Original Article

A Study on The Effectiveness of Body Weight Supported Treadmill Training along with Conventional Physiotherapy for Osteoarthritis in Improving Knee Joint Function.

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Abstract

Background: Osteoarthritis is one of the most prevalent and chronic disabling joint disease of knee joint. It may due to aging, obesity, sedentary lifestyle, overuse, malalignment, and abnormal loading of the jointcauses pain and difficulty in walking. Hence, there is a need to study Body Weight Supported Treadmill Training along with conventional physiotherapy for osteoarthritis to restore normal gait patterns by increasing the joint space.

Method: This study was a quasi-experimental study of pre and post type carried out in Adhiparasakthi Medical sciences and Research Institute. Melmaruvathur. 60 subjects with knee osteoarthritis were chosen for the study of age above 45 years, according to inclusion criteria. They were equally divided into two groups. Group 1, 30 subjects were given with Body weight supported treadmill training withconventional physiotherapy. Group 2 , 30 subjects were given with conventional physiotherapy alone. Treatments were given for 6 sessions for 2 weeks .Both the groups were measured with pre and post-test for pain, range of motion, and walking speed using a Numerical pain rating scale, goniometer, and pedometer respectively.

Result: At the end of the treatment program, there is a significant relief of pain, increased knee joint range of motion, and walking speed in patients treated with Body weight-supported treadmill training along with conventional physiotherapy.

Conclusion:From this study, it was concluded that the Body weight supported treadmill training along with conventional physiotherapy reduces pain, and increases knee joint range of motion and walking speed among patients with knee osteoarthritis.

Keywords: Osteoarthritis, Range of motion, walking speed ,Numerical pain rating scale, goniometer, pedometer .

Introduction

Osteoarthritis is one of the most prevalent and chronic disabling joint disease.Worldwidely, Osteoarthritis affects more than 250 million people above the age of 45 years. In India 22 to 39% of middle-age peoples are affected. Females are most commonly affected than males due to menopause, hormonal changes, ageing, obesity, sedentary life-style, over use, malalignment and abnormal loading of the joint.[1]World Health Organisation reports it as the fourth and eighth most common cause of disability in women and men respectively.

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Knee pain and difficulty in walking are the major complaints of osteoarthritis patientleading to disability.[2]

In knee Osteoarthritis, the medial compartment is more frequently affected than the lateral compartment due to the higher transfer of loads through the medial compartment.[3] Body weight is the super most common risk factor associated with the onset and progression of knee osteoarthritis.[4]Body Weight supported Treadmill TrainingImproving speed of walking Improve endurance, Improve balance, and functional walking.[5]Hence, there is need for studying Body Weight supported Treadmill Training for osteoarthritis to restore their normal gait pattern by increasing the joint space.

Disease progression is commonly associated with gradual and debilitating joint pain and stiffness, which leads to an overall de-conditioning of the musculoskeletal system and manifests as, a loss of thigh muscle strength about the knee [6] diminished knee joint function [7]increased body weight or Body mass index[8]Each of these changes makes it difficult to distance walking, stair climbing, stooping, kneeling, carrying weights, and performing heavy household activities which may result in a reduced quality of life.[7]So the aim of the study is to evaluate the effectiveness of body weight supported treadmill training along with conventional physiotherapy for osteoarthritis to improve function of the knee joint**.**

Biomechanics Of Knee Joint

The knee is the largest and most complex joint of the body. The complexity is the results of fusion of three joints in one. It is formed by fusion of the lateral tibiofemoral, medial tibiofemoral and patellofemoral joints.[9]The tibiofemoral joint is a double condyloid joint with three degrees of freedom of angular motion.Flexion and extension occur in the transverse plane around the coronal axis through the epicondyles of the distal femur.The medial and lateral rotation occurs in the transverse plane about a longitudinal axis through the lateral side of the medial tibialcondyle. Abduction and adduction occur in the frontal plane around an anteroposterior axis.[10]

Weight Bearing Forces:

a. In a bilateral stance, the weight-bearing stresses on the knee joint are therefore equally distributed between the medial and lateral condyles.
b. However, once a unilateral stance is adopted or dynamic forces are applied to the Joint, compartmental loading is altered.
c. In the case of a unilateral stance, the weight-bearing line shifts towards the medial compartment to account for the smaller base of support below the center of mass, this shift increases the compressive forces on the medial compartment.
d. If the forces from the floor extend medial to the knee joint center, then an adduction movement is created around the knee joint, which acts to rotate the knee into a relatively greater varus (Adduction).
e. Thus the magnitude of the knee adduction moment can be used as a surrogate measure for medial compartment loading during gait and other activities of daily living. Abnormally high knee adduction moment is associated with the development of knee OA.
f. The association between knee malalignment and the progression of knee osteoarthritis has implications for patients who present with abnormal anatomical alignment.

Body Weight Supported Treadmill Training:

GOALS: To practice walking and standing, To work on walking quality and speed,To train fitness and health.

Body weight-supported treadmill training is considered one of the newest evidence-based clinical approaches to improve ambulation in patients with lower limb disability.Body weight-supported treadmill training is a therapy modality in which part of a person's body weight is supported while walking on a treadmill.It is usually done using an overhead suspension system attached to a harness thatpartially or completely supports part of a person's body weight over a treadmill.While supported, the person walks with or without assistance from health providers on a treadmill.

During Body weight-supported treadmill the patient is partially suspended in a harness, which reduces the joint loading by increasing the joint space and improving the functional ability of the knee joint.Body weight-supported treadmill training will directly increase the demand placed on the postural control mechanics of your body. Thus BWSTT helps to prepare your body to achieve the right alignment and posture to walk.[11]The advantages of BWSTT are the convenience of walking, lesser risk of falling while using a harness, better walking speed, and the amount of load that can adjusted according to thepatient's potential.[12]

EQUIPMENT HAVE : A harness,Groin and abdominal straps and padding, An overhead suspension system, A treadmill with adjustable speeds, A ramp up to the treadmill, Additional tubing or strapping, Parallel bars , Braces and orthoses.

PEDOMETER APP: Pedometer App is one of the smartphone App that records the number of steps you have walked and displays along with number of calories you have burned,distance,walking time and speed per hour[13]

Ask the patient to turn on the start icon of the pedometer App, patient either hold the mobile phone in hand or keep in pocket while walking.After 10 minutes turn off the App and see the steps walked.The best advantages of this App is ,easy to use.

Methodology

Study design :Quasi experimental study
Sampling technique:Convenient sampling
Study population:Osteoarthritispatient
Sample size :n= 60

Sample size was calculated using previous research standard deviation and variance by the software G power3.1.9.4and calculated.Sample size -44 osteoarthritis patient ,each group had 22 members(Jason peeler,phd,CATCO et al, june 12,2018,wolterkluwer Health).

Participant selection: 60 samples are selected based on criteria and they are equally divided into two groups without any gender ,age bias.Before treatment,informed consent were getting from all subjects. Treatment were given for both groups . three sessions per week, totally 6 sessions for 2 weeks.

Inclusion Criteria:1. Age over 45 year ,2.Both female and male 3.BMI>25KG/m.sq 4.Mild to moderate knee osteoarthritis,kellegren and Lawrence scale(Grade 2 and 3)5. Walk independently, 6. Chronic knee pain.

Exclusion Criteria:1.Total knee replacement patient. 2.Any previous surgeries on lower limb. 3.Fracture around the knee joint.4.Cardiovascular disease. 5. Renal condition patients. 6.Malignancy or tumor around the knee joint.7.Intrarticular steroid injection to the knee joint. 8.Inflammatory arthritis.9. Meniscal and ligament injury.

Variables of the Study

DEPENDENT VARIABLE: Pain**,**Decreased knee joint range of motion, walking speed.

INDEPENDENT VARIABLE: Wax therapy, Body weight supported treadmill training, Conventional physiotherapy-(stretching and isometric strengthening exercises).

OUTCOME MEASUREMENT SCALE: Numerical pain rating scale, Goniometer, pedometer

MATERIALS USED: Body weight supported treadmill, wax therapy, Low couch**,**Pillows**,** Goniometer, Assessment chart, Numerical pain rating scale pedometer app.

Experimental group:(Group 1)

30 subjects were treated with body weight supported treadmill training along with conventional physiotherapy.Body weight supported treadmill training(20 mins)

Wax therapy(10 mins),Exercises(15 mins). (Based on manual muscle length examination strengthening and stretching exercise are advised to the patient).

Figure 1 Body weight supported treadmill training

Control group: (Group 2)

30 subjects were treated with conventional physiotherapy alone.Wax therapy(10 mins),Exercises(15 mins). (Based on manual muscle length examination strengthening and stretching exercise are advised to the patient.

Data Analysis

Table 1 Paired Samples StatisticsNumerical Pain Rating –Experimental Group-1

Numerical Pain Rating –Experimental Group-1		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	8.1000	30	1.24152	.22667
	Posttest	3.9333	30	1.11211	.20304

Table 2 Paired Samples TestNumerical Pain Rating –Experimental Group-1

Numerical Pain Rating –Experimental Group-1 Mean		Paired Differences					t	Df	Sig. (2-tailed)
		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
				Lower	Upper				
Pair 1	Pretest–Posttest	4.1666	1.36668	.24952	3.65634	4.67699	16.699	29	.000

Table 3 Paired Samples StatisticsNumerical Pain Rating –Control Group-2

Numerical Pain Rating –Control Group-2		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	8.0333	30	1.21721	.22223
	Posttest	5.6333	30	1.06620	.19466

Table 4 Paired Samples TestNumerical Pain Rating –Control Group-2

Numerical Pain Rating –Control Group-2 Mean		Paired Differences					t	Df	Sig. (2-tailed)
		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
				Lower	Upper				
Pair 1	Pretest–Posttest	2.4000	.72397	.13218	2.12966	2.67034	18.157	29	.000

Table 5 Paired sample statistics Goniometer Experimental Group-1

Goniometer Experimental Group-1		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	74.6667	30	10.67815	1.94956
	Posttest	97.3667	30	9.75734	1.78144

Table 6 Paired sample test Goniometer Experimental Group-1

Goniometer Experimental Group-1 Mean		Paired Differences					t	Df	Sig. (2-tailed)
		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
				Lower	Upper				
Pair 1	Pretest–Posttest	-22.700	7.14939	1.30529	-25.36963	-20.03037	-17.39	29	.000

Table 7 Paired sampe statistics Goniometer Control Group-2

Goniometer Control Group-2		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	74.9333	30	10.78611	1.96927
	Posttest	85.0667	30	12.14548	2.21745

Table 8 Paired sample test Goniometer Control Group-2

Goniometer Control Group-2 Mean		Paired Differences					t	df	Sig. (2-tailed)
		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
				Lower	Upper				
Pair 1	Pretest–Posttest	-10.133	4.32103	.78891	-11.74683	-8.51984	-12.84	29	.000

Table 9 Paired sample statistics Pedometer Experimental Group-1

Pedometer Experimental Group-1		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	687.8000	30	108.64285	19.83538
	Posttest	738.9667	30	110.25690	20.13006

Table 10 Paired sample test Pedometer Experimental Group-1

Pedometer Experimental Group-1 Mean		Paired Differences					t	df	Sig. (2-tailed)
		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
				Lower	Upper				
Pair 1	Pretest - Posttest	-51.166	11.28955	2.06118	-55.38226	-46.95108	-24.82	29	.000

Table 11 Paired sample statisticsPedometer Control Group-2

Pedometer Control Group-2		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	681.1667	30	124.84448	22.79338
	Posttest	702.3000	30	124.73009	22.77250

Table 12 Paired Samples Test Pedometer Control Group-2

Pedometer Control Group-2 Mean		Paired Differences					t	df	Sig. (2-tailed)
		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
				Lower	Upper				
Pair 1	Pretest - Posttest	-21.133	6.19083	1.13029	-23.44503	-18.82164	-18.69	29	.000

Result

By the statistical analysis of the data of group A and group B ,the scores of group A who received **Body weight supported treadmill training along with conventional physiotherapy,** thep value is 0.00 in Numerical pain rating scale, goniometer and pedometer measurement.Hence the technique has highly significant among the osteoarthritis patient.

Discussion

Body weight-supported treadmill training (BWSTT) has emerged as a promising rehabilitation method for individuals suffering from knee osteoarthritis.BWSTT involves the partial unloading of body weight during treadmill walking, offers a low-impact exercise option that can help reduce pain, improve function, and enhance the overall quality of

life in individuals with knee OA.Knee OA is characterized by the degeneration of joint cartilage and changes in the subchondral bone, leading to pain, stiffness, and reduced mobility. Conventional exercise is essential in managing knee OA, but the pain associated with weight-bearing activities often limits participation. BWSTT mitigates this issue by reducing the load on the knee joint during ambulation, allowing patients to engage in aerobic and strengthening exercises with less discomfort.Lim et al 2015 had emphasized that reduced load on the knee joint during BWSTT can decrease joint stress, which is beneficial in slowing the progression of OA.the repetitive nature of treadmill walking under supported conditions can improve gait mechanics, muscle strength, and cardiovascular fitness without exacerbating joint symptoms. These improvements may contribute to better joint stability and reduced pain over time.[14]When compared to other non-pharmacological interventions for knee OA, such as aquatic therapy or cycling, aerobic exercise.BWSTT offers a unique combination of reduced joint loading and functional weight-bearing exercise. While aquatic therapy provides similar joint unloading, it does not replicate the specific biomechanical patterns of walking, which are crucial for everyday function. Cycling, although beneficial for cardiovascular fitness, does not engage the lower extremity in a weight-bearing manner, which is essential for improving gait and leg strength. Aerobic exercises have beneficial in weight andpain reduction but not play a role in enhancing balance and gait.BWSTTdirectiy increase the demand placed on postural control mechanics of body to achieve the postural alignment and balance of body.

BWSTT can also complement traditional therapeutic exercises by allowing patients to progress to more challenging activities as their pain and functional status improve. As patients become more comfortable with weight-bearing, the amount of body weight support can be gradually reduced, facilitating a smoother transition to full-weight-bearing activities.[15]

One unique aspect of our study was individualised adjustementof body weight support based on real timefeedback and patient tolerance.while many other studies implement a fixed percentage of weight support, we allowed flexibility in adjusting the weight bearing load throughtout the intervention.this adaptive approach may be contributed to the improved functional outcomes.

Customizable BWSTT yields superior, sustained improvements in gait and pain relief compared to standard ,fixed approaches.

Limitations and Future Directions

Despite its benefits, BWSTT is not without limitations. Access to specialized equipment and the need for professional supervision may limit its widespread availability. Additionally, the long-term effects of BWSTT on the progression of knee OA remain unclear, and more research is needed to determine the optimal duration and frequency of training. Short duration of treatment and lack of long term follow up to determine long term effectiveness of treatement were also other potential limitation of this study.

Future research should focus on comparing BWSTT with other exercise modalities, exploring its cost-effectiveness, and investigating its long-term impact on disease progression and quality of life in patients with knee OA. Additionally, studies should explore the potential benefits of combining BWSTT with other therapeutic modalities, such as resistance training or manual therapy, to maximize patient outcomes.Body weight-supported treadmill training presents a valuable therapeutic option for individuals with knee osteoarthritis, offering a way to engage in low-impact exercise while minimizing pain and joint stress. It can improve pain, mobility, and overall function, particularly in patients for whom traditional weight-bearing exercises are challenging. As evidence continues to emerge, BWSTT may become a standard component of knee OA rehabilitation, helping to improve the quality of life for many individuals affected by this chronic condition.

CONCLUSION: This study concluded that , the Group 1 received **Body weight supported treadmill training along with conventional physiotherapy** is much more effective in reducing pain,increasing knee joint range of motion and walking speed among osteoarthritis patient than Group 2 received conventional physiotherapy alone

Ethical clearance:Taken from MelmaruvathurAdhiparasakthi institute of medical science and Research, Reg. No.ECR\1487inst\TN\2020 , MAPIMS\IEC\52\2023 on 08.12.2023.

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