DYNAMIC CONCENTRIC ACTIVITY CAN INCREASE THE GLUT-1 EXPRESSION ON MUSCLE MEMBRANE ON DIABETIC MICE

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ABSTRAK

Diabetes mellitus adalah gangguan yang mempengaruhi kemampuan tubuh untuk membuat atau menggunakan insulin. Resistensi insulin mengakibatkan penurunan ekspresi GLUT-1 otot diabetes yang menyebabkan fasilitasi ambilan glukosa terganggu. Aktivitas konsentrik dinamik merupakan salah satu model aktivitas berdasarkan jenis kontraksi otot. Penelitian ini berjenis penelitian eksperimental. Instrumen pada penelitian ini adalah alat treadmill (merk: modified colombus treadmill) dengan sudut kemiringan 10 derajat (uphill), kecepatan 21 cm/detik (pilihan kecepatan tertera pada treadmill), dan lama waktu pemberian latihan 16 menit 30 detik (diukur menggunakan stopwatch). Pada penelitian ini, terdapat tiga grup, Normal (K0), DM (K1), DM + Konsentrik Dinamik (K2). Berdasarkan hasil data statistik, nilai korelasi p=0,00 (p<0,05), bahwa ada hubungan yang signifikan antara kadar gula darah dengan GLUT-1. Pengaruh aktivitas konsentrik dinamik pada penderita diabetes dapat meningkatkan jumlah GLUT-1 sehingga dapat menurunkan kadar gula dalam darah. ***(FMI 2018;54:113-115)***

Kata kunci*: Diabetes; konsentrik dinamik; GLUT-1*

ABSTRACT

Diabetes mellitus is a type of a degenerative disorder that affects the body's ability to make or use insulin. The resistance of insulin may affect the decline of GLUT-1 expression of diabetic muscle, causing impaired glucose uptake. Dynamic concentric activity is one of the activity models based on muscle-contraction-type activity. This study used experimental method. The instrument in this study was a treadmill (brand: modified columbus treadmill) with 10-degree slope (uphill), with the velocity of 21 cm/sec (the speed options showed on the treadmill), and the duration of the exercise was 16 minutes and 30 seconds (measured using stopwatch). In this study, there were 3 groups of samples, Normal (K0), DM (K1), and DM + Dynamics Concentric (K2). Based on statistical results of correlation value p=0.00 (p<0.05), there was significant correlation between blood sugar level and GLUT-1. Dynamic concentric activity for diabetics had an effect in increasing the amount of GLUT-1, resulting in decreased blood glucose levels. ***(FMI 2018;54:113-115)***

Keywords*: Diabetic; concentric dynamic; GLUT-1*

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INTRODUCTION

Diabetes mellitus is a type of degenerative disorders that affects the body's ability to make or use insulin. Insulin is a hormone produced in the pancreas that helps to transport glucose from bloodstream into cells, so they can break it down and use it for fuel (Riaz 2009). People who suffer from type 2 diabetes mellitus mostly will encounter translocation and dislocation disorder of GLUT-4 due to the insulin resistance. Insulin therapy of GLUT-4 approach would only give a short-term effect and the patients would still experience hyperglycemia. Insulin resistance in DM inhibits the muscle's responses to insulin stimulation, but they still remain to be able in responding to contraction stimulation (Alessio & Hagerman 2006). The resistance of insulin may affect the decline of GLUT-1 expression of diabetic muscle, causing impaired glucose uptake, and high blood glucose level (hyperglycemia) in basal conditions (Ciaraldi et al 2005).

Dynamic concentric activity is one of the activity models based on muscle-contraction-type activity. The condition of muscle stress due to the contraction in dynamic concentric activity causes the shortening of sarcomere in muscle cells that triggers the activation of a stress protein, the p38 Mitogen Activated Protein Kinase (MAPK), in cells. Activation of p38 MAPK stimulates the translocation and expression of GLUT-1 (the transporter of glucose type 1) to the surface of the cell membrane. Therefore, besides GLUT-4, GLUT-1 can also help to mediate the glucose intake into cells (Xi et al 2001).

The objective of this study was to prove the effect of dynamic concentric activity to increase the expression

of transporter-1 glucose (GLUT-1) in the muscles of experimental animals, which consisted of diabetic mice. The activity in this study can be used as an alternative for diabetics in the form of muscle-contraction-type activity.

MATERIALS AND METHODS

This study used randomized post test only control group design (Zainuddin 2000). The samples in this study were mice recruited using random sampling. The study was conducted for 5 months at the Biochemistry Laboratory of the Faculty of Medicine, Universitas Airlangga, Surabaya. The characteristics of mice used in this study were male-adult mice aged 8-12 weeks, healthy and active, with 25 ± 2 grams body weight. The mice were divided into three groups, nine mice in each group. The control group was the normal group (K0), and diabetes mellitus groups were DM (K1) and DM + Dynamics Concentric (K2) groups.

The tools used in this study were a mice treadmill (modified columbus treadmill) in the Department of Physiology, Faculty of Medicine, Universitas Airlangga, glucometer and stick glucometer (Easy Touch), stopwatch (Diamond), analytical digital scales (Shimadzu). The additional element used in this study was streptozotocin with a dose of 150 mg/kg bw. Four mice were used to determine the maximum slope and velocity in the dynamic concentric activity. The various degree of slopes of the treadmill attempted for the mice were 50, 100, and 150. We assigned 10 degrees-slope on the treadmill for dynamic concentric activity.

The instrument in this study was a treadmill (brand: modified columbus treadmill) with 10-degree slop (uphill), with the velocity of 21 cm/sec (the speed options showed on the treadmill), and the duration of the exercise was 16 minutes and 30 seconds (measured using stopwatch). Initially, the determination instruments were tested to the mice. In the procedure, the mice in K1 and K2 were induced with the streptozotocin to obtain the diabetic mice models. The induction was done intraperitoneally based on the dose needed for each mouse and the induction was only done once (KKAMR 2013). After the induction, on the first night, the mice were given with 10% of dextrose to avoid hypoglycemia. After fourty eight hours post-induction of streptozotocin, the mice were not fed for 6 hours before being treated with dynamic concentric activity.

For the post test of dynamic concentric activity, we obtained the data by cutting the mice's tails of 1 mm from the edge of the tails and the blood was taken, then the quadricep muscles of the mice were also obtained. The data were tabulated and analyzed statistically. We used a computer program of SPSS 17.

RESULTS

Statistical calculation found that the diabetic mice with dynamic concentric activity (K2) had an average number of GLUT-1 expression higher than that in K1. Different between groups test showed that there were significant differences of K0 blood glucose with K1 and K2.

Table 1. Analysis of GLUT-1 descriptions

Groups	Mean±SD	
	GLUT-1 (/15625 μm^2)	Glucose level (mg/dl)
Normal (K0)	-	165.44±4.54
DM (K1)	1.88±0.20	347.33±6.60
DM+ Dynamic Concentric (K2)	2.74±0.50	224.22±5.30

Table 2. Different test between groups

Between Groups	p (sig)
Blood glucose	0.000

Note: $p<0.05$ indicates that there is a significant difference

Table 3. Correlation test between K1 and K2

	N	GLUT-1	p Value (sig)
Blood glucose	18	0.678	0.000

Note: $p <0.05$ shows a significant correlation

Table 3 shows that there is a correlation between blood glucose with GLUT-1. It means the higher the dynamic concentric activity, the higher the GLUT-1 expression, and the lower the blood sugar level.

DISCUSSION

The dynamic concentric activity can give the best impact to decrease the glucose level in mice. The concentric contraction is closely related to the muscle metabolism and the release of Ca2+ ions from the sarcoplasmic reticulum. When a concentric contraction happens, the myosin cross-bridge is attached and the actin protein is closed together, giving the result of sarcoma-shortening. This shortening may result in the contraction of sarcoplasma reticulum and the release of calcium ion substances. This constant shortening also produces the tension in the sarcoma involving the actin and myosin proteins. These two physiological processes of concentric contraction will give stimulation on glucose transporter in muscle cells, thereby it can increase the glucose uptake of the muscle.

This analysis result was in line with the theory which says that the contractions can cause the increasing formation of oxygen radical. Oxygen radicals can also be generated within cells, through superoxide release by mitochondria. The release of the superoxide is stimulated by TNF-α which is released by the muscles themselves (autocrine regulation) (Zhan et al 2006). Exercise can induce the expression of TNF protein which can trigger the intake of glucose into the muscle cells. Exercise causes excessive TNF-α expression in the muscle tissue. On the other hand, TNF-α can be linked into insulin resistance, but parallely, it can facilitate the glucose intake into the muscle cells through signaling insulin mechanism.

One of the stressed-proteins which is activated from the condition of stressed-metabolic in muscle cells is the p38 Mitogen Activated Protein Kinase (p38 MAPK) stressed-proteins. P38 MAPK is a part of the signal of the stressed-oxidative which is generated through the physical stimulation of muscles (Chambers et al 2009). The activation of p38 MAPK stimulates the expression and the translocation of GLUT-1 to cell membrane's surface, so GLUT-1 can also trigger the intake of glucose into the cells (Xi et al 2001).

CONCLUSION

Applying concentric dynamic activity to diabetic patients can increase their GLUT-1 expression in the muscle as well as reducing the blood glucose levels. It also reveals that muscle-contraction-type activity is better than the ordinary activity.

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