

## *Correlation of bone mineral density in elderly patients with type 2 diabetes mellitus*

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**Abstract:** Objective to explore the relationship between glycosylated hemoglobin (HbA1c), hemoglobin (Hb) and bone mineral density in elderly patients with type 2 diabetes mellitus. Methods 154 elderly patients with type 2 diabetes mellitus in the inpatient department of Xi'an Hospital of Traditional Chinese Medicine were selected, and their HbA1c was measured. According to the HbA1c level, they were divided into two groups: group A (73 cases with HbA1c < 7.0%) and group B (81 cases with HbA1c ≥ 7.0%). Age, body mass index (BMI), hemoglobin (Hb) and bone mineral density (BMD) were measured respectively. Results There was no statistically significant difference between HbA1c and bone mineral density in elderly T2DM patients in group A (P > 0.05), but there was a statistically significant difference between HbA1c and bone mineral density in group B (P < 0.05). According to the analysis of related factors of bone mineral density, there was a correlation between bone mineral density and Hb, BMI and age, and the difference was statistically significant (P < 0.05). It is discussed that when HbA1c ≥ 7.0% in elderly T2DM patients, the bone density T value obviously decreases, which increases the risk of osteoporosis, and there is a positive correlation between bone density T value and Hb and BMI. The decrease of Hb and BMI may increase the risk of osteoporosis.

### 1. Introduction

With the aging society and the improvement of living standards, the incidence of diabetes is getting higher and higher <sup>[1]</sup>. Diabetes mellitus is a metabolic disease characterized by relative or absolute insufficiency of insulin secretion, which mainly causes metabolic disorder, thus causing diseases of many organs such as heart, kidney, eyes, blood vessels and bones <sup>[2]</sup>. The incidence of osteoporosis in patients with type 2 diabetes mellitus is 37.8%, of which 40.1% are elderly people over 60 years old <sup>[3]</sup>. Diabetic osteoporosis is a complication with high incidence among diabetic complications <sup>[4]</sup>. Epidemiological survey shows that the incidence of DOP among diabetic patients can reach 60% <sup>[5]</sup>. DOP is a secondary osteoporosis, a common chronic metabolic complication of diabetes, characterized by hyperglycemia, decreased bone density and easy fracture <sup>[6]</sup>. The purpose of this paper is to study the correlation between glycosylated hemoglobin level, hemoglobin and bone mineral density in patients with type 2 diabetes, so as to facilitate early prevention and treatment of

osteoporosis in clinic.

## 2. Materials and methods

### 2.1 Material collection

① Inclusion criteria: 154 patients in Xi'an Hospital of Traditional Chinese Medicine from January 2020 to January 2021 were selected. According to the definition of the elderly by WHO, T2DM patients aged  $\geq 60$  years were taken as the research object. ② Diagnostic criteria: All patients meet the diagnostic criteria of diabetes in 2017 guidelines for diabetes prevention and treatment, and the symptoms of diabetes (polydipsia, polyuria and unexplained weight loss)+plasma glucose  $\geq 11.1$  mmol/L at any time, or fasting blood glucose  $\geq 7.0$  mmol/L, or glucose tolerance test  $\geq 11.1$  mmol/L; Those with atypical symptoms need to be confirmed again. ③ Case exclusion: Type I diabetes and other diabetes, taking drugs that affect bone metabolism, long-term bed-rest history, excluding other diseases that affect bone metabolism, such as hyperthyroidism, connective tissue diseases and taking glucocorticoids. ④ Grouping: According to the goal of blood sugar control in China's diabetes guidelines in 2017, the patients with HbA1c were divided into group A (73 cases of HbA1c  $< 7.0\%$ ) and group B (81 cases of HbA1c  $\geq 7.0\%$ ).

### 2.2 Research methods

On the second day after admission of 154 T2DM patients, venous blood was collected to measure blood routine, fasting venous blood was taken to measure HbA1c and lumbar L1 ~ 4 bone density. HbA1c was determined by HPLC. Bone mineral density was measured by France MEDILINKOST EOCORE dual-energy X-ray bone densitometer. The bone mineral density of patients' lumbar L1~4 was measured. The automatically measured T value was used as the bone mineral density value. According to the WHO diagnostic standard T value score, the T value was less than -2.5, which was osteoporosis.  $-1 \leq T \leq -2.5$  is the decrease of bone mass; A value of  $T < -1$  indicates normal bone mass<sup>[7]</sup>.

### 2.3 Statistical methods

Use SPSS 25.0 software for data analysis. The measurement data conforming to normal distribution is expressed by ( $\bar{x} \pm s$ ). Pearson correlation was used to analyze the correlation between glycosylated hemoglobin and bone mineral density in elderly T2DM patients in group A and B. Pearson simple correlation method was used to analyze the correlation factors between bone mineral density and age, BMI and Hb.  $P < 0.05$  is the difference with statistical significance.

## 3. Results

### 3.1 General information

The bone mineral density T value of group A was  $< (1.962 \pm 1.13)$ , while that of group B was  $< (2.54 \pm 0.93)$ . Pearson correlation analysis showed that there was no significant difference between glycosylated hemoglobin and bone density in group A ( $r = -0.173$ ,  $P > 0.05$ ), but there was significant difference between glycosylated hemoglobin and bone density in group B ( $r = -0.237$ ,  $P < 0.05$ ). Comparing the two groups, the bone mineral density of group B is lower than that of group A, and the difference between the two groups is statistically significant ( $P < 0.05$ ).

### 3.2 Comparative analysis of glycosylated hemoglobin and bone mineral density in two groups of elderly T2DM patients

The bone mineral density T value of group A was  $< (1.962 \pm 1.13)$ , while that of group B was  $< (2.54 \pm 0.93)$ . Pearson correlation analysis showed that there was no significant difference between glycosylated hemoglobin and bone density in group A ( $r = < 0.173, P > 0.05$ ), but there was significant difference between glycosylated hemoglobin and bone density in group B ( $r = < 0.237, P > 0.05$ ). Compared between the two groups, the bone mineral density of group B is lower than that of group A, and the difference between the two groups is statistically significant ( $P < 0.05$ ). Pearson correlation analysis showed that there was a correlation between glycosylated hemoglobin and bone mineral density in 154 elderly patients with type 2 diabetes mellitus ( $r = < 0.330, P < 0.01$ ). See table 1.

Table 1: Glycosylated hemoglobin in two groups of elderly patients with type 2 diabetes mellitus  
Correlation with bone mineral density

	cases	HbA1c	T	r	P
Group a	73	6.215	-1.96±1.13	-0.173	0.142
Group b	81	8.306	-2.54±0.93	-0.237	0.033
comprehensive	154	7.315±1.345	-2.266±1.065	-0.330	0.000

### 3.3 Analysis of related factors of bone mineral density in elderly patients with type 2 diabetes mellitus

Pearson univariate correlation analysis showed that Hb level was positively correlated with lumbar bone density ( $r=0.269, P < 0.01$ ). There was a negative correlation with age and lumbar bone mineral density ( $r = < 0.224, P < 0.01$ ). There is a positive correlation between BMI and lumbar bone mineral density ( $r=0.201, P < 0.05$ ). See table 2.

Table 2: Analysis of related factors of bone mineral density in elderly patients with type 2 diabetes mellitus

project	bone density	
	r	P
BMI	0.201	0.013
Hb	0.269	0.001

## 4. Discussion

Osteoporosis and T2DM are common diseases of the elderly. With the increase of age, the occurrence of osteoporosis and the increased risk of falls will lead to fractures, which will further affect the quality of life of the elderly and increase the risk of hospitalization and death<sup>[8]</sup> and osteoporosis is the highest risk factor of all-cause death of the elderly<sup>[9]</sup>. Moreover, T2DM patients are more prone to fracture than normal people. According to the research of Salamat and others<sup>[10]</sup>, even with higher bone density, the fracture risk of T2DM patients is at least 4 times higher than that of normal people.

The mechanism of diabetes-induced osteoporosis is complex, which is currently considered to be mainly related to hyperglycemia, insulin-like, advanced glycation end products and so on<sup>[11]</sup>. The main influencing mechanisms of hyperglycemia on bone metabolism are: osmotic diuresis caused by hyperglycemia, promoting calcium and phosphorus excretion, increasing bone calcium mobilization and decalcification, leading to the decrease of bone density and osteoporosis; Strict diet control of diabetic patients will cause gastrointestinal dysfunction, insufficient intake of calcium and

phosphorus, and increase bone resorption. Glucose itself can stimulate osteoclast differentiation<sup>[12]</sup>. In the research results of Fu Wenping<sup>[13]</sup>. The results showed that the levels of blood AGEs in diabetic patients were significantly higher than those in healthy people, and the levels of serum AGEs in simple diabetes, diabetes with osteopenia and diabetes with osteoporosis increased in turn. Serum AGEs had an influence on diabetes, bone density reduction and osteoporosis. Sun Mingjin et al<sup>[14]</sup> showed that the level of IGF-1 in patients with type 2 diabetes mellitus was significantly lower before and after blood glucose control, and the bone density was positively correlated with it ( $P < 0.05$ ), so it was speculated that the decrease of IGF-1 secretion was related to the decrease of bone formation in type 2 diabetes mellitus. Studies have shown that by studying the biochemical indexes of bone, it is found that the C-peptide of type I collagen in urine is increased and the osteocalcin is decreased, which indicates that the bone formation of patients with type 2 diabetes is decreased and the bone resorption is increased<sup>[15]</sup>.

A few scholars at home and abroad have discussed the relationship among HbA1c, Hb and bone mineral density. When Yu Zhou<sup>[3]</sup> and others studied the relationship between HbA1c and bone mineral density, they found that when  $HbA1c \geq 7.0\%$ , the bone mineral density T value decreased significantly, which was consistent with the conclusions of group A and group B in this study. Fu Mengfei et al.<sup>[16]</sup> showed that glycosylated hemoglobin was positively correlated with osteoporosis through MATE analysis of influencing factors of osteoporosis in type 2 diabetic population. GEVA, a foreign scholar, also thinks that after HbA1c rises, triacylglycerol drops, thus BMI drops, which has a protective effect on bone<sup>[17]</sup>. High BMI can increase the mechanical load of bone tissue, reduce bone resorption and stimulate bone formation, and the decline of BMI will inevitably lead to an increase in the incidence of osteoporosis<sup>[18]</sup>, which is consistent with the positive correlation between BMI and bone density T value analyzed in this paper. However, some scholars believe that there is no relationship between glycosylated hemoglobin and bone mineral density in male diabetic patients<sup>[19]</sup>. According to the above viewpoints, there are differences between glycosylated hemoglobin and bone mineral density, and the results of this study are consistent with those of Yu Zhou, Fu Mengfei and others. Korkmaz and others also found that anemia with low Hb can affect bone metabolism, which leads to the decrease of bone density, thus increasing the risk of osteoporosis<sup>[20]</sup>. In the research of Xiu Shuangling<sup>[21]</sup> and others, it was found that Hb in elderly T2DM patients was significantly correlated with bone mineral density, and Hb was an independent influencing factor of osteoporosis. It is consistent with the results of this study, but some studies have shown that there is no correlation between bone mineral density and Hb level<sup>[22]</sup>. This paper only analyzes the correlation between Hb and bone mineral density, but can't judge the causal relationship between them, which needs to be further explored in the future.

From this study, it can be seen that when  $HbA1c \geq 7.0\%$  in elderly T2DM patients, the probability of osteoporosis will probably increase when the bone density T value is obviously reduced, but when  $HbA1c < 7.0\%$ , it does not mean that it can inhibit and delay the development of bone density, and the influence on bone density may also be related to BMI, Hb, etc. There are not many cases in this study, and only the T value of lumbar bone mineral density has been measured. The relationship between HbA1c, Hb and bone mineral density T value needs further exploration. However, it is of great significance for the elderly patients with T2DM to control the blood sugar to reach the standard, and at the same time, it is necessary to prevent the decrease of Hb and BMI.

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