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Submission date: 18-Oct-2022 06:06AM (UTC+0700)
Submission ID: 1928114549
File name: Takdir_Tahir_Saldy_Yusuf__Enfermeria_2021.pdf (299.29K)
Word count: 2318
Character count: 10627

Enfermería Clínica 31 (2021) S709–S712

ELSEVIER

Enfermería Clínica

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ORIGINAL ARTICLE

The effect of Buerger Allen exercise and the provision of oral vitamin C toward the improvement of peripheral tissue perfusion and healing of diabetic foot ulcers☆

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Received 4 January 2021; accepted 19 July 2021

KEYWORDS
Buerger Allen exercise;
Foot ulcer;
Peripheral perfusion:
Vitamin C

Abstract
Objective: To determine the effect of Buerger Allen exercise (BAE) and oral vitamin C provision toward the improvement of peripheral tissue perfusion and wound healing of diabetic foot ulcer (DFU).
Methods: The research used quantitative methods with pre and post-experimental designs without control. The respondents in this study were 30 people with DFU in a Public Health Center, Barru, Eastern Indonesia. Our independent variables were Burger Allen exercise (BAE) and oral vitamin C provision. Meanwhile, the dependent variable is peripheral tissue perfusion, which evaluates by the Ankle Brachial Index (ABI) and wound healing using a diabetic foot ulcer assessment score (DFUAS). Participants allocated into three groups (BAE, Ester C, and BAE+Ester C).
Results: The ABPI value significantly increase in the BAE group (p:0.010), and BAE+Ester C (p:0.013) in day 14. Meanwhile, the DFUAS score also significantly improve at BAE group (p:0.024), and BAE+Ester C (p:0.001).
Conclusion: BAE combined with oral vitamin C can improve peripheral tissue perfusion and accelerate wound healing of DFU.
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☆Peer-review process of the 3rd International Nursing & Health Sciences Students & Health Care Professionals Conference (INHSP) 2019 is under the responsibility of the scientific committee of the 3rd International Nursing & Health Sciences Students & Health Care Professionals Conference (INHSP).
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https://doi.org/10.1016/j.enfcli.2021.07.022
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Introduction

One of the acute complications of diabetes mellitus (DM) is the development of diabetic foot ulcer (DFU), which associated with infection and foot deformities to amputation of limbs.[1] The incidence of DFU is around 12%, while the risk of it is approximately 55.4%.[2] Other studies show that the epidemiology and implications of DFU occur every 20 s in the world; neuropathic diabetic affects almost 50% and increases DFU morbidity, amputations, and 85% faster mortality.[3]

One etiological factor of DFU is the decrease of capillary and arterial blood flow.[4] Currently, Buerger Allen exercise (BAE) proposed as an intervention to increase peripheral blood flow.[5] Prompt and regular movements increase vascularity of blood vessels, leading to increasing the supply of blood in the tissues.[6] Another issue related to damages to endothelial blood vessels, so tissue perfusion to the distal, can cause ulcers.[7] The provision of non-enzymatic vitamins can reduce oxidative stress in patients with DM.[8] The provision of vitamins is significant as an inhibitor of oxidative damage in the body, including vitamin C.[9] So far, there is no combination approach to both BAE and supplementation of vitamin C to manage peripheral tissue perfusion in DFU. Therefore, the purpose of this study is to determine the effects of BAE and oral vitamin C provision (Ester C) against peripheral tissue perfusion of DFU.

Methods

The study design was a pre-test and post-test without control. This research was conducted at two Public Health Center in Barru, eastern Indonesia. The total sample was 30 participants, which allocated in three intervention groups (BAE, oral Ester C, and combination BAE and oral Ester C). The inclusion criteria were DFU patients aged >18 years, having normal blood pressure, having ABPI value <0.9 mmHg. The exclusion criteria were DFU patients with comorbidities, such as heart disease, lung disease, kidney disorders, and patients with a decreased level of consciousness. This research has obtained ethical clearance from the Medical Faculty of Hasanuddin University (Makassar, Indonesia) number 1214/UN4.6.4.5.31/PP36/2019.

BAE Procedures performed in the supine position, and the position of both legs were elevated 45° supported by the pillow for 5 min, stretched back for 5 min, then lowered to hang on the side of the bed or sit in a chair for 5 min, then returned with the supine position with the legs covered for 5 min. Was given for 20 min 2 times a day for 14 days. Vitamin C (oral Ester C) 320 mg was given two times (morning and evening) 14 days. The measurement of ABI was done using an ultrasound doppler. The ABI measure three times (day 6th and 14th day) after the intervention of BAE. Meanwhile, the healing process of DFU measured by the Indonesian version of DFUAS scale,[10] the validity of DFUAS has reported in

Table 1 The characteristics of demography, health, DM, and DFU status.

Variable	BAE		Ester C		BAE & ester C		Total		*p*
	(n:10)	%	(n:10)	%	(n:10)	%	(n:10)	%	
Age (years) (mean ± SD)	57.6	±6.8	58.4	±6.5	61.9	±7.5	59.3	±68.3	0.897
Gender									
Male	5	50.0	2	20.0	1	10.0	8	26.7	0.653
Female	5	50.0	8	20.0	9	90.0	22	73.3	
Blood pressure									
Systole (mmHg) mean ± SD	114.9	±36.2	123.3	±22.4	130.0	±10.5	123.3	±22.4	0.103
Diastole (mmHg) mean ± SD	82.7	±4.7	81.0	±4.5	758.5	±3.3	81.0	±4.5	0.456
Weight (kg) mean ± SD	55.4	±5.6	50.4	±5.5	48.3	±3.5	50.4	±5.5	0.066
Blood glucose (mg/dl) mean ± SD	254.0	±53.5	292.0	±59.1	265.1	±63.3	292.0	±59.1	0.485
DM duration									
<5 year	6	60.0	4	40.0	4	40.0	14	31.8	0.773
5–10 year	3	30.0	5	50.0	4	40.0	12	27.3	
>10 year	1	10.0	1	10.0	2	20.0	4	13.3	
DFU duration									
5–6 months	2	20.0	–	–	1	10.0	3	10.0	1.219
2–3 months	3	30.0	2	20.0	2	20.0	7	23.3	
<2 months	4	50.0	8	80.0	7	70.0	20	66.7	
Etiology of DFU									
Traumatic	4	40.0	1	10.0	2	20.0	7	23.3	0.277
Non-traumatic	5	50.0	8	80.0	7	70.0	20	66.7	
Unknown	1	10.0	1	10.0	1	10.0	3	10.0	

Table 2 The differences of ABI value in the groups of BAE, Ester C, a combination of BAE+Ester C.

Group	Days of observations			*p*
	Mean(SD)			
	Day 0	Day 6	Day 14	
BAE (n:10)	0.74 ± 0.096	0.88 ± 0.047	0.97 ± 0.045	0.010
Ester C (n:10)	0.81 ± 0.084	0.91 ± 0.042	0.96 ± 0.017	0.430
BAE+Ester C (*n* = 10)	0.77 ± 0.045	0.91 ± 0.042	1.01 ± 0.043	0.013

Table 3 The wound healing process based on the DFUAS score.

Group	Days of observations			*p*
	Mean(SD)			
	Day 0	Day 6	Day 14	
BAE (n:10)	37.20 ± 3.55	32.10 ± 3.87	27.20 ± 4.78	0.024
Ester C (n:10)	36.80 ± 3.45	31.00 ± 5.98	27.20 ± 4.78	0.012
BAE+Ester C (*n* = 10)	36.40 ± 2.45	30.00 ± 1.76	20.20 ± 2.25	0.001

Indonesia.[11] The DFUAS score measured three times (day 6th and 14th day).

Results

We included the 30 participants. The mean of the age is 59.3 ± 8.3, male (*n* = 8, 26.7%) and female (*n* = 22, 73.3%). The mean of the blood pressure systole is 123.3 ± 22.4 mmHg, and diastole pressure 81.0 ± 4.5 mmHg with the mean of the weight is 50.4 ± 5.5 kg. The duration of DM mostly <5 years (*n* = 14.31.8%), 5–10 years (*n* = 12, 27.3%), and >10 years (*n* = 4, 13.3%). The most causes of DFU is non-traumatic (*n* = 20.66.7%) (Table 1). There were significant changes in the ABI value in the three intervention groups, in the BAE group (*p*:0.010), in the Ester C group (*p*:0.430) and the BAE+Ester C group (*p*:0.013) (Table 2). While in the wound healing process based on DFUAS, found in the BAE group (*p*:0.024), the Ester C group (*p*:0.012) and in the BAE+Ester C (*p* = 0.001) (Table 3).

Discussion

We found there is an improvement of the ABI value in the BAE+Ester C group. Our finding consistent with the previous study that BAE are a useful intervention in the management of peripheral arterial disease.[12] BAE also enables one to restore the limb function and improve the quality of life.[13] Practicing BAE twice a day shows that there is a significant increase in perfusion in the lower limb.[14] One of the potential answers that BAE associated with arterial dilation and the increase of permeability that allows glucose absorption by muscle cells.[15]

Thus, it recommended to performed BAE regularly and repeatedly.[16] Regarding the wound healing process, we found that the DFUAS score improves significantly in three groups. It has been known that various factors affect the wound healing process, including local and systemic factors. The local factors directly affect the ulcer condition, while systemic factors are overall conditions or specific diseases that can affect ulcer healing, including hormones, stress, other diseases, and nutrition.[17] Implementation of BAE might be contributing to the wound healing process by increasing local peripheral blood flow. We note some limitations regarding the current study-small sample size, which affects the power analysis and short-term observation. Therefore, we recommend a multi-site study with a long-term prospective study will increase the evidence of BAE.

Conclusion

BAE combined with oral vitamin improve peripheral tissue perfusion and accelerate wound healing of DFU.

Conflict of interest

The authors declare no conflict of interest.

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