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RESEARCH ARTICLE

EFFECT OF MULLIGAN TAPING ON QUADRICEPS STRENGTH, KNEE PAIN AND FUNCTION IN KNEE OSTEOARTHRITIS USING VISUAL ANALOGUE SCALE AND KOOS

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Abbreviations

ADL: Activities of Daily Living
HHD: Hand Held Dynamometer
IPOST: Immediate post taping
KOOS: Knee Injury and Osteoarthritis
Outcome Score
MWM: Mobilization with Movement
QOL: Quality of Life
VAS: Visual Analogue Scale
48POST: 48 hours post taping

ABSTRACT

Background: Osteoarthritis is a degenerative, non-inflammatory, joint disease characterized by destruction of articular cartilage and formation of new bone at the joint surface and margins. Quadriceps strengthening is widely recommended in knee osteoarthritis as it decreases pain and improves function. Studies say with malalignment and laxity, muscle forces may increase stress on localized areas of articular cartilage. Malalignment in the knee joint may alter the line of action of the quadriceps forces thereby distributing unequal forces across the joint. Strengthening in such malaligned joint can hasten the progression of osteoarthritis. Mobilization with Movement (MWM), a joint mobilization technique developed by Brian Mulligan says that pain and movement restriction is due to positional faults. Correction of this positional fault has an immediate effect on pain and disability in knee osteoarthritis. Studies show that taping improves knee joint kinematics taping reduces pain and allows a more comfortable quadriceps contraction. The aim of this study was to check if immediate pain relief and correction of joint malalignment (joint tracking) by Mulligan (tibial internal rotation) taping has an effect on quadriceps strength.

Objective: To assess the effect of Mulligan taping and Placebo taping on knee pain, quadriceps strength and knee function in patients with knee osteoarthritis. To compare the effect of Mulligan taping and Placebo taping on knee pain, quadriceps strength and knee function in patients with knee osteoarthritis.

Methods: study design: Prospective experimental study design. 62 participants were included in the study after taking their informed consent. Participants were divided into 2 groups of 31 each using computer generated randomized table. Group A received Mulligan taping (with tibial internal rotation glide). Group B received Placebo taping (without tibial internal rotation glide). Participants were assessed for pain, Q angle, quadriceps strength and knee function before taping, immediately after taping and 48 hours after taping using Visual Analogue Scale, 1RM, Knee Injury and Osteoarthritis Outcome Score respectively.

Results: Both Mulligan taping group and Placebo taping group showed reduction in pain, increased quadriceps strength and improved knee function. However, on comparing both the groups, Mulligan taping was more effective in reducing pain, improving quadriceps strength and improving knee function as compared to Placebo taping group.

Conclusion: Mulligan taping was more effective than Placebo taping in reducing knee pain, improving quadriceps strength and knee function in patients with knee osteoarthritis.

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INTRODUCTION

Osteoarthritis is a degenerative, non-inflammatory, joint disease characterized by destruction of articular cartilage and formation of new bone at the joint surface and margins (John Ebnezar). Osteoarthritis has a prevalence rate of 17% to 60.6% in India and its incidence increases with age making it a major contributor to disability in the elderly (Radha and Gangadhar, 2015). Osteoarthritis commonly affects the weight bearing joints like hip, knee and ankle (John Ebnezar). However, knee osteoarthritis is the most common. In osteoarthritis, with increasing age, degeneration of articular cartilage (cartilage flaking), eventually leads to loss of articular cartilage, thus

exposing underlying subchondral bone which has a rich nerve supply. Movement in this joint causes rubbing of the subchondral bone which is a common cause of pain in patients with osteoarthritis. Damaged articular cartilage also stimulates formation of osteophytes (bone spurs) (John Crawford Adams and David Hamblen). With time, as osteophytes expand, it puts a stretch on the pain sensitive periosteum thereby inducing pain. Also, to restrict this painful movement, muscles acting on the joint undergo protective spasm (Rene Cailliet). Quadriceps strengthening is recommended in knee osteoarthritis as it decreases pain and improves function. Strengthening exercises help to maintain cartilage health and joint stability. Studies say with malalignment and laxity, muscle forces may increase stress on localized areas of articular cartilage. Malalignment in the knee joint may alter the line of action of the quadriceps forces thereby distributing unequal forces across the joint.

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Strengthening in such malaligned joint can hasten the progression of osteoarthritis (Leena Sharma *et al.*, 2013). Mobilization with Movement (MWM), a joint mobilization technique developed by Brian R. Mulligan says that pain and movement restriction is due to positional faults. Correction of this positional fault has an immediate effect on pain and disability in knee osteoarthritis (Oskay *et al.*, 2015). Mobilization with Movement involves applying pain-free passive glide with simultaneous active movement. Mulligan technique uses PILL response, i.e., P - PAIN FREE, I- INSTANT RESULT, LL-LONG LASTING. PILL response is used to test if Mulligan technique is indicated for the joint. Thus, initial painful movement when performed with passive glide must show reduction or absence of pain (Brian R. Mulligan). In order to maintain this pain-free glide, Mulligan taping is applied in the direction of the passive glide (Oskay *et al.*, 2015). Studies show that taping improves knee joint kinematics; onset timing of the vasti and increases leverage of the quadriceps as the patella is shifted medially, thereby improving the mechanical advantage of the quadriceps. Also, taping reduces pain and allows a more comfortable quadriceps contraction (Pooja Arora *et al.*, 2012). In osteoarthritis, pain during movement is the most common complaint. Pain causes reflex inhibition of muscles acting on the joint which over a period disturbs mechanical integrity of the joint leading to malalignment. Pain shows direct relationship with muscle strength. Increased pain is associated with decreased muscle activation and as a consequence decreased muscle strength (N Shakoor *et al.*, 2008). Prolonged inhibition leads to muscle disuse thereby increasing the risk of instability and joint injury, thus pain and muscle inhibition form a vicious cycle. Conventional therapy aims at pain reduction before strengthening is started, thus preventing early resistance training. Also, pain increases patient apprehension to perform exercises. Thus, eliminating pain has two benefits:

- Early resistance training,
- Decreased patient apprehension towards exercising.

Hence, the need of the study is to check if immediate pain relief and correction of joint malalignment (joint tracking) by Mulligan (tibial internal rotation) taping has an effect on quadriceps strength.

MATERIALS AND METHODS

Design: Prospective experimental study design

Participants: Approval from the Ethics Committee was sought. Participants were included in the study after screening for inclusion and exclusion criteria. A written consent was taken from the participants after explaining the study procedure. Total 62 participants with knee osteoarthritis, who showed PILL response (P-PAIN FREE, I- INSTANT RESULT, LL-LONG LASTING) when tibial internal rotation glide was given by the therapist, were selected. Participants were divided into 2 groups of 31 each using computer generated randomized table. Group A received Mulligan taping with tibial internal rotation glide. Group B received Placebo taping (zinc oxide) without tibial internal rotation glide. For both groups; knee pain, Q angle, quadriceps muscle strength and knee function were measured before tape application, immediately after tape application, and 48 hours after tape application.

Inclusion Criteria

1. According to American College of Rheumatology Inclusion Criteria for Knee Osteoarthritis (John Ebnezar):

- Knee pain for most days of prior month.
- Crepitus on active joint motion.
- Morning stiffness equal and not more than 30 minutes in duration.
- Age equal to more than 38 years.
- Bony enlargement of the knee on examination.

Any 3 of the above mentioned criteria should be present.

2. V.A.S between 4 and 6.

3. 40-60 years of age (Radha and Gangadhar, 2015).

Exclusion Criteria

Patients with:

- Any history of ligamentous injury.
- Trauma to the knee joint.
- Infective arthritis.
- Diabetes mellitus.
- Any neuromuscular or vascular disorders of lower limbs.
- Associated musculoskeletal problems in proximal and distal joints.

Outcome Measures

- Pain on Visual Analogue Scale (VAS) in cm.
- Q angle.
- Muscle strength (1 RM) on Hand Held Dynamometer (HHD) in Kg.
- Knee function on Knee Injury and Osteoarthritis Outcome Score (KOOS).

1. Pain on Visual Analogue Scale (VAS) (David J. Magee)

0 10
(No pain) (Worst pain)

A 10 cm line was used to find the intensity of pain where 0 = no pain and 10= worst pain experienced. Participants were asked to mark their pain intensity on the scale.

2. Q angle measurement (David Magee): Participant lying supine, the angle was obtained by first ensuring that the lower limbs were at right angle to the line joining both the ASIS. Hip and foot were maintained in neutral position (with respect to rotations). A line was drawn from ASIS to the midpoint of patella on the same side and from tibial tubercle to the midpoint of patella. The angle formed by crossing of these two lines formed the Q angle.

3. Muscle Strength Measurement (1 RM) on Hand Held Dynamometer (HHD) (Martin *et al.*, 2006): Participants were made to lie supine with a bolster under the testing knee. Bolster position maintaining the knee at 35 degrees angle from full knee extension which was confirmed using a goniometer. Participants were asked to maintain contact with the bolster throughout the testing. Opposite leg was flexed at the hip and knee so that the foot was flat on the plinth, this helped to stabilize the pelvis. Hips were kept stationary with the glutei in

contact with the plinth. Participant's arms were placed loosely across the chest. Hand Held Dynamometer was placed at the ankle proximal to the medial and lateral malleoli. Isometric make test was used wherein the Hand Held Dynamometer was held in a fixed position and the participants were asked to push maximally against the Hand Held Dynamometer trying to straighten their leg from the knee. Test was performed with 5 seconds muscle contraction; one trial was performed, followed by two further attempts which were recorded. A 120 seconds rest period was given between each attempt. Mean of the three readings were taken for calculation.

4. Knee Function on Knee Injury and Osteoarthritis Outcome Score (KOOS) (Ewa *et al.*, 2013): To measure knee function, KOOS was used. KOOS consists of 5 subsets; pain, symptoms, activities of daily living, sports and recreational activities and quality of life. Sports and recreation subscale was not included in the study as the participants were not involved in any sports. In our study, KOOS questionnaire in regional languages (Hindi and Marathi) were used to evaluate the knee function (Richa Goswami *et al.*, 2012; Swati Meshram and Kartik Doshi, 2013).

Intervention

Mulligan Tape Application (Brian Mulligan): The participants stood with 5 to 10 degrees of knee flexion. Foot and tibia were internally rotated as far as possible on the femur. The femur was then taken into external rotation by asking the participants to do opposite side trunk rotation. Mulligan tape was then wrapped diagonally so that the upper edge of the tape crossed just below the patella. The tape included the posterior part of the fibula laterally; tape was then advanced medially upwards anteriorly so that the other end of the tape wrapped, up and around the thigh medially and finally ended at the lateral end of the lower thigh. An underwrap was used before applying the Mulligan tape. The tape was kept for 48 hours; however, if the participants reported any skin irritation, the tape was removed immediately.

Placebo Tape Application: The participants stood with knee in extension. Placebo tape was wrapped diagonally so that the upper edge of the tape crossed just below the patella. The tape included the posterior part of the fibula laterally; tape was then advanced medially upwards anteriorly so that the other end of the tape wrapped, up and around the thigh medially and finally ended at the lateral end of the lower thigh. The tape was kept for 48 hours; however, if the participants reported any skin irritation, the tape was removed immediately.

Data Analysis

- Data was analysed using SPSS16.0 software.
- Descriptive analysis of the data was done.
- Data was tested for normality using Shapiro – Wilk test.
- Visual Analogue Scale, Knee Injury and Osteoarthritis Outcome Score (KOOS) which are ordinal scales, data within group were analysed using Friedman's Two – Way Analysis Of Variance by Ranks. Between groups the data were analysed using Mann – Whitney U test.
- Hand Held Dynamometer (HHD) and Q angle which are ratio scales, data was tested for normality. Since it

did not pass normality, data within group were analysed using Friedman Two – Way Analysis Of Variance by Ranks. Between groups the data were analysed using Mann – Whitney U test.

- The level of significance was set at 0.05.

RESULTS

- The mean age in group A was 49.10 ± 6.94 years and in Group B was 50.97 ± 5.89 years respectively.
- The total number of subjects that participated in the study was 62. Out of which 17.74% subjects were males and 82.25% subjects were females.
- In both the groups, VAS, strength and KOOS using Friedman's test showed statistically significance ($p < 0.05$).
- In Group A, Q angle using Friedman's test showed statistical significance ($p < 0.05$)
- In Group B, Q angle using Friedman's test showed no statistical change.
- On comparing both the groups for VAS, strength and KOOS using Mann - Whitney U test, the result were found statistically significant at p value < 0.05 , for a two - tailed test. This indicates that Mulligan taping was more effective than Placebo taping in reducing pain, improving strength and knee function.

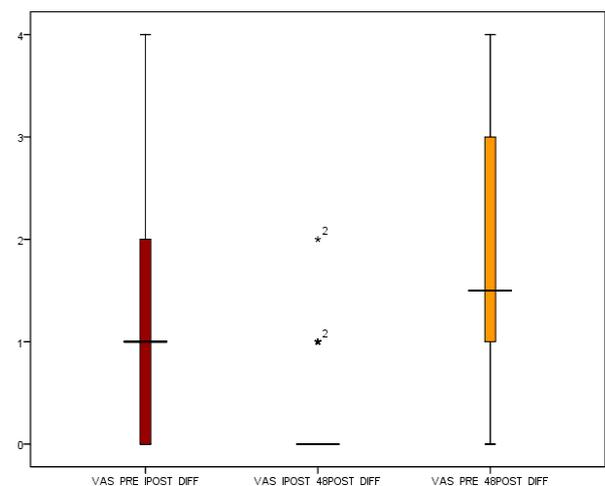


Figure 1. Boxplot shows comparison of pain in both groups.

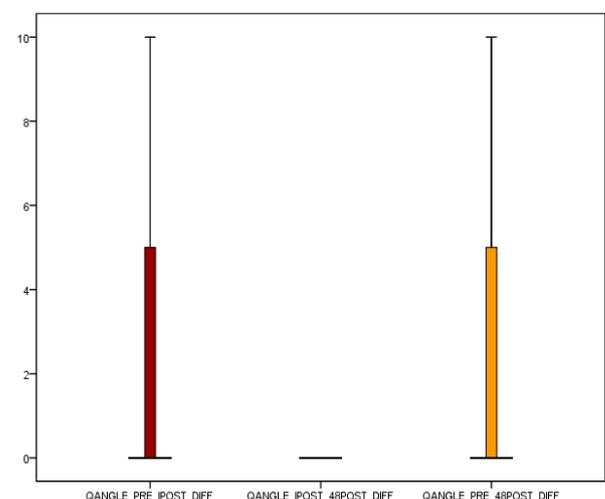


Figure 2. Boxplot shows comparison of Q angle in both groups.

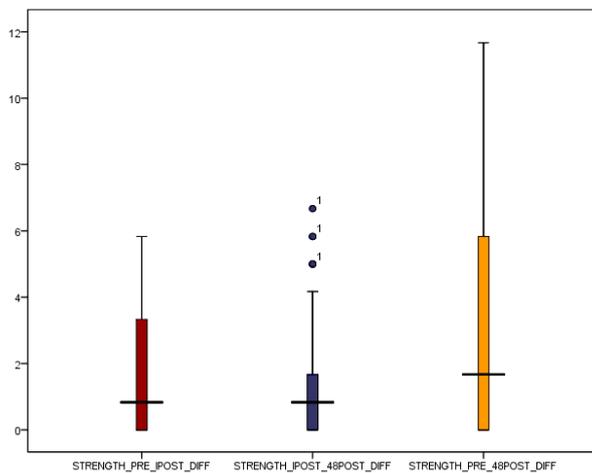


Figure 3. Boxplot shows comparison of strength in both groups

- For comparing the Q angle between groups, Mann-Whitney U test was used, the result were found statistically significant at p value < 0.05, for a two-tailed test both immediately post taping and 48 hours post taping when compared with pre taping values. The results were not statistically significant at p value > 0.05 on comparing immediate post taping and 48 hours post taping values. This indicates that the glide given with Mulligan tape to correct Q angle was maintained even at 48 hours.

DISCUSSION

Pain: Both Mulligan and Placebo taping groups showed reduction in pain. According to Melzack and Wall pain gate theory, stimulation of large diameter myelinated afferent neurons inhibits nociceptive afferent input at the spinal cord level. Descending pain inhibitory system also plays a role in pain inhibition. Mulligan mobilization stimulates this descending pain inhibitory system thereby causing immediate pain relief. Taping has an effect on pain; cutaneous stimulation provided by the taping techniques stimulates the large mechanoreceptors thereby causing neural inhibition and decreased pain perception (Pooja Arora *et al.*, 2012). In addition to this, Mulligan taping improves patellar alignment thereby decreasing patellofemoral contact pressures and decreased load distribution on the lateral facet of patella (Pooja Arora *et al.*, 2012). In our study since correction of patellar tracking is only done in Mulligan group, this group showed more reduction in pain. Study comparing two Mulligan techniques for knee osteoarthritis (medial glide and tibial internal rotation glide) showed tibial internal rotation glide to be more effective in reducing pain as this glide corrects the tibial external rotation which is the positional fault seen in patients with knee osteoarthritis (Dharmesh Solanki, 2015). In our study tibial internal rotation glide was used which also probably has helped in pain relief by correcting the positional fault.

Q angle: Mulligan group showed an improvement in Q angle immediately with no further improvement at 48 hours, whereas Placebo group showed no change in Q angle. According to Brian R Mulligan, tibial internal rotation glide used in patients with knee osteoarthritis corrects patellar tracking (Brian Mulligan). Correction of patellar tracking improves

mechanical advantage of quadriceps by shifting the patella medially as it returns to the trochlear groove of the femur (Pooja Arora *et al.*, 2012). On comparing both the groups, Mulligan taping shows more improvement in Q angle than Placebo taping group. However, no further change in Q angle was seen when immediate post taping values were compared with 48 hours post taping values indicating that tibial internal rotation glide given with the Mulligan tape improved the Q angle and it was maintained even at 48 hours.

Strength: Both Mulligan and Placebo group showed an improvement in quadriceps strength, but on comparing both the groups Mulligan group shows more improvement in quadriceps strength. Results of our study are supported by N. Shakoor *et al* who showed a direct relationship of pain with muscle strength and proprioception in patients with knee osteoarthritis (N. Shakoor *et al.*, 2008). Stacy Pagorek found that manual mobilization with movement done on patients with chronic lateral epicondylitis showed reduced pain and increased grip strength (Stacy Pagorek, 2009). Study by Pooja Arora *et al* says that tibial internal rotation glide improves the mechanical advantage of the quadriceps by repositioning the patella thereby improving quadriceps force of contraction and onset timing of vasti (Pooja Arora, 2012).

Knee Injury and Osteoarthritis Outcome Score (KOOS): Ewa M Roos *et al* states that Knee Injury and Osteoarthritis Outcome Score (KOOS) was developed to know about early and late disease specific symptoms like symptoms of knee osteoarthritis, pain, function, quality of life and activity level. In our study the KOOS scale gives an objective measure of the effectiveness of Mulligan taping and Placebo taping in reducing symptoms and improving the quality of life in patients with knee osteoarthritis. As already discussed, both the groups showed improvement in pain and strength which has led to improvement in symptoms, activities of daily living and quality of life. However, Mulligan taping group showed better results than the Placebo taping group as the positional fault was corrected by realigning the patella to its original position in addition to stimulation of large fibre mechanoreceptors only in the Mulligan group.

Conclusion

Mulligan taping and Placebo taping both were effective in decreasing knee pain, improving quadriceps strength and improving knee function in patients with knee osteoarthritis. On comparing the groups, Mulligan taping was more effective than Placebo taping in decreasing knee pain, improving quadriceps strength and improving knee function in patients with knee osteoarthritis.

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Conflict of Interest: Nil

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