous studies demonstrate the effectiveness of footwear modifications and orthotics in altering medial knee joint loads [17]. Research has been conducted to study foot posture in individuals after re-alignment of the knee following Total Knee Replacement [18]. However, there are a limited number of studies on the assessment of foot posture following conservative treatments directed at the Knee joint.

The aim of this study was to determine the short term effects of Mulligan's Rotation MWM and taping (applied to the knee joint) on knee pain, foot posture and functional status in individuals with medial compartment knee OA. Rotation MWM was chosen considering the coupling movement between the rearfoot and the tibia [19]. The Aggregated Locomotor Function (ALF) score was chosen for the study of functional status as it gives an objective assessment of functional capability of the patient during tasks like stairclimbing, rising from sitting and walking on a level surface [20].

The objectives of the study were as follows: (1) Identification of the direction of positional fault by clinical examination (2) Pre-Intervention assessment of Pain intensity, Foot posture, Functional status, Knee Range of motion, Quadriceps and tibial torsion angles. (3) Post-Intervention re-assessment of the parameters mentioned above. (4) Comparison of the above mentioned parameters before and after administration of treatment sessions to determine the difference pre and post treatment.

MATERIALS AND METHODS

This Quasi experimental (Single group Pre-test - Post-test design) study was conducted on a purposive sample of 54 individuals with medial compartment Knee OA in the age group of 50-70 years. Ethical clearance was obtained from the Institutional Ethics Committee prior to commencement of the study. Participants were provided an information sheet with the details of the study in their preferred language and were verbally explained the aim and purpose of the study. All participants signed an informed consent form prior to enrolment.

Screening procedure

72 patients were screened, out of which 61 patients fulfilling the eligibility criteria were enrolled in the study. The final number of participants in the study was 54 after 7 patients were lost to follow-up.

Inclusion Criteria

- Individuals with unilateral or bilateral medial compartment tibiofemoral Knee OA on radiographic diagnosis by orthopaedic consultation (Grade 2 and Grade 3 on the Kellgren and Lawrence classification for Knee OA) referred to the physiotherapy out-patient department. In case of bilateral involvement, the knee with greater range restriction or symptoms was considered for data collection.
- Knee pain with an onset of less than or equal to 2 years for most days of the prior month on weight-bearing activities like lunging, sit-to-stand, walking or stair-climbing and descending, responding to Mulligan's Rotation MWM.
- Limited or painful Knee flexion movement responding to Mulligan's Rotation MWM.
- Overweight or Grade 1 obese.

Exclusion Criteria

- Uncontrolled systemic diseases, pre-existing neurological or orthopaedic conditions that affect walking.
- History of trauma, internal derangement at the knee joint in the previous 6 months.
- Allergy to rigid tape, past history of allergy and other dermatological conditions.
- History of Surgical procedure or intra-articular injection in the knee joint in the previous 6 months or oral corticosteroid intake in the previous 4 weeks.
- Patients undergoing medical treatment for pain management or any other physiotherapy treatment.
- Predominant Patello-femoral or lateral compartment Knee Osteoarthritis.
- Patients with congenital or fixed deformities of the foot.
- Fixed Flexion Deformity (FFD) at the Knee.

Identification of the glide direction for the MWM treatment technique

Sustained manual glide (Rotation) was applied by the therapist during active knee flexion and extension in supine lying. The manual glide was applied with one hand grasping the lower leg, the heel of the hand posterior to the the proximal fibula, and the other hand grasping the spine of the tibia. The tibia was rotated on the femur as the patient performed active knee flexion and extension. The glide was initially applied in the internal rotation direction followed by external rotation if the patient did not respond to an internal rotation glide. The glide direction that reduced pain and/or improved knee range of motion was chosen as the glide for the MWM and taping treatment. If pain was not present in supine lying, then the glide direction was assessed in a weight-bearing position in a similar manner. This involved lunging with the affected extremity ahead [8,11].

Outcome measures

Assessment was performed at the baseline and 24 hours after administration of the 4th and final treatment session. (All participants underwent sessions of therapist-applied MWM and taping daily for 4 consecutive days after the baseline assessment. Tape was removed prior to the post-intervention assessment.)

Knee Pain

Intensity of Knee Pain was assessed using a 100mm Visual Analogue Scale (VAS) [21]. Patients were asked to rate the intensity of knee pain at rest, during forward lunging on the affected leg and while performing a movement or task which the patient reported as most difficult or offending.

Foot Posture

Foot posture was assessed by Navicular Height (NH) measurement and the Foot Posture Index (FPI). NH was measured in subtalar resting position using a business card from the navicular tuberosity to the floor. (22) (Fig 1) During assessment of the FPI, the patients were asked to stand still in a relaxed standing position with double limb support, arms by the side of the body with the head facing straight ahead. The patients were asked to perform spot marching prior to settling into a comfortable relaxed stance position. The patients were asked to stand in this position for 2 minutes with their eyes open. The rearfoot was assessed via palpation of the head of the talus, observation of the curves above and below the lateral malleoli and measuring the extent of inversion/eversion of the calcaneus. The observations of the forefoot consisted of assessing the bulge in the region of the talonavicular joint, the congruence of the medial longitudinal arch and the extent of abduction/adduction of the forefoot on the rearfoot (Fig 2). Each item was scored on a 5 point scale between -2 and +2. The total score was obtained by calculating the sum of the individual scores and ranged from -12 (highly supinated foot) to +12 (highly pronated foot) [23].

Fig 1: Navicular Height Measurement

Fig 2: The left sided calcaneal eversion is more as compared to the right, and no medial toes are visible bilaterally. Lateral toes are clearly visible.

Functional Status

Aggregated Locomotor Function (ALF) score was used to assess the functional status. The score was obtained by summating the mean timed scores (in seconds) from 3 locomotor functions (Walking time, Transferring time, and Stair ascent –descent time). A 10 meters walkway was used for the assessment of level ground walking and a flight of 7 steps was utilized for stair ascending and descending function. For assessment of transferring time, a distance of 2 meters was marked and a chair without armrests was placed at one end. The patients were asked to walk at a comfortable pace starting from the other end towards the chair, sit down and then immediately stand up and walk back to the start. All 3 functions were performed at a naturally preferred comfortable pace and use of walking aids was permitted if required [20].

Knee ROM

Measurement of Knee ROM was performed in supine position using a universal goniometer [24].

Quadriceps Angle

The Q-angle was measured in the relaxed standing position using a universal goniometer [25].

Tibial Torsion Angle

In this study, the tibial torsion was measured using a universal goniometer. The subject position was prone lying with the knee flexed to 90 degrees and ankle neutral. The centre point of each malleolus was marked and the 2 points were joined by a line across the plantar aspect of the heel. This line approximated the transmalleolar axis. The angle between a line perpendicular to the transmalleolar axis and the long axis of the thigh was measured [26].

INTERVENTION

Mobilization with Movement (MWM)

In the first session- 1 set of 3 repetitions of MWM were administered followed by taping in a direction consistent with the glide applied. In the subsequent 3 sessions, 3 sets of 10 repetitions each were administered followed by taping. Patients were instructed to remove the tape after 8 hours and the appropriate method of tape removal was taught to the patient. The patients were instructed to remove the tape immediately in the presence of skin itching or irritation. The technique was performed initially in lying position and was later progressed to weight-bearing positions when the movement in lying position was pain free. In weight-bearing, the patient was instructed to lunge only slightly not allowing the knee to bend beyond the level of the toes of the foot. Overpressure was applied at the end of the range within pain-free limits [8,11].

Application of the glide prior to Taping

Non-elastic adhesive-backed rigid tape was applied over a medical underlay. The tape was applied with the patient in a standing position. The patient was asked to place the affected leg ahead with the hip in medial rotation and the knee in slight flexion. With the affected leg placed firmly in contact with the ground, the patient was asked to turn and step forwards with the unaffected leg, placing the unaffected leg slightly antero-lateral to the affected leg. This resulted in a lateral rotation of the femur of the affected side on the fixed tibia, indirectly resulting in an internal rotation glide of the tibia over the femur. For Lateral Rotation MWM, the limb was placed in external rotation and the opposite set of movements were performed. The patient was asked to step backwards placing the unaffected leg postero-lateral to the affected leg, resulting in a medial rotation of the femur on the fixed tibia. The glide was thus passively applied and sustained due to the position adopted by the patient and the tape was applied without any pull or tension [8,11].

Taping for Medial rotation MWM

The medical underlay was applied followed by the non-elastic rigid tape starting at the posterior border of the proximal fibula, going anteriorly over the tibial tuberosity, below the joint line on the medial side, posteriorly crossing the popliteal fossa and ending anteriorly on the thigh, above the lateral joint [8,11].

Taping for Lateral Rotation MWM

The medical underlay was applied followed by the non-elastic rigid tape starting at the posterior border of the proximal tibia, going anteriorly over the tibial tuberosity, below the joint line on the lateral side, posteriorly crossing the popliteal fossa and ending anteriorly on the thigh, above the medial joint line (Fig- 3a and 3b) [8,11].

Fig 3a: Anterior view of Tibiofemoral Lateral Rotation Mulligan Taping .

Fig 3b: Posterior view of Tibiofemoral Lateral Rotation Mulligan Taping.

STATISTICAL ANALYSIS

Analysis of the collected data was done using Statistical Package for Social Sciences (SPSS) version 19. The estimated sample size for the study was 52 participants.

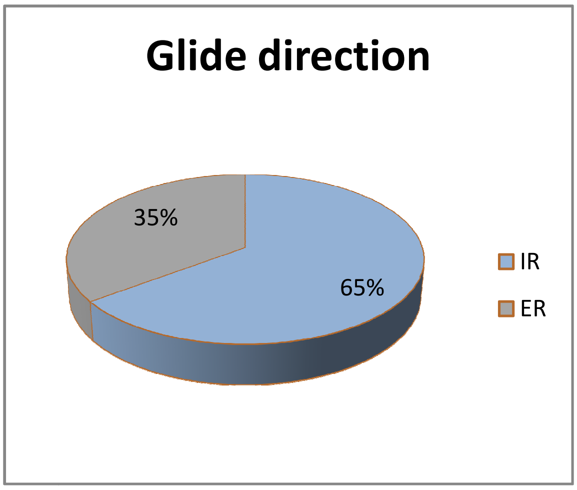
Calculation of sample size was done using the following formula: $n = (t^2 * S.D^2)/E^2$ (n=sample size, t= constant, S.D= Standard Deviation, E= Error).Wilcoxon Signed-Ranks test was used to analyse VAS and the FPI scores. The paired t test was used to analyse Knee flexion ROM, Q angle, Tibial torsion angle, NH and ALF score. The tests were applied at 95% Confidence Interval (C.I) with the p value set at 0.05. The results were taken to be statistically significant if $p \leq 0.05$.

RESULTS

Out of the 54 patients participating in the study, 72.2 % were females. 85% of the patients had bilateral involvement.

Variable	Mean ± S.D
Age (years)	58.2 ± 5.84
BMI (kg/m^2)	27.5 ± 2.45

Table 1: Demographic data: Age, BMI



Graph 1: Pain-Free Glide Direction (IR: Internal Rotation, ER: External Rotation)

Table 1 shows the Demographic data of the participants. Graph 1 demonstrates the direction of Rotation to which the patients responded during initial screening. The direction of the Positional fault at the tibiofemoral joint was considered clinically to be in a direction opposite to the pain-free glide direction.

Table 2: Pain Intensity

Variable	Pre-Intervention (Mean ± S.D)	Post-Intervention (Mean ± S.D)	Wilcoxon Signed-Ranks Test (Z)	p Value
VAS –At Rest (mm)	33.34 ± 24.54	18.48 ± 17.83	5.01	<0.001 HS*
VAS –Lunging (mm)	52.35 ± 21.34	35.04 ±19.82	5.63	<0.001 HS
VAS- Most-offending movement (mm)	70.00 ± 21.12	42.98 ± 21.66	6.36	<0.001 HS

*HS- Highly Significant

Table 2 shows the comparison of VAS scores pre and post-intervention at rest, during lunging and during the most-offending movement Most-offending movements varied for each patient and included activities such as sit to stand, sitting cross-legged, stair ascending, stair descending, lunging, squatting, standing for a prolonged period, getting up from the floor and walking. A statistically highly significant reduction was noted in all the 3 readings of pain intensity post-intervention as compared to the pre-intervention scores.

Table 3: Foot Posture

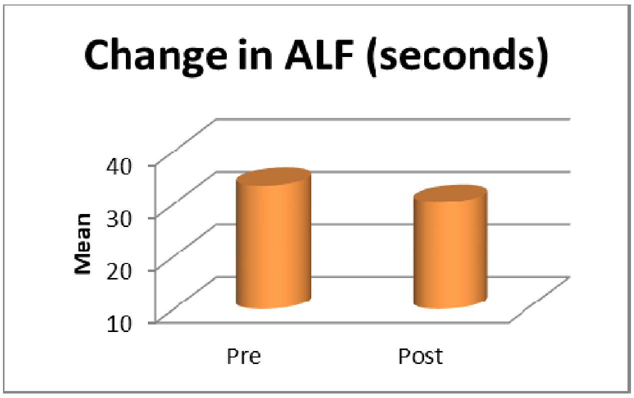
Variable	Pre-Intervention (Mean ± S.D)	Post-Intervention (Mean ± S.D)	Statistical Test	p Value
NH (cm)	3.43 ± 0.63	3.63 ± 0.62	Paired t test (t) 6.092	<0.001 HS

FPI Score	6.20 ± 1.82	6.06 ± 1.84	Wilcoxon Signed- Ranks Test (Z) 2.309	0.021 Sig*

*Sig-Significant

Table 3 demonstrates the baseline and post-intervention values of the NH and FPI. A statistically significant increase in the NH was seen in the individuals post-intervention as compared to the pre-intervention values. A statistically significant reduction in the FPI-score was noted post intervention as compared to the baseline score.

Graph 2: ALF score



Graph 2 shows that there was a statistically highly significant reduction in the ALF score post-intervention compared to pre-intervention values which is indicative of an improvement in the functional status of the individuals. Table 4 demonstrates the baseline and post-intervention values of the ALF score.

Table 4: The baseline and post-intervention values of the ALF score

Variable	Pre-Intervention (Mean ± S.D)	Post-Intervention (Mean ± S.D)	Paired t test (t)	P Value
ALF Score (In Seconds)	33.49 ± 7.27	30.30 ± 6.71.	9.499	<0.001 HS

Comparison of pre and post-intervention scores of Knee ROM, Q angle and Tibial Torsion angle are demonstrated in Table 5. A statistically significant increase in the Knee flexion ROM was noted post-intervention as compared to the pre-intervention values. There was no statistically significant difference in the value of the Q-angle. A statistically significant decrease in the tibial torsion angle was noted post-intervention as compared to the baseline value.

Table 5

Variable (In degrees)	Pre-Intervention (Mean ± S.D)	Post-Intervention (Mean ± S.D)	Paired t test (t)	p Value
Knee ROM	118.63 ± 12.33	121.46 ± 12.16	3.579	0.001 Sig
Q angle	18.50 ± 4.52	18.09 ± 3.73	1.062	0.293 NS*
Tibial torsion angle	18.48 ± 6.80	16.89 ± 5.78	2.211	0.031 Sig

*NS- Not significant

DISCUSSION

Pain in the early stages of OA is usually intermittent, localized to the affected joint, triggered by specific activities (referred to as offending movements) and relieved by rest. Early OA pain has been attributed to the activation of nociceptors within the joint due to local structural changes and abnormal joint loading. Innervated structures within the joint include the knee joint capsule, synovium, ligaments, menisci, periosteum and subchondral bone. Pain in OA may arise from any of these structures as well as the surrounding soft-tissues. Along with joint nociception, peripheral and central neural mechanisms have also been shown to contribute to pain in the later stages of the disease. Mechanisms of pain in OA have been explained using the biopsychosocial model which involves an interaction of physiological, psychological and social factors [1, 27, 28].

The mechanisms by which manual therapy leads to pain relief have been explained by Bialosky et al using a comprehensive model. Along with the biomechanical effect occurring at the joint level, the mechanical force applied during manual therapy is said to initiate a chain of neurophysiological responses acting at the peripheral, spinal and supraspinal levels [29]. Studies have demonstrated both Biomechanical (Positional fault correction with mobilization and maintenance of the glide with taping) and neurophysiological mechanisms contributing to the pain relief achieved by MWM techniques along with taping [9].

In this study, a statistically significant reduction in pain levels at rest, during lunging and during the performance of the most offending or difficult movement was seen post-intervention of rotation MWM and taping as compared to baseline pain levels. A Statistically significant increment in the Knee flexion ROM was also noted post-intervention compared to baseline levels. 65% of individuals responded to an Internal Rotation MWM glide. According to the positional fault hypothesis, these individuals demonstrated a positional fault in the direction of external rotation of the tibia over the femur and thus responded to a glide applied in a direction opposite to that of the positional fault. Positional faults have been defined as subtle sustained malalignments leading to altered joint kinematics [9, 10]. Several studies have demonstrated alteration in the normal joint alignment and kinematics in patients with medial compartment Knee OA [30, 31]. Matsui Y et al reported that varus deformity in knee OA is associated with a significant rotational deformity in which the tibia is positioned in an externally rotated position relative to the femur [31]. An absence of the normal screw-home mechanism has also been noted in patients with medial knee OA. In a weight-bearing position, the femur undergoes external rotation over a fixed tibia during knee flexion. The range of femoral external rotation and posterior translation of the lateral condyle has been found to be reduced in patients with medial knee OA as compared to controls [30].

Thus the mobilization applied, which was in an internal rotation direction in 65% patients, may have led to correction of the positional fault at the tibiofemoral joint, leading to improvements in pain levels and an increase in knee flexion ROM. Application of the tape enabled the maintenance of the glide applied. None of the patients in the study reported any discomfort or skin irritation with the application of the tape which would require tape removal prior to the stipulated time period. The tape might have also led to a sustained stretching of the surrounding soft-tissue structures around the knee joint which may have led to increased extensibility of these tissues resulting in pain reduction and improved range of motion.

Taping of the tibia into internal rotation over the femur is also based on the premise that the taping leads to a reduction in joint stresses at the patella-femoral joint. Internally rotating the tibia has been suggested to alter the tracking of the patella in the femoral groove. Lee et al studied the effects of tibial rotation on the patella-femoral joint and demonstrated that fixing the tibia in 15 degrees of external tibial rotation beyond neutral resulted in significant increases in both the average and peak patellofemoral joint contact pressures at all knee flexion angles [32]. In the present study, patients with a predominant involvement of the patella-femoral joint were excluded.

Foot posture which was evaluated using the NH and FPI scores showed statistically significant differences post-intervention as compared to the baseline values. NH in the participants at baseline was lower than the normative values of NH (3.6-5.5 cm) [22]. Mean FPI score was 6.20 $\pm$ 1.82 at baseline indicative of a pronated type foot as per the FPI-score reference values. The post-treatment FPI-score was also indicative of a pronated type foot, even in the presence of a statistically significant difference compared to the baseline [33].

The joints of the lower limb work in a closed kinetic chain during functional activities like walking, lunging, sit-to-stand, stair-ascending and descending. A malalignment affecting any aspect of the closed kinetic chain brings about an associated correlated motion at the adjacent joints. A compensatory motion is brought about at the adjacent joints in the closed chain to overcome the malalignment at the affected area. Excessive subtalar pronation occurs in patients with genu varum malalignment as a compensatory motion to allow the medial heel of the foot to contact the ground during weight-bearing [14]. Increased subtalar pronation is also adapted by the patient in an attempt to reduce the load on the medial compartment by laterally shifting the centre of pressure and potentially reducing the Knee adduction moment (KAM) [15]. In this study, the improvement in the foot posture with increase in the arch height may have occurred due to the reduction in the knee symptoms and a reduced need of foot compensation to reduce the knee joint loads.

Mackay et al studied the effect of Mulligan Knee taping on ankle biomechanics in female patients with patello-femoral pain. Lower limb kinematics and kinetics were studied during functional tasks such as Single Leg Squatting and running. The study utilized the rigid tape as well as elastic tape applied at maximal available tension and compared between the two types of taping. Increased ankle dorsiflexion angles during squatting were noted when the rigid tape was used which correlated with increased knee flexion noted during the single leg squat with the rigid tape. Both tapes significantly reduced inversion-eversion ROM and peak ankle inversion moments during running as compared to the control group [34].

Statistically significant improvements in locomotor function were noted post-intervention as compared to baseline measurements in the current study. There was an increase in the speed of walking, stair-ascending and descending and sit-to-stand functions which was demonstrated by a decrease in the ALF score. The findings of this study are consistent with previous studies conducted by Takasaki et al and Altmış et al in patients with Knee OA. A prospective case series conducted by Takasaki et al studied the Immediate and short-term effects of Mulligan's mobilization with movement on knee pain and disability associated with Knee osteoarthritis. Significant immediate pain relief, improved Knee flexion ROM and knee function were noted post-intervention as compared to baseline [35,36].

Altmış et al investigated the acute effects of MWM and taping on function and pain intensity in patients with Knee OA. Patients were divided into 3 groups in which the first group received MWM and Internal Rotation taping, second group received MWM and placebo taping while the 3rd group received only placebo taping. In the first group, the determination of glide direction was performed similar to the current study but all glide directions were included and taping was performed in an internal rotation direction consistently for all participants. Kinesiological tape with a submaximal stretch was utilized for taping. Pain intensity and performance was assessed during various functional tasks. The study concluded that MWM and taping resulted in pain relief and improved performance during functional tasks. The authors emphasized the importance of taping as better performance in functional tasks was observed in the group which received taping as compared to the group which received MWM without taping. Similar to the present study, pain-relief was observed even in the absence of the tape in the acute period post-intervention. The authors noted that neurophysiological mechanisms such as desensitization of the pain pathways due to the positive effects of repetition of pain-free movements in the presence of appropriate joint alignment could play a role in pain-reduction in the acute phase even in the absence of the tape.[36] Repetition of pain free movements in weight-bearing positions, supported by taping may have contributed to the improved locomotor function seen in the patients in the present study. The MWM was performed in the weight-bearing position which requires muscular activity and might have led to increase in the motor performance with a reversal of the reflex pain inhibition.

Schein et al conducted a study to evaluate the association between pain intensity and improvements in functionality and health-status in patients with chronic OA of the hip or knee. They concluded that there was a positive correlation between the degree of pain intensity improvement and improvement of functional status measured using the WOMAC scale and the health status measured using the SF-36 scores [37]. Thus the improved pain scores in the present study could have played a role in improving locomotor function.

There was a statistically significant decrease in the tibial torsion angle post-intervention compared to baseline. A decrease in the Tibial torsion angle is indicative of a decrease in the amount of external tibial torsion [26]. Normative values of tibial torsion measured by CT scan in non-arthritic adult Indian population have been reported to be 21.6 +/- 7.6 degrees of external torsion [38]. In studies conducted in patients with medial Knee OA, it has been reported that with advancing severity of Knee OA, there is a reduction in the external tibial torsion.[39] Considering the short duration and conservative nature of the treatment in this study, it is unlikely that the changes observed post-intervention were due to actual bony changes in the torsion of the tibia. The methods used to measure tibial torsion in this study did not enable the differentiation between tibial rotation at the tibio-femoral joint and tibial torsion. The reduction observed in the tibial torsion angle may reflect changes in the resting position of the tibia over the femur due to the change in the length of the soft tissue structures around the knee that may have occurred due to sustained stretch applied in an Internal rotation direction in majority of the patients in this study.

In this study, there was no statistically significant difference in the Q-angle post-intervention compared to baseline. The normative value for the Q-angle varies from 8 to 22.8 degrees in different populations. The mean value of the Q-angle in healthy adult Indian participants in a study has been reported to be 14.48 $\pm$ 2.02 degrees in females and 10.98 $\pm$ 1.75 in males [40]. The tibial tuberosity is one of the bony prominences used in the measurement of the Q-angle and thus influences the value of the angle due to changes in its position relative to the Anterior Superior Iliac Spine (ASIS) and the Centre of the Patella (CP) In Genu varum, there is a lateral displacement of the patella relative to the ASIS, thus reducing the Q-angle. In case of external tibial torsion, there is a lateral displacement of the tibial tuberosity leading to an increase in the Q-angle [41]. The statistically insignificant reduction seen in the Q-angle in this study may have occurred due to the change in the position of the tibial tuberosity due to alteration in the resting position of the tibia over the femur.

Clinical Implication

Rotation MWM and taping may be utilized in the treatment of patients with medial compartment Knee OA as a modality for pain-relief which would enable patients to participate in exercises and functional activities. Self-mobilization may be taught to patients to manage activity-related episodic pain. The post-intervention changes seen in this study were not limited to the level of application of the treatment (knee joint), but also affected the foot as demonstrated by significant changes in foot posture.

Future Scope

To study the long-term effects of treatment as well as plantar pressure changes associated with foot posture correction after application of Mulligan's Rotation MWM and taping in Knee OA.

CONCLUSION

Mulligan's Rotation MWM and taping produced statistically significant short-term reductions in Knee pain along with improvements in the Knee Range of Motion and locomotor function in patients with medial compartment Knee OA. Along with the local effects seen at the site of glide application at the Knee, statistically significant improvements in foot posture were also observed post-intervention. Clinical examination showed the presence of an External rotation positional fault of the tibia over the femur in majority of the patients in this study. Considering the short-term duration of the treatment, statistically significant reductions seen in the Tibial torsion angle may be attributed to tibio-femoral rotation alterations rather than changes in tibial torsion.

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