



ISSN: 2230-9926

Available online at <http://www.journalijdr.com>

# IJDR

International Journal of Development Research  
Vol. 16 Issue, 02, pp. 70002-70012, February, 2026  
<https://doi.org/10.37118/ijdr.30573.02.2026>



RESEARCH ARTICLE

OPEN ACCESS

## EFFICACY OF MANUAL THERAPY VERSUS EXERCISES IN PATIENTS WITH OSTEOARTHRITIS OF KNEE

\*Rachna Kocheta

E-8, Meera Nagar, a Block, Nakodapuram, Shobhagpura, Behind Magnus Hospital India

### ARTICLE INFO

#### Article History:

Received 17<sup>th</sup> November, 2025  
Received in revised form  
28<sup>th</sup> December, 2025  
Accepted 29<sup>th</sup> January, 2026  
Published online 27<sup>th</sup> February, 2026

#### Key Words:

Knee Osteoarthritis, Manual Therapy, Mulligan technique.

### ABSTRACT

**Aim of the Study:** The aim of the study to compare the efficacy of manual therapy versus exercises in patients with knee osteoarthritis in terms of decreasing pain.

#### Hypothesis:

**Null Hypothesis:** There may be no significant difference in the effectiveness of manual therapy and exercise therapy in patients with knee osteoarthritis.

**Alternate Hypothesis:** There may be significant difference in the effectiveness of manual therapy and exercise therapy in patients with knee osteoarthritis.

#### INTERVENTION

##### Group A: Manual Therapy

Manual physiotherapy protocol consisted of Treatment is done for two sessions per week for four weeks. Knee Mandatory interventions:

1. Knee flexion, non-thrust Antero-posterior directed force to the tibia,
2. Tibio-femoral joint, non-thrust
3. Knee extension, non-thrust Postero-anterior directed force to the tibia
4. Tibio-femoral joint, non-thrust
5. Patellar gliding force, non-thrust
6. Manual stretch to quadriceps, hamstring, triceps surae muscle groups
7. Soft tissue manipulation, quadriceps and Peripatellar connective tissue, hamstring, hip adductor and triceps surae muscles groups

Treatment is done for two sessions per week for four weeks.

##### Group B: Exercise Therapy

This group performed a closely supervised standardized knee exercise program at twice a week for four weeks at eight treatment sessions. This program consists of active range of motion exercise for knee, muscle strengthening exercise for hip and knee, muscle stretching for lower limbs and riding a stationary bike.

#### Aerobic exercises

- Up to 10 minutes stationary bicycle or walk.
- Stretching exercises:
  - Standing calf stretch - 3 repetitions with 30 sec hold
  - Supine hamstring stretch - 3 repetitions with 30 sec hold
  - Prone quadriceps stretch - 3 repetitions with 30 sec hold
- Range of motion exercises:
  - In long sitting position,
    - Knee mid flexion to end range extension - two 30 sec bouts with 3 sec hold at end range
    - In long sitting position, knee mid flexion to end range flexion - two 30 sec bouts with 3 sec hold at end range
- Strengthening exercises:
  - Static quad sets in knee extension - one set of 10 repetitions with 6 sec hold, 10 sec rest between repetitions.
  - Short arc terminal extension exercises for the knee joint.
  - Quadriceps non-weight bearing progressive resistance exercises with weighted cuffs.
  - Supine Straight Leg Rise (SLR)
  - Neuromuscular control exercises:
    - Closed chain progression:
      - Seated leg press - one 30 sec bout
      - Standing weight - shifting exercises
    - Side- stepping
    - Step ups
    - Forward-backward and shuttle - walking drills

**Results:** Knee function of all patients increased significantly after the 4-week intervention program in both the groups of MANUAL THERAPY and EXERCISE THERAPY but Group A Manual therapy improved more significantly when compared to Group B Exercise therapy.

**Conclusion:** Treatment effect was more in the patients received Manual therapy when compared to Exercise therapy. This finding suggests that Manual therapy can be useful intervention supplement in patients with osteoarthritis of knee.

\*Corresponding author: Rachna Kocheta

Copyright©2026, Rachna Kocheta. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Citation: Rachna Kocheta. 2026. "Efficacy of Manual therapy versus exercises in patients with osteoarthritis of knee". *International Journal of Development Research*, 16, (02), 70002-70012.

## INTRODUCTION

Osteoarthritis is a chronic and degenerative joint disease, leading to softening of the matrix, loss of articular cartilage, sclerosis of subchondral bone, osteophytes formation and subchondral cysts<sup>1</sup>. Osteoarthritis is considered one of the most common musculoskeletal disorder. OA knee is a disease common in ageing population (55-92 years), in general it is a disease of advancing years but even young people are subjected to OA knee if articular cartilage is subjected to abnormal stress at early life.<sup>2</sup> Knee osteoarthritis is the most common form of symptomatic osteoarthritis. It is a most coprogressive joint disease in the elderly and has a significant impact on quality of life as functional status disease that decrease as a result of pain .It is widespread slowly developing disease that increasing prevalence with increasing age. OA of the knee is reported to be a major health problem in world wide. OA knee is clinically characterized by pain, morning stiffness more than 30 minutes, edema, joint tenderness, weakness, muscle wasting, bony overgrowth, crepitus and limited joint Range Of Motion<sup>3</sup>. The etiology of OA knee is not entirely clear but its incidence increases with age and obesity is a risk factor for the development and progression of disease. In addition certain factors augment the incidence of developing OA knee such as sedentary lifestyle, improper diet and lack of exercise that correlates with loss of quadriceps femoris muscle strength resulting in disability and pain.<sup>4-6</sup> OA knee is considered as one of the most common cause of disability as it poses difficulty in performing the activities of daily living like walking, stair climbing, bending and transferring , these functional limitations poses threat to an older person's ability to live independently.<sup>7-9</sup> About 40% of the total population aged over 70 suffers from the most common form of OA. The incidence of knee OA in INDIA is as high as 12% .In the USA more than 9,000,000 people are affected by clinically and radio graphically confirmed OA. It is considered the leading cause of musculoskeletal disability in the elderly population worldwide. Radiographic evidence of knee OA in men and women older than 65 yrs is reported to be 80% and approximately one third of these people are symptomatic. OA is the degenerative articular disease which is slowly evolving that appears to originate in the cartilage by breaking down and affects the underlying bone ,soft tissues and synovial fluid.

Mainly OA is grouped into primary and secondary OA knee. Primary OA knee mostly occurs in younger age group due to any joint pathology, trauma, additional load into joint frequently, repetitive injury, bleeding from joint and any congenital diseases. Secondary knee OA occurs in old age group and mainly it affects weight bearing joints and follows wear and tear phenomenon. Pain is one of the most important causes for decline of life quality. OA of the knee is one of the major causes of reduced activities of daily living and lowers the quality of life in elderly. The knee joint is the most commonly affected large weight bearing joint where the disease can be particularly disabling because of the consequent difficulties in rising from a chair, climbing stairs, kneeling, standing and walking. Symptoms range from aching at rest to sharp pain with movement, locking, as they might hear crunching as they bend knee. The presence of pain combined with muscle weakness, Increases body away, impaired balance, put affected individuals at risk of falls and decreased activity. OA has a significant impact on quality of life as functional status decreases as a result of pain. The risk of disability from knee OA alone is comparable with that of cardiac disease and is greater than those for other medical disorders in the elderly. A likely to become the fourth most important global cause of disability in women and the eighth most important cause in men. The OA is associated with pain and inflammation of joint capsule, articular stiffness, crepitations, articular edema, joint deformities, articular instability, impaired muscular stabilization, reduced ROM and functional disability. Mechanism by which OA develops in the knee is not fully understood. It has been hypothesized that weakness of shock absorbing and weight bearing muscles may lead to structural

damage of articular cartilage and sub chondral bone , as well as decrease joint stability, which is a risk factor for knee OA progression. Risk factors: OA is a common complex disorder with multiple risk factors. Factors affecting OA are genetic factors – heritability, constitutional factors – ageing, females, obesity, high bone density, local biomechanical risk factors – joint injury, occupational or recreational usage, decrease in muscle strength, joint laxity, joint ma Treatment options includes medical management and physiotherapy. Since OA knee is a condition usually affecting elderly people there is a risk of developing gastric problems with the use of drugs , hence the other safe and effective means of reducing pain and discomfort is by undergoing physiotherapy.<sup>10-12</sup>Physiotherapy is the means by which pain can be reduced to a minimal extent with the use of Ultrasound, Interferential Therapy, Trans-cutaneous Electrical Nerve Stimulation, Moist Heat Therapy, Manual Physical Therapy (soft tissue mobilization, Accessory joint movement, stretching, Passive movement). Strengthening exercise and aerobic exercises.<sup>13</sup> For several years regular participation in physical activity has been recognized as been beneficial in the management of OA knee.<sup>3</sup> While there is agreement that exercise therapy can be helpful, the effect of exercise therapy on pain, quadriceps strength, and physical function appears to be small to moderate in clinical trials.<sup>4-9,14</sup> Adams T et al in their study stated manual physical therapy, therapeutic exercise, patient education, and weight management are strongly supportive to conservative treatment for OA knee but additional research is needed to determine the most effective approach.<sup>17</sup> New developments in manual physical therapy have demonstrated promising developments in pain and physical function.<sup>18-19</sup>

Jhonson MJ et al in their study found that exercise therapy plus manual mobilization showed a moderate effect size on pain compared to the small effect sizes for strength training or exercise therapy alone in treating OA knee.<sup>20</sup> Alexandra et al suggested that a combination of manual physical therapy and supervised exercise maybe a cost-effective way to delay or prevent the need for surgical interventions in patients with OA knee.<sup>21</sup> In another study Henry Pollard et al found that manual physical therapy compared to exercise therapy resulted in superior improvements in pain and physical function in subjects with OA knee and effects lasted at six months follow-up.<sup>22</sup>Deyle et al conducted two trials of manual physical therapy inpatients with OA knee. In the first a multi-modal intervention of individually tailored manual physical therapy plus stretching, strengthening, Range Of Motion and home exercises resulted in clinically significant superior outcomes compared with a placebo control group. In the second multi-modal intervention of individually tailored manual physical therapy plus stretching, strengthening, Range Of Motion and home exercises resulted in clinically significant superior outcomes compared with home exercise alone. In both studies benefits were still evident at the 12- month follow-up.<sup>7,23</sup>

**Exercise Therapy:** Exercise is a key component of the management of OA symptoms and has been shown to be beneficial for individuals with OA disease of all severities. Aerobic, strengthening, flexibility, stretching, proprioceptive , balance, kinaesthesia, agility, neuro muscular, aquatic and Tai chi exercise are beneficial for improving pain and function in people with OA with benefits seen across the range of disease severities. The optimal exercise dosage is yet to be determined and an individualized approach to exercise prescription is required based on an assessment of impairments, patient preference, co - morbidities and accessibility. Given the large body of evidence demonstrating the beneficial clinical effects of exercise in people with lower limb OA varying in severity from mild to severe, exercise therapy is regarded as the corner - stone of conservative management for the disease. The main goals of exercise in this patient group are to reduce pain, improve physical function and optimize participation in social, domestic, occupational and recreational pursuits. Regular exercise can improve physiological impairments associated with OA including muscle strength, joint range of motion, proprioception, balance

and cardiovascular fitness. Other potential benefits of exercise for this patient group include improvements in mobility, falls risk, body weight, psychological state and metabolic abnormalities. Exercise therapy for people with lower limb OA may take many forms however given the significant impact of muscle weakness on pain and function in OA, muscle strengthening is a key component of most exercise regimens for knee OA. Exercise practitioners play an important role in prescribing appropriate exercise for patients taking into account individual symptoms, problems and preferences. Encouraging exercise adherence behaviors and reinforcing healthy lifestyle habits will assist in optimizing outcomes from treatment. Furthermore, exercise programs should be combined with education and behavioral strategies to improve positive lifestyle change and increase overall physical activity levels. The benefits of exercise are additive when delivered with other interventions such as weight loss particularly given the high prevalence of overweight individuals with knee OA. Exercise helps in decrease pain, improving strength and endurance, improving ROM and connective tissue elasticity as well as exercise decrease functional limitation by improving walking speed, gait, physical activity and decrease depression and anxiety. A growing body of evidence shows that exercise improves knee joint function and decreases symptoms. Furthermore, the findings of a recent study suggest that physical therapy intervention including exercise may reduce the need for knee arthroplasty and intra articular injections. However, the most effective types and combinations of exercise and dosage are unclear. The setting in which the exercises should be performed and the level of professional attention required to initiate and maintain the exercise program also should be the subject of further investigation.

**Manual Therapy:** Manual therapy is defined as the application of manual forces of the therapist, to change or improve the quality and the ROM of joints and soft tissues. Mobilization is a manual technique that through repeated passive motion at low speed replicates normal joint glides at varying amplitudes, while manipulations is defined as fast with a small force, small amplitude and high speed of movement of a joint. The International Federation of Orthopaedic Manipulative Physical Therapists (IFOMPT) defines manual therapy techniques as:

“Skilled hand movements intended to produce any or all of the following effects: improved tissue extensibility; increase range of motion of the joint complex; mobilize or manipulate soft tissues and joints; induce relaxation; change muscle function; modulate pain; and reduce soft tissue swelling, inflammation or movement restriction”.

The American Academy of Orthopaedic Manual Physical Therapists (AAOMPT) has proposed the following framework for describing manipulative interventions:

1. **Rate of force application:** Describe the rate at which the force was applied.
2. **Location in range of available movement:** Describe whether motion was intended to occur only at the beginning, towards the middle, or at the end point of the available range of movement. The term available range of movement is intended to describe the available movement as perceived by the therapist after the patient has been positioned and at the time the technique is applied. The available movement may or may not be the same as the range of motion available at a particular joint or region under other circumstances. The use of the terms beginning, mid and end point of available movement are only relevant in the context of describing the particular technique at the time it applied. The term end point should not be associated with any particular anatomic structures, as many structures have the potential to limit motion depending on the individual patient and technique.
3. **Direction of force:** Describe the direction in which the therapist imparts the force. This description should be devoid of the

“intent” of the technique and, instead, should follow standard anatomical and biomechanical conventions.

4. **Target of force:** Describe the location where the therapist intended to apply the force. In the case of the spine, force may be directed at a specific level, or more generally across a particular region such as mid lumbar or lower thoracic. The task force suggests that replication of techniques among therapists will be more easily achieved if clearly palpable structures are used as reference points. For most peripheral joints associated with the appendicular skeleton, the target of force may be appropriately described using a specific joint as a reference. It is important to note that the use of a joint, or a particular spinal level, for reference as to where the force is applied is not intended to imply any particular theoretical assumptions as to structures affected by a manipulation, but only to provide information about where the force was applied.
5. **Relative structural movement:** Describe which structure or region was intended to remain stable and which structure or region was intended to move, naming the moving structure or region first and the stable segment second, separated by the word “on” for example, a “lower lumbar on upper lumbar” technique implies that the clinician intended to move the lower lumbar region while stabilizing the upper lumbar region. Techniques associated with the peripheral joints would be described utilizing the same convention (e.g.: tibia on femur, humerus on scapular glenoid).
6. **Patient position:** Describe the position of the patient (e.g.: supine, prone, recumbent). This would include any premanipulative positioning of a region of the body, such as being positioned in rotation or side bending. Non – pharmacological, non- surgical interventions, primarily exercise therapy and more recently manual therapy, are recommended as the first line of treatment for hip and knee OA. However there is little evidence for the long – term effectiveness of exercise therapy, and there is insufficient evidence on the effectiveness of manual therapy.

It is well established that various forms of exercise are effective in reducing pain and increasing physical function in people with knee OA. However, there is little knowledge about which forms of exercise provide the greatest and most enduring benefit, with few studies having followed participants to or beyond 12 months. New development in manual physiotherapy have demonstrated promising improvements in pain and physical function for knee OA, but effectiveness has not yet been established. Manual therapy is intended to improve musculoskeletal function and pain by addressing impaired kinematics of the joint, which in OA can be affected by joint capsule contracture. Loss of periarticular flexibility and increased intracapsular pressure. On the strength of just one randomized clinical trial, the 2008 NICE clinical guidelines for OA recommends that manual therapy should “be considered an adjunct to core treatment “for knee OA. No randomized controlled trial has investigated the benefits of manual therapy in addition to usual care alone or compared to exercise therapy in patients with hip or knee OA. This study is planned to investigate the effectiveness of an individualized manual physiotherapy programme compared to a multi – modal, individualized, supervised exercise physiotherapy programme. Physiotherapists frequently use manual physical therapy and exercise procedures as an important part of rehabilitation programs to help patients regain joint mobility and function.<sup>24-26</sup> Manual physical therapy brings mobility in the soft tissues surrounding the knee joint and exercise helps in strengthening the muscles and improves weight bearing.<sup>27</sup>

**Need for the Study:** Osteoarthritis is a nearly universal, slowly progressive degenerative condition affecting men and women as they age. If diabetes was thought to be the most prevalent ailment affecting the people, it could be wrong. While much has been said about high incidence of diabetes, HIV and cancer in India, a recent study suggests that OA beats them all to claim the number one spot among ailments in country. Dr. Shishir Rastogi, professor of ORTHO at AIIMS says, that there are many reasons for the high prevalence of OA knee in India. Genetic is the

strongest reason which makes us more predisposed to it. Several other factors like popular squatting position in India, rise in obesity sedentary lifestyle and poor diet are responsible for its high incidence. Exercises are very important of OA knee. It helps pain relief, maintain stability of joint, controls the effusion, and improves the blood supply to joint structures. During exercises there is release of endogenous opiates and thus relieves pain and improves muscle power. Osteoarthritis (OA) of knee is one of the major causes of reduced activities of daily living and lowers the quality of life in the elderly. The commonest obstacle for the elderly to carry out ADL is the problem of joint-pain and decreased mobility. Estimated population prevalence for OA knee is 7.2% in those aged 40yr or older, 12.5% in those aged over 45 yrs and 14.8% in those aged 50 yrs or older. The prevalence of knee OA increases with age throughout the elderly years.

The incidence of knee osteoarthritis in India is as high as 12 per cent. Factors such as age, family history, obesity and hyper mobility increase susceptibility to OA. Symptomatically, the most commonly affected joint in OA is the knee joint. The objectives of management of OA knee are to relieve pain, maintain or improve mobility, and minimize disability. Some researchers have a demonstrated that physiotherapy interventions are effective in reducing pain and improving activity in people with knee pain. The initial treatment for osteoarthritis of the knee is conservative, consisting of restriction of activity, patient education, and physical therapy. Exercises are very important of OA knee. It helps pain relief, maintain stability of joint controls the effusion, and improves the blood supply to joints structures. During exercises there is release of endogenous opiates and thus relieves pain and improve muscle power. Electrotherapy, thermotherapy, joint mobilization and exercise therapy are widely used in physical therapy management of osteoarthritis of knee to reduce pain and improve function. Non-pharmacological, non - surgical interventions, such as the treatments offered by physiotherapists, are recommended as the first line of treatment for knee osteoarthritis (OA), however there is still insufficient evidence about many such interventions to make specific, recommendations regarding management of this disorder. Given the prevalence of OA, its economic and human burden, and accumulating evidence supporting the effectiveness of various physiotherapy interventions for patients with OA the hip or knee, further research is warranted. Two common forms of physiotherapy intervention are exercise therapy and manual therapy.

Manual therapy and exercise therapy have been shown to be a useful modality to reduce knee pain. The American college of Rheumatology recommends exercise for patients with osteoarthritis, but there is little evidence to justify its use. There is a need to establish the effect of therapeutic knee exercise pain and disability in patients with symptoms of knee osteoarthritis and to determine if any benefits could be maintained after stopping treatment. Manual therapy is a contemporary form of joint mobilization consisting of a therapist-applied pain-free accessory gliding force. There are reports of pain relief and improved function in response to manual therapy in several musculoskeletal conditions. Many clinicians have found that exercise therapy techniques will enhance the patient's ability to use a particular joint in a functional manner such as improvement in walking or climbing stairs. To our knowledge, there have been no published randomized clinical trials to date evaluating the effects of manual therapy on knee pain and improving function. There are no studies that could be retrieved comparing the effectiveness of exercise therapy and manual therapy on OA knee.

This study aimed to compare the effects of manual therapy versus exercise therapy on pain and functional improvement in OA knee. There are few studies in which manual therapy and exercise therapy are given in combination and compared with usual care, pain relieving medications or cortico steroid injections. However, no studies have compared manual therapy versus exercise therapy in patients with osteoarthritis on knee in Indian population. Hence there is a need for the study to compare the

manual versus exercise therapy inpatients with osteoarthritis of knee in Indian population in terms of decreasing pain and improving function. This study if successful will also help us in decreasing or delaying the rate of TKR inpatients with knee osteoarthritis.

## METHODOLOGY

**Study design:** experimental study with pre and post intervention comparison design.

**Sample size:** 30 subjects fulfilling inclusion and exclusion criteria

**Sample method:** convenience method

**Intervention period:** 4 weeks

**Study period:** one year duration from date of approval

**Study setting:** Physiotherapy Out Patient Department at Pacific medical college and hospital.

**Method of collection of data:** 30 subjects were selected who fulfilled the inclusion and exclusion criteria. The purpose and procedure of the study were explained to all the subjects for maximum cooperation and written consent was taken from them.

### Inclusion Criteria

- Both male and female patients aged between 38 to 70 years.
- Meet Altman's clinical criteria for knee OA (mentioned below)
- Have radiographic evidence of knee OA

#### A. knee pain for the most days of the prior month and

1. crepitus with active motion (and)
2. morning stiffness in knee <30 min (and)
3. age >38

#### B. Knee pain for most days of the prior month and

1. crepitus with active motion (and)
2. Morning stiffness in knee >30 min (and)
3. Bony enlarg

#### C. Knee pain for most days of prior month and

1. No crepitus (and)
2. bony enlargement Altman's clinical criteria for knee OA

### Exclusion Criteria

- Previous history of neurological disorders
- History of cardiovascular, pulmonary, endocrine disorders
- Hip osteoarthritis
- Any hip injury
- Any contraindications against physical activity
- Dermatological problems
- Systemic disease
- History of knee injuries
- History of taking steroids
- Knee or hip replacement of affected limb
- Any other surgeries of lower limb in previous 6 months
- Initiation of opioids in previous 30 days

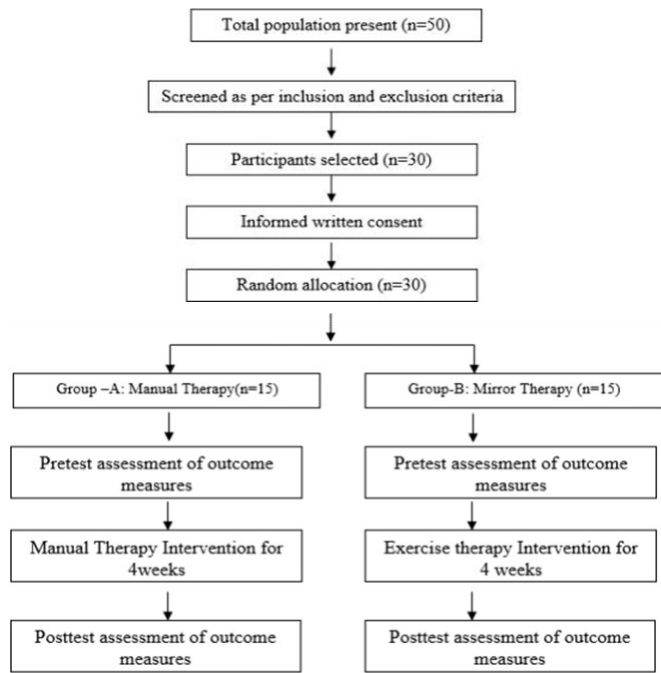
### Materials Used

- Towel
- Stopwatch
- Measuring tape.

### Outcome measures:

- Visual Analogue Scale (VAS)
- Western Ontario McMasters universities Arthritis Index (WOMAC)
- 6 Minute Walk Test (6MWT).

## PROCEDURE



**Treatment Procedure:** Participants (30) will be randomly allocated to 15 in each group to 2 groups by using Microsoft Excel program (Microsoft Corporation, Redmond, Washington). The treatment intervention in each group will be as follows.

- Group A (MANUAL THERAPY)
- Group B (EXERCISE THERAPY)

**Group A: MANUAL THERAPY:** Manual physiotherapy the manual therapy protocol consisted of procedures intended to modify the quality and range of motion of the target joint and associated soft tissue structures. Additional manual therapy interventions will be prescribed individually for each participant randomized to this intervention on the basis of the physical examination findings, from a limited list of interventions defined in our protocol. In addition we prescribe a home program of joint range of motion activities to be completed three times per week. The manual therapy protocol did not provide or prescribe aerobic, strengthening or neuromuscular control exercises. Treatment is done for two sessions per week for four weeks.

## Knee

### Mandatory interventions:

1. Knee flexion, non-thrust
2. Antero-posterior directed force to the tibia, Tibio-femoral joint, non-thrust
3. Knee extension, non-thrust
4. Postero-anterior directed force to the tibia, Tibio-femoral joint, non-thrust
5. Patellar gliding force, non-thrust
6. Manual stretch to quadriceps, hamstring, Triceps surae muscle groups.
7. Soft tissue manipulation, quadriceps and Peripatellar connective tissue, hamstring, hip adductor and triceps surae muscle groups.

**Secondary (non-mandatory)** - few additional interventions may be done when indicated by assessment findings. Home program of reinforcing activities prescribed up to six range of motion activities to reinforce clinic interventions. Individualized manual physiotherapy - Manual therapy is defined as skilled therapist applied manual procedure intended to modify the quality and range of motion of the target joint and associated soft tissue structures. The manual therapy protocol did not provide or prescribe aerobic,

strengthening or neuromuscular control exercises. The home program of reinforcing activities did not include any exercise therapy exercises.<sup>43</sup>

**Group B: EXERCISE THERAPY:** This group performed a closely supervised standardized knee exercise program at twice a week for four weeks at eight treatment sessions. This program consists of active range of motion exercise for knee, muscle strengthening exercise for hip and knee, muscle stretching for lower limbs and riding a stationary bike.

### Aerobic exercises

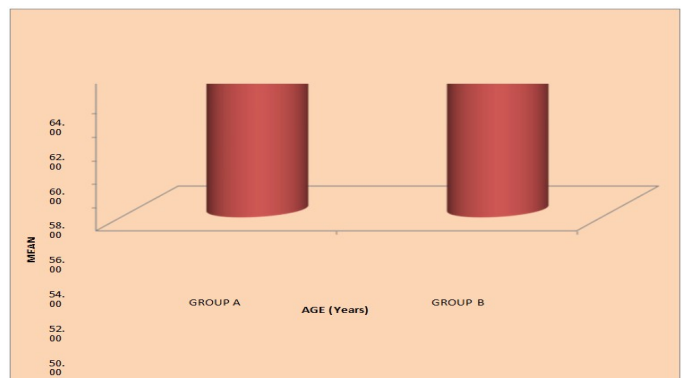
- Up to 10 minutes stationary bicycle or walk. Stretching exercises:
- Standing calf stretch - 3 repetitions with 30 sec hold
- Supine hamstring stretch - 3 repetitions with 30 sec hold
- Prone quadriceps stretch - 3 repetitions with 30 sec hold Range of motion exercises:
- In long sitting position, Knee mid flexion to end range extension - two 30 sec bouts with 3 sec hold at end range
- In long sitting position, knee mid flexion to end range flexion - two sec bouts with 3 sec hold at end range
- Strengthening exercises:
- Static quad sets in knee extension -one set of 10 repetitions with 6 sec hold,10 sec rest between repetitions.
- Short arc terminal extension exercises for the knee joint.
- Quadriceps non-weight bearing progressive resistance exercises with weighted cuffs.
- Supine Straight Leg Rise (SLR)
- Neuromuscular control exercises: Closed chain progression:
- Seated leg press - one 30 sec bout
- Standing weight -shifting exercises
- Side- stepping
- Step ups
- Forward-backward and shuttle - walking drills

**Supervised exercise physiotherapy-** The exercises therapy protocol did not allow therapist - applied manual forces. Home program is prescribed up to six of the above activities to reinforce clinic interventions.<sup>7</sup>

**Statistical analysis:** All statistical analysis in this study was done using SPSS ver16.0. The general characteristics of the participants were expressed in terms of mean and standard deviation by using descriptive analysis. T comparison for within the group between pre and post intervention, paired t-tests were performed. And independent t-test was used for comparing differences between the groups. The statistical significance level was set at equal to or less than 0.05 for all tests.

### Age:

|     | GROUP   | N  | Mean  | Std. Deviation | Std. Error Mean |
|-----|---------|----|-------|----------------|-----------------|
| AGE | GROUP A | 15 | 62.33 | 4.220133       | 1.090           |
|     | GROUP B | 15 | 63.2  | 4.07431        | 1.052           |



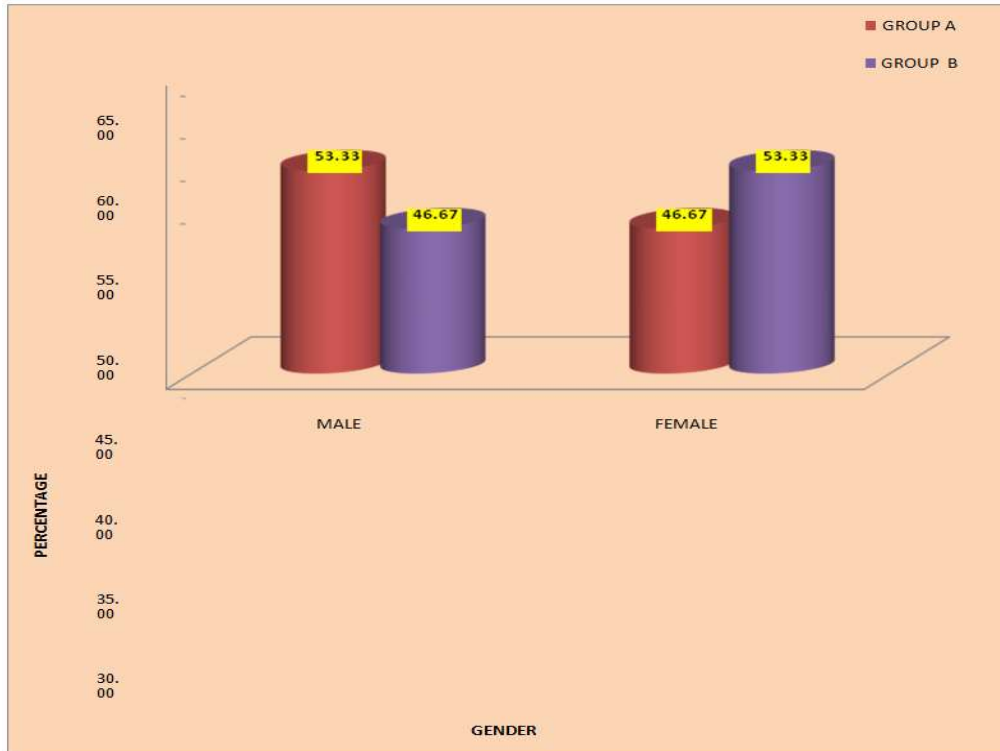
Bar graph showing mean age values of group a and b

| t-test for Equality of Means |       |    |                 |                 |                       |   |         |
|------------------------------|-------|----|-----------------|-----------------|-----------------------|---|---------|
|                              | t     | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |         |
|                              |       |    |                 |                 |                       | Lower                                     | Upper   |
| AGE                          | -.572 | 28 | .572 > 0.05     | -.86667         | 1.51459               | -3.96915                                  | 2.23582 |

P > 0.05 no significance difference in the age between two groups

**Gender:**

| GENDER | GROUP   |       |         |       | TOTAL |     | Chi-square | P Value      |
|--------|---------|-------|---------|-------|-------|-----|------------|--------------|
|        | GROUP A |       | GROUP B |       | NO    | %   |            |              |
|        | NO      | %     | NO      | %     |       |     |            |              |
| MALE   | 8       | 53.33 | 7       | 46.67 | 15    | 50  | 0.133      | 0.715 0.05 > |
| FEMALE | 7       | 46.67 | 8       | 53.33 | 15    | 50  |            |              |
| TOTAL  | 15      | 100   | 15      | 100   | 30    | 100 |            |              |



$\chi^2 = 0.136$  P = 0.713 > 0.05 Not Significant difference in gender between two groups

**Bar Graph Showing Percentage of Male and Female of Group A and B**

**Group -A**

| Paired Samples Statistics |        |    |                |                 |
|---------------------------|--------|----|----------------|-----------------|
|                           | Mean   | N  | Std. Deviation | Std. Error Mean |
| VAS PRE TEST              | 6.47   | 15 | 0.915          | 0.236           |
| VAS POST TEST             | 3.4    | 15 | 0.632          | 0.163           |
| WOMAC PRE TEST            | 53.52  | 15 | 7.874          | 2.033           |
| WOMAC POST TEST           | 27.62  | 15 | 6.294          | 1.625           |
| 6MWT PRE TEST             | 178.22 | 15 | 34.038         | 8.789           |
| 6MWT POST TEST            | 286.2  | 15 | 56.586         | 14.610          |

| Paired Samples Test              |                    |                |                 |   |           |         |    |                 |
|----------------------------------|--------------------|----------------|-----------------|---|-----------|---------|----|-----------------|
|                                  | Paired Differences |                |                 |   |           | t       | Df | Sig. (2-tailed) |
|                                  | Mean               | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference |           |         |    |                 |
|                                  |                    |                |                 | Lower                                     | Upper     |         |    |                 |
| VAS PRE TEST - VAS POST TEST     | 3.0667             | .70373         | .18170          | 2.67695                                   | 3.45638   | 16.877  | 14 | .000**          |
| WOMAC PRE TEST - WOMAC POST TEST | 25.900             | 5.17328        | 1.33574         | 23.03513                                  | 28.76487  | 19.390  | 14 | .000**          |
| 6MWT PRE TEST - 6MWT POST TEST   | -107.979           | 27.2125 9      | 7.02626         | -123.04917                                | -92.90950 | -15.368 | 14 | .000**          |

\*\*Highly Statistical Significant

As can be seen from the output, a significant difference exists between pre and post of VAS and pre and post of WOMAC and pre and post of 6MWT of GROUP A.



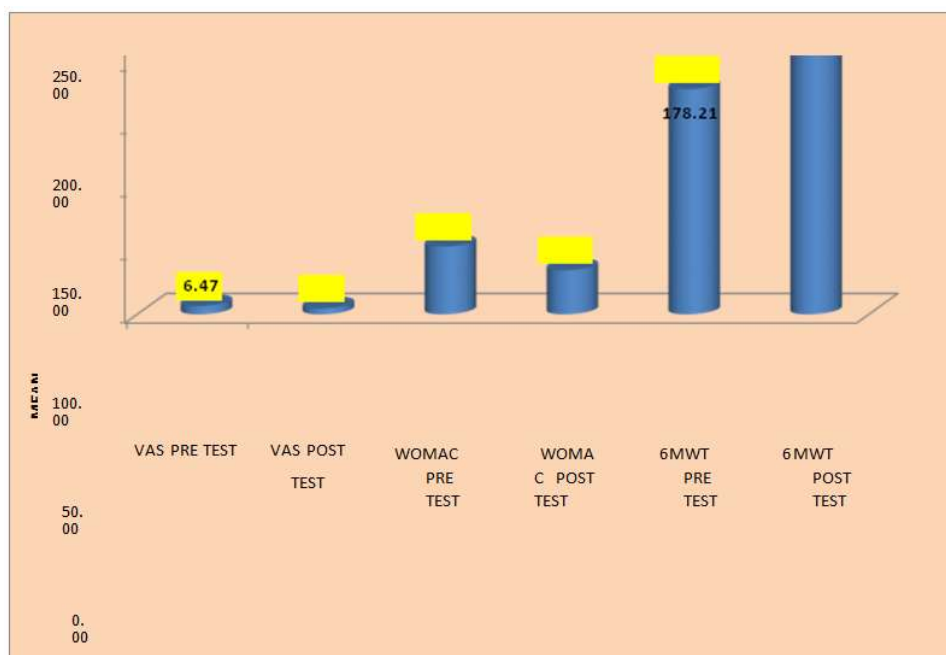
Bar Graph representing mean values of pre and post of vas and pre and post of womac and pre and post of 6mwt of Group A Group-B

| Paired Samples Statistics |        |    |                |                 |
|---------------------------|--------|----|----------------|-----------------|
|                           | Mean   | N  | Std. Deviation | Std. Error Mean |
| VAS PRE TEST              | 6.47   | 15 | 0.915          | 0.236           |
| VAS POST TEST             | 4.67   | 15 | 0.724          | 0.187           |
| WOMAC PRE TEST            | 53.52  | 15 | 7.874          | 2.033           |
| WOMAC POST TEST           | 34.84  | 15 | 7.538          | 1.946           |
| 6MWT PRE TEST             | 178.21 | 15 | 34.043         | 8.790           |
| 6MWT POST TEST            | 234.42 | 15 | 49.358         | 12.744          |

| Paired Samples Test              |                    |                |                 |   |         |        |                 |        |
|----------------------------------|--------------------|----------------|-----------------|---|---------|--------|-----------------|--------|
|                                  | Paired Differences |                |                 |   | t       | df     | Sig. (2-tailed) |        |
|                                  | Mean               | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference |         |        |                 |        |
|                                  |                    |                |                 | Lower                                     | Upper   |        |                 |        |
| VAS PRE TEST - VAS POST TEST     | 1.800              | 0.414          | .10690          | 1.57071                                   | 2.029   | 16.837 | 14              | .000** |
| WOMAC PRE TEST - WOMAC POST TEST | 18.680             | 4.237          | 1.09406         | 16.33347                                  | 21.027  | 17.074 | 14              | .000** |
| 6MWT PRE TEST - 6MWT POST TEST   | -56.213            | 24.191         | 6.24603         | -69.60974                                 | -42.817 | -9.000 | 14              | .000** |

\*\* Highly Statistical Significant

As can be seen from the output, a significant difference exists between pre and post of VAS and pre and post of WOMAC and pre and post of 6MWT of GROUP B.



Bar Graph representing mean values of pre and post of vas and pre and post of womac and pre and post of 6mwt of Group b

## Group A VS B:

| Group Statistics | GROUP   | N  | Mean   | Std. Deviation | Std. Error Mean |
|------------------|---------|----|--------|----------------|-----------------|
| VAS PRE TEST     | GROUP A | 15 | 6.47   | 0.915          | 0.236           |
|                  | GROUP B | 15 | 6.47   | 0.915          | 0.236           |
| VAS POST TEST    | GROUP A | 15 | 3.4    | 0.632          | 0.163           |
|                  | GROUP B | 15 | 4.67   | 0.724          | 0.187           |
| WOMAC PRE TEST   | GROUP A | 15 | 53.52  | 7.874          | 2.033           |
|                  | GROUP B | 15 | 53.52  | 7.874          | 2.033           |
| WOMAC POST TEST  | GROUP A | 15 | 27.62  | 6.294          | 1.625           |
|                  | GROUP B | 15 | 34.84  | 7.538          | 1.946           |
| 6MWT PRE TEST    | GROUP A | 15 | 178.22 | 34.038         | 8.789           |
|                  | GROUP B | 15 | 178.21 | 34.043         | 8.790           |
| 6MWT POST TEST   | GROUP A | 15 | 286.2  | 56.586         | 14.610          |
|                  | GROUP B | 15 | 234.42 | 49.358         | 12.744          |

|                 | t-test for Equality of Means |    |                 |                 |                       |                         |                   |
|-----------------|------------------------------|----|-----------------|-----------------|-----------------------|-------------------------|-------------------|
|                 | t                            | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Interval Difference | Confidence of the |
|                 |                              |    |                 |                 |                       | Lower                   | Upper             |
| VAS PRE TEST    | .000                         | 28 | 1.000           | .00000          | .33428                | -.68475                 | .68475            |
| VAS POST TEST   | -5.104                       | 28 | .000**          | -1.26667        | .24817                | -1.77502                | -.75832           |
| WOMAC PRE TEST  | .000                         | 28 | 1.000           | .00000          | 2.87519               | -5.88956                | 5.88956           |
| WOMAC POST TEST | -2.848                       | 28 | .008*           | -7.22000        | 2.53552               | -12.41378               | -2.02622          |
| 6MWT PRE TEST   | .001                         | 28 | .999            | .01400          | 12.42988              | -25.44746               | 25.47546          |
| 6MWT POST TEST  | 2.671                        | 28 | .012*           | 51.78000        | 19.38758              | 12.06635                | 91.49365          |

\* Statistically significant \*\* Highly statistical significant



### Bar Graph representing mean values between the groups a and b of vas pre and post, womac pre and post and 6 mwt pre and post

As seen from the output, there is no significant difference exists between Group A and Group B of VAS pre, WOMAC pre and 6MWT pre.

As seen from the output, there is significant difference exists between Group A and Group B of VAS post, WOMAC post and 6 MWT post.

## RESULTS

Statistical analysis of the data showed that is no significant difference of age and gender exists between group A and B (p value >0.05). There is homogeneity maintained between the groups regarding the age and gender.

Data indicate that there is no significant difference exists between pre values of group A and B of VAS, there is no significant difference exists between pre values of group A and B of WOMAC and there is no significant difference exists between pre values of group A and B of 6MWT. There is significant difference exists between the pre and post of VAS, WOMAC and 6MWT of group A.

There is significant difference exists between the pre and post of VAS, WOMAC and 6MWT of group B. There is significant difference exists between the group A and B of VAS post (p<0.001), there is significant difference between the group A and B of WOMAC post (p<0.001) and there is significant difference between the group A and B of 6MWT post (p<0.001).

### Mean values of outcome measures of group A and B:

| Mean Values | GROUP-A | GROUP-B |
|-------------|---------|---------|
| VAS PRE     | 6.47    | 6.47    |
| VAS POST    | 3.4     | 4.67    |
| WOMAC PRE   | 53.52   | 53.52   |
| WOMAC POST  | 27.62   | 34.84   |
| 6MWT PRE    | 178.22  | 178.21  |
| 6MWT POST   | 286.2   | 234.42  |

Both the groups A and B showed significant difference from pre to post intervention, but mean values when compared showed more improvement in group A(MANUAL THERAPY) than group B(EXERCISE THERAPY).

## DISCUSSION

The purpose of this study was to find out the effective treatment techniques in reducing patient's pain and improving physical function in patients with OA knee. Two treatment techniques had been compared for this purpose, one was manual therapy and the other one was exercise therapy. After commencement of all the treatment sessions patients who were treated with manual therapy experienced clinically and statistically significant improvements in self perception of pain, stiffness and functional ability when compared to exercise group. New developments in manual physiotherapy have demonstrated promising improvements in pain and physical function for hip and knee OA<sup>44,45</sup>, but effectiveness has not yet been established<sup>46</sup>. Manual therapy is intended to improve musculoskeletal function and pain by addressing impaired kinematics of the joint, which in OA can be affected by joint capsule contracture, loss of periarticular flexibility, and increased intracapsular pressure<sup>47</sup>. There are several treatment options for OA. Despite the benefits of exercise and various modalities, manual therapy techniques have also been reported to be effective when used in conjunction with joint mobility and strengthening exercises<sup>45</sup>. G D Deyle et al. 2005<sup>48</sup> found that there was greater improvement in functional status and symptoms of the knee with passive physiological and accessory movements in OA knee than home exercises alone.

Physical Therapy treatment approaches include exercise therapy, manual therapy, cryotherapy acupuncture and electrotherapy. prior studies have proved the effectiveness of electrotherapy, exercise therapy, acupuncture, cryotherapy and manual therapy all by giving them individually and together. Two studies conducted in the United States proved that the manual physical therapy and supervised exercises when given in combination can generate functional benefits in patients with OA knee<sup>44,45</sup>. One retrospective study conducted in Canada on 26 patients showed that the high proportion of patients with moderate to severe knee joint disease may experience continued functional benefits from relatively brief out-patients physiotherapy program including exercises, electrotherapy, ice/heat and manual therapy<sup>49</sup>. A study conducted in Australia proved the efficacy of short term manual therapy knee protocol for reducing pain and improving knee function in participants with OA knee pain<sup>50</sup>. According to GD Maitland gentle passive physiologic and accessory movement techniques stimulate neurophysiologic and mechanical effects thus can be used to treat painful joints, muscle spasm and joint hypomobility<sup>51</sup>. As an outcome measure WOMAC index is a reliable measuring tool used in various studies. Deyle et al found significant reduction in WOMAC index score after treating patients of knee OA with manual therapy and exercise therapy. Patients of knee OA have cardinal feature of knee pain which restricts their activity of daily living. Pain had significantly reduced after manual therapy sessions as supported by the studies. Moss et al explored the immediate effects on pressure pain threshold after giving 9 minutes of accessory tibiofemoral joint mobilizations on subjects with mild to moderate knee OA. Study disclosed that the mobilizations would instantly reduce the mechanical pain and produced both local and widespread hypoalgesic effects, which would ultimately improve the motor function. Pollard et al,

reported immediate reduction in pain and improvement in the knee function after 2 weeks of manual therapy knee protocol as compare to control group that had shown no change in symptoms. The benefits of treatment were achieved in eight clinic visits. Most previous studies have demonstrated the benefits of exercise in 36-48 clinical visits<sup>52,53</sup>. One study required 24 telephone contacts and 4 home visits in addition to 36 clinical visits. The greater overall improvement compared with results of previous studies may be due to the manually applied treatment, which allowed the therapist to focus treatment on the specific structures that produced pain and limited function for each patient. The effects of manual therapy procedures cannot be separated from either the clinical or home exercise programs. However, a recent randomized clinical trial found that a combination of manual therapy and clinical exercise provided greater improvements in strength, pain, and function than did clinical exercise alone for impingement syndrome of the shoulder, another chronic inflammatory joint condition<sup>54</sup>. The exercise program was simple, but it adequately addressed the lower limb physical findings that are common in patients with osteoarthritis of the knee. To prevent increasing inflammation, pain and boredom with the program, patients did not perform multiple exercises with the same therapeutic effect or exercise more than once each day. Yetterberg stressed the importance of targeting the clinical treatment and appropriately dosing the exercise to improve joint motion, muscular strength, and cardiovascular fitness for patients with OA of the knee<sup>55</sup>. In this study manual therapy treatment protocol for OA was more effective in reducing pain, stiffness and increasing physical function as compared to the exercise group which was supported by the study of Hoeksma et al, on comparison of manual therapy with exercise therapy in treating hip OA. Techniques used in manual physical therapy are aimed at relaxing tense muscles and restricted joints in order to decrease pain and increase flexibility. Soft tissue work applies pressure to the soft tissue as muscles. This pressure helps in relaxing muscles, increasing circulation and ease pain in the soft tissues. The accessory movement helps loosening tight tissues around a joint, reduce pain in a joint and surrounding tissue and help with flexibility and alignment<sup>24,56</sup>. Oatis C et al conducted a review to describe the treatments that physical therapists use in order to supplement their exercise programs to enhance the effects of rehabilitation, and findings from the study was shown that use of manual physical therapy, taping and balance provides significant benefits in treating OA knee and have made it easy for the subjects to participate in treatment programs and improve their physical activity<sup>57</sup>. Therefore manual physical therapy produces greater effects compared to exercise in patients with OA knee.

### Limitations and Recommendations: Limitations:

- Sample size taken was small.
- Followup was not done after the last assessment.
- Knee range of motion and strength of the muscles were not measured.
- Home program taught to the patients was not supervised.
- There was lack of control group.

### Recommendations for Further Studies:

- Study should be carried out on larger population.
- Followup should be done to rule out the long term effectiveness of the therapy.
- Study can be conducted on different age groups. Changes in the exercise protocol can be done.

## CONCLUSION

The study compared the effectiveness of two interventions that is manual therapy and exercise therapy in patients with osteoarthritis of knee. The study concludes that manual therapy yields significant improvements in subjective measures of pain, stiffness and functional ability in patients with OA knee.

## REFERENCES

1. Jamtvedt G et al. Physical Therapy interventions for osteoarthritis of knee, 2008 Jan 88(1):122 -36.2
2. Franssen M et al. Therapeutic exercises for osteoarthritis of knee or hip .2002 Aug ;29(8)1737-45
3. Oatis C et al: role of physical therapy in management of knee osteoarthritis. Dept of Phys. Therapy, school of health and rehabilitation sciences Mar 2004 ;16:169-175
4. Deyle GD et al: effectiveness of manual physical therapy and exercise in treating OA knee. Brook Army medical Centre Ann Int Med 2002;24:119-122
5. Marlene F et al: physical therapy is effective for patients with OA knee. Dept of Rheum 1999;18:189-199
6. Hicks JE et al: exercise in patients with inflammatory arthritis and connective tissue disease. Rheum Dis Clin North AM 1990 Nov ;16(4):845-70
7. Deyle GD et al: benefits of Phys therapy and exercise in OA of knee. Ann Int Med 2000 Feb 1, 132 :173
8. Members of CR health care need limited trials. Effectiveness between manual physical therapy and exercise therapy in reducing pain and improving function in OA knee.
9. Henderson NE et al: can a program of manual physical therapy and supervise exercise improves the symptoms of OA knee. Ann Int Med 2000;132:173-81
10. Van Barr ME et al: The effectiveness of exercise therapy in patients with osteoarthritis of the hip or knee ; a randomized clinical trial. J Rheumatol 1998 ,25 : 2432 - 2439.
11. Rogind H. Bibow-Nielsen B. Jensen B, et al.: The effects of a physical training program on patients with osteoarthritis of the knees. Arch Phys Med Rehabil 1998, 79 ; 1421-1427.
12. Ottawa panel members, method groups-School of rehabilitation sciences, faculty of health sciences Ottawa. Ontario Canada.
13. K L Bennel et al: Efficacy of physiotherapy management of knee joint osteoarthritis A randomized double blind placebo controlled trial. Ann rheum disease 2005. 64: 906-912.
14. Dekker J et al: Exercise therapy in patients with osteoarthritis of knee. The journal of rheumatology 1998; 25: 2432-2439.
15. H>P>French et al: Manual therapy for osteoarthritis of hip or knee . Manual therapy vol 16 pages 119-124; 2009.
16. J Crosbie et al: Physical therapy is effective for treating osteoarthritis knee. A randomized controlled clinical trial. Dept of Rheum . St Georgia hospital. Sept 2006; 23:654-666.
17. Adams J et al: Physiotherapy management for knee osteoarthritis. Internal journal of rheumatic diseases. vol 14; 145-151 2011.
18. Brenda W et al: the effect of a manual therapy knee protocol in treating osteoarthritis knee pain. A randomized controlled trial. Chiropracassoc 2008. DEC;54: 229-242
19. Peloquin et al: effects of a across training exercise program in patients with osreoarthritis knee. Journal of physiotherapy June 1999; 42: 116-111
20. Mariette J Jhonson et al: strength training alone, exercise therapy alone, exercise with manual mobilization each reduces pain and disability in people with osteoarthritis knee. Journal of physiotherapy 2011; 78: 45-51
21. Alexandra et al: physical therapy and exercise helps osteoarthritis knee. Feb 1, 2000 RCT American PhysTher association, Annals of Int Med; 167: 201-205
22. Henry pollard et al: manual therapy and exercise for prevention of disability in activities of daily living in older patients with osteoarthritis knee. Archives of Intmed . Oct 2001; 16: 334-339
23. Deyle GD et al: physical therapy treatment effectiveness for osteoarthritis of the knee; a randomized comparison of supervised clinical exercise and manual therapy versus a home exercise program. PhysTher2005, 85(12):1301-1317
24. Penny Moss et al: the initial effects of knee joint mobilization on osteoarthritic hyperalgesia. Manual therapy volume 12, pages 109-118; 2007
25. Bennel KL et al: a physiotherapist delivered integrated exercise and pain coping skills training for individuals with OA knee. BMC musculoskeletal disorder 2012 July 24; 13:129-145
26. Shi - Yi Wang et al: physical therapy interventions for knee pain. Ann int med 6 Nov 2012; 157(9): 632-644
27. K R B aker et al: the efficacy of home based progressive strength training in older adults with knee OA. THE JOURNAL OF RHEUMATOLOGY 2002; 45: 45-4
28. Gail D Deyle et al: physical therapy treatment effectiveness for OA of the knee: a randomized comparison of supervised clinical exercise and manual therapy procedures versus a home exercise program. Physical therapy. volume 85. Number 12. December 2005
29. TAESUNG KO et al: manual therapy and exercise for OA knee: effects on muscle strength, proprioception, and functional performance. J.Phys. Ther. Sci.21: 293-299,2009
30. Kazunori itoh et l: a pilot study on using acupuncture and transcutaneous electrical nerve stimulation (TENS) to treat OA.
31. Boonstra p, Anne U et al: reliability and validity of VAS in patients with musculoskeletal pain. International journal of rehab research 2008: 31(2) : 165-169
32. Transcutaneous electrical nerve stimulation and interferential current combined with exercise for the treatment of knee OA: A randomized controlled trial. Dept of medical rehabilitation, obafemiawolowo university, ile-ife and dept. of physiotherapy, university of Maiduguri teaching hospitals, Nigeria
33. Bellamy N et al: validity study of WOMAC; a health status instrument for measuring clinically important patient relevant outcome to ant rheumatic drug therapy in patients with hip or knee OA, j Rheumatol, 1988;15: 1833-40
34. Bellamy N et al: validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with OA of the hip or knee.1988(12): 1833-40
35. Carlson AM et al: assessment of chronic pain. I. Aspects of reliability and validity of the VAS. Pain. 1983 may ; 16(1): 87-101
36. SibelBasaran et al: validity, reliability, and comparison of the WOMAC OA index and lequesnealgofunctional index in Turkish patients with hip or knee OA. Clinical Rheumatology 2010
37. Thumboo J et al: validation of the WOMAC in Asians with OA in Singapore. Article in OA and cartilage 9(5): 440-6. Aug 2001
38. Gail D.deyle, Nancy E et al: a manual physical therapy intervention for symptoms of knee OA and associated fall risk. physiotherapy theory and practice feb 2018
39. Van baar ME ,Dekkerj et al: effectiveness of exercise therapy inpatients with OA of the hip or knee: a systematic review of randomized clinical trials; arthritis rheum 1999 Jul;42(7): 1361-9
40. Felson DT, et al: American college of rheumatology. Preliminary definition of improvement in rheumatoid arthritis: 1995 Jun; 38(6): 727-35
41. FelsonDT,Zhang Y and anthony J: weight loss reduces the risk for symptomatic knee OA in women. The Framingham study: Ann Intern Med 1992 Apr 1;116(7): 535-9
42. K.M. Crossley yzx\*et al: exercise, education, manual-therapy and taping compared to education for patellofemoral osteoarthritis: a blinded, randomized clinical trial: osteoarthritis and cartilage 23 (2015) 1457-1464
43. J. Haxby abbott, Catherine M.Chapple,G.Kelleu Fitzgerald,Julie M.Fritz,JohnD.Childs,Helen Harcombe et al:The incremental effects of manual therapy or booster sessions in addition to exercise therapy for knee osteoarthritis:A randomized clinical trial;jospt:vol45,12, DEC 2005
44. Deyle GD, Allison SC, MatekelRL,Ryder MG, Stang JM et al:physical therapy treatment effectiveness for osteoarthritis ofknee: a randomized comparison of supervised clinical exercise and manual therapy procedures versus a home exercise program. PhysTher 2005;85(12):1301-1

45. Deyle GD, Henderson NE et al: effectiveness of manual physical therapy and exercise in osteoarthritis of knee. A randomized, controlled trial. *Ann Intern Med* 2000;132(3):173-81
46. Panel Ottawa. Ottawa panel evidence based clinical practice guidelines for therapeutic exercises and manual therapy in the management of osteoarthritis. *PhysTher* 2005;85(9):907-9
47. Robertsson O, Wingsstrand H et al: intracapsular pressure and pain in coxarthrosis. *J Arthroplasty* 1995;10(5):632-5
48. Gail D Deyle, Stephen C Allison et al., Physical Therapy Treatment Effectiveness for OA knee: A randomized comparison of supervised clinical exercise and manual therapy procedures versus a home exercise program, *PHYS THER* . 2005;85(85):1301-17
49. Marks R, Cantin D. symptomatic OA of knee. The efficacy of physiotherapy. *J Phys.*1997;83(6):306-12
50. Pollard H, Ward G et al., the effect of a manual therapy knee protocol on osteoarthritic knee pain: a randomized controlled trial. *J Can ChiroprAssoc* 2008;52(4):229-42
51. Maitland GD. *Peripheral Manipulation*.4<sup>th</sup> edition; 2005
52. Fisher NM, Pendergast DR, Gresham GE, Calkins E. muscle rehabilitation: its effect on muscular and functional performance of patients with knee osteoarthritis *Arch Phys Med Rehabil.* 1991;72:367-74

\*\*\*\*\*