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Evaluation of Calcium Regulating Hormones in a Sample of Patients with Thyroid Disorders

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Abstract: *The present study aims to evaluate the levels of calcium regulating hormones in patients with thyroid disorders. Ninety Iraqi subjects with age range (20-55) years were divided into three groups; first group included 30 patients with hyperthyroidism, second group included 35 patients with hypothyroidism, while third group included 25 subjects with euthyroid as controls. Venous blood samples were collected to determine the levels of calcium and phosphorus, thyroid profile [triiodothyronine (T_3), thyroxin (T_4), and thyroid stimulating hormone (TSH)]; and levels of calcium regulating hormones [parathyroid hormone (PTH), calcitonin, and vitamin D3]. The results showed that levels of calcium was significantly ($p<0.05$) higher in hyperthyroidism group as compared with hypothyroidism and euthyroid groups; while it was significantly ($p<0.05$) lower in hypothyroidism group as compared with euthyroid group. Levels of phosphorus was significantly ($p<005$) lower in hyperthyroidism group as compared with hypothyroidism and euthyroid groups; while it was significantly ($p<0.05$) higher in hypothyroidism group as compared with euthyroid group. Levels of T_3 and T_4 were significantly ($p<0.05$) higher in hyperthyroidism group as compared with hypothyroidism and euthyroid groups; while they were significantly ($p<0.05$) lower in hypothyroidism group as compared with euthyroid group. TSH level was significantly ($p<0.01$) lower in hyperthyroidism group as compared with hypothyroidism and euthyroid groups; while it was significantly ($p<0.01$) higher in hypothyroidism group as compared with euthyroid group. The findings of calcium regulating hormones revealed a significant ($p<0.05$) decrease in PTH level in hyperthyroidism group as compared with hypothyroidism and euthyroid groups; while a significant ($p<0.05$) increase was found in hypothyroidism group as compared with euthyroid group. A significant ($p<0.05$) increase was found in levels of calcitonin and vitamin D_3 in hyperthyroidism group as compared with hypothyroidism and euthyroid groups; while a significant ($p<0.05$) decrease was found in hypothyroidism group as compared with euthyroid group. According to these results, it can be concluded that calcium regulating hormones are affected by thyroid disorders.*

Keywords: *Hyperthyroidism, Hypothyroidism, Calcium regulating hormones*

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I. Introduction

The body metabolism, blood pressure, heart rate, and temperature of the body are controlled by thyroid hormones which include triiodothyronine (T_3) and thyroxin (T_4) [1]. Imbalance in production of these hormones start from disorder of the thyroid gland itself, the hypothalamus, which normalize the pituitary gland by thyroid releasing hormone (TRH) or the pituitary gland, which produced thyroid stimulating hormone (TSH) [2]. Thyroid disorders includes: hyperthyroidism and hypothyroidism; hyperthyroidism is the situation that occurs due to extreme production of thyroid hormone by the thyroid gland (Chair *et al.*, 2011), while hypothyroidism is a condition resulting from deficiency in thyroid hormones discharge and action (Laurence *et al.*, 2006). Historically, three hormones are considered to be necessary physiologically in the regulation of calcium homeostasis in mammals, these hormones are parathyroid hormone (PTH), calcitonin, and vitamin D [5]. The essential role of the parathyroid glands in regulating Ca^{+2} homeostasis by altered bone metabolism [6]Calcitonin is forms from the parafollicular C cells of the thyroid gland which create in the neural crest. Although calcitonin can decrease plasma [Ca^{2+}] by declining renal reabsorption of calcium and phosphate and reducing osteoclast activity, its actions are temporary, and chronic excess or insufficiency is not connected with disordered calcium or bone metabolism [7]. Vitamin D3 is created in the skin when exposure to ultraviolet B radiation by the action of the enzyme 7-dehydrocholesterol reductas [8]. The hormonal form of vitamin D (1α, 25–dihydroxyvitamin D3) acts to mobilization of calcium in bone and calcium reabsorption in the kidney, absorption of calcium and phosphate in the intestine and have non-calcaemic functions via nuclear receptors [9]. Calcium is the fifth most abundant element in the human body [10]. Component calcium of bone in the body is approximately 99%, small amount is found in the cytosol of most cells. Phosphorus is wanted for cellular structural components and bone mineralization, for energy storage as ATP, for oxygen transport, and for acid base balance [11].

II. Materials and Methods

2.1 Subjects and Blood Collection

Ninety Iraqi subjects with age range (20-55) years have been involved in this study during their attendance to The Endocrine Glands Center and Diabetes. The studied subjects were divided into three groups; first group included 30 patients with hyperthyroidism, second group included 35 patients with hypothyroidism, while third group included 25 subjects with euthyroid as controls. Patients with history of hepatic disease, renal disease, rheumatoid disease, diabetic mellitus, dermatoid supplements and dietary supplements were excluded from the study. Venous blood sample (5 ml) has been collected from the studied subjects and serum has been collected and kept at (-20°C) until used.

2.2 Measurement of calcium and phosphorus levels

Serum calcium and phosphorus levels were spectrophotometrically estimated using commercial kits (Human, Germany).

2.3 Determination of thyroid profile assay and calcium regulating hormones

Cobas e411 apparatus (Company Roche) was used to carry out the thyroid profile assay (T_3, T_4, and TSH) and calcium-regulating hormones (PTH, Calcitonin, and Vitamin D_3) according to manufacture recommended procedure by using specific kit for each hormone.

2.4 Statistical analysis

Statistical analysis was performed with statistical package for social sciences (SPSS), version20, and computer software. All results were reported as mean ± SE. Statistical comparisons between groups were made using an analysis of variance (ANOVA). The significant level was set as $P \leq 0.05$.

III. Results And Discussion

2.1 Levels of serum calcium and phosphorus

Serum levels of calcium was significantly ($p<0.05$) higher in hyperthyroidism group (10.91±0.21 mg/dl) as compared with euthyroid (8.87±0.16 mg/dl); while it was significantly ($p<0.05$) lower in hypothyroidism group (7.02±0.10 mg/dl) as compared with euthyroid group. Levels of serum calcium was significantly ($p<0.05$) higher in the hyperthyroidism group as compared with hypothyroidism group, as shown in figure (1).

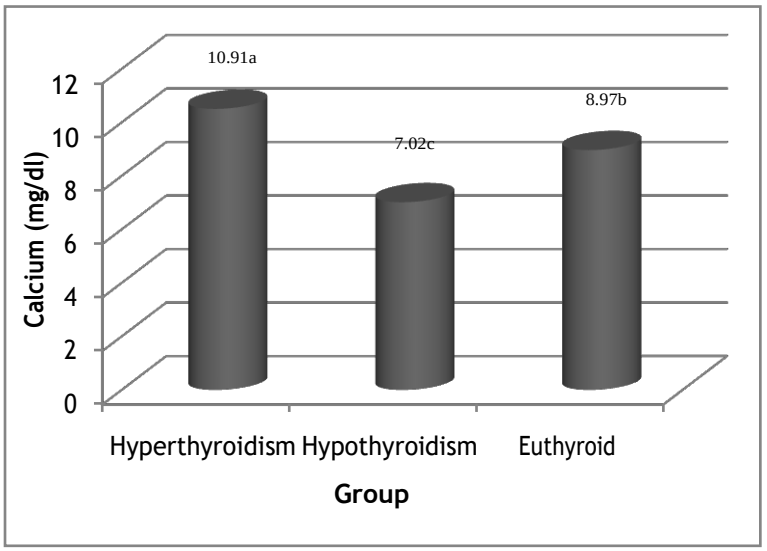

Figure (1): Levels of serum calcium in the studied groups

- Mean carrying different letters indicate a significant difference ($p<0.05$).
- Mean carrying similar letters indicate a non-significant difference ($p>0.05$).

Regarding the hyperthyroidism group, these findings are similar to that of previous studies [12, 13] which reported a significant increase in calcium levels among hyperthyroidism as compared to controls. This may be due to poor mobilization of calcium in hyperthyroidism that leads to increase its concentration in blood [14]. The excess thyroid hormone stimulates osteoclast cells and increases their activities to mobilize calcium

from bone matrix into blood [15]. On the other hand, the results of hypothyroidism group are agreement with [16] who reported a significant decrease in calcium levels as compared to controls. This may be due to slow overall metabolism in hypothyroidism which leads to low absorption of calcium from the gut and more excretion in urine result in decrease of serum calcium levels [17].

Serum levels of phosphorus was significantly ($p<005$) lower in hyperthyroidism group (3.10±0.21 mg/dl) as compared with euthyroid group (4.07±0.11 mg/dl); while it was significantly ($p<0.05$) higher in hypothyroidism group (5.95±0.14 mg/dl) as compared with euthyroid group. Levels of serum phosphorus was significantly ($p<0.05$) lower in hyperthyroidism group as compared with hypothyroidism group, as shown in figure (2).

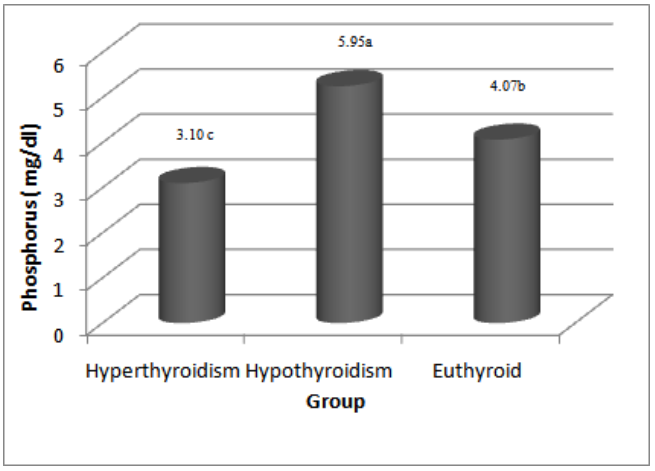

Figure (2): Levels of serum phosphorus in the studied groups

- Mean carrying different letters indicate a significant difference ($p<0.05$).
- Mean carrying similar letters indicate a non-significant difference ($p>0.05$).

These findings are in agreement with previous studies [19].The increased of serum phosphorus in hypothyroidism group could be attributed to increased production of calcitonin which promote tubular reabsorption of phosphate resulting in hyperphosphatemia and tubular excretion of calcium causing hypocalcaemia [20].

2.2 Thyroid profile assay of the studied groups

The results of thyroid profile assay are shown in figures (3, 4, and 5). Figure (3) shows that level of T_3 was significantly ($p<0.05$) higher in hyperthyroidism group (4.65±0.58 nmol/L) as compared with euthyroid group (2.93±0.07 nmol/L); while it was significantly ($p <0.05$) lower in hypothyroidism group (1.73±0.12 nmol/L) as compared with euthyroid group. Level of T3 was significantly ($p<0.05$) higher in hyperthyroidism group as compared with hypothyroidism group.

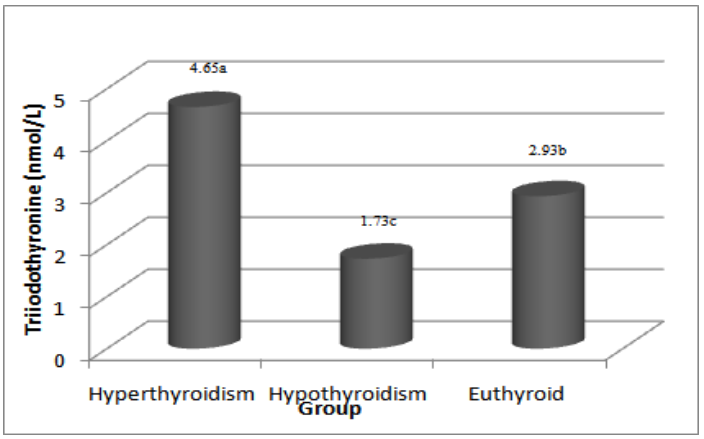

Figure (3): Levels of triiodothyroninein the studied groups

- Mean carrying different letters indicate a significant difference ($p<0.05$).
- Mean carrying similar letters indicate a non-significant difference ($p>0.05$).

The same findings were reported by previous studies [22, 23]. Other author [13] shows a significant increase in T3 levels among hyperthyroidism as compared to controls. This may be due to increasing the level of iodine in the body by eating too much of iodine, inflammation of thyroid gland, too much synthetic thyroid hormone by the thyroid gland [24]. Similar findings were reported by other study [25], which reported a significant decrease in T3levels among hypothyroidism as compared to controls. This may be due to a lack of vitamin D contributed to the possibility of low thyroid hormones [26].

The results of T_4 levels in figure (4) reveals that it was significantly ($p<0.01$) higher in hyperthyroidism group (172.20±13.26 nmol/L) as compared with euthyroid group (108.00±5.89 nmol/L); while it was significantly ($p<0.01$) lower in hypothyroidism group (77.33±6.08 nmol/L) as compared with euthyroid group. Level of T_4 was significantly ($p<0.01$) higher in hyperthyroidism group as compared with hypothyroidism group.

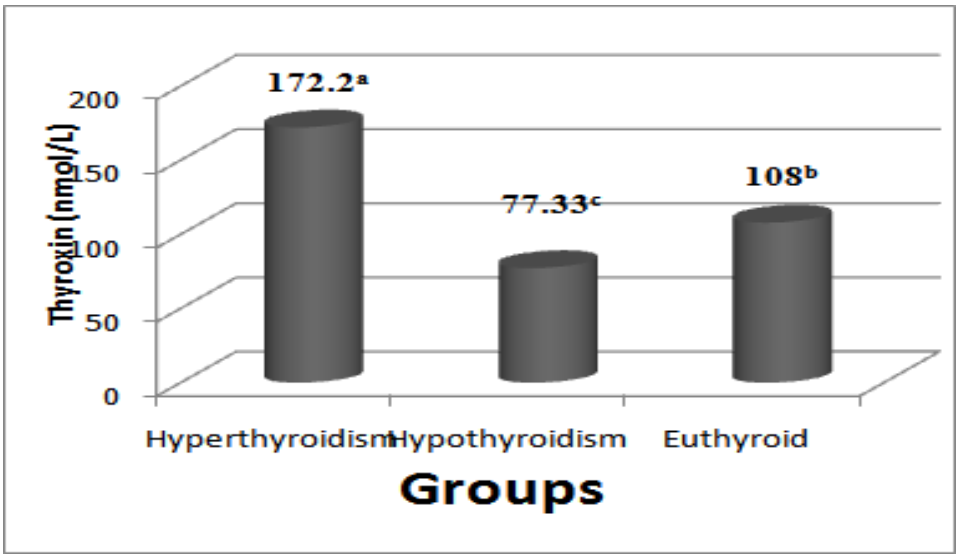

Figure (4): Levels of thyroxin in the studied groups

- Mean carrying different letters indicate a significant difference ($p<0.05$).
- Mean carrying similar letters indicate a non-significant difference ($p>0.05$).

Similar findings were reported by other authors [18,19, 13].The increase production of T_3 and T_4 may be This due to may be attributed to solitary or multiple thyroid nodules, which resulted because of hyperplasia of some follicular cells lead to increase iodide uptake more than surrounding tissues. Therefore elevated of and T_4 production, while TSH secretion is depressed while the adjacent tissues in thyroid become inactive [27]. Attention was directed at the iodine effects on thyroid gland physiology. There is evidence to suggest that elevated levels of iodine in the diet in endemic area of iodine deficiency were associated with autoimmune thyroid disease in susceptible individuals [28]. On the other hand, decrease in T_4 levels among hypothyroidism may be due to inadequate function of the gland itself (primary hypothyroidism), inadequate stimulation by TSH from the pituitary gland (secondary hypothyroidism), or inadequate release of TRH from the brain's hypothalamus (tertiary hypothyroidism) [29, 30].

Figure (5) shows that the TSH level was significantly ($p<0.01$) lower in hyperthyroidism group (0.04±0.01µIU/mL) as compared with euthyroid group (5.22±0.20 µIU/mL); while it was significantly ($p<0.01$) higher in hypothyroidism group (24.12±4.43µIU/mL) as compared with euthyroid group. Level of TSH was significantly ($p<0.01$) lower in hyperthyroidism group as compared with hypothyroidism group.

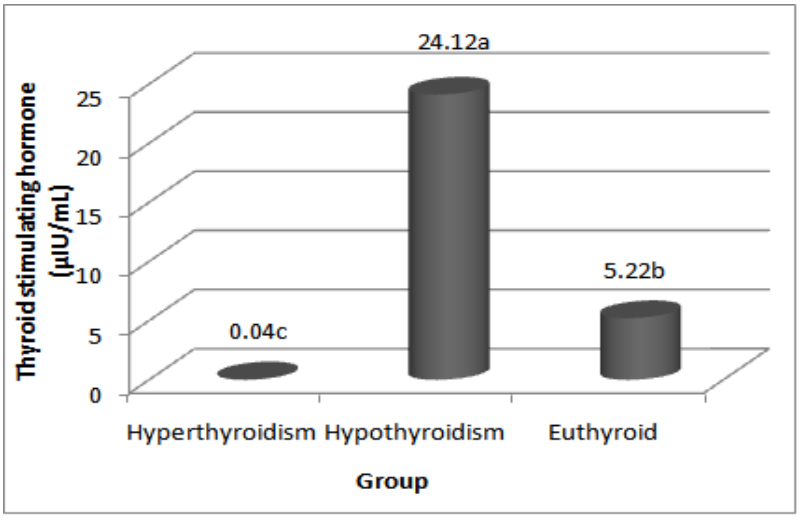

Figure (5): Levels of Thyroid stimulating hormone in the studied groups

- Mean carrying different letters indicate a significant difference ($p<0.01$).
- Mean carrying similar letters indicate a non-significant difference ($p>0.01$).

These results are in agreement with previous studies [20, 16, 31]. This may be due to T_3 and T_4 output from the thyroid gland is regulated by TSH secreted from the anterior pituitary gland, which itself is regulated by TRH produced by the hypothalamus [32]. In hyperthyroidism TSH decrease due to the presence of anti-thyroid autoantibodies in the circulation. In this, autoimmune condition, there is production of antibodies against normal thyroid antigen. The source of these antibodies is immune competent plasma cells. The antibodies bind with TSH receptors to initiate and increase T_3 and T_4 synthesis and production regardless of decrease level of TSH by negative feedback mechanism exerted by T_3 and T_4 on pituitary and hypothalamic axis [33]. In hypothyroidism TSH increase due to pituitary is response to the decreased hormone levels.

2.3 Levels of calcium-regulating hormones in the studied groups

The results of calcium-regulating hormones are presented in figures (6, 7, and 8). Regarding the PTH level and as shown in figure (6), there was a significant ($p<0.05$) decrease in hyperthyroidism group (45.74±5.1 pmol/L) when compared with euthyroid group (50.98±5.15 pmol/L); while there was a significant ($p<0.05$) increase in hypothyroidism group (60.23±4.94 pmol/L) when compared with euthyroid group .When a comparison has been made between the hyperthyroidism group and hypothyroidism group, the results revealed a significant ($p<0.05$) decrease in hyperthyroidism group.

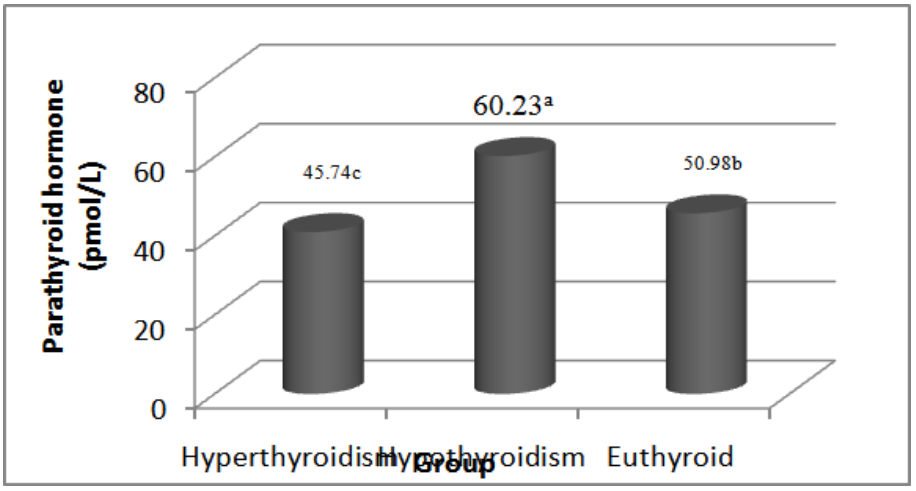

Figure (6): Levels of parathyroid hormone in the studied groups

- Mean carrying different letters indicate a significant difference ($p<0.05$).C
- Mean carrying similar letters indicate a non-significant difference ($p>0.05$).

It has been demonstrated that levels of PTH was decreased in hyperthyroidism cases compared with hypothyroidism and euthyroid cases [34, 35]. The explanation behind these results is that thyroid hormones generally stimulate bone reabsorbtion directly by increasing ionized serum calcium and phosphorus level and suppressing PTH [36].

Concerning of the calcitonin level and as show in figure (7), There were non-significant ($p<0.05$) differences in calcitonin levels between hyperthyroidism group (1.990 ± 0.52pg/ml) and hypothyroidism group (0.802 ± 0.22 pg/ml); while a significant differences between hypothyroidism and euthyroid (2.694 ± 0.68 pg/ml).There was non-significant differences between hyperthyroidism and euthyroid.

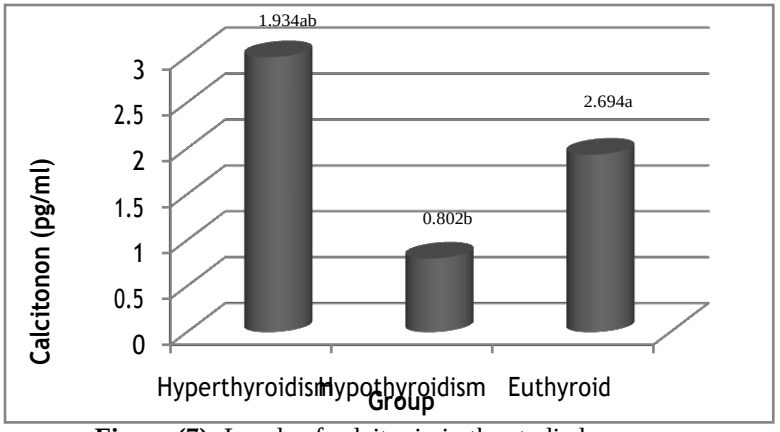

Figure (7): Levels of calcitonin in the studied groups

- Mean carrying different letters indicate a significant difference ($p<0.05$).
- Mean carrying similar letters indicate a non-significant difference ($p>0.05$).

These results support the previous result regarding calcium levels (serum levels of calcium was significantly ($p<0.05$) higher in hyperthyroidism group as compared with euthyroid; while it was significantly ($p<0.05$) lower in hypothyroidism group as compared with euthyroid group. Levels of serum calcium was significantly ($p<0.05$) higher in the hyperthyroidism group as compared with hypothyroidism group).However; in hyperthyroidism cases the results don't increase above the normal value. [37] Shows elevated calcitonin levels can be found in various pathological conditions e.g. medullary thyroid carcinoma, leukemic and myeloproliferative disorders or may be produced ectopically in small cell lung cancer or breast cancer. Furthermore elevated levels can also be found in hypergastrinemia, and renal failure and chronic inflammatory disease. After total thyroidectomy detectable levels of serum calcitonin may be indicative of persistent or recurrent MTC.

Figure (8) shows levels of vitamin D3 in the studied groups. It is obvious from this figure that the level of vitamin D3 was significantly ($p<0.05$) higher in hyperthyroidism group (9.86±1.18 ng/ml) as compared with euthyroid group (8.32±1.02 ng/ml); while it was significantly ($p<0.05$) lower in hypothyroidism group (6.24±0.59ng/ml) as compared with euthyroid group .When a comparison has been made between the hyperthyroidism group and hypothyroidism group, the results revealed a significant ($p<0.05$) increase in hyperthyroidism group.

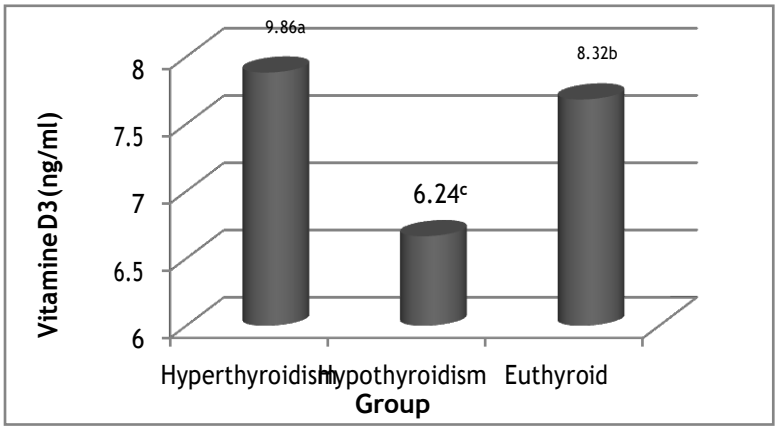

Figure (8): Levels of vitamin D3 in the studied subjects

- Mean carrying similar letters indicate a non-significant differences ($p>0.05$).
- Mean carrying different letters indicate a non-significant differences ($p>0.05$).

The finding that hypothyroidism is associated to low vitamin D3 levels has been reported in a previous study [37]. On the other hand ,the present finding that euthyroid cases, as healthy control ,had higher level of vitamin D3 but still the values were towered the lower end of the spectrum has been observed in other studies [35,31].This result may be explained on the ground that in Muslim countries, covering clothing for religious reasons is practiced, resulting in low sun exposure ending to hypocalcaemia due to vitamin D may influence the thyrotrophs by acting on vitamin D receptors, which are widely distributed through distinct portions of the brain system [38]. Since the primary source of vitamin D in body is its synthesis from cholesterol in skin with the help of sunlight, there seems to be other factors as well leading to its insufficient levels [39]. Also, the explanation behind these results is that the most cases of the present study were females so that the level of vitamin D3 was low when compared with the normal range. It is well documented that female had lower serum vitamin D3 levels as compared with males [40, 41].Other reason is sluggish intestines as seen in hypothyroidism and the reduced absorption of vitamin D3 [42]. Also, the inadequate dietary intake of calcium and increased in bone turnover in hyperthyroid patients lead to increase in level of calcium and hence negative feedback on the secretion of PTH hormone and vitamin D synthesis [43, 44]. [45] Concluded that the requirement of 25(OH) vitamin D for patients with thyroid disease is probably higher than healthy population to control PTH level.

IV. Conclusion

Calcium regulating hormones were affected by the thyroid profile (T_3, T_4 and TSH) levels. Decreased of PTH and increased of calcitonin were found in hyperthyroidism; while the inverse status was found in hypothyroidism. Clear decrease was found in the levels of vitamin D3 in all studied groups (hyperthyroidism, hypothyroidism and euthyroid).

References

[1]. S. Huether, and K. McCance, *Understanding pathophysiology* (Ed.), 4(St. Louis: Mosby, Elsevier, 2008) 1194.

[2]. M. I. Surks, E. Ortiz, G. H. Daniels, C. T. Sawin, N. F. Col, R. H. Cobin, J. A. Franklyn, J. M. Hershman, K. D. Burman, M. A. Denke, C. Gorman, R. S. Cooper, N. J. Weissman, Subclinical thyroid disease: scientific review and guidelines for diagnosis and management, Journal of the American Medical Association, 291(2), 2004,228–238.

[3]. R. S. Bahn Chair, H. B. Burch, D. S. Cooper, J. R. Garber, M. C. Greenlee, I. Klein, P. Laurberg, I. R. McDougall, V. M. Montori, S. A. Rivkees, D. S. Ross, J. A. Sosa, and M. N. Stan, Hyperthyroidism and other causes of thyrotoxicosis: management guidelines of the American Thyroid Association and American Association of Clinical Endocrinologists, Thyroid, 21(6), 2011, 593-646.

[4]. M. D. Laurence, and S. Carole, The thyroid physiology and thyroid function test In: Carl, A. B., Edwared, R. A. and David, E. B., (ed.). Tietz texetbook of clinical chemistry and molecular diagnostic,4th ed ,USA ,Elsevier SAUNDERS ,2006 2053-2061.

[5]. P. F. Hirsch, G. E. Lester, R. V. Talmage, Calcitonin, an enigmatic hormone: does it have a function, Journal of musculoskeletal & neuronal interactions, 1(4), 2001, 299-305.

[6]. K. D. Rudser, I. H. de Boer, A. Dooley, B. Young, B. Kestenbaum, Fracture risk after parathyroidectomy among chronic hemodialysis patients, The Journal of the American Society of Nephrology, 18(8), 2007, 2401–2407.

[7]. Beckett, Geoffrey, Walker, W. Simon, Rae, Peter, Ashby, Pete, Clinical biochemistry. Eighth edition; by Wiley- Blackwell, 71-93, (2010).

[8]. G. Muscogiuri, J. Mitri, C. Mathieu, K. Badenhoop, G. Tamer, F. Orio, T. Mezza, R. Vieth, A. Colao, A. Pittas, Mechanisms in endocrinology: Vitamin D as a potential contributor in endocrine health and disease, European Journal of Endocrinology, 171(3), 2014, R101–R110.

[9]. V. Donald, and V. G. Judith, Biochemistry volume one. biomolecules, mechanisms of enzyme action, and metabolism, 3rd edition, New York: John Wiley & Sons, pp. 663–664, (2004).

[10]. M. Peacock, Calcium Metabolism in Health and Disease, Clinical Journal of the American Society of Nephrology, 5 (1), 2010, S23-S30.

[11]. K. Lau, Phosphate disorders. In Kokko, J.P., Tannen, R.L. (eds). Fluids and electrolytes. WB Saunders Co, Philadelphia, pp 398-471, (1986). .

[12]. M. B. Shivaleela, R. T. Poornima, and J. P. D. S. murthy, Serum calcium and phosphorus in thyroid dysfunction, Indian Journal of Fundamental and Applied Life Science, 2(2), 2012, 79-83

[13]. J. M. Shah, R. Jan, and M. Yousaf, Effects of thyroid dysfunctions on bone markets in non-pregnant women, Journal of Postgraduated Medical Institute, 31(2), 2017, 169-175.

[14]. S. Melmed, K. Polonsky, P. Larsen, H. Kronenberg, William's text book of endocrinology. Calcium and phosphorus metabolism in hypothyroidism. 12th ed. Saunders, PP 10-11, 2011. ,

[15]. H. Engler, R. E. Oettli, and W. F. Riesen, Biochemical marker of bone turnover in patients with thyroid dysfunction and euthyroid controls: a cross sectional study, International Journal of Clinical Chemistry, 289(1-2), 1999, 72-159.

[16]. G. K. Sidhu, R. Rahima Malek, A. Khubchandani, S. Mansuri, P. Gaadhe, and A. Adarsh, Assessment of variations in serum Phosphorus, Calcium, Sodium and Potassium levels in hypothyroid patients, Journal of International Medical Research, 3(3), 2016, 26-29.

[17]. R. L. Dutra, G. A. Cantos, E. Carasek, Analysis of Zinc in biological samples by flame atomic absorption spectrometry, Biological Element Research, 111(1-3), 2006, 265.

[18]. M. G. Gohel, A. M. Shah, A. M. Shah, J. S. Makadia, A study of serum calcium, magnesium and phosphorous level in hypothyroidism patients, International Journal of Medical and Health Sciences, 3(4), 2014.

[19]. A. Bharti, Sh. Shrestha, R. Rai, and K. M. Singh, Association between serum ferritin and thyroid hormone profile in hypothyroidism, 1(6), 2015, 259-263.

[20]. B. Suneel, D. R. Nagendra, R. R. Aparna, D. Balakrishna, and J. N. Naidu, Mineral status in thyroid disorder (Hypo & Hyper), International Journal of Applied biology and Pharmaceutical Technology, 2(4), 2011, 423-429.

[21]. J. H. A. Widad, R. K. H. Ali, and S. Alfallouji, The Correlation between oxidative stress and thyroid hormones in serum and tissue homogenized of hypothyroidism patients, Medical Journal of Babylon, 9(4), 2012, 843-849.

[22]. E. Hassan, A. S. Ashmaik, H. M. Gabra, A. O. M. Elzein, N. M. A. Eldin, and S. Elhashimi, Assessment of serum levels of calcium and phosphorous in Sudanese patients with hypothyroidism, Asian Journal of Biomedical and Pharmaceutical Sciences, 3(25), 2014, 21-26.
[23]. A. Sachdeva, V. Singh, I. Malik, P. S. Roy, H. Madaan, and R. Nair, Association between serum ferritin and thyroid hormone profile in hypothyroidism. International Journal of Medical Science and Public Health, 4(6), 2015, 863-865.
[24]. D. Devereaux, and S. Tewelde, Hyperthyroidism and thyrotoxicosis, Emergency Medicine Clinics of North America, 32 (2), 2014, 277–92
[25]. N. Koch, J. Kaur, A. Mittal, A. Gupta, I. P. Kaur, Sh. Agarwal, Status of vitamin D levels in hypothyroid patients and its associations with TSH, T3 and T4 in north Indian population of Meerut, a cross sectional study, International Journal of Clinical Biochemistry and Research, 3(3), 2016, 295-298.
[26]. B. Richards, Low Vitamin D contributes to Thyroid Problems. Health News, 2008.
[27]. Kosugi, and Shinji, Non –auto immune hyperthyroidism and hyperfunctioning thyroid adenomas caused by activating mutation of thyrotropin receptor. Japanese Journal of Clinical Medicine, 60(2), 2002, 91-96.
[28]. B. L. Langdahl, A. G. Loft, N. Moller, J. Week, and E. F. Eriksen, Skeletal responsiveness to thyroid hormones is not altered at menoponse. Bone, 19(5), 1996, 57-64.
[29]. D. Y. Gaitonde, K. D. Rowley, and L. B. Sweeney, Hypothyroidism: an update, American Family Physician., 86 (3), 2012, 244-51.
[30]. J. R. Garber, R. H. Cobin, H. Gharib, J. V. Hennessey, I. Klein, J. I. Mechanick, R. Pessah-Pollack, and P. A. Singer, Clinical practice guidelines for hypothyroidism in Adults.Thyroid, 22 (12), 2012, 1200–1235.
[31]. S. Sonawane, and S. Bansal1, Vitamin D deficiency and its association with thyroid diseases, International Journal of Contemporary Medical Research, 4(8), 2017, 1765-1767.
[32]. W. Boron, and E. Boulapep, Medical Physiology (2nd ed.). Philadelphia: Saunders. 2012, 1052.
[33]. J. G. Hollowell, N. W. Staehling, W. D. Flanders, W. H. Hannon, E. W. Gunter, C. A. Spencer, and L. E. Braverman, Serum TSH, T4, and thyroid antibodies in the United States population (1988 to 1994): National Health and Nutrition Examination Survey (NHANES III), The Journal of Clinical Endocrinology & Metabolism, 87 (2), 2002, 89-199.
[34]. R. Bouillon, E. Muls, and P. M. Moor, Influence of thyroid function on the serum concentration of 1, 25-dihydroxyvitamin D3, The Journal of Clinical Endocrinology and Metabolism, 51(4), 1980, 793-797.
[35]. S. H. Bhardwaj, B. Mishra, S. Yadav, E. Malik, and A. Jain, Vitamin D levels correlated with hypothyroidism in Indian population: a pilot study, International Journal of Recent Scientific Research, 5(5), 2014, 984-987.
[36]. L. Mosekilde, M. S. Christensen, Decreased parathyroid function in hyperthyroidism: interrelationship between serum parathyroid hormone, calcium, phosphorus metabolism and thyroid function. European Journal of Endocrinology, 84(3), 1977, 566-575.
[37]. Bank, E. (2017). Hormones that regulate calcium and phosphate homeostasis. Sciencing Biology.
[38]. C. I. Nettore, L. Albano, P. Ungaro, A. Colao, P. E. Macchia, Sunshine vitamin and thyroid, Reviews in Endocrine and Metabolic Disorders, 18(3), 2017, 347–354.
[39]. K. Prufer, T. Veenstra, G. F. Jirikowski, and R. Kumar, Distribution of 1, 25-dihydroxyvitamin D3 receptor immune reactivity in the rat brain and spinal cord, Journal of Chemical Neuroanatomy, 16 (2), 1999 135-145.
[40]. M. Rotondi, and L. Chiovato, Vitamin D deficiency in patients with Graves' disease: probably something more than a casual association. Endocrine. 43(1), 2013, 3-5.
[41]. A. M. Mackawy, B. M. Al-Ayed, and B. M. Al-Rashid, Vitamin D deficiency and its association with thyroid disease. International Journal of Health Sciences Education, 7(3), 2013, 267-275.
[42]. Q. Zhang, Z. Wang, M. Sun, M. Cao, Z. Zhu, Q. Fu, Y. Gao, J. Mao, Y. Li, Y. Shi, F. Yang, S. Zheng, w. Tang, Y. Duan , X. Huang, W. He, and T. Yang, Association of high vitamin D status with low circulating thyroid-stimulating hormone independent of thyroid hormone levels in middle-aged and elderly males, International Journal of Endocrinology, 2014, 1-6.
[43]. R. Goswami, R. K. Marwaha, N. Gupta, N. Tandon, V. Sreenivas, N. Tomar, D. Ray, R. Kanwar, and R. Agarwal, Prevalence of vitamin D deficiency and its relationship with thyroid autoimmunity in Asian Indians: a community-based survey, British Journal of Nutrition , 102(3), 2009, 328-386.
[44]. A. A. Iqbal, E. H. Burgess, D. L. Gallina, M. S. Nanes, and C. B. Cook, Hypercalcemia in hyperthyroidism: patterns of serum calcium, parathyroid hormone, and 1, 25- dihydroxyvitamin D3 levels during management of thyrotoxicosis, Endocrine. Practice. 9(6), 2003 517-521.
[45]. C. V. Harynarayan, and S. R. Joshi, Vitamin D status in India- Its implications and remedial measures, Journal of the Association of Physicians of India , 57, 2009, 40-48.
[46]. R. Zhang, and D. P. Naughton, Vitamin D in health and disease: Current perspectives, Nutrition Journal, 9, 2010, 65.

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