

EFFECTS OF RETRO-WALKING UNDERWATER TREADMILL TRAINING ON PAIN, FUNCTIONAL PERFORMANCE & FUNCTIONAL MOBILITY IN PATIENTS WITH KNEE OSTEOARTHRITIS

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ABSTRACT

Background: Osteoarthritis is a degenerative disease characterised by pain, stiffness and reduced ROM which results in difficulty in ADLs due to reduced functional performance and mobility. The purpose of this study is to evaluate and compare the effects of retro-walking on underwater treadmill along with conventional treatment and conventional treatment alone on pain, functional performance and mobility in patients with knee osteoarthritis (OA).

Methods: In this experimental study, 30 subjects with knee osteoarthritis fulfilling the inclusion & exclusion criteria were selected and randomly allocated in two groups. Control group received conventional closed chain exercises for 2 weeks. Experimental group received retro-walking on underwater treadmill for 10 minutes along with the conventional exercises. Outcome measures like visual analogue scale (VAS), Western Ontario and McMaster Universities Arthritis Index (WOMAC) and timed up and go (TUG) were used for pain, functional performance and mobility respectively. Comparison of intra-group changes was made using Wilcoxon signed-rank test or paired t-test for all the outcome measures. The inter-group comparison for all the outcome measures was done using Mann-Whitney U-test.

Results: Inter-group analysis showed a significant reduction in pain levels and improvement in functional performance and mobility in the experimental group. ($p < 0.005$)

Conclusion: This concludes that retro-walking on underwater treadmill group is effective in reducing the pain levels, improving functional performance and mobility in patients with knee OA than the conventional treatment alone. Hence it can be used in the protocol.

KEY WORDS: Retro-walking, Underwater treadmill, closed chain exercises, knee OA.

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INTRODUCTION

Osteoarthritis is a degenerative and a progressive condition resulting in loss and damage of articular cartilage, remodelling of new bone, osteophyte formation, ligamentous laxity, weakening of periarticular muscles, synovial inflammation [1].

This is generally characterised by pain, stiffness and decrease in ROM. These people have decreased functioning and mobility which leads to decreased ability to carry out ADLs and physical activities and the factors responsible for this are pain, joint movement restriction, muscle weakness, and coordination impairment.

Among all there is high prevalence of knee OA affecting 15-40% of people aged 40 and 60-70% of the population older than 60 years [2]. It is characterized by:

- Wear and tear of articular cartilage,
- Hypertrophy of bone at the margins
- A host of biochemical and morphological alterations of the synovial membrane and joint capsule.
- Subchondral bone sclerosis making it stiffer than normal [3].

All this results in increased friction, increased joint loading & decreased shock absorption.

In patients with knee OA, there is a prominent loss in proprioception compared with control subjects of the same age and gender, this adds on to functional insufficiency by generating impairment in walking rhythm, shortening step distance, and a decrease in walking speed [4].

Patients with knee OA are often prescribed exercise regimen. This exercise therapy includes- supervised strengthening exercise, manual therapy, taping, aquatic therapy & electrical modalities with or without thermal modalities as measures for pain reduction.

Aquatic exercises may allow patients to perform longer & more strenuous workouts compared to land exercises.^[5] Aquatic environment provides reduced weight bearing due to the buoyancy but this varies with the depth of water & velocity of the movement [6,7].

Underwater treadmill exercises are only form of aquatic exercises where intensity, speed of the belt & depth of the pool can be controlled. Previous research have shown that underwater treadmill exercises have proved to have significant effect on reducing perceived pain & improving mobility of the patients with knee OA [8].

Closed chain kinematic exercises can be easily performed in water due to reduced joint load. Closed chain kinematic exercises for knee joint can be incorporated in many ways; one of them is retro-walking [9].

Retro-walking is referred to as backward walking. Since there is propulsion in backward direction and reversal of leg movement in retro walking, different muscle activation patterns from those in forward walking are required [9].

A gait cycle during retro-walking can be defined as toe-on of a limb to the subsequent toe-on of the same limb [10]. Along with a unique muscle activation pattern; Retro walking is associated with increased cadence, decreased stride length and different joint kinematics as compared to forward walking; hence may offer some benefits over forward walking alone [11]. Retro-walking significantly lowers peak patellofemoral joint compressive force and a significantly slower rate of loading. Trauma to the articular cartilage is reduced during retro-walking; therefore it could be used as a mode of training [10].

Considering the advantageous effect of retro-walking with respect to forward walking in decreasing the compressive load on knee; the current study aimed at finding out the effectiveness of retro-walking on underwater treadmill in comparison with the conventional closed chain exercise programme in chronic knee patients.

METHODS

The type of study performed was Experimental study. Sample size was obtained through convenient sampling method. Females (BMI > 25 kg/m²) between 45-55 years of age having unilateral and bilateral involvement were included. Subjects willing to participate in this study were included. Subjects with deformity of hip, knee & ankle; any CNS or PNS involvement, people with hydrophobia, recent steroidal or intraarticular injections(3 months), systemic inflammatory disease were excluded.

The outcome measures used in this study were pain with functional disability and functional mobility and pain intensity which were measured using Western Ontario and McMaster Universities Arthritis Index (WOMAC), Timed up and go test (TUG), Visual Analogue Scale (VAS) respectively. Western Ontario and McMaster Universities Arthritis Index (WOMAC) of OA, was used to assess pain, stiffness and physical function levels in the subjects. It measures 5 items for pain, 2 for stiffness, and 17 for functional limitation. Physical functioning questions cover activities of daily living. Its psychometric properties have been established. It has good test retest reliability in pain and physical function domain [12]. Timed up and go

test (TUG), was used to assess functional mobility related to balance [13].

A firm chair with arms (seat height of 46 cm) was placed at one end and an object was placed at the other end at a distance of 3-m. The participants were instructed as follows: "On the word "go", stand up, walk comfortably and safely to the object at the end on the floor, walk around the object, come back, and sit all the way back in your chair." Timing was started on the word "go" and ended when the participant returned to the chair, with back resting against the chair. The average of the 2 recorded trials was used for data analysis. The perception of joint pain was assessed immediately before and after each exercise session using a continuous visual analogue scale. The left end of the scale was labelled "no pain" and the right end was labelled "very severe pain." To improve consistency of implementing the pain scale, we provided written instructions to each participant before they rated their pain. The instructions were, "please mark the line to indicate the arthritis related joint pain that you feel right now; the further to the right, the more discomfort/pain you feel." Visual analogue scales, such as the one used in this study, are reported to be reliable assessments of pain perceptions and are more precise than ordinal scales that rank responses[14-16]. The pain scales were analysed by measuring the distance from the left of the scale to the vertical mark drawn by each subject.

Subjects with OA were screened & selected as per inclusion criteria. They were explained about the procedure & need for study. Written informed consent was obtained from each participant. The assessments of each group were performed before and after the intervention. Subjects were randomly allocated in two groups having 15 subjects in each: GROUP A(control group) & GROUP B (experimental group)

Both the groups received conventional treatment which included:

- Hot packs for 10 mins
- Static Quadriceps and Static Hamstrings
- Straight leg raises (SLR) and Straight leg abduction (SLA),
- Knee bending in prone,
- Closed chain kinematic exercises – (Forward Lunges, Mini squats).

2 sets per day with 10 repetition of each exercise for 2 weeks. (1 session was supervised and rest was given as home programme).

Experimental group was given retro walking on underwater treadmill along with the conventional treatment. These subjects were first familiarized with the backward walking pattern on level ground such that during backward walking the toes strike the ground first instead of the heel. All subjects practiced walking backward in water at lowest speeds until confident enough with support of hand railings. They were asked to rest for 5 to 10 minutes, and then continue with their backward walking treatment protocol. The protocol followed was retro walking on underwater treadmill at the speed of 1.0 km/hr for 1 week & then at the speed of 1.5 km/hr for next 1 week along with conventional exercises. Given for 10 mins and 5 days per week, thus completing a 2 week intervention. Water level was upto the xiphisternum. Outcome measures for pain, functional performance & mobility i.e. VAS, WOMAC, TUG were taken both before & after intervention that is on Day 1 and day 10. Data was collected & statistically analysed.

RESULTS

Statistical analysis of the present study was done using GraphPad Prism software 8 so as to verify the results obtained. Comparison of

Table 1: Pre & Post comparison of variables for control group.

Conventional	PRE		POST	
	Mean± SD	P Value	Mean ±SD	P Value
Visual analogue scale	5.53333 ±1.18723	<0.0001	3.26667 ± 1.222799	<0.0001
WOMAC	54.06667 ± 3.972525	<0.0001	49.66667 ± 3.848314	<0.0001
TIME UP & GO	20.933333 ± 1.437590	<0.0001	17.2 ± 1.424279	<0.0001

Inference: There is a statistical difference in VAS score, WOMAC score and TUG score in the control group.

intra-group changes, i.e., preintervention changes and postintervention changes on day 1 and day 10 was made using Wilcoxon signed-rank test or paired t-test for all the outcome measures. The Inter-group comparison for all the outcome measures was done using Mann–Whitney U-test on the basis of normal distribution. Data is presented as the mean and standard deviation.

Table 2: Pre & Post comparison of variables for experimental group.

Experimental	PRE		POST	
	Mean±SD	P value	Mean±SD	P value
VAS	5.6±1.121224	<0.0001	2.2±1.146	<0.0001
WOMAC	50.333± 3.90	<0.0001	44.4±4.339	<0.0001
TIME UP & GO	21.333± 2.257	<0.0001	16.93± 2.120	<0.0001

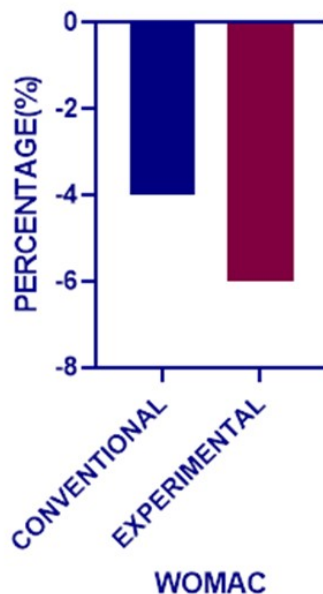
Inference: There is a statistical difference in VAS score, WOMAC score and TUG score in experimental group.

Table 3: Comparison between two groups for outcome variables.

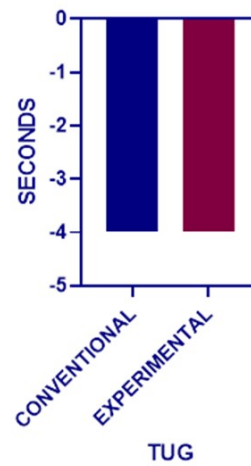
Outcome measures	P Value	Statistical Significance
VAS*	<0.0001	HIGHLY SIGNIFICANT
WOMAC*	0.041	SIGNIFICANT
TUG*	0.0345	SIGNIFICANT

Inference: There is a statistical significant difference in all the parameters between experimental & control group.

*VAS-Visual Analogue Scale, WOMAC- Western Ontario And McMaster Universities Osteoarthritis Index, TUG- Time Up & Go

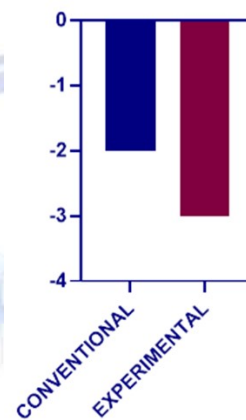


Graph 1: Western Ontario And McMaster Universities Osteoarthritis Index



Graph 2: Time Up & Go

VISUAL ANALOGUE SCALE



Graph 3: Visual Analogue Scale.

DISCUSSION

The purpose of this study is to determine the effects of retro walking underwater treadmill training on pain, functional mobility and functional performance in patients with knee osteoarthritis. Retro-walking on a land treadmill has shown positive results in patient population with patellofemoral pain and anterior cruciate ligament injury rehabilitation [17]. It has been useful in treating knee OA by decreasing pain and functional disabilities [18].

One of the most important outcome measures in determining the efficacy of any physical therapy treatment for OA patients is reduced pain (Edmonds, 2009; Hurley, 2003). It was observed in the current study that perceived joint pain was less after the treadmill exercises, suggesting that underwater treadmill exercise may be efficacious for OA patients. The mechanism for this reduced pain is unknown but may be related to aquatic factors such as buoyancy, hydrostatic pressure, and temperature.^[8] The pain relief occurs also because, during backward locomotion, patellofemoral joint reaction forces,

and eccentric loading of the patellar tendon are both reduced. Specifically, peak patellofemoral joint compressive forces are significantly lower and occur significantly later in the stance phase in backward locomotion. Retro-walking may have effect on pain relief by reducing excess adductor moment at knee joint decreasing the compressive forces on medial compartment of knee joint [19].

In addition to joint pain; patients with knee OA often show reduced mobility. This study observed that mobility, based on the TUG, is improved after short term retro walking underwater treadmill exercises. Denning et al. (2010) observed mobility, based on Timed up and go(TUG) scores, improved after an acute bout of aquatic training as opposed to land training. These similar findings could infer that neuromuscular aspects of the body and balance improved, rather than walking speed and step length [8].

Improvement in functional performance assessed with WOMAC occurred due to the greater impact of retro walking in increasing extension moment improvising strength in functional range with decline compression force which assist in improving physical function [18].

Gondhalekar and Deo postulated that as advantages of retro-walking include improvement in muscle activation pattern, reduction in adductor moment at knee during stance phase of gait and augmented stretch of hamstring muscle groups during the stride; all of these may have helped in reducing disability thus leading to improved function [19]. Retro walking also helps to reduce hip flexion moment during stance phase and thus preventing abnormal loading at knee joint and, in turn, the disability [18,19]. When walking backward, the knee extensor musculature plays a major role in generating the force necessary for propulsion. A study (Kenji Masumoto a, Shin-ichiro Takasugi et. al) showed significantly greater muscle activation from the vastus medialis, tibialis anterior while walking backward in water compared to walking forward on an underwater treadmill. Increased dorsiflexion of the ankle joint occurs while walking backward, this can be assumed due to increased muscular activity [20,21]. Hence, the study concludes retro walking underwater treadmill

exercise along with conventional treatment is effective in reducing symptom and overcoming physical dysfunction and improving mobility in osteoarthritis of knee.

Limitations: The limitations of this study are that it's sample size and the period of intervention is small. Also measurement of other parameters could have been done. Long term follow-up was not taken.

CONCLUSION

The above study concludes that retro-walking on the underwater treadmill along with conventional treatment is more beneficial in reducing the pain levels, improving the functional performance & mobility in patients with knee OA than the conventional treatment.

ABBREVIATIONS

OA- Osteoarthritis

VAS- Visual Analogue Scale

WOMAC- Western Ontario And McMaster Universities Osteoarthritis Index

TUG- Timed Up and Go

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Conflicts of interest: None

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