Turkish Journal of Endocrinology and Metabolism, (1999) 4 : 169-172 **ORIGINAL ARTICLE**

# The Evaluation of Bone Mineral Density in Male and Postmenopausal Female Patients with Type 2 Diabetes Mellitus

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**The effect of Type 2 d iabetes mellitus on bone metabolism and bone mineral density is a controversial topic. Epidemiological studies show in part discrepant results: bone mass has been reported to be diminished or unchanged. The objective of this study was to assess the changes in bone mineral density (BMD) in male and postmenopausal female patients with Type 2 diabetes mellitus. This prospective study was performed in the Departments of Endocrinology and Metabolism, and of Nuclear Medicine of Erciyes University Medical School Hospital. One hundred consecutive patients (43 males and 57 females aged 57.4±9.7 years) with Type 2 diabetes, and 30 healthy volunteers (12 males and 18 females aged 55.4±7.2 years) were included in the study. We examined BMD with dual-energy X-ray absorbtiometry (DXA) technique at the lumbar and femoral levels and we also measured the levels of parathyroid hormone (PTH). Additionally the influences of age, sex, duration of diabetes, body mass index (BMI) and menopause were evaluated. We found that BMD values were lower in patients with Type 2 diabetes mellitus than control subjects in all regions ($p<0.001$) and also found that female patients have a greater risk of bone loss compared with male patients ($p<0.001$). Moreover, age adjusted BMD values were significantly lower in the postmenopausal patients compared with postmenopausal controls. Our findings also showed that age, duration of diabetes and sex were the additional risk factors for the development of bone loss ($p<0.01$, $<0.02$, $<0.001$, $<0.05$; respectively). In conclusion, this study shows that BMD values are lower in the patients with Type 2 diabetes mellitus than in the controls and BMI has a protective effect on bone loss.**

**Key Words: Diabetes mellitus, osteoporosis, bone mineral density.**

## Introduction

Osteoporosis is characterized by a reduction in the amount of bone in the skeleton, associated with skeletal fragility and an increased risk of fracture after trauma (1). Osteoporosis may be classified into primary or secondary osteoporosis, depending on the presence of an underlying condition known to cause the disease (1). Senile and postmenopausal osteoporosis are termed as primary (1). There are a large number of causes of secondary osteoporosis, including endocrine disorders such as diabetes mellitus. While the relationship between Type 1 diabetes and osteoporosis is well documented in the literature, data on the presence of this complication in Type 2 diabetes have not been well established (2). Epidemiological studies show in part discrepant results: bone mass was diminished in some studies, unchanged in others (3). Some studies showed bone loss in Type 2 diabetes

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mellitus (4, 5). But many investigators found that BMD did not change or increased in Type 2 diabetes compared with non-diabetic subjects (2, 6, 7, 8, 9). In these studies, it is suggested that genetic factors, BMI, sustained hyperglycemic state, duration of diabetes, reduction of insulin/ insulin like growth factor-I action and chronic diabetic complications such as polyneuropathy, nephropathy and myopathy may play an important role in the development of bone mass (3, 6, 9).

The objective of this study was to assess the association of Type 2 diabetes mellitus with BMD in male and postmenopausal female patients.

## Patients and Methods

This prospective study was performed in the Departments of Endocrinology and Metabolism and of Nuclear Medicine of Erciyes University Medical School Hospital. One hundred consecutive patients (43 males and 57 females with aged 57.4±9.7 years) with Type 2 diabetes mellitus and 30 healthy volunteers (12 males and 18 females aged 55.4±7.2 years) were included in the study. Patients having other causes of secondary osteoporosis or any prior treatment with drugs which are known to have effects on bone metabolism were not included in the study.

We examined BMD with dual-energy X-ray absorbtiometry (DXA) technique (Hologic QDR-4500A; Waltham, MA, USA) at the lumbar and femoral levels and we also measured the levels of PTH. DXA results were evaluated by the same investigator (A.T.). Additionally, the influences of age, sex, duration of diabetes, BMI and menopause on BMD were evaluated.

### *Statistical analyses*

All results are expressed as the mean ± SE. Comparisons between groups were assessed by Multivariate Analysis, Univariate Analysis, Analysis of Covariance, and Multiple Linear Regression. Significance was indicated for $p<0.05$.

## Results

The mean age (SD (57.4±9.7 versus 55.4±7.2) and male/female ratio (43/57 versus 12/18) were similar in patients and controls ($p>0.05$, $>0.05$; respectively).

Age and sex adjusted BMD values of patients were compared with controls (Table 1) and BMD values of patients were found to be significantly lower than controls in all regions ($p<0.001$).

**Table 1.** A multivariate analysis of age and sex adjusted BMD values in patient and control groups*.

| Region of BMD | Patients (n=100) | Controls (n=30) | p value |
|---|---|---|---|
| Femoral Neck | 0.735 ± 0.014 | 0.833 ± 0.026 | <0.001 |
| Femoral Trochanter | 0.582 ± 0.012 | 0.696 ± 0.022 | <0.001 |
| Lumbar Spine (L1-4) | 0.870 ± 0.013 | 1.014 ± 0.023 | <0.001 |
| Ward's triangle | 0.565 ± 0.016 | 0.662 ± 0.030 | <0.001 |

* $p<0.001$

Age adjusted BMD values of male and female patients were significantly lower than sex matched controls ($p<0.001$, $<0.001$; respectively) (Table 2). While BMD values were low in all regions in female patients, they were low only at the femoral trochanter and lumbar spine in male patients.

**Table 2.** Age adjusted BMD levels of male/female patients (43/57) and controls (12/18).

| Sex | | Patients | Controls | p value |
|---|---|---|---|---|
| Female* | Femoral Neck | 0.716 ± 0.017 | 0.785 ± 0031 | <0.001 |
| | Femoral Trochanter | 0.568 ± 0.015 | 0.638 ± 0.028 | <0.001 |
| | $L_{1-4}$ | 0.845 ± 0.016 | 0.964 ± 0.029 | <0.001 |
| | Ward's triangle | 0.547 ± 0.022 | 0.630 ± 0.039 | <0.001 |
| Male** | Femoral Neck | 0.769 ± 0.023 | 0.874 ± 0.043 | >0.05 |
| | Femoral Trochanter | 0.609 ± 0.017 | 0.751 ± 0.033 | <0.002 |
| | $L_{1-4}$ | 0.912 ± 0.020 | 1.061 ± 0.037 | <0.003 |
| | Ward's triangle | 0.595 ± 0.024 | 0.685 ± 0.046 | >0.05 |

*$p<0.001$;**$p<0.001$

We evaluated the relationship between some additional risk factors and BMD values (Tablo 3). We found that age, BMI and duration of diabetes might affect BMD values ($p<0.01$, $<0.05$, $<0.001$; respectively). There was no relationship between metabolic control and BMD values ($p>0.05$).

BMD levels of male patients were compared with female patients, and were found significantly lower in women in all regions ($p<0.001$) (Table 4).

**Table 3.** The relationship between some additional risk factors and BMD in the patients.

| | Femoral Nec | Femoral Trochanter | L1-4 | Ward's Triangle |
|---|---|---|---|---|
| Age | R:-0.165 | -0,223 | -0.148 | -0.283 |
| | p>0.05 | <0.05 | >0.05 | <0.003 |
| Fasting glucose | R:-0,072 | -0.085 | -0.066 | -0.025 |
| | p>0.05 | >0.05 | >0.05 | >0.05 |
| BMI | R:0.196 | 0.177 | 0.123 | 0.224 |
| | p<0.05 | >0.05 | >0.05 | <0.01 |
| Duration of diabetes | R:-0.276 | -0.262 | -0.133 | -0.297 |
| | p<0.01 | <0.01 | >0.05 | <0.01 |
| PTH | R:-0,224 | -0.163 | -0.030 | -0.114 |
| | p<0.05 | >0.05 | >0.05 | >0.05 |
| $HbA_1C$ | R:0.015 | -0.081 | -0.070 | -0.022 |
| | p>0.05 | >0.05 | >0.05 | >0.05 |

**Table 4.** Comparison of BMD levels (adjusted for age, duration of diabetes and BMI) between male and female patients.

| | Men (n:43) | Women (n:57) | p value |
|---|---|---|---|
| Femoral Neck | 0.780 ± 0.023 | 0.701 ± 0.020 | <0.01 |
| Femoral Trochanter | 0.615 ± 0.019 | 0.559 ± 0.016 | <0.001 |
| $L_{1-4}$ | 0.917 ± 0.022 | 0.835 ± 0.019 | <0.001 |
| Ward's triangle | 0.599 ± 0.024 | 0.535 ± 0.021 | <0.001 |

## Discussion

Osteoporosis is a systemic skeletal disorder characterized by low bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility (1). Several conditions have been described as causing osteoporosis (2). The relationship between diabetes mellitus and bone metabolism is unclear. Previous studies suggest that low bone mass is a potential complication of Type 1 diabetes mellitus (10, 11). However, the effect of Type 2 diabetes mellitus on bone metabolism and bone mineral density is a matter of debate (6, 12).

Piepkorn et al. (6) showed that BMD was increased in patients with Type 2 diabetes mellitus. Similarly, Isaia et al. (2) showed that BMD values were higher in postmenopausal patients with Type 2 diabetes compared with postmenopausal control subjects. van Daele et al. (7) also showed that BMD values were higher in Type 2 diabetic patients aged 55 years or more compared with age matched control subjects, and Type 2 diabetes in women was associated with a lower frequency of nonvertebral fractures. Barrett-Connor and Holbrook (9) also found similar results in a Type 2 diabetic group including white men and women aged 55 to 88 years. They showed that older women with Type 2 diabetes or hyperglycemia had better BMD than women with normal glucose tolerance (9). In another study which was performed in premenopausal women, while BMD values were found to be lower in patients with Type 1 diabetes than controls, they were not different in patients with Type 2 diabetes and controls (8). Koçkar et al. also showed that BMD values were not different in patients with Type 2 diabetes and healthy controls (13).

On the contrary, Verhaeghe et al. (14) suggest that the long-standing diabetes results in a low-turnover osteoporosis in the spontaneously diabetic BB rat. Ishida et al. (4) also found that the bone mass in 26.2% of patients with Type 2 diabetes was clearly decreased and in 11.9% was severely decreased.

Krakauer et al.(5) showed that BMD values were lower in both Type 1 and Type 2 diabetic patients than in nondiabetic subjects. They also found that bone loss in Type 2 diabetes was slower than in Type 1 diabetes (5).

Kwon et al. (12) showed that age, duration of menopause and diabetes mellitus were among the risk factors for decreased BMD in 185 female patients with Type 2 diabetes. Similarly, Ayvaz et al. found that age and duration of diabetes were the risk factors for osteoporosis (15).

Because of the previous confusing findings in Type 2 diabetes, we assessed BMD in patients with Type 2 diabetes. BMD values were measured in lumbar vertebrae (L1-4), femoral neck, femoral trochanter and Ward's triangle. This study showed that BMD values were lower in patients with Type 2 diabetes mellitus than in age matched healthy subjects in all regions, and also showed that diabetic women have more risk of bone loss. Moreover, age adjusted BMD values were significantly lower in the postmenopausal patients compared with postmenopausal controls.

These results showed that BMD values were lower in the patients with Type 2 diabetes than controls, independent of age, sex and menopause. Our findings also showed that age, menopause, duration of disease and sex were the additional risk factors for developing of osteopenia and osteoporosis in Type 2 diabetic patients.

In a recent study, Okazaki et al. (16) showed that metabolic improvement of poorly controlled Type 2 diabetes decreased bone loss. But, several studies revealed that there is no relationship between metabolic control of Type 2 diabetes mellitus and BMD (11, 17). Our results suggest that metabolic control of Type 2 diabetes does not affect BMD.

There is a positive correlation between body weight and BMD (1). In several studies, a significant relationship was found between BMD and BMI in Type 2 diabetic population (6, 17, 18). Our findings confirm these reports.

As a result; this study showed that BMD values were lower in the patients with Type 2 diabetes than in the age and sex-matched controls. Although age, menopause, duration of diabetes and sex were additional risk factors for the development of bone loss, BMI has a protective effect on bone loss.

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