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Relation of diabetic control status in Type 2 diabetes mellitus patients and level of PTH, Vitamin D, Bone marrow density in them

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Abstract

Background: The relationship between parathormone (PTH), vitamin D, BMD, and diabetic control status is of particular significance in understanding the complex interplay between these factors and their impact on bone health in Type 2 diabetic patients. **Aim**: To study the association between PTH, vitamin D levels, BMD, and diabetic control status in patients with Type 2 diabetes. **Methodology**: This cross-sectional observational study was conducted in the Department of Medicine. A total of 50 participants were included in the study. A semi-structured questionnaire was administered and relevant clinical data was obtained. **Result:** As per our finding, level of vitamin D in patients with uncontrolled Diabetes Mellitus was significant (p=0.0047). Also no significant relationship (p=0.5042) between fasting lipid profile and diabetes control was found. **Conclusion:** Most patients with uncontrolled diabetes mellitus had significantly low Vitamin D levels.

Keywords: Bone Mineral density, Vitamin D, Type 2 Diabetes Mellitus

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Introduction

Osteoporosis and Type 2 diabetes mellitus are two common and interrelated chronic conditions that have substantial implications for public health. Osteoporosis is characterized by reduced bone density and an increased susceptibility to fractures, while Type 2 diabetes is a metabolic disorder marked by insulin resistance and hyperglycaemia. These conditions are prevalent worldwide, and their coexistence presents a unique challenge for healthcare professionals.

Osteoporosis and Type 2 diabetes share a complex relationship, with both influencing each other's pathophysiology. Individuals with Type 2 diabetes are known to experience alterations in bone metabolism, potentially leading to reduced bone mineral density (BMD) and an elevated risk of osteoporosis. The relationship between parathormone (PTH), vitamin D, BMD, and diabetic control status is of particular significance in understanding the complex interplay between these factors and their impact on bone health in Type 2 diabetic patients.

This study seeks to explore these intricate associations to provide valuable insights into the management and prevention of osteoporosis in individuals with Type 2 diabetes. Specifically, we aim to investigate the relationship between PTH, vitamin D levels, BMD, and diabetic control status in a cohort of Type 2 diabetic patients. By unravelling these connections, we

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hope to contribute to a deeper understanding of the multifaceted nature of osteoporosis in the context of Type 2 diabetes, ultimately guiding healthcare interventions that promote optimal bone health in this high-risk population.

Understanding the interactions between PTH, vitamin D, BMD, and diabetic control status in Type 2 diabetes is essential to formulate effective strategies for preventing osteoporosis, improving patient outcomes, and enhancing overall quality of life in this vulnerable population.

Aim: To study the association between PTH, vitamin D levels, BMD, and diabetic control status in patients with Type 2 diabetes.

Objectives

1. To assess the relationship between PTH levels and BMD in Type 2 diabetic patients.
2. To examine the association between vitamin D levels and BMD in Type 2 diabetic patients.
3. To evaluate the impact of diabetic control status on BMD in Type 2 diabetic patients.

Material and Methods

1. **Study Setting:** This cross-sectional observational study was conducted in the Department of Medicine in tertiary care hospital.
2. **Study Population and Sample**: The study population consisted of patients with Type 2 Diabetes mellitus in the age group of 45-60 years. The study sample comprised patients with Type 2 Diabetes mellitus who were attending the Department of Medicine.
3. **Study Type and Design:** Observational cross sectional study.
4. **Sample Size**: A total of 50 participants were included in the study.
5. **Selection Criteria:**
    1. **Inclusion Criteria:**
       Patients with Type 2 Diabetes mellitus in the age group of 45-60 years who were attending the medicine Outpatient Department (OPD) of the Department of Medicine, were considered eligible for the study.
    2. **Exclusion Criteria:**
       Patients who did not have Type 2 Diabetes, those in critical medical condition, individuals undergoing anticonvulsant therapy, patients with extensive skin disorders, post-total thyroidectomy patients, individuals with thyroid disorders or other chronic diseases, and those with chronic infectious diseases like HIV or tuberculosis were excluded from the study.
6. **Ethical Considerations:** The study strictly adhered to ethical guidelines and obtained informed consent from all participating patients. Additionally, approval from the hospital's Institutional Review Board was obtained before initiating data collection. Patient privacy and data confidentiality were maintained throughout the study.
7. **Data Collection Procedure:**
    A. **Participant Recruitment:** Eligible participants are identified among patients aged 45-60 years attending the medicine Outpatient Department (OPD) at the Department of Medicine. Potential participants were informed about the study's objectives and the data collection process. Informed consent is obtained from those willing to participate.
    B. **Demographic Questionnaire:** A semi-structured questionnaire is administered to collect demographic information from the participants. The

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questionnaire includes variables such as age, gender, educational background, occupation, duration of diabetes, lifestyle factors (e.g., smoking, physical activity), dietary habits, and medical history.

C. **Clinical Data Collection**: Relevant clinical data are obtained for each participant. This included HbA1c levels, which provide insights into diabetes control. Comorbidities and any other medically relevant information are documented during the clinical assessment.

D. **Bone Mineral Density (BMD) Assessment**: BMD measurements are obtained using Dual-Energy X-ray Absorptiometry (DEXA) scanning. Trained radiology technicians performed the DEXA scans, ensuring standardized procedures and data accuracy. Measurements were typically taken at specific sites, such as the lumbar spine (L1-L4) and the hip (femoral neck and total hip), to assess BMD accurately.

E. **Blood Sample Collection**: Blood samples are drawn from the study participants to assess parathormone (PTH) levels and vitamin D status. Standardized methods for blood collection were employed to ensure sample integrity and reliability.

F. **Data Entry and Management:** Collected data, including demographic, clinical, and BMD information, were entered into a computerized database using software like Microsoft Excel and SPSS. All data entry procedures are conducted with high accuracy to minimize errors.

Results

Table 1: Table showing relation between thyroid profile and diabetes control.

Thyroid Profile	**Hba1c**	
	Controlled n= 13	**Uncontrolled n = 37**
Normal	11 (84.61%)	31 (83.78%)
Sub clinical Hypothyroid	1 (7.69%)	4 (10.81%)
Hypothyroid	1 (7.69%)	2 (5.40%)

Table 1 shows out of 13(26%) patients with controlled Type 2 DM 11 (84.61%) were euthyroid, 1 (7.69%) case was subclinical hypothyroid, and 1(7.69%) case was hypothyroid while out of 37(74%) patients with uncontrolled Type 2 DM, 31(83.78%) were euthyroid, 4(10.81%) cases were subclinical hypothyroid, and 2(5.40%)case were hypothyroid. Only 3(6%) cases had hypothyroidism and 5 (10%) had subclinical hypothyroidism. In our study, it was found that there is no statistically significant difference in prevalence of hypothyroidism in controlled and uncontrolled population.

Table 2: Relation between BMD and diabetes control.

BMD	**Diabetes control**	
	Controlled	**Uncontrolled**
Normal	4(40%)	6(60%)
Osteopenia	7(31.81%)	15 (68.18%)
Osteoporosis	2 (11.11%)	16(88.88%)

Table 2 shows co relation between BMD and diabetes. Out of 10(20%) patients with normal BMD 4 (40%) patients were having control diabetes while 6 (60%) were having uncontrolled diabetes. Out of 22(44%) patients with osteopenic cases 7 (31.81%) patients were having control diabetes while 15 (68.18%) were having uncontrolled diabetes. Out of 18(36%)

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patients with osteoporosis 2 (11.11%) patients were having control diabetes while 16 (88.88%) were having uncontrolled diabetes.

Table 3: Relation between Diabetes control and serum Vitamin D level.

Diabetes control (n=50)	Low vitamin d	Normal vitamin d	Fisher's Exact test
Controlled	4(30.8%)	9(69.2%)	P=0.0047
Uncontrolled	29(78.4%)	8(21.6%)	

Table 3 shows that among total 50 patients with controlled Diabetes, 4(30.8%) were having low Vitamin D And 9(69.2%) were having normal Vitamin D Level. Out of 37(74%) patients with uncontrolled Diabetes, 29(78.4%) were having low Vitamin D and 8(21.6%) were having normal Vitamin D Level. It was found that the level of vitamin D was found to be lower in majority of controlled diabetes patients and the relation is statistically very significant(p=0.0047).

Table 4: Relation of Vit D and Diabetes Control in patients with normal BMD.

Vit D	Diabetes control		Fisher's exact test
	Controlled	Uncontrolled	
Normal	2 (66.66%)	1(33.33%)	
Low level	2(28.57%)	5 (71.42%)	P=0.50

Above table shows correlation between vitamin D and diabetes in patients with normal BMD. 10 patients were taken I study. Out of 3(30%) patients with normal Vit D 2 (66.66%) patients were having control diabetes while 1 (33.33%) was having uncontrolled diabetes while out of 7(70%) patients with low vitamin D cases 2 (28.57%) patients were having control diabetes while 5(71.42%) were having uncontrolled diabetes. Statistical analysis done by Fisher's test shows that there in no significant relationship present (p=0.5000) between Vit D and diabetes control.

Table 5: Relation of Vit D and Diabetes Control in patients with osteopenia.

Vit D	Diabetes control		Fisher's exact test
	Controlled	Uncontrolled	
Normal	4 (40.%)	6 (66%)	
Low level	3 (25%)	9 (75%)	P=0.6517

Above table shows correlation between vitamin D and diabetes in osteopenic patients. 22 patients were taken in study. Out of 10(45.45%) patients with normal Vit D 4 (40%) patient were having control diabetes while 6 (60%) were having uncontrolled diabetes while out of 12(54.54%) patients with low vitamin D cases 3 (25%) patient were having control diabetes while 9 (75%) were having uncontrolled diabetes. Statistical analysis done by Fisher's test shows that there is no significant relationship present (p=0.6517) between Vit D and diabetes control.

Table 6: Relation of Vit D and Diabetes Control in osteoporotic patients.

Vit D	Diabetes control		Fisher's exact test
	Controlled	Uncontrolled	
Normal	1 (33.33%)	2 (66.66%)	
Low Level	1 (6.66%)	14 (93.33%)	P=0.3137

Above table shows correlation between vitamin D and diabetes in osteoporotic patient. 18 patients were taken in study. Out of 3(16.66%) patients with normal Vit D 1

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(33.33%) patients was having control diabetes while 2 (66.66%) were having uncontrolled diabetes while out of 15(83.33%) patients with low vitamin D cases 1 (6.66%) patients was having control diabetes while 14 (93.33%) were having uncontrolled diabetes. Statistical analysis done by Fisher's test shows that there is no significant relationship present (p=0.3137) between Vit D and diabetes control.

Table 7: Relation between fasting lipid profile and diabetic control.

Fasting lipid	Diabetes control		Fisher's exact test
	Controlled (n=13)	Uncontrolled (n=37)	P=0.5042
Normal	6(46.2%)	12 (32.4%)	
Dyslipidaemia	7 (53.8%)	25 (67.6%)	

Above table shows that the out of 13 patients with controlled Diabetes, 6 (46.2%) were having normal lipid profile, while 7 (53.8%) cases were having dyslipidemia while out of 37 patients with uncontrolled Diabetes, 12 (32.4%) were having normal lipid profile, while 25 (67.6%) cases were having dyslipidaemia. Statistical analysis done by Fisher's test shows that there is no significant relationship present (p=0.5042) between fasting lipid profile and diabetes control.

Discussion

Type 2 Diabetes Mellitus (DM) is a major cause of mortality, but several studies indicate that diabetes is likely underreported as a cause of death. This study has reconfirmed that a large proportion of patients with Type 2 DM has developed osteoporosis due to vitamin D deficiency and diabetic complication and interrelationship between vitamin D, Parathormone (PTH) and Bone mineral density (BMD).

As per results, 16% of patients had evidence of thyroid dysfunction of which 3(37.5%) had Hypothyroidism and 5(62.5%) had subclinical hypothyroidism. In our study, it was found that there is no statistically significant difference in prevalence of Hypothyroidism in controlled and uncontrolled population.

Similar prevalence of thyroid disease in diabetic population was reported to be 16.3% In a study in Saudi Arabia by Akbar *et al.*[8] In a study by Perez *et al.*, the prevalence of hypothyroidism in patient with Type 2 DM was 5.7%.[9] In a study by Athanasia *et al.* the prevalence of thyroid dysfunction among Greek diabetic patients is 12.3%.[10] A study done by Patricia Wu at el prevalence of thyroid disease is in T2DM is 10.81% of which the prevalence of Hypothyroidism was 36%, subclinical hypothyroidism was 51.3% comparable with our study results. In a study by Palma *et al.* in-Diabetes mellitus, Subclinical hypothyroidism was the most frequent dysfunction found corresponding to 11.8% of the patients.[11] New thyroid disease was diagnosed in 6.8% (89 patients) of the population screened; the commonest diagnosis was subclinical hypothyroidism (4.8%) followed by hypothyroidism (0.9%), hyperthyroidism 0.5%), and subclinical hyperthyroidism (0.5%) [12]. The NHANES III study reported that the prevalence of subclinical hyperthyroidism was 3.4% in males and 5.8% in females [13]. In addition, a study in 420 adult females with T2D randomly selected from participants in the community- based Fremantle Diabetes Study showed that the prevalence of subclinical hyperthyroidism was 8.6%[14]. Finally, a recent study revealed that the prevalence of subclinical hyperthyroidism was 5.2% in males and 8.4% in females with T2DM.[15]

The study of relation between BMD and parathormone levels in patients with normal Vitamin D levels showed that, most patients with osteopenia and osteoporosis had normal PTH as compared to an expected hyperparathyroidism. But amongst patients with low Vitamin D

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levels, it was observed that most of the patients with osteopenia had normal Vitamin D levels and most of the patients with osteoporosis had hyperparathyroidism.

The analysis of the relation between Vitamin D and Diabetes control in patients with normal BMD showed that there is no statistically significant difference in levels of Vitamin D. As per our finding, level of vitamin D in patients with uncontrolled Diabetes Mellitus was significant (p=0.0047). In a study by Daga *et al.*, it was found that the vitamin D levels were significantly low in Diabetic patients than controls without Diabetes.[16] Similarly in a study by Mohammad Alhumaidi *et al.* it was found that prevalence of vitamin D deficiency is 76.6% in diabetic patient.[17] Similarly, the analysis of the relation between Vitamin D and Diabetes control in patients with osteopenia showed that there is no statistically significant difference in levels of Vitamin D.

As per analysis of the relation between Vitamin D and Diabetes control in patients with osteoporosis showed that there is no statistically significant difference in levels of Vitamin D.

Also in patients with osteopenia, most of the patients with normal and low Vitamin D had normal PTH levels contrary to the expected Hyperparathyroidism in all. The normal levels of parathormone level may be attributed to the coexisting hypophosphatemia.

It is expected that patients with hypovitaminosis D should have a secondary hyperparathyroidism. But to the contrary, our study showed that most of the patients with hypovitaminosis D had normal or low parathormone levels. A negative relationship has been observed between BMD of the hip and serum PTH [18,19,20]. As it has suggested in previous studies, the variability of PTH in hypovitaminosis D may be due to concomitant magnesium deficiency.[21] Patel *et al.*[22] suggested that glomerular filtration rate is the single most important factor in maintain PTH levels. Gunnarsson *et al.*,[23] while supporting the kidney function hypothesis, felt that body mass index may play a role in women by lbunting the levels of PTH and added that in men, insulin-like growth factor 1, smoking and testosterone levels may do the same.

As per our analysis, among patients with osteoporosis, 4(25%) had controlled Diabetes mellitus and 12(75%) had uncontrolled diabetes. Among patients with osteopenia, 3(23.07%) had controlled Diabetes mellitus and 10(76.92%) had uncontrolled diabetes mellitus.

The study by Albright & Reifenstein study [43] and Mima *et al.* [44] also showed that Diabetes Mellitus is associated with osteoporosis. The Moghimi *et al.* study showed that diabetic women had lower T-Score and were more prone to osteoporotic in comparison with healthy women [45]. Also Roe *et al.* showed that vertebral bone density in insulin-dependent diabetic children is lower than that in healthy children [43].

As shown in results, 64% cases had dyslipidaemia cases in that 67.6% had uncontrolled diabetes. Similar results were shown in study done by Mithal *et al.* who found a 48% prevalence of dyslipidaemia in diabetic patients (44). The study by Jayram *et al.* [45] which showed 44.2% males and 42.97% females had dyslipidaemia were comparable with our study.

Conclusion

- The following conclusions were made from the present study:

1. At enrolment the prevalence of uncontrolled Diabetes mellitus was 84%.
2. Thyroid dysfunction was present in 16% of patients of which subclinical Hypothyroidism was the most common(62.5%) abnormality seen followed by overt hypothyroidism (37.5%) had subclinical hypothyroidism.
3. Most of the patients with osteoporosis had hyperparathyroidism, but most with osteopenia had normal parathormone levels.

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4. Most patients with uncontrolled diabetes mellitus had significantly low (p=0.0047) Vitamin D levels.
5. In patients with osteopenia, most of the patients with normal and low Vitamin D had normal PTH levels contrary to the expected Hyperparathyroidism.
6. In osteoporotic patients with uncontrolled diabetes, most of the patients had normal parathormone levels as against the expected hyperparathyroidism.
7. No significant correlation existed between thyroid profile and osteoporosis.
8. Dyslipidaemia was common in patients with Type 2 Diabetes mellitus with a prevalence of 65%.

Limitations

The present study had limitations of being a hospital based. The present study showed that there is a high prevalence of osteoporosis and osteopenia in patients with Diabetes mellitus. Similarly, the prevalence of other endocrine abnormalities like hypothyroidism and hypovitaminosis D is common in patients with Diabetes mellitus. The study also showed a predominant hypoparathyroidism or normal parathormone levels in contrary to the expected hyperparathyroidism in patients with hypovitaminosis D. Further investigations may be warranted regarding the exact reasons behind this unexpected relation between Vitamin D and Parathormone levels. Also, studies in a larger population may be warranted for confirmation of obtained results.

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