The Relationship Between Osteoporosis and Parathyroid Hormone by Measuring Some Biochemical Parameters in Patients with Diabetes Mellitus

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Abstract

Diabetes mellitus is widely recognized as a metabolic disorder that can negatively affect multiple body system ,especially in patients with poor glycemic control. Osteoporosis is considered one of the complications associated with diabetes due to disturbances in bone metabolism and mineral balance. Parathyroid hormone (PTH) plays an important role in calcium regulation and bone turnover. This study aimed to evaluate the relationship between osteoporosis and PTH levels in patients with type 2 diabetes mellitus and to assess selected biochemical parameters. This case study was conducted at Al-Hussein Teaching Hospital in Al-Muthanna Province,Iraq. A total of 61 participants were included and divided into three groups: diabetic patients with osteoporosis (n=17 including 12 males and 5 females), diabetic patients without osteoporosis (n= 22 including 7 males and 15 females), and healthy group (n=22 including 11 males and 11 females). Blood samples were collected after fasting and analyzed for fasting blood sugar (FBS), glycated hemoglobin (HbA1c), calcium, phosphate, alkaline phosphatase (ALP), PTH, and 25-hydroxyvitamin D levels. The results showed that PTH, ALP, PO4, FBS and HbA1c levels were higher in diabetic patients with osteoporosis compared to other groups, while vitamin D levels were lower. No significant difference was observed in calcium levels among the groups. In conclusion, diabetes mellitus is associated with changes in bone-related biochemical markers, and monitoring these parameters may help in early detection of osteoporosis.

Keywords: Osteoporosis, type 2 diabetes, Parathyroid Hormones, Vitmin D.

Introduction:

Diabetes mellitus (DM) is a multifactorial metabolic disorder associated with a wide range of chronic complications affecting multiple organ systems [1,2]. An important global health concern is the increasing prevalence of diabetes in the world, which is due mainly to the aging of the population, as well as a lack of physical activity and poor dietary habits [3,4]. Among the many complications of diabetes that affect the cardiovascular, renal, and neurological systems, the complications of diabetes on the

skeletoarticular systems are important as are being identified in research and in the clinics [5].

Chronic hyperglycemia has various effects on bone tissue. High blood sugar leads to an increase in oxidative stress, advanced glycation end products, and impaired osteoblast function, causing disruption in bone formation and maintenance [6,7]. Osteoporosis is a condition characterized by reduced bone mass and deterioration of bone microarchitecture, resulting in increased bone fragility and a higher risk of fractures[8,9]. In type 2 diabetes mellitus patients, bone loss due to age may become more pronounced, and the typical bone remodeling processes may become even more disrupted [11]. Dual energy X-ray absorptiometry (DEXA) remains the references standard for evaluating bone mineral density and estimating fracture [12, 13]. Diabetes, PTH, vitamin D, and other bone metabolism-related markers can help identify patients at risk for osteoporotic fractures. Recent studies have highlighted the significant role of biochemical markers in assessing bone alterations in diabetic patients [25]. Diabetes, PTH, vitamin D, and other bone metabolism-related markers can help identify patients at risk for osteoporotic fractures. Primary prevention of fractures can improve diabetic patients' quality of life. Therefore, this study aimed to investigate the relationship between osteoporosis and PTH levels in patients with type 2 diabetes mellitus , with a focus on selected biochemical parameters related to bone metabolism.

2. Methodology (Experimental Procedure)

This case–control study was conducted between February and April 2023 at the Endocrinology and Diabetes Center, Al-Hussein Teaching Hospital, Al-Muthanna Province, Iraq. A total of 61 participants were enrolled and divided into three groups: healthy individuals (control group), patients with type 2 diabetes mellitus without osteoporosis, and patients with type 2 diabetes mellitus diagnosed with osteoporosis. Blood sampling and biochemical analysis:Approximately 5mL of venous blood was collected from each participant after overnight fasting under aseptic conditions. Blood samples were left to clot at room temperature and subsequently centrifuged to separate the serum. The obtained serum was then collected and stored at -20ºC until further analysis. The biochemical parameters assessed in this study included fasting blood glucose (FBS), glycated hemoglobin (HbA1c), calcium, phosphate, alkaline phosphatase (ALP), parathyroid hormone (PTH), and 25-hydroxyvitamin D.

Fasting blood glucose, calcium, phosphate, and alkaline phosphatase were measured using standard spectrophotometric techniques. Parathyroid hormone (PTH) concentrations were determined by enzyme-

linked immunosorbent assay (ELISA), whereas vitamin D levels were evaluated using an automated immunoassay system.

Demographic and clinical data (age and sex) were sourced from medical records and structured interviews. Hem venous blood samples were drawn after an overnight fasting (for blood glucose) and then measured using standard spectrophotometric techniques for fasting blood sugar, calcium, phosphate, and alkaline phosphatase. An enzyme-linked immunosorbent assay was used to measure PTH levels, while an automated immunoassay system was used to assess vitamin D status through serum 25-hydroxyvitamin D levels.

Statistical analysis was carried out using SPSS software (version 15.0; IBM Corp., Armonk, NY,USA). The results were expressed as mean ± standard deviation (SD). Group comparisons were performed using the independent t-test and one-way analysis of variance (ANOVA) in accordance with standard statistical methods (Field, 2009). A p-value of less than 0.05 was considered statistically significant [26].

3. Results

The demographic characteristics of the the participants are summarized in Table 1.

No statistically significant differences were observed in age or sex among the study groups, suggesting that they were comparable at baseline. However, analysis of glycemic parameters showed significantly higher levels of fasting blood glucose and HbA1c in diabetic groups compared to the healthy group.

Significant differences were observed among the study groups in several biochemical parameters (Table 2). patients with type 2 diabetes mellitus and osteoporosis showed higher levels of parathyroid hormone (PTH), fasting blood glucose (FBS), glycated hemoglobin (HbA1c), phosphate, and alkaline phosphatase (ALP) compared to both diabetic patients without osteoporosis and healthy controls ($p<0.05$). In contrast, vitamin D levels were significantly lower in diabetic patients with osteoporosis ($p<0.05$). However, no significant differences was found in serum calcium levels among the studied groups ($p>0.05$). These findings are further illustrated in Figure 1.

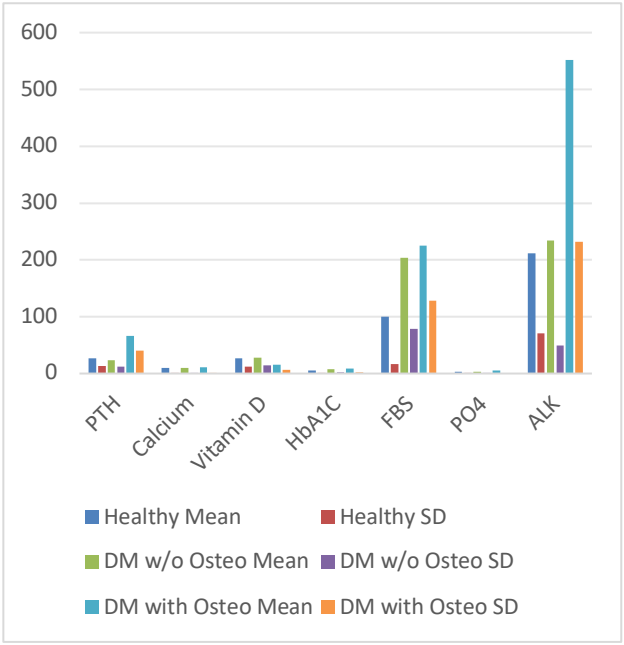

Fig.(1): Comparison of Biochemical Parameters (PTH,ALP,FBS, HbA1c, phosphate, vitamin D, and calcium) among the three study groups.

Sex based analysis revealed significant differences in several parameters (Table 3). Female patients showed more pronounced alterations in PTH, ALP, HbA1c, and phosphate levels compared to males ($p < 0.05$).

Table 1: The table summarizes demographic info for participants from the three study groups.

Parameter	Healthy Mean ± SD)(	Diabetes without osteoporosis (Mean ± SD)	Diabetes with osteoporosis (Mean ± SD)
Age	46.13±12.13	51.63±11.781	35.64±25.97
Gender(M/F)	11/11	7/15	12/5

Table 2: Biochemical parameters among study participants.

Biochemical Markers	Healthy (Mean ± SD)	Diabetes without osteoporosis (Mean ± SD)	Diabetes with osteoporosis (Mean ± SD)	P-Value
PTH(pg/ml)	26.4±13.11	23.5±11.92	66.06±40.5	<0.0001 (****)
Calcium(mg/dl)	9.84±0.57	9.8±0.52	10.88±0.52	0.59 (ns)
Vitamin D(ng/ml)	26.58±11.72	27.9±14.49	15.31±6.27	0.0029 (**)
HbA1C(%)	5.34±0.42	8.01±1.65	8.26±1.81	<0.0001 (****)
FBS(mg/dl)	99.63±16.74	203.31±79.04	225.41±128.1	<0.0001 (****)
PO4(mg/dl)	3.56±0.76	3.5±0.87	5.25±1.22	<0.0001 (****)
ALK(U/L)	211.45±70.96	234.2±48.88	552.17±232.3	<0.0001 (****)

Table 3: Analysis of Biochemical Parameters Based on Sex

Comparison of biochemical parameters based on sex among healthy and diabetic patients, with and without osteoporosis.

Parameters	Male Healthy	Male Diabetes without osteoporosis	Male Diabetes with Osteoporosis	P-value	Female Healthy	Female Diabetes without osteoporosis	Female Diabetes with Osteoporosis	P-value
PTH(pg/ml)	31.98±14.3	23.1±12.68	54.34±44.3	0.025 (*)	20.83±9.3	24.37±11.1	70.94±39.8	0.0002 (***)
Ca(mg/dl)	9.8±0.73	9.8±0.49	10.88±0.52	0.0046 (**)	9.8±0.39	9.6±0.61	9.87±2.62	0.97 (ns)
Vitamin D(ng/ml)	32.89±11.79	31.73±15.49	16.61±7.03	0.07 (ns)	20.27±7.88	19.7±7.75	14.77±6.17	0.16 (ns)
HbA1C(%)	5.34±0.38	8.49±1.73	7.65±1.43	<0.0001 (****)	5.33±0.47	6.96±0.86	8.51±1.95	0.0001 (****)
FBS(mg/dl)	97.09±16.65	214.5±83.21	179.4±86.71	0.0007 (***)	102.2±17.24	179.4±68.82	244.6±140.6	0.005 (**)
PO4(mg/dl)	3.54±0.81	3.39±0.75	4.63±1.85	0.06 (ns)	3.59±0.74	3.77±1.09	5.51±0.82	<0.0001 (****)
ALK(U/L)	197.8±75.04	238.4±49.67	459.4±249.3	0.0005 (***)	225.1±67.35	225.4±49.76	590.8±224.5	<0.0001 (****)

4.Discussion

The findings of this study indicate that diabetes mellitus is associated with changes in the bone metabolism, particularly in patients developing osteoporsis. Diabetic patients with FBS and hbA1c levels indicated poor glycemic control and showed considerable changes in bone related biochemical markers. This is in agrement with other studies where chronic hyperglycemia is shown to adversely affect bone health [14,15].

An important discovery was the rise of the parathyroid hormone (PTH) levels in the diabetic patients with osteoporosis. This increase may be a compensatory response to the changes in vitamin D and minerals that would increase the rate of bone loss [16,17]. Comparable results have been

documented in other studies with diabetic patients with compromised bone health [18,20]. Diabetic patients with osteoporsis had significantly lower levels of vitamin D, which may lead to poorer calcium absorption and increased PTH secretion [17]. Serum calcium levels were rather stable, this seems to show more regulation of the calcium homeostasis mechanism than to the maintenance of the bone structure [10,13]. The analysis by gender showed that female patients had more serious problems with their biochemistry than male patients. This is consistent with studies demonstrating that women suffer from osteoporosis more than men, especially when there are metabolic problems [21]. Moreover, when comparing bone problems with diabetes, patients with diabetes showed bone problems beyond aging. This suggests that diabetes-related bone problems begin early in life [22].These findings show the value of satisfying both the assessement of glycemic control and evaluation of bone-related biochemical markers in clinical practice. The might help in the early diagnosis of osteoporosis among diabetic patients and assist in early preventive and the therapeutic measures [23,24].

5. Conclusions

Patients with osteoporosis may experience greater complications as diabetes mellitus can further disrupt normal bone metabolism and worsen bone health. Increased vitamin D deficiency, PTH, and alkaline phosphate disruptions due to abnormal bone remodeling signify deficiency. In diabetes, monitoring biochemical markers related to the bone is essential to implement preventative strategies on the diabetes patients with high bone metabolism risks.

Even through serum seems to show the same levels throughout the study groups, it shows more regulation of calcium due to the more hormonal factors present and less due to the intactness of the bone. In addition, the more biochemical imbalances noticed in the female cases indicate that women suffer more due to related factors along the bone diabetic deficiency. In all, the combination of glycemic control together with the consideration of bone metabolism markers can assist in the early diagnosis and management of diabetes-induced osteoporosis.

Gridiate Author Contributions Statements

The authors contributed equally to the conception, design, data collection, analysis, and writing of the manuscript .

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Data Availability statement

The data supporting findings of this study are available from corresponding authors upon responsible request.

Conflict of Interest Statement

The authors confirm that they have no competing interest related to the publication of this paper.

Ethical considerations

Ethical approval for this study was obtained from the Institutional Review Board of the Directorate of Health in Al-Muthanna Province, Iraq (Approval No.94.(

Informed consent

Written informed consent was obtained from all participants included in the study.

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