ijlpr 2022; doi 10.22376/ijpbs/lpr.2022.12.1.L38-46

International Journal of Life science and Pharma Research

ISSN 2250-0480

Research Article

Physiotherapy

Effectiveness of Combined Kinetic Chain Exercises In the Treatment of Knee Osteoarthritis in Peri-Menopausal and Post-Menopausal Women in Guwahati, Assam, India

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Abstract: Osteoarthritis (OA) is an extremely prevalent Rheumatic Musculoskeletal disorder and the prevalence of knee OA in peri-menopausal and post-menopausal women is reported to be high in many parts of India. Though a growing body of evidence suggests the effectiveness of Combined Kinetic Chain Exercises (CCEs) in the management of knee OA but a precise protocol is yet to be established. The study was aimed to evaluate and compare the effectiveness of two different protocols of CCEs versus conventional CCEs in the management of knee osteoarthritis.151 peri-menopausal/ post menopausal women (40-65 years) with knee osteoarthritis were randomly allocated to either group A (Control group: conventional combined kinetic chain exercises), group B (retrowalking and conventional combined kinetic chain exercises) or group C (perturbation training and conventional combined kinetic chain exercises). Intervention was given for 3 days/week for 6 weeks. Outcome measures used were Numeric Pain Rating Scale (NPRS), Timed Up and Go test (TUG) and Lower Extremity Functional Scale (LEFS). SPSS 21.0 version was used for all statistical analysis. Paired t-test was used for within group analysis and unpaired t-test was used for between group comparisons. Level of significance was considered as $p<0.05$.Statistically significant improvements were seen within all the three groups at the end of 6 weeks of treatment. Subjects in both the experimental groups (group B and group C) exhibited statistically significant improvements than group A (control group) in all outcome measures. Group B showed better improvements in all outcome measures when compared to group C; but the differences were not statistically significant. It can be concluded that Retrowalking combined with conventional CCEs and Perturbation exercises combined with conventional CCEs are equally effective in the treatment of knee OA; but significantly better than conventional CCEs alone.

Keywords: Osteoarthritis, Combined Kinetic Chain Exercises, Retrowalking, Perturbation, Peri- menopausal, Post-menopausal.

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Received On 25 September 2021
Revised On 03 December 2021
Accepted On 06 December 2021
Published On 05 January 2022

Funding This research did not receive any specific grant from any funding agencies in the public, commercial or not for profit sectors.

Citation Madhusmita Koch , Pratap Chandra Sarma, Abhijit Dutta and Abhijit Kalita , Effectiveness of Combined Kinetic Chain Exercises In the Treatment of Knee Osteoarthritis in Peri-Menopausal and Post-Menopausal Women in Guwahati, Assam, India.(2022).Int. J. Life Sci. Pharma Res.12(1), L38-46 http://dx.doi.org/10.22376/ijpbs/lpr.2022.12.1.L38-46

1. INTRODUCTION

Osteoarthritis (OA) is an extremely prevalent Rheumatic Musculoskeletal Disorder that affected 303 million people worldwide in 2017.[1] Among the joints affected in OA, the knee is the most common.[2] Menopause is defined as the irreversible discontinuance of menstrual period due to associated decreasing ovarian functions.[3,4] Peri-menopause is the time period from the emergence of menopause-related symptoms, until one year after complete stoppage of menstrual cycle or amenorrhea. Peri-menopause is defined as the duration during which a woman's body makes the natural transition to menopause signifying the ending of the reproductive years of a woman's life. During this entire duration, women suffer from irregular periods, vaginal dryness, mood changes, night sweats, hot flashes, and sleep problems, delayed metabolism causing weight gain, breast changes such as loss of fullness, dry skin, and thinning hair. Post-menopause can be defined as the time period after a woman undergoes an absolute termination of menstrual cycle for at least twelve months.[5,6] Prevalence of knee OA in peri-menopausal and post-menopausal women is reported to be high in many parts of India; 21.6% in Gurdaspur, Punjab; 47.3% women in South Delhi and 28.3% in Guwahati, Assam.[7-9]Although conservative treatment of knee OA has been the subject of numerous studies, there is no agreement on the most effective management strategy. Recently, there has been recognition of the fact that closed kinetic chain exercises (CKCs) are beneficial in managing knee joint osteoarthritis.[10] A number of studies in the literature also reveal that Combined Chain Exercises (CCEs) are more effective than either Open Kinetic Chain Exercises (OKCs) or Closed Kinetic Chain Exercises (CKCs) alone for pain relief in patients with knee OA.[11,12] Traditionally different protocols of OKC and CKC exercises such as isometric quadriceps, terminal knee extension, isometric hip adduction exercise, straight leg raising exercise, leg press, and semi-squat have been routinely used by clinicians in their practice globally.[13] A type of CKC exercise, walking, is commonly utilized in knee joint rehabilitation protocol since consistent walking is found to be beneficial in knee joint OA patients.[14] Literature review unveils that it has been established long back that retrowalking (i.e. backward walking) has many advantages over the usual forward walking e.g. reduced patellofemoral compressive forces, increase cardiopulmonary demand etc.[14-17] Apart from it, the regular benefits of walking like increasing quadriceps strength is also provided by retrowalking;[18] but the utilization of retrowalking is not that frequently seen in clinical practice. Another type of CKC, perturbation exercises, are also extensively utilized in the rehabilitation of OA knee patients and published literature seconds the fact that these exercises are also very effective in improving symptoms allied with knee joint osteoarthritis. Knee instability e.g. "episodes of giving way" of their knees during activities of daily living has been consistently reported by individuals with knee joint osteoarthritis. Hence, it can be speculated that integrating perturbation exercises that have been reported to be instrumental in managing knee stability for patients with ligament injuries should also be of benefit to patients with knee joint arthritis when prescribed at reduced intensity. Published studies also reported the efficacy of this exercise.[19-21] Though a growing body of evidence suggests the role of Combined Kinetic Chain exercises in improvement of symptoms and joint function in knee OA; precise guidelines regarding their type and dosage have not been made clear and significantly no comparative studies have been conducted between different combinations of open and closed kinetic chain exercises with significant results. Since there is a lack of evidence revealing comparative effectiveness of these techniques of treatment in OA, hence there is a need for comparison among them.

2. MATERIALS AND METHODS

The comparative experimental design used balanced, randomized allocation to 3 parallel groups. All procedures performed in this study involving human participants were in accordance with the ethical standards of the Gauhati Medical College and Hospital Ethics Committee (190/2007/Pt-11/Oct 2019/62). The Declaration of Helsinki protocol was followed for conducting the study. The protocol followed the CONSORT guidelines for reporting of non-pharmacological interventions (Figure 1). Written consent was obtained from all the subjects participating in the study. Source of data was patients suffering from knee OA referred for physiotherapy by physician or orthopaedic doctor at Physical Medicine and Rehabilitation OPD of Gauhati Medical College and Hospital, Bhangagarh, Guwahati, Assam. Purposive Sampling technique was used, based on inclusion and exclusion criteria.

2.1 Criteria for Sample Selection

The inclusion criteria were as follows: Age group 40-65 years, Females with menopause or menopause related symptoms, Diagnosed as a case of knee OA according to the American College of Rheumatology (ACR) criteria, Patients with unilateral/bilateral involvement, Radiographic grade of 2 and 3 as per Kellgren-Lawrence[22], knee pain for more than 6 weeks. The exclusion criteria were as follows: Males, patients less than 40 years of age and more than 65 years of age, not fulfilling American College of Rheumatology (ACR) criteria for diagnosis of knee OA, knee pain for less than 6 weeks, low back ache, history of any lower extremity injury or underlying pathology or surgery, any spinal surgery, any physical / medical problems wherein exercises are contraindicated, any deformity related to knee, hip or the back, history of inflammatory joint disease, patients using an assistive device for ambulation, patients who has taken physiotherapy treatment or intra-articular injection in the knee within a span of last 3 months, and any established mental illness. Subjects were randomly allotted to one of three groups (Group 1, Group 2 or Group 3) using an on-line tool with a random number generator function[23], allocation concealment done by using a sequentially numbered opaque and sealed envelope method. Implementation was done by a person, who was not related to the study, enrolled the participants and allocated them to groups based on numbers found in the envelope. Outcome assessors were blinded to group allocation, and were not involved in providing the interventions. The statisticians conducting the statistical analyses were also blinded to group allocation until the analyses were completed.

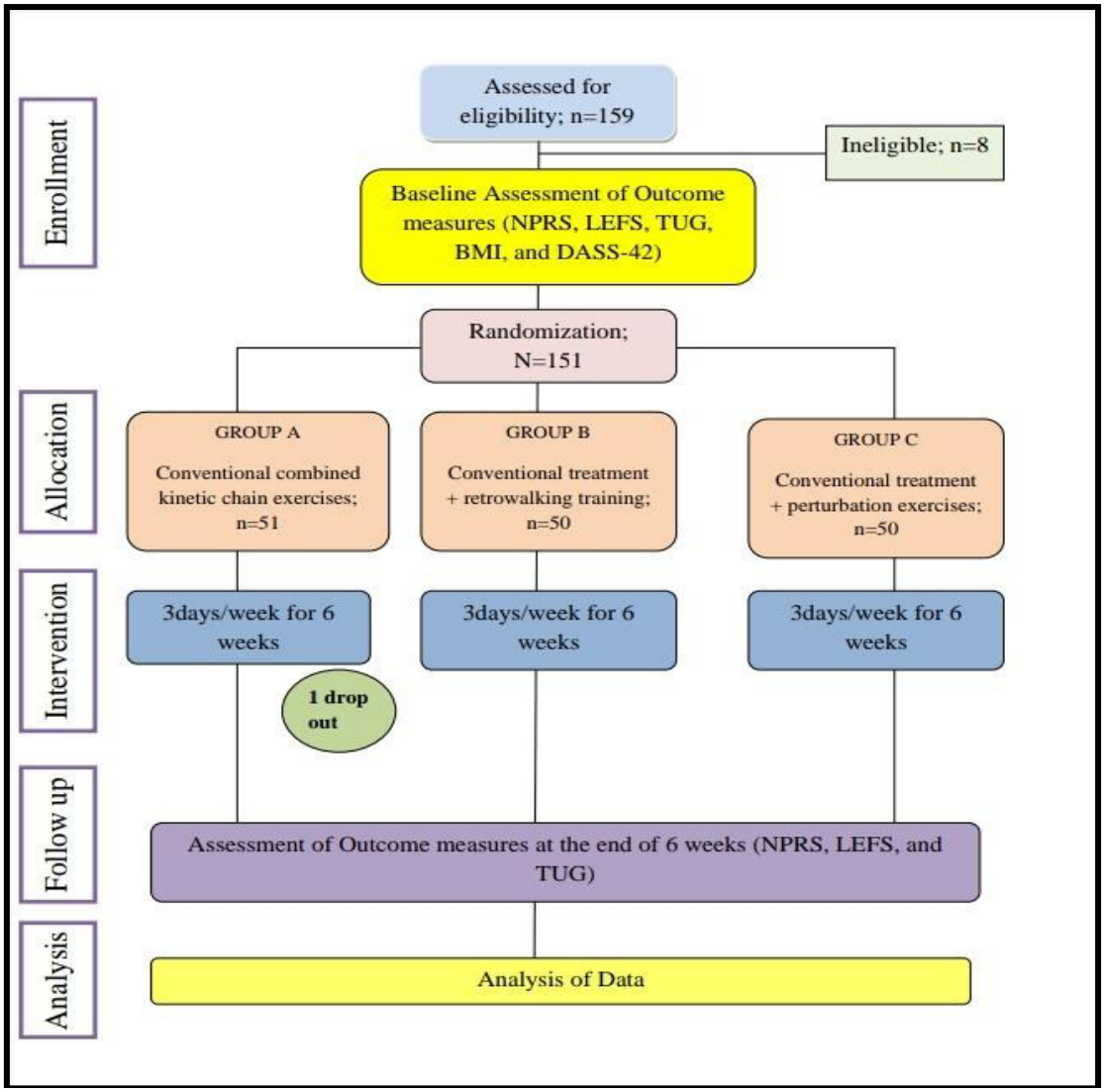


Fig 1: Consort Diagram

2.2 *Hypothesis*

- Null hypothesis: There will be no statistically significant difference in improvement of pain, mobility and physical function following retro-walking training combined with conventional CCE or perturbation exercises combined with conventional CCE as compared to conventional CCE alone in the treatment of peri-menopausal and post-menopausal women with knee OA.
- Alternate hypothesis: There will be statistically significant difference in improvement of pain, mobility and physical function following retro-walking training combined with conventional CCE or perturbation exercises combined with conventional CCE as compared to conventional CCE alone in the treatment of peri-menopausal and post-menopausal women with knee OA.

2.3 *Outcome Measures*

- Measurement of pain: Numeric Pain Rating Scale (NPRS)[24]
- Measurement of mobility: Timed Up and Go test (TUG)[25]
- Measurement of physical function: Lower Extremity Functional Scale (LEFS)[26]

2.4 *Methodology*

Pre-treatment assessment of pain, mobility, and physical function was recorded for all the groups using the outcome measures. After completion of all baseline measurements participants were randomly allocated to one of two intervention groups (Group B or Group C) or the control group (Group A).Study protocol was based on published studies[27-33]

Group A (control group)

Subjects received conventional combined kinetic chain exercises 3 days per week for 6 weeks.

Group B (experimental group)

Subjects received retro walking training along with conventional combined kinetic chain exercises 3 days per week for 6 weeks.

Group C (experimental group)

Subjects received perturbation exercises along with conventional combined kinetic chain exercises 3 days per week for 6 weeks. All the participants were restricted from performing any home exercise or walking program other than the prescribed program. All exercises were performed bilaterally and all the participants received moist heat[32] for 10 minutes around the affected knee joint before exercise.

2.4.1 *Conventional Combined Kinetic Chain Exercises* [27-30]

Participants in all the three groups received a supervised conventional combined kinetic chain exercise protocol, an amalgamation of open and closed kinetic chain exercises from previous published studies consisting of Open kinetic chain exercises: Full-arc extension and Straight leg raising (SLR) and closed kinetic chain exercises: Wall slides and Quadriceps setting.

2.4.2 Retrowalking [31, 32]

Warm-up: In the warm up period, the subjects performed ankle toe movements, hamstring and calf muscle stretching, and heel raise exercises. Retro Walking: The participants underwent a supervised 10 min retro-walking training on a flat surface at their comfortable speed. The participants gradually increased the walking time up to 30 min over a period of 6 weeks. Cool down: In the cool down period, the subjects performed the same exercises as performed in the warm up phase.

2.4.3 Perturbation Exercises[32,33]

Double leg foam balance activity: Subject stood on a soft foam surface with both feet on the ground. Therapist attempted to perturb patient balance in random fashion. The duration of the activity was approximately 30 seconds. The difficulty progressed as the subject improved by progressing to ball catching with the therapist perturbing the subject's balance while standing on foam and progressing to single-leg support if tolerated without knee pain, swelling, or buckling. Wobble board (tilt board) balance training: Subject stood on a wobble board with both feet on the board. The therapist perturbed the wobble board in forward and backward and side-to-side directions for approximately 30 seconds each. The difficulty of the activity was progressed by adding ball catching during the perturbations and progressing to single-limb support perturbations if the subject tolerated single-limb weight-bearing without knee pain swelling or buckling. Roller board and platform perturbations: Subject stood with one limb on a stationary platform and the other limb on a roller board. Therapist perturbed the roller board in multiple directions, at random, and the subject attempted to resist the perturbations. Activity lasted for 30 seconds and was repeated by changing the limbs on the platform and the roller board. Activity began with subjects in the semi-seated position, with the hips resting on the plinth if the subject had difficulty doing the activity in full standing. The activity was then progressed to full standing position when the subject was able to tolerate this position without pain. Post-treatment assessment of pain, range of motion, mobility and physical function was recorded after 6 weeks of intervention for all the groups for comparison with the pre-treatment assessment data.

3. STATISTICAL ANALYSIS

The sample size (n) of minimum 50 patients per group (Total n=150) was calculated based on a formula provided for superiority trials (clinical/statistical) by Zhong B (2009).[34] SPSS 21.0 version was used for all statistical analysis. Demographic data and baseline scores of all outcome measures were presented to evaluate baseline comparability of treatment groups. One way ANOVA was used for significance testing in the mean age of study participants between the three groups. Descriptive data was reported for each group as the mean change in the outcome measures at baseline and at the end of the 6 weeks of treatment. Paired t-test was used for within group analysis and unpaired t-test was used for between group comparisons.

4. RESULTS

A total of 159 patients were assessed for eligibility. Of these, 5 subjects did not meet the inclusion criteria, 3 refused to participate. 151 subjects were enrolled in this study and 51 subjects were allocated to Group A, 50 subjects to group B and 50 subjects to group C. 1 subject dropped out of the study due to transportation issues in lockdown related to COVID-19 pandemic. Dropout was excluded in the final analysis.

Table 1: Mean age of the study participants in 3 groups

					95% Confidence Interval for Mean			
Group	**N**	**Mean Age**	**Standard Deviation**	**Standard Error**	**Lower Bound**	**Upper Bound**	**Minimum**	**Maximum**
A	50	48.68	11.649	1.647	45.37	51.99	4	65
B	50	51.10	8.844	1.251	48.59	53.61	5	65
C	50	52.80	7.500	1.061	50.67	54.93	40	65
Total	150	50.86	9.577	.782	49.31	52.41	4	65

Table 1 illustrates the mean age of study participants in all the three groups along with their standard deviations.

Table 2: Testing the significant difference in the mean age of the study participants in 3 groups

ANOVA					
	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	428.680	2	214.340	2.380	.096
Within Groups	13237.380	147	90.050		
Total	13666.060	149			

N: Sample size; Df: degrees of freedom; F: F value of ANOVA; Sig: Significance [p]< 0.05 statistically significant

Table 2 illustrates the comparability of mean age of the study participants in 3 groups and reveals that p-value is more than 0.05; hence there is no significant difference between the mean ages of participants across all the 3 groups. It implies that ages of participants across the groups are comparable at baseline.

Table 3: Group A (Testing the significant difference in the outcome measures between baseline and post 6 weeks treatment scores)							
	Mean	**SD**	**SE**	**CI (95%)**	**T**	**Df**	**Sig(2-tailed)**
Pre NPRS Post NPRS	2.160	.738	.104	1.950 to 2.370	20.638	49	**.000***
Pre TUG Post TUG	2.59400	.41028	.05802	2.47740 to 2.71060	44.707	49	**.000***
Pre LEFS Post LEFS	-11.040	4.005	.566	-12.178 to -9.902	-19.492	49	**.000***

SD: Standard Deviation; SE: Standard Error; CI: Confidence Interval; t: t test value; df: degrees of freedom; Sig: Significance[p]< 0.05 statistically significant; *Statistically significant

Table 3 illustrates the within group comparisons of outcome measure scores of participants of Group A at baseline and after 6 weeks of treatment. p-value in all three outcome measure is less than 0.05. Hence, it implies that improvement seen in participants of Group A is statistically significant.

Table-4: Group B (Testing the significant difference in the outcome measures between baseline and post 6 weeks treatment scores)							
	Mean	**SD**	**SE**	**CI (95%)**	**T**	**Df**	**Sig(2-tailed)**
Pre NPRS Post NPRS	3.720	.991	.140	3.438 to 4.002	26.555	49	**.000***
Pre TUG Post TUG	4.05400	1.15037	.16269	3.72707 to 4.38093	24.919	49	**.000***
Pre LEFS Post LEFS	-24.900	10.514	1.487	-27.888 to -21.912	-16.746	49	**.000***

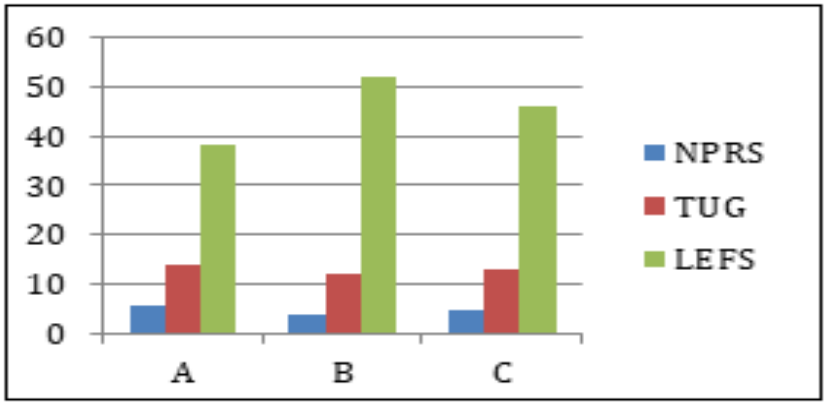
SD: Standard Deviation; SE: Standard Error; CI: Confidence Interval; t: t test value; df: degrees of freedom; Sig: Significance[p]< 0.05 statistically significant; *Statistically significant

Table 4 illustrates the within group comparisons of outcome measure scores of participants of Group B at baseline and after 6 weeks of treatment. p-value in all three outcome measure is less than 0.05. Hence, it implies that improvement seen in participants of Group B is statistically significant.

Table 5: Group C (Testing the significant difference in the outcome measures between baseline and post 6 weeks treatment scores)							
	Mean	**SD**	**SE**	**CI (95%)**	**T**	**Df**	**Sig(2-tailed)**
Pre NPRS Post NPRS	2.880	.940	.133	2.613-3.147	21.669	49	**.000***
Pre TUG Post TUG	3.27959	.85440	.12206	3.03418-3.52500	26.869	48	**.000***
Pre LEFS Post LEFS	-17.760	7.032	.994	-19.759 to -15.761	-17.858	49	**.000***

SD: Standard Deviation; SE: Standard Error; CI: Confidence Interval; t: t test value; df: degrees of freedom; Sig: Significance[p] < 0.05 statistically significant; *Statistically significant

Table 5 illustrates the within group comparisons of outcome measure scores of participants of Group C at baseline and after 6 weeks of treatment. p-value in all three outcome measure is less than 0.05. Hence, it implies that improvement seen in participants of Group C is statistically significant.



NPRS: Numeric Pain Rating Scale; TUG: Timed Up and Go test; LEFS: Lower Extremity Functional Scale

Fig 1: Mean values of outcome measures after 6 weeks of treatment

Figure1 illustrates the comparison of mean values of outcome measures after 6 weeks of treatment in all the three groups. It implies that according to mean values, NPRS score assessing pain is least in group B depicting the highest improvement followed by group C. TUG score assessing mobility are also least in group B depicting the highest improvement followed by group C. LEFS score assessing physical function is highest in group B depicting the highest improvement followed by group C.

Table 6: Testing the significant difference in the outcome measures between Group B and Group A (control) after 6 weeks of treatment

	T	Df	Sig (2-tailed)	Mean difference	SE difference	CI (95%)
NPRS	-4.519	98	**.000***	-1.68000	.37180	-2.41783 to -.94217
TUG	-3.593	98	**.001***	-1.91800	.53388	-2.97746 to -.85854
LEFS	4.865	98	**.000***	13.94000	2.86561	8.25330to 19.62670

T: t test value; Df: degrees of freedom; Sig: Significance[p]< 0.05 statistically significant; *Statistically significant; SE: Standard Error; CI: Confidence Interval

Table 6 illustrates the between group comparisons of outcome measure scores of participants of Group B and Group A (control) after 6 weeks of treatment. p-value in all three outcome measure is less than 0.05. Hence, it implies that the difference of improvement seen in participants of Group B is statistically significantly better than Group A.

Table 7: Testing the significant difference in the outcome measures between Group C and Group A(control) after 6 weeks of treatment

	T	Df	Sig (2-tailed)	Mean difference	SE difference	CI (95%)
NPRS	-2.585	98	**.011***	-.98000	.37914	-1.73239 to -.22761
TUG	-2.583	97	**.011***	-1.31596	.50944	-2.32706 to -.30486
LEFS	2.889	98	**.005***	7.96000	2.75527	2.49226to 13.42774

T: t test value; Df: degrees of freedom; Sig: Significance[p]< 0.05 statistically significant; *Statistically significant; SE: Standard Error; CI: Confidence Interval

Table 7 illustrates the between group comparisons of outcome measure scores of participants of Group C and Group A (control) after 6 weeks of treatment. p-value in all three outcome measure is less than 0.05. Hence, it implies that the difference of improvement seen in participants of Group C is statistically significantly better than Group A.

Table 8: Testing the significant difference in the outcome measures between Group B and Group C (between both experimental groups) after 6 weeks of treatment

	T	Df	Sig (2-tailed)	Mean difference	SE difference	CI (95%)
NPRS	-1.736	98	.086	-.70000	.40330	-1.50034 to .10034
TUG	-1.073	97	.286	-.60204	.56109	-1.71565 to .51157
LEFS	1.888	98	.062	5.98000	3.16703	-.30487 to 12.2649

T: t test value; Df: degrees of freedom; Sig: Significance[p]< 0.05 statistically significant; *Statistically significant; SE: Standard Error; CI: Confidence Interval

Table 8 illustrates the between group comparisons of outcome measure scores of participants of Group B and Group C after 6 weeks of treatment. p-value in all three outcome measure is more than 0.05. Hence, it implies that the difference of improvement seen in participants between Group B and Group C is not statistically significant.

5. DISCUSSION

The primary intention of the study was to determine and compare the effectiveness of conventional combined kinetic chain exercises over retrowalking in addition to conventional combined kinetic chain exercises or perturbation exercises in addition to conventional combined kinetic chain exercises in peri-menopausal and post-menopausal women with knee joint osteoarthritis. The three groups were comparable at baseline with respect to age (Table 1&2), sex and severity of knee joint osteoarthritis; hence, any subsequent difference between them can be attributed to the difference in the effects of the interventions. Statistically very high significant difference has been observed between pre and post NPRS, pre and post TUG as well as in pre and post LEFS in all the three groups (Table 1,2&3). This implies that combined kinetic chain exercises, in general, are highly effective in the management of knee joint osteoarthritis. The significant effects of all the three different protocols of combined kinetic chain exercises on pain, mobility and physical function is consistent with reports from a previous study by Olabegi OM et al[11] in which they reported the superiority of combined kinetic chain exercises over open and closed kinetic chain exercises in terms of reduction of average daily pain and pain associated with walking of participants in patients with knee joint osteoarthritis. In the present study, a comparative statistical analysis between the control group with the two experimental groups revealed that subjects in the Groups B and C (both experimental groups) exhibited statistically significant improvements than Group A (control group) in all outcome measures (Table 6&7). Group B showed better improvements in all outcome measures when compared to group C (Figure 1) but the differences were not statistically significant (Table 8). It can be concluded that effectiveness of Retrowalking and Perturbation exercises both in combination with conventional combined kinetic chain exercises are comparable to one another but

significantly better than conventional combined kinetic chain exercises alone. Improvement seen in Group A could be attributed to the strengthening exercises for hip and knee. Strong muscles can support and protect joints that are affected by osteoarthritis. Previously published studies have attributed decrease in pain levels and consequent improvement in physical function after quadriceps strengthening exercise to increased stability of the knee joint as a result of improvement in quadriceps muscle strength.[11,35,36] These findings seem to corroborate with the present study showing improvements in pain, mobility and physical function after conventional combined kinetic chain exercises strengthening the knee joint. The improvements in Group B may be because of the unique kinematics of backward walking or retrowalking wherein the knee provides the primary power producer (co-contraction of hamstring and quadriceps) and ankle plantar flexors acts as shock absorber. In contrast to forward walking, the knee joint shear force is directed forward initially during retro walking thus leading to significantly lower patellar compressive force than forward walking. Moreover, as reported by previous studies, retro-walking helps to reduce maximal vertical force and impulsive force on knee compared to forward walking because of toe-heel contact pattern.[37] In addition to this, retro-walking may have effect on pain relief by reducing excess adductor moment at knee joint and decreasing the compressive forces on medial compartment of knee joint.[38] Various published studies have reported the efficacy of retro walking in knee OA by reducing pain, enhancing mobility, dynamic balance and physical function, decreasing extension lag and better quality of life in knee OA patients.[15,16,18,37,38,39,40] Improvement seen in Group C: Literature review reveals that aging and knee joint OA both diminishes proprioceptive acuity, i.e. the awareness of joint position, joint movement (kinesthesia), and sense of resistance.[41,42] These proprioceptive deficits may be a contributing factor in reducing the dynamic stability of the knee joint. Perturbation exercise programs are designed to decrease proprioceptive impairment by using balance movements to activate, challenge, and adapt the nervous system's proprioceptors. Thus these exercise protocols would decrease the proprioceptive deficit thereby increasing dynamic knee stability. Improved joint stability, therefore, has the potential to both improve symptoms of knee OA and slow the disease's progression. These results are similar to the study done by Diracoglu et al. (2005) in which superior results are reported with the addition of Kinesthesia, Balance and Agility training to a Resistance training(RT) program compared to RT alone.[43]

5. CONCLUSION

From the above discussion, it may be concluded that since both retro walking and perturbation exercises combined with conventional CCE showed better improvements than CCE alone, either of the protocols may be opted for the treatment of knee joint osteoarthritis. But from the authors' viewpoint, the protocol involving retrowalking provides an edge over the perturbation exercise protocol because retrowalking doesn't involve any equipment and neither has it required assistance of a physiotherapist in contrast to perturbation training. Moreover, though not statistically significant, improvement seen in the group receiving retro walking training with CCE was more as compared to perturbation training plus CCE group (Figure 1). Physiotherapists are encouraged by the findings from this study to combine open and closed kinetic chain exercises for pain relief and improvement of function in patients with Grade 2/3 OA as per Kellgren Lawrence scale. Future studies should investigate the effects of combined chain exercises on different age groups and gender of patients with knee OA. The efficacy of CCEs in osteoarthritis of other joints such as the hip may also be investigated.

6. LIMITATIONS

- The present study did not assess a long-term follow up due to poor history of patients follow up in the current hospital setting.
- Medications of patients, activities of daily living and recreational activities of patients were not taken into account.
- Home exercise program was not given.
- The age group of the participants was restricted to only women aged 40–65 years.

7. AUTHORS CONTRIBUTION STATEMENT

Madhusmita Koch carried out this research work as a partial fulfillment for the completion of her structured Doctorate of Philosophy (PhD) programme under the supervision of Dr. Pratap Chandra Sarma. Madhusmita Koch conceived and designed the study, performed the review of literature, collected and analyzed the data and wrote the first and the final draft of the article. Dr. Pratap Chandra Sarma supervised the entire research work, critically reviewed the article and approved the final version of the article to be published. Dr. Abhijit Dutta helped in conceptualizing the study and in reviewing literature. Abhijit Kalita contributed to data collection, discussion and organized matter in various drafts of the article. All the authors read and approved the final version of the manuscript

8. ACKNOWLEDGEMENTS

The authors would like to thank all the subjects of the study for their participation and duly acknowledge the statistical help obtained from Dr. Manjula Anil.

9. CONFLICTS OF INTEREST

Conflicts of interest declared none.

10. REFERENCES

1. GBD. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018;392(10159):1789-858. doi: 10.1016/S0140-6736(18)32279-7, PMID 30496104.
2. Simms R. Osteoarthritis. In: Andreoli T, Carpenter C, Cecil R, editors Andreoli and Carpenter's Cecil essentials of medicine. Philadelphia: Saunders Company; 2007. p. 845-7.
3. Eunice Kennedy Shriver National Institute of Child Health and Human Development. Menopause: overview; 2013. Available from: https://web.archive.org/web/20150402111845/http://www. Available from: http://nichd.nih.gov/health/topics/menopause/Pages/default.aspx.

4. Institute for Quality and Efficiency in health care (IQWiG). Cologne, Germany; 2006. Menopause: Overview. [updated Jul 2 2020]. Available from: InformedHealth.org [internet]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK279311/.
5. InformedHealth.org, NCBI. Bookshelf. Menopause Overview. 2020.
6. Midlarsky E, Graber L. Menopause definition; 2018. Available from: https://www.researchgate.net /publication/323335845_Menopause_Definition.
7. Kaur R, Ghosh A, Singh A. Prevalence of knee osteoarthritis and its determinants in 30-60 years old women of Gurdaspur, Punjab. Int J Med Sci Public Health. 2018;7(11):825-30. doi: 10.5455/ijmsph.2018.0516207062018.
8. Salve H, Gupta V, Palanivel C, Yadav K, Singh B. Prevalence of knee osteoarthritis amongst peri-menopausal women in an urban resettlement colony in south Delhi. Indian J Public Health. 2010;54(3):155-7. doi: 10.4103/0019-557X.75739, PMID 21245586.
9. Koch M, Sarma P. Prevalence of knee joint osteoarthritis among peri-menopausal and post menopausal women in Guwahati, Assam, India. Vidyabharati International Interdisciplinary Research [journal:2020];10(2):131-8.
10. 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.
11. Olagbegi OM, Adegoke BOA, Odole AC. Effectiveness of combined chain exercises on pain and function in patients with knee osteoarthritis. Bangladesh J Med Sci. 2016;15(2):178-88. doi: 10.3329/bjms.v15i2.24808.
12. Anwer S, Alghadir A, Brismée JM. Effect of home exercise program in patients with knee osteoarthritis: a systematic review and meta-analysis. J Geriatr Phys Ther. 2016;39(1):38-48. doi: 10.1519/JPT.0000000000000045, PMID 25695471.
13. Alghadir A, Anwer S. Effect of retro and forward walking on quadriceps muscle strength, pain, function, and mobility in patients with knee osteoarthritis: a protocol for a randomized controlled trial. BMC Musculoskelet Disord. 2016;17:161. doi: 10.1186/s12891-016-1021-z, PMID 27072798.
14. Zhang W, Moskowitz RW, Nuki G, Abramson S, Altman RD, Arden N, Bierma-Zeinstra S, Brandt KD, Croft P, Doherty M, Dougados M, Hochberg M, Hunter DJ, Kwoh K, Lohmander LS, Tugwell P. OARSI recommendations for the management of hip and knee osteoarthritis, Part I: Critical appraisal of existing treatment guidelines and systematic review of current research evidence. Osteoarthr Cartil. 2007;15(9):981-1000. doi: 10.1016/j.joca.2007.06.014, PMID 17719803.
15. Flynn TW, Soutas-Little RW. Patellofemoral joint compressive forces in forward and backward running. J Orthop Sports Phys Ther. 1995;21(5):277-82. doi: 10.2519/jospt.1995.21.5.277, PMID 7787851.
16. Terblanche E, Page C, Kroff J, Venter RE. The effect of backward locomotion training on the body composition and cardio respiratory fitness of young women. Int J Sports Med. 2005;26(3):214-9. doi: 10.1055/s-2004-820997, PMID 15776337.
17. Flynn TW, Connery SM, Smutok MA, Zeballos RJ, Weisman IM. Comparison of cardiopulmonary responses to forward and backward walking and running. Med Sci Sports Exerc. 1994;26(1):89-94. PMID 8133744.
18. Flynn TW, Soutas-Little RW. Mechanical power and muscle action during forward and backward running. J Orthop Sports Phys Ther. 1993;17(2):108-12. doi: 10.2519/jospt.1993.17.2.108, PMID 8467337.
19. Fitzgerald GK, Childs JD, Ridge TM, Irrgang JJ. Agility and perturbation training for a physically active individual with knee osteoarthritis. Phys Ther. 2002;82(4):372-82. doi: 10.1093/ptj/82.4.372, PMID 11922853.
20. Roy J, Dutta A, Koch M, Boruah L. To study the effect of agility and perturbation exercises versus dynamic resistance exercises to improve knee function in knee osteoarthritis – a comparative study. Int J Physiother. 2015;2(5):834-9. doi: 10.15621/ijphy/2015/v2i5/78242.
21. Choudhary N, Kishor A. Effectiveness of modified agility and perturbation training in patients with osteoarthritis knee: A case control study. Iran Rehabil. 2013;11(17):94-6.
22. Kellgren JH, Lawrence JS. Radiological assessment of osteo-arthrosis. Ann Rheum Dis. 1957;16(4):494-502. doi: 10.1136/ard.16.4.494, PMID 13498604.
23. Urbaniak GC, Plous S; 2013. Research randomizer. 4.0 version [Computer Software]. Available from: http://www.randomizer.org/.
24. Dworkin RH, Turk DC, Farrar JT, Haythornthwaite JA, Jensen MP, Katz NP, Kerns RD, Stucki G, Allen RR, Bellamy N, Carr DB, Chandler J, Cowan P, Dionne R, Galer BS, Hertz S, Jadad AR, Kramer LD, Manning DC, Martin S, McCormick CG, McDermott MP, McGrath P, Quessy S, Rappaport BA, Robbins W, Robinson JP, Rothman M, Royal MA, Simon L, Stauffer JW, Stein W, Tollett J, Wernicke J, Witter J, IMMPACT. Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. Pain. 2005;113(1-2):9-19. doi: 10.1016/j.pain.2004.09.012, PMID 15621359.
25. Alghadir A, Anwer S, Brismée JM. The reliability and minimal detectable change of Timed Up and Go test in individuals with grade 1-3 knee osteoarthritis. BMC Musculoskelet Disord. 2015;16:174. doi: 10.1186/s12891-015-0637-8, PMID 26223312.
26. Binkley JM, Stratford PW, Lott SA, Riddle DL. The lower extremity functional scale (LEFS): scale development, measurement properties, and clinical application. North American Orthopaedic Rehabilitation Research Network. Phys Ther. 1999;79(4):371-83. PMID 10201543.
27. Balraj AM, Kutty RK, Kamraj B, Saji VT. Impact of retro-walking on pain and disability parameters among chronic osteoarthritis knee patients. Physiother Rehabil. 2018;3:157. doi: 10.4172/2573-0312.1000157.
28. Olagbegi OM, Adegoke BOA, Odole AC. Effectiveness of combined chain exercises on pain and function in patients with knee osteoarthritis. Bangladesh J Med Sci. 2016;15(2):178-88. doi: 10.3329/bjms.v15i2.24808.
29. Kisner C, Colby LA. Therapeutic exercises: foundations and techniques. Philadelphia: F. A. Davis Company; 2007. p. 314-6, 475-6.
30. Adegoke BOA. Comparative efficacy of open and closed kinetic chain exercises in the treatment of osteoarthritic knee [PhD thesis]. Department of Physiotherapy, University of Ibadan; 2003.
31. Alghadir A, Anwer S. Effect of retro and forward walking on quadriceps muscle strength, pain, function,

and mobility in patients with knee osteoarthritis: a protocol for a randomized controlled trial. BMC Musculoskelet Disord. 2016;17:161. doi: 10.1186/s12891-016-1021-z, PMID 27072798.
32. Fitzgerald GK, Piva SR, Gil AB, Wisniewski SR, Oddis CV, Irrgang JJ. Agility and perturbation training techniques in Exercise therapy for reducing pain and improving function in people with knee osteoarthritis: A randomized clinical trial. Phys Ther. 2011;91(4):452-69. doi: 10.2522/ptj.20100188, PMID 21330451.
33. Fitzgerald GK, Childs JD, Ridge TM, Irrgang JJ. Agility and perturbation training for a physically active individual with knee osteoarthritis. Phys Ther. 2002;82(4):372-82. doi: 10.1093/ptj/82.4.372, PMID 11922853.
34. Zhong B. How to calculate sample size in randomized controlled trial? J Thorac Dis. 1990. Clinical trials, a practical approach. 2009;1(1):51-4. PMID 22263004.
35. Anwer S, Alghadir A. Effect of isometric quadriceps exercise on muscle strength, pain, and function in patients with knee osteoarthritis: a randomized controlled study J. J Phys Ther Sci. 2014;26(5):745-8. doi: 10.1589/jpts.26.745, PMID 24926143.
36. Baker KR, Nelson ME, Felson DT, Layne JE, Sarno R, Roubenoff R. The efficacy of home based progressive strength training in older adults with knee osteoarthritis: a randomized controlled trial. J Rheumatol. 2001;28(7):1655-65. PMID 11469475.
37. Van der Esch M, Holla JF, van der Leeden M, Knol DL, Lems WF, Roorda LD, Dekker J. 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. Arch Phys Med Rehabil. 2014;95(10):1962-8. doi: 10.1016/j.apmr.2014.06.007, PMID 24977932.
38. Kudo M, Watanabe K, Otsubo H, Kamiya T, Kaneko F, Katayose M, Yamashita T. Analysis of effectiveness of therapeutic exercise for knee osteoarthritis and possible factors affecting outcome. J Orthop Sci. 2013;18(6):932-9. doi: 10.1007/s00776-013-0443-9, PMID 24085378.
39. Gondhalekar GA, Deo MV. Retro walking as an adjunct to conventional treatment versus conventional treatment alone on pain and disability in patients with acute exacerbation of chronic knee osteoarthritis: a randomized clinical trial. N Am J Med Sci. 2013;5(2):108-12. doi: 10.4103/1947-2714.107527, PMID 23641371.
40. Messier SP, Royer TD, Craven TE, O'Toole ML, Burns R, Ettinger WH. Long-term exercise and its effect on balance in older, osteoarthritic adults: results from the Fitness, Arthritis, and Seniors Trial (FAST). J Am Geriatr Soc. 2000;48(2):131-8. doi: 10.1111/j.1532-5415.2000.tb03903.x, PMID 10682941.
41. Swanik CB, Rubash HE, Barrack RL, Lephart SM. The role of proprioception in patients with DJD and following total knee arthroplasty. In: Lephart & Fu: eds. Proprioception and Neuromuscular Control in Joint Stability. Champaign, IL: Human Kinetics Publishers; 2000. p. 323-38.
42. Lephart SM, Riemann BL, Fu FH. Introduction to the sensorimotor system. In: Lephart & Fu: eds. Proprioception and Neuromuscular Control in Joint Stability. Champaign, IL: Human Kinetics Publishers; 2000. p. xvii-xiv.
43. Diracoglu D, Aydin R, Baskent A, Celik A. Effects of kinesthesia and balance exercises in knee osteoarthritis. J Clin Rheumatol. 2005;11(6):303-10. doi: 10.1097/01.rhu.0000191213.37853.3d, PMID 16371799.