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A comparative study of upper body strength training exercise vs. treadmill walking on patients with intermittent claudication

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ABSTRACT

Objective: Intermittent claudication is one of the symptoms of painful Peripheral Arterial Disease (PAD) in which walking was conventionally used treatment, though forcing patients with PAD to walk with increasing pain is challenging. The purpose of the study was to compare the effect of upper body strength training exercise vs. treadmill walking on intermittent claudication through which an alternative, effective and pain free protocol could be implemented in the clinical settings.

Methods: In this study fifty four patients were enrolled in two groups through convenience sampling. Data were collected for 18 patients in Group A (upper body strength training) and 16 in group B (treadmill walking) for analysis. Independent t test was used for inter group comparison and ANOVA for intra group comparison of Ankle Brachial Index (ABI), Pain Free Walking Distance (PFWD), Maximum Walking Distance (MWD), Heart Rate (HR) and Walking Impairment Questionnaire (WIQ) ($p< 0.05$).

Results: Comparison of both groups for PFWD, HR and WIQ were shown significant difference during post and follow up values while no apparent changes were noted in MWD and ABI. p values for pre-post and pre-follow up phases for all outcome measures except ABI were <0.05 indicated statistical significance.

Conclusions: Upper body strength training and treadmill walking both forms of exercise appears to be an effective for improving PFWD, HR and WIQ in intermittent claudication. However, upper body strength training is the primary choice in patients unable to complete treadmill walking training.

Key words: *Upper body strength training, treadmill walking, intermittent claudication*

Introduction

PAD affects more than 202 million people worldwide which is an occlusive condition where peripheral arteries blood flow is reduced due to atherosclerosis and endothelial dysfunction affects quality of life, reduce functional capacity and may cause significant morbidity and mortality [1-4]. 'Intermittent claudication' (IC) one of the characteristics of symptomatic PAD and is defined as the aching sensation of physically limiting muscle pain due to increased oxygen demand secondary to physical activity which causes peripheral limb ischemia [2,3]. An individual with intermittent claudication self imposes a sedentary life style in order to prevent pain during ambulation which in turn elevates health related risk factors associated with inactivity [2,5,6].

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Management for PAD includes medications, surgical therapy like revascularization, risk factor modifications, among these all exercise is an effective and economical treatment for improve functional ability and quality of life [3,5,7-10]. Conventional PAD exercise training protocol includes walking, though according to evidences due to pain potential for self-reported walking declines 8.4 meters per year [5,6]. Apart from this lower limb strength training has no beneficial effect is already proven [11].

This finding indicates the requirement of developing alternative, effective and pain free exercise program [6,11,12]. Upper limb aerobic exercises with arm ergometer are effective for IC and involvement of upper limb PAD incidence is compare to lower limb 20 times less frequent though upper body ergometer is costly and difficult to obtained compare to strength training equipment [3,5,6,8,9,11-16]. Previously one study was conducted to find out the short term effect of upper body strength training exercises (UBST) on PAD, however study itself has some limitations in methodology and selection procedure [11,15]. So, there is need to develop effective, economical and easily manageable upper body exercise protocol for IC and find out long term effect which may justify the efficacy of treatment regime in patients with PAD. [8,11,16,17] The objective of the study is to compare the long term effect of UBST vs. lower body treadmill walking on IC.

Materials and Methods

In this quasi experimental study total of 54 patients were selected through convenience sampling who visited our surgery department from August 2013 to March 2015. A study was approved by the institutional ethical committee (11/4220/2013). Subjects were first evaluated and clinically diagnosed by surgery department through history and physical examination and then confirmed by the ABI. After taking proper assessment, which included the history of cardiovascular disease and its risk factors, any surgery, current medicine etc, subjects who were diagnosed as PAD with IC grade I or II by Boyd's classification were recruited randomly in the group A and B through chit method by the person who was blinded.

Subjects with upper limb involvement, rest pain, unstable disease, exercise tolerance and strength limited by medical or musculoskeletal conditions, unstable cardio respiratory conditions, or sever lumbar spine disease were excluded. Study procedure and effects were properly explained to all participants and well informed consent was taken, who were on long term medication for PAD can continue with their treatment.

Outcome measures: Outcome measures were taken before starting of intervention, at the end of sixth week and after twenty-four weeks of follow up by the same physical therapist. The patients were instructed to avoid any vigorous exercise and not take any beverages before twenty four hours of testing which might affect the outcome measures.

Ankle Brachial Index (ABI): ABI is a simple, inexpensive and independent predictor of not only PAD but also coronary and cerebrovascular conditions and become more sensitive after exercise. ABI < 0.9 was considered as abnormal and presence of occlusion [18-20].

Walking performance: After sufficient rest simple walking test was performed on minimum 30 m long plain surface at a speed of approximately 100 m/ min (equivalent to two steps/ second). PFWD prior to onset of claudication pain and MWD was covered distance after which patient was unable to continue because of severe claudication pain, were taken as an outcome measures [11,21]. ACSM claudication pain rating scale was used to note the changes in severity of pain during the test. The scale was 1 indicates minimal discomfort, 2 moderate pain (patient can be distracted), 3 intense pain, and 4 unbearable pain [2]. All participants reached up to the maximum walking distance level that limited further walking.

Heart rate (HR): The changes in the HR were noted as hemodynamic changes at baseline and after intervention to investigate the exercise induced changes in cardiac demands [4,11].

WIQ is a PAD disease-specific, self-reported, quantitative type of valid questionnaire used to monitor effect of intervention which includes walking distance, speed and severity of impairment symptoms. In this 0% indicates severe claudication of pain and 100% indicates no claudication pain or maximum physical ability [12,22,23].

Exercise Intervention: Group A was upper body strength training group included total six weeks mod-

erate intensity (60% of 1 RM) resisted exercises of biceps curl, triceps curl, rear deltoid row, partial curl ups and pushups three sets of 10 repetition in between two minutes rest of total 45 minutes duration for three days a week which was supervised by the physical therapist. The 1 RM was accurately tested by physical therapist initially and then after every two weeks for recalibrated intensity. The average value was taken among three trials with 3 minutes rest in between. Training session's starts and ends with five minutes of warm up and cool down.

Treadmill walking group B was first familiarized and described the graded treadmill protocol by therapist during the first visit then data collection was started after the second visit. Protocol was started with five minutes of warm up then treadmill walking at a speed that produced IC pain grade 3 into ACSM claudication scale within 5-10 minutes with 0% grade followed by the rest. This intermittent walking should repeat for 35 minutes and every session was followed the same protocol until patient could complete this with ease. After that every week speed was increased 0.3 km/m or grade by 1%. The session was ended by five minutes cool down period which included stretching of some major muscles.

Data collection: PFWD, MWD, HR, ABI, and WIQ are the variables in this study. The data was collected before starting the treatment as a pretreatment after six weeks of intervention as post treatment and then, after twenty four months at follow-up appointments.

Results

The statistical analysis of ABI, PFWD, MWD, HR and WIQ were done through SPSS version 16.0 software ($p<0.05$). Independent T test was used to compare all the variables for inter group comparison between group A and B. Intra group comparison was done by post hoc bonferroni ANOVA test.

Out of 64 patients who were assessed for eligibility, 54 were randomly divided into group A (28) and group B (26). 10 patients in group A and seven in group B did not receive the treatment. During the period of follow up withdrawal of three patients in group B without giving

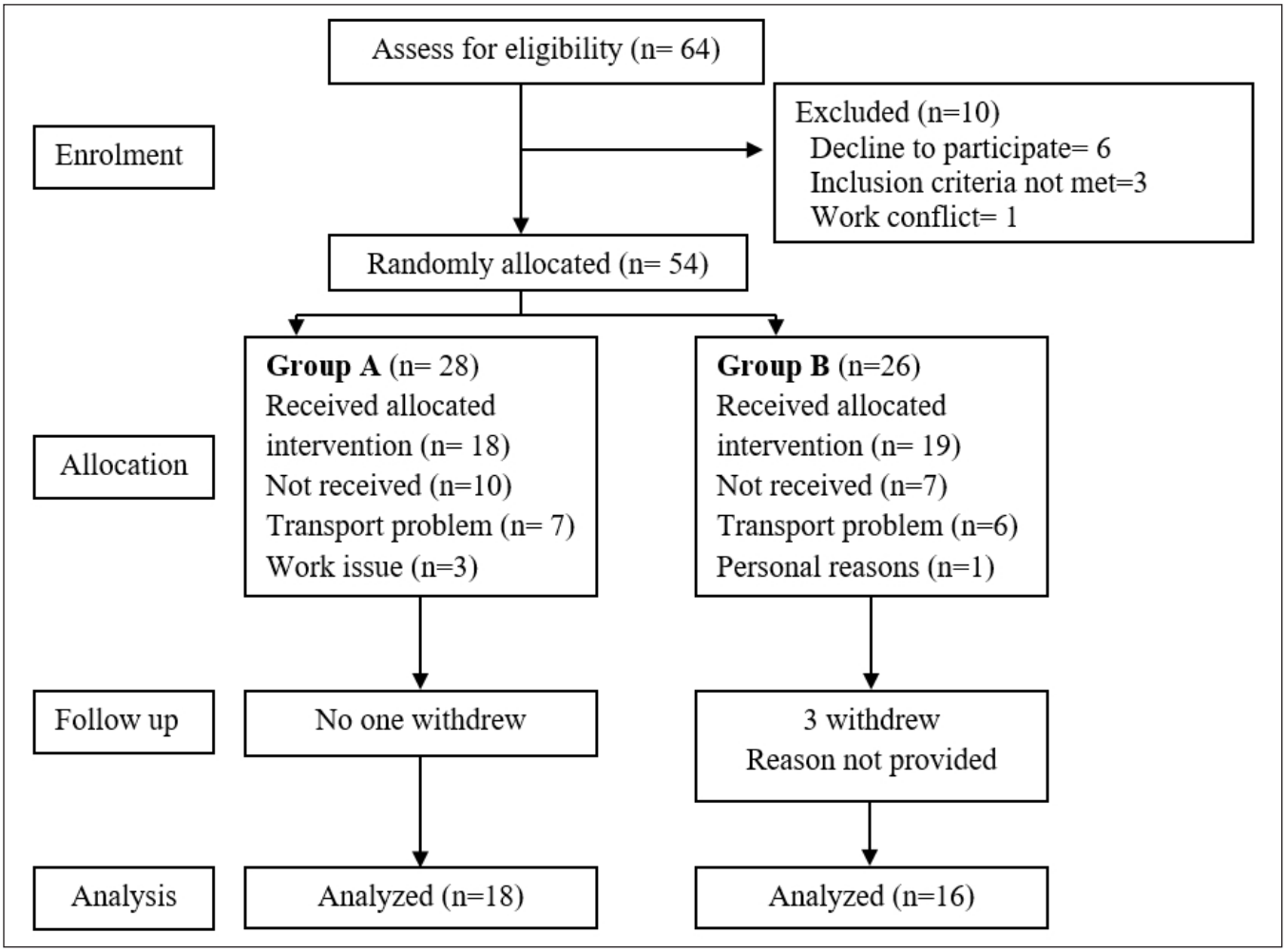

Figure 1. Flow diagram of the participant.

Table 1. Demographic detail of patients.

Variable	Group A		Group B		P-Value (5% significance level)
	Mean	SD	Mean	SD	
Age (Years)	54.72	± 10.62	53.49	± 9.87	0.129
Weight (Kg)	58.44	± 8.54	54.26	± 6.9	0.103
BMI (Kg/m^2)	26.41	± 4.78	26	± 5.12	0.246
Duration of claudication (months)	16	± 9	15	± 7	0.100
Smoking status (packs/year)					
Current	2 (11.11%)		3 (18.75%)		
Previous	8 (44.44%)		7 (43.75%)		
Never smoked	8 (44.44%)		6 (37.5%)		
Gender	14 Male- 77.77% 4 Female- 22.22%		14 Male- 87.5% 2 Female- 12.5%		
Symptomatic side	12 Right- 66.66% 6 Left- 33.33%		10 Right- 62.5% 6 Left- 37.5%		

Table 2. Inter group treatment comparison between Group A & B.

Parameter	Phase	t-Value	P-Value (5% significance level)
MWD	Pre Treatment	0.02	0.98
	Post Treatment	0.31	0.13
	Follow up	0.56	0.10
PFWD	Pre Treatment	0.03	0.87
	Post Treatment	2.11	0.04
	Follow up	2.02	0.03
HR (Rest)	Pre Treatment	0.53	0.92
	Post Treatment	1.56	0.04
	Follow up	1.41	0.04
WIQ (Distance)	Pre Treatment	-0.06	0.79
	Post Treatment	4.59	0.00
	Follow up	2.78	0.03
WIQ (Speed)	Pre Treatment	-0.06	0.79
	Post Treatment	-1.56	0.01
	Follow up	-2.02	0.04
ABI	Pre Treatment	0.26	0.94
	Post Treatment	0.21	0.73
	Follow up	0.02	0.59

reason were noted. So, for data collection and analysis purpose in group A 18 and in group B 16 patient's data were included (Figure 1). Demographic details were shown homogeneity among group A and B (Table 1).

The pretreatment comparison of MWD, PFWD, HR, WIQ (distance and speed) and ABI did not show significant change between group A and B ($p > 0.05$). Significant difference were noted between group A and B during post treatment and follow up values of PFWD ($p=0.04$ and 0.03) (Table 2). While compared to mean values group A showed significant improvement than group B (Table 4). In case of post treatment and follow up, p values of MWD and ABI no apparent significant change were noted between group A and B ($p > 0.05$). Though mean values of MWD showed significant increase in group B compared to group A (Table 4). Inter group comparison of HR and WIQ were noted significant difference between post and follow up values ($p<0.05$) (Table 2). Mean values of HR and WIQ were indicated more changes in group A compared to B (Table 4).

In both groups, the p values of PFWD, MWD, HR, and WIQ for pre- post and pre- follow - up phase comparison were less than 0.05 indicated statistically significant while compared to post- follow up phase values which were indicated no significant change ($p > 0.05$). ABI p values for all phases in group A and B were more than 0.05 (Table 3).

Discussion

The aim of the study was to find out the long term effect of UBST on IC compared to treadmill walking so that effective and feasible treatment protocol can be implemented in clinical setting. The main observation of the study was that the results of PFWD, HR and WIQ showed improvement in both the groups after treatment and remained almost stable during the period of follow up. These changes are more pronounced in group A compare to group B which was supported by the results of other studies [4,14].

Table 3. Intra group treatment comparison within Group A & B.

	Group	Phase		P-Value
MWD	A	Pre	Post	0.027
		Post	Follow up	1.000
		Pre	Follow up	0.040
	B	Pre	Post	0.024
		Post	Follow up	1.000
		Pre	Follow up	0.047
PFWD	A	Pre	Post	0.028
		Post	Follow up	1.000
		Pre	Follow up	0.043
	B	Pre	Post	0.015
		Post	Follow up	1.000
		Pre	Follow up	0.041
HR (Rest)	A	Pre	Post	0.000
		Post	Follow up	1.000
		Pre	Follow up	0.000
	B	Pre	Post	0.045
		Post	Follow up	1.000
		Pre	Follow up	0.022
WIQ (Distance)	A	Pre	Post	0.038
		Post	Follow up	1.000
		Pre	Follow up	0.024
	B	Pre	Post	0.014
		Post	Follow up	1.000
		Pre	Follow up	0.017
WIQ (Speed)	A	Pre	Post	0.020
		Post	Follow up	1.000
		Pre	Follow up	0.035
	B	Pre	Post	0.040
		Post	Follow up	1.000
		Pre	Follow up	0.039
ABI	A	Pre	Post	1.000
		Post	Follow up	1.000
		Pre	Follow up	1.000
	B	Pre	Post	1.000
		Post	Follow up	1.000
		Pre	Follow up	1.000

Post-treatment reduction in HR and increased PFWD may be due to central and peripheral adaptations of the body. A possible explanation for this can be that peripherally resisted exercises enhance metabolic stress, increased muscle blood flow, and recruitment of fast twitch fibers in skeletal muscles. Large muscle group exercises may alter systemic cardiovascular responses by enhancing cardiac output and decreasing sympathetic drive with epinephrine and nor epinephrine levels which may be responsible for reduction in heart rate [4,21,24,25]. Improvement in both component of WIQ were present in both the group though more pronounced in Group A which was similar to other studies might be due to alternative upper limb pain free exercises and can perform relatively at higher intensity. Interesting finding was that both the techniques have shown improvement in PFWD, WIQ and HR after 6 weeks and improvement were remained unchanged even after 6 months of duration [12].

Though PFWD and MWD are the components of walking performance, significant changes were noted in PFWD and not in MWD between both the groups. This was similar to other studies though some studies have shown contrary results [4,11-14,26]. The reason behind these might be that improvement in PFWD depends on generalized systemic improvement which could be possible more in group A due to claudication pain free movement. While comparing mean values of MWD negligible improvement were seen in group B due to not only systemic effect but also local skeletal muscle adaptations which were impossible in group A. Further improvement was observed while comparing pre MWD values with post and follow up values in both the groups which could be due to effect of exercise by improving oxygen carrying capacity and transfer effect of systemic cardiovascular responses [11,14].

In cases of PAD, ABI was precise outcome measure and due to some limitations values of ABI were not included in previous studies. In ABI values, no noticeable changes were noted between both groups. Similar to findings of other studies in this study also there was no improvement in values of ABI after treatment in both the groups [4,5,11,13].

There are number of factors like individual perception of pain, intensity of exercise which could not be under control and affect the claudication distance though to reduce this effect in this study pain rating scale and individual supervision were taken to ensure standardized exercise protocol. The study was not financially supported so in future more advanced study with different outcome measures like muscle biopsy and cardiac function measurements should be included to know local and systemic effect of both treatment. Compara-

Table 4. Inter group treatment comparison between Group A & B.

Parameter	Phase	Group A		Group B	
		Mean	SD	Mean	SD
MWD	Pre Treatment	393.86	166.95	392.95	159.27
	Post Treatment	448.04	130.02	476.59	185.72
	Follow up	438.26	126.45	459.04	184.32
PFWD	Pre Treatment	153.10	94.45	153.91	66.91
	Post Treatment	242.22	96.35	169.46	83.52
	Follow up	233.81	103.7	165.96	71.76
HR (Rest)	Pre Treatment	82.50	10.82	80.56	10.46
	Post Treatment	68	11.79	73.5	8.12
	Follow up	67.66	8.20	72.5	11.58
WIQ (Distance)	Pre Treatment	.183	.05	.185	.06
	Post Treatment	.272	.07	.174	.04
	Follow up	.270	.99	.191	.06
WIQ (Speed)	Pre Treatment	.183	.06	.185	.06
	Post Treatment	.182	.04	.185	.06
	Follow up	.189	.05	.235	.07
ABI	Pre Treatment	.737	.09	.729	.09
	Post Treatment	.759	.11	.751	.10
	Follow up	.741	.10	.741	.11

tively shorter treatment duration might be the reason for low dropout rate which was beneficial for the result of the study. Additionally, the follow up period which indicates that even twenty four weeks after treatment also positive changes in PFWD, HR and WIQ were remained constant. This result could be generalized by further larger sample size randomized controlled trial. The study protocol is easily applicable, shorter in duration and necessary equipment are easily available in clinical settings.

The conclusion of the study is that UBST and treadmill walking both forms of exercise appears to be an effective for IC as far as walking ability, quality of life and systemic effect by improvement in PFWD, WIQ and HR are concerned. However, UBST is a useful complementary treatment in patients with IC and primary choice in patients unable to complete treadmill walking training.

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Conflict of interest statement

The authors have no conflicts of interest to declare.

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