



Original Article

The Comparison of the Effects of Contrast Bath on Circulation of Contralateral Lower Limb in Type 2 Diabetic and Healthy Women

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ABSTRACT

Background: Contrast bath is a thermal agent that is used as alternative heat and cold water on a target limb. Type 2 diabetes mellitus in long term leads to vascular insufficiency. It seems that contrast bath is useful for patients with diabetes mellitus due to the increase in blood flow and vascular pumping. The purpose of this study is to investigate the effect(s) of contrast bath on circulation of contralateral lower limb in women with type 2 diabetes mellitus compared to healthy subjects.

Methods: Fifteen diabetic females aged between 30-60 years, who were diagnosed with type 2 diabetes, and 30 matched control females participated in this research. The oral temperature, skin temperature of the first web space of the foot, and the pulse of dorsalis pedis artery were measured and recorded. These results were evaluated prior to, immediately and 10 minutes after the contrast bath. The contrast bath protocol included the immersion of the right foot in the warm bath (38-44 °C) for four minutes and then in the cold bath (10-18 °C) for one minute. These processes were repeated five times as the total duration of the intervention was 24 minutes. The treatment was started and terminated with warm water. Repeated measures and independent t-test were used for data analysis.

Results: The dorsalis pedis pulse was significantly higher at all times of the measurements except between immediately post the contrast bath and after 10 minutes of applying it in the diabetic group ($P=0.58$). The results of the skin temperature measurement demonstrated incremental changes in the healthy and the diabetic groups. The oral temperature at all times was not significantly different in the normal and the diabetic groups ($P>0.05$).

Conclusion: The results of this study showed that contrast bath can increase circulation in the contralateral limb. However, its influence on superficial and deep blood flow is uncertain.

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Introduction

Contrast bath is a thermal treatment modality that is used as alternative heat and cold water on a target limb [1-3]. The alternative temperature of the water leads to

increase in blood flow and vascular pumping. Reduction of pain, stiffness, edema and increase in mobility are the effects of contrast bath [1,4]. Various methods for the application of contrast bath are mentioned in the literature, according to change of time, temperature and total treatment duration [5-7]. Petrofsky et al. believe that the effects of contrast bath on increase of circulation are more effective than immersion in warm water bath alone [8,9]. Contrast bath as an alternative heat and cold

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modality enhances skin circulation and leads to more vasodilatation than warm bath alone [8,10]. This modality can increase superficial blood flow, but its effects at the intramuscular level are not obvious [5,8]. It seems that this treatment is useful for patients with circulatory deficiency such as diabetes mellitus [8].

Type 2 diabetes mellitus is a common chronic metabolic disease. The long term complications of this disease involve the eye, kidney, nerve and blood vessels [11]. Diabetes mellitus leads to vascular endothelial damage. Therefore, blood flow decreases in these patients as compared to healthy individuals [8,12,13]. The impairment of the autonomic nervous system because of damage to the neurons, synapses, sensory receptors and blood vessels is another complication of diabetes mellitus. The nutrition of body tissues is provided by blood flow, and so the damage of blood vessels has a serious impact on different organs. As a result of neuropathy and sensory impairment in diabetic patients, the use of long term heat is dangerous. A previous study has shown that higher oral temperature is a characteristic of type 2 diabetic patients [14]. As an increase in vasodilator activity after exercise lead to decrease in vascular resistance and increase in blood flow in the contralateral limb, we assume that a similar mechanism occurs with the use of contrast bath [15].

According to our knowledge, the effects of contrast bath on contralateral limb circulation have not been evaluated till now. Therefore, this study aims to investigate the effect(s) of contrast bath on circulation of the contralateral lower limb in women with type 2 diabetes mellitus in comparison to healthy subjects. It is hypothesized that applying contrast bath on the unaffected limb may have beneficial effects on affected limb circulation and accelerate the healing process of diabetic ulcer.

Methods

Fifteen diabetic females aged between 30-60 years diagnosed with type 2 diabetes and 30 control females of matching age participated in this experimental, case-control study similar to previous researches [8,9]. Both the healthy participants and the diabetic patients were included as per convenience sampling. The diabetic patients were referred to an endocrinologist, who checked the eligibility factors, and all the patients used oral tablets for diabetes control. The exclusion criteria were the presence of sensory neuropathy, lower limb vascular disease, heart disease, infectious disease and any ulcer in the lower extremity. The study was approved by the local

Ethics Committee. All the participants were informed about the procedure, and they signed a detailed formal consent prior to the study.

Oral temperature measurement is a noninvasive and accurate method for measuring body temperature, and it was measured by an oral thermometer placed under the tongue for three minutes [16,17], and skin temperature of the foot first web space was measured by a digital thermometer (BeurerFieberthermometer, FT 09/1, Germany). Also the pulse of dorsalis pedis artery was measured and recorded in accordance with previous studies [18-20]. Palpation of this artery as a quick and reliable method was demonstrated earlier by some researches [19,21].

Test-retest was used for validating the measurements. The outcome measures (skin temperature, oral temperature, and pulse of dorsalis pedis artery) were evaluated prior to the contrast bath, immediately after it and 10 minutes after that. For contrast bath protocol, the right foot was immersed in the warm bath (38-44 °C) for four minutes and then in the cold bath (10-18 °C) for one minute [5]. These processes were repeated five times as the total duration of intervention was 24 minutes. The treatment was started and terminated with warm water [5].

During intervention, all the subjects were in the sitting position. As the procedure was performed on the right foot, the measurements were taken on the left side.

Statistical Analysis

According to Shapiro-Wilk test, the distribution of all the data was normal except for oral temperature. Therefore Repeated Measures and Independent-t-test were used for statistical analysis by SPSS software (SPSS, version 16, SPSS Inc. Chicago, IL, USA). The statistical significance was defined at $\alpha=0.05$. The Bonferroni correction was used for determining the level of significance.

Results

Fifteen diabetic females aged between 30-60 years diagnosed with type 2 diabetes and 30 control females of matching age participated in this research. Table 1 shows the mean \pm SD of variables prior to, immediately after and after 10 minutes of applying contrast bath.

To determine the level of differences for dorsalis pedis pulse (in both groups) and skin temperature (in healthy subjects), the t-test analysis with Bonferroni correction was used.

Although the results of the present study showed an

Table 1: Comparing mean of pulse of dorsalis pedis, skin temperature and oral temperature

Variables	Groups	Mean \pm SD			P value
		Pre	Immediately Post	After 10 minutes	
Dorsalis Pedis Pulse	Healthy	83.86 \pm 13.82	90.46 \pm 12.67	87.23 \pm 13.06	0.000*
	Diabetic	92 \pm 9.26	98.53 \pm 9.78	97.53 \pm 9.67	0.001*
Skin Temperature (°C)	Healthy	33.82 \pm 1.12	34.07 \pm 1.15	33.41 \pm 1.13	0.002*
	Diabetic	33.28 \pm 1.57	33.91 \pm 0.87	33.36 \pm 1.11	0.073
Oral Temperature (°C)	Healthy	37.28 \pm 0.72	37.35 \pm 0.7	37.31 \pm 0.72	0.132
	Diabetic	40.44 \pm 0.61	40.49 \pm 0.58	40.48 \pm 0.58	0.372

*Significant differences at 0.05 levels

increasing trend in all the variables immediately after the contrast bath, this pattern was reversed after 10 minutes. However, they were more than the initial values.

According to Tables 1 and 2, the dorsalis pedis pulse was significantly different at all times of measurements in the healthy and the diabetic groups expect between immediately post and after 10 minutes of applying the contrast bath in the patient group (P=0.58). This finding shows the increase of dorsalis pedis pulse was maintained as long as passing time. The results of skin temperature measurement demonstrated increment changes in the healthy and the patient groups. The oral temperatures at all times were not significantly different in both groups (P>0.05).

The results of the independent-t-test analysis show that in contrast to skin temperature, the pulse of dorsalis pedis artery and the oral temperature were significantly different between the patient and the control groups at all times. However, the mean differences in variation of skin temperature between the groups were not significant (P<0.05) (Table 3, Figures 1-3).

Although the dorsalis pedis pulse before the treatment was different between the groups (P=0.025), in post-test and after 10 minutes of applying the contrast bath, the differences between the two groups were still significantly different (P=0.036, P=0.005, respectively); however, at all times, the mean differences between the two groups were

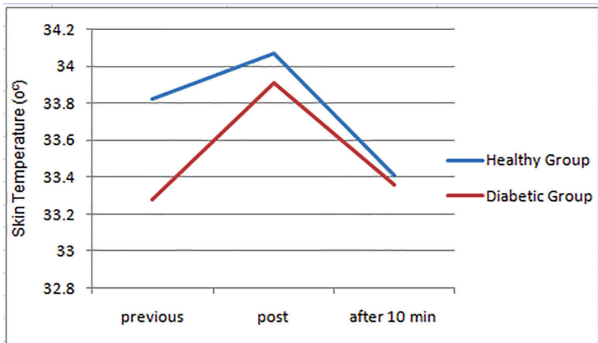


Figure 1: The comparison of skin temperature between the groups

not significant (P>0.05) (Table 3, Figure 2).

It seems that the pattern of skin temperature was somewhat similar to the dorsalis pedis pulse.

The results of the present study demonstrated higher oral temperature of diabetic patients during the three times of measurement.

Discussion

The aim of this study was to investigate the effect(s) of contrast bath on contralateral lower limb circulation in women with type 2 diabetes mellitus in comparison to healthy individuals.

The results of Tables 1 and 2 revealed that the dorsalis pedis pulse immediately and 10 minutes after the contrast

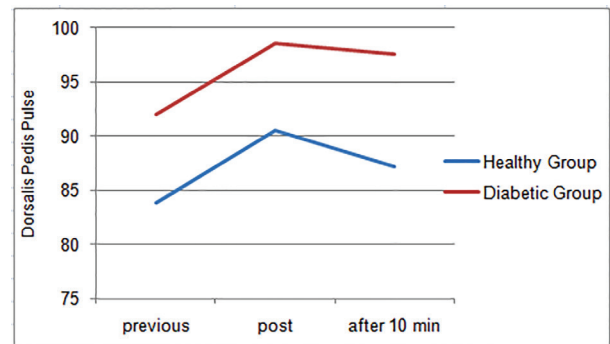


Figure 2: The comparison of dorsalis pedis pulse between the groups

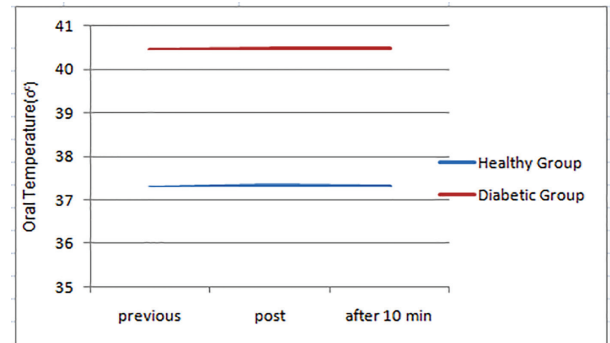


Figure 3: The comparison of oral temperature between the groups

Table 2: The level of differences for significant variables of Table 1

Variables	Groups	P value		
		Immediately Post & After 10 min	Pre & After 10 min	Pre & Immediately Post
Dorsalis Pedis Pulse	Healthy	0.001+	0.014+	0.001 +
	Diabetic	0.586	0.003+	0.001 +
Skin Temperature (°C)	Healthy	0.001*	0.028*	0.220

+Significant differences at 0.016 levels according to Bonferroni correction

Table 3: Comparing the differences of mean of dorsalis pedis pulse, skin temperature and oral temperature between the groups

Variables	Groups	Mean Difference	P value	Mean Difference	P value	Mean Difference	P value
		Pre & Post		Pre & after 10 min		Post & after 10 min	
Dorsalis Pedis Pulse	Healthy	6.6±5.9	0.967	3.34±7.06		3.23±5.01	0.223
	Diabetic	6.53±2.87		5.53±5.97	0.314	1±6.93	
Skin Temperature (°C)	Healthy	0.25±1.07	0.301	0.41±0.96		0.65±0.7	0.619
	Diabetic	0.63±1.33		0.09±1	0.118	0.55±0.62	
Oral Temperature (°C)	Healthy	0.07±0.21	0.670	0.03±0.22		0.04±0.1	0.243
	Diabetic	0.05±0.15		0.04±0.19	0.923	0.006±0.06	

*Significant differences at 0.016 levels according to Bonferroni correction

bath were significantly higher than prior to it in the healthy group, but there was no significant difference between immediately post contrast bath and after 10 minutes in the patient group. The finding showed the increase of dorsalis pedis pulse was the same with passing time. Although this variable was decreased after 10 minutes, this amount was still higher than before the modality in both groups. These results coincide with those of Petrofsky's study [8].

The skin temperature was higher immediately after contrast bath in both groups, although the mean differences were not significant.

As skin temperature is related to skin blood flow, any changes in that characteristic lead to variations in this variable. Therefore, higher skin temperature is related to rise in skin blood flow. Therefore, the increase in skin temperature after the contrast bath can be the result of increased circulation in the contralateral limb. Although a decrease of limb circulation after 10 minutes led to drop in the temperature, these values remained higher than before in the patient group. This finding might be one of the important points of the current research as mentioned in the context of continuing of treatment effects.

The use of oral temperature in measuring core body temperature is popular in many clinics.

According to Mazerolle's systematic review, oral temperature is not an accurate measurement of core body temperature [22]. In type 2 diabetic patients, the core is defective as an endothelial dysfunction [23]. Therefore, no significant changes at any of the test times of this study may relate to these issues. Due to reduced general blood flow through time, we can explain why the oral temperature after 10 minutes was not significantly higher than that prior to the modality. Other researches have also accepted that contrast bath therapy leads to peripheral changes in circulation, and do not have considerable effects on the core temperature [24,25].

As mentioned in Table 3, the mean differences of all the variables were not significant between the two groups; However, there were significant differences between the participants in the variables prior to the contrast bath therapy, except in skin temperature ($P=0.245$). Despite the significant differences of dorsalis pedis pulse and oral temperature during testing, the skin temperature was not significantly different between the two groups ($P>0.05$). According to the results, the increase in pulse and temperatures immediately after intervention could be the reason for the increase in contralateral limb circulation. As the increased pulse and oral temperature have more obvious changes as shown in the present study, it could be concluded that these alterations were due to increased deep blood flow. It is in contrast to the findings of Breger Stanton et al. These researchers believed that contrast bath leads to increased superficial blood flow and skin temperature [5].

Though the differences of the mean were not significant between the two groups, the pulse of dorsalis pedis artery in the diabetic patients was more than in the healthy individuals immediately and after 10 minutes of using the contrast bath ($P=0.036$ and $P=0.005$, respectively). Skin temperature values showed no significant changes

during those times ($P=0.646$ and $P=0.889$, respectively). According to the results, the increase in pulse and skin temperature immediately after intervention could be the reason for the increase in contralateral limb circulation. As shown in the present study, the increase in pulse has more obvious changes, and it can be assumed that these changes were due to increased deep blood flow in the contralateral limb. However, minor changes in the average of skin temperature may be due to superficial skin vessels and less related to the effect of contrast bath on superficial circulation in the other side of the body. Although oral temperature changes in the normal participants and the diabetics were not remarkable throughout testing, it seems the differences among them were the results of primary differences and not systematic effects of the contrast bath ($P=0.001$).

The notable finding of the present study was the consistency of treatment effects after 10 minutes as compared to pre-intervention. This means that blood flow (local and general) in the other side of the body at the end of the procedure was more than before.

Based on ethical principles, all the subjects were women, and this was the limitation of the present study. Since oral temperature is not an accurate index of core body temperature, the authors suggest the use of rectal temperature in further research.

Conclusion

The results of this study showed that contrast bath can increase circulation in the contralateral limb. However, its influence on superficial and deep blood flow is uncertain.

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Conflict of interest: None declared.

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