Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231-6345 (Online)
An Online International Journal Available at http://www.cibtech.org/jls.htm
2012 Vol. 2 (2) April-June, pp.179 -183/Shivaleela et al.
Research Article

SERUM CALCIUM AND PHOSPHOROUS LEVELS IN THYROID DYSFUNCTION

***Shivaleela MB, Poornima RT and Jayaprakash Murthy DS**
Department of Biochemistry, J. J. M. Medical College, Davangere -577004, Karnataka, India.
**Author for Correspondence*

ABSTRACT
Thyroid hormones play an important role in homeostasis of Calcium and Phosphorous levels by their direct action on bone turnover. Calcium & phosphorous metabolism is frequently disturbed in thyroid dysfunction. A negative calcium balance may eventually lead to hyperthyroid osteopenia. The objective of the present study is to evaluate the changes in serum calcium & phosphorous levels in Hyperthyroidism & Hypothyroidism. 40 cases each of Hyperthyroidism & Hypothyroidism were included in the study. 40 healthy euthyroid individuals were taken as controls. The mean serum calcium levels were significantly higher in Hyperthyroidism patients ($p<0.01$) and significantly lower in Hypothyroidism patients ($p<0.01$) compared to controls. Similarly the mean serum phosphorous levels were significantly higher in Hyperthyroidism patients ($p<0.05$) and significantly lower in Hypothyroidism patients ($p<0.05$) when compared to controls. The findings suggest that there is significant alterations in the levels of serum calcium and phosphorous in thyroid disorders. Thyroid disorders are important cause for secondary osteoporosis. Serum calcium and phosphorous levels can be fairly used as index of bone resorption. Preventive measures like supplementation of minerals or hormone replacement therapy can be initiated early in those who are at rapid bone losers and prevent osteoporotic fractures.

Key Word: *Calcium, Hypothyroidism, Hyperthyroidism, Phosphorous*

INTRODUCTION
Disorders of thyroid gland are among the most abundant endocrine disorders in India. Thyroid diseases have wide spread systemic manifestations including their effects on bone and mineral metabolism. Mineral metabolism (calcium and phosphorous) is frequently disturbed in hyperthyroidism (Manicourt *et al.*, 1979). Thyroid hormones exert its effects on osteoblasts via nuclear receptors to stimulate osteoclastic bone resorption (Rizzoli *et al.*, 1986; Sato *et al.*, 1987); Hyperthyroidism is thus one of the major causes of secondary osteoporosis (Riggs and Melton, 1986). Thyroid hormones stimulate bone resorption directly there by increasing the serum calcium and phosphorous levels and suppressing PTH (Mosekilde *et al.*, 1977). Opposite effects are seen in Hypothyroidism.

Previous studies done on serum calcium and phosphorous levels in thyroid disorders have conflicting results. Some studies have reported normal levels (Beqic *et al.*, 2001; Sabuncu *et al.*, 2001), while others have reported decreased serum calcium and phosphorous levels in hypothyroidism (Gammage and Logan, 1986; Malamos *et al.*, 1969).

There are variable reports on serum phosphorous levels in patients with hyperthyroidism. Most of the studies indicate hyperphosphatemic state. However, a few studies show normal or low levels of serum phosphorous (Mosekilde and Christensen, 1977). Western data suggest that hyperthyroid patients have hypercalcemia and hyperphosphatemia and decreased bone mineral density. In contrast to this, hypercalcemia is not a feature of Indian patients with hyperthyroidism. In fact, 26 % of these patients showed hypocalcaemia (Dhanwal *et al.*, 2010). Thus Indian patients are different from western patients from bone mineral homeostasis point of view. On one hand, thyroid disorders are most common prevalent conditions and on the other hand, Indian studies focusing on the blood levels of calcium & phosphorous in thyroid disorders are sparse. Hence the present study has been undertaken to study the serum calcium and phosphorous levels in thyroid disorders.

MATERIALS AND METHODS

This study was conducted in department of Biochemistry, J.J.M.Medical College, Davangere from November 2010 to October 2011. Patients attending outpatient department of Bapuji hospital (it is attached to our teaching institute) for evaluation of their thyroid status were enrolled in the study. Forty patients with Hyperthyroidism and Forty patients with Hypothyroidism were taken as cases. The inclusion criteria were newly diagnosed and untreated cases of hyperthyroidism and hypothyroidism. The diagnosis of hyperthyroidism was defined by the presence of increased serum T3 (> 2.0 ng/ml) and T4 (>11.6 µg/dl) levels associated with decreased TSH levels (<0.28uIU/ml). Similarly the diagnosis of hypothyroidism was made by the presence of decreased serum T3 (<0.5ng/ml) and T4 (<4.6 µg/dl) levels associated with increased with TSH levels (> 5.4 µIU/ml). Forty age & sex matched healthy volunteers with normal thyroid hormone profile were taken as controls. Patients with history of hepatic disease, renal disease, alcoholism, or other major medical conditions or those who were on mineral supplementation, ant thyroid drugs or any medications that might affect calcium and phosphorous concentrations were excluded from the study.

After taking informed consent, about 2ml of venous blood was drawn in a plain bulb. Serum was separated by centrifugation and stored at 4-8^{o}**C** until the estimation of biochemical parameters. Serum T3, T4 and TSH were estimated by chemiluminiscence immunoassay method (Acculite, Monobind.Inc, USA) on Lumax 4101: G instrument. Serum calcium and phosphorous was estimated on semiautoanalyzer (Erba Chem-5 plus v2) using commercially available kits.

STATISTICAL ANALYSIS

The results are expressed as Mean ± S.D. Student's't' test was used to compare the different biochemical parameters between the cases and controls. $p<0.05$ was considered as statistically significant.

RESULTS

Patients and control subjects thyroid profile, laboratory characteristics and statistical differences between the groups are shown in table 1.

Table 1: Comparison of serum Calcium and Phosphorous levels in thyroid dysfunction patients and healthy controls

	Hyperthyroidism (n = 40)	**Hypothyroidism (n = 40)**	**Controls (n = 40)**
Gender(F/M)	24/16	28/12	26/14
Age(Yrs)*	42.85 ± 1.56	43.23 ± 1.84	39.40 ± 2.91
T3(ng/ml)*	2.7 ± 0.13	0.21 ± 0.12	1.08 ± 0.10
T4(µg/dl)*	13.9 ± 0.08	3.36 ± 0.02	8.47 ± 0.06
TSH(µIU/ml)*	0.03 ± 0.56	7.73 ± 0.09	2.38 ± 0.31
Calcium(mg/dl)*	10.02 ± 0.87 [a]	9.14 ± 0.51 [a]	9.41 ± 0.45
Phosphorous(mg/dl)*	3.98 ± 0.87 [b]	2.85 ± 0.36 [b]	3.36 ± 0.45

** The values are expressed as Mean ± SD ; n is number of patients.*
a = *p<0.01 compared with controls ; b = p<0.05 compared with controls*

The mean serum calcium levels were significantly higher in Hyperthyroidism patients (10.02 ± 0.87mg/dl, $p<0.01$) and significantly lower in Hypothyroidism patients (9.14 ± 0.51mg/dl, $p<0.01$) when compared to controls (9.41 ± 0.45mg/dl).

Similarly the mean serum phosphorous levels were significantly higher in Hyperthyroidism patients (3.98 ± 0.87mg/dl, $p<0.05$) and significantly lower in Hypothyroidism patients (2.85 ± 0.36mg/dl, $p<0.05$) when compared to controls (3.36 ± 0.45mg/dl).

DISCUSSION

Hyperthyroidism is characterized by accelerated bone turnover, which is caused from direct stimulation of bone cells by high thyroid hormone concentrations (Mundy *et al.,* 1976; Abu *et al.,* 1997). Majority of patients with hyperthyroidism in the west have normal serum calcium levels and the mean calcium concentration is higher than in controls (Dhanwal, 2011). However, few studies have also reported hypercalcemia in thyrotoxicosis. Baxter and Bandy (1966) have reported prevalence of hypercalcemia to be around 23% in hyperthyroidism. In another series, percentage of patients with hypercalcemia in thyrotoxic state varied between 5 & 27 % and the frequency of hypercalcemia increased to 50% when ionized calcium was measured instead of total serum calcium (Burman *et al.,* 1976). Demonstration of high levels of mean serum calcium & phosphorous in hyperthyroidism patients in our study is in accordance with Manicort *et al.,* (1979) and Mosekilde *et al.,* (1977). In contrast to our study, Dhanwal et al., reported 26% hypocalcemia in Indian patients . Associated vit D deficiency may be the cause for hypocalcemia in Indian hyperthyroid patients (Dhanwal et al., 2010). Negative calcium & phosphorous balance present during hyperthyroid status is converted to positive soon after euthyroidism is attained (Cook *et al.,* 1959). The changes in serum phosphorous levels are due to effect of PTH supression as well as direct effect of thyroid hormones(independent of PTH) on tissue phosphate metabolism and renal phosphate handling (Auwerx and Bouillon, 1986).

Calcium & phosphorous levels in hypothyroidism are usually normal but calcium may be slightly elevated. Calcium balance is also variable & any changes in the serum calcium levels are slight. The exchangable pool of calcium & its rate of turnover are reduced, changes that reflect decreased bone formation and resorption (Eriksen *et al.,* 1985; and Eriksen 1986). In our study, mean value of serum calcium & phosphorous levels were significantly lower from that of controls. Hypocalcemia may cause neuromuscular irritability including perioral paraesthesia, tingling of toes & fingers , spontaneous or latent tetany (Bringhurst *et al.,* 2003).

Sometimes hypercalcemia may be severe enough to induce anorexia, polyuria and occasionaly impairement of renal function (Eriksen *et al.,* 1985). Although the changes in serum calcium & phosphorous levels may be slight in thyroid disorders and may not be an acute problem for the patient , it is possible that these disturbances will be important for patient in the long term. Negative calcium and phosphorous balance in hyperthyroidism may eventually lead to hyperthyroid osteopenia and increase the risk of secondary osteoporosis (Auwerx and Bouillon, 1986). In hypothyroidism ,opposite mechanisms are seen and the clinical significance needs to be investigated further.The study can be extended by measuring serum ionized calcium instead of total calcium levels and correlating it with duration and severity of thyroid disorders .

In conclusion, the serum calcium & phosphorous levels are significantly altered in thyroid disorders, so it is important to check the levels of these minerals in all thyroid disorders. Treatment of the primary cause and if necessary supplementation of minerals should be done in order to prevent further bone complications.

REFERENCES

Abu EO, Bord S, Horner A, Chatterjee UK, Compston JE (1997). The expression of thyroid hormones receptor in human bone. *Bone* **21**(2) 137-142.

Auwerx J and Bouillon R (1986). Mineral and bone metabolism in thyroid disease: A Review. *Quarterly Journal Of Medicine* **60**(2) 737-752.

Baxter JD and Bondy PK (1966). Hypercalcemia of thyrotoxicosis. *Annals of Internal Medicine* **65**(3) 429-442.

Beqic KS, Wagner B, Raber w, Schneider B, Hamwi A, Waldhausl W, Vierhapper H (2001). Serum calcium in thyroid disease. *Wiener klinische Wochenschrift* **113**(1-2) 65-68.

Bringhurst FR, Demay MB, Kronenberg HM (2003). Hormones and disorders of mineral metabolism. In: *Williams's textbook of Endocrinology*, 10th edn, edited by Larsen PR (WB Saunders publishers, Philadelphia) 1303-1372.

Burman KD, Monchik JM, Earll JM , Wartofsky L (1976). Ionized and total serum calcium and parathyroid hormone in hyperthyroidism. *Annals of Internal Medicine* **84**(6) 668-671**.**

Cook PB, Nassim JR and Collins J (1959). The effects of thyrotoxicosis upon metabolism of calcium, phosphorous and nitrogen. *Quarterly Journal Of Medicine* **28**(4) 505-529.

Dhanwal DK, Kochupillai N, Gupta N, Cooper C, Dennison EM (2010). Hypovitaminosis D and bone mineral metabolism and bone density in hyperthyroidism. *Journal of Clinical Densitometry* **13**(4) 462-466.

Dhanwal DK (2011). Thyroid disorders and bone mineral metabolism. *Indian journal of Endocrinology and Metabolism* **15**(6) **107-112**.

Eriksen EF, Mosekilde L and Melsen F (1985). Trabecular bone remodeling and balance in hyperthyroidism. *Bone* **6**(6) 421-428**.**

Eriksen EF (1986). Normal and pathological remodeling of human trabecular bone –three dimensional reconstruction of remodeling sequence in normal and in metabolic bone disease. *Endocrine Reviews* **7**(4) 379-408.

Gammage MD and Logan SD (1986). Effects of thyroid dysfunction on serum calcium in the rat . *Clinical Science* **71**(3) 271-276.

Malamos B, Sfikakis P and Pandos P (1969). The renal handling of phosphate in thyroid disease. *Journal of Endocrinology* **45**(2) 269-273.

Manicourt D, Demeester M N, Brauman H, Corvilain J (1979). Disturbed mineral metabolism in hyperthyroidism : good correlation with triiodthyronine. *Clinical Endocrinology* **10**(4) 407-412.

Mosekilde L and Christensen MS (1977). Decreased parathyroid function in hyperthyroidism : interrelationship between serum parathyroid hormone, calcium phodphorous metabolism and thyroid function. *Acta Endocrinologica* **84**(3) 566-575.

Mosekilde L, Melsen F, Bagger JP, Myhre JO, Schwartz SN (1977). Bone changes in hyperthyroidism : interrelationship between morphometry, thyroid function and calcium-phosphorous metabolism. *Acta Endocrinologica* **85**(3) 515-525.

Mundy GR, Shapiro JL, Bandelin JG, Canalis EM, Raisz IG (1976). Direct stimulation of bone resorption by thyroid hormones. *The Journal of Clinical Investigation* **58**(3) 529-534.

Riggs BL and Melton LJ 3rd (1986). Involutional osteoporosis. *The New England Journal of Medicine* **314**(26) 1676-1686.

Rizzoli R, Poser J, Burgi U (1986). Nuclear thyroid hormone receptors in cultured bone cells. *Metabolism* **35**(1) 71-74.

Sabuncu T, Aksoy N , Arikan E, Ugur B , Tasan E, Hatemi H (2001). Early changes in parameters of bone and mineral metabolism during therapy for hyperthyroidism and hypothyroidism. *Endocrine Research* **27**(1-2) 201-213.

Sato k, Han DC, Fujii Y, Tsushima T, Shizume K (1987). Thyroid hormone stimulates alkaline phosphatase activity in cultured rat osteoblastic cells through 3,5,3'-triiodo-L-thyronine nuclear receptors. *Endocrinology* **120**(5) 1873-1881.