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The Effect of Nutrition Education on Bone Health and Dietary Calcium Intake in Adolescent Girls with Chronic Lymphocytic Thyroiditis

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Abstract

Aim: The aim of our study is to evaluate adolescent girls with chronic lymphocytic thyroiditis (CLT), regarding eating habits, dietary calcium intake, anthropometric measurements, biochemical findings, bone mineral density (BMD) and to evaluate the effect of nutritional education on these parameters.

Material and Methods: Adolescent girls with CLT that were treated in our hospital were included. A matching group of healthy adolescent girls were also evaluated as a control group. Nutritional education was given at the beginning of study and every month during the study period. Anthrophometric measurements, biochemical findings and BMD were evaluated at the beginning of the study and after six months. The effect of nutritional recommendation was also evaluated.

Results: At the beginning of the study; adolescent girls with chronic lymphocytic thyroiditis had a dietary calcium intake about 54.4% (701±233 mg/day). It was shown that they reached a dietary calcium intake about 78.3% (1017±212 mg/day) after six months from the beginning of nutritional education ($p<0.001$). Positive correlations were found between dietary calcium intakes and BMD-z score ($p= 0.037$, $r = 0.376$).

Conclusions: This study supported the idea that nutritional education and calcium intake might have positive effects on the BMD in the girls with chronic lymphocytic thyroiditis.

Keywords: Bone mineral density, Children, Chronic lymphocytic thyroiditis, Dietary calcium intake, nutrition education

Introduction

Chronic lymphocytic thyroiditis (CLT) is an autoimmune disorder frequently seen among adolescent girls. Levothyroxine therapy is given to these patients with overt hypothyroidism or to the patients who have subclinical hypothyroidism with or without goiter (1). Tri-iodothyronine (T3), regulates intramembranous and endocondral mineralization of bones and controls lineer growth and bone maturation by their effects on TRα receptors on chondrocytes and osteoblasts (2). It is believed that subclinical hyperthyroidism along with levothyroxine therapy can negatively affect BMD. On the other hand, low thyroid stimulating hormone levels

was shown to be related with diminished skeletal construction (1). Clinical and subclinical hyperthyroidism is reported to be related to bone fracture risk. In a recent study, subclinical hyperthyroidism was reported to be associated with an increased risk of hip and other fractures, particularly among those with low TSH levels (3-5).

Although, some studies have shown the negative impacts of long-term levothroxin therapyon BMD, results of the clinical studies about this topic are controversial, especially in adolescent age group (6,7).

Calcium (Ca) plays a key structural role as a component of hydroxyapatite. Dietary requirements for Ca varies according to the needs for bone development and maintenance, with greater needs during the periods of rapid growth in childhood and adolescence. In later years inadequate dietary Ca accelerates bone loss and may contribute to osteoporosis. However, it is unclear whether Ca supplementation in this period leads to optimization of BMD. Ca supplementation of the usual diet in post-menopausal women and older men has been shown to reduce the rate of loss of BMD. We have hypothesized that a diet rich in Ca can help decreasing the negative effect of thyroid hormone replacement on BMD for patients with hypothyroidism and planned to increase dietary Ca intake of these patients by means of nutritional education (8).

To our knowledge, there is no study investigating the effect of nutritional education on BMD in patients with chronic lymphocytic thyroiditis receiving levothyroxine treatment. The aim of this study was to investigate the nutritional advice about calcium-rich diet on BMD in adolescent girls with chronic lymphocytic thyroiditis.

Materials and Method

The study protocol was approved by the local ethic committee of. [Removed for blind peer review]

Patients

This study was conducted in the period between September 2010 and June 2012 in [Removed for blind peer review] on 31 adolescent girls, receiving levothyroxine therapy for the chronic lymphocytic thyroiditis, with the average age of 15.2 ± 1.8 (12.0–17.8) years. The initial dose of levothyroxine was 1-2 mcg/kg/day then the continual adjustment of dose has been performed based on the patients' thyroid function tests to maintain euthyroidism. In addition, 30 healthy adolescent girls with no systemic disease and with an average age of 15.2 ± 1.8 (12.3–17.6) years were included as a control group. Diagnosis of CLT had been made by elevated antithyroid peroxidase antibodies (TPOAb) and/or antithyroglobulin antibodies (TgAb) as well as typical hypoechogenicity of the thyroid in high-resolution ultrasonography.

Female patients between 12-18 years of age, with a Tanner stage IV-V and within postmenarcarchal period and having levothyroxine treatment for at least 2 years with a diagnosis of CLT were included in the study. Patients who have Ca and/or vitamin D supplementation or who have vitamin D deficiency were not included in the study. Patients with other chronic diseases were also excluded.

At the beginning of the study, anthropometric measurements, laboratory tests, bone mineral densityand food consumption were evaluated. The study group was seen monthly for 6 months to be trained about calcium-rich diet principles. The possible effect of dietary advices was assessed by re-performing the above-mentioned evaluations at the end of the study.

Anthropometric Analysis

Body weight was measured without shoes in light indoor clothing using SC-105 model electronic body scale from Bari-Med which was precise to 0.1 kg. Height was measured to the nearest 0.1 cm using Stadiometer Model S100 height rod from Ayrton. Stature was measured from the highest point on the head when subject is standing in erect posture with head in Frankfurt horizontal plane. Body mass index (BMI) is formulated as weight (kg)/height (m^2). Weight standard deviation score (SDS), height-SDS and BMI-SDS were calculated for each subjects.

Biochemical Analysis

All the laboratory measurements were conducted at the laboratory of [Removed for blind peer review] Hospital. Blood and urine samples were obtained in the morning, minimumafter 12 hours of midnight fasting. Serum calcium (Ca), phosphorus (P) and parathormone levels (PTH), alkaline phosphatase (ALP) activity and urinary calcium/creatinine (Ca/Crea) ratio were determined. Serum 25(OH) vitamin D [25(OH)D] was analysed by high performance liquid chromatography.

BMD

Bone mineral density was measured by Dual Energy X-Ray Absorptiometry (DEXA) in the spine lumbar area L1-L4 (Bone density measurements were performed with a Hologic QDR-4500A S/N 45130 bone densitometer (Hologic Inc., Bedford, MA, USA)). BMD z-score for age and gender was determined using the reference values for Turkish children (9).

Food Analysis

Energy and nutrient intake data was collected by 3-days dietary record, with one day being a weekend day, and was calculated by using BEBIS 7.0 version(Ebispro for Windows, Stuttgart, Germany; Turkish Version(BeBİS 7), Pasifik Dayanıklı Company (www.bebis.com.tr); Istanbul, 2017) (10).

The percentage of children meeting recommended dietary allowances for energy and nutrients was calculated based on "Dietary Guidelines for Turkey". Dietary calcium requirements are average 1300±20% mg/day for adolescent girls. Four portion/a day dairy foods intake was considered to meet dietary reference calcium intake with this age groups (11).

All subjects, enrolled in the study, initially were questioned about their eating habits to identify the group. The patient group was given verbal instructions about calcium-rich diet, and performance of education was evaluated with 3-day food record in every follow up visit each month. Dietary Guidelines for Turkey was used as visual material during training (11). The patient group was monitored during six months with their 3-day food record, and positive behaviors were supported and the training was repeated. Also, some advices on negative eating habits were provided.

The study protocol was approved by the local ethic committee of [Removed for blind peer review] Training and Research Hospital. Written informed consent from all the subjects and parents was obtained.

Statistical Analysis

Statistical analysis was performed using the SPSS version 17.0 statistics package program (SPSS Inc UK Ltd., UK) Numerical data were expressed as mean ± standard deviation. If displayed normal distribution, "Repeated Measures Analysis of Variance" was used for within- and between-group comparisons over time. "Paired T" test and "Independent T" test were performed in the case of significant interaction. "Wilcoxon test" and "Mann Whitney-U Test" were used, respectively, to examine within-group and between-group variables over time for data without a normal distribution. Correlations between variables were calculated using "Pearson's Correlation Analysis" for numerical data. Group differences or correlations with $p<0.05$ were considered to be statistically significant.

Results

Anthropometric and Biochemical Findings

There was no difference between weight-SDS, height-SDS, and BMI-SDS, Ca, P, ALP, PTH, 25(OH)D levels, urinary Ca/Crea ratio, age-matched BMD z-scores and daily calcium intake at the beginning of the study of the groups.

There was no difference between the two groups regarding serum Ca, P, ALP, PTH, 25(OH)D levels, at the end of the study (p>0.05) (Table 1). BMD z-score showed an increasing trend in the 31 adolescent girls with chronic lymphocytic thyroiditis (p=0.05). However, in the control group, BMD z-scores showed a trend to decrease, but this difference was not statistically significant (p>0.05) (Table 2).

Table1. *Anthropometric and biochemical measurements of the subjects*

Measurements	At beginning	After six months	
	Mean±SD	**Mean**±SD	P_2
Weight (kg)			
Study	52.87±7.75	53.66±7.25	0.673
Control	53.43±9.00	54.01 ±8.52	0.673
p_1	0.827	0.827	
Height (cm)			
Study	159.30±6.16	160.49±5.55	0.056
Control	159.37±6.43	159.95±6.39	0.056
p_1	0.880	0.880	
BMI(kg/m^2)			
Study	20.86±2.59	20.92±2.37	0.698
Control	21.20±3.17	21.13±2.84	0.698
p_1	0.695	0.695	
Calcium (mg/dl)			
Study	9.81±0.37	9.75±0.48	0.077
Control	10.03±0.47	9.73±0.68	0.077
p_1	0.400	0.400	
Phosphorus(mg/dl)			
Study	4.19±0.67	4.12±0.55	0.169
Control	3.88±0.74	3.98±0.53	0.169
p_1	0.139	0.139	
Alkalen phosphatase(U/L)			
Study	323.45±178.44	310.01±165.44	0.580
Control	209.30±151.26	199.25±140.36	0.580
p_1	0.643	0.643	
Parathormon (pg/ml)			
Study	49.12±16.44	48.96±21.14	0.929
Control	49.91±20.22	49.50±18.35	0.929
p_1	0.888	0.888	
Vitamin D (ng/ml)			
Study	14.62±8.91	14.17±7.40	0.962
Control	13.46±7.84	13.04±6.04	0.619
p_1	0.773	0.629	
Urinary Ca/creatinin			
Study	0.07±0.12	0.04±0.03	0.523
Control	0.03±0.03	0.03±0.04	0.920
p_1	0.248	0.293	

p_1: It shows that the difference between the groups is statistically significant. **p2:** It shows that the difference within-group is statistically significant.

Table2. *BMD Z-score values and daily calcium intake of the subjects*

Measurements	At beginning	After six months	
	Mean±SD	Mean±SD	P_2
BMD Z-SCORE			
Study	-0.12±1,19	-0.08±1,25	0.546
Control	-0.28±0,99	-0.24±0,90	0.325
p_1	0.332	0.251	
Daily calcium intake			
Study	707 ± 233	1017 ± 212	**<0.001**
Control	690 ± 189	700 ± 187	0.544
p_1	0.757	**<0.001**	

p_1: It shows that the difference between the groups is statistically significant. **p2:** It shows that the difference within-group is statistically significant.

Dietary Calcium Intake and BMD

Dietary daily calcium intake of the study group significantly increased after six months follow up. While they were meeting 54.4% (21.7-83.8) of their daily requirements at the beginning of the study, this percentage reached to 78.3% (54.0-127.0) at the last follow-up visits (p<0.001). Ca intake had significantly increased in the educated study group (p<0.001) but serum Ca levels were not different (p>0.05). In both groups, serum Ca levels were in the normal ranges as baseline values. At the end of the study, a positive correlation was determined between dietary calcium intake and BMD during follow up period only in the study group (P=0.023). Similarly, BMD z-scores was positively correlated with dietary calcium intake (r: 0.376 p=0.037) in the study group (Figure. 1).

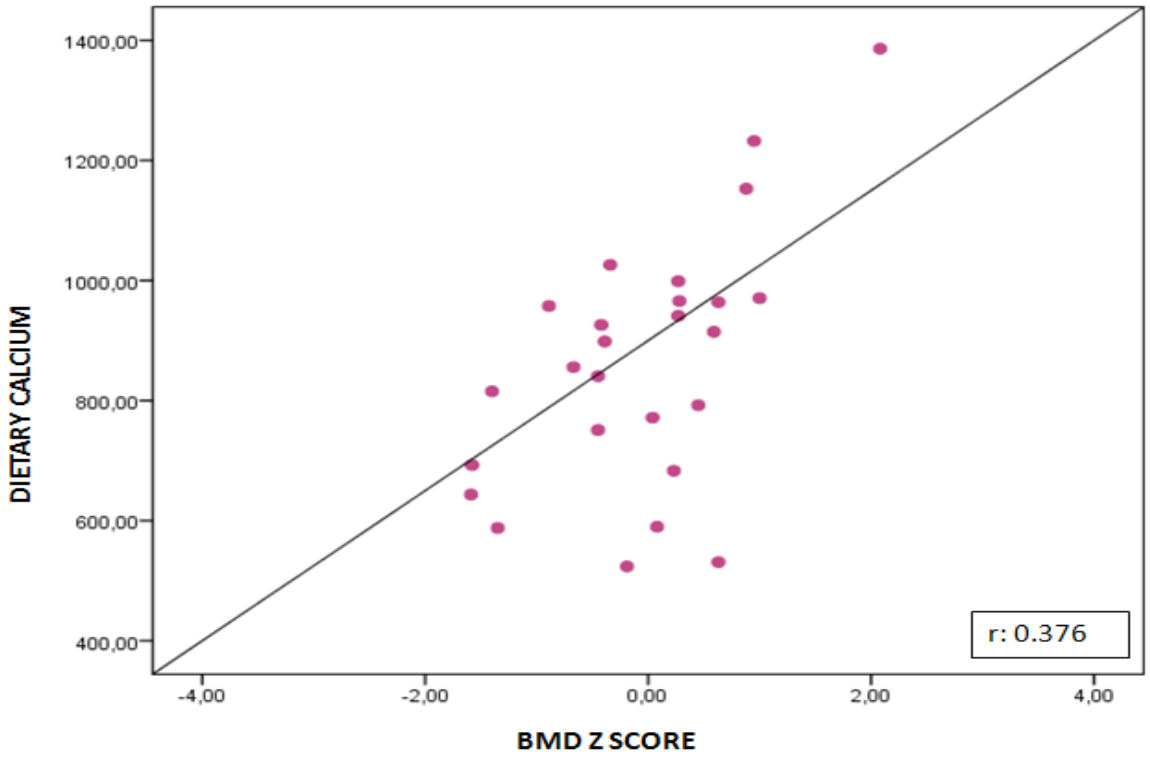

Fig1. *Correlation's graphs of dietary calcium intake and BMD Z score*

Discussion

Calcium is required for normal growth, development and maintenance of the skeleton, where it provides strength and structure. Structure of bone is made of hydroxyaapatite crystals ($Ca_{10}(PO_4)_6(OH)_2$ and other ions, an organic phase (osteoid) of collagen fibres and a ground substance formed by glycolproteins and proteoglycans. For optimal peak bone mass, nutritional Ca intake should be adequate and this effects the achievement of and modifies the rate of bone loss associated with ageing (8).

This study shows that, dietary calcium intake and meeting the percentage of recommended dietary requirements increased significantly in adolescent girls educated at frequent intervals for the six months to the study group. Nutritional education may result in a significant increase in BMD. Although, genetic, nutritional, environmental and lifestyle factors can also affect bone health, nutrition is an important modifiable factor in the maintenance of bone mass and in the prevention and treatment of osteoporosis (12,13). Similar to our study, the findings of other studies conducted in USA indicate that dietary calcium intake was lower than the recommended amounts in adolescents (14,15). Animal and vegetable protein sources rich in dietary calcium can meet the daily requirement, and epidemiologic studies suggest that lifetime high calcium intake is found to be associated with a reduced risk of fracture (12,16-18). Calcium retention significantly depends on the level of nutrient intake and bone mass increases when calcium intake is sufficient. In both females and males, the rate of maximal increase in whole body bone mineral content occurs during adolescence period. Hence, adequate dietary intake of calcium during adolescence is necessary to attain a peak bone mass that may lessen the risk of the fracture and the latter development of osteopenia (19). Most of the studies demonstrated that long-term levothyroxine treatment in children with congenital or acquired hypothyroidism did not affect BMD (20-25).On the other hand, a negative correlation between BMD and the duration of the therapy was shown by some other studies (25-28). Our study indicates that levothyroxine treatment does not have a negative effect on BMD in adolescent girls, similar to most of the studies.

In a study conducted by Salerno et al (21), children with congenital hypothyroidism who was taking calcium lower than the recommended amount (1300 mg/day) in the diet, had a similar BMD as adolescents given higher levels of calcium. But in our study, BMD increased significantly in adolescent girls with CLT who have taken higher levels of dietary calcium during follow up period. However, a positive correlation was only observed between the dietary intake of patients with CLT and BMD and BMD z-scores. This study suggested that dietary calcium had a positive effect on bone mineral density. The studies conducted in healthy, growing children showed that dietary calcium intake and the consumption of milk and dairy products were associated with increased bone mineral content (29-32). However, considering the fact that the study period was quite short, only six months, studies with longer follow-up is needed to define the positive benefits of nutrition education at frequent intervals on bone health.

In conclusion, in recent years, the importance and continuity of nutrition education for the prevention of many diseases and for the maintenance of health was emphasized in our country and the world (33-35). This study shows that continuous nutritional education for adolescent girls with CLT may have a positive impact on dietary calcium intake, and accordingly increased BMD.

Study Limitations

Evaluation of a larger group could be better for statistical analysis. Another point is that all of our patients had nutritional education for a calcium rich diet and thus we could not determine what would happen if they did not have such an education. A control group of adolescent girls with a diagnosis of CLT would help us reveal whether patients with a standart diet would have a decrease in BMD during thyroxine treatment and whether nutritional education would cause a significant difference. But for ethical reasons, we could not leave a group

without education. Because of better BMD in the study group correlating with healthy controls and correlating with their BMDs at the beginning of the study, we commented that nutritional education is helpful for better dietary Ca intake and an improvement in BMD.

Future Directions: Governments should support programmes for increasing dietary Ca intake in every age group, for both patients and healthy children.

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Author's Contribution: Dr. Koc is the first author, wrote the paper and collected the data.

All authors have participated in the concept and design, analysis and interpretation of the data revising of the manuscript and approved the final version.

Blinded Information: This study was conducted in the period between September 2010 and June 2012 in Ankara Children's Hematology Oncology Training Hospital, Department of Pediatric Endocrinology on 31 adolescent girls, receiving levothyroxine therapy for the chronic lymphocytic thyroiditis, with the average age of 15.2 ± 1.8 (12.0–17.8) years.

All the laboratory measurements were conducted at the laboratory of Ankara Children's Health and Diseases Hematology Oncology Training and Research Hospital.

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