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Effect of Pilates on osteoarthritis of Knee

Madhura Jadhav[1*], Dr. Keerthi Rao[2]
[1] BPT Intern, Dr. A.P.J. Abdul Kalam College of Physiotherapy, Pravara Institute of Medical Sciences Loni, Rahata, Ahmednagar, Maharashtra, India
[2] Professor, Dr. A.P.J. Abdul Kalam College of Physiotherapy, Pravara Institute of Medical Sciences Loni, Rahata, Ahmednagar, Maharashtra, India

Abstract
Background: Osteoarthritis, commonly known as wear-and-tear arthritis, is a condition in which the natural cushioning between joint-cartilage wears away. Knee joint osteoarthritis is the most common of all. The main clinical features are pain, stiffness and restrictions in functional activity. Mostly women are affected than men. Pilates exercise is a mind body fitness program and mainly it concentrates on core muscle stabilization. So the study is carried out using the Pilates Exercise technique to know its effects on patients having knee osteoarthritis.
Objective: The study is undertaken to see the effectiveness of pilates exercise on patients having knee osteoarthritis.
Methodology: The study included 30 participants having osteoarthritis knee, intervention period was of 4 weeks. The exercises were explained to all the patients and pre and post treatment WOMAC scoring was taken
Outcome measures: WOMAC osteoarthritis index.
Results: The result shows the difference in WOMAC scoring pre and post treatment. Pre WOMAC scoring was 29.06666667 and post treatment the WOMAC scoring decreased to 17.03448276.
Conclusion: The present study concluded that Pilates exercise was very effective on patients having osteoarthritis knee.

Keywords: osteoarthritis, Pilates, pain, stiffness, WOMAC osteoarthritis index

Introduction

Osteoarthritis is a common disease of age, population and one of the leading causes of disability [1]. The disease of osteoarthritis is considered to be an active process involving the entire synovial joint with both degenerative and repair processes. Osteoarthritis affects all the structures of the joint. It also involves progressive loss of cartilage. The cartilage tries to repair itself and the bone remodels, the underlying (subchondral) bone hardens, and bone cysts form. There are different phases of this process. The stationary phase in osteoarthritis involves osteophytes formation and narrowing of joint space. And then it progresses with obliteration of the joint space. When there is appearance of subchondral cysts it indicates the erosive phase of disease progression in osteoarthritis. The last phase in osteoarthritis progression involves bone repair and remodeling. Osteoarthritis is the most common type of arthritis; it not only causes loss of articular cartilage, but also causes capsular stretching, ligament laxity, bony remodeling and weakening of muscles. With a large area of cartilage loss and bony remodeling the joint becomes weak and it further can lead to mal alignment. Mal alignment can further lead to structural deterioration of the joint. Pain and other symptoms of OA have adverse effect on quality of life affecting both physical function and psychological parameters [2]. Radiological features include joint space narrowing, osteophytes formation and subchondral sclerosis [3]. Pain is the most common symptom in knee OA, which is a leading cause of chronic disability, and a major source of the disability. Pain severity ranging from barely perceptible to immobilizing. Pain, in knee OA increases by activity and relieves by rest. In advanced cases synovitis may appear and can leads to pain at rest [3]. Clinical features include joint pain, stiffness, and crepitation initially and may further lead to structural deterioration of joint and disability [4]. Short duration of stiffness less than 30 minutes may be seen in OA patients in the morning or following periods of inactivity. Tenderness to palpation may be evident in physical examination. Joint effusions may be present, which typically exhibit a mild pleocytosis, normal viscosity, and modestly elevated protein. Crepitus during joint motion or walking is a common. Limitation of range of motion are all common signs of OA of the knee [4]. Age, weight, trauma to joint due to repetitive movements in particular squatting and kneeling are common risk factors of knee osteoarthritis. History of cancer, diabetes or cardiovascular accident and the process of waking disability are other major factors [5]. Other risk factors causing knee osteoarthritis are: 1]Genetic susceptibility 2]Obesity 3]Female gender 4]Repetitive knee trauma 5]Muscle weakness 6]Joint laxity 7]Mechanical force 8]Meniscal injuries.

About 13% women and 10% men of aged 60 years and above have symptomatic knee osteoarthritis. The proportions of people affected with symptomatic knee OA is likely to increase due to the aging of the population and the rate of obesity or overweight in the general population [6]. During a one year period, 25% of people over 55 years may demonstrate persistent episode of knee pain, in which about one in six have to consult their general practitioner about it in the same time period. About 10% of people aged over 55 years have painful disabling knee OA of whom one quarter is severely disabled [7]. Prevalence rate of knee OA in men is lower as compared with that of women. The incidence of knee osteoarthritis increases with age, and women have

higher rates than men, especially after the age of 40 years. Evidence of knee osteoarthritic change on radiographs increases with age and has been found in 72.1% of symptomatic participants and 41.6% of asymptomatic participants aged 40 or older. There is a higher prevalence of OA with advanced age and in females. Most of the knee pain which occurs in the elderly is due to OA. Knee osteoarthritis produces significant changes in health-related quality of life, particularly physical, mental and social components of health. Prevalence rate of symptomatic knee osteoarthritis in the general population vary, with estimates of 7.2% in aged 40 or older, 12.5% in aged over 45 and 14.8% in aged 50 or older. OA in younger adults is most commonly due to a result of the specific injury to the knee, particularly intra-articular injury involving the anterior cruciate ligament**.** Although cartilage degeneration defines OA, this disease also involve the participation of the synovial membrane and subchondral bone. Both clinical and laboratory evidence indicate an altered subchondral bone metabolism in OA, possibly due to abnormal osteoblast behavior. Pathogenesis of osteoarthritis includes the contribution of biochemical and metabolic factors which alters the tissue homeostasis of articular cartilage and subchondral bone. The main role is played by cell and extra-cellular matrix [ECM] interactions, which are mediated by cell-surface integrins [8]. Integrins modulate cell/ECM signaling which is essential for regulating growth and maintaining cartilage homeostasis. In patients with osteoarthritis the abnormal integrin expression alters cell/ECM signaling and modifies chondrocytes synthesis and cause imbalance of destructive cytokines over regulatory factors [8]. IL-1, TNF-α and other pro-catabolic cytokines activate enzymatic degradation of the cartilage matrix. The main enzyme which is involved in ECM breakdown is metalloproteinases [MMPS]. Intriguing is the role of growth factors such as TGF-β, IFG, BMP, NGF, and others simply repair the tissue damage induced by catabolic factors and play an important role in osteoarthritis pathogenesis [8].

Treatment options for osteoarthritis of knee are: 1] Weight loss - Losing even a small amount of weight, if needed, can significantly decrease knee pain from osteoarthritis. 2] Exercise - Strengthening the muscles around the knee makes the joint more stable and decreases pain. 3] Stretching exercises helps to keep the knee joint flexible. 4] Pain relievers and anti-inflammatory drugs - This includes over-the-counter choices such as acetaminophen, ibuprofen, or naproxen sodium. Taking them for longer increases the chance of side effects [8]. 5] Injections of corticosteroids or hyaluronic acid into the knee. Steroids are powerful anti-inflammatory drugs. Hyaluronic acid is a type of lubricating fluid present in the joint. Alternative therapies that can be effective includes topical creams, acupuncture, or supplements, including glucosamine and chondroitin. 6] Using devices such as braces. - Two types of braces are available, one is: "unloader" braces, which take the weight away from the side of the affected knee; and the other is "support" braces, which provide support for the entire knee. 7] Physical therapy - Having trouble with daily activities, physical therapy can be helpful. Physical therapist teaches you ways to strengthen muscles and increase flexibility in your joint and to perform daily activities, such as housework, with less pain. 8] Surgery -When other treatments don't work, surgery is a last option [8].

Pilate's exercises were designed by Joseph Pilates in Germany in 1883. It is a mind-body fitness program. Pilates exercise are constructed in order to develop a strong core, create a balance of strength and flexibility, train efficient movement patterns, create a long and lean appearance and concentrate on the mind-body connection [9]. Originally it was developed as mat exercises. But Pilates exercises were used in rehabilitation for the first time in New York in late 1960. Pilates exercise is used to enhance rehabilitation programs by focusing on core stabilization. This method can be used in treatment of osteoarthritis to improve strength, range of motion, balance, flexibility and proprioception. The advantage of Pilates is that participants enjoy this exercise [9].

Twenty-three studies, published between the year 2005 - 2016, met the inclusion criteria. These papers assessed the effectiveness of Pilates in the rehabilitation of low back pain, ankylosing spondylitis, multiple sclerosis, post-menopausal osteoporosis, non-structural scoliosis, hypertension and chronic neck pain. Nineteen papers suggested Pilates to be more effective than the other comparative group in improving outcomes including pain and disability levels. When assessed with the CONSORT and PEDro scales, the quality of the papers varied, with more falling toward the upper end of the scale. Conclusion: The majority of the clinical trials in the last five years which used Pilates as their rehabilitation tool have found that it is effective in achieving desired outcomes, particularly the outcomes including pain and disability. It indicates the need for further research in these many areas, and especially into the benefits of particular Pilate's exercises in the rehabilitation of specific conditions [10].

The Pilates method helps to strengthen the powerhouse as one of its primary goals. Strengthening the powerhouse is core-stabilization.

The Pilates techniques to be used in the study are:

- The One Hundred
- Single leg stretch
- Double leg stretch
- Shoulder bridge
- Hip twist preparation

Methodology

Source of Data: The source of data is patients with osteoarthritis knee

Method of collection of data

Type of Data: Data will be primary collected by the principal investigator

Study Design: The type of study design is Experimental study [4 weeks intervention]

Sample size: 30

Participants: Patients with OA knee both male and female who were willing to participate are included

Sampling Method: Simple Random Sampling

Study Duration: 4 weeks intervention

Procedure

The ethical clearance form registration no. BPT/INT/2018/16 It is an experimental study which constitute of 30 patients of osteoarthritis knee aged between 40-60 years. The participants will be screened and after finding suitability according to the inclusion and exclusion criteria, they will be requested to participate in the study.

They will be explained about the study and intervention. The participants will be briefed about the nature of the study, duration of the intervention and the intervention being used will be explained in the language best understood by the participants. They will be encouraged to clarify the queries regarding the study if any. The respondents will be made clear that the identity of the participants will not be disclosed and the information gathered would be used for research purpose. A consent form is to be given to each participant. The demographic data will be obtained and the detailed assessment will be done. The participants will be assessed on the first day for the severity of pain and strength. Numerical Pain Rating Scale is used pre and post treatment to assess the severity of pain. WOMAC questionnaire will be administered to the study subject's pre and post treatment. The protocol was of 4 weeks 3 sessions are to be taken each week. Each session will be of 40 minutes. All Pilate's sessions will be given and supervised by the same physiotherapist. The repetitions of Pilate's exercises will be increased gradually from 5 repetitions. In the second week participants will do 6 repetitions, in the third week 7 repetitions and in the fourth week 8 repetitions will be performed. The warm up exercises will be given to the patients for 5-10 minutes. Warm up exercises will include:

1. Stretching exercises:
   - Quadriceps muscle
   - Hamstring muscle
   - Gastrocnemius muscle
2. Spot jogging
3. Foot arch activation
4. Toe wave

Note: Pilates General Guidelines for Clients with Arthritis

1. Encourage clients with arthritis to exercise their joints daily.
2. Always begin with a warm-up of slow exercises (i.e., fundamentals).
3. Keep the room warm. Use warmed towels as props. Heat relaxes joints and muscles and helps relieve pain.
4. Keep the flow of the exercises slow. Allow rest period between exercises.
5. Clients should be encouraged to attempt full range of motion,
6. Breathing in a normal deep rhythmic pattern should be encouraged, especially the classis Pilates breath of in through the nose to warm and filter the breath and out through the mouth to encourage the deep core stabilizers.
7. Encourage the patient to perform the exercise according to their comfort zone and if anything hurts, then the exercise should be stop.
8. Exercises should be started at low resistance with two or three repetitions in beginning, and then progress to five or six repetitions.

Pilate's exercises to be included in the study are

1. Hundreds

- Lie on your back with your hips and knees in 90-90 position and your shin parallel to the floor. Relax breathe in and pull your abdomen in.
- Exhale Bring your head up and, using your abs, curl your upper spine up off the floor. The shoulders should be kept down and engaged in the back.
- Stay at this position and inhale.
- Exhale: At the same time, pull you abdomen in tightly and extend your arms and legs.
- Hold your position. Breathe in and out. Take short breathes.
- To finish: Keep your spine curved and bring your knees toward your chest. Hold your both the knees and lower down the upper spine and head back to the floor. Take a deep breath in and out. Repeat it for 5 times.

2. Single leg stretch

- As you inhale, begin to fold your left knee in and stretch your right leg out. Take hold of your left shin and bring it to your chest, left hand above the ankle, right hand below the knee. As you change from one leg to the other keep your pelvis and spine stable and maintain your abdominal support. Keep your shoulders open and your elbows high and wide as you bring your leg to your chest. Repeat it for 3 times. Hold for 30secs.
- Continue inhaling as you switch legs, folding your right knee to your chest and extending your left leg.

Double leg stretch

- Lie on your back with your hips and knees in 90-90 position, parallel to the floor inhale.
- Exhale: Pull your abdominals in to curve your upper body up off the floor. Bring your head toward the knees.
- Inhale: Your shoulders should be away from your ears, and your abs should be pulled in, as you simultaneously reach your arms and legs in opposite directions. Extend as far as possible while your abs should be kept pulled in and the lower back on the mat.
- Exhale: As you sweep your arms out to the sides and reach around to grasp your shins your abdominals should be pulled in and pulling the legs in to center. Repeat it for 3 times. Hold for 30 secs

3. Shoulder bridge

- Lie on your back, your spine and neck in neutral with your knees bent and feet on the floor.
- Breathe in and pull in your abdomen tightly, then tilt your pelvis forward and lift your hips off the mat while curling your spine and breathe out.
- Breathe again and move your hands in a semicircle so that they are resting behind your head on the floor.
- Breathe out and bring your hands beside your hips. Breathe in again as you hold the position. Breathe out gently lowering your hips to the floor back on the mat.
- Repeat it 5 times.

4. Hip Twist Preparation

- Sit on the mat in neutral position with your knees bent and toes on the floor.
- Keeping your hips firmly on the mat, inhale as you move both legs to the right, circle them down towards mat, exhale as you swing them up the left and back to their starting position.
- Try to keep your pelvic position as you move and don't let your back arch as you lower the legs.
- Repeat other side alternating the direction of the circle each time. Repeat five times for each side.

Table 1

Week	Exercise
1	Hundreds
2	Week1+ One leg stretch. Double leg stretch
3	Week2+ One leg stretch Shoulder bridge
4	Week 3+ Shoulder bridge Hip twist

Cool Down Exercises

- This will be followed by cool down exercises for 10mins.
- The protocol for cool down exercises will be similar to warm up exercises.
- Ergonomic advice will be given to the patients.

Fig 1: One Hundred

Fig 2: Single Leg Stretch

Fig 3: Double Leg Stretch

Fig 4: Shoulder Bridge

Fig 5: Hip Twist Preparation

Results

Various statistical measures such as mean, standard deviation (SD) and test of significance such as student's paired 't' test were analysed in the data. The results were concluded to extremely significant with the p value <0.0001

The pre-intervention mean average score and Standard deviation (SD) for WOMAC Osteoarthritis Index was 29.0666667 and 5.812788122. The post-intervention mean average score and Standard deviation (SD) for WOMAC Osteoarthritis Index was 17.03448276 and 4.544669734. This table represents the difference in pre and post WOMAC scoring. The t value is 16.312 and p value is <0.0001. The values are extremely statistically significant.

Table 2: pre and post readings of WOMAC **scoring**.

Mean		SD		t value	p value
Pre	Post	Pre	Post		
29.06666667	17.03448276	5.812788122	4.544669734	16.312	< 0.0001

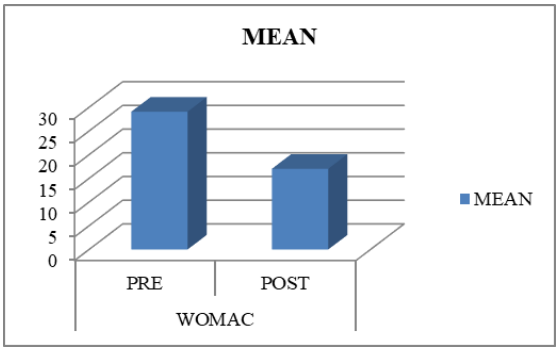

Fig 6

Table 2: Data representation of age and gender

Age	Male	Female
40-41	4	4
42-43	1	2
44-45	0	2
46-47	1	3
48-49	1	3
50-51	1	2
52-53	0	4
54-55	0	1
56-57	0	1
	0.888889	2.444444444

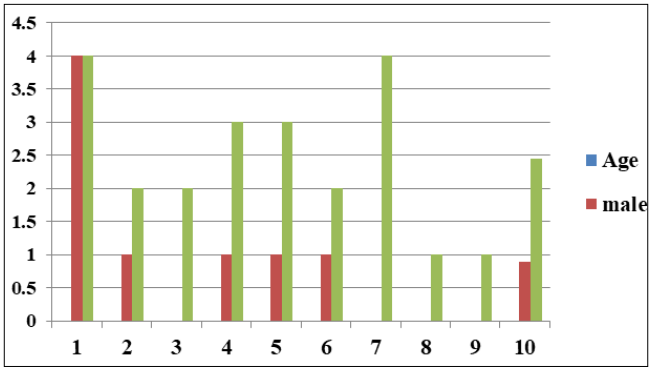

Fig 7

Discussion

The study evaluated the effect of pilates exercise in patients with knee osteoarthritis. The sample size of the study was of 30 participants with knee osteoarthritis. The intervention was of 4 weeks. Outcome measure used was WOMAC Osteoarthritis Index. WOMAC scoring was done pre and post the treatment. All the exercises were explained to all the patients. The duration of each session was of 40 mins and 3 sessions per week were conducted. The result of this study showed that pilates exercise were effective on patients with osteoarthritis knee. Pain was reduced and patients were able to perform the functional activities more easily than before.

Pilates was developed by German-born Joseph Pilates, this method of training has been dubbed "Contrology" since it revolves around conditioning your body. Taking into consideration the alignment of the body, breathing pattern and developing core strength of the body, Pilates exercise can be helpful to take charge of the whole body.

Pilates method works on six key principle: 1]Centre 2]Control 3]Precision 4]Breath 5]Flow

Pilates exercise helps to: (1) Boost energy levels; (2) Relieve stress; (3) Build strength; (4) Increase flexibility; (5) Improve balance and co-ordination; (6) balance muscle development; (7) Develop proper posture; (8) Develop proprioception; (9) Decrease pain; (10) Improve core strength; (11) Improve peripheral mobility. **(1)** Boost energy levels: One of the reasons is simply that every time you exercise, your body releases endorphins, the natural 'feel-good' hormones. But there's also more to it than that. The breathing exercises essential to Pilates promote good circulation, improve lung capacity and improve overall energy level of the body. Deep breathing increases the oxygen in the blood, helping to activate the mind, brain and body and helps to forget the day-to-day stress. **(2)** Relieve stress: Pilates can be incredibly powerful and helpful in providing a place for the body to relax, rejuvenate and release tension. It also provides a space for the mind to focus on the present and relieves the stress. The Pilates principle, breath, helps to oxygenates the blood which activates the brain and relaxes it. The breath creates a physiological response in the body which decreases our stress and anxiety. **(3)** Build strength, improve posture and core strength: Unlike working out on the weight machine, Pilates routines usually focus on bettering the whole body and not just one muscle. In addition, Pilates helps to build different kinds of muscles by focusing on core stabilization technique. For strengthening the abdominal and back, pilates is one of the best exercise. **(4)** Increase flexibility: Pilates is known for helping people develop both strength and flexibility. The following set of Pilates stretches includes exercises that increase the flexibility of the back, hamstrings, and quadriceps. It also helps in increases the range of motion in a joint. All of these exercises helps to promote strength and flexibility. Pilates exercises also help to deal with coordination and balance. Balance allows you to stay upright and in control of the body's movement, while coordination is a skill allowing you to move two or more body parts smoothly and efficiently to complete a task. **(5)** Improve balance: Co-ordination requires good balance. "Every activity we do in our daily life relies heavily on our balance, yet it is often neglected and is underrated as a form of exercise training," Pilates experts quoted this statement. "From early childhood development, through our later years of life the ability to maintain a controlled body position while performing a certain task is essential for our every-day functioning." Pilates instructor, Crystal Chin, stated that "You don't need to be a dancer to realize how important coordination is in daily life. From hand-eye coordination to mind-body coordination, we all need it to drive, eat, walk, and workout… Pilates was specifically designed to improve coordination of the entire body." The physiological effects of Pilates exercises are: 1] It increases neuromuscular co-ordination. 2] Brings about co-contraction of muscles around knee joint. 3] Increases recruitment of muscle fibers. 4] It improves stimulation of proprioception around knee joint. A pilot study was conducted on osteoarthritis knee patients by using pilates exercise of the knee, and it may be more effective when group exercise is applied. Aim of the study was to see the effects of Pilates exercises in patient with osteoarthritis of the knee. Material and method: One hundred twenty seven patients with knee osteoarthritis were examined for the study out of which 67 patients were included in the study. Patients were divided in two groups according to their pain. First group was of patients performing in a group program session and other group was of patients performing home program. Comparison of the scores of knee extension muscle strength, WOMAC Osteoarthritis Index, Oswestry Disability Index, Health Assessment Questionnaire, and Timed up and Go test, was done before and after Pilates exercise programs. Group program was applied 3 times a week for 4 weeks. Each session was of 60 minutes. Home program was carried on every week for four weeks. All patients were participated, and patient education sessions once a month was done. Results: An improvement was recorded statistically in all parameters according to pre-treatment values ($p<0.05$) except for TUG in both group program and home program. Changes of the parameters with exercise education was higher in group program ($p<0.05$). Conclusion: The results showed that Pilates exercises are an effective and a

clinically practicable approach for patients with osteoarthritis. Another comparative study was done on patients with osteoarthritis for 3 weeks. Comparison was done between conventional physiotherapy and pilates exercise. Aim: To find out the effect of pilates v/s conventional physiotherapy exercises in osteoarthritis of knee. Method: This experimental study was carried out using Numerical Pain Rating Scale (NPRS) and WOMAC scale amongst osteoarthritis of knee in hospitals across Maharashtra state, India. A total of 30 samples aged between 50-65 years were included in the study. There were 2 groups the first was Pilates group and second was conventional physiotherapy exercises group. The protocol was of three weeks which consisted four sessions per week. Results: When Pilates and conventional PT exercises were compared results showed that there is significant improvement in physical functioning on WOMAC scale than pain on NPRS. On WOMAC scale 3 components were calculated separately (i.e. pain, stiffness, physical function) pre and post intervention. Out of which physical function component scoring was improved significantly as compared to pain and stiffness. Hence we can say that Pilates are more helpful in improving physical functioning of the participants. Conclusion: From the study we can conclude that patients with OA knee can achieve significant benefits using Pilates exercises. They have been found efficacious for the improvement of knee functions. The result of both studies mention are in conjunction with my study.

Conclusion

On the basis of the present study, it is concluded that Pilates exercise technique is effective in treating patients with osteoarthritis knee.

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