



Dual energy X-ray absorptiometry assessment of bone mineral density response to aerobic exercise training in non-insulin dependent diabetic patients

İnsüline bağımlı olmayan diyabetik hastalarda aerobik egzersiz eğitimi nin kemik mineral yoğunluğuna etkisinin değerlendirilmesinde dual enerji X-ray absorpsiyometri değerlendirmesi

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ABSTRACT

Purpose: Type 2 diabetes mellitus has recently been linked to an increased fracture risk, even our understanding of how to use exercise effectively in diabetic patients in prevention of osteoporosis is incomplete and has prompted our interest to identify the type of effective osteogenic exercise. The aim of this study was to compare the changes in bone mineral density after 6 months of aerobic exercise training in patients with type 2 diabetes mellitus. **Method:** Eighty patients with type 2 diabetes mellitus participated in this study and were included into two equal groups; the first group (A) received aerobic exercise training, where the second group (B) was considered as a control group who received no exercise training. The program consisted of three sessions per week for six months. **Results:** The mean values of bone mineral density of the total hip, total lumbar spine and the femoral neck were significantly increased in group (A), while changes were not significant in group (B). In addition, there were significant differences between mean levels of the investigated parameters in group (A) and group (B) after treatment. **Conclusion:** The current study provides evidence that aerobic exercise training on treadmill is appropriate to improve bone mineral density of patients with type 2 diabetes mellitus.

Key words: Dual energy X-ray absorptiometry, bone mineral density, aerobic exercise, type 2 diabetes mellitus

ÖZET

Amaç: Tip 2 diyabetes mellitus son zamanlarda artan kırık riski ile ilişkilidir. Osteoporozun önlenmesinde diyabetik hastalarda etkin egzersizin nasıl kullanılacağı tam anlaşılmamış ve etkili osteojenik egzersiz türünü tanımlamak ilgi alanı olmuştur. Bu çalışmanın amacı, tip 2 diyabetli hastalarda aerobik egzersiz eğitiminin 6 ay sonra kemik mineral yoğunluğundaki değişiklikleri karşılaştırmaktır. **Yöntem:** Tip 2 diyabetes mellitusu olan seksen hasta çalışmaya alındı ve iki eşit gruba ayrıldı. Birinci grup (A); aerobik egzersiz eğitimi almış, ikinci (B) grubu hiçbir egzersiz eğitimi almamış kontrol grubu. Program altı ay boyunca haftada üç oturumdan oluşmaktadır. **Bulgular:** Grup A'da total kalça, femur boynu ve lumbar vertebra kemik dansitesi belirgin olarak artmıştır. Grup (B) belirgin değişiklik yoktu. Buna ek olarak tedavi sonrası (A) ve (B) grubu arasında incelenen parametreler açısından anlamlı farklılık bulunmuştur. **Sonuç:** Bu çalışma koşu bandı üzerinde aerobik egzersiz eğitiminin tip 2 diyabetli hastalarda kemik mineral yoğunluğunu arttırmak için uygun olduğunu göstermektedir.

Anahtar kelimeler: Dual enerji X-ray absorptiometre, kemik mineral yoğunluğu, aerobik egzersiz, tip 2 diyabetes mellitus

Introduction

Recently, type 2 diabetes mellitus (T2DM) is a common problem that affect about 300 million subjects worldwide, and the number of the affected subjects is expected to reach about 440 million by 2030 [1]. The risk of fractures among diabetics is greater than non-diabetics and the actual pathogenesis of the involvement of bones in patients with diabetes is not clear [2-4].

Diabetes mellitus is associated with multiple complications such as micro-and macro-vascular pathologies, nephropathy, neuropathy and alterations in bone homeostasis. The latter aspect is referred to as diabetic bone disease which is associated with high risk of fracture and subsequently delayed fracture healing and potentially non-union [5,6].

Defects in metabolism of bones which are associated with diabetes mellitus are more common than non-diabetic subjects [7-10]. The rate of pathological fracture is higher among diabetic subjects as they usually suffer from osteoporosis and reduction in mineral bone density [10,11] which is usually measured by Dual Energy X-ray Absorptiometry (DXA) [11] in order to detect subjects with osteoporosis [12]. Prevention of osteoporosis is of high priority in daily clinical practice [13-15].

Regular aerobic, weight bearing and resistance exercises are the most commonly types of exercise training for maintenance of normal bone density [16]. While, Greendale et al., proved that exercise training with low threshold at home may be effective in osteoporosis prevention [17]. Therefore, this study was designed to measure mineral bone density response to six months of aerobic exercises for patients with non-insulin dependent diabetes mellitus.

Material and Methods

Subjects

Eighty non-insulin dependent diabetic patients were enrolled in this study, the mean of their age was 45.58 ± 6.41 years (41 to 56 years). Patients who are smokers, having any endocrine, musculoskeletal, renal, liver, cardiac disorders, obesity, chest diseases and medicine that may adversely affect bone metabolism or other pathologic processes were excluded. Participants were randomly assigned in two equal study groups; group (A) received a program of aerobic exercises, while the second study group (B) was considered as a control group and received no exercise training. All participants signed an informed consent before participation. Ethical approval for this study was obtained from the Scientific Research Ethical Committee, Faculty of Applied Sciences, King Abdulaziz University, Jeddah, Saudi Arabia.

Measurements

Dual Energy X-Ray Absorptiometry ((DXA) GE Lunar Prodigy enCORE software version 8.80, GE Medical Systems, Madison WI) was the method for measurement of bone mineral density of total lumbar spine, the total hip and the femoral neck. Assessment of bone mineral density was applied at the beginning of the study (pre-test) and at the end of the study after six months.

Procedures

Following the previous evaluation, all participants were divided randomly into the following groups:

1. Patients in Group (A): Participants of group (A) received treadmill aerobic exercise training, each session was 40 minutes (warming up for 5 minutes, treadmill aerobic training for 30 minutes and cooling down for five minutes), the intensity of the exercise training was 60-80% maximum heart rate (HRmax) [18].
2. Patients in group (B) were considered as a control group and received no exercise training.

Statistical analysis

Mean values of the investigated parameters was compared by student paired "t" test. While, the unpaired "t" test was used to compare between the two groups (p<0.05).

Table 2. Mean value and significance of BMD of total lumbar spine, the total hip and the femoral neck of group (A) before and after the study.

	Mean ±SD		T-value	p value
	Before	After		
Total hip	0.84±0.13	1.32±0.14	7.18	<0.05
Total lumbar spine	1.15±0.25	1.41±0.23	8.27	<0.05
Femoral neck	0.76±0.16	0.98±0.17	8.16	<0.05

BMD: Bone Marrow Density

Table 1. The baseline descriptive characteristics of both groups

	Group (A)	Group (B)
Age (year)	46.37±6.28	45.16±7.14
BMI (kg/m ²)	30.25±4.31	29.78±4.12
HBA1c (%)	7.33±1.15	7.12±1.26
FPG (mg/dl)	139.14±9.18	138.27±10.35
Hb (gm/dl)	12.56±1.72	12.32±1.63
Total Bilirubin (mg/dl)	1.58±0.69	1.50±0.81
SBP (mm Hg)	137±10.48	135±10.24
DBP (mm Hg)	88±6.21	87±5.32
TC (mg/dl)	197.13±12.28	195.87±11.46
HDL-c (mg/dl)	34.11±3.24	33.64±3.19
LDL-c (mg/dl)	132.50±9.75	130.82±10.31
TG (mg/dl)	153.12±10.88	152.54±11.16

BMI : Body Mass Index; Hb : Hemoglobin; FPG: Fasting Blood Glucose; SBP: Systolic blood pressure ; DBP: Diastolic blood pressure ; HBA1c = glycosylated hemoglobin; TC: Total cholesterol; HDL-c: High density lipoprotein cholesterol ;TG: Triglyceride; LDL-c: Low density lipoprotein cholesterol ; (*) indicates a significant difference between the two groups, p<0.05.

Table 3. Mean value and significance of BMD of total lumbar spine, the total hip and the femoral neck of group (B) before and after the study.

	Mean +SD		T-value	p value
	Before	After		
Total hip	0.81±0.12	0.76 ± 0.11	0.65	>0.05
Total lumbar spine	1.13±0.23	1.02±0.22	0.78	>0.05
Femoral neck	0.69±0.18	0.64±0.15	0.81	>0.05

BMD: Bone Marrow Density

Table 4. Mean value and significance of BMD of total lumbar spine, the total hip and the femoral neck of group (A) and group (B) after the study.

	Mean +SD		T-value	p value
	Before	After		
Total hip	1.32±0.14	0.76±0.11	6.45	<0.05
Total lumbar spine	1.41±0.23	1.02±0.22	7.18	<0.05
Femoral neck	0.98±0.17	0.64±0.15	7.14	<0.05

BMD: Bone Marrow Density

Results

Table (1) presents the baseline criteria of the participants in both groups. Both groups were homogenous as there were no significant differences between both groups. The mean values of bone mineral density of the femoral neck, total hip and lumbar spine significantly increased in group (A) who received treadmill aerobic exercise training, while changes were not significant in group (B). (Table 2 and 3). Also, comparison between both groups revealed significant differences between values of the bone mineral density of the femoral neck, total hip and lumbar spine at the end of the study ($p < 0.05$) (Table 4).

Discussion

Fracture is more common among patients with non-insulin dependent diabetic patients than non-diabetic subjects, moreover, healing of fracture of diabetic patients takes longer time than non-diabetics [19]. In addition, non-insulin dependent diabetic patients have lower levels of fitness and strength than their healthy peers. The physical therapist, along with the medical team for care of patients with non-insulin dependent diabetes mellitus can work together to help diabetic patients to regain their normal body built, bone health and good well-being. Our study was a trial to investigate mineral bone density response to six months of aerobic exercises for patients with non-insulin dependent diabetes mellitus.

Our results revealed that the mean values of bone mineral density of the femoral neck, total hip and lumbar spine significantly increased in participants of group (A) who received treadmill aerobic exercise training for six months. These results agreed with Bradney et al. and Welton et al. reported that children who practiced weight-bearing exercises obtained improvement in bone mineral density and reported that exercise training is so important to enhance mineral bone density to a level that may be more important than dietary intake of calcium [20, 21]. However, Lanyon et al., reported that the actual mechanism for improving of bone mineral density that is obtained by weight bearing training is not ac-

curately detected, also they said that this mechanism may be related to the mechanical impact of dynamic strain that is applied on the bone which regulate the rate of bone resorption and bone formation [22]. Also, Lester et al. studied the response of the bone turnover markers for bone formation and resorption to different exercise programs (resistance, aerobic and combined), the program duration was eight weeks of training. They proved that both resistance training and combined training (resistance and aerobic training) increase in the bone formation biomarkers in addition to reduction in bone resorption biomarkers in all three training programs, moreover there was little positive changes in bone mineral density in leg bones in subjects practiced both aerobic and combined training (aerobic and resistance) [23].

The current study has important strengths and limitations. The major strength is the supervised nature of the study. Supervising physical activity removes the need to question compliance or to rely on activity questionnaires. Further, all exercise sessions were supervised and adherence to the diet and activities was essentially 100%. Moreover, the study was randomized; hence, we can extrapolate adherence to the general population. In the other hand, the major limitations is only non-insulin dependent diabetic patients enrolled in the study, so the value of this study only related to non-insulin dependent diabetic patients, also small sample size in both groups may limit the possibility of generalization of the findings in the present study. Finally, within the limit of this study, aerobic exercise training on treadmill is appropriate to improve bone mineral density of non-insulin dependent diabetic patients. Further researches are needed to explore the impact of weight reduction on quality of life and other biochemical parameters among non-insulin dependent diabetic patients.

In conclusion, the current study provides evidence that aerobic exercise training on treadmill is appropriate to improve bone mineral density of patients with type 2 diabetes mellitus.

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