RESEARCH PAPER

Bone Mineral Density and Osteopenia Prevalence in Male Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Study from Northern India

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ABSTRACT

Background:

Type 2 diabetes mellitus (T2DM) is increasingly recognized as a metabolic disorder associated with altered bone metabolism and increased fracture risk. Despite normal or increased bone mineral density (BMD) reported in some studies, diabetic patients often demonstrate poor bone quality and increased osteopenia. Data regarding BMD in male patients with T2DM from Northern India remain limited.

Objectives:

To evaluate bone mineral density in male patients with type 2 diabetes mellitus and determine the prevalence of osteopenia and osteoporosis compared with non-diabetic controls.

Methods:

This cross-sectional case–control study included adult male patients with T2DM and age-matched non-diabetic controls. Clinical details including age, duration of diabetes, BMI, and glycemic parameters were recorded. Bone mineral density was assessed using dual-energy X-ray absorptiometry (DEXA) at lumbar spine and femoral neck. BMD was categorized using WHO criteria into normal, osteopenia, and osteoporosis.

Results:

Male patients with T2DM demonstrated significantly lower BMD at both lumbar spine and femoral neck compared with controls. Osteopenia was the most common abnormality among diabetic patients. Longer duration of diabetes and poor glycemic control were associated with lower BMD values. Osteoporosis was less frequent but more prevalent in diabetic patients compared with controls.

Conclusion:

Male patients with T2DM have increased prevalence of osteopenia and reduced BMD compared with non-diabetic individuals. Routine BMD screening in diabetic males may help identify individuals at risk of fragility fractures and guide early preventive strategies.

Keywords: Type 2 diabetes mellitus, Bone mineral density, Osteopenia, Osteoporosis, DEXA

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INTRODUCTION

Type 2 diabetes mellitus is a major global health concern with rapidly increasing prevalence. While traditionally associated with microvascular and macrovascular complications, emerging evidence suggests that diabetes also affects bone metabolism. Patients with T2DM have an increased risk of fractures despite having normal or increased bone mineral density in some populations. This paradox suggests that diabetes influences bone quality, microarchitecture, and turnover.

Hyperglycemia, insulin resistance, advanced glycation end products, and chronic inflammation contribute to impaired bone formation and increased bone fragility. Additionally, diabetic complications such as neuropathy, retinopathy, and hypoglycemic episodes further increase fall risk and fracture incidence. Several studies have reported reduced bone mineral density in patients with T2DM, particularly in males with long-standing disease.

Bone mineral density assessment using dual-energy X-ray absorptiometry remains the gold standard for evaluating osteoporosis and osteopenia. Early identification of reduced BMD in diabetic patients may help prevent fractures and associated morbidity.

The present study was conducted to assess bone mineral density in male patients with type 2 diabetes mellitus and compare it with non-diabetic controls. The study also evaluated the prevalence of osteopenia and osteoporosis and their association with duration of diabetes and glycemic control.

MATERIALS AND METHODS

This cross-sectional case–control study was conducted in the Department of General Medicine at a tertiary care teaching hospital in Northern India. Adult male patients diagnosed with type 2 diabetes mellitus were recruited. Age-matched non-diabetic males served as controls.

Inclusion Criteria

Male patients aged more than 30 years
Diagnosed cases of type 2 diabetes mellitus
Patients willing to participate in study

Exclusion Criteria

Type 1 diabetes mellitus
Chronic kidney disease
Chronic liver disease
Thyroid disorders
Patients on steroids
Known metabolic bone disease
Malignancy

Detailed clinical history including age, duration of diabetes, BMI, and treatment history was recorded. Laboratory investigations included fasting blood sugar and HbA1c.

Bone mineral density was measured using dual-energy X-ray absorptiometry at:

Lumbar spine (L1–L4)
Femoral neck

BMD values were expressed as T-scores and categorized according to WHO criteria:

Normal: T score ≥ −1
Osteopenia: T score −1 to −2.5
Osteoporosis: T score ≤ −2.5

Statistical analysis was performed using appropriate tests. Continuous variables were expressed as mean ± standard deviation and categorical variables as percentages.

RESULTS

Baseline Characteristics

Table 1 shows baseline demographic characteristics of study participants.

Table 1: Baseline Characteristics

Parameter	Diabetic Group	Control Group
Mean Age (years)	54.2 ± 8.1	52.6 ± 7.4
BMI (kg/m²)	26.8 ± 3.2	25.9 ± 2.8
Duration of Diabetes (years)	8.3 ± 4.6	—
HbA1c (%)	8.1 ± 1.2	5.3 ± 0.4

Bone Mineral Density Comparison

Diabetic patients showed lower BMD values compared with controls at both lumbar spine and femoral neck.

Table 2: Comparison of BMD

Site	Diabetic Group	Control Group
Lumbar Spine T score	−1.48 ± 0.76	−0.82 ± 0.54
Femoral Neck T score	−1.32 ± 0.68	−0.70 ± 0.49

Prevalence of Osteopenia and Osteoporosis

Osteopenia was significantly more common in diabetic patients. Osteoporosis was also more prevalent in diabetic group.

Table 3: BMD Category Distribution

Category	Diabetic (%)	Control (%)
Normal	36%	58%
Osteopenia	48%	34%
Osteoporosis	16%	8%

Association with Duration of Diabetes

Patients with diabetes duration more than 10 years showed significantly lower BMD compared to those with shorter duration.

Poor glycemic control (HbA1c >8%) was associated with lower T-scores.

DISCUSSION

This study evaluated bone mineral density in male patients with type 2 diabetes mellitus and compared findings with non-diabetic controls. The results demonstrated significantly lower BMD in diabetic patients, particularly at lumbar spine and femoral neck. Similar findings have been reported in several studies showing increased prevalence of osteopenia and osteoporosis among patients with type 2 diabetes mellitus.[1]

Osteopenia was the most common abnormality observed in diabetic patients. This finding is clinically important because osteopenia often remains asymptomatic but significantly increases fracture risk. Reduced bone strength in diabetes is multifactorial and includes poor bone quality, impaired microarchitecture, and altered bone turnover. Chronic hyperglycemia leads to accumulation of advanced glycation end products (AGEs) in bone collagen, which reduces bone elasticity and increases fragility.[2]

Insulin resistance also plays an important role in diabetic bone disease. Insulin has anabolic effects on bone through stimulation of osteoblast proliferation. In type 2 diabetes mellitus, insulin resistance and relative insulin deficiency reduce osteoblastic activity and impair bone formation. Additionally, inflammatory cytokines such as TNF-alpha and IL-6 contribute to increased bone resorption and decreased bone formation.[3]

Duration of diabetes was an important determinant of bone mineral density in the present study. Patients with longer duration of diabetes showed lower BMD values. Chronic exposure to hyperglycemia leads to progressive deterioration in bone quality. Similar observations have been reported in previous studies demonstrating that duration of diabetes correlates negatively with BMD and increases fracture risk.[4]

Poor glycemic control was also associated with reduced bone mineral density. Higher HbA1c levels reflect chronic hyperglycemia and increased AGE formation. These metabolic changes impair osteoblast differentiation and promote osteoclast-mediated bone resorption. Previous studies have demonstrated that HbA1c is an independent predictor of reduced bone mineral density in diabetic patients.[5]

Diabetic microvascular complications may further contribute to reduced bone mass. Neuropathy, retinopathy, and nephropathy increase fall risk and reduce physical activity, thereby increasing fracture risk independent of bone density. Additionally, diabetic nephropathy may alter calcium and vitamin D metabolism leading to bone loss.[6]

Obesity, commonly seen in type 2 diabetes mellitus, has complex effects on bone metabolism. While increased body weight may increase mechanical loading and improve BMD, adipokines and inflammatory mediators released from adipose tissue may negatively affect bone quality. Therefore, diabetic patients may have normal BMD but still exhibit increased fracture risk due to poor bone quality.[7]

The present study showed that osteoporosis was more prevalent in diabetic patients compared with controls. Similar findings have been reported in multiple studies where diabetic males demonstrated lower BMD and higher prevalence of osteoporosis. Early screening using DEXA scan is therefore recommended in patients with long-standing diabetes.[8]

The clinical implication of this study is that diabetic males should be considered a high-risk population for osteopenia and osteoporosis. Routine screening for BMD, strict glycemic control, adequate calcium and vitamin D intake, and lifestyle modification may help reduce fracture risk. Early identification and management of reduced BMD in diabetic patients can significantly reduce morbidity and improve quality of life.[9]

Thus, type 2 diabetes mellitus is associated with reduced bone mineral density, increased prevalence of osteopenia, and higher risk of osteoporosis. Poor glycemic control and longer duration of diabetes are important predictors of bone loss. Regular screening and early intervention are recommended for prevention of diabetic bone disease.[10]

LIMITATIONS

Single	center	study
Small	sample	size
Cross-sectional		design

Bone turnover markers not evaluated

CONCLUSION

Male patients with type 2 diabetes mellitus demonstrate reduced bone mineral density compared with non-diabetic controls. Osteopenia is highly prevalent among diabetic males. Longer duration of diabetes and poor glycemic control are associated with lower BMD. Routine screening for bone mineral density in diabetic males should be considered for early detection and prevention of osteoporosis.

DECLARATION

Ethics Approval and Consent to Participate

The study was conducted in accordance with the ethical standards of the institutional research committee and the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee of School of Medical Sciences & Research, Sharda University, Greater Noida. Written informed consent was obtained from all participants prior to enrolment in the study.

Consent for Publication

Written informed consent for publication of anonymized clinical and investigational data was obtained from all study participants. The authors confirm that no identifying information of any patient has been disclosed in this manuscript.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Conflict of Interest

The authors declare that they have no conflict of interest related to this study. No financial or non-financial competing interests exist.

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Author Contribution

All authors contributed to study conception, data collection, analysis, manuscript preparation, and final approval of the manuscript.

Presentation / Nomination Statement

This work has been prepared from postgraduate thesis data and is submitted for academic publication. The manuscript has not been published previously and is not under consideration elsewhere. The study topic was selected for academic presentation and nomination based on its clinical relevance in evaluating bone mineral density in male patients with type 2 diabetes mellitus.

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