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Effect of Proprioceptive and Flexibility Exercise Program along with Resisted Training on Glycosylated Hemoglobin and Pain among Patients with Diabetic Neuropathy

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ABSTRACT

Objective: *Diabetic neuropathy is a common complication of diabetes. Though the beneficial effect of exercise on diabetes is well established, specifically the relationship between the effect of exercises over pain and the levels of glycosylated hemoglobin in diabetic neuropathy has not been explored. Hence, the objective of this study was to examine the effect of exercise on pain and glycosylated hemoglobin in people with diabetic neuropathy.* ***Methods:*** *Total 64 sedentary individuals (mean age 57±5.11 years) with diabetic neuropathy were enrolled in an 8-week, supervised exercise program. Group A received proprioceptive exercise and Group B underwent flexibility exercises along with a resisted exercise program for both groups. The VAS and hemoglobin A1c (HbA1c) were measured at the pre-intervention and post-intervention (4 weeks and 8 weeks) as outcomes of interest.* ***Results:*** *Significant reductions in HbA1c and pain remained unchanged.* ***Conclusion:*** *The results from our current study suggests that proprioceptive exercises with flexibility exercises combined with resisted exercise are equally effective in reducing the pain as well as Hba1c level among the diabetic neuropathy patients.*

Keywords: Diabetic neuropathy, Proprioceptive exercises, Glycosylated hemoglobin, Greenhouse-Geisser correction

INTRODUCTION

This study was undertaken as a part of doctoral work on the effect of exercises in diabetic peripheral neuropathy (DPN) patients. Diabetic neuropathy is heterogeneous and one of the most common complications of diabetes mellitus in its presentation with significant morbidity [1]. Diabetic peripheral neuropathy (DPN) is the single leading cause for amputations in patients with type 2 diabetes mellitus (T2DM). It is associated with a poor quality of life which is reported among patients with diabetic foot ulcers in comparison with patients with T2DM and healthy individuals. The primary factor for the pathogenesis of diabetic neuropathy is hyperglycemia which plays an important role. As a consequence of metabolic alterations that happen within the body presence of advanced glycation end products are observed. Glycation is defined as a non-enzymatic addition of glucose to proteins, and glucose which forms a chemically reversible product with a protein called as Schiff base. The concentration of blood plasma glucose determines the degree of glycation with the presence of hyperglycemia and aging contributing to the pathophysiology of vascular disease in diabetes [2].

It has been reported that the proliferation of endothelial cells of the endoneurial vessels increases the thickness of the basement membrane which results in the closure of the lumen of the vessels. This has been reported as one of the important reason for pain associated with diabetic neuropathy due to damage to the neuron and resulting in the poor conduction in the neurons.

Effect of aerobic exercise on metabolic control has been widely reported as an important focus for glycemic control in T2DM. Previous studies and position statement by the American Heart Association (AHA) have reported that exercise of 8-week duration leads to improvements in metabolic control, measured by glycosylated hemoglobin (HbA1c), blood glucose or insulin sensitivity in patients with T2DM [3,4].

The American College of Sports Medicine and the American Diabetes Association (ADA) in their joint position statement have reported the ameliorative effect of exercise on hyperglycemia in type 2 diabetes. Previous studies have mentioned further evaluation on a large scale to determine whether the ameliorative effect of aerobic exercise training on hyperglycemia can be useful in the management of DPN in elderly T2DM patients [5]. Hence, the objective of the present study was to evaluate the effect of 8-weeks supervised exercise programme on glycemic control (HbA1c) in patients with T2DM and peripheral neuropathy. Benefits of exercise on glycemic control are enormous with levels of HbA1c being considered as a gold standard for glycemic control in diabetes as it accurately reflects glycemic control over a period of time. In a clinical setting, T2DM usually presents with a poor glycemic control which increases the morbidity and mortality risk in the population. Higher levels of HbA1c concentrations not only predispose patients to an increased risk of developing DPN and may also impose risks of developing diabetic retinopathy and nephropathy in due course of time [6-8].

MATERIALS AND METHODS

Subjects

Total 64 sedentary individuals (mean age 57 ± 5.11 years) with a confirmed diagnosis of painful DPN were enrolled in an 8-week, supervised exercise program. Group A received proprioceptive exercise and Group B flexibility exercise and a resisted exercise program for both the groups. The VAS and hemoglobin A1c (HbA1c) were measured at pre-intervention and post-intervention (4 weeks and 8 weeks) as outcomes of interest.

Measurements

For measurement of glycosylated hemoglobin, the blood samples after fasting for 12 hours was taken from each patient in clean tubes for estimation of glycosylated hemoglobin (HbA1c) using the colorimetric method.

Procedure

Both the groups completed 8-week of exercise training program. The physical exercise comprised of:

Group A: 1-minute warm-up exercises, proprioceptive exercises (15 minutes), rest (3 minutes), resisted exercises (15 minutes), 1-minute cooldown exercises, 35 minutes daily for 4 days/week for 8-week.

Group B: 1-minute warm-up exercises, flexibility exercises (15 minutes), rest (3 minutes) resisted exercises (15 minutes), 1-minute cooldown exercises, 35 minutes daily for 4 days/week for 8-weeks.

Flexibility exercises: General flexibility exercise involve all major muscle groups for 15 minutes duration, (upper limb, lower limb, trunk) 2 to 4 repetitions, static stretching holding for 15 seconds described by AHA statement [9]. Resisted exercises involve major muscle group for 10 repetitions, 2 sets, and mild intensity, described by Ronald, et al., [10].

Proprioceptive exercises (15 minutes), 3 minute rest in between of exercises and 3 repetitions with eye-opening and closing, exercises are without holding anything raising from the chair, place some objects on the ground as obstacles and try to cross object by stepping, head rotation, forward stepping, sideways stepping, tandem walking, single leg standing, stand on one leg with pillow described by El-wishy [11].

The training program was performed not beyond 70% of the individual age-predicted maximal heart rate (HRmax) according to Tanaka, et al. The exercise sessions were supervised and exercise was monitored and registered [12-14].

Statistical Analysis

All statistical analysis was performed using the SPSS™ version 20.0. Prior to final analysis, data were screened for transcription errors, normality assumptions, homogeneity of variance, as prerequisites for parametric calculations of the analysis of difference and analysis of related measures. Alpha level was set at 0.05 to control for type I error and confidence interval was set at 95% for all statistical analysis. Descriptive statistics and repeated measures multivariate ANOVA was used for within and between-group comparisons at each follow-up period.

RESULTS

Descriptive Statistics of the Main Study

Table 1 represents descriptive statistics of age, weight, height, duration of pain symptoms of 64 subjects in both the groups. Baseline comparison between the groups has been done using independent samples t-test.

Table 1 Descriptive statistics of the study

Characteristics	Group A (N=32)	Group B (N=32)	p-value
	Mean ± SD	Mean ±SD	
Age (years)	56.18 ± 4.04	56.77 ± 3.52	0.311
Height (cm)	161.18 ± 4.93	160.89 ± 5.05	0.718
Weight (kg)	65.45 ± 7.12	65.32 ± 8.43	0.704
Duration of the condition (months)	41.76 ± 27.83	41.52 ± 28.61	0.673

Table 2 represents the baseline comparisons between both groups.

Table 2 Baseline comparisons in both groups

Outcome measures	Group A (N=32)	Group B (N=32)	t-value	p-value
	Mean ± SD	Mean ± SD		
HbA1C Baseline	7.44 ± 0.66	7.48 ± 0.85	-0.245	0.807
Vas Baseline	4.34 ± 1.75	4.03 ± 1.65	0.733	0.466

Table 3 summarizes that with the addition of flexibility or proprioceptive exercises to resistance exercises, there is significant reduction in glycosylated HbA1C and pain levels in both the group of patients intermittently at 4-weeks and at 8-weeks.

Table 3 Means and SD of variables at the end of 4th week and follow up period in both the groups

Follow Up At	Outcome Measure	Group A	Group B
		Mean ± SD	Mean ± SD
Week 4	HbA1C	6.68 ± 0.43	6.83 ± 0.34
	VAS	3.16 ± 1.58	2.78 ± 1.36
Week 8	HbA1C	6.24 ± 0.33	6.54 ± 0.28
	VAS	2.16 ± 1.24	1.56 ± 0.56

The within-group comparison of the result of Group A and Group B (N=32) is summarised in Table 4.

Table 4 Within-group comparison results with interaction (N=32)

Outcome Measure	F-value	p-value	Effect Size (Partial Eta Squared)
HbA1C	110.15	0.00	0.64
VAS	145.96	0.00	0.702

Repeated measure multivariate ANOVA for within-group comparison

The between-group comparison of the result of Group A and Group B (N=32) (Table 5).

Table 5 Between-group comparison of various outcomes for Group A and Group B

Outcome Measure	F-value	p-value	Effect Size (Partial Eta Squared)
HbA1C	2.686	0.106	0.042
VAS	1.808	0.184	0.028

HbA1C

The within-group repeated measure multivariate ANOVA with Greenhouse-Geisser correction (GGC) showed the significant statistical difference with F=110.15, p<0.000. A repeated measure multivariate ANOVA with (GGC) between-group analysis showed that the Group A and Group B were not different statistically with F=2.686, p<0.106.

VAS

The within-group repeated measure multivariate ANOVA with Greenhouse-Geisser correction (GGC) showed the significant statistical difference with F=145.96, p<0.000. A repeated measure multivariate ANOVA with (GGC) between-group analysis showed that the Group A and Group B were not different statistically with F=1.808, p<0.184.

DISCUSSION

Our main aim of this study was to find if there are any changes in the levels of HbA1C and pain associated with diabetic peripheral neuropathy following specific protocols of combinations of exercises. Though it has been established that resistance exercises improve the markers like HbA1C and insulin sensitivity without much effect on body composition, the effect of combining flexibility or proprioceptive exercises with resistance exercises has not been studied [15]. The glycemic effects of resistance versus aerobic exercise have been reported. In non-obese, young women (18-35 years of age), 6 months of either aerobic or resistance training improved muscular glucose disposal by different mechanisms. While aerobic exercise training done by individuals with T2DM increases the levels of glucose transporter 4 (GLUT4) in trained muscle, along with insulin receptors, protein kinase B, glycogen synthase (GS), and GS total activity after acute training and aerobic training which enhanced insulin sensitivity independently of changes in FFM or maximal aerobic capacity [16-18].

So, resistance training is recommended for patients with T2DM because it has the potential to improve muscular strength and endurance, enhance flexibility, improve body composition, and decrease risk for cardiovascular disease, all while increasing amounts of insulin-sensitive muscle mass. As skeletal muscle accounts for up to 80% of glucose disposal following ingestion or infusion, whereas adipose tissue only accounts for 3-4% of insulin-mediated glucose uptake more prudent use of exercise with standard care as a therapy may lower the risk of hypoglycemia, may also help patients achieve improved glucose control for longer periods and thus reduce the risk of complications in T2DM. The findings of the current research show that exercises of 8-week duration may be an imperative line of therapy for achieving glycemic control for T2DM patients with DPN [19-21].

In our study, both the groups are matched in terms of baseline parameters of age, weight, height, and duration of the condition. Baseline outcome measures also indicated matched pairs of subjects from both Group A and Group B suggesting better inference from the statistical results. Previous recommendations of exercises for DPN reported that resistance exercises for more than 8-weeks improved levels of HbA1C significantly but not the body mass [15]. In this study, from Table 3, it can be seen that, with the addition of flexibility or proprioceptive exercises to resistance exercises, there is a significant reduction in Glycosylated HbA1C and pain levels in both the group of patients intermittently at 4 weeks and at 8 weeks.

With respect to pain, both the groups showed significant reductions in pain, Hba1c level. The better improvement in both the outcomes in Group A and Group B can be related to proprioceptive exercises similar to resistance exercises whereas similar to previous reports flexibility exercises does not report of any major changes in the metabolic control [9]. However, it needs further understanding through objective quantification on the effect of proprioceptive exercises compared to flexibility exercises on whether a significant change can be produced. Further study is also needed to throw light on the effect of another outcome measure like the quality of life [22,23].

CONCLUSION

The results from our current study suggest that proprioceptive exercise with flexibility exercises combined with resisted exercise are equally effective in reducing the pain as well as Hba1c level among the diabetic neuropathy patients.

DECLARATIONS

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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