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A Comparative Study to Analyze the Effect of Aerobic Exercise Training and Resistance Training Versus Aerobic Exercise alone in Patients with Type II Diabetes Mellitus

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Abstract: ***Background and purpose: The WHO estimated that there were 135 million diabetics in 1995 and this number would increase to 300 million by the year 2025. Physical activity is one of the principal therapies which lowers the blood glucose in type 2 diabetes due to its synergistic action with insulin in insulin-sensitive tissues. Exercise helps to increase glucose uptake by skeletal muscle that is retained for up to 48 hr during the recovery from a single bout of exercise in non-diabetics and type II diabetics. Objectives: To find out the effectiveness of aerobic exercise combined with resistance training and aerobic exercise alone. Methods: Total samples consist of 40 subjects with type II diabetes and from the age group of 40-55 years. Twenty (n=20) subjects were allocated in one group in which they received aerobic training with Progressive resistance training. Twenty (n=20) subjects were allocated in other group in which they received aerobic training alone. Outcome measures: The subjects were randomly assigned in experimental and control group respectively. The blood glucose level of the 40 subjects was assessed before and after 12 weeks of treatment by automated analyzer. The obtained data was analyzed & compared with pretest – posttest volume of the same group by using paired-"t" test for both experimental & control group. Unpaired "t" test was used to analyze the data between the groups. Results: Inter group comparison of both experimental and control group shows that there is a highly significant difference in the post test volumes of blood glucose level. (p<0.0001). Conclusion: Aerobic exercises combined with resistance training are having an anti diabetic effect in type2 diabetes.***

Keywords: Type 2 Diabetes Mellitus, Aerobic exercise, resistance training, glycemic control

1. Introduction

Diabetes mellitus is one of the oldest diseases known to man. It was described in India in 400 B.C and again in the fourth century B.C in the Egyptian ebers papyrus. [1]

World Health Organization (WHO) defines Diabetes as a chronic disease that occurs when the pancreas does not produce enough insulin, or when the body cannot effectively use the insulin it produces. Hyperglycemia, or raised blood sugar, is a common effect of uncontrolled diabetes and over time leads to serious damage to many of the body's systems, especially the nerves and blood vessels.

Type II diabetes mellitus (NIDDM) formerly called as maturity onset diabetes is the commonest type of diabetes mellitus when on estimates the prevalence especially over 40 years of age. Type II diabetes mellitus is the commonest form of diabetes in India. The prevalence of type II diabetes is 2.4% in rural and 11.6% in urban population. Subjects under 40 years of age have a higher prevalence of impaired glucose tolerance than diabetes. Type II diabetes is also increasing rapidly globally and is occurring at a younger age including in adolescence and childhood. [2]

The common treatment of diabetes mellitus includes pharmacological agents, weight control, physical activity and exercises. [3]
Physical activity is one of the principal therapies which lowers the blood glucose in type 2 diabetes due to its synergistic action with insulin in insulin-sensitive tissues.

Exercise helps to increase glucose uptake by skeletal muscle that is retained for up to 48 hr during the recovery from a single bout of exercise in non-diabetics and type II diabetics. [4]

According to ASCM the aerobic exercise is defined as "Any activity that uses large muscle groups, can be maintained continuously, and is rhythmic in nature. The common aerobic exercises are Aerobic Dance, Bicycling, Cross Country Skiing, In-line Skating, Fitness Walking, Jumping Rope, Running, Stair Climbing and Swimming.

Aerobic exercise has consistently been shown to improve glucose control, enhance insulin sensitivity, and improve cardiovascular risk factors such as visceral adiposity, lipid profile, arterial stiffness, and endothelial function.[4] The exercise Training is dependent on sufficient intensity, duration, and frequency. Training produces a cardiovascular and/or muscular adaptation and is reflected in an individual's endurance.

Progressive resistance exercise (PRE) is a type of Dynamic resistance training in which a constant load is applied to the contracting muscle by some mechanical means usually a free weight or a machine and incrementally progressed. [6]

With increased age, there is a tendency for progressive declines in muscle mass, leading to 'sarcopenia,' decreased functional capacity, decreased resting metabolic rate, increased adiposity, and increased insulin resistance, and resistance training can have a major positive impact on each

of these. Resistance exercise improves insulin sensitivity to about the same extent as aerobic exercise."
However the role of progressive resistance training as a treatment regimen for improving the metabolic profile of older patients with type II diabetes has received little attention. Given that the prevalence of type II diabetes increases with age[7] and that aging is associated with a reduction in muscle strength and metabolic control, both of which are influenced by the progressive age-related decline in muscle mass.[8] Resistance training may represent an effective exercise alternative for older adults.[9]
In the absence of contraindications like ischemic heart disease, uncontrolled hypertension etc. people with type II diabetes should perform resistance exercise three times per week, targeting all major muscle groups and progressing to three sets of eight to ten repetitions at a weight that cannot be lifted more than eight to ten times.[10]Further, a combination of these exercises regimens may even be more beneficial in improving insulin sensitivity and glycemic control.[11]

Thus, the purpose of this study was to examine the effectiveness of aerobic exercise combined with progressive resistance exercise and aerobic exercise alone.

2. Methods of Data Collection

The study was conducted in the Navodaya Medical College, Hospital & Research Center, Raichur, which is a 1200 bedded multi-specialty hospital, with fully equipped Cardio-respiratory rehabilitation unit. Total samples consist of 40 subjects with type II diabetes and from the age group of 40-55 years. The subjects diagnosed with type II diabetes by the physician were chosen for this experiment. The subjects were assessed thoroughly and included in the study based on the inclusion -exclusion criteria and were randomly assigned into either of the two different groups; Group (A) treated by aerobic exercise and resistance training and group (B) treated with aerobic exercise alone.A brief explanation of the procedure was given to prepare the subjects after obtaining the informed consent. Randomized blood sugar level was assessed by using auto analyzer before giving treatment and after 12 weeks of treatment.

3. Procedure

A brief explanation of the procedure was given to prepare the subjects after obtaining the informed consent. Randomized blood sugar level was assessed by using auto analyzer before giving treatment and after 12 weeks of treatment.

Treadmill walking exercise up to 50-70 % of THR based on ADA & AHA.

Repetition maximum (RM) was used as a principle to prescribe the resistance exercise.

DeLorme's technique was used to progress the resistance which is based on the principle of 10 RM. Vital signs were monitored before, during, and after every treatment session to ensure safety.

Glucose, sugar candies and fresh juices were kept ready as a precautionary measure in case of any hypoglycemic attack.

3.1 Training Protocol

Aerobic Exercise
Mode: - Treadmill walking
Intensity: - Moderate intensity 50 to 70 % of target heart rate (according to ADA & AHA)
Frequency: - 60 minutes / day, 3 days / week including warm up and cool down period.
Duration: - 12 weeks

Resistance Training
Mode: For lower limb - Squatting with weight. Standing leg curl (ankle weight)-Hip flexion, Knee extension, Heel rise with weight.
For upper limb - Dumbbell seated shoulder press, dumbbell seated biceps curl, Dumbbell triceps kick back.
All subjects were asked to perform each repetition in a slow, controlled manner with a rest of 90-120 seconds.
Frequency: - 60 minutes / day, 3 days / week including warm up and cool down period.
Duration: - 12 weeks

Statistical Test
The obtained data was analyzed & compared with pretest – posttest score of the both experimental & control group by using"t" test.

Inclusion Criteria
- Patients with type II diabetes mellitus (NIDDM)
- Age 40 to 55 years.
- Subject prescribed with the same medication by the physician for diabetes.
- Patient who are willing to participate actively in the study.
- Patient who are psychologically sound.
- Patient with the negative exercise tolerance test
- Blood sugar level 150-180 mg/dl

Exclusion Criteria
- Respiratory and cardiovascular abnormalities
- Musculoskeletal abnormalities
- Mentally retarded patient
- Type I diabetes (IDDM)
- Age below 40 & above 55 years
- Uncontrolled Hypertensive patients
- Blood Glucose level above 180 mg/dl
- Neuropathy, retinopathy, vasculopathy

3.2 Materials and Methods

- Treadmill
- Auto analyzer (ERBA)
- Dumbbells
- Weight cuff.

4. Results

Participants (n=40) were 47.15-year-old with type II diabetes. Twenty (n=20) participants with mean age of 47.75 year assigned in experiment group and twenty (n=20)

participants with mean age of 46.55 in control group. All participants in both group completed all study phases according to group assignment.

Pre Test Comparison of Blood Glucose Level in Control and Experimental Groups

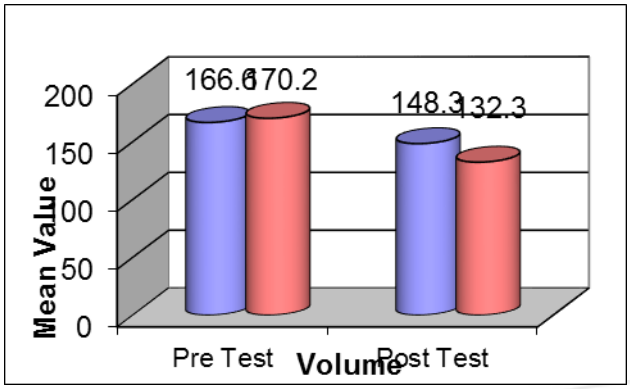

Table 1 Shows intergroup comparison of pre test of control and experimental groups. The mean of the control and experimental groups on pre test are 166.6 and 170.2, the S.D of the control and experimental groups on pre test are 7.97 and 7.20 respectively, the obtained "t" value was 1.367 with the df of 38. This finding suggests that there was no statistical significant difference between the groups (P>0.05).

Comparison between Pre-and Post Test Volumes of Blood Glucose Level in Experimental Group

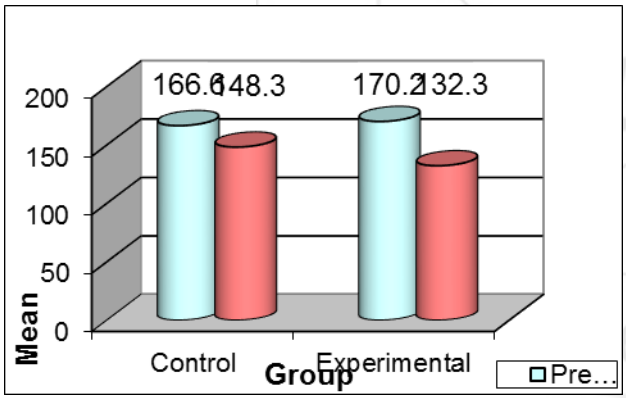

Table 2 shows intra group comparison of pretest and posttest of experimental group. The mean of experimental group on pretest and posttest are 170.2 and 132.3 respectively. The SD of experimental group on pretest and posttest are 7.20 and 5.64 respectively; the obtained "t" value was 19.39 with df of 19. This finding shows that there was statistically significant difference between pretest and posttest score (P<0.0001).

Comparison between Pre and Post Test Volumes of Blood Glucose Level in Control Group

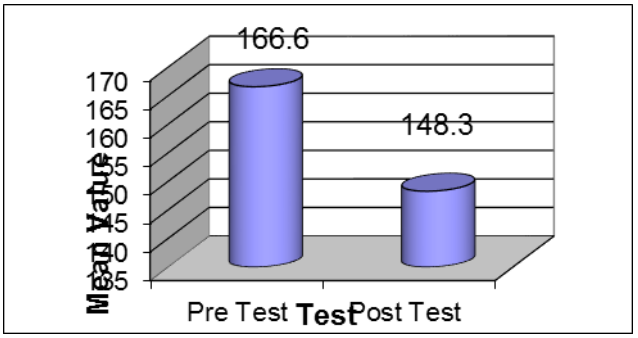

Table 3 shows intra group comparison for the pretest and posttest of control group. The mean of control group on pretest and posttest are 166.6 and 148.3 respectively. The SD of control group on pretest and posttest was 7.97 and 6.77 respectively; the obtained "t" value was 7.60 with df of 19. This finding had showed that there was statistically significant difference between pretest and posttest score (P<0.001).

Post Test Comparison of Blood Glucose Level in Control and Experimental Groups

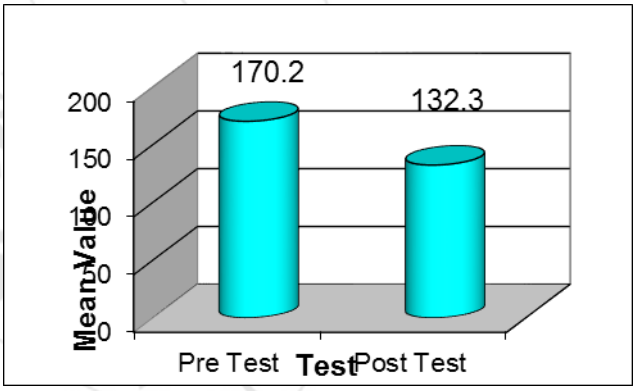

Table 4 shows intergroup comparison for the posttest of control and experimental groups. The mean of control group and experimental group on posttest are 148.3 and 132.3 respectively & the SD was 6.77 and 5.64. The obtained "t" value was 10.98 with df of 38. It can be observed that there is statistically highly significant difference between posttest of control group and posttest of experimental group (P<0.0001).

So this analysis had shown that there is no significant difference in base line data of experimental and control group (p>0.05).

Intra group analysis of both experimental and control group shows a significant difference in pre and post test values of blood glucose level. Inter group comparison of both experimental and control group shows that there is a highly significant difference in the post test volumes of blood glucose level. (p<0.0001).

5. Discussion

The purpose of this study was to analyze the effect of aerobic exercise training and resistance training on glycemic control, and that the combination of these two forms of exercise was superior to either type of exercise alone in patients with type II diabetes mellitus.

We have analyzed the effect of adding resistance training to an Aerobic training program on glycemic control. The principal finding was that a combined Aerobic exercise plus Resistance training program elicited significant improvements in glycemic control compared with the Aerobic exercise alone.

Many authors had concluded that Aerobic Endurance Training increases insulin action there by it reduces the blood sugar level in patients with type II diabetes, and also that the effect of training is predominantly located to the skeletal muscle. Furthermore, with the increased insulin action, the need for insulin to mediate the clearance of a given amount of glucose is lessened. Thus, the need for exogenous insulin or oral hypoglycemic agents is decreased. Apart from the beneficial effects on glucose metabolism, physical training also exerts marked improvement on most of the components of the metabolic syndrome.

For patients with type 2 diabetes, Resistance training probably represents an attractive exercise modality, but little is known about the overall effect, and the effect in muscle has not been studied. The role of progressive resistance training as a treatment regimen for improving the metabolic profile of patients with type II diabetes has received little attention. Given that the prevalence of type II diabetes increases with age and that aging is associated with a reduction in muscle strength and metabolic control, both of which are influenced by the progressive age-related decline in muscle mass. Resistance training may represent an effective exercise alternative for older patients.

Three days per week, for 12 weeks of aerobic exercise with addition of resistance exercise program lead to greater improvement in glycemic control in patient with type 2 diabetes mellitus. The result of this study shown that aerobic exercise combined with resistance exercise was superior over aerobic exercise alone to improve glycemic control.

In the present study, significant gain in glucose uptake occurred in patients with type 2 diabetes. Exercise helps to increase glucose uptake by skeletal muscle that is retained for up to 48 hr during the recovery from a single bout of exercise in non-diabetics and type II diabetics. This response is a combination of increased insulin sensitivity, as well as an endogenous effect in increased $GLUT_4$ (glucose transporter-4) on the sarcolemmas of the exercised muscle fibers. The endogenous effect within skeletal muscle is related to the synthesis of muscle glycogen and can last for up to 5 hours.

The present study was not designed to study effects of exercise volume or duration, and the superior effect of combined aerobic and resistance training may reflect the greater amount of exercise performed by the combined exercise training group. However, because the physiologic effects of aerobic training differ from those of resistance training, we cannot assume that our results reflect only additional exercise time.

Aerobic training involves continuous activity of multiple large muscle groups, whereas Resistance training involves isolated, brief activity of single muscle groups. Combination of both induced more utilization of glucose by muscle due to increase insulin sensitivity.

A study by Holten et al (2004) in which they investigated the effect of strength training in increases Insulin-Mediated glucose uptake, GLUT4 Content, and insulin signaling in skeletal muscle in patients with type 2 diabetes and suggested that strength training increases insulin action in skeletal muscle and the strength-training induced increase in GLUT4 protein expression also found in patients with type 2 diabetes training is novel and important.

L M Fenicchiaa et al (2004) conducted a study to evaluate the effects of resistance training program on insulin responses to a glucose load in women with type II diabetes and they resistance exercise was effective in improving integrated glucose concentration, including reducing peak glucose concentrations in women with type II diabetes. The effects of Aerobic and Resistance exercises on fitness are complementary: Aerobic exercise increases cardiorespiratory fitness, whereas resistance training increases muscle strength and endurance

A study by Daniel Tessierab et al (2000) to determine the impact of an aerobic physical exercise program in the treatment of a group of elderly patients with type 2 diabetes mellitus (DM) in relation to metabolic control, physical capacity, quality of life (QOL) and attitudes toward diabetes. They suggest that physical exercise has significant effects on glucose excursion during an OGTT and exercise tolerance in elderly patients with type 2 DM.

In present study, the duration and intensity of exercise program is more or less similar to AHA and ADA recommendation.

6. Future Scope

Limitation of this study is that sample size and the result of this study is limited to given age group. Longer-term effect of exercise program after 12 weeks is not followed. The results cannot be generalized to the patients who are receiving insulin or have advanced diabetic complications. The present study findings cannot be generalized to unsupervised exercise programs.

Further studies are necessary to assess the longer term effect with large sample size.

7. Conclusion

In present study, there was no significant difference found in the base line data of control and experimental groups.

Comparison in pre and post test of experimental and control groups respectively showed significant difference however the Post test comparison between control and experimental group had shown high statistical significance difference.

The experimental group treated with Aerobic exercise and Resistance exercise showed greater improvement in reducing blood glucose level as compared with control group treated with Aerobic exercise alone

Thus the researcher concludes that, the Aerobic exercise along with Resistance exercise program can be used in reducing the blood glucose level in patients with type II diabetes mellitus. Hence Null hypothesis is rejected and Alternative hypothesis is accepted.

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