

Effectiveness Combination of Foot Care with Active Range of Motion (ROM) and Plantar Exercise for Reducing Diabetic Foot Ulcer Risk in Diabetes Mellitus Type II

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Received: July 23,2019; Accepted: Aug 28,2019; Published: Sep 3,2019

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Abstract

Diabetic Foot Ulcer (DFU) is a devastating complication of diabetes mellitus and affects 15% of people with diabetes mellitus. Approximately 50-70% all of lower limb amputations are due to DFU. Moreover, DFU causes losses in financial and physical distress. The American Diabetes Association stated that preventive care could decrease DFU risk.

This study aimed to assess the effectiveness of a combination of foot care with active ROM and plantar exercise for preventing DFU and reducing its risks. Thirty-four people with diabetes mellitus type 2 who fulfilled the inclusion criteria were selected randomly and divided to control and intervention groups. They were assessed by questionnaires and observation checklist. The pre-test was assessed using Inlow's 60-second diabetic foot screening tool. All the subjects got daily foot care for two weeks. But subjects in the intervention group got the combination of daily foot care every day and active Range of Motion (ROM), and plantar exercise every two days. The data were analyzed statistically (dependent and independent-test)

The result showed that there was a significant difference before and after intervention in both groups. But the contribution of risk decrease in the intervention group (40.1%) was higher than the control one (14.3%). There was a significant influence of the combination of daily foot care with ROM and plantar exercise (p-value 0.000). This combination of daily foot care with ROM and Plantar Exercise is recommended to prevent the complication of Diabetes Mellitus.

Keywords: Diabetic foot ulcer; Prevention; Foot care; Range of motion; Plantar exercise

Introduction

Diabetes mellitus is a metabolic disorder from insulin resistance that causes increased glucose in blood circulation. [1] In long term condition, diabetes mellitus causes microvascular complication, especially diabetic foot ulcer (DFU) which is a damage condition of the skin that extends to the tissues, tendons, muscle, bone and joint in the people with diabetes mellitus.[2] According to the International Diabetes Federation, in 2017, there were 425 million people age 20-79 suffer diabetes mellitus.

[1,3,4] This prevalence would increase in 2030. The result of basic health research in 2018 showed that 10,9% of Indonesian people suffered from diabetes mellitus. The number increased 2% from the previous five years. It is possible in the next years this prevalence will increase more than it. It is estimated that 15% of people with diabetes mellitus suffered from DFU, and this DFU could cause 50-70% of lower limb amputations[4]. Besides, DFU causes losses in financial and physical distress, especially in productive people.[2] The American Diabetes Association declared preventive care could improve diabetes mellitus condition and decrease the risks associated with DFU. The other diabetic professional organization suggested for preventing DFU as follow; control blood sugar, health education, pharmacological therapies, physical exercises, and foot care for diabetic patients [5,6] In this study, we assess the prevention of DFU by reducing its risk score using daily foot care combined with physical exercises such as active Range of Motion (ROM) and Plantar exercise.

Methods

This study was a Quantitative study using experimental pre and post-test with control group design. The subjects were 34 people suffered from diabetes mellitus type 2. They were divided into two groups – the intervention and control group - and randomly chosen using the lottery method. Inlow's 60-second diabetic foot screening tool used to assess the risk of diabetic foot ulcer on the first day before the intervention was done. All the subjects on both groups got daily foot care, but those in the intervention group got the combination of active ROM and plantar exercise every two days. After 14 days, both groups had been assessed the risk of diabetic foot ulcer using the same tool. All the subjects agreed with the informed consent and had been approved by the Ethics Commission of Medical Faculty of Universitas Islam Sultan Agung (016/B.1-KEPK/SA-FKG/II/2019).

The procedure of foot care consisted of daily foot inspection, washing part of the foot, giving moisturizer, cutting nails as needed, and using safe footwear suggestion. In this study, this

procedure on the intervention group was combined with active range of motion (ROM) and plantar exercise every two days. Active ROM procedure covered flexion-extension-adduction-abduction in the hips and toes, flexion-extension of the knees, dorsiflexion and plantar flexion in the ankles, and inversion-eversion of the legs. Whereas plantar exercise was done using a tennis ball that is moved forward, backward, and rotated along of plantar for approximately five minutes. The data were statistically analyzed.

Results

Based on [Table-1], most DM patients were women (88%).

The age of DM patients was mostly in the range of 40-60 years (79.5%) with the minimum age is 33 years old, and the maximum age is 69 years old. Based on socio-demographic characteristics, the overall data in the group was homogeneous ($p>0.05$). Beside of these characteristics, there were confounding factors that possible associated with the risk of diabetic foot ulcers such as duration of illness, diet, therapy, blood glucose, and blood pressure condition. All of the confounding variables had p -value >0.05 , so their variables didn't affect the score of DFU risk.

Table 1: Socio-Demographic Characteristic and Confounding Variable of Study Participants

Characteristic	Control group (n=17)		Intervention group(n=17)		Total		p
	n	%	n	%	n	%	
Socio-Demographic Characteristic							
Gender							1
Male	2	11.8	2	11.8	4	11.8	
Female	15	88.2	15	88.2	30	88.2	
Age (Mean SD)	51±10.95		54± 3.84		53±8.29		0.072
Minimum - maximum	33 - 69		45 - 63		33 - 69		
21 – 40 years old	3	17.6	0	0	3	8.8	
41 – 60 years old	11	64.7	16	94.1	27	79.5	
61 – 80 years old	3	17.6	1	5.9	4	11.7	
Job							0.735
Office employee	2	11.8	2	11.8	4	11.8	
Farmer	5	29.4	3	17.7	8	23.5	
Housewife	10	58.8	12	70.5	22	64.7	
Confounding Variable							
Duration of DM							1.00*
≥ 10 years	4	23.5	5	29.4	9	26.5	
< 10 years	13	76.5	12	70.6	25	73.5	
Diet							
Yes	9	52.9	10	58.8	19	55.9	0.35*
No	8	47.1	7	41.2	15	44.1	
Pharmacology Therapy							
Sulfonylurea	5	29.4	3	17.6	8	23.5	0.34*
Biguanida	4	23.5	5	29.4	9	26.5	
Insulin	1	5.9	0	0	1	2.9	
No Therapy	7	41.2	9	53	16	47.1	
Blood Glucose (mg/dL)	234±72,38 (115-382)		241±102,69 (85-451)				1.00*
Systole Blood Pressure	121 ±16,14 (95 – 157)		124 ±12,55 (105-150)				0.56*
Diastole Blood Pressure	80 ±7,9 (70 – 100)		82 ±14,26 (70 – 135)				1.00*
*p-value of correlation 0.05 significant							

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According to [Table-2], the reduction of DFU risk in the intervention group (3.65) was higher than in the control group (1.03) and significantly reduced DFU risk (p-value 0.000).

Knowing the effect of the intervention, it should be tested the difference of DFU risk reduction in-between group, as described in the following [Table-3]

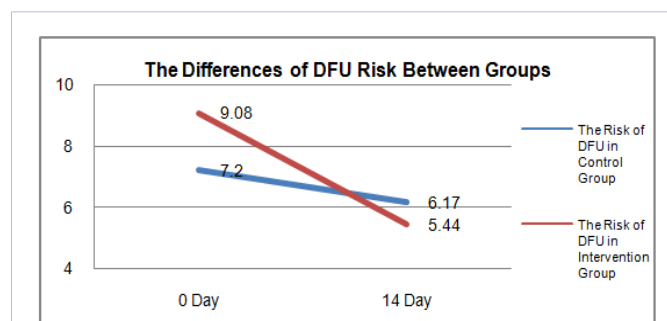
Table 2: The Differences of Diabetic Foot Ulcer Risk between Pre and Post-test within Groups

Variable	Control Group			Intervention Group		
	Mean±SD	<i>A</i>	<i>p</i>	Mean±SD	<i>A</i>	<i>p</i>
DFU Risk Pre-test	7.20±1.76	1,03	0,000	9.09±2.08	3,65	0,000
DFU Risk Post-test	6.18±1.40			5.44±1.21		

Table 3: The Differences of Diabetic Foot Ulcer Risk between the Control and Intervention Group

Variable	KelompokKontrol		KelompokIntervensi		<i>p</i>
	Mean±SD	Min-Max	Mean±SD	Min-Max	
DFU Risk Pre-test	7,20±1,76	4,5 – 10,0	9,08±2,08	6,5 – 13,0	0,005
DFU Risk Post-test	6,17±1,40	4,0 – 9,0	5,44±1,21	3,5 – 8,0	0,112
<i>ΔDFU Risk</i>	1,03±0,93	0,0 – 3,5	3,65±1,27	1,5 – 6,0	0,000

There was a significant difference between the reduction score of DFU risk of the control and intervention group (p-value 0.000). The effectiveness of the reduction could be seen in the following graph (Graph-1). We could see that the DFU reduction on the intervention group (red line) was decreased sharply compared with the control group (blue line). The reduction of DFU risk on the intervention group was higher (40.1%) than the control group (14.3%).



Graph 1: The effect of DFU reduction between the control and intervention group

Discussion

Diabetes Mellitus

In this study, most of the subjects were female in the range of 40-60 years old. Based on gender, the female had three to seven times the risk of DM compared to male[7,8] due to the lipid level in female (20-25%) was higher than male (15-20%). Previous studies also found an association between gender and diabetes mellitus[4,9]. The higher the lipid level (LDL and triglyceride) was, the more the presence of callus and claw toes which was determinant in the development of a diabetic foot ulcer risk[4]. Based on ages, the previous study described that there was glucose intolerance on the age of 40-60 years old due to the aging process of beta cell in the pancreas[10].

Meanwhile, we found most of the subjects were housewives. It was in line with previous studies that explain DM patients type II was dominated by the housewives who had free time and mild activities. Another study also described that the lifestyle of housewives was influenced by socio-economic changes and diet imbalance that affect health, nutrition, and metabolism of their body[9,11].

Diabetic Foot Ulcer (DFU) Risk

Hyperglycemia condition could be the starting point of DFU risk. Chronic hyperglycemia could cause disturbances on sensory and motoric nerves and developed into neuropathy. Neuropathy on motoric nerves could decrease foot muscles, make them imbalance and atrophy. It could make the changes in the foot's structure. Besides, hyperglycemia condition could increase the free radicals that damage the endothelial cells of blood's vessels. This condition could decrease the blood supplies to peripheral tissues and become DFU risk [12].

The assessment of DFU risk includes gender, ages, time of suffering from Diabetes Mellitus, blood glucose level, blood's pressure, the obedience of anti-diabetic treatment, physical activities, and foot care. Inlow's 60-second diabetic foot screening is the instrument to assess DFU risk. This instrument consists of twelve questions about DFU risk's indicator [13].

In this study, there were confounding variables that measured and controlled by stratification methods, such as duration of illness, diet, blood glucose level, and blood pressure. Statistically, those confounding factors were not contributed to reduce DFU risk (p-value>0.05).

The reducing of DFU risk happened in the control and intervention groups due to the daily foot care.

Daily foot care and its combination

Daily foot care is primer prevention for diabetic foot ulcer that consists of a series of activities, such as foot's observation for

detecting early abnormalities on diabetic foot, maintaining nails, using good footwear, maintaining the foot's hygiene and physical activities[14,15]. Nowadays, daily foot care has been developed with the addition of foot's gymnastic for thirty minutes. Embuai (2018) found that daily foot care combined with foot's gymnastic could decrease DFU risk 87%[15].

In this study, daily foot care was combined with ROM and plantar exercise. Statistically, the decrease of DFU risk on the intervention group was more effective than the control group. The reduction of DFU risk on the intervention group was higher (40.1%) than the control group (14.3%). Some literature said that active ROM on diabetic foot could minimize DFU risk because it could maintain the joint's mobility and prevent muscle's deformity and atrophy[16]. Active ROM method covers the movement of lower side joints, including hips joint, knees, ankles, and also the condyloid radius of the foot[17].

Meanwhile, plantar exercise could stimulate the muscles on plantar or soles by using arch ball roll method. This combination could stimulate the foot's muscles to contract and compress blood's vessels to increase blood's supplies to peripheral tissues [18]. It causes more open capillary nets and more insulin receptors available and active to facilitate blood glucose entry into cells, so the blood glucose level was decreased and reduce the risk of DFU complications[16,19]. The daily foot care could decrease DFU risk significantly, but the combination of daily foot care with ROM and plantar exercise could decrease 40.1 % higher than daily foot care itself (14.3%). Hence the combination of foot care with active range of motion and plantar exercise on reducing diabetic foot ulcer risk was found to be effective.

Acknowledgement

There is no funding support for this study.

Declaration

All authors declared there is no conflict interest in this study. All the subjects agreed with the informed consent and had been approved by the Ethics Commission of Medical Faculty of Universitas Islam Sultan Agung (016/B.1-KEPK/SA-FKG/II/2019).

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