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Original Research Article

Radiological Study of Long Bones and Vertebral Column in Patients with Thyroid Dysfunctions

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Abstract

Background: Bone health is a constant worry. Thyroid hormones have an impact on bone mineral homeostasis and bone mineral density. Once we reach what is known as our peak bone mass as an adult, we start to lose bone. There are several ways to evaluate bone health, however the majority of them only provide a general idea rather than a precise representation. Dual-energy X-ray absorptiometry (DXA), the industry standard method for determining bone mineral density, has been used to estimate bone mass (BMD). However, the gold standard for determining bone density and revealing its precise state is bone mass assessment. The most accurate indicator of fracture risk is the assessment of bone mass. The relationship between thyroid conditions, bone mineral density, osteoporosis, long bones, and the vertebral column is still up for debate. The purpose of the current study is to fill in these gaps in our knowledge of how thyroid diseases affect long bones and vertebrae.

Aim: Radiological examination of the vertebral column and long bones in thyroid disease patients. This study's primary goal is to assess the alterations in long bones and vertebrae brought on by various thyroid diseases.

Material and Method: The study group included both male and female participants, ranging in age from 18 to 60 years. The study participants were split up into three groups. 50 hypothyroid patients, both male and female (25) in Group I, 50 euthyroid individuals, both male (25) and female (25) in Group II, and 50 hyperthyroid patients, both male (25) and female (25), were in Group III (25). The quantity of bone minerals per unit volume of bone tissue is calculated using the term "bone mineral density" (BMD). By employing dual energy X-ray absorptiometry, it is computed as grams per square centimeter of bone tissue (DEXA).

Results: The current study's findings demonstrated that hypothyroid patients' femoral neck and lumbar vertebral BMD was substantially higher than that of euthyroid subjects. The results of the present investigation demonstrated that, when compared to euthyroid control subjects, hypothyroidism patients had significantly higher BMD, lower serum calcium, and higher vitamin D levels. In contrast, patients with hyperthyroidism of both sexes had significantly lower BMD at the femoral neck and lumbar vertebra when compared to euthyroid control participants. In contrast to euthyroid controls, hyperthyroidism patients of either sex had considerably higher serum calcium levels. However, both male and female hyperthyroidism patients had significantly lower levels of vitamin D compared to euthyroid individuals.

Conclusion: As a result, we recommend that each patient with hypothyroidism or hyperthyroidism have their BMD, blood calcium, and vitamin D levels measured. Patients with hypothyroidism and hyperthyroidism may benefit from assessment of BMD, serum

calcium, and vitamin D to maintain the conditions of healthy bones. To adopt a proper screening program for healthy bone architecture and reduce the risk of fracture in thyroid problem patients, however, studies on a broader population are necessary.

Keywords: Long Bone, Vertebral Column, Thyroid Dysfunction, Bone Mineral Density.

Introduction

Bone health is a constant worry. Today's modern civilization has recently given attention to the issue of bone health. [1] Thyroid hormones have an impact on bone mineral homeostasis and bone mineral density. Today's sedentary lifestyle, lack of exercise, poor eating habits, nutritional deficiencies, and a number of illnesses like hormonal imbalances and metabolic disorders can impair bone health in a number of different ways. [2]

There are several ways to evaluate the health of the bones, including x-rays, radiogrammetry, radiographic absorptiometry, and biochemical approaches. [3] However, the majority of these strategies and tactics only provide a generalized picture of bone health. The gold standard for determining bone density and revealing its precise state is bone mass assessment, on the other hand. [4] One of the most important and trustworthy factors to accurately estimate the state of the bone is bone mineral density (BMD). The exact prognosis of many bone health conditions, such as osteopenia and osteoporosis, can be made using bone mineral density (BMD) The most accurate indicator of fracture risk is the assessment of bone mass. [5,6]

Dual-energy X-ray absorptiometry (DEXA), the gold standard technique for determining bone mineral density (BMD), has been used to evaluate bone mass because of its reliability, extensive normative data, non-invasive nature, short treatment times, and low radiation exposure. [7] A severe public health issue is the syndromes of bone disease and deformities brought on by problems with nutrition, bone, and mineral metabolism. There are not many studies on this topic. [8]

The thyroid gland, which has two lobes, one on each side, and isthmus connecting them across the middle line, is one of the most vascular organs. The thyroid is situated at the front and sides of the neck; its weight varies somewhat but is typically around 30 grams. The thyroid gland in females is slightly heavier because it slightly enlarges during menstruation and pregnancy. [9] There is debate concerning the connection between thyroid hormones and osteoporosis. Even though it's a rare disorder, evidence suggests that high thyroid hormone levels are linked to reduced bone density, which may somewhat exacerbate postmenopausal osteoporosis. [10]

In hypothyroid patients, a higher TSH level increases the risk of bone fracture. [11] The osteoblast and osteoclast precursor cells include the TSH receptor, which mediates the direct effects of TSH on bone remodeling. Femoral neck bone mineral density is lower in women with asymptomatic hyperthyroidism and subclinical hypothyroidism. [12] In euthyroid people, any modifications to normal thyroid function are associated with variations in body weight. Additionally, there is a positive association between thyroid hormones and BMI in women; however, this correlation is negligible in men. In addition, changes in body weight are due to variations in thyroid function. [13] Additionally, in

healthy postmenopausal women, variations in bone mineral density and the incidence of non-vertebral fractures are linked to physiological variations in thyroid hormones. [14] Additionally, it appears that subclinical hypothyroidism and obesity both impact bone mineral density. Because bone mineral density can be overestimated in the early stages of osteoporosis, subclinical hypothyroidism should be considered while tracking the progression of the disease. [15] There is a negative connection between serum TSH levels and serum calcium in subclinical hypothyroidism and overt hypothyroidism compared to euthyroid. [16]

In people without a history of fracture, bone mineral density is regarded as one of the key predictors of fracture. One crucial method for detecting osteopenia and osteoporosis early, particularly in women, is DXA. The T score will deviate from normal more when the departure from the young bone is greater. Additionally, the risk of fracture increases by 1.6 to 2.6 times for every 1-SD fall in age-adjusted bone mineral density. [17]

Material And Methods

Study Design

This cross-sectional study was conducted in the Department of Radio-Diagnosis, Patients were selected from the patients attending the OPD of Hospital. Permission from the ethical committee of the college was taken to perform this study. Informed consent of the patient was taken to include them in study.

Study Population

Male and female study participants, ranging in age from 18 to 60, were included in the group. Three groups made up the study's participant population. 50 patients from Group I (the hypothyroid group), 50 from Group II (the euthyroid group), and 50 from Group III (the hyperthyroid group), all of the group contain 25 male and 25 female subjects respectively.

Inclusion Criteria

Males and females with a body mass index (BMI) of 20 to 40 kg/m^2 are either euthyroid or have hypo- or hyperthyroidism, respectively.

Exclusion Criteria

- Patients with any kind of chronic illness, such as diabetes mellitus, TB, renal failure, or hypertension.
- Patients with any form of physical impairment.
- Hormone replacement therapy-related topics
- Subjects using any type of medication, including antihypertensive drugs.
- Alcoholics and smokers.

Measurements

Anthropometric measurements

X ray procedure

The x-ray was taken by a certified X-ray technician. First, the patient was instructed to take off all of their clothing and jewelry and put on a hospital gown. The patient is correctly positioned by the x-ray technician such that the body portion being imaged is sandwiched between the x-ray beam and the film plate. On an adjustable table, the subject was invited to lie down. A lead apron protects bodily parts that were particularly susceptible to x-ray damage. During the x-ray, the subject was instructed to remain still because movement blurs the image.

Procedure X-ray lumbar spine

The subject was instructed to stand up straight in front of the X-ray machine while the image was taken, and a plain X-ray of the five lumbar vertebrae that make up the lower (lumbar) spine was taken (A.P view). The person was placed between the flat plastic X-ray cassette, which contains and shields the film, and the X-ray tube, which is the device that

generates the real rays that will pass through the subject's body and land on the plate to create the X-ray image. [18]

Methods

Bone density changes are assessed using several techniques. The quantity of bone minerals in a given volume of bone tissue is calculated as bone mineral density (BMD). It is calculated using dual energy X-ray absorptiometry and expressed as grams per square centimeter of bone tissue (DEXA). [19]

Sample collection

5 ml of fasting venous blood was drawn from each patient. the five minutes. At 2500 rpm, the samples were centrifuged. The plasma was divided into aliquots and kept at -20°C.

Estimation of thyroid function

The serum concentrations of the following parameters will be used to determine the thyroid disorder profile in that serum sample.

- Estimation of triiodothyronine (T3)
- The fT4 investigation is a solid phase competitive enzyme immunoassay. [20, 21]
- The TSH ELISA test is based on the principle of a solid phase enzyme-linked immunosorbent assay. [20, 21]
- Cholesterol was measured according to the kinetic protocol. [20]
- The GPO-PAP procedure was used to calculate serum concentration of triglycerides
- Measurement of HDL-Cholesterol was done following the method that has been made according to the kinetic protocol. [20]
- To measure Serum calcium level Arsenazo III Method was used [20]
- The Enzyme-linked immunosorbent assay (ELISA) used mainly in immunology, is a biochemical technique founded on the competitive binding enzyme immunoassay method. [20]

Statistical analyses: Participants in the study's baseline characteristics were represented in Mean+/-SEM (Standard Error of Mean). The variations in baseline characteristics across the three groups were analyzed using a one-way ANOVA. Unpaired student t tests were performed to examine how thyroid treatment affected various groups. The relationship between thyroid hormones and BMI, serum calcium, and BMD was examined using the Pearson correlation test on the total data set as well as within each group. In order to evaluate the effects of thyroid hormones on various factors, logistic regression analysis was utilized.

Result: -

Table 1: Comparison of basic and anthropometric parameters in group I hypothyroid patients, group II control subjects and group III hyperthyroid patients.

Parameters	Hypothyroid patients (n = 50)	Euthyroid subjects (n = 50)	Hyperthyroid Subjects
BMI (Kg/m^2)	18.65 ±92.19	16.73 ±85.59	16.02±90.32
T3 (ng/ml)	0.30 ±0.10	78.02± 0.15	1.31± 0.80
FT4 (ng/dl)	88.04± 0.50	98.03 ±0.52	1.77 ±0.92
TSH	21.82±10.85	64.39± 91.32	0.34 ±0.66

Additionally, there were notable differences in the levels of the thyroid hormones in the groups I hypothyroid T3, FT4, TSH, group II euthyroid T3, FT4, TSH, and group III hyperthyroid T3, FT4, TSH. Weight and BMI significantly correlated with thyroid hormone levels.

Table 2: Comparison of difference between intragroup I & II female hypothyroid and difference between intragroup I & II male hypothyroid.

Parameters	Female	Male
BMD (FN)	0.022±0.01	0.03±0.002
BMD (LV)	0.023±0.020	0.022±0.01
Serum Calcium	0.19±0.38	0.71±0.22
Vitamin D	11.38±2.71	16.86±4.77

Table 2 demonstrates that there was a statistically significant difference in BMD at the femoral neck for male hypothyroid patients compared to female hypothyroid patients when comparing group I female hypothyroid patients and group II female euthyroid subjects with group I male hypothyroid patients and group II male euthyroid subjects. In contrast to male hypothyroid patients, however, the difference in serum calcium was more pronounced in female hypothyroid individuals. In addition, vitamin D differences were more pronounced in male hypothyroid individuals than in female hypothyroid patients.

Table 3: Comparison of lipid profile in group I hypothyroid patients and group II control subjects.

Parameters	Hypothyroid patients (n = 50)	Euthyroid subjects (n = 50)
TC (mg/dl)	188.33±23.72	172.37±20.80
TG (mg/dl)	116.55±19.45	101.25±14.10
HDL (mg/dl)	36.66±3.79	38.72±5.44
LDL (mg/dl)	125.01±22.55	119.40±17.66

Table 3 compares the lipid profiles of the euthyroid people in group II and the hypothyroid patients in group I. In comparison to group II euthyroid subjects, group I hypothyroid patients' mean total cholesterol, triglyceride, and LDL cholesterol levels were considerably higher. In addition, group I hypothyroid participants had considerably lower HDL cholesterol than group II euthyroid subjects.

Discussion

Today's modern civilization has recently given attention to the issue of bone health. Thyroid hormones have an impact on bone mineral homeostasis and bone mineral density. In addition, any change in thyroid hormone levels may affect BMD in those with thyroid disorders, raising their risk of fracture. [22] One of the most prevalent endocrine gland illnesses is thyroid condition, which most frequently takes the forms of hypothyroidism and hyperthyroidism. Bone abnormalities and variations in serum calcium levels have both been linked to changes in thyroid function. [23] Patients with hypothyroidism may have lower serum vitamin D levels as a result of thyroid problems. The literature has made the claim that hyperthyroidism may cause a drop in vitamin D levels. Patients with thyroid problems may experience an increased risk of fracture because thyroid dysfunctions alter the rebuilding process of the bones. The quality of the bone as well as the health of the bone might be impacted by an imbalance between the resorption process and rebuilding process. [24, 25]

In hypothyroidism patients of either sex, Mane AV et al. [26] and Marwaha R K et al. [27] found a significant decrease in T3 and FT4, whereas they found a significant increase in TSH. On the other hand, they found a significant increase in T3, FT4,

and a significant decrease in TSH in patients with hyperthyroidism, both male and female. Similar to this, Shivaleela MB et al.[28] found a substantial difference in thyroid hormone levels between hypothyroid, hyperthyroid, and euthyroid individuals.

study by Marwaha R K et al. [27] found that compared to euthyroid participants, hypothyroid patients had considerably higher BMD levels. The current study differs from theirs in that it only covered a limited population of participants aged 18 to 60, regardless of gender, whereas their study included a sizable number of populations aged over 50. [28]

Similar to this, Ribot C et al. [29] found that, as compared to the same participants in euthyroid state, there was a significantly greater BMD at the femoral neck (7%, $p<0.001$) and lumber vertebra (5.4%, $p<0.001$).

In contrast to the current investigation, Bauer D. C. et al [30] and Gonzalez-Rodriguez L. A. et al. [31] did not find any link between TSH and hip bone BMD in their studies of postmenopausal women done in the USA and Puerto Rico, respectively.

In contrast to euthyroid people (2.450.89 mmol/l), hypothyroid patients had considerably lower blood calcium levels (1.610.39 mmol/ml), according to Mane AV et al. [32] Furthermore, these findings support the findings of a study by Ashmaik AS et al., [33] which showed that patients with hypothyroidism had significantly lower mean serum calcium levels than the control group.

The fundamental function of vitamin D is to maintain the balance of bones and minerals, and new research has linked vitamin D insufficiency to a number of illnesses, including osteoporosis, cancer, and cardiovascular disease. [34]

When compared to control subjects, vitamin D levels in hypothyroid patients were considerably lower, according to Mackawy AM et al. [35] (14.79 ± 2.11 ng/ml vs 44.53 ± 14.91 ng/ml, $p<0.001$). Similar to other studies, Kivity S et al.36 discovered that hypothyroidism has a markedly low level of vitamin D. The prevalence of vitamin D (25-OH) deficiency was found to be significantly higher in patients with autoimmune thyroid diseases (AITDs) compared with healthy people (72% vs. 30.6%; $P<0.001$) as well as in patients with Hashimoto's thyroiditis compared to patients with non-AITDs (79% vs. 52%; $P<0.05$), according to research by Kivity S. et al. [36] Additionally, the findings of our investigation are in line with those of Chio YM et al., [37] who noted a comparable drop in Vitamin D levels in hypothyroid patients.

The current study's findings showed that group I hypothyroidism patients' mean total cholesterol, triglyceride, and LDL cholesterol levels were considerably higher than those of group II euthyroid people. In addition, group I hypothyroidism patients' HDL cholesterol levels were considerably lower than those of group II euthyroid participants.

As evaluated by Murgod R et al [38], hypothyroid individuals had significantly higher levels of total cholesterol, triglycerides, and LDL when compared to controls ($p<0.001$). In their investigation, it was shown that overt hypothyroidism was associated with higher levels of total cholesterol and LDL-C. They hypothesized that it was because thyroid hormones influence the expression of the LDL receptor. Another study by Jiskra J et al. [39] in 2007 found that patients with overt hypothyroidism had a significant rise in TC, TG, and LDL. In contrast to the current study, their research found that hypothyroid patients had higher HDL levels than control subjects. In subclinical hypothyroidism as well as clinical hypothyroidism patients compared to euthyroid participants, Khanet FA et al.

[40] showed considerably high levels of TC, TG, and LDL-C while a significantly lower level of HDL-C. [41

The current investigation showed that both hypothyroid and hyperthyroid individuals had a number of biochemical abnormalities in their serum lipids, an increase in their lipid profiles, and dyslipidemia, which is one of the main risk factors for atherosclerosis and coronary disease. Patients with hypothyroidism had higher total cholesterol, lower HDL cholesterol, and higher levels of VLDL cholesterol. Additionally, patients with hyperthyroidism have higher levels of total and LDL cholesterol as well as lower HDL-C levels. However, there was no difference between the hypothyroidism and hyperthyroidism groups.

Conclusion:

The impact of thyroid disease treatment on frequently occurring bone fractures could not be determined because this was a short-term trial. Finding the impact of a patient being euthyroid on the frequency of bone fractures requires a long-term study. Each patient with hypothyroidism or hyperthyroidism should have their BMD, blood calcium, and vitamin D levels evaluated. In order to stop bone degradation and fractures, vitamin D and serum calcium supplements may be effective in conjunction with modern thyroid problem treatment. Patients with hypothyroidism and hyperthyroidism may benefit from assessment of BMD, serum calcium, and vitamin D to maintain the conditions of healthy bones. To reduce the incidence of fracture in people with thyroid issues, studies on a larger population are necessary before implementing an effective screening program for healthy bone architecture.

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