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Research Article

Effectiveness of Patellofemoral Mobilisation, Stretching and Strengthening on walking Ability and Stair Climbing in Subjects with Osteoarthritic knee - A Comparative Study

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Abstract

Introduction: Much of functional impairment during walking and stair negotiation is directly related to the knee and is manifest in healthy individuals as they age and in those who live with knee osteoarthritis.

Aim of the study: To find out effects of (i) patella-femoral mobilisation, (ii) strengthening of quadriceps, hamstrings and hip abductors, (iii) stretching of knee joint capsule and tight rectus femoris, hamstrings, hip adductors, iliotibial band, TA and pyriformis muscles, and to compare the effects of these three techniques in pain and functional ability of persons with knee osteoarthritis.

Materials and Methods: The selected subjects were randomly assigned into 3 groups-Mobilisaion, Strengthening and Stretching with 10 subjects each. Subjects in group 1 received patellar mobilisation in all directions plus isometric exercise of quadriceps, group 2 received strengthening exercise of quadriceps, hamstrings and hip abductors plus isometric exercise of quadriceps and group 3 received stretching exercise of rectus femoris, hamstrings, hip adductors, pyriformis, posterior knee joint capsule, IT band, calf muscle plus isometric exercise of quadriceps. Total duration of treatment was 5 days in a week for 4 weeks.

Results: Results of the study suggested that all the three groups had a significant improvement in pain and functional ability in knee osteoarthritis after treatment for 4 weeks. However the mobilization group showed greater change as compared to the strengthening and stretching groups, and strengthening group showed more improvement than stretching group.

Conclusion: The study demonstrates that mobilisation, strengthening exercise and stretching reduced pain and improved functional ability in persons with osteoarthritis knee, and mobilisation is more effective.

Keywords: *Knee Osteoarthritis; Patello-Femoral Mobilization; Strengthening; Stretching*

Introduction

Osteoarthritis is a progressive degenerative disease that affects the joint cartilage, subchondral bone, synovial and joint capsule. It has a multi-factorial etiology and affects around 60% of individual aged over 50 years. According to Davis., *et al*. OA affects 9% of men and 18% of women over 65 years old and is responsible for high levels of absenteeism and retirement due to disability [1].

The clinical manifestations are joint pain, stiffness, decreased range of joint movement, muscle weakness and alteration in proprioception. Decreased strength in the muscle groups involving the joints is significant because it causes progressive loss of function. These symptoms significantly restrict the individual's ability to get up from a chair, walk or climb stairs. Walking with a limp and instabilities can also be observed in individuals with OA. During movement, crepitation can heard because of irregular joint surfaces due to degeneration [1].

It appears that patella-femoral joint compartment is an important source of symptoms associated with knee osteoarthritis, and possibly more important than tibio-femoral joint. Targeted intervention for patella-femoral joint osteoarthritis is required because of differences between this compartment and the tibio-femoral joint [2]. There is two common dysfunctions of the patella-femoral joint: (1) patella becoming too compressed against the femur; and (2) moving too far laterally in the intercondylar groove. Both conditions cause abrasion of the cartilage, leading to inflammation and degeneration [3].

Patella becomes too compressed due to increased flexion of the knee, which is caused by sustained tension in the hamstrings, iliotibial band (ITB), and gastrocnemius or by a shortened joint capsule. This compression force is dramatically increased when a person climb stairs or gets up from chair. Adductor muscle play a role in the stability of the pelvis, which can cause an external rotation that may result in compensatory foot pronation [3]. If the specific muscle group is restricted, more emphasis may be placed on that area, but there must be stretching of all the major muscle groups of the lower limb, because they all have an effect on the biomechanics of the Knee. In addition to its sedative effect, stretching exercise increases knee capsule extensibility and joint range of motion [4].

Dynamic stability at knee joint is provided by many muscles that surround the knee joint. Many muscles acting on the thigh have their insertions around the knee [4]. The quadriceps are the largest group of muscles crossing the knee joint and have the greatest potential to generate and absorb forces at the knee. Many clinical studies have shown consistent improvements in knee extension strength after training, as well as reduction in pain and physical disability of people with OA knee [4].

OA knee affects hamstring muscle more than the quadriceps muscle. Strengthening the hamstring muscle has been found to enhance the functional ability of deficient knee. The ratio of quadriceps to hamstring muscle strength is important for stability of the knee and for protection from excessive stress [4].

Decreased activity of hip abductor musculature during gait has also been suggested in individuals with knee OA and activity of the hip abductors may play role in disease progression [5]. Hip abductor muscle weakness may result in impaired frontal – plane pelvic control during gait, leading to greater medial compartment loading in people with knee OA. Thus, increasing the strength of the hip abductor muscles can reduce knee load and improve pain and physical function in people with knee OA [6].

A systematic review has shown that exercises reduces pain and improves function in patients with OA of the knee. Physical therapies commonly advocated for treating the symptoms of OA, include a wide variety of technique. But no study has been done to compare the effect of strengthening, stretching and patellar mobilisation for reduction of pain and improve in functional ability of patient with osteoarthritis of knee joint.

Aim of the Study

To find out effects of (i) patella-femoral mobilisation, (ii)strengthening of quadriceps, hamstring and hip abductor, (iii)stretching of knee joint capsule and tight rectus femoris, hamstring, adductor, iliotibial band, posterior capsule and pyriformis muscles, and (iv) to compare the effects of these three techniques in pain and functional ability of persons with knee osteoarthritis.

Materials and Methods

Study Design: Pre test and post test experimental study design.

A total of 30 subjects with osteoarthritis knee diagnosed clinically who met inclusion and exclusion criteria were recruited from the department of Physiotherapy, SVNIRTAR and a written consent was obtained from each subject. The selected subjects were randomly assigned to mobilisation, strengthening and stretching groups.

Inclusion Criteria: Subjects with bilateral OA knee, who met the current American rheumatology criteria for OA knee, Grade II and III of Kellgren and Lawrence radiographic changes in one or more compartments of knee, VAS >= 5, Normal cognitive, vision, auditory or vestibular system, Age 45 to 65 years, both sex, Independent in ambulation, not requiring any assistive device, no history of fall in the previous year, and able to ambulate 100 feet independently.

Exclusion Criteria: Other musculoskeletal conditions involving the knee joint, Knee OA secondary to inflammatory arthritis, Cortisone injection to knee joint within the previous 30 days, Surgical procedure on lower extremity within the past 6 months, Total knee arthroplasty, Uncontrolled hypertension, History of cardiovascular disease, History of neurological disorder that affect lower extremity function.

Procedures: All the subjects after meeting inclusion and exclusion criteria were asked to fill the consent form and then randomly divided into 3groups. (i) Mobilisation group – 10 subjects, (ii) strengthening group -10 subjects, (iii) stretching group – 10 subjects. Before initiating treatment, subjects were assessed for baseline values of all the dependent variables. (i) Visual analogue scale: Horizontal visual analogue scale was used for subjective pain intensity assessment. This is a card with uncallibrated scale ranging from 0 to 10 on one side end with 0-representing no pain and on other side end with 10- representing worst pain and it is corresponding to 10 cm ruler with each centimetre representing one pain value; it has a pointer, which can be easily moved from one end to other. (ii) Measurement of Six minute walk test: Six minute walk test (SMWT) quantified walking performance test. The distance travelled by the subject in 6-minutes was calculated. (iii) Measurement of Timed Stair Climbing (up and down) test: Timed stair climbing (up and down) quantified stair climbing performance test. The test was administered on a set of 11 steps with handrails on both sides, and a platform at the top and one at the bottom. The time was recorded after completion of stair climbing up and down.

Therapy was started day after the measurement was taken. Mobilisation group received rhythmical patella-femoral mobilisation in all direction as tolerated by the subject for 3 - 4 minutes. Strengthening group received strengthening for quadriceps, hamstring and hip abductors. According to De Lorme (PRE) 10 repetitions with 50% of 10 RM, 10repetitions with 75% of 10 RM, 10 repetitions with 100% OF 10 RM, total 3 sets of 10 repetitions and 2 minute rest between the sets. Progression in 10 RM was made every week.

Stretching group received passive stretching of rectus femoris, hamstrings, hip adductors, ilio-tibial band, and posterior capsule of knee joint, each of 30 seconds duration with 3 repetitions. Range was increased during stretching period if subject reported of decreased stretch discomfort. Isometric exercise of the quadriceps was given to subjects in all the three groups. One set of 10 repetition with 6 seconds hold and 10 seconds rest between the repetition. This procedure is repeated 20 times in initial 2 weeks and progressing to 3X10 repetitions in further two weeks.

Total duration of treatment was 5 days per week for 4 weeks.

Data Collection: Measurements were taken prior to the beginning of treatment and were repeated after completion of four weeks.

Data Analysis: The data was analysed with SPSS (statistical package for social sciences) 23 version for windows. The dependent variable were analysed using a mixed design 3x3 ANOVA, with repeated measurements in second factor. There was one between factor (groups) with 3 level (mobilisation, strengthening ex, stretching ex groups) and one within factor (time) with two levels(pre and post treatment measures). All pair wise post hoc comparison was done using a 0.05 level of significance.

Results

6– Minute Walk Test

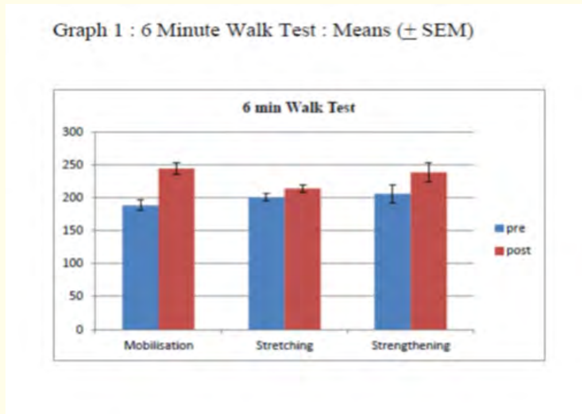

Figure 1: *Illustrated that there was improvement in 6 – minute walk test over time to a greater extent in mobilisation group than in strengthening group than stretching group.*

There was main effect for time, F = 386.727, df = 1, P = 0.000. There was main effect for group did not attain significance level, F = 0.589, df = 2, P = 0.562. The main effect were qualified by time x group interaction, F = 50.137, df = 2, P = 0.000.

Turkey's HSD analysis showed that all the three groups improved significantly in 6 minute walk test over time. Mobilisation group improved significantly more than the strengthening and stretching groups from pre to post measurement. Between later two groups, strengthening group showed more improvement than stretching group from pre to post measurement.

6– Minute Walk Test VAS

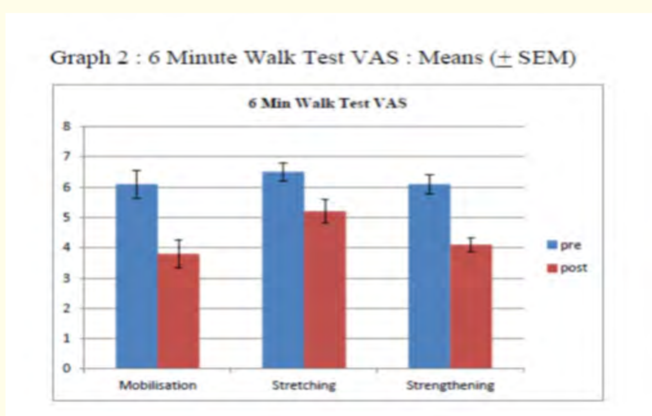

Figure 2: *Illustrated that there was improvement in 6 – minute walk test VAS over time to a greater extent in mobilisation group than in strengthening group than stretching group.*

There was main effect for time, F = 174.222, df = 1, P = 0.000. There was main effect for group did not attain significance level, F = 2.154, df = 2, P = 0.136. The main effect were qualified by time x group interaction, F = 4.389, df = 2, P = 0.022.

Turkey's HSD analysis showed that all the three groups improved significantly in 6 minute walk test VAS over time. Mobilisation group improved significantly more than the strengthening and stretching groups from pre to post measurement. Between later two groups, strengthening group showed more improvement than stretching group from pre to post measurement.

Timed Stair Climbing

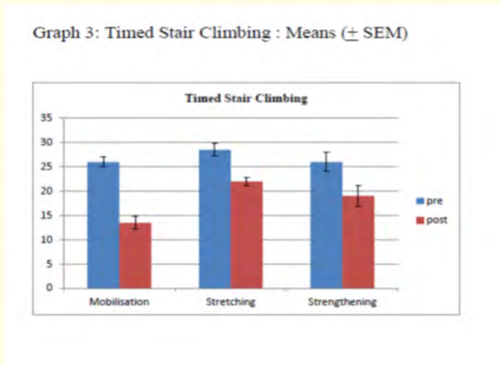

Figure 3: *Illustrated that there was improvement in timed stair climbing overtime to a greater extent in mobilisation group than in strengthening group than stretching group.*

There was main effect for time, F = 336.133, df = 1, P = 0.000 .There was main effect for group, F = 3.711, df = 2, P = 0.038. The main effect were qualified by time * group interaction, F = 16.533; df = 2, P = 0.000.

Turkey's HSD analysis showed that all the three groups improved significantly in timed stair climbing over time. Mobilisation group improved significantly more than the strengthening and stretching groups from pre to post measurement. Between later two groups, strengthening group showed more improvement than stretching group from pre to post measurement.

Timed Stair Climbing VAS

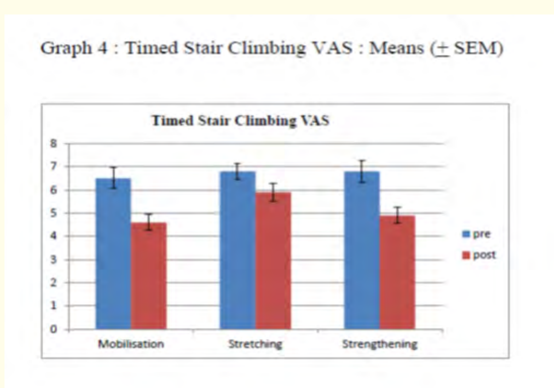

Figure 4: *: Illustrated that there was improvement in timed stair climbing VAS over time to a greater extent in mobilisation group than in strengthening group than stretching group.*

There was main effect for time, F = 185.804, df = 1, P = 0.000 .There was main effect for group did not attain significant level, F = 1.152, df = 2, P = 0.331. The main effect were qualified by time x group interaction, F = 8.411; df = 2, P = 0.001.

Turkey's HSD analysis showed that all the three groups improved significantly in timed stair climbing VAS over time. Mobilisation group improved significantly more than the strengthening and stretching groups from pre to post measurement. Between later two groups, strengthening group showed more improvement than stretching group from pre to post measurement.

Discussion

Overall result of study showed there was improvement in 6-min walk , timed stair climbing up and down , as well as pain in walking and stair climbing in all the three groups (mobilisation, stretching, strengthening) after 4 weeks of intervention. However mobilization group showed better improvement than strengthening as well as stretching group. Among stretching and strengthening group strengthening group had more improvement in all parameters than stretching group after 4 weeks of intervention.

Pain in VAS for Walking Ability and Stair Climbing

Results showed all the groups (mobilisation, strengthening, stretching) showed reduction in pain. Mobilisation group showed better improvement than strengthening as well as stretching groups and among stretching and strengthening groups strengthening group is better than stretching group.

In this study all the 3 groups have common isometric exercise. Isometric quadriceps might have helped in increasing the force production of quadriceps enabling the muscle to absorb part of load on the joint and with strength training there would be decrease in pain [7].

Additionally, isometric contraction produced low articular pressure and are well tolerated by OA patients with painful joints and helped in improving muscle strength static endurance [8]. The isometric exercise might have attributed to prevent neural dissociation through muscular contraction which stimulated the mechanoreceptors system in the joint capsule and surrounding ligaments and led to reduced pain. Isometric exercises emphasize co-contraction of antagonistic muscle groups surrounding proximal joints to increase postural control, which might have led to increment in strength gain with pain reduction in all the 3 groups in this study.

The result of the study show significant greater decrease in pain in mobilisation group than the strengthening as well as stretching groups. This group showed decrease in pain in walking and stair climbing by 37.70% and 29.23% respectively.

Application of medial glide stretches the tight lateral retinaculum [9]. The presence of tight IT band could limit the mobility of the patella and restrict its ability to shift medially during flexion, contributing to increased stress under the lateral facet of patella. Stretching must have relieved the stress on the lateral facet of patella and thus contributing to decrease in pain [9]. Lateral glide of patella was applied along with medial glide of patella. This must have also caused the breaking of adhesion in the medial capsule and contributing to decrease in pain. Patellar gliding in all direction increased the strain on the tight retinaculum; this could have provided maximum stretch to the tight retinaculum and thus decreasing pain. Neuro-anatomical studies of portion of the lateral retinaculum excised during operations on patients with anterior knee pain have demonstrated a greater distribution of nerve fibers and neural growth factors than in patient without knee pain [10].

Accessory movement of the knee joint might have stimulated the remaining non damaged articular mechanoreceptors and thereby reduced joint pain by inhibiting the nociceptive input at the spinal level. Human studies have demonstrated joint mobilisation produces rapid hypoalgesia with concurrent sympathetic nervous system and motor system excitation, a pattern similar to that generated by direct stimulation of the periaqueductal gray matter [11].

The above findings are supported by NorAzlin., *et al*. 2011 studied effect of passive joint mobilisation for 4 weeks in subject with OA knee. They found that inclusion of joint mobilisation into conventional physiotherapy reduces pain greater than conventional physiotherapy alone (44% to 20% respectively) [12].

This result is in congruous with the finding by Kumar., *et al*. (2006)who combined complex knee mobilisation and electrotherapy and Moss., *et al*. (2007), who compared tibio-femoral joint mobilisation against manual contact and non – contact control procedure in subject with mild to moderate OA knee [12].

Vanden Dolder and David L. Roberts (2006) reported that 6 session of manual therapy, each session lasted for 15 – 20 minutes resulted in decreased pain by -8 mm (95% CI- 17 to1, p = 0.08) and pain on stairs by -10 mm (95% CI- 4 to 16, p = 0.004) and no. steps in 60 sec by 5 (95% CI – 2 to 8, p = 0.001) compared with the control group [13].

In a study conducted by Gail D. Deyle., *et al*. 2000, treatment group received mobilisation and standardized knee exercise program for a period of 4 week and 8 week duration. This study showed the experimental group gained significantly over 6 min walk test and WOMAC scores and after 8 weeks average 6 min walk test improved 13.11% and WOMAC scores improved by 55.8% over baseline value in treatment group [14].

A study by Moss., *et al*. (2007), 9 minutes of accessory mobilisation immediately demonstrated a significantly greater mean (95% CI) percentage increase in pain threshold {27.3% (20.9 – 33.7)} than after manual contact {-0.4% (-4.2 to 3.5)} or no contact control {+7.9% (2.6-13.2)} in subject with mild to moderate knee OA. This study provides strong evidence that non – noxious accessory mobilisation of anosteoarthritic peripheral joint can immediately decrease hyperalgesia [11].

Among stretching and strengthening groups strengthening group showed significant greater decrease in pain than stretching group.

Abnormal neuronal inputs from muscle might contribute with abnormal inputs rom joints leads to pain. Noxious stimuli from diseased joint could also cause inhibition of motor neuron and muscle weakness. (Melzack 1977, 62) [15,16].

Strengthening exercise facilitated a strong balanced contraction of muscle, and thus improved the controlled loading of joint, improved stability and reduced instability and prevented harmful mechanical noxious forces generated during gait and other knee activities and reduced pain in knee osteoarthritis. Strengthening exercise reduced the abnormal joint loading, cartilaginous damage and the joint inflammatory changes. As a result it regulated the altered sensory inputs and prevented peripheral and central sensitization of neurons of peripheral and central nervous system respectively thus playing major role in reduction of pain.

The quadriceps and hamstrings muscles have the potential to provide dynamic frontal-plane knee stability because of their abduction and/or adduction moment arms. Using a neuromuscular biomechanical model, Lloyd *et al*. noted that the quadriceps and hamstrings not only have the potential to support frontal-plane moments, but also provide support for abduction-adduction moments. Furthermore, they observed that these muscle groups appear capable of supporting up to 100% of the applied abduction-adduction loads [4].

Sufficient quadriceps and hamstrings strength, both isometric and dynamic, is essential for undertaking basic activities of daily living such as standing and walking. Muscle strength testing has revealed that those with knee OA have a 25% to 45% loss of knee extension strength and a 19% to 25% loss of knee flexion strength. The strengthening exercises on the hamstring muscle have been found to enhance the functional ability of a deficient knee. This is probably due to an overall increase in both the hamstring and quadriceps strength, increase in the hamstring to quadriceps ratio (H: Q), and minimization of anterior-lateral subluxation of the tibia [4].

The strength relationship between the quadriceps femoris and hamstring muscles has been measured and reported by various researchers, and it is important for the stability of the knee and for protection from excessive stress. Thus, they concluded that strengthening of the hamstring in addition to strengthening of the quadriceps is beneficial for improving subjective knee pain, range of motion, and decreases the limitation of functional performance of patients with knee osteoarthritis [4].

Strengthening the hip abductor musculature is to directly influence the frontal plane moments of force about the hip joint during gait. Hip abductor strengthening might have increased trunk stability, thus decreasing lateral trunk lean towards the stance limb. The gluteus medius is the main hip abductor and a large portion of this muscle acts in the frontal plane to stabilise pelvis and lower leg during gait [6].

Hip muscles control medial lateral balancing at the knee both directly, through the illiotibial tract shifting compressive joint force at the knee laterally and indirectly through pelvis stabilization. The ITB is considered a continuation of the tendinous portion of the tensor fascialata muscle and is indirectly attached to parts of the gluteus medius, gluteus maximus, and the vastus lateralis muscles. This finding is found similar to the finding of Michael Fredericson., *et al*. 2000.

In the present study resistance training exercise decreased the pain during walking and stair climbing by 32.78% and 27.94% respectively.

After resistance training there is change in motor unit firing frequency or synchronization and increased recruitment in the number of motor unit firing. Simonsen EB 2002, Sale D 1992 [17]. These changes are caused by a decreased in the inhibitory function of central nervous system, decreased sensitivity of the golgi tendonorgan (GTO) or changes at myoneural junction of the motor unit (KreamerWJ 2001) [18].

This finding is supported by previous studies of Kraemer WJ 2002 [19], Ha''KKinen, K 1995 [19], Keen D. 1994, Moritani T and H.A. Deuries 1980 [20] which showed systemic strength training not only in middle - aged but also in elderly people can lead to substantial increase in strength performance. This might primarily result from considerable neural adaptation observed, especially during earlier weeks of training.

Increased strength and normalise sensory feedback from joint and muscle spindle may contribute to decrease in pain and improvement in functional activity, and improvement in lower extremity kinematics during functional activities. Strength training decrease joint stiffness and increase muscle strength and proprioception in knee osteoarthritis. Proprioception allows better regulation of force output and it is closely related to functional performance and walking speed (Hurleyand Sharma, 1999) [21].

In a study conducted by Petrella., *et al*. isotonic strengthening exercises and 3 range of motion exercises were performed 3 - 5 times per week, for 6 weeks. There was a statistically significant improvement in pain and function in the exercise group, relative to the control group and thus was also an improvement in the time needed to ascend and descend stairs in pain severity during stair climbing.

Daily low intensity resistance training exercise decreased the pain during walking and stair climbing by 19% to 20% respectively ('O'Reily 1998) [22].

In the present study stretching exercise decreased the pain during walking and stair climbing by 20% and 13.23% respectively.

The pain reduction in stretching might be due to its effect to both tight periarticular muscles and intra-articular posterior capsule structures which remove noxious substance, broke the adhesion and improve the mobility and it may normalise the altered biomechanics due to tight tissue which are thought to be related to aggravation of pain. Stretching may reduce pain and probably improved the subject's ability to perform activity with less discomfort. Stretching decreases the micro-elastic behaviour of muscle and tendon which leads to decrease in stiffness and improvement of performance by requiring less energy to move the limb.

Excessive tightness or shortening of some tissue such as hamstring, IT band orrotator of hip causes excessive strain of patella-femoral joint. Muscle contains spindle and golgi tendon organ that have reflexive connections to the mechanoreceptors in the soft tissue surrounding the joint, including the ligament and joint capsule. The flexors of the knee are typically short and tight, inhibiting the quadriceps. Attachment point is usually thickened and fibrosed with overuse and injury. Sustained flexion due to degeneration shortens and thickens the hamstring and gastrocnemius attachment. Stretching the tight muscle around the knee must have resulted in decrease in pain in the stretching group.

These results are supported by Deyle., *et al*. 2000 [14], in which the treatment group received hamstring, calf, and quadriceps stretching along with isometric quadriceps and ROM exercises for a period of 4 weeks and 8 weeks duration. This study after 4 weeks showed the experimental group gained significantly over baseline WOMAC scores and walking distance and after 8 weeks average6 min walk test improved 13.11% and WOMAC score improved by 55.8% over baseline value in treatment group.

In a study Adel Rashed Ahmed (2010) [23] instructed to perform home based knee stretching exercise once a day for about 3 month and found significant improvement in knee pain (from 6.43 + 1.86to 4.21 + 1.09), knee ROM (from 117 + 12.13 to 126 + 11.34) and over WOMAC (63.54 + 8.87 to 51.63 + 7.62), similar to our study in which pain in walking reduced from 6.5 to 5.2 and in stair climbing by 6.8 to 5.9 in 10 point VAS scale.

The improvement in all the three groups (mobilisation, strengthening and stretching) was significantly different from each other. The reduction of pain in mobilisation group, strengthening group and stretching group during 6 min walk test were 37.70%, 32.78%, 20% respectively.

The reduction of pain in mobilisation group, strengthening group and stretching group during timed stair climbing up and down were 29.23%, 27.94%and 13.23% respectively.

Difference in reduction of pain during walking ability and stair climbing was significantly more in mobilisation group than strengthening as well as stretching. Mobilisation group showed significantly more reduction in pain than strengthening as well as stretching groups. Study shows in osteoarthritic knee, patella is laterally tract most commonly due to tight lateral retinaculum leading to over lengthening of medial capsule. Due to this, with course of time, along with tightness of lateral retinaculum, medial retinaculum gets thickened, fibrosed, taut and inextensible. In our present study, only mobilisation groupfocused on stretching of tight retinaculum. Strengthening and stretching groups only focused on muscle and capsule around knee joint, not the tight retinaculum. According to study by Vanden Dolder., *et al.* 2006 [13], six session of manual therapy to the lateral retinaculum resulted insignificantly greater improvement in active knee flexion and the ability to step up / down a step in people with anterior knee pain than does no intervention. Furthermore the purpose of manual mobilisation technique is to restore damaged peri-articular and intra-articular connective tissue. Deyle and colleagues (2000) [14] suggested that periarticular and muscular connective tissue could be implicated as symptom sources in patient with osteoarthritis of knee. One (pilot) study analysed the effect of knee joint mobilisation on osteoarthritis hyperalgesia and found favourable effects on pain [11]. Skyba., *et al*. (2003) suggested that analgesic effect following knee joint mobilization was primarily due to enhancement of the descending pain inhibitory pathway in the spinal cord, which utilized serotonergic (5-HT1A) and noradrenergic receptors (alpha-2) [24].

Among strengthening and stretching groups strengthening group showed significantly better reduction in pain as it regulated the altered sensory inputs and prevented peripheral and central sensitization of neurons of peripheral and central nervous system respectively thus playing major role in reduction of pain. Reduction of pain in stretching group was only because of minimising shortening and increasing flexibility of muscle but in strengthening in addition to flexibility strengthening also had effects on neurological and morphological adaptation and increase in cross section area of whole muscle and individual muscle fibre which was lacking in stretching group.

There is relationship between joint pain and decreased in muscle strength are beginning to be recognised as more complex than simply disuse of joint pain contribute to muscle atrophy and muscle weakness of surrounding joint (Sharma and Hurley 1999) [21].

Walking ability and Stair Climbing

The result of the study showed significantly greater improvement in walking ability and stair climbing in mobilisation group than the strengthening as well as stretching group. Among strengthening and stretching group, strengthening group had significantly more improvement in walking ability and stair climbing than stretching group.

Higher effects on pain tend to be paired with higher scores on physical function because the relationship between effects for pain and physical function was fairly strong. Higher effects on pain tend to be paired with higher scores on physical function because the relationship between the effects for pain and physical function was fairly strong. Similarly, in a cross-sectional survey it was found that in men and women with knee osteoarthritis pain intensity during the last eight days was significantly associated with WOMAC physical function (Perrot., *et al*. 2009). In a 3-year cohort study, increased pain was found to be associated with worsening of limitations in activities in patients with osteoarthritis of the hip or knee (VanDijk., *et al*. 2006). So, for many patients with osteoarthritis of the knee it is suggested that pain relief is accompanied by improvements in functioning [24].

In the present study all the groups (mobilisation, strengthening and stretching) showed significant improvement in walking ability and stair climbing with significant reduction in pain.

The improvement in mobilisation group, strengthening group and stretching group during 6 min walk test were 29.60%, 15.83%, 6.73% with reduction in pain by 37.70%, 32.78%, 20% respectively.

The improvement in mobilisation group, strengthening group and stretching group during timed stair climbing up and down were 48.07%, 26.92% and 22.80 with reduction in pain by 29.23%, 27.94% and 13.23% respectively.

The improvement in all the three groups (mobilisation, strengthening and stretching) was significantly different from each other. Difference in improvement of walking ability and stair climbing was significantly more in mobilisation group than strengthening as well as stretching. This may be due to the target achieved by stretching the tight retinaculum which was lacking in strengthening as well as stretching groups. According to study by Vanden Dolder., *et al*. 2006 [13], six session of manual therapy to the lateral retinaculum resulted in significantly greater improvement in active knee flexion and the ability to step up / down a step in people with anterior knee pain than does no intervention.

Among strengthening and stretching groups, strengthening group significantly improved to greater extent than stretching group as in addition to flexibility strengthening also had effects on neural adaptation which was lacking in stretching group. Improved strength in muscle enhance normal muscle spindle activity and steady stated is charge from both primary and secondary endings in muscle spindle signals, constant muscle length and sub-serves joint position sense. Primary endings are highly sensitive to changes in muscle length and velocity of stretch and sub-serves joint motion sense. And as mentioned earlier that neural adaptation following strengthening may have lead to improvement in motor learning and improved coordination during functional activities. Strengthening improves motor control of muscle and improves its rate of force production during gait.

Conclusion

From this study it is concluded that mobilisation, strengthening exercise and stretching reduced pain and improved walking distance and timed stair climbing up and down, over 4 weeks of training in osteoarthritis knee. This study showed that mobilisation is more effective in reducing pain and improving walking distance and timed stair climbing up and down than strengthening than stretching inpatients with osteoarthritis knee.

Limitation

i) Small sample size, ii) No control, iii) Short duration, iv) no follow up was taken v) Quadriceps muscle strength was not taken.

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