Effect of proprioceptive neuromuscular facilitation stretching versus aerobic training on glycosylated hemoglobin (HbA1C) in patients with type 2 diabetes mellitus

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ABSTRACT
The study aimed to compare the effect of Proprioceptive neuromuscular facilitation stretching Vs. Aerobic training on HbA1c levels in patients with type 2 diabetes mellitus. Forty sedentary type 2 diabetes mellitus patients (22 males & 18 females) were randomly allocated in Aerobic Training group(n=20) and Proprioceptive neuromuscular facilitation stretching group(n=20) with twelve-week protocol for both the groups. Glycosylated Hemoglobin (HbA1c) was measured before and after the intervention to examine the effect on blood glucose level. Both Aerobic training and Proprioceptive neuromuscular facilitation stretching induced decrease in blood glucose levels (Glycosylated Hemoglobin HbA1c) after the protocol (P< .001). There was no significant difference between the two groups (P>0.001). This study shows that both Aerobic training and Proprioceptive neuromuscular facilitation stretching reduced blood glucose levels. There is no significant difference between the two interventions. Proprioceptive neuromuscular stretching may be an alternative to aerobic training to those patients who are unable to perform aerobic training to control blood glucose levels.

Keywords: Type 2 diabetes mellitus, Aerobic training, Proprioceptive neuromuscular facilitation stretching, Glycosylated Hemoglobin.

INTRODUCTION
Diabetes is fast gaining the status of epidemic in India and currently represents 49 percent of world diabetes burden [1]. Diabetes mellitus is a group of metabolic disease characterized by hyperglycemia results in decrease insulin secretion, insulin action, or both [2]. Among different pathophysiology of this disease, type 2DM (DM2), also known as non-insulin dependent usually affect middle aged individuals who present altered level of insulin resistance as well as deficiency in this hormone secretion in response to the destruction of β- pancreatic cells [3]. If good glucose control is not achieved over time, prolonged hyperglycemia can lead to negative and severe outcomes such as retinopathy, nephropathy, neuropathy, cardiovascular disease, stroke, pressure ulcers, neuropathic wounds, loss of peripheral protective sensation, gangrene, limb amputation and death.

Exercise is considered as cornerstone treatment of type2 diabetes alongside diet and medication of proven efficacy [4]. Aerobic exercises involve repeated and continuous moment of large muscle group activities such as walking cycling jogging and swimming rely primarily on aerobic energy producing system [4,5].

Recent reviews and meta-analysis, including the 2016 joint position statement on physical activity and DM2 from the American Diabetes Association have highlighted the beneficial effects of chronic endurance training (ET), Resistance training (RT) and/or combined (ET+RT) intervention for ameliorating insulin sensitivity and glycemic control in individual with type 2 diabetes [5,6,7].

Static stretching of skeletal muscle provides the benefits of exercise without any physical stress as in case of aerobic exercise and resisted exercise [8]. Nelson et al conducted a study on effectiveness of stretching on blood glucose in subject with diabetes and concluded that passive static stretching of the skeletal muscles may be an alternative to exercise to help lower blood glucose levels.

Research point to the possibility of stretching increasing GLUT4 incorporation. The protein Kinase B activity partially controls GLUT4 incorporation and activation. Sakamoto et al (2003) found that protein kinase B was stimulated by passive stretching isolated muscle for 10 minutes [2]. Proprioceptive neuromuscular
facilitation (PNF) stretching is one of the types of dynamic stretching which uses both active and passive contraction of muscles, but it senses to have potential to decrease blood glucose with more efficacy as it involves both participation of patient through isometric contraction and increased lengthening of stretched muscle with the help of the Physiotherapist.

The 2014 American diabetes association guidelines denote your means of diagnosing diabetes. The first of these is glycosylated hemoglobin (HbA1c) > 6.5 [8].

The idea of incorporating PNF stretching into the exercise protocols of a diabetic patient is a novelty as no research has been done in this direction. It can emerge as alternative regime in treatment of a diabetic patient who does not want to put much efforts in aerobic and strengthening exercises due to various reasons [9].

MATERIALS AND METHODS

Study Design

This was a pre-post comparative study with subjects allocated to 2 groups through chit methods conducted at Institute of applied medicine and research Centre, in Ghaziabad Uttar Pradesh India. Ethical clearance was obtained from the institutional ethical committee (IAMR/20/1111) and from Amity University (AUUP/IEC/2020-JAN-01), registered in Clinical Trial Registry of India (CTRI/2020/09/027539). The written inform consent was taken from the subjects before intervention. Fifty-six patients were screened for the study and based on inclusion and exclusion criteria 40 patients were included in the study and randomly allocated in two groups; Group A (Aerobic training group) and Group B (PNF stretching group) All participants were screened for fitness by Physical Activity Readiness Questionnaire (self-declaration form) before recruitment for intervention.

In inclusion criteria, subject with type 2 DM. Sedentary lifestyle (not involved in sports activity, 6 months before the study) Age group 35 to 55 years (both males and females) HbA1c level between 6.5 to 9 Ready to adherent to diet chart have been whereas any neurological deficits. Recent Musculoskeletal injury Current Insulin therapy Changes during previous 3 months in oral hypoglycemic medication, anti-hypertensive medication and lipid lowering medication considered in exclusion criteria.

Interventions

Group A (Control Group)

An aerobic training program was planned according to study of Bwearietal7 Maximum heart rate was determined for all subject in the study by single exercise bout to self-reported exhaustion. Subjects went for 30 minutes of aerobic (walking/brisk walking/jogging) session at 60% of max HR with 10 min of warm up and 10 mins of cool down period. Exercise was given 5 days a week for 12 weeks during the study.

Group B (PNF Strengthening Group)

PNF stretching group was given PNF stretching (hold and relax) in D1F, D2F, D1E, D2E pattern for upper and lower limbs 3 days a week for 12 weeks. These patterns were included in this study because they stretched all the major muscles of lower limb and upper limb. Each pattern was held in stretched position for 30 sec and was repeated four times. A 15 sec relaxation period was given between each repetition and 30 sec relaxation period was given between different patterns.

Outcome Measures

Glycosylated Hemoglobin (HbA1c) was measured pre and post intervention.

Statistical Analysis

Paired t-test was used to determine the significance difference with in the groups. T-test was used to compare the significance difference in effect between the groups. P<0.0001 is considered as significance of the study. SPSS software version 24 was used for calculation.

RESULTS AND DISCUSSION

The baseline subject characteristics are shown in table 1.

Table 1: Subject’s characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group A(n=20)</th>
<th>Group B(N=20)</th>
<th>Total (n=40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (in years)</td>
<td>Mean ± SD (n)</td>
<td>48.75 ± 2.91(20)</td>
<td>49.10 ± 2.67(20)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total n (%)</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Male n (%)</td>
<td>11 (27.5%)</td>
<td>11 (27.5%)</td>
<td>22 (55.0%)</td>
</tr>
<tr>
<td>Female n (%)</td>
<td>9 (22.5%)</td>
<td>9 (22.5%)</td>
<td>18 (45.0%)</td>
</tr>
<tr>
<td>Pre HbA1c (%)</td>
<td>Mean ± SD (n)</td>
<td>7.04 ± 0.195(20)</td>
<td>6.97 ± 0.195(20)</td>
</tr>
</tbody>
</table>

Analysis of HbA1c within the groups:

Table 2: Analysis of HbA1c within the groups

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± SD</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre HbA1c (%) group A</td>
<td>7.04 ± 0.19(20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post HbA1c (%) group A</td>
<td>6.89 ± 0.19(20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre HbA1c (%) group B</td>
<td>6.97 ± 0.19 (20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post HbA1c (%) group B</td>
<td>6.77 ± 0.19 (20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair difference pre-post HbA1c (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>0.15 ± 0.076 (20)</td>
<td>[0.11; 0.18]</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Group B</td>
<td>0.20 ± 0.117 (20)</td>
<td>[0.15; 0.25]</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

Data are expressed as mean ± standard deviation or as number and percentage.
P-value generated from Paired T-
Test between the Pre and Post HbA1c values from both groups.

95% CI: 95% Confidence Interval

Data are expressed as mean ± standard Error or as number and percentage.

Using mixed model, least square means of two groups and difference between the groups as dependent variable.
P-value calculated based on the same consideration.
95% Confidence Interval (95% CI).

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In Aerobic training group pre-test HbA1c mean ± S.D. as 7.04 ± 0.19 and post mean ± S.D. as 6.89 ± 0.19. Using paired t-test within the group [CI 95%] the p-value was less than 0.0001. stating that aerobic training induced decreases in blood glucose levels (HbA1c) after 12 weeks of training.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate ± SE</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre HbA1c (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LS Means</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>7.04 ± 0.044</td>
<td>[6.95; 7.12]</td>
<td></td>
</tr>
<tr>
<td>Group B</td>
<td>6.97 ± 0.044</td>
<td>[6.88; 7.06]</td>
<td></td>
</tr>
<tr>
<td>Group Difference</td>
<td>0.07 ± 0.062</td>
<td>[-0.06; 0.19]</td>
<td>0.2989</td>
</tr>
<tr>
<td>Post HbA1c (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LS Means</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>6.89 ± 0.044</td>
<td>[6.80; 6.98]</td>
<td></td>
</tr>
<tr>
<td>Group B</td>
<td>6.77 ± 0.044</td>
<td>[6.68; 6.86]</td>
<td></td>
</tr>
<tr>
<td>Group Difference</td>
<td>0.12 ± 0.062</td>
<td>[-0.01; 0.25]</td>
<td>0.062</td>
</tr>
</tbody>
</table>

In PNF stretching group pretest HbA1c was mean ± S.D. as 6.97 ± 0.19 and the past test mean ± S.D. as 6.77 ± 0.19 using paired t-test within the group [CI 95%] the p-value was less than 0.0001 stating that PNF stretching induced decrease in blood glucose levels (HbA1c) after 12 weeks of PNF stretching.

Analysis of post intervention HbA1c between the groups using mixed model, least square means of two groups and difference between the groups as dependent variable. P-value was 0.062 (more than 0.001) indicating that there was no significant difference between the group.

Aerobic training decreases blood glucose levels (HbA1c) after twelve weeks of training (p-value is less than 0.0001). Aerobic training increases mitochondrial density, insulin sensitivity, oxidative enzymes, compliance and reactivity of blood vessels, lung function, immune function, and cardiac output [5]. In individuals with type 2 diabetes, regular training reduces A1C, triglycerides, blood pressure, and insulin resistance [5]. According to the byproduct of energy phosphorylation, called CAMP, is recognized as a mediator responsible for the insulin-independent activation of glucose transporter proteins (GLUT4) [10].

PNF stretching decreases blood glucose levels (HbA1c) after twelve weeks of training (p-value is less than 0.0001). Stretching increases metabolic activity, increased metabolic activity is related to increased activation of the adenosine monophosphate kinase (AMPK) facilitated glucose transporter (GLUT 4) activation pathway , it is possible that the increased metabolic activity accompanying passive muscle stretching have activated the incorporation of GLUT 4 into the stretched muscles [11].

PNF stretching incorporates both passive and active compartment of stretching, that supports our study results, our PNF stretching program induced decrease in blood glucose levels.

**Limitation**
Study sample size was small and we could not have taken follow up of the participants.

**CONCLUSIONS**
The study shows both PNF stretching and aerobic training reduces blood glucose levels. There is no significant difference between the two interventions.

**Ethical Clearance**
Institute of Applied Medicine and Research, Amity Institute of Physiotherapy Ethical Clearance was obtained from the institutional ethical committee (AUUP/IEC/2020-Jan/01) and (IAMR/20/1111), written inform consent taken from the subjects before intervention.

**Conflict of Interest**
No conflict of interest

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**REFERENCES**


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