Effects of Exercise Training On The Performance Of Diabetic Heart

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Introduction

Structural and functional abnormalities of the diabetic heart respond favorably to exercise training, and therefore, exercise can be used as an effective cardio protective agent in diabetes [1]. Diabetes induces myocardial tissue damage and diabetic cardiomyopathy (DCM) is manifested by deposition of interstitial collagen in the myocardium [3]. These pathological features compromise the normal contractility and compliance of the diabetic heart [4] Endurance training increases the cardiac output in diabetic rats under high preload conditions [5]. The objective of this study is to characterize the effects of exercise training on the improvement from cardiac dysfunction noted in the untreated insulin-dependent diabetes using high resolution cardiac magnetic resonance imaging (MRI) in rat model of diabetes

Materials and Methods

Twelve male Sprague-Dawley rats (Harlan, Indianapolis, IN) aged 2 months with an initial mean body mass of 250 g were randomly divided into three groups (n=4 per group): 1) sedentary non-diabetic control (SC); 2) sedentary diabetic (SD); and 3) exercised diabetic (ED). The rats in the diabetic groups were given a single intraperitoneal injection of streptozotocin (STZ; 65 mg/kg, Sigma, St. Louis, MO) in 10 mM sodium citrate buffer, pH 4.5. The SC group was treated with the same volume of vehicle. Diabetes was confirmed in the SD and ED groups by measuring the non-fasting plasma glucose level (> 300 mg/dl) two days following the injection.

The rats in the ED group underwent pretraining for a period of 2 weeks prior to diabetes induction followed by 9 weeks of exercise with diabetes. At the end of 9 weeks of diabetes, cardiac MRI was performed using a 9.4 T horizontal bore scanner (Varian Inc., Palo Alto, CA) and 60 mm radio frequency volume coil using 1.5% isoflurane anesthesia delivered in a mixture of air and oxygen (60% and 40%, respectively). After confirming heart position with an initial set of scout images, EKG gated gradient echo based cine images of LV were captured from a short axis view of the heart. The LV was spatially resolved into 6 slices .The cardiac cycle was temporally resolved into 10 equally incremented phases. The following settings were used for image acquisition: TR/TE = 25/2.44 ms, number of averages = 1, field of view = 60 x 60 mm, image matrix = 256 x 256, slice thickness = 2.0mm.

Results and Discussion

Representative cine MRIs are shown in Fig. 1. End-diastolic and end-systolic volumes were significantly improved in ED increased by 29% and decreased by12%, respectively compared to SD (Fig.2). Eventually ED end-diastolic and end-systolic volumes were close to that of SC. Stroke volume, ejection fraction, and LV output were significantly improved as well in ED changing only by 8%,2% and 5% ,respectively ,while these parameters were changed by 55%,32%,and 58% respectively in SD compared to SC. In conclusion, the MRI-based data obtained in this study show that exercise can rectify the abnormalities seen in cardiac dysfunction in diabetic animals.

References

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Figure 1. Representative cardiac cycle phase images of the third LV slice (from apex) from sedentary control (A), sedentary diabetic (B) and exercised diabetic (C) groups.

Figure 2. LV volumes changes with cardiac cycle phase for SC, SD, and ED.