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Effect of 8 weeks resistance training on renal function in type2 diabetic men

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Abstract

Introduction: Exercise is recommended for the management of type 2 diabetes, but its effects on diabetic nephropathy are still unknown. The aim of this study was to investigate the effect of 8 weeks resistance training on renal function in type2 diabetic men.

Material & Methods: Twenty two type 2 diabetic men (Age: 51.1 ± 10.1 years) participated in this study as the subject. The subject based on their fasting blood glucose were divided into control (n=12) or resistance training (RT) (n=10) group randomly. Subjects in RT group executed six resistance exercises selected to stress the major muscle groups in the following order: chest press, leg extension, shoulder press, leg curls, latissimus pull down and leg press. Resistance training consisted of 50-60 min of weight training per day, 3 days a week, for 8 weeks.

Results: The results indicated that fasting blood glucose and insulin resistance (HOMA-IR) were decreased in response to

RT compare to the control group ($P<0.05$). There was no meaningful difference in fasting insulin and glomerular filtration rate (GFR) between control or RT group.

Conclusions: RT improves blood glycemia and insulin resistance however further studies are needed to determine the effect of these training on renal function in patients with type 2 diabetes.

Keywords: Type 2 diabetes, Resistance training, Renal function, Nephropathy, Glomerular filtration rate

1. Introduction

Diabetes mellitus now affects approximately 250 million people worldwide, a figure expected to reach 400 million (approximately 7% of the adult population) by 2025 (1). This global epidemic of diabetes is in large part due to obesity and sedentary lifestyle. Diabetic kidney disease and its most severe manifestation, end-stage renal disease, remains one of the leading causes of reduced lifespan in people with diabetes (2). Diabetes is the main cause of end-stage renal disease, accounting for 40–50% of new cases in the U.S. and the largest annual health care expenditure compared with all other primary end-stage renal disease diagnoses (3,4). Up to one-third of adults with newly diagnosed type 2 diabetes have chronic kidney disease (4), implying that it often develops during the course of prediabetes. The major determinants of kidney disease and its progression to end-stage kidney failure in type 2 diabetes are uncontrolled blood glucose, blood pressure and albuminuria (5,6). Complications of diabetes include macrovascular complications (coronary heart disease, peripheral vascular disease, and cerebrovascular accident) and microvascular complications (neuropathy, retinopathy, and nephropathy) (7). Diabetic nephropathy is a progressive kidney disease caused by angiopathy of capillaries in the kidney glomeruli. It is characterized by nephrotic syndrome and diffuse glomerulosclerosis. It is due to longstanding diabetes mellitus, and is a prime indication for dialysis in many developed countries. It is classified as a small blood vessel complication of diabetes (8).

Exercise plays an important part in diabetes prevention and management. Regular exercise has been shown to have benefits in patients with type 2 diabetes by blood glucose control, reduce insulin resistance and increase insulin sensitivity (9-11). Physical activity is inversely associated with rates of kidney dysfunction among diabetic patients (12,13). Despite this evidence, patients with chronic kidney disease tend to be inactive (14). Youssef and Philips (2016) studied the effect of aerobic and resistance exercise on renal function in patients with diabetic kidney disease (15). The study results indicated that 3 month of resistance exercise, as well as aerobic exercise, had a positive effect on decreasing urea, creatinine, glucose and blood pressure in patients with diabetic kidney disease (15). In another study, however, no significant changes were observed by Leehey et al. (2009) in glomerular filtration rate (GFR), hemoglobin, glycated hemoglobin, serum lipids, or Creactive protein (CRP) after 18 weeks of supervised home aerobic exercise in obese diabetic patients with chronic kidney disease (16). Recently, Neveen et al. (2019) also reported that serum creatinine and urine creatinine decreased after 8 weeks of moderate-intensity intradialytic aerobic exercise program in patients with diabetic nephropathy, but no significant change in urine albumin and estimated GFR were observed (17). Work is needed to increase awareness of the potential benefits of resistance training (RT) on renal function in patients with type2 diabetes. Thus, the aim of this study was to investigate the effect of 8 weeks RT on renal function in type2 diabetic men.

2. Material & Methods

Study Design

This was an 8-week randomized controlled study. After baseline screening, subjects were randomized to an exercise or control group. Subjects randomized to exercise underwent thrice weekly training for 6 weeks. This research was carried out in compliance with the Helsinki Declaration and was approved by the ethic committee of the Islamic Azad University, Marvdasht branch. Written informed consent was obtained from each participant.

Subjects

Twenty two type 2 diabetic men (Table 1) volunteered to participate in this study. Patients were included if they were diagnosed as having type 2 diabetes for more than 5 years. Patients were excluded if they had poorly controlled hypertension, uncompensated heart failure, cardiac arrhythmia requiring treatment, recent unstable angina, significant valvular heart disease, myocardial infarction within the past 6 months, significant cerebral or peripheral arteriosclerosis, bone disease with a risk for fracture, orthopedic, or musculoskeletal limitations, a recent significant change in the resting echocardiography, third-degree atroventricular heart block without pacemaker, severe aortic stenosis, suspected or known dissecting aneurysm, active or suspected myocarditis or pericarditis thrombophlebitis or intracardiac thrombi, and recent systemic or pulmonary embolus and acute infection. The subject based on their fasting blood glucose were divided into control (n=12) or RT (n=10) group randomly.

Table 1. Anthropometric and body composition characteristics (mean ± SD) of the subjects

	Control (mean ± SD)	**RT (mean ± SD)**
Body weight (Kg)	66.4 ± 7.1	80.1 ± 8.5
BMI (Kg/m^2)	22.9 ± 2.2	27.3 ± 4.2
Body fat (%)	17.0 ± 5.1	21.2 ± 3.5
WHR	0.91 ± 0.01	0.97 ± 0.04

Resistance exercise protocol

In familiarization sessions, all the subjects familiarize with different resistance exercises using weight-training machines and also familiarize with performing the 1-RM test. Maximal strength was determined using a concentric (1-RM). The warm-up consisted of running on treadmill for 5 min, two sets of progressive resistance exercises similar to the actual exercises utilized in the main experiment, and 2-3 min of rest accompanied by some light stretching exercises. After the warm-up, subjects performed the 1-RM test, and the heaviest weight that could be lifted once using the correct technique was considered as 1-RM for all the exercises and used to calculate the percentage of resistance. Subjects executed six resistance exercises selected to stress the major muscle groups in the following order: chest press, leg extension, shoulder press, leg curls, latissimus pull down and leg press. RT consisted of 50-60 min of weight training per day, 3 days a week, for 8 weeks. Each training session was followed by cool-down.

Variables measurement

All patients were initially assessed for their weight and height using weight and height scale to calculate body mass index (BMI), and assessed for their vital signs as well. Waist circumference was determined by obtaining the minimum circumference (narrowest part of the torso, above the umbilicus) and the maximum hip circumference while standing with their heels together. The waist to hip ratio (WHR) was calculated by dividing waist by hip circumference (cm). Body fat percentage was assessed by skinfold thickness protocol. Skinfold thickness was measured sequentially, in triceps, abdominal, and suprailiac by the same investigator using a skinfold caliper (Harpenden, HSK-BI, British Indicators, West Sussex, UK) and a standard technique. Blood samples were taken to measure serum creatinine, glucose and insulin level, and estimated glomerular filtration rate (GFR) using the following formula (18,19):

$$\mathrm{eCcr} = \frac{(140 - \mathrm{age}) \times \mathrm{mass\ (kg)} \times (0.85\ \ \mathrm{if\ female})}{72 \times \mathrm{serum\ creatinine\ (mg/dl)}}$$

Fasting glucose was determined by the oxidase method. Fasting insulin was also determined by ELISA kit (Mercodia, Sweden). The intra and inter-assay coefficients of variation for glucose were $<1.3\%$ and a sensitivity of 1 mg/dl. Insulin resistance was calculated using the HOMA-IR model (20).

$$\text{HOMA-IR} = [\text{glucose (nmol/L)} \times \text{insulin } (\mu\text{U/mL})/22.5]$$

Laboratory investigations (renal function and glycemic status) were carried out for both groups before and after 8 weeks of RT program.

Statistical analysis

Descriptive analysis was used for all measured parameters in the form of mean and SD. Level of significance for all tests was set at P-value of 0.05. Paired t-test and analysis of covariate (ANCOVA) test was used to compare the results of fasting glucose and insulin, insulin resistance and GFR within and between the two groups.

3. Results

Changes in GFR in response to 8 weeks RT in patients with type 2 diabetes are presented in Figure 1. Date revealed that there was no significant change in GFR after 8 weeks of RT (P=0.2).

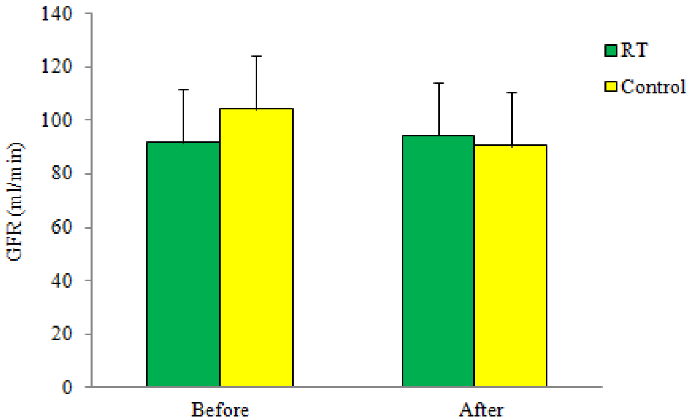

Figure 1. Changes of GFR in response to 8 week RT

Changes in fasting glucose in response to 8 weeks RT in patients with type 2 diabetes are presented in Figure 2. AVCOVA test indicated that fasting glucose was decreased in RT group compare to the control group (P=0.01).

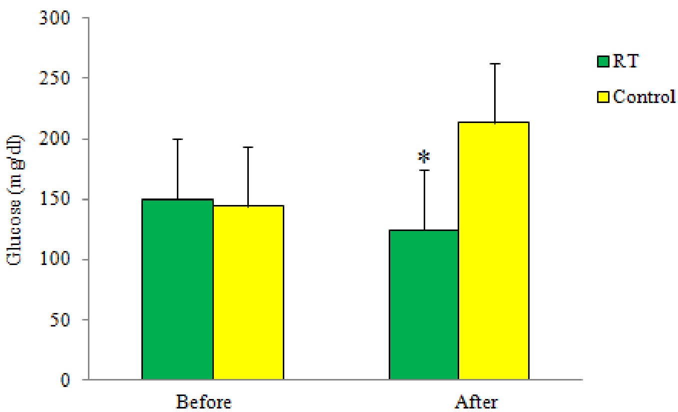

Figure 2. Changes of fasting glucose in response to 8 week RT

Changes in fasting insulin in response to 8 weeks RT in patients with type 2 diabetes are presented in Figure 3. No significant change was observed in fasting insulin after 8 weeks of RT (P=0.6).

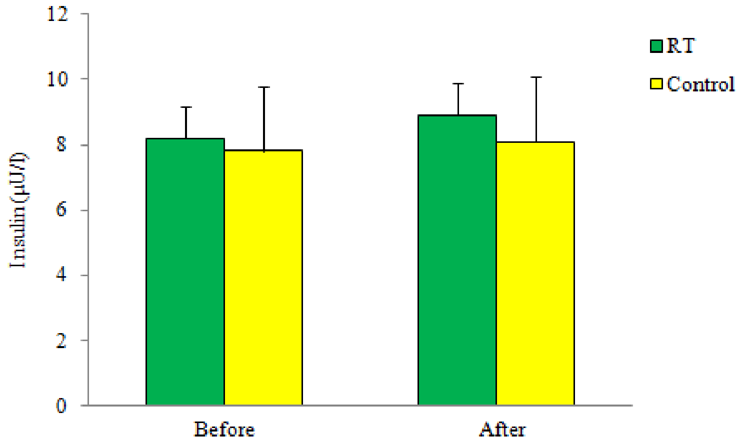

Figure 3. Changes of fasting insulin in response to 8 week RT

Changes in insulin resistance determined by HOMA-IR in response to 8 weeks RT in patients with type 2 diabetes are presented in Figure 4. Results indicated that HOMA-IR was decreased in RT group compare to the control group (P=0.01).

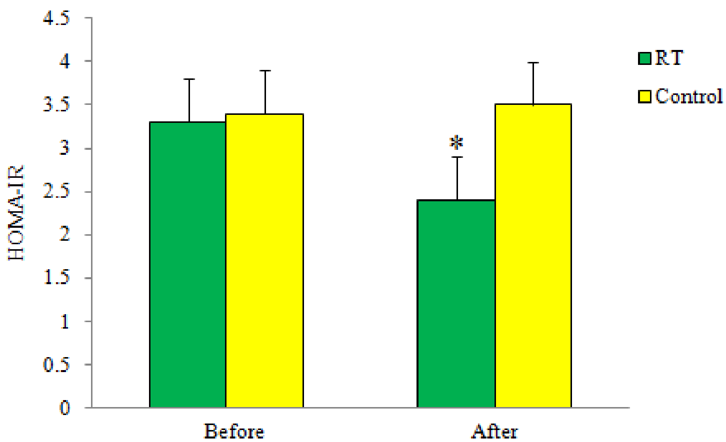

Figure 4. Changes of fasting insulin in response to 8 week RT

4. Discussion

In the present study, the results revealed that although the GFR was increased in RT group compared with control group, there was no significant difference between the two groups. The results of this study are in agreement with a study by Neveen et al. (2019) who studied the effect of intradialytic aerobic exercise on patients with diabetic nephropathy, in that they could not identify aerobic exercise as an important factor for improving GFR (17). Yu et al. (2014) also reported that physical activity is not important factor for reducing albuminurea and estimated GFR (21). In another study by Leehey et al. (2009), no significant changes were observed in GFR, hemoglobin, glycated hemoglobin, serum lipids, or CRP after 18 weeks of supervised home aerobic exercise in obese diabetic patients with chronic kidney disease (16). In addition to these results, the results of Yuji et al. (2012) were in line with this study in that, after 8 weeks of exercise on mice with diabetic nephropathy, there was no significant difference in urine albumin level or GFR value between the study and the control group (despite a slight increase in GFR in the study group and a slight decrease in urine albumin level, but not statistically significant) (22). Moreover, Kurdak et al. (2010) reported that GFR value was decreased after 8 weeks of aerobic exercise in streptozotocin-induced diabetic rats; however no significant difference was observed in albumin in urine level between the study and the control group (23), which coincides with our study result. These discrepancies probably relate to differences in study samples, types of exercise, diabetes and renal dysfunction status. Physical activity can improve patient's quality of life as well. Thus, increased physical activity should be encouraged among patients with diabetes mellitus (17).

The results of present study indicated that although no significant change was observed in fasting insulin after 8 weeks of RT, but fasting glucose and insulin resistance improves after the intervention. Resistance exercise increase insulin effect in skeletal muscle dramatically. The related mechanism involves inconsistencies such as increasing capillary density, increasing the amount of glucose-carrying proteins, especially GLUT4, and shifting to the types of insulin-sensitive myofibrils and possible changes in the composition of sarcolemma phospholipids, increasing glycolic and oxidative enzyme activity, and increasing glycogen activity synthesize (24). Exercise increases the activation of protein kinases with adenosine monophosphate (AMP), which is induced by the increase in translocation of GLUT4 towards surface membranes. Also, AMP-activated protein kinase (AMPK) function increases the glucose transmission via the increase in the rate of GLUT4 on the cellular level in skeletal muscle resistance to the insulin and it mediated the GLUT4 expression effects (24). Indeed, positive changes in blood glucose are mainly caused by collective effects of several times reduction in the rate of blood glucose in each exercise (25). Aerobic exercise could changes the insulin effect on each muscle fibers without the increase in fibers, while resistance exercise preferably improve glucose absorption with the increase in the size of each fibers (26). In fact, repeated contraction of muscles during exercises has an effect as insulin and transmits a high amount of glucose into the cell to produce energy. These repeated contractions increase the number of GLUT4 and membrane permeability to glucose (27).

5. Conclusion

RT improves blood glycemia and insulin resistance however further studies are needed to determine the effect of these training on renal function in patients with type 2 diabetes.

6. Acknowledgment

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Conflict of interests: There are no conflicts of interest.

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