20. Shoe Insole For Eccentric Activities On Daily Application Prevents Muscular Damage And Improves Fasting Blood Glucose

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Submission date: 09-Jun-2021 02:06PM (UTC+0800)
Submission ID: 1603286001
File name: Prevents_Muscular_Damage_And_Improves_Fasting_Blood_Glucose.pdf (54.09K)
Word count: 2488
Character count: 13011

SHOE INSOLE FOR ECCENTRIC ACTIVITIES ON DAILY APPLICATION PREVENTS MUSCULAR DAMAGE AND IMPROVES FASTING BLOOD GLUCOSE

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ABSTRAK

Kontraksi eksentrik terbukti dapat memperbaiki ekspresi Glut-1 otot dan kadar glukosa puasa mencit. Kontraksi eksentrik yang sama ditemukan pada manusia saat berjalan atau berlari dengan menggunakan sepatu jinjit. Inovasi terhadap kontraksi eksentrik dengan sepatu jinjit dapat dilakukan dengan menggunakan insole sepatu khusus. Desain insole sepatu bagian belakang dibuat lebih tebal dibandingkan bagian depan. Tujuan penelitian ini adalah untuk mengetahui efek aplikasi insole sepatu model aktivitas eksentrik pada sepatu kerja keseharian terhadap penanda kerusakan otot rangka pasca pemakaian insole. Kerusakan otot rangka diukur berdasarkan kadar sTnI serum. Metode yang digunakan adalah penelitian eksperimental pretest-posttest design. Subjek yang terlibat merupakan wanita pekerja nondiabetes di lingkungan FK Unair, dibagi ke dalam dua kelompok. Masing − masing kelompok mewakili kelompok pemakaian insole 50 dan kelompok pemakaian insole 100. Sudut yang digunakan untuk insole sepatu adalah 50 dan 100. Insole sepatu digunakan setiap hari kerja selama satu minggu. Darah subjek diambil satu hari setelah berhenti memakai insole. Data hasil penelitian menunjukkan kadar glukosa darah puasa (GDP) subjek yang memakai insole 100 memiliki nilai p<0,05. Pemakaian insole sepatu menyebabkan penurunan kadar glukosa darah puasa (GDP). Hasil penelitian ditemukan bahwa kadar sTnI pada kelompok yang memakai insole sepatu 50 dan kelompok insole 100 tidak berpengaruh signifikan terhadap kadar skeletal muscle troponin I sebelum dan setelah perlakuan. ***(FMI 2017;53:233-236)***

Kata kunci*: Kontraksi eksentrik; insole; glukosa darah puasa; sTnI*

ABSTRACT

The eccentric contraction has been proven to improve Glut-1 expression in muscle and fasting glucose levels in mice. The same eccentric contraction occurs in human being when walking or running while wearing high heels. Innovation on the eccentric contraction with high heels can be done by using a specific shoe insole. The design of the rear insole is made thicker than the front. The purpose of this study was to determine the effects of insole use specified for eccentric activities on daily work shoes on the skeletal muscle damage after wearing the specified insole. Skeletal muscle damage was measured based on sTnI level. This was experimental study with pretest-posttest design. The subjects involved were non-diabetic woman workers in Faculty of Medicine of Universitas Airlangga, and were divided into two groups. Each group represented group members who wore 5-degree and 10-degree insoles respectively. The angle used for the shoe insoles were 5° and 10° respectively. These insoles were worn on weekdays for one week. Blood was taken one day after the subjects stop wearing the insoles. Data results showed that the levels of fasting blood glucose (FBG) of subjects who wore the 10-degree insole had a value of p<0.05. The use of insole lead to decreased levels of fasting blood glucose (FBG). This study found that the sTnI levels in the 5-degree and 10-degree insole groups had no significant effect on troponin I skeletal muscle levels before and after treatment. ***(FMI 2017;53:233-236)***

Keywods*: Eccentric contraction; insole; fasting blood glucose; sTnI*

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INTRODUCTION

Eccentric activity is one of the activities used to promote the prevention of diabetes mellitus. Studies on animal doing eccentric activity in the form of running downhill on a treadmill with a declination angle of 5 degrees and 10 degrees proved that the activity fixes Glut-1 expression within the muscles as well as improves fasting glucose levels (Purwanto 2014). On the other hand, the activities which involve eccentric contraction cause skeletal muscle damage. Troponin I skeletal muscle level as a marker of skeletal muscle damage found in blood serum increases significantly 4 hours after the eccentric activity stopped (Sorichter et al 1997).

Eccentric muscle contraction in human being cannot be found as a single activity. Each activity always involves eccentric and concentric muscle contractions. Experiments on the effects of human eccentric contraction have struggled to break the obstacle of finding the appropriate activities which triggers dominant eccentric contraction. One of activities which involves dominant eccentric contraction is inspired by the use of high heels

(Purwanto 2016). The use of high heels is not universal, as this type of shoes nowadays is mostly applicable for women.

The function of additional heel on high heels is transferred to the declination of shoe insoles. The shoes might be flat, but the declination is obtained from the insoles which are thicker at the rear. The insoles were designed to have differences in thickness between the front and rear parts, that forms angles of 5 degrees and 10 degrees respectively. This study aimed to analyze the effects of the use of specifically-designed insoles on the blood glucose level as well as on the markers of muscular damage.

MATERIALS AND METHODS

This was an experimental study with pre-posttest design. The treatment involved in this study was the use of specifically-designed insoles during weekdays for one week. The insoles formed the angled of 5 degrees and 10 degrees respectively. The subjects were divided into three groups, namely control group, treatment group one (5-degree insoles) and treatment group two (10-degree insoles).

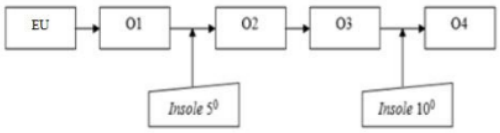

Fig. 1. Flowchart of the study.

Notes:
EU : Experimental Unit
O1 : First observation and subjects' blood sampling before the treatment
O2 : Second observation and subjects' blood sampling after the first treatment
O3 : Third observation and subjects' blood sampling after before the second treatment
O4 : Fourth observation and subjects' blood sampling after the second treatment
Insole 5° : The use of 5-degree insole
Insole 10°: The use of 10-degree insole

The subjects of this study were from the same population, namely the staff of Faculty of Medicine, Universitas Airlangga. The subjects were selected based on preliminary data which showed the subjects' tendency to high blood glucose levels. The subjects were all female and had proportional weights and diverse age. Shoe insoles used were made of super EVA sponge and velvet, and they were inserted into shoe soles to add some degree to the heels. The angles measured were 5 and 10 degrees. The subjects were suggested to fast the night prior to blood sampling. The level of fasting blood glucose and sTnI in blood were tested. Those subjects wore 5-degree insoles for one week; then, their blood was retaken to see the level of fasting blood glucose as well as the sTnI after the use of the 5-degree insole. After that, the subjects wore the 10-degree insoles for one week; and, after a week of wearing the insole, their blood was tested for the third time.

RESULTS

The subjects of this study were all women who had diabetes risk and owned overweight in their body mass index (=25 kg/m^2). The detailed characteristics of the subjects are available on Table 1.

Table 1. Characteristics of research subjects

Mean ± SD			
Age (year)	Weight (kg)	Height (cm)	BMI (kg/m^2)
32.88 ± 8.39	66.63 ± 13.37	156.44 ± 6.43	27.29 ± 5.74

The measurement result of fasting blood glucose level prior to the application of insole (pre-test) was at the threshold of normal human fasting blood glucose level. Hence, the subjects' condition at the time of measurement of fasting blood glucose level prior to the use of the insoles is assumed not to be different from the groups who wore the 5-degrees and10-degrees insoles.

The use of the 5-degree insoles for five weekdays did not cause significant changes to the fasting blood glucose level. Whereas, the use of the 10-degree insoles for five weekdays produced significantly different fasting blood glucose levels during pretest and posttest. The significant different on the 10-degree insole usage indicated the decrease of fasting blood glucose level. The measurement results of the pretest-posttest fasting blood glucose level for both groups as well as the difference test are available in Table 2.

Table 2. Fasting blood glucose transformation after wearing the insoles

Variable	N	Mean ± SD		p Value
		Pretest	*Posttest*	
The use of 5° insole	8	75.75 ± 8.48	71.37 ± 6.65	0.149
The use of 10° insole	8	78.25 ± 6.86	60 ± 6.39	0.000

The measurement results of the sTnI level prior to the insole use (pretest) were at the threshold of normal human serum sTnI level during a break. sTnI human serum level during break is in the range of 2000 pg / ml (Sorichter et al 1997). In this fashion, the condition at the time of sTnI measurement before the use of insole was assumed to be similar with the human condition before performing an eccentric activity (break).

The use of 5-degree and 10-degree insoles on working shoes for five weekdays did not change the sTnI level. The increased sTnI level showed the damage that occurred on skeletal muscular fibers. The unchanged sTnI serum level on the use insole for 5 days indicated there was no damage found in skeletal muscular fibers. The measurement result of of the sTnI level during pretest and posttest for both groups and difference test between them are available on Table 3.

Table 3. Changes on markers of muscular damage (sTnI level) shows significant difference on user 5-degree and 10-degree groups

Variable	N	Mean ± SD		p Value
		Pretest	*Posttest*	
The use of 5° insole	8	2872.42 ± 1549.41	2348.29 ± 904,43	0.400
The use of 10° insole	8	2597.76 ± 1208.55	2877.74 ± 993.32	0.518

The results of sTnI level measurement were confirmed by the measurement results of degree of pain using a Likert scale of muscular soreness. The measurement results of the Likert scale of muscle soreness also indicated no difference, consistent with the sTnI measurement results. The research subject did not complain of pain or complain of any pains with a very low intensity. However, the subject complained of blisters on the skin in the dorsal pedis due to friction with the upper part of the shoes. The measurement results of degree of pain by using a Likert scale is available on Table 4.

Table 4. The measurement results of degree of pain using a Likert Scale of Muscle soreness is not different between the two groups

Variable	N	Mean ± SD	p Value
The use of 5° insole	8	0.500 ± 0.926	0.163
The use of 10° insole	8	1.375 ± 1.506	

DISCUSSION

There were two types of shoe insoles used. The first type was insoles with 5-degree angle 50 and the second type was insoles with 10-degree angle. The shape of the insoles was modified so that the front part was flat and the rear part was elevated to create angles of 5 degrees and 10 degrees. This is in line with some types of shoes that is often prescribed by doctors to patients with diabetes mellitus. The shoes include healing shoes, in-depth shoes, external modification shoes, orthoses or insert, and costume-made shoes (The American Orthopaedic Foot & Ankle Society (AOFAS) 2015). In-depth shoes or shoe insoles is the basis for most prescribed footwear. Generally, it was a type of athletic shoes with additional ¼ to ½ inch of the depth of the shoes. The insoles used are usually light, and are available in various sizes based on the size of the subject's shoes.

Eccentric contraction is an immediate response of eccentric strain that makes the muscles undergo the long additions. If the response is hampered, the muscles will potentially be damaged (Paulsen at al 2010). The use of 5-degree and 10-degree insoles did not statistically show significant increase on muscular damage when compared with the use of insoles on control group. In fact, there was a decrease on sTnI level as the marker of muscular damage on the group that wore the 5-degree insoles. This demonstrated that the use of the 5-degree insoles may generate the amount of muscular force which compensated for gravity, so it may maintain the integrity of the microstructures of the sarcomere from potential damage.

The use of 10-degree insoles did not produce muscular damage, but its application caused blisters on the skin. The use of proper and fitting shoes is important for the patients with early diabetes mellitus to prevent complications. Excessive pressure and friction of the wrong kind of shoes or boots can cause ulceration. Diabetes is the main cause of serious muscular damage in the feet. Diabetes reduces or distorts nerve functions, causing a condition called neuropathy, a condition which causes numbness and loss of sensation. People with neuropathy often do not notice injuries on their legs. Minor wounds or blisters can become infected and develop into ulcers (open sores). Neuropathy can also cause the skin to dry and chapped which makes it more vulnerable to infection. Diabetes also causes poor blood circulation, which can increase the risk for infection and slow down the healing process (Ma 2015). The roles of eccentric contraction in improving performance, efficiency in terms of mechanical and energy saving, on the other hand, causes an increase on blood circulation so that metabolism disorders of carbohydrates, fat and proteins in patients with diabetes mellitus can be improved,

which is characterized by a decrease in fasting blood glucose levels.

This study results are applicable to be used as a reference in the future for shoe manufacturers as well as shoe wearer to determine the height of the pedestal which is good to use, safe, and is also beneficial to health.

CONCLUSION

The use of insole special for eccentric activities with the declination angle of 10 degrees affects the reduction in fasting blood glucose levels. The use of 5-degree and 10-degree insole does not cause muscular damage to wearers.

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