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Effects of Buddhist walking meditation on glycemic control and vascular function in patients with type 2 diabetes

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ABSTRACT

Objective: To investigate and compare the effects of Buddhist walking meditation and traditional walking on glycemic control and vascular function in patients with type 2 diabetes mellitus.
Methods: Twenty three patients with type 2 diabetes (50–75 years) were randomly allocated into traditional walking exercise (WE; n = 11) or Buddhism-based walking meditation exercise (WM; n = 12). Both groups performed a 12-week exercise program that consisted of walking on the treadmill at exercise intensity of 50–70% maximum heart rate for 30 min/session, 3 times/week. In the WM training program, the participants performed walking on the treadmill while concentrated on foot stepping by voiced "Budd" and "Dha" with each foot step that contacted the floor to practice mindfulness while walking.
Results: After 12 weeks, maximal oxygen consumption increased and fasting blood glucose level decreased significantly in both groups ($p < 0.05$). Significant decrease in HbA1c and both systolic and diastolic blood pressure were observed only in the WM group. Flow-mediated dilatation increased significantly ($p < 0.05$) in both exercise groups but arterial stiffness was improved only in the WM group. Blood cortisol level was reduced ($p < 0.05$) only in the WM group.
Conclusion: Buddhist walking meditation exercise produced a multitude of favorable effects, often superior to traditional walking program, in patients with type 2 diabetes.

1. Introduction

Diabetes is a chronic disease that triggers a number of serious complications that affect the quality of life and elevate medical expenses.[1] Diseases involving large blood vessels, including coronary artery disease, cerebrovascular disease and peripheral artery disease as well as small vascular-related diseases, including retinopathy, nephropathy and neuropathy are often reported in people with diabetes.[2] Hyperglycemia resulting in endothelial dysfunction is thought to be a major cause of these complications.[3]

The prevalence of depression, anxiety, and stress is substantially higher among patients with type 2 diabetes.[4] Patients with diabetes must control the disease regularly through a combination of diet, aerobic exercise, and medication. Unfortunately, considerable modifications of lifestyles as well as the difficulty in controlling blood glucose levels may drive patients with diabetes to be psychologically stressed.[5] Moreover, patients with diabetes often have a feeling of insecurity because they are uncertain when the symptoms will recur. Chronic psychological stress can promote and aggravate the development of insulin resistance, atherosclerosis and cardiovascular disease.[6] An increased secretion of cortisol, a major stress hormone, produces an inflammatory response[7] and may contribute to worsening the metabolic and insulin sensitivity and inducing a higher prevalence of chronic diabetes complications.[8]

Complementary and alternative medicines have become popular in recent decades as methods of managing stress and improving health.[9] Among them, mind-body medicine can be prescribed and practiced in a form of meditation, relaxation, hypnosis, guided imagery, faith, and prayer[10–12] and are combined into a form of exercise, including yoga,[13] tai chi,[14] and qigong.[15] The use of mind-body medicine appears to be effective in reducing depression, anxiety, posttraumatic stress disorder, and pain, and helps control diabetes and high blood pressure.[16] It can also improve cardiovascular function and lipid profile and is associated with

Abbreviations: BMI, body-mass index; FMD, flow-mediated dilatation; baPWV, brachial-ankle pulse wave velocity; ABI, ankle-brachial index.

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improved function of the endocrine, immune, and inflammation systems.[17]

Walking meditation is widely practiced among Buddhist monks and is composed of the concentration on movement or position of the arms or legs while walking to create intention, which leads to the subsequent relaxation. A recent study from our laboratory showed that Buddhist-arm-swing-walking meditation improved endothelium-dependent vasodilation and reduced depression in elderly subjects with depression symptoms.[18] It is unknown if walking meditation would be effective in achieving glycemic control and in improving vascular complications in patients with diabetes. In our previous study involving otherwise healthy but depressed elderly, the subjects walked on the ground outside. In the present study, Buddhism-based meditation practice was implemented in the walking on the treadmill. This required less exercise space and could control the exercise intensity in the supervised setting. This treadmill walking meditation could help control blood glucose levels, improve vascular function, and reduce stress levels resulting in preventing complications of diabetes.

Accordingly, the aim of this investigation was to determine the effects of Buddhism treadmill walking meditation on glycemic control, vascular reactivity, and arterial stiffness in middle-aged and older patients with type 2 diabetes. In order to assess the relative efficacy of this mind-body therapy, the results were compared with those obtained from the traditional walking exercise program.

2. Materials and methods

2.1. Subjects

A total of 27 adults with type 2 diabetes aged 40–75 years were recruited from one of the Primary Health Promoting Hospital in Samut Prakan Province, Thailand by invitation using the mailing list of the clinic. The inclusion criteria included HbA_1c 7–9%[19]; no diabetic complications; no musculoskeletal disorders that could limit walking; on oral diabetic medications but not yet treated with insulin injections; have not attended any exercise program (e.g., structured aerobic exercise, resistance exercise, or other modes of exercise including yoga) within the last 6 months and normal resting electrocardiogram. These inclusion criteria were checked on self-report questionnaire and verified by the patient's primary medical staff. The study was approved by the Institutional Review Board at Chulalongkorn University. An informed consent was obtained from all subjects.

The eligible participants were first stratified by gender and the duration of diabetes and then randomized into one of the two groups using a random allocation sequence; traditional walking exercise training (TW; $n = 13$) and Buddhist walking meditation exercise training (WM; $n = 14$). Four subjects dropped out because of illness and/or a lack of compliance (less than 80% of the total training time) and these subjects were eliminated from the analyses. As a result, there were 11 subjects in the TW group and 12 subjects in the WM group.

2.2. Exercise training program

Both TW and WM training programs were divided into two phases. In the phase 1 (weeks 1–6), the training programs were conducted at mild to moderate intensity (50–60% maximum heart rate) and in the phase 2 (weeks 7–12), the training intensity was increased to moderate intensity (60–70% maximum heart rate). In both phases, the exercise sessions consisted of a 10 min warm-up and general static stretching, followed by 30 min workout and 10 min cool-down and general static stretching, giving a total session time of 50 min, 3 times per week. The prescribed exercise intensity was confirmed by using the heart rate monitors (Polar, USA). All the walking exercise training was performed on the treadmill and was closely supervised. Both training programs started with 12 types of stretching as warm-up and ended with another stretching as cool-down. The WM training program for this study was based on aerobic walking exercise combined with Buddhist meditation. The subjects performed walking on the treadmill while concentrating on foot stepping. The subjects had to voice "Budd" and "Dha" while setting each foot on the floor. The goal was to practice mindfulness while walking. In the present study, we did not include the non-exercising control group. Because the subjects were middle-aged and older patients with diabetes (i.e., patients at high risk), it was considered unethical not to provide any treatments that would be beneficial to them as they might experience any events during the study.

2.3. Measurements

Measurements were performed twice before and after the exercise training interventions.

2.3.1. Physical fitness assessments

Body composition was measured using bioelectrical impedance body composition analyzer (ioi 353, Jawon Medical, Korea) as previously described.[20] Body mass index (BMI) was calculated using the equation: body weight in kg/height in m^2. Maximal oxygen consumption (VO_2max) was assessed using the metabolic cart (Vmax^{TM} Encore 29, Yorba Linda, CA) during modified Bruce protocol for treadmill test.[21] Muscle strength was measured with isometric leg strength test using the back/leg muscle strength dynamometer (Takei Scientific Instruments, Tokyo, Japan) as previously described.[22]

2.3.2. Flow-mediated dilatation (FMD)

Endothelium-dependent vasodilation was assessed using blood occlusion technique on the right forearm. All subjects rested in supine position for 20 min. The brachial artery was imaged above the antecubital fossa in the longitudinal plane with the ultrasound machine (CX50, Philips, Andover, MA). Baseline data were monitored and the cuff placed around the right forearm was inflated to 50 mmHg above systolic blood pressure for 5 min and then deflated for 5 min of recovery.[23] FMD was calculated from the formula $FMD = (D2 - D1) \times 100/D1$ when D1 is the brachial artery diameter at baseline, D2 is the maximal post-occlusion brachial artery diameter.

2.3.3. Arterial stiffness

Pulse wave velocity (PWV) measurement was assessed with MD6 bidirectional transcutaneous Doppler transducers (Hokanson, Bellevue, WA). R-waves on ECG were used as timing markers for PWV identification. Peripheral PWV measures were obtained from the left brachial artery to the ipsilateral posterior tibial artery. The distance between the PWV measurement locations was measured with a measuring tape and recorded to the nearest cm. An average of 10 pulse recordings were analyzed.[24]

2.3.4. Ankle-brachial index (ABI)

ABI was evaluated with a manual MD6 bidirectional transcutaneous Doppler probe (Hokanson, Bellevue, WA). After allowing each subject to rest in a supine position for 5 min, systolic blood pressure was measured in both arms and in both ankles. The blood pressure cuffs were placed above both antecubital fossa for the brachial pressure and above both medial malleolus for the ankle pressures. When arterial pulse has been heard by using the Doppler probe then the cuffs were inflated to about 50 mmHg above the measured systolic blood pressure. After arterial pulse sound