



Bone Mineral Density and Fracture Risk Assessment in Type II Diabetic Patients

Authors

Saima Ejaz¹, Shireen Jawed², Nagah M. Abo-Elfetoh³, Atif Mahmood⁴, Hafeezullah Wazeer⁵

¹Department of Physiology, College of Medicine, Northern Border University, female Campus, Arar, Saudi Arabia

Email: saimaejaz84@hotmail.com

²Department of Physiology, Islam Medical College, Sialkot, Pakistan

Email: drshireenjawed@gmail.com

³Department of Community Medicine, College of Medicine, Northern Border University, female Campus, Arar, Saudi Arabia

Email: apdo3332008@yahoo.com

⁴Department of Physiology, College of Dentistry, Bhitae Medical College, Mirpur, Pakistan

Email: atif_mahmood20@yahoo.com

⁵Department of Physiology, College of Medicine, Northern Border University, Male Campus, Arar, Saudi Arabia

Email: hafeezullah2k@hotmail.com

ABSTRACT

Objectives: To assess BMD and its association with fracture risk in elderly type II diabetic patients by using Fracture Risk Assessment Tool as a standard predictor of fracture risk.

Introduction: Diabetes mellitus is the most common health problem worldwide and is estimated to be 6 - 8% of the overall population world over. A change in bone health is one of the many complications of this metabolic disorder. Most of the studies reported reduced bone mineral density (BMD) in Type 1 diabetes with increased risk of osteoporotic fractures. However, there have been conflicting results on the effects of type II diabetes on BMD and incidence of osteoporotic fracture due to the pathogenic complexity of the condition. Fracture Risk Assessment (FRAX) tool is a standard predictor of fracture risk assessment and assesses the ten-year risk of osteoporosis fracture based on individual risk factors, with or without BMD.

Methodology: A case control study was conducted on a purposive sample of 252 type II diabetic and non-diabetic patients from different health care centres of Karachi. The participants were asked to fill a detailed questionnaire about their personal, present and past medical history and risk factors of osteoporosis were assessed. Type II diabetics with a history of at least 3 years were included in the study. Patients with history of drug and hormone intake that affects bone metabolism or any disease or surgery involving any joint; cancer and renal failure were excluded from the study. BMD measurements were

done by Bone Densitometer (SONOST 3000). BMD was calculated by combining BUA and SOS which yields the QUI index. Calcaneus bone of right heel was used for measurement. T scores were used to evaluate BMD and risk of osteoporosis and Osteopenia were assessed by FRAX tool.

Results: The mean age of the diabetic patients was 60.16% (\pm 8.06) years whereas 59.8 (\pm 6.2) years in non-diabetic patients. Mean BMI among diabetic patients was 25.9 ± 5.7 kg/m² while $24.4(\pm 4.43)$ Kg/m² was in non-diabetic patients. Mean waist/hip ratio of the diabetic patients was $0.93 (\pm 0.11)$ while of non-diabetic patients was 0.89 ± 0.087 . The mean SOS and BUA in diabetic population was $1509 (\pm 21.12)$ and $81.23 (\pm 16.725)$ while in non-diabetic was 1414 ± 30.5 and 71.88 ± 13.73 respectively. Of the respondents, 13.1% were males and 86.9% were females. 30.5% had a family history of osteoporosis and 69.5% didn't have a family history of osteoporosis. The mean T score in diabetic patients was -1.46 ± 0.95 while in non-diabetic patients was -4.7 ± -0.7 . The major osteoporotic fracture risk and hip fracture risk was $9.3 \pm 7.26\%$ and $7.1 \pm 5.2\%$ in diabetics whereas $2.6 \pm 0.5\%$ and $1.3 \pm 0.4\%$ in non-diabetic patients respectively. A weak negative correlation (-0.32) has been observed between BMD and Hip Fracture risk among diabetic patients.

Conclusion: Type 2 diabetic patients have increased risk for hip fractures despite of higher BMD.

Key words: Type II diabetes, BMD, Fracture risk assessment, Osteopenia, Osteoporosis, FRAX tool

1. INTRODUCTION

Diabetes mellitus is the most common health problem worldwide, associated with an increased mortality rate and an overall functional decline. [1]

Diabetes affects an estimated 6-8% of the population worldwide. Along with many complications this metabolic disorder is also associated with changes in bone health. Most of the studies reported reduced Bone Mineral Density (BMD) in Type 1 diabetes, [2, 3] with increased risk of osteoporotic fractures. [4] However, there have been conflicting results on the effects of type II diabetes on Bone mineral density and incidence of osteoporotic fracture due to the pathogenesis complexity of the condition. Indeed BMD was found to be reduced in some studies [5,6] but increased [7, 8] or unchanged, [9] among most large scale epidemiological studies. This protective role of type II diabetes on bone density may be due to increase Body mass index (BMI) that reflects reduce risk of developing osteoporosis and fracture. [10]

Although increased BMD is associated with decrease fracture risk in older patients [11] but conflicting results have been reported in type II diabetic patients. Some recent studies found higher incidence of fractures with increase bone mineral density [12] may be because of neurological and visual complications, history of fall and low bone quality due to microvascular complications that seems to be independent of BMD. [13, 14]

There is need to evaluate risk of fracture in type II diabetic patients with other measures along with BMD because only BMD levels are not sufficient for fracture risk assessment in type II diabetes mellitus.

The aim of our study is to assess BMD and its association with fracture risk in elderly type II diabetic patients by using FRAX Tool (Fracture Risk Assessment Tool) as they are standard predictors of fracture risk assessment. FRAX assesses the ten-year risk of osteoporosis fracture based on individual risk factors, with or without BMD.

BMD is the amount of calcium in various sites of bones.¹⁵ Although DEXA scan considered to be the gold standard test for the BMD measurement but its high cost and hazards of radiations limits its use for community based studies. However, Quantitative Ultrasound technique has recently been approved in the United States for diagnostic evaluation of low bone mass. It is a non- invasive technique for assessing bone structure, composition and bone mass.^[16]

2. MATERIAL AND METHODS

A case control study was conducted (n =252) on type II diabetic and non-diabetic males and females. Data was collected from different health care centres of Karachi city, where posters were pasted before one week of examination. Informed written consent was taken from each subject using material approved by Institutional review board of Dow University of Health sciences and confidentiality of results was ensured.

A detailed questionnaire was filled by each participant for personal information, present and past medical history, risk factors of osteoporosis such as smoking habit, use of alcohol, use of glucocorticoids, previous history of fracture and parent's hip fracture. Height and weight of subjects were measured by measuring tape and weighing machine without heel or shoes, through which Body Mass Index was, calculated (weight in kg/height in meter²).

Subjects with current and past history of rheumatoid arthritis, primary hyperparathyroidism bilateral hip

replacement, renal failure, active cancer, dementia, stroke, Neurological problems, or a history of falls or traffic accidents were excluded to eliminate the possibility of injury-associated fractures. Patients using any medications or hormones that affects bone metabolism were also excluded from study. However, among type II diabetic Patients, only duration of 3 years or more were included in the study.

2.1 Bone Mineral Density Measurement:

In this study we measured BMD by QUS technique. It measures usually BMD of the calcaneus (heel), other anatomical sites that are routinely measured by ultrasound include the phalanges (fingers) and tibia (shin).^[7]

Table 01:BMD T _SCORE according to WHO

BMD T score	
> -1.0	normal
- 1.0 to -2.5	osteopenia
< -2.5	Osteoporotic

2.2 Fracture Risk Assessment:

Fracture Risk assessment tool (FRAX) was used for the assessment of fractures risk, organized by WHO. BMD measurement has proven to be specific, but not sensitive for fracture assessment Clinical risk factors that predict increased risk of fractures are: Age, Sex, BMI, Prior fragility fracture after age 50, Current smoking status, History of corticosteroid use, Parental history of hip fracture, Rheumatoid arthritis, Secondary osteoporosis and use of alcohol.

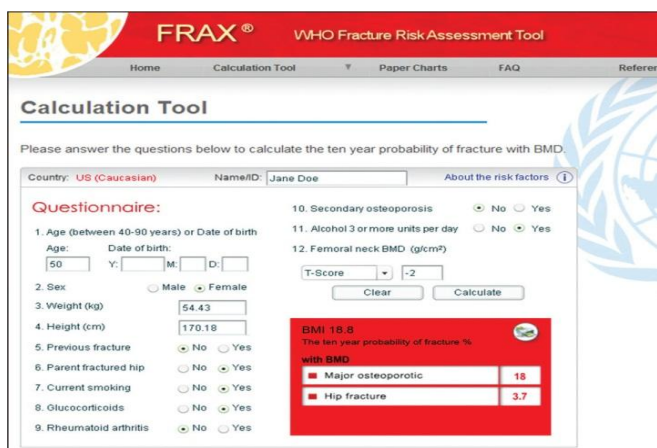


Fig 01. WHO fracture assessment tool

3. RESULTS

The mean age of the diabetic patients was 60.16% (± 8.06) years whereas 59.8 (± 6.2) years in non-diabetic patients. Mean BMI among diabetic patients was $25.9 \pm 5.7 \text{ kg/m}^2$ while $24.4(\pm 4.43)\text{Kg/m}^2$ was in non-diabetic patients. Mean waist/hip ratio of the diabetic patients was $0.93 (\pm 0.11)$ while of non-diabetic patients was 0.89 ± 0.087 . The mean SOS and BUA in diabetic population was $1509 (\pm 21.12)$ and $81.23 (\pm 16.725)$ while in non-diabetic was 1414 ± 30.5 and 71.88 ± 13.73 respectively. Of the respondents, 13.1% were males and 86.9% were females. 30.5% had a family history of osteoporosis and 69.5% didn't have a family history of osteoporosis.

Table I: Demographic characteristics of the population studied

Variable	Frequency (n)	Percentage (%)
Sex		
Male	33	13.1
Female	219	86.9
Marital Status		
Single	36	14.3
Married	207	82
Widowed	9	3.8
Smoking		
Yes	243	96.4
No	9	3.6
Exercise (min/day)		
Yes	51	20.2
No	201	79.8
Family History of Osteoporosis		
Yes	77	30.5
No	175	69.5

Table II: Mean values and standard deviation of the variables Among Diabetic and Non Diabetic Patients

Mean Value	Diabetic	Non Diabetic	P value
Age(years)	60.16 ± 8.06	57.80 ± 6.2	<0.01
BMI(kg/m^2)	25.9 ± 5.7	24.4 ± 4.43	<0.031
Waist / Hip	0.93 ± 0.11	0.89 ± 0.087	<0.007
T Score	-1.46 ± 0.95	-2.3 ± 0.71	<0.00
SOS	1509 ± 21.12	1414 ± 30.5	<0.001
BUA	81.23 ± 16.725	71.88 ± 13.73	<0.000

The mean T score in diabetic patients was -1.46 ± 0.95 while in non-diabetic patients was -4.7 ± -0.7 . The major osteoporotic fracture risk and hip fracture risk was found to be $9.3 \pm 7.26\%$ and $7.1 \pm 5.2\%$ in diabetics whereas $2.6 \pm 0.5\%$ and $1.3 \pm 0.4\%$ in non-diabetic patients respectively.

Table III: 10 years Probability of Fracture Risk among Diabetic and Non Diabetic Patients

	Diabetic Patients	Non Diabetic Subject	P Value
Major Osteoporotic	9.3 % ± 7.26	2.6% ± 0.5	<0.007
Hip Fracture	7.1 % ± 5.2	1.3% ± 0.4	<0.00

Correlation of BMD with hip and major osteoporotic fracture probability was observed insignificant (< 0.21 and < 0.388). In this study we found higher BMD T score (less negative) in older type II diabetic patients of both sexes (-1.46) as compared to matched control subject (-2.3) with p value < 0.00 .

4. DISCUSSION

The significantly higher FRAX score for osteoporotic fracture were observed in diabetic patients ($p < 0.007$) as compared to non-diabetic patients and also major hip fracture risk was significantly higher in diabetic patients ($p < 0.005$) then in age matched non diabetic patients. Our study suggests that patients with type II diabetes have higher bone-mineral density (BMD) and, paradoxically, higher fracture risk independent of BMD.

Fracture risk was calculated according to the World Health Organization's FRAX tool, which rates risk according to a number of factors such as age, sex, height and weight, smoking, glucocorticoid use, and personal or parental history of hip fracture and BMD was analysed at calcaneus (heel) by Quantitative Ultrasound technique (QUS) which

provides an accurate indication of osteoporosis fracture risk, particularly for hip fracture

In this study we found higher BMD T score (less negative) in older type II diabetic patients of both sexes (-1.46) as compared to matched control subject (-2.3) with p value < 0.00 .

Similar results were reported by Raki et al, who also found the higher BMD T score in type II diabetic patients but they also found higher fracture risk in type II diabetic patients found to be independent of BMD T score.^[17] The differences between our study and in their study is the difference of method for risk assessment. We use BMD, T score and WHO Fracture Risk Algorithm (FRAX) score as they are reliable indicators of fracture risk in elderly people with type II diabetes mellitus (DM) and they use BMD T score along with biochemical and hormonal markers of bone metabolism.

In another study, Ann V. Schwartz and colleagues examined the association between femoral neck BMD T score and the FRAX score, hip and non-spine fracture risk in older adults with type II diabetes. Data from 9,449 women and 7,436 men in three observational studies with adjudicated fracture outcomes was analysed. Among all the participants, 770 women and 1,199 men had type II diabetes. They found femoral neck BMD T score and FRAX score are both associated with fracture risk in older adults with type II diabetes mellitus.^[12]

In large scales of studies, lower^[18] and higher^[4] rates of fractures in type II diabetes were reported. Forsen L, study in Norway also showed a strong association between diabetes and risk of hip fracture in both women and men.^[19] Study of osteoporotic fracture (SOF) reported an increased

risk of hip and proximal humerus fractures in older women with type II diabetes, despite having higher BMD. ^[20]

However, exact mechanisms for negative effects of type II diabetes on fracture risk have not been clearly elucidated. Although possible mechanisms for increased risk of hip fracture in type II diabetes may be its related co-morbidities such as diabetic retinopathy, peripheral neuropathy, cerebral stroke, or hypoglycaemia, which may increase the risk of falling. Poor bone quality and frequent falls would be expected to increase the risk of fracture independent of BMD. ^[13,14] The limitation of this study is that the QUS can indicate only the risk for hip fractures not the others, but there are evidences of higher risk for hip, humerus and foot fractures in type II diabetics patients. ^[17,20] The advantage of QUS is low cost, free of hazards of X-ray and its portability.

5. CONCLUSION

The study has suggested that type II diabetic patients have increased risk for hip fractures despite of higher BMD but there is need to elucidate exact aetiology of fracture in type II diabetes and implication for preventive measures.

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