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ORIGINAL ARTICLE

Adjunctive Retrowalking Combined with Conventional Therapy Improves Clinical Manifestation in Knee Osteoarthritis: A Randomized Controlled Trial

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ABSTRACT

Background: Osteoarthritis (OA) is a degenerative joint disease and one of the major health problems that cause functional disability that inhibits the performance of daily activities. Previous studies reported the beneficial effect of retrowalking in patients with knee osteoarthritis. The current study aims to determine the effectiveness of retrowalking exercise as an adjunct to conventional therapy in improving clinical manifestations in patients with knee osteoarthritis.

Methods: A randomized control trial design was conducted at the outpatient Medical Rehabilitation Department from December 2018 to March 2019. Thirty-eight patients with knee OA participated in this study, which were randomly into 2 groups: experimental and control groups. The subjects from both groups received conventional therapy and only the experimental group received retro walking exercise, 3x/week for 4 weeks. WOMAC Index was used to measure functional disability before and after intervention. Data was analyzed using SPSS version 20.

Results: Per-protocol analysis showed a statistically significant change in the WOMAC index score in patients who received retrowalking exercises compared to the control group (p= 0.027) after 4 weeks of intervention. Only the pain subscale of the WOMAC index showed a statistically significant difference between the experimental and control groups (p= 0.043).

Conclusions: The 4 weeks retrowalking exercise as an adjunctive therapy in patients with knee osteoarthritis is more effective at reducing clinical manifestation compared to conventional therapy alone.

Keywords: Exercise Training, Adjunctive Therapy, Retrowalking, Disability Evaluation, Osteoarthritis of Knee

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INTRODUCTION

Osteoarthritis (OA) is a degenerative joint disease that affects the cartilage and the tissues surrounding it. It results in articular cartilage degradation and loss, subarticular bone remodeling, osteophyte formation, ligamentous laxity, periarticular muscles weakening and synovial inflammation.[1] This is particularly apparent at the knee joint, one of the commonest sites to be affected. As the prevalence of OA increases with age, and aging is associated with declining physiological function, the combination has significant health implications.[2] The physical disability arising from knee OA inhibits the performance of daily activities and has a detrimental impact on the quality of life. Several factors including pain, joint movement restriction, muscle weakness, and coordination impairment play roles in the occurrence of physical disability.[3] Statistics from the Centers for Disease Control (CDC) indicate that 1 of 3 patients with arthritis has limitations in daily activities.[4] Therapeutic exercises often used to improve physiological disability such as reduced joint motion, muscle weakness, impaired balance, disability, and proprioception.[5,6]

The focus of knee rehabilitation exercise has changed from open kinetic chain (OKC) to closed kinetic chain (CKC) exercises. The closed kinetic chain exercises are closely linked to our daily activities and more practical in nature.[7,8] Retrowalking is considered a closed kinetic chain exercise as the compressive forces at the patellofemoral joint are reduced.[9] Due to backward propulsion and reversal of the leg movement in retrowalking, different muscle activation patterns are compared from those in forward walking. During retrowalking, the muscular system supporting the ankle and knee reversed their role.[10] Therefore, damage to the articular cartilage is minimized during retrowalking, and it may be used as a mode of training after suffering lower limb injury.

Anadkat et al. provides evidence that retrowalking treadmill training in addition to conventional exercises is beneficial to reduce pain with knee osteoarthritis patients.[11] Another study reported the effects of retrowalking in improving muscle strength, reducing joint compression and facilitating rehabilitation.[12] Considering the beneficial effect of retrowalking in reducing the joint compression on knee, and improving muscle strength in functional range, retrowalking may provide additional benefits in patients with knee osteoarthritis. Limited single sex RCTs have examined the effectiveness of retrowalking as an adjunct to conventional therapy in patients with knee osteoarthritis. The aim of this study was to find the effectiveness of retrowalking exercise as an adjunct to conventional therapy on functional disability in patients with knee osteoarthritis.

METHODS

Design and Participants

A single-center, parallel group randomized controlled trial (RCT) was conducted in the outpatient rehabilitation clinic of a tertiary academic referral hospital. This RCT is performed to assess the effect of a 4-week retrowalking exercise on functional disability in patients with knee osteoarthritis as adjunctive therapy. Participants were recruited consecutively from the outpatient Department of Medical Rehabilitation and randomly allocated to either the experimental or control group using a simple randomization procedure. Randomization was done using computer generated random generated numbers with sealed opaque envelopes. Intervention group receiving retrowalking and standard exercise categorised in Group A, and Group B as control group only received standard exercises.

Participants recruitment took place from December 2018 to March 2019 at the Department of Medical Rehabilitation. Participants were required to sign a written informed consent form accepted by the Ethical Committee of the Faculty of Medicine in University of Indonesia. The study was approved by the Bioethic Committee of University of Indonesia (Approval number: (0782/UN2/F1/ETIK/2018).

For this study, patients with knee osteoarthritis were recruited, diagnosed by the physician according to American College of Rheumatology (ACR) 1998 clinical criteria for knee osteoarthritis (see Table 1).[13]

Table 1. The American College of Rheumatology (ACR) 1998 Clinical Criteria for Knee Osteoarthritis[13]

Presence of knee pain plus at least one of the following six clinical features:
• Age greater than 50 years • Morning stiffness of the knee lasting less than 30 minutes • Crepitus on active motion of the knee

Single sex was chosen to exclude the effect of sex on the study results. The other inclusion criteria were age over 40 years, radiographic grades 1-3 on the Kellgren-Lawrence scale,[14] knee pain with VAS less than 4, full range of motion of knee joint, and Timed Up and Go Test (TUG) less than 12 seconds. The participants were excluded due to a history of knee surgery, knee deformity > 15^0, systemic arthritis, balance disorders due to vestibular disease or other diseases, using walking aids, or uncorrected visual disorders. The drop-out criteria were where the participants didn't exercise 3 times in one week and the clinical condition worsened.

Interventions

Participants were randomly assigned to one of the two treatment groups, group A received retrowalking exercise and conventional therapy as experimental group and group B only received conventional therapy as control group. The WOMAC Index was taken on the first day and after the total study duration of 4 weeks.

Conventional therapy

Conventional therapy comprises a combination of aerobic exercise, isotonic strengthening exercise, and balance exercise. All exercises were done 3 days per week for 4 weeks. Aerobic exercise consists of ergometer cycling with moderate intensity (50-60% resting heart rate), during 15 minutes/session at the 1st week, 30 minutes at the 2nd week, 45 minutes at the 3rd week and 60 minutes at the 4th week. Moreover, it required 5 minutes of warm-up and 5 minutes of cool-down.

Isotonic strengthening exercise applied to quadriceps and hamstring muscle. The exercises were applied as 10 reps with 50% of 10 RM, 10 reps with 75% of 10 RM, and 10 reps with 100% of 10 RM (de Lorme progressive resistance technique) with about 30 seconds to 1-minute pause between sets.[15] 10 RM is the maximum weight that can be lifted 10 times, which is adjusted every 2 weeks. Balance exercises consist of standing balance exercises on a balance board for 15 minutes for the first 2 weeks and 30 minutes for the next 2 weeks.

Retrowalking exercise

The retrowalking exercises were conducted at the Obesity Clinic in the Department of Rehabilitation Medicine in Cipto Mangunkusumo Hospital. As familiarization, on the first day of the study, participants in the intervention group who received the retrowalking exercise were asked to walk 5 steps forward and 4 steps backwards and observed any discomfort. Participants received a retrowalking exercise on a flat surface floor for 15 minutes, 3 days / week for 4 weeks. Walking speed started at 2 km/h and was adjusted based on participants' comfort. During exercise the patient is accompanied by a safety chaser, and their vital signs were observed to ensure patient safety.

Outcome

The Western Ontario and McMaster (WOMAC) index assessed the functional disability of patients with knee osteoarthritis. It provides information on pain, stiffness and physical function in patients with knee OA.[3] WOMAC includes 5 items that measure pain, 2 items that measure stiffness and 17 items that measure physical function and was scored on a five-point Likert scale. Scores for each scale are created by summing the points of the individual items. Higher scores represent worse health status. It is a reliable and valid measure.[16]

Data analysis

Data were analysed using SPSS version 20 (Statistical Package for Social Science). Descriptive statistics (mean ± standard deviation) were determined for all measured variables. Baseline scores of all outcome measures and demographic data were provided to determine the patient group comparability of the baseline. In parametric variables, paired t-test was used for comparing data within each group and unpaired t-test for comparing between the groups. In nonparametric variables, Wilcoxon's and Friedman's were used for comparing data within each group and Mann-Whitney U test for comparing between the groups. Data was considered statistically significant with $p<0.05$.

RESULTS

Enrollment and follow up

The sample size is determined using the formula for testing hypothesis for the means of two independent populations, which is:

$$n = 2\left\{\frac{(Z\alpha + Z\beta) \times SD}{x_1 - x_2}\right\}^2$$

n = the sample size
Statistical significance value of $\alpha = 0.05$; $Z\alpha = 1{,}96$
Power = 80%; $Z\beta = 0{,}842$[17]
SD = standard of deviation between both groups = 28.56[17]
$\chi_1 - \chi_2 =$ the minimum meaningful clinical difference = 27.2[17]

Based on this calculation, the sample size was 17.31, which rounded to 18 people per group. Adding to the 10% drop out rate, the sample size needed was 20 people per group.

There were a total of 41 participants, divided into two groups: 21 subjects in the experimental group (group A) and 20 subjects in the control group (group B). Three participants were excluded after randomization (two from group A and one from group B). Analysis was done with 19 participants per group **(Figure 1)**. The number of subjects is still in accordance with the sample calculation at the beginning of the study. Patient compliance rates were 90.5% in group A and 95% in group B. No meaningful imbalance in baseline characteristics was observed after the change between the groups in the final per-protocol sample. The analysis was conducted by protocol.

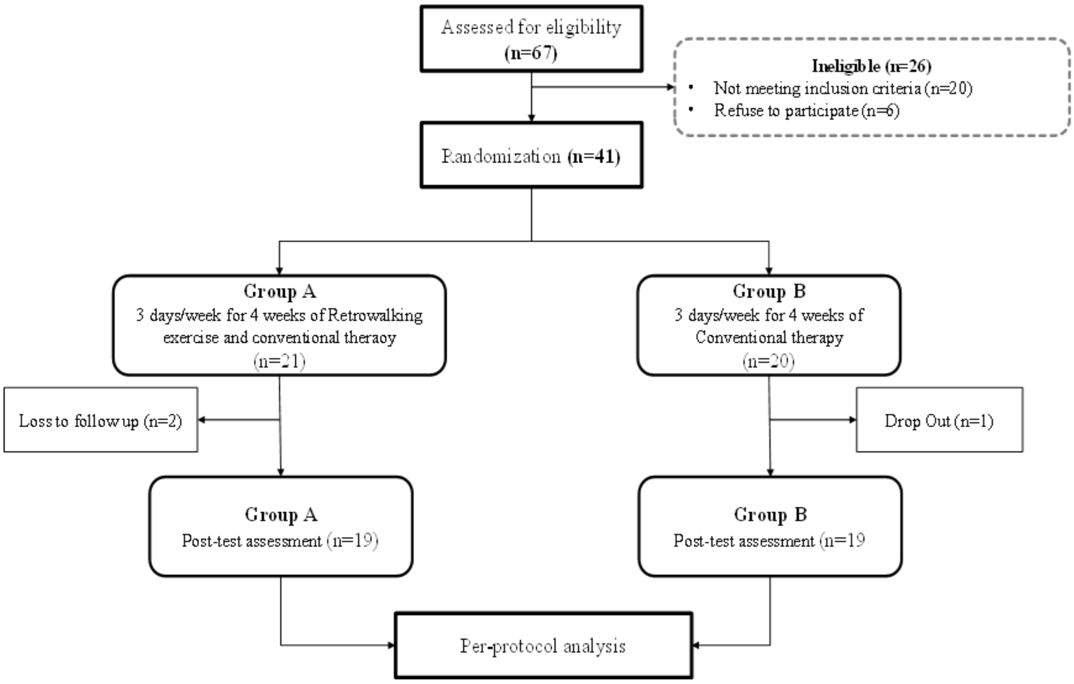

Figure 1. Flow Chart of Participants

Patient characteristics

Multiple statistical tests were conducted. Distribution of BMI, total WOMAC score were non-normal, only age showed normal distribution. Homogeneity was found in all three variables in both groups using Levene's test.

A comparison test was performed using multiple different tests. There were no significant differences in age, BMI, OA grade and baseline WOMAC scores. Both in groups A and B, most of the participants were housewives, 14 subjects (73.7%) in group A and 13 subjects (68.4%) in group B. The mean of body mass index (BMI) in group A was 27.56 kg / m^2 and in group B was 28.16 kg / m^2, there were no significant differences between groups. Before the intervention, there were no significant differences among the groups with respect to the WOMAC Index. Patient characteristics of this study are shown in **table 2.**

Outcome

Table 3 explained the outcome assessment at the end of the study. Per-protocol analysis showed that the WOMAC index within the experimental and control groups had a significant reduction in functional disability *(p <0.001)*. In the subscale of pain, stiffness and physical function of the WOMAC index in the experimental group were all found significant statistically. However, no significant change was observed in the stiffness sub-scale in the control group.

Table 3 showed a comparison of changes in the WOMAC Index after the intervention was given to the experimental and control groups. The intervention group demonstrated a greater reduction in total WOMAC score compared to control (median change: 11 vs 3 points; p=0.027) after 4 weeks of intervention. Only subscale of pain from the

WOMAC index has shown statistically significant between experimental and control group.

Friedman test to compare the 3 subscales of WOMAC Index was also performed, differences in both groups found significant. It can be concluded that retrowalking exercise as an adjunct therapy has a significant change in pain as an indicator of improvement in clinical manifestation after 4 weeks of intervention.

Table 2. Baseline characteristics of patients and WOMAC scores according to demographics

Characteristics	Experimental (n=19)	Control (n=19)	*P value*[1]	*Mean p value*[2]	*Median p value* (with adjusted df)[2]	*Comparison test p value*[2]
Age (years) (mean ± SD)	61.26±6.25	61.68±7.06	Group A= 0.208[a] Group B = 0.445[a]	0.398[b]	0.376[b]	0.847*
Occupation				- (categorical variables)		0.609†
Housewife	14 (73.7 %)	13 (68.4 %)				
Employee	2 (10.5 %)	4 (21 %)				
Retired	3 (15.8 %)	1 (5.3 %)				
Entrepreneur	0 (0 %)	1 (5,3 %)				
Education				- (categorical variables)		0.750†
Elementary-junior high school	1 (5.3 %)	3 (15.8 %)				
Senior high school	9 (47.4 %)	6 (31.6 %)				
Diploma	2 (10.5 %)	2 (10.5 %)				
Bachelor	7 (36.8 %)	8 (42.1 %)				
Body Mass Index (kg/m^2) (median (min-max))	28.44 (23.01-29.97)	28.89 (24.80-29.89)	Group A = 0.007 Group B = 0.009	0.133[b]	0.413[b]	0.488‡
Grade of OA (Kellgren-Lawrence)				- (categorical variables)		0.091†
Kellgren-Lawrence grade 1	4 (21.1 %)	0 (0 %)				
Kellgren-Lawrence grade 2	8 (42.1 %)	12 (63.2 %)				
Kellgren-Lawrence grade 3	7 (36.8 %)	7 (36.8 %)				
Total WOMAC Score (median (min-max))	16 (5-36)	10 (6-39)	Group A = 0.156[a] Group B = 0.000	0.600[b]	0.858[b]	0.258‡

**Independent T-test*, †*Chi-square test, and* ‡*Mann-Whitney U test* of statistical significance $p<0.05$, [a]Saphiro-Wilk's test and [b]Levene's homogeneity test of statistical significance p>0.05.
Abbreviations: OA = osteoarthritis; WOMAC = Western Ontario and McMaster Index

Table 3. Functional disability based on the WOMAC Index before and after intervention with comparison based on the median changes between both group

Parameters	Experimental (n=19)			Control (n=19)		
	Pre	Post	*p*	Pre	Post	*p*
Total WOMAC Score	16 (5-36)	6 (2-10)	<0.001*	10 (6-39)	7 (3-13)	<0.001*
Pain	4 (1-11)	2 (0-4)	<0.001*	3 (1-11)	2 (0-4)	0.002*
Stiffness	1 (0-3)	1 (0-1)	0.003*	1(0-3)	1 (0-2)	0.08
Physical function	11 (3-23)	4 (1-5)	<0.001*	7 (4-26)	4 (3-7)	0.001*

Median Changes (baseline – 4 weeks)	Experimental (n=19)	Control (n=19)	Mann-Whitney U test between groups *p*
Total WOMAC Score	11 (2-26)	3 ((-1)-31)	0.027‡
Pain	3 (0-7)	1 ((-1)-7)	0.046‡
Stiffness	1 ((-1)-2)	0 ((-2)-2)	0.181
Physical function	8 (0-18)	2 ((-1)-23)	0.075

*Wilcoxon test of statistical significance $p<0.05$ †Friedman test of statistical significance $p<0.05$, ‡Mann-Whitney U test of statistical significance $p<0.05$

DISCUSSION

Of the total 38 subjects in this study, the average age of patients with knee osteoarthritis in both groups was 61 years old. In United states, the age prevalence of knee radiographic OA in people age ≥ 45 was 19.2% among the Framingham Study and 27.8% in the Johnston Country Osteoarthritis Project, approximately 37% of people age > 60 years or older had radiographic knee OA based on the third National Health and Nutrition Examination Survey (NHANES III).[18] In Indonesia, the prevalence of OA reaches 11.1% at age less 45-54 years, 15.5% at age 55-64 years, and 18.6% at age more than 65 years.[19] Age is one of the most significant risk factors for OA. However, the exact mechanism behind the increased prevalence and incidence of OA with age is poorly understood. A variety of changes including the ability of joint tissues to respond to biomechanical threats, biological changes such as cellular senescence and decreased capacity to adapt to biomechanical challenges as a result of age-related sarcopenia and increased bone turnover are likely contributing factors.[20]

The most occupational subjects in both groups were housewives, as many as 73.7% in the experimental group and 68.4% in the control group. Household activities are related to movements that increase the load on the knee joints repeatedly over a long period, such as standing while sweeping and cooking, squatting while washing clothes, going up and down stairs, and carrying heavy loads. Repetitive joint movements have been associated with an increased risk of OA. Studies have found that individuals whose occupations require squatting or kneeling have twice the risk of developing knee OA than occupations that do not require physical activity, particularly among those who are overweight or whose jobs required carrying or lifting.[21] Since the prevalence of OA increases with age and progression increases due to household activities, this combination has implications for functional disability.

The purpose of this study was to determine the effectiveness of retrowalking exercise on functional disability in patients with knee OA. The results of the present study indicated that the retrowalking exercise is effective in improving pain after 4 weeks intervention in people with knee OA. Statistically, this study showed a significant reduction of the total WOMAC score in the experimental and control groups after the 4 weeks intervention (*p<0.001*). In the subscale of pain and physical function of both groups also showed significant changes (*p <0.05*). The stiffness subscale was observed to have significant changes in the experimental group, with no difference in reduction between groups.

Similarly, a previous study showed that the retrowalking group had a significantly greater reduction of functional disability (mean changes of total WOMAC score, 4.8 versus 2.2; *p = 0.008*) than the control group after 6 weeks intervention.[22] Other study on the efficacy of retrowalking in chronic knee osteoarthritis found that retrowalking showed improvement in WOMAC index, extension lag and dynamic balance due to its greater impact in increasing extension moment improvising strength in functional range with decreased compressive force that helps improve physical function.[23]

Numerous studies have shown that pain in knee OA as a result of increased ground reaction force (GRF) in knee joints and decreased knee extensor moments.[24] Based on biomechanics, retrowalking requires greater concentric quadriceps muscle activity, especially during the initial contact and push-off phases to push the body backwards which acts primarily as an isometric stabilizer and concentric accelerator.[10,25,26] Whereas on the forward walking, the main activity of the quadriceps muscle is the eccentric decelerator.[10,26] This is one of the benefits of retro walking over forward walking. The increased concentric activity of quadriceps will result in decreased compressive force at knee joint, resulting in a reduced pain intensity at the knee. Other benefits of retrowalking exercises include the reduction of the compressive force in the patellofemoral joint, the prevention of excessive stretching of the ACL and the vertical reduction of the GRF peak. This impact is very helpful in patients with knee osteoarthritis, as it can slow the progression of joint damage and improve functional abilities. Furthermore, retrowalking exercises also facilitate the co-contraction and stimulate proprioceptive of lower limb muscle which enhance joint stability and improve balance during weight bearing activity.[27–29]

In this study, no adverse effects were found in all participants of both groups. All subjects were familiarized at the first exercise to assess whether there were any discomforts such as dizziness or a feeling of falling that would affect the exercise. Retrowalking exercise is a supervised adjuvant therapy which is capable, cost-effective, and safe exercise. The limitation of this study was the lack of blinding of the assessor. Furthermore, the study was conducted on single sex only and included a small sample size which might affect the generalization of results. This study was done in a short period of four weeks and did not include follow-up, so that long-term effect of retrowalking exercise could not be assessed. Limited parameters of the outcome measures as well as limitations of this study. The absence of an intention-to-treat analysis may limit the generalizability of the findings.

CONCLUSION

The present study has proved that 4-weeks retrowalking exercise as an adjunctive therapy is effective in reducing clinical manifestation compared to conventional therapy alone in patients with knee osteoarthritis

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