Original Article

Correlation Between Bone Mineral Density and Anthropometric and Glycemic Parameters in Type 1 Diabetic Children

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Background: The foundation of bone health is established during the pre and postnatal developmental stages especially childhood and adolescence. During this period the bone development may be altered by genetic and acquired disorders. Type 1 diabetes mellitus is one of chronic diseases in children and has great impact on the growth of children.

Objective: To access bone mineral density in type 1 diabetic children of 9-15 years as compared to age matched healthy subjects and correlate these values with anthropometric and glycemic parameters.

Subjects and Methods: This cross sectional study was carried out in 60 boys 9-15 years old , in Department of Physiology, University of Health Sciences, Lahore. The control group consisted of 30 healthy boys and diabetic group comprised of 30 boys suffering from type 1 diabetes mellitus. Weight, height were measured and BMI was calculated. Fasting blood glucose was determined by glucose oxidase method and HbA1c by affinity liquid chromatography. Bone mineral density was measured with bone profiler based on quantitative ultrasound measurement (QUS).

Results: There was statistically non significant ($p > 0.05$) difference of bone mineral density in diabetic and non-diabetic boys. The correlations between bone mineral density and anthropometric and glycemic parameters were not significant ($p > 0.05$).A significant negative ($p < 0.05$) correlation was observed between duration of diabetes and height. Significant ($p < 0.05$) positive correlations were also observed between age and weight and age and height in diabetic boys.

Conclusion: In type 1 diabetic children, bone mineral density, height and weight are not significantly affected by glycemic parameters but duration of diabetes has a significant negative impact on height in children.

Keywords: Type 1 diabetes mellitus, bone mineral density, quantitative ultrasound measurement (QUS), body mass index (BMI), fasting blood glucose.

Introduction

Diabetes mellitus (DM) is a heterogeneous group of syndromes characterized by an elevation of fasting plasma glucose that is caused by a relative or absolute deficiency of insulin.[1] Diabetes mellitus can affect almost every system in the body.[2] Insulin deficiency as occurs in type 1 diabetes mellitus or tissue resistance to insulin in type II DM, both are associated with several deleterious consequences related with skeletal growth.[3]

Evidence shows that type 1 DM along with poor glycemic control disturbs the growth hormone insulin like growth factor (GH-IGF) axis resulting in alteration of the levels of bone resorption factors like parathyroid hormone (PTH), type 1 collagen cross linked carboxy terminal telopeptide (1CTP) and bone formation markers such as bone alkaline phosphatase and osteocalcin resulting in decreased bone mineral density (BMD).[4,5]

Children and adolescents with type 1 DM show severe impairment of bone metabolism and structure resulting in a higher risk of decreased bone mass and its related complications later in life.[6]

The pathogenesis of osteopenia in type 1 diabetic patients is not clear.[7] Osteopenia is the consequence of lowered bone formation with predominance of bone resorption in male patients with insulin dependent diabetes mellitus.[8]

Several mechanisms are thought to contribute to skeletal damage in diabetes mellitus including the increased urinary excretion coupled with lower intestinal absorption of calcium, the inappropriate homeostatic response in terms of parathyroid hormone and alteration of vitamin D regulation.[9]

The purpose of this study was to access bone mineral density in type 1 diabetic children of 9-15 years as

compared to age matched healthy subjects and correlate these values with anthropometric and glycemic parameters.

Material and Methods

This cross sectional study was carried out in Department of Physiology, University of Health Sciences, Lahore.

Sixty boys 9-15 years old were selected. The control group consisted of 30 healthy boys and diabetic group comprised of 30 boys suffering from type 1 diabetes mellitus. Children having co-morbidity of other endocrinopathies or history of bone surgery/ malignancy were excluded from the study. Blood sample was drawn after overnight fasting of 12 hours. Weight and height were measured and BMI was calculated. Fasting blood glucose was determined by glucose oxidase method and HbA1c concentrations were found out by affinity liquid chromatography. Bone mineral density was determined with bone profiler based on quantitative ultrasound measurement, Z score was determined according to WHO criteria.[10] All calculations were carried out with SPSS version 15. Arithmetic mean and standard deviation (SD) of each parameter were determined. The significance of differences among the two groups was analyzed by student's t-test. Pearson's correlation coefficient was used to determine correlation between variables of interest. P value <0.05 was considered statistically significant.

Results

No significant differences were observed in the value of weight, height and BMI ($p>0.05$) between the type 1 diabetics and non-diabetic controls. HbA1c and fasting plasma glucose levels were high significantly ($p<0.01$) in diabetic boys as compared to the control group **(Table 1)**

Table-1: Anthropometric and glycemic parameters of type 1 diabetics and non-diabetics

Parameters	Controls (n=30)	Type 1 diabetes (n=30)	p value
Chronological age (CA) (years)	12.77±1.77	12.27±1.91	>0.05*
Duration of diabetes (years)	-	3.5±2.3	-
Weight (kg)	39.77±11.64	35.23±8.72	>0.05*
Height (m)	1.51±0.14	1.47±0.13	>0.05*
BMI (kg/m^2)	16.83±1.96	16.04±2.4	>0.05*
Fasting blood glucose (mg/dl)	92.5±5.45	261.03±113.75	<0.001**
HbA_1C (%)	5.27±0.23	11.1±3.26	<0.0001**

** Not statistically significant* *** Statistically significant*

Table-2: Comparison of bone mineral density (Z score) of type 1 diabetics and non-diabetic controls

Parameters	Non-diabetic controls (n=30	Type 1 diabetes (n=30	p value
Bone mineral density (Z-score)	-2.68±1.84	-2.66±2.59	>0.05*

** Not statistically significant* *** Statistically significant*

Table-3: Correlations between duration of diabetes and anthropometric and glycemic parameters in type 1 diabetics.

Correlation between duration of DM and	Pearson's Correlation Coefficient (r)	p-value
Chronological Age (CA)	-0.191	0.313
Weight	-0.346	0.061
Height	-0.390	0.033**
BMI	-0.130	0.492
Fasting blood sugar	-0.118	0.533
HbA_1C	0.043	0.821

Table-4: Correlations between bone mineral density (Z-score) and anthropometric and glycemic parameters in type 1 diabetics.

Correlation between BMD and	Pearson's correlation coefficients (r)	p-value
Duration of diabetes	-0.057	0.764*
Chronological age (CA)	-0.205	0.278*
Weight	-0.185	0.328*
Height	0.330	0.103*
BMA	-0.047	0.805*
Fasting blood sugar	0.085	0.654*
HbA_1C	-0.154	0.417*

Table-5: Correlations between chronological age (CA) and different parameters in type 1 diabetics.

Correlation between CA and	Pearson's correlation coefficients (r)	p-value
Weight	0.466	0.009**
Height	0.661	0.00**

Table 2 shows bone mineral density (Z-score) of diabetic boys and of non-diabetic control group and their difference was found to be statistically non-significant ($p > 0.05$) .

Table 3 indicates correlations of duration of diabetes with anthropometric and glycemic parameters in type 1 diabetics. A significant negative correlation ($p<0.05$) was observed between duration of diabetes and height ($r= -0.390$).

Table 4 shows correlations between BMD (Z-score) and anthropometric and glycemic parameters in type 1 diabetic boys. No significant correlation was observed between BMD and other parameters.

Significant ($p<0.05$) positive correlations were observed between chronological age and weight ($r=0.466$) and also between chronological age and height ($r=0.661$) in diabetic boys **(Table-5).**

Discussion

A number of skeletal defects associated with type 1 DM have been reported including diminished linear bone growth during the pubertal growth spurt, decreased adult bone density, an increased risk for the adult osteoporosis, poor healing and regeneration characteristics.[3]

A poor metabolic control may expose adolescents with long standing type 1 DM to the risk of developing osteopenia in adult age and optimization of metabolic control of glucose levels in growing children may prevent osteoporosis in later life.[11] On the other hand a study conducted in Greece suggests that control of patient's blood glucose levels and duration of diabetes do not appear to influence BMD.[12] Our study also showed no significant correlation of diabetic duration and control (HbA_1C) with bone mineral density in diabetic boys. However, it is also found in a study that longer diabetic duration and poor metabolic control resulted in reduced bone turnover which could damage bone health in IDDM,[13] while Heap et al (2004) reported that metabolic control of diabetes affects the bone mineral acquisition.[14]

It was found that boys with IDDM had an increased height until 1 year before diagnosis and this increased height was followed by a delay in growth just before the onset of IDDM.[15] However it was also found that children with IDDM have normal height at the time of diagnosis.[16,17] It is also indicated in the present study that height of diabetic boys was not significantly affected by the disease when compared to healthy controls. However the duration of diabetes had significant negative correlation with the height of the diabetic boys indicating that with increase in the duration of disease, height of boys decreases .

It is reported that weight gain by diabetic children is independent of diabetic duration and weight at the time of diagnosis but it is positively correlated with HbA_1c.[18] Our study indicates that weight of diabetic boys does not significantly differ from non-diabetic controls and there is also no significant correlation between weight of diabetic boys and HbA_1c. However weight of diabetic boys showed significant positive correlation with chronological age and height of diabetic boys showing that even in diabetes, weight increases with age and height.

The present study showed no significant difference of bone mineral density (Z-score) between type 1 diabetic children and non-diabetic control children.In our study bone profiler [which is based on quantitative ultrasound technique (QUS)] was used and measured BMD at the phalanx. Quantitative ultrasound measurement (QUS) is a useful method for measuring the physiological bone development in children and adolescent.[19]

Bone metabolism and bone mineral density in patients with type 1 DM have been extensively investigated and these patients seem to be at risk of decreased bone mass.[9] Diabetes mellitus is thought to impair the attainment of peak bone mass and also increases the risk of osteoporosis with its related complications in later life.[12,15]

Type 1 diabetes mellitus has also been related to reduced bone mineral density (BMD) in childhood.[20] Whether diabetes mellitus is a risk factor for developing osteoporosis or whether osteoporosis is one of the long term complications of diabetes, remains controversial.[21]

The present study showed that bone mineral density (Z-score) of diabetic boys and of non-diabetic control group did not show significant difference indicating that type 1 DM has no significant effect on acquisition of bone mineral density. Our study did not indicate any significant correlation of bone mineral density with anthropometric as well as glycemic parameters in diabetic children.

In contrast to our finding , a number of studies

showed that patients of type 1 diabetes mellitus had reduced bone mineral density indicating that osteopenia was a common complication in type 1 diabetes mellitus.[4,15,22,23] A study conducted on adolescents of type 1 DM with long term poor metabolic control found decreased bone mineral density (Z-score) and negative correlation between Z-score and age of diabetic subjects.[12] Damilakis et al (2004) evaluated bone status at radius and phalanx in children and adolescents with type 1 DM by using QUS. It was found that male and female patients with type 1 DM did not have significantly different bone mineral density[24] supporting the finding of our study. Similarly a study conducted in Germany showed that BMD of children with type 1 DM were within the reference range.[25]

Conclusion

The present study concludes that type 1 DM does not significantly affect bone mineral density, height and weight. Bone mineral density is not significantly affected by the glycemic control. However, duration of diabetes has a significant negative impact on height in children.

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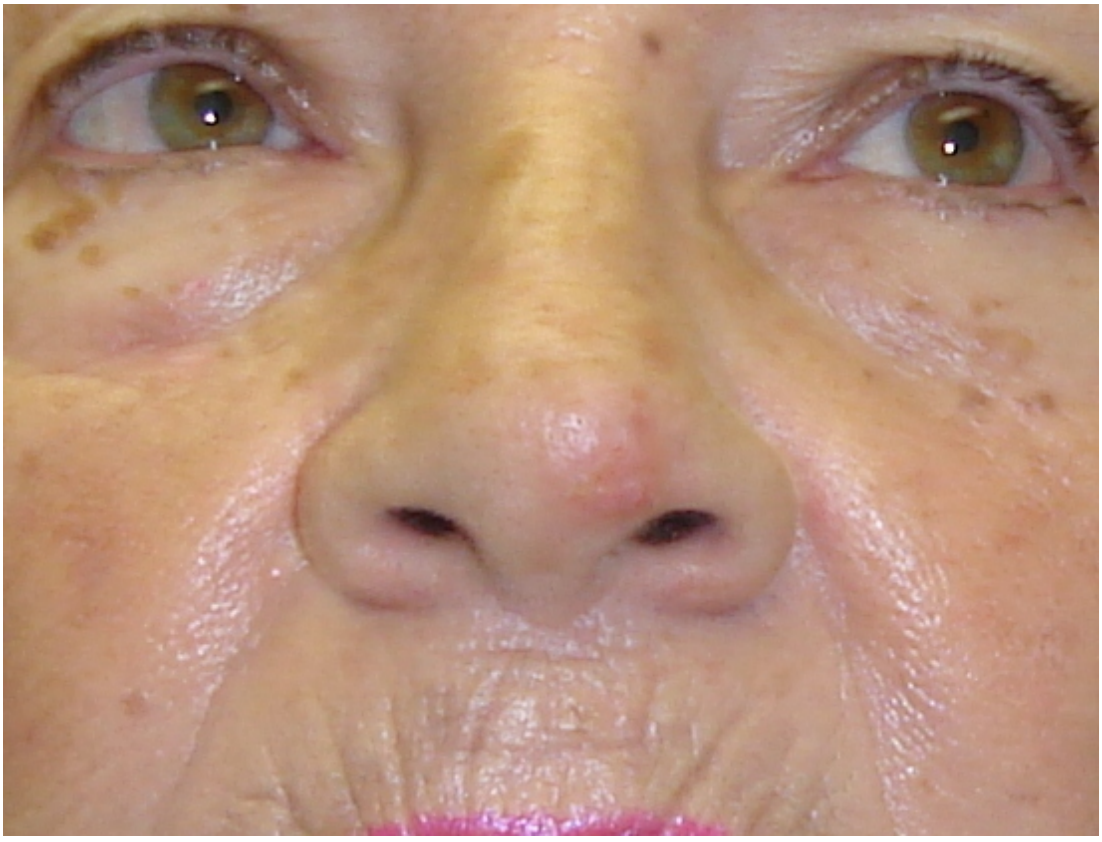
Picture Quiz

A 76-year-old woman was seen in OPD. She complained of dizziness and was found to be hypertensive. This is a photograph of her face.



What is the diagnosis?

See Answer on Page No. 24