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Effectiveness of Retro Walking Exercise Versus Core Stability Exercise for Coastal Patients with Osteoarthritis of the Knee - A Randomized Active Control Study

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Keywords:

Coastal life, Knee Osteoarthritis, Retro walking exercise, Core stability exercise, Numeric pain rating scale.

Abstract

Background: Most patients who suffer from osteoarthritis (OA), a chronic degenerative disease, are in their fourth and fifth decades of life. When one ages, it leads to joint wear and tear. Bones, cartilage, and synovium are the structures that are impacted. Retro walking is regarded as a successful closed kinetic chain workout to enhance the body's equilibrium and lower-body strength. Core stability exercises are exercises designed to improve the strength and stability of the muscles that support the spine, hips, and knees, core stability exercise lessen the strain on the lumbar muscles and lower extremities as well as the intradiscal pressure. An adapted curriculum for the needs is needed.

Objective: The study's goal was to investigate the effectiveness of retro walking exercise versus core stability training.

Methodology: 30 subjects with osteoarthritis knee were selected. They were randomly assigned to two groups that is Retro walking exercise (RWE) group and Core Stability Exercise (CSE) group. RWE group received retro walking exercise and conventional exercise and CSE group received core stability exercise and conventional exercise. Exercise is given for 6 weeks Western Ontario McMaster Universities Osteoarthritis Index (WOMAC) and the Numeric Pain Rating Scale (NPRS) were used to measure pain and functional activity scores prior to and following the intervention.

Result: The data was analysed and interpreted using the SPSS version. There was a significant reduction in NPRS and WOMAC score in both groups and a significant difference was found between RWE group and CSE group ($p<0.05$).

Conclusion: From the above study, we draw the conclusion that both exercises were successful in treating patients with knee osteoarthritis, but retro walking demonstrates an additional notable extent of handicap decrease.

1. Introduction

The coastal climate may also be beneficial to joint inflammation. A healthy body weight, consistent physical activity, and appropriate medical care are still required for osteoarthritis management. . Osteoarthritis (OA) is a chronically progressive degenerative disease that primarily affects persons in their forties and fifties.. Osteoarthritis (OA) is a disorder that impacts the joints over time and is caused by the gradual breakdown of cartilage.[1]. Therefore, cysts and osteophytes form at the joint edge. [2]. Knee OA is the seventh most common cause of mobility impairment [1], affecting 100 million people worldwide. In India, the prevalence ranges from 22% to 39%, while in rural areas, it is 5.78% [3,4]. Another factor that has been linked to a widespread incidence of symptomatic knee OA is knee trauma and injury, as well as physically demanding activities such extended standing and kneeling. [5]. Nonetheless, the prevalence of OA rises sharply with ageing and is more prevalent in women than in males. While radiological

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evidence is detected in 70% of women over 65, nearly 45% of women over 65 show symptoms. In especially for women, OA of the knee is a significant contributor to reduced mobility. OA was ranked as the 10th most common nonfatal burden cause. Joint health, inflammation, genetic susceptibility, mechanical pressures, and cellular and biochemical processes all play a role in the multifactorial, complex interaction of constitutional and mechanical elements that leads to OA [6-13]. Andrianakos et al. observed that only 8.9% of adults had clinically severe osteoarthritis of the knee, hand, or hip, Felson et al. Reported that approximately one-third of all adults have radiological evidence of osteoarthritis [14,15]. According to studies, in men aged 60 to 64, the right knee (23%) is more likely to have osteoarthritis than the left knee (16.3%), but the breakdown appears to be more equitable in women (right knee, 24.2%; left knee, 24.7%). [16].

The distal femur, proximal tibia, and patella, along with ligaments and a synovial membrane, make up the knee, the largest synovial joint in humans. Along with cartilage from the meniscus, it also contains hyaline cartilage. [17]. This joint undergoes a lot of stress and wear, therefore painful disorders like OA frequently develop there [18]. Among the most common clinical signs of knee OA are discomfort, tenderness, crepitus, muscle weakness, deformity, impaired proprioception, limited joint motion,. [19]. The diagnosis is based on the results of the physical examination and history, and x-rays are frequently used to confirm it. Typically, laboratory testing is used to rule out alternative diagnosis. Modern therapy seeks to improve function and quality of life. They currently also include physical therapy, weight loss, transcutaneous electrical nerve stimulation (TENS) devices, intra-articular cellular injections for mild arthritis, in addition to NSAIDs and acetaminophen. One of the various choices for treating severe arthritis is still surgery. [20]. Exercise therapy is widely used for such conditions to decrease morbidity [21]

Retro walking is recognised as a beneficial closed kinetic chain workout for improving body balance and lower-body strength. The act of walking backwards is known as retro walking. Retro-walking requires different muscle activation patterns than forward walking since it involves reverse propulsion and leg movement reversal. [22]. Backward walking has been shown to substantially decrease the peak patellofemoral joint compressive force and slow the pace of loading. Consequently, retro walking causes less damage to the articular cartilage. In retro walking, individuals walk backwards at a slow and controlled pace, often using a treadmill or a designated walking path. The exercise can be performed for a specified period or for a set distance. Depending on the individual's physical condition and the severity of their knee osteoarthritis, retro walking may be performed daily or several times per week Retro walking might be employed as a type of exercise during knee rehabilitation because it eliminates excessive joint loads and ligament excessive stretching while strengthening the quadriceps. [23].

The muscles that support the knee joint atrophy and lose strength as a result of osteoarthritis. Core stability ,pelvic and knee stability can improve coordination by engaging the crucial lumbopelvic-hip complex muscles and periarticular knee muscles. Proper training regimens aiming at regaining muscular strength have been shown to protect joints from pathological deterioration [24]. Core stability will increase the work of dynamic muscles, and the presence of these muscles' coordinated and simultaneous contractions will create stiffness to support the trunk. This lowers intradiscal pressure, lumbar muscle and lower extremity effort, and abnormal lumbar muscular tension. [25]. .The goal of this study was to evaluate retro walking exercise with core stability to see which type of exercise was more effective for controlling pain and functional activity in individuals with OA knee.

2. Methodology

It is a quasi-experimental study with convenient sampling that includes a total of 30 participants. The participants in this study were taken from the department of physiotherapy in our institute, after being diagnosed with osteoarthritis by an orthopaedic. The participants included in this study were both male and female between age group of 40 to 55 with both unilateral and bilateral knee osteoarthritis, a numerical pain rating scale of more than score 5, radiographic grades on the Kellgren-Lawrence scales of 1 to 3, participants with independent walking, participants who were able to walk continuously for 20 mins and participants who have soft tissue injuries around the knee joint, recent surgeries around the knee joint, participants with balance deficits, fixed flexion

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deformities, and who were not willing to participate for 6 weeks, were excluded from the study. After signing the informed consent, participants were randomly allocated into two groups: the Retro Walking Exercise Group (RWE) and the Core Stability Exercise Group (CSE) by lottery method; each group consists of 15 participants.

INTERVENTION PROCEDURE

Retro Walking Exercise (RWE) Group

The program lasted for 6 weeks, with one session per day and four sessions per week, for a total of 24 sessions, each lasting for 45 minutes.

The warm-up and cool-down exercises included heel raises, ankle toe movements, and stretches for the gastrocnemius-soleus and hamstring muscles, and they lasted for 5 minutes.

The conventional exercise training involved performing a single set of 10 repetitions once a day for 4 days per week for a total of 6 weeks. However, you have not provided any details about what exercises were included in the conventional training program.

The retro-walking training began with participants walking four steps in a retro-walk and being observed for any discomfort. If there was no discomfort, the participants were made to walk 10 meters in a retro-walk on a flat surface, with their toes striking the ground first instead of the heel. They gradually increased their walking time up to 20 minutes over the 6-week period, and they were instructed to walk between two cones that were placed at a distance of 10 meters from each other.

Overall, this exercise training program appears to be well-structured and includes both conventional exercises and retro-walking, which is a unique form of exercise that may provide additional benefits. The gradual increase in retro-walking time over the 6-week period also suggests that the program was designed to promote safe and sustainable progress.

Core Stability Exercise (CSE) Group

The exercise of core stability group received both core stability and conventional exercise. The 6-week exercise training schedule included one session per day and four sessions per week, for a total of 24 sessions. Each session was around forty minutes long.

Conventional exercise training is doing a single set of 10 repetitions once a day for four days a week for six weeks. After conventional exercise core stability exercise were given, as mentioned in **table 1.**

Table 1

Core Stability Exercise	Frequency	Repetitions	Hold sec	Relax sec
Cross curl ups	4days/week	1set of 10 repetition/ day	10 sec	5 sec
Quadrupedal stance	4days/week	1set of 10 repetition/ day	10 sec	5 sec
Bridge exercise	4days/week	1set of 10 repetition/ day	10 sec	5 sec
Spinal rotation	4days/week	1 set of 10 repetition/day	10 sec	5 sec

Conventional Exercise for Both Groups

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Conventional exercise training involves performing a single set of 10 repetitions once a day for 4 days per week for a total of 6 weeks. **Table 2** outlined the conventional exercise for both groups.

Table 2

Conventional exercise	Frequency	Repetitions	Hold sec	Relax sec
Isometric quadriceps	4days/week	1set of 10 repetition/ day	10 sec	5 sec
Straight leg raise	4days/week	1set of 10 repetition/ day	10 sec	5 sec
Terminal knee extension	4days/week	1set of 10 repetition/ day	10 sec	5 sec
Isometric hip adduction	4days/week	1set of 10 repetition/ day	10 sec	5 sec
Hamstring setting	4days/week	1set of 10 repetition/ day	10 sec	5 sec

OUTCOME MEASURE

Table 3 mentioned the outcome measures that were tested to ascertain the success of the treatment. The outcome comprises the level of knee discomfort and ability to function. All measurements were taken at the start of the intervention (week 0) and at the end (week 6).

Table 3

OUTCOME	MEASUREMENT TOOL
Knee pain	Numeric Pain Rating SCALE (NPRS)
Functional activity	Western Ontario McMaster Universities Osteoarthritis Index (WOMAC)

Numeric Pain Rating Scale

The NPRS is an 11-point scale with numbers ranging from 0 to 10, with 0 representing "no pain" and 10 representing "worst imaginable pain." Patients are instructed to choose the number on the scale that best depicts their level of pain. [26].

Western Ontario McMaster Universities Osteoarthritis Index

The WOMAC index, a dependable, valid, and adaptable disease-specific tool, was used by the participants to report their knee function. Lower scores imply greater function on the 24 categories that make up the WOMAC index, which include pain (scoring 0-20), stiffness (score 0-8), and physical function (score 0-68) [27].

STATISTICAL ANALYSIS

Regarding the statistical evaluation, SPSS software was employed. The mean and standard deviation are displayed for each result. All outcome measures' baseline scores were displayed. The Shapiro-Wilk test was used to figure out the normality of the data.. For all measurements of outcome, data was examined using a paired t-test to compare within-group changes on day 1 and at the end of 6 weeks. The result is shown as mean and standard deviation, with p0.05 indicating statistical significance. Tables 4,5,6,7 and Graphs 1,2,3,4 describe the data analysis.

3. Result Analysis

Table 4 displays mean and standard deviation of NPRS of RWE Group measured before the treatment (Pre),

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and after the treatment (post). The Mean of base line of NPRS is 7.4 ± 1.06 and after treatment 2.8 ±0.94. According to parametric Paired Sample t test, obtained t-value is 28.1 and p value is 0.0001 (<0.05). This result shows significant difference in pre and post value of NPRS.

Table 5 displays mean and standard deviation of WOMAC of RWE Group measured before the treatment (Pre), and after the treatment (post). The Mean of base line of WOMAC is 65.5 ± 7.60 and after treatment 45.4 ±7.81. According to parametric Paired Sample t test, obtained t-value is 12.96 and p-value is 0.0001 (<0.05). This result show significant difference in pre and post value of WOMAC.

Table 6 displays mean and standard deviation of NPRS of CSE Group measured before the treatment (Pre), and after the treatment (post). The Mean of base line of NPRS is 7.6 ± 0.98 and after treatment 4.2 ±0.77. According to parametric Paired Sample t test, obtained t-value is 20.98 and p value is 0.0001 (<0.05). This result shows significant difference in pre and post value of NPRS.

Table 7 displays the mean and standard deviation of WOMAC of CSE Group measured before the treatment (Pre), and after the treatment (post). The Mean of base line of WOMAC is 66.7 ± 8.63 and after treatment 54.07 ±7.29. According to parametric Paired Sample t test, obtained t-value was 9.68 and p value 0.0001 (<0.05). The results showing significant difference in pre and post value of WOMAC.

Table 4 Analysis of pre & post values of NPRS on RWE group

Group	Test	N	Mean	S.D	t-value	p-value
RWE	PRE – TEST	15	7.4	± 1.06	28.1	0.0001
	POST - TEST	15	2.8	± 0.94		

Table 5 Analysis of pre & post values of WOMAC on RWE group

Group	Test	N	Mean	S. D	t-value	p-value
RWE	PRE – TEST	15	65.5	± 7.60	12.96	0.0001
	POST - TEST	15	45.4	± 7.81		

Table 6 Analysis of pre and post values of NPRS on CSE group

Group	Test	N	Mean	S. D	t-value	p-value
CSE	PRE – TEST	15	7.6	± 0.98	20.9	0.0001
	POST - TEST	15	4.2	± 0.77		

Table 7 Analysis of pre and post values of WOMAC on CSE group

Group	Test	N	Mean	S. D	t-value	p-value

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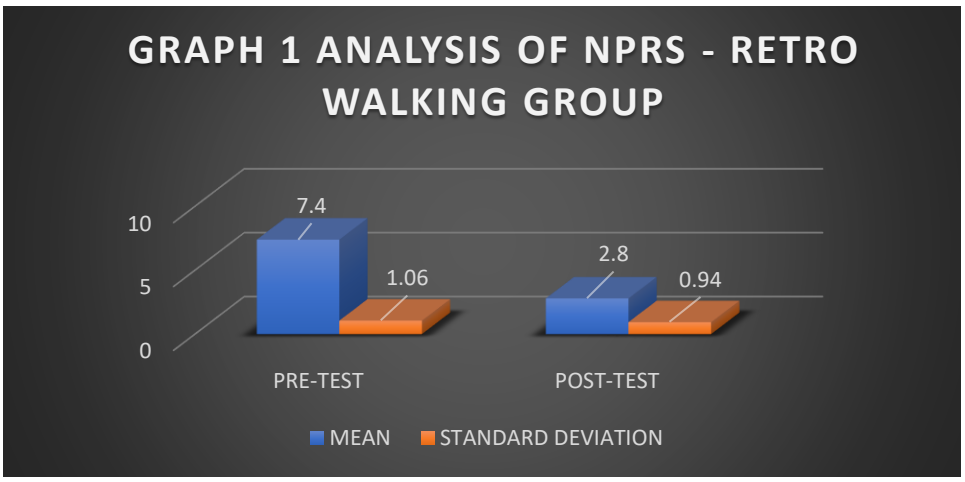
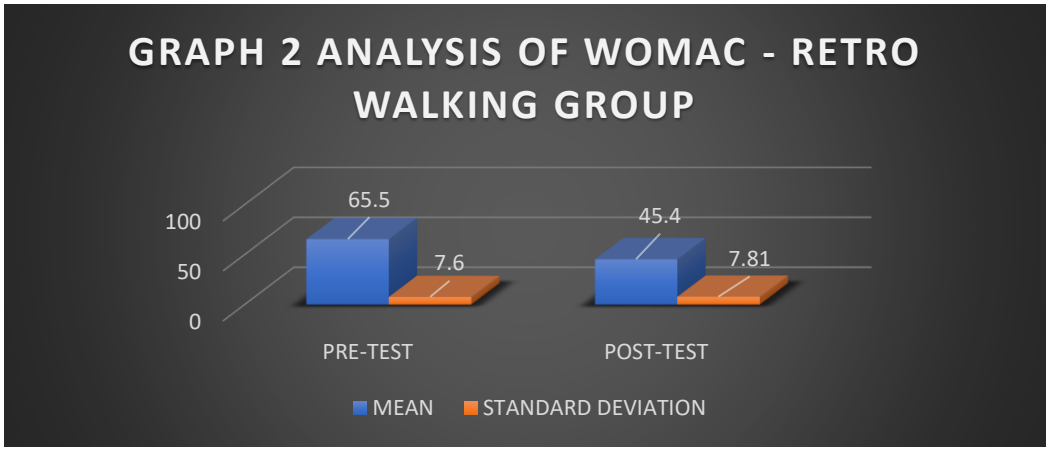
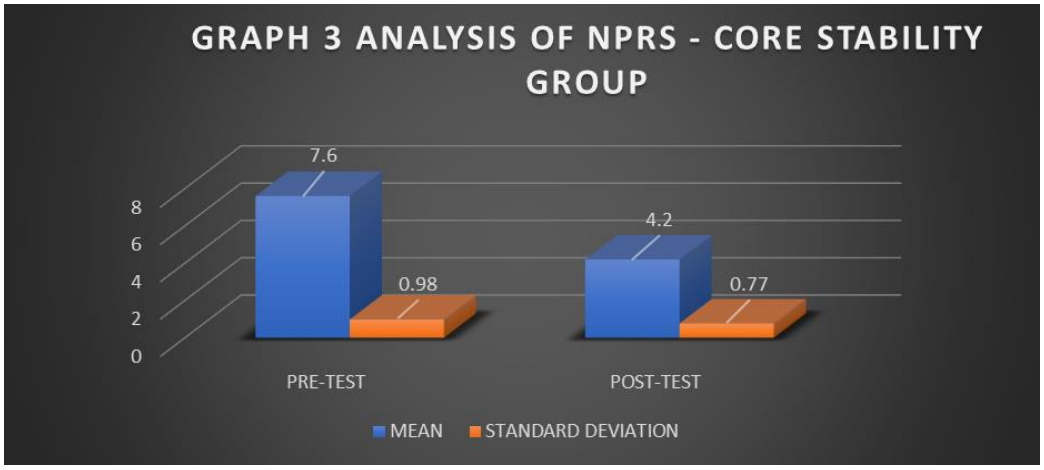
CSE	PRE – TEST	15	66.7	± 8.63	9.68	0.0001
	POST - TEST	15	54.07	± 7.29		







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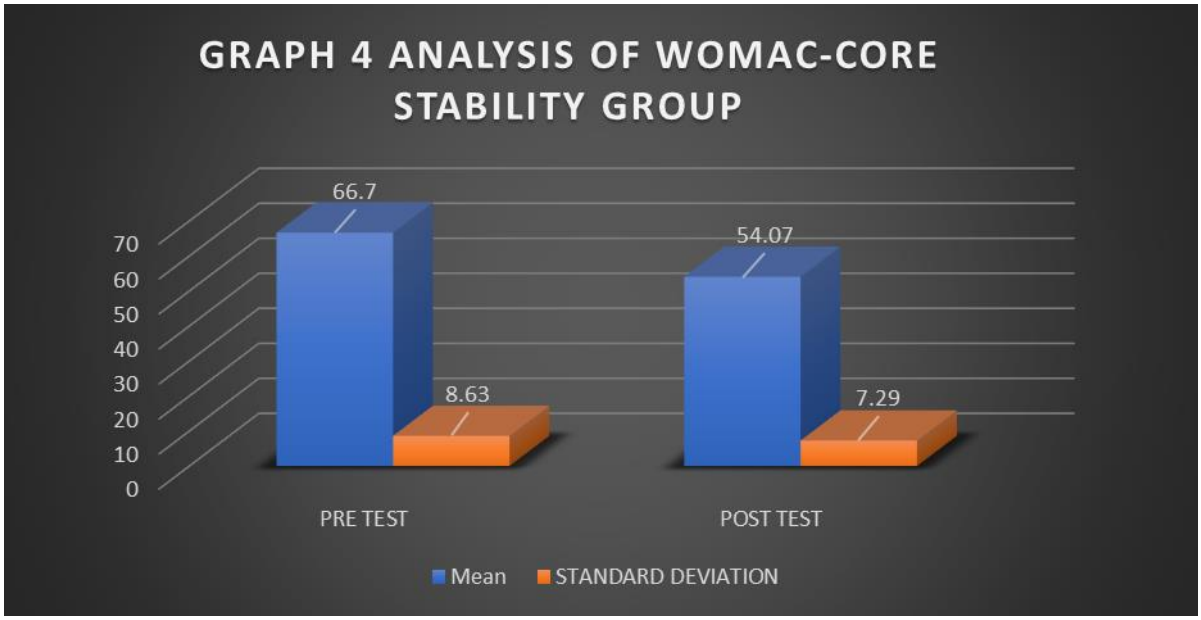

4. Result

On comparing the mean values of RWE group and CSE group on pain level assessed by NPRS shows significant decrease in the post-test mean value. RWE group has mean value of 2.8 which is lower that CSE group which is 4.2. On comparing the mean value of RWE group and CSE group on functional activity assessed by WOMAC shows significant decrease in the post-test mean value. CSE group has mean value of 45.4 which is lower than CSE group which has 54.07.

5. Discussion

The goal of this study was to assess the benefits of retro walking exercise against core stability exercise in patients with knee OA. The current study found that the retro walking programme is helpful in lowering pain and enhancing functional activity in people with knee OA after 6 weeks of intervention. Both groups experienced statistically significant decreases in NPRS and WOMAC. However, the retro walking exercise group improved more than the core stability exercise group. The descriptive analysis shows the mean and standard deviation of the NPRS and WOMAC scores for the RWE Group and the CSE Group. Each group's difference has a 95% confidence interval. Furthermore, when compared to the CSE Group, the mean value of RWE Group has been reduced, and this indicates that retro walking exercise is more effective when compared to core stability group

During retro-walking, the biomechanical movement of the muscles around the ankle and knee was reversed. In retro-walking, the knee serves as the main power provider with the quadriceps and hamstrings contracting simultaneously, and the ankle plantar flexors serve as a shock absorber [28]. As opposed to forward walking, retro-walking involves the knee joint's shear force moving posteriorly rather than anteriorly [29]. Also, when walking backwards, the patellar compressive force is substantially lower than when walking forwards [30]. Retro walking may help with pain reduction by minimising the extra adductor moment at the knee joint and the compressive stresses on the knee joint's medial compartment. Reduced joint kinetics and kinematics during functional motions, decreased discomfort, and enhanced muscle activation patterns can all be linked to improvements in function. Through this mechanism, it had been believed that retro walking exercise had an effect in pain reduction and physical function improvement.

The result of the present study is also consistent with the Algadhir et al found that 6 weeks of retro walking exercise had greater reduction in pain level and improvement in physical function in individuals with OA knee that the forward walking and control group. The author also discussed that retro walking program

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more effectively improved performance measured by TUG test and quadriceps muscle strength [33]. Whereas similar effect was found in the present study that there is a reduction in pain level and improvement in physical function level.

According to Wallis et al, people with significant knee osteoarthritis could walk for 70 minutes per week at an appropriate intensity safely, practically, and tolerably. Longer walking sessions, on the contrary may exacerbate knee pain. [32]. In the trial, the walking programme length was gradually increased from 40 minutes per week to 80 minutes per week over a 6-week period to avoid symptom worsening. Messier et al. discovered that combining a forward walking plan with weight training improved pain and impairment in knee OA patients.. [31]. In our research, similar outcomes such as pain reduction and increase in physical function were discovered. In contrast to the current trial, a phase II RCT reported no reduction in knee pain after a 12-week walking programme in individuals with severe knee OA [32]. However, there was a methodological difference between the previous study and the current one. Those with severe knee OA were excluded from the current study. The earlier study included patients with severe knee OA, which could explain why there were no significant improvements in knee pain after a 12-week walking exercise.

The ability to support or move the extremities is developed by greater levels of activation of the extremities or limbs because of enhanced core stability activation pattern, it will serve as the foundation for all arm and leg movements while in motion and aid in maintaining proper posture [34]. The effects of training the hip and quadriceps muscles were assessed in relation to strengthening the quadriceps alone in a trial of 70 females with patellofemoral pain syndrome after a 4-week course. According to the findings, the hip and quadriceps strengthening group saw larger pain and function improvements. [35]. After 6 weeks of rehabilitation, a study of patellofemoral pain patients evaluated pain, function, muscular strength in the knees and hips, and core endurance between knee and hip regimens. Despite equal results at six weeks, the hip treatment demonstrated quicker pain relief and greater strength increases than the knee protocol [361]. This was the evidence for the present study result which core stability exercise was done for 6 weeks for 4 times per week and the result of the study has shown reduction in pain level and improvement in physical function level.

Based on this present study result, both the exercise protocol found to be reducing the pain level and improving the physical function level, however retro walking exercise protocol lead to higher the reduction in the pain level and improvement in the physical function level in patients with osteoarthritis of knee.

The current study has some limitations: This study has no control group. The study was conducted in short duration. The sample size was modest, as befitting a feasibility study. No follow up was done to see if the improvement was maintained or not. The study's participants were then a relatively small, (patients aged 40–55 years old).

Future Recommendations:

To test a larger sample size and control group. Long-term impacts of exercise must be studied for a longer period of time. To assess the effects of the same activity in different age groups. This study features a more feminine population, which could be due to the higher frequency of OA knee in women than in males. This study could be expanded to include the noncoastal worldwide female population in the future.

6. Conclusion

The coastal climate may also be beneficial to joint inflammation. A healthy body weight, consistent physical activity, and appropriate medical care are still required for osteoarthritis management. But yet in our study, the value of physiotherapy was established. From the result analysis, we conclude that both the exercise treatment in the form of adaptive curriculum were effective in treating osteoarthritis of the knee but retro walking exercise treatment is more effective than core stability exercise in managing pain and functional activity level with disability reduction for Osteoarthritis of the knee.

Conflict of interest: NIL

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Reference

[1] Lützner, Jörg, et al. "Surgical Options for Patients With Osteoarthritis of the Knee." Nature Reviews Rheumatology, vol. 5, no. 6, Springer Science and Business Media LLC, June 2009, pp. 309–16.

[2] Fitzgerald, G K. "Therapeutic exercise for knee osteoarthritis: considering factors that may influence outcome." Europa medicophysica vol. 41,2 (2005): 163-71.

[3] Litwic, A., et al. "Epidemiology and Burden of Osteoarthritis." British Medical Bulletin, vol. 105, no. 1, Oxford UP (OUP), Jan. 2013, pp. 185–99.

[4] Xie, Yujie, et al. "Quadriceps Combined With Hip Abductor Strengthening Versus Quadriceps Strengthening in Treating Knee Osteoarthritis: A Study Protocol for a Randomized Controlled Trial." BMC Musculoskeletal Disorders, vol. 19, no. 1, Springer Science and Business Media LLC, May 2018

[5] Mahir L, Belhaj K, Zahi S, Azanmasso H, Lmidmani F, El Fatimi A. Impact of knee osteoarthritis on the quality of life. Ann Phys Rehabil Med 2016 Sep;59

[6] Berenbaum F. Osteoarthritis as an inflammatory disease (osteoarthritis is not osteoarthrosis!). Osteoarthritis Cartilage. 2013 1 21(1):16-21

[7] Daghestani HN, Kraus VB. Inflammatory biomarkers in osteoarthritis. Osteoarthritis Cartilage. 2015 11 23(11):1890-6

[8] Greene MA, Loeser RF. Aging-related inflammation in osteoarthritis. Osteoarthritis Cartilage. 2015 11 23(11):1966-71

[9] Malfait AM. Osteoarthritis year in review 2015: Biology. Osteoarthritis Cartilage. 2016 1 24(1):21-6

[10] Orlowsky EW, Kraus VB. The role of innate immunity in osteoarthritis: When our first line of defense goes on the offensive. J Rheumatol. 2015 3 42(3):363-71

[11] Scanzello CR, Goldring SR. The role of synovitis in osteoarthritis pathogenesis. Bone. 2012 8 51(2):249-57

[12] Scanzello CR, Goldring SR. The role of synovitis in osteoarthritis pathogenesis. Bone. 2012 8 51(2):249-57

[13] Sellam J, Berenbaum F. Is osteoarthritis a metabolic disease? Jt Bone Spine. 2013 12 80(6):568-73

[14] Andrianakos AA, Kontelis LK, Karamitsos DG, et al.: Prevalence of symptomatic knee, hand and hip osteoarthritis in Greece. The ESORDIG study. J Rheumatology 2006; 33: 2507–13.

[15] Felson DT, Couropmitree NN, Chaisson CE, et al.: Evidence for a Mendelian gene in a segregation analysis of generalized radiographic osteoarthritis. The Framingham Study. Arthr Rheum 1998; 41: 1064–71

[16] D'Ambrosia RD: Epidemiology of osteoarthritis. Orthopedics 2005; 28 (Suppl. 2): p. 201–205.

[17] Sharma, Vandana, et al. "Arthritis of the Knee." DeckerMed Pain Management, Decker Medicine, Apr. 2017

[18] Richebé P, Capdevila X, Rivat C. Persistent Postsurgical Pain: Pathophysiology and Preventative Pharmacologic Considerations. Anesthesiology. 2018.

[19] van der Esch, M et al. "Clinical phenotypes in patients with knee osteoarthritis: a study in the Amsterdam osteoarthritis cohort." Osteoarthritis and cartilage vol. 23,4 (2015): 544-9

[20] Lespasio, Michelle J et al. "Knee Osteoarthritis: A Primer." The Permanente journal vol. 21 (2017): 16-183.

[21] Jönsson T, Ekvall Hansson E, Thorstensson CA, Eek F, Bergman P, Dahlberg LE. The effect of education and supervised exercise on physical activity, pain, quality of life and self-efficacy - an intervention study with a reference group. BMC Musculoskeletal Disorders 2018;19

[22] Kim K, Lee S, Lee K. Effects of Progressive Body Weight Support Treadmill Forward and Backward Walking Training on Stroke Patients' Affected Side Lower Extremity's Walking Ability. Journal of Physical Therapy Science 2014; 26:1923–7.

[23] Brink M. The effect of backward locomotion as a rehabilitation program on functional ability of patients following knee injury. Stellenbosch University. 2010.

[24] Hernandez, Daniel, et al. "Efficacy of Core Exercises in Patients With Osteoarthritis of the Knee: A Randomized Controlled Clinical Trial." Journal of Bodywork and Movement Therapies, vol. 23, no. 4, Elsevier BV, Oct. 2019, pp. 881–87.

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

[25] Kisner, C., & Colby, L. (2011). Therapeutic Exercise: Foundation and Techniques.

[26] Hjermstad, Marianne Jensen et al. "Studies comparing Numerical Rating Scales, Verbal Rating Scales, and Visual Analogue Scales for assessment of pain intensity in adults: a systematic literature review." Journal of pain and symptom management vol. 41,6 (2011): 1073-93.

[27] Ayala, Alba, et al. "Scale Invariance and Longitudinal Stability of the Physical Functioning Western Ontario and MacMaster Universities Osteoarthritis Index Using the Rasch Model." Rheumatology International, vol. 38, no. 3, Springer Science and Business Media LLC, Dec. 2017, pp. 473–79.

[28] Chen LY, Su FC, Chiang PY. Kinematic and EMG analysis of backward walking on treadmill. Conf Proc IEEE Eng Med Biol Soc. 2000; 2:825–7)

[29] Kumar TR, Ashraf M. The effect of backward walking treadmill training on kinematics of the trunk and lower limbs. Serb J Sports Sci. 2009; 3:121–7.).

[30] Esch, Martin van der, et al. "Decrease of Muscle Strength Is Associated With Increase of Activity Limitations in Early Knee Osteoarthritis: 3-Year Results From the Cohort Hip and Cohort Knee Study." Archives of Physical Medicine and Rehabilitation, vol. 95, no. 10, Elsevier BV, Oct. 2014, pp. 1962–68

[31] Messier, Stephen P., et al. "Exercise and Weight Loss in Obese Older Adults with Knee Osteoarthritis: A Preliminary Study." Journal of the American Geriatrics Society, vol. 48, no. 9, Wiley, Sept. 2000, pp. 1062–72.

[32] Wallis JA, Webster KE, Levinger P, Singh PJ, Fong C, Taylor NF, Maximum tolerated dose of walking for people with severe osteoarthritis of the knee: a phase I trial, Osteoarthritis and Cartilage (2015),

[33] Alghadir, Ahmad H., et al. "Effect of 6-week Retro or Forward Walking Program on Pain, Functional Disability, Quadriceps Muscle Strength, and Performance in Individuals with 1Knee Osteoarthritis: A Randomized Controlled Trial (Retro-walking Trial)." BMC Musculoskeletal Disorders, vol. 20, no. 1, Springer Science and Business Media LLC, Apr. 2019

[34] Kibler, W. Ben, et al. "The Role of Core Stability in Athletic Function." Sports Medicine, vol. 36, no. 3, Springer Science and Business Media LLC, 2006, pp. 189–98

[35] Fukuda TY, Rossetto FM, Magalhaes E, et al. Short-term effects of hip abductors and lateral rotators strengthening in females with patellofemoral pain syndrome: a randomized controlled clinical trial. J Orthop Sports Phys Ther 2010;40: 736–742

[36] Ferber R, Bolgla L, Earl-Boehm JE, et al. Strengthening of the hip and core versus knee muscles for the treatment of patellofemoral pain: a multicenter randomized controlled trial. J Athl Train 2015; 50: 366–377.

[37] Wallis JA, Webster KE, Levinger P, Singh PJ, Fong C, Taylor NF. A walking program for people with severe knee osteoarthritis did not reduce pain but may have benefits for cardiovascular health: a phase II randomised controlled trial. Osteoarthr Cartil. 2017;25(12):1969–79.