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Assessment of Iron Profile and Selected Hematological Parameters in Sudanese Patients with Hypothyroidism

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Abstract

Background: Thyroid hormones are essential for maintaining metabolic balance and play a significant role in hematopoiesis. The thyroid gland influences erythropoiesis by stimulating erythropoietin secretion and increasing erythroid progenitors.

Objective: This study aimed to assess iron profile and selected hematological parameters in Sudanese patients with hypothyroidism.

Methodology: A case-control study was conducted at Yastibshroon Hospital in Khartoum, Sudan, involving 50 hypothyroid patients (12 males, 38 females; mean age: 40.2 years) and 50 age- and gender-matched healthy controls. Venous blood samples were analyzed for thyroid hormones (T3, T4, TSH), iron profile (serum iron, ferritin, total iron-binding capacity), hemoglobin, RBC count, and hematocrit using advanced automated analyzers. Data were statistically evaluated using SPSS version 25.

Results: Hypothyroid patients demonstrated significantly lower serum iron and ferritin levels, elevated total iron-binding capacity, and reduced hemoglobin, RBC count, and hematocrit compared to controls ($p \leq 0.05$).

Conclusion: The study highlights an association between hypothyroidism and altered iron metabolism, emphasizing the need for iron status monitoring in hypothyroid patients to improve clinical outcomes.

Key words: Iron Profile, Ferritin, Total Iron Binding Capacity, Hypothyroidism, Sudan

Introduction

In humans, thyroid hormones (THs) play a vital role in regulating various physiological functions. THs may have a regulatory effect on human hematopoiesis in the bone marrow (1). There is a known correlation between anomalies in hematological parameters and thyroid disorders. Hypothyroidism, a common endocrine disease, occurs when there is a decrease in thyroid hormone production, specifically total thyroxine (TT4) and total triiodothyronine (TT3). It is more prevalent in females than in males (2). On one hand, hypothyroidism can lead to specific types of anemia, while on the other hand, it can result in an abnormal increase in immature erythroid progenitors. The anemia associated with hypothyroidism is often mild microcytic hypochromic anemia (3). Conversely, patients with hyperthyroidism commonly exhibit erythrocytosis, but anemia is less frequently observed in these individuals (4,5). It has been identified that when a euthyroid condition is achieved, all hematological parameters return to normal (6). It is believed that iron acts as a co-factor facilitating the function of crucial biological enzymes such as thyroid peroxidase (TPO) (7). TPO is responsible for catalyzing the first two steps of thyroid hormone production (8). This enzyme is membrane-bound and oxidizes iodide while binding iodine to the thyroglobulin tyrosyl residue (9). Reduced TPO efficiency can significantly impact overall thyroid hormone metabolism due to low levels of body iron (8). Indicators of bodily iron reserves include ferritin, which exhibits changes in serum levels during hypothyroidism (10). The relationship between thyroid hormone metabolism and iron metabolism is complex. Assessing serum ferritin, iron, and total iron-binding capacity (TIBC), which measures the saturation of transferrin with iron during transit, can have significant implications for hypothyroidism. Several trace elements, including iron, iodine, selenium, and zinc, are essential for both the synthesis and metabolism of thyroid hormones, making them crucial for maintaining a healthy thyroid (11). The thyroid hormone (T3) plays a pivotal role in the differentiation, development, and maintenance of body homeostasis. Similar to steroid hormones, T3 exerts its effects through intracellular T3-receptor proteins (TRS), which bind to specific T3-response regions in target genes to primarily influence transcription. T3 also exerts significant post-transcriptional effects that regulate the expression of numerous genes (12). Understanding the interplay between thyroid function and iron metabolism is crucial in hypothyroidism management. The findings provide valuable insights into potential diagnostic markers and treatment strategies for hypothyroid patients, particularly in regions like Sudan with limited data on this subject. The research problem addresses the high prevalence of hypothyroidism and anemia in Sudan and the lack of sufficient regional studies exploring the relationship between thyroid function and iron metabolism. Despite the known interplay between thyroid hormones and hematological parameters, the specific impact of

hypothyroidism on iron status and related hematological indices remains inadequately understood in this population. This gap in knowledge limits the development of effective diagnostic and therapeutic strategies, underscoring the need for comprehensive research to elucidate these associations and improve clinical outcomes. This study aims to investigate the relationship between iron metabolism and thyroid function by assessing iron profiles and hematological parameters in Sudanese hypothyroid patients compared to healthy controls.

Material and Methods

This case-control study was conducted at Yastibshroon Hospital, Khartoum, Sudan, and the faculty of medical laboratory Al-neelain University in July 2019. A total of 100 participants were enrolled, with 50 of them being diagnosed with Hypothyroidism disease. Among the patients, 12 (24%) were males and 38 (76%) were females, with an average age of 40.2 years. The remaining 50 participants served as the normal control group, with 13 (26%) males and 37 (74%) females. Their age was matched with the case group. Under aseptic conditions, 5 ml of venous blood was collected from fasting subjects. Thyroid hormones (T3, T4, and FSH), serum iron, serum ferritin, and total iron-binding capacity were measured using an automated chemical analyzer Cobas INTEGRA 400. Hematological parameters were analyzed using an automated hematological analyzer Sysmex XK N-21.

Data collection and analysis: Data were collected using a directly structured interviewer questionnaire. Data were analyzed by using a statistical package for the social science (SPSS) Version 25. T. test and ANOVA test used to compare between the study groups. The p-value considered significant when less than 0.05.

Exclusion Criteria: Every patient with pregnancy, lactation, hepatic disorder, renal diseases, polycystic ovarian syndrome, and chronic medical condition or iron supplements were excluded from this study.

Ethical Clearance: The ethical approval of the present study was obtained from Al Neelain University, Faculty of Medical Laboratory Sciences ethical board. The consent was also taken from all participants in the study before samples were gathered.

Results

The study demonstrated significant differences in thyroid hormone levels, iron profiles, and hematological parameters between hypothyroid patients and healthy controls.

Thyroid Hormones: The levels of T3 and T4 were significantly lower in hypothyroid patients (1.15 ± 0.26 nmol/L and 53.7 ± 6.73 nmol/L, respectively) compared to the control group (2.56 ± 0.61 nmol/L and 96.32 ± 13.68 nmol/L, respectively), with a p-value of 0.001. Conversely, TSH levels were markedly higher in hypothyroid patients (12.25 ± 2.11 µmol/L) than in controls (2.19 ± 2.56 µmol/L, p = 0.001) (Table 1).

Iron Profiles: Hypothyroid patients exhibited significantly lower serum iron (48.2 ± 4.35 µg/dL) and ferritin levels (23.60 ± 6.31 ng/mL) compared to the control group (83.9 ± 10.25 µg/dL and 44.71 ± 7.10 ng/mL, respectively, p = 0.001). Conversely, total iron-binding capacity (TIBC) was significantly elevated in hypothyroid patients (348.36 ± 12.36 µg/dL) relative to controls (271.06 ± 20.12 µg/dL, p = 0.001) (Table 2).

Hematological Parameters: Significant reductions were observed in hemoglobin levels (11.5 ± 0.96 g/dL), red blood cell counts (3.98 ± 0.53 × 10^6/µL), and hematocrit values (35.40 ± 2.41%) among hypothyroid patients compared to controls (13.92 ± 0.72 g/dL, 4.43 ± 0.45 × 10^6/µL, and 44.86 ± 2.20%, respectively, p = 0.001) (Table 3).

These findings highlight the profound impact of hypothyroidism on thyroid hormone levels, iron metabolism, and hematological indices, suggesting a critical relationship between these parameters.

Table1: Comparison of thyroid hormones between the studied groups

Parameter	Patients	Normal control	P-value
T3(nmol/l)	1.15±0.26	2.56 ± 0.61	0.001
T4 (nmol/l)	53.7±6.73	96.32± 13.68	0.001
TSH (µmol/l)	12.25 ±2.11	2.19±2.56	0.001

Table 2: Comparison of serum iron, ferritin and TIBC between the studied groups

Parameter	Patients	Normal control	P-value
Iron (µg/dl)	48.2 ± 4.35	83.9 ± 10.25	0.001
Ferritin (ng/ml)	23.60 ± 6.31	44.71 ± 7.10	0.001
TIBC (µg/dl)	348.36± 12.36	271.06 ± 20.12	0.001

Table3: Comparison of serum iron, ferritin and TIBC between the studied groups.

Parameter	Patients	Normal control	P-value
Hb (g/dl)	11.5±0.96	13.92 ± 0.72	0.001
RBCs	3.98±.0.53	4.43±0.45	0.001
Hematocrit (%)	35.40±2.41	44.86±2.20	0.001

Discussion

The thyroid gland is the most important endocrine gland in the human body, secreting two hormones (T3 and T4) that play a crucial role in cell and organ metabolism. Additionally, the thyroid gland has a significant impact on erythropoiesis by stimulating the production of erythropoietin and the proliferation of erythroid progenitors (13) Studies have also shown a connection between body iron status (including iron metabolism, ferritin, and serum iron) and thyroid hormone function. (14). In this study, the average age of hypothyroid patients was 40.22±8.3, while it was 35.60±9.93 in the normal control group. Females accounted for 76% of the total cases, compared to 24% for males.. This finding was similar to the one reported in 2014 by Desai et al. (15). Similarly, a relationship between iron metabolism, ferritin, serum iron, and thyroid hormone functions was also reported. Hypothyroidism affects body iron status, blood cells, and can cause varying degrees of anemia (16,17). Thyroid dysfunction can also lead to changes in blood indices such as hemoglobin. (18). Our findings indicate a significant decrease in Hb levels among hypothyroid patients when compared to a normal healthy control group. These results are consistent with a study conducted by Dorgalaleh et al (2013), which examined the RBC count, Hb levels, and hematocrit in 102 hypothyroid patients and 118 healthy individuals as the control group. The study found that these parameters were significantly lower in the case group compared to the healthy group. Conversely, these parameters were elevated in cases of hyperthyroidism. (19). The levels of serum iron and serum ferritin were observed to decrease in patients with hypothyroidism, while the total iron-binding capacity was found to increase compared to the healthy control group. These findings are consistent with other studies that have reported a correlation between low levels of thyroid hormones and iron deficiency. (20, 21). These findings indicate that anemia is associated with high levels of TSH. Similarly, it was observed that patients with iron deficiency have significantly lower FT3 levels. In a separate study conducted in Bangladesh on the general population, iron-deficient subjects exhibited significantly elevated serum TSH levels and lower serum FT4 levels compared to healthy individuals. However, the serum FT3 levels were almost the same in both iron-deficient subjects and healthy individuals (22). These results suggest that anemic and iron-deficient patients are at a higher risk for hypothyroidism, which is linked

to anemia and iron deficiency. Therefore, these findings imply that iron insufficiency may impair thyroid metabolism, as reported in previous experiments. The synthesis of thyroid hormones, which involves two primary steps, is catalyzed by a heme-containing enzyme called thyroid peroxidase. Severe iron insufficiency can decrease the activity of thyroid peroxidase, leading to hindered synthesis of thyroid hormones and ultimately resulting in hypothyroidism (23).. Studies have revealed that anemia caused by iron deficiency affects the thyroid's metabolism, resulting in decreased concentrations of TT3 and TT4 in the plasma, as well as reduced conversion of T4 to T3 in the peripheral tissues (24). Previous research has shown that hypothyroidism induced by thyroid removal surgery leads to increased levels of ferritin in the liver of rats, which is attributed to post-transcriptional modifications in the synthesis rate of ferritin. Conversely, administering T3 to hypothyroid individuals significantly raises serum ferritin levels (25). However, contrasting findings indicate that hyperthyroid rats with elevated T3 and T4 levels exhibit an increased rate of ferritin protein synthesis in the liver (26). Our findings of reduced serum iron and ferritin levels in individuals with hypothyroidism can be considered as an indication of decreased iron turnover in line with diminished production of red blood cells. Some theories have been proposed to explain how thyroid hormones stimulate red blood cell production. The main explanations include enhanced metabolic rate and the associated increase in oxygen demand. Erythropoietin has been suggested as the mediator of this process. Supporting this idea, Cinemre et al. (2009) state that hemoglobin, hematocrit, and erythropoietin levels increase after levothyroxine therapy in patients with subclinical hypothyroidism (27).

Conclusion

In conclusion, our data indicate that changes in thyroid state affect the hematological index and serum iron metabolism. Anemia and diminished bodily iron reserves are frequently linked to hypothyroidism.

The study recommends regular screening for iron deficiency in hypothyroid patients, integrating iron profile assessments into routine evaluations, training healthcare providers on the relationship between thyroid function and iron metabolism, conducting longitudinal research to explore causal mechanisms and the effects of iron deficiency treatment on thyroid function, and raising public awareness about the importance of maintaining balanced iron levels for thyroid health.

Limitation of the study

This study had some limitations. We couldn't obtain all the demographic details of our study groups. The small sample size enrolled in this study.

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Conflict of Interest

The author declared no conflict of interest.

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