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Assessment Oxidative Stress and Antioxidants in Hypothyroidism Patients Before and After Treatment

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Abstract: *Background: Thyroid hormones influence the majority of bodily functions by directly impacting various physiological processes and the operation of numerous tissues. They are essential for the operation of other hormones. Aim of the study : Assessment level of glutathione (GSH), glutathione peroxidase (GSH-PX), and malondialdehyde (MDA), ,Thyroxine (T4) and triiodothyronine (T3),and lipid profile in hypothyroidism women before and after treatment with levothyroxine. Materials and methods: 60 patients (before and after taking Levothyroxine treatment) and 30 control group were selected for the study. The study sample was selected from (15-54) years for the period from the end of September 2024 to the beginning of March 2025. The peak age of women with hypothyroidism was between (35-54) years, and its percentage reached 40%. Samples were taken from people who visit specialists in outpatient clinics and health centers in Samarra city. Result: The serum levels of GSH, GSH-PX, and MDA in hypothyroid patients before and after treatment were significantly distinct from those in the control group ($p < 0.001$). The lipid profiles, including total cholesterol, triglycerides, low-density lipoprotein (LDL) cholesterol, and high-density lipoprotein (HDL) cholesterol, in the serum of hypothyroid patients exhibited significant differences from those of the control group before and after treatment ($p = 0.01$). Thyroid hormone levels (TSH, T3, and T4) exhibited a substantial rise ($p < 0.01$) in the serum of hypothyroid patients pre- and post-treatment in comparison to the control group. Conclusion: The current study concluded increase MDA in patient with hypothyroidism before treatment, while decrease after treatment. In contrast decrease both GSH, GSH-PX, and HDL in in patient with hypothyroidism before treatment, while increase after treatment*

Keywords: *Hypothyroidism, Oxidative Stress, Antioxidants, Levothyroxine Treatment, Lipid Profile*

Introduction

The thyroid gland is among the largest endocrine glands in the body, weighing roughly 15 to 20 grams in a typical adult(1). It secretes two principal hormones essential for the proper functioning of several physiological processes that influence nearly every organ system in the body(2). The secretion of thyroid hormones is regulated by the hypothalamic-pituitary-thyroid (HPT) axis(3).

Numerous biochemical events occur within our body to sustain homeostasis, facilitate growth, promote healing, and avert illnesses. These reactions produce deleterious chemicals and radicals, termed free radicals, which can modify nearby cellular structures, hence impacting cellular function. Consequently, the innate defense mechanism, comprising the antioxidant system, operates continuously against free radicals. The

disruption of the equilibrium between free radical production and antioxidant activity leads to oxidative stress (OS) (4).

The existing data about oxidative stress and antioxidant capability in hypothyroidism are limited and contentious. Certain authors propose that tissues might be safeguarded from oxidative damage due to a hypometabolic condition in hypothyroidism (5, 6), whereas other research indicate that oxidative stress is elevated in hypothyroidism (7). Moreover, the degradation of peroxidized lipids produces a diverse array of end-products, including MDA (8). Consequently, the measurement of MDA is extensively utilized as a marker of lipid peroxidation (9). Elevated concentrations of lipid peroxidation products have been linked to numerous illnesses in both humans and experimental systems (10).

Methodology

This study was conducted in Samarra city, where samples were randomly collected from females with hypothyroidism between late September 2024 and early March 2025. Samples were taken from individuals visiting specialists in outpatient clinics and health centers in Samarra city. A total of 90 samples were collected.

Group Patient

60 samples were collected from hypothyroid patients aged (20-60) years. Blood samples were taken for two periods: when they were diagnosed with hypothyroidism by a specialist doctor and after 3 months of taking Levothyroxine treatment. A questionnaire was used to record personal information for each of them.

Control Group

30 samples were collected from women who were not suffering from hypothyroidism, their ages ranged between (20-60) years, and they were selected from the residents of Samarra city.

Collection of Blood samples

5 ml of blood was taken from diseased patients and control group members. Blood was inserted in a sterile 10 ml gel tube without anticoagulant to separate serum. After 30 minutes at lab temperature, it was centrifuged at 2500 rpm for 10 minutes to extract serum, which was extracted with an automated pipette. The serum was placed in three Eppendorf tubes, firmly sealed, and stored at -20°C until use.

Assessment of biochemical variable

Both groups were tested for MDA, GSH and GSH-PX using BT (Bioassay Technology Laboratory) ELISA kits from China. Estimate the concentration of TSH , T3, and T4 hormone in the blood serum using a ready-made analysis kit provided by VEDA.LAB-France. The BIOLABO reagent kit was used to quantify serum TC, TG, HDL, and LDL in accordance with the method described by(11).

Statistical analysis

The data was statistically examined using SPSS software version 27 (SPSS, Inc.) and the Analysis of Variance (ANOVA) test. The goal was to find out how significant the differences were between the control group and the hypothyroidism patients.

Result and Discussion

Hypothyroidism patients' sera were compared to healthy people's for GSH, GSH-PX, and MDA levels before and after treatment. Table (1) shows a 0.01 P-Value difference.

Table (1): Comparison of the levels of GSH, GSH-PX and MDA in the sera of patients with hypothyroidism before and after treatment with the control groups

Study groups	No	Mean ± SD		
		GSH-PX U\g	GSH nmol/ml	MDA Nmol\g
Before treatment	60	0.64± 0.11	28.81±5.31	5.46±0.60
After treatment	60	0.94± 0.41	35.83±6.04	2.59±0.44
Control	30	0.85± 0.32	48.82±12.02	1.83±0.76
P. value		0.01	0.01	0.01

Lipid profiles TC, TG, LDL , HDL were measured in the serum of hypothyroid patients before and after treatment compared to healthy controls. The results, as shown in Table (2), showed a significant difference (P-value = 0.01). However, no significant differences (P-value = 0.06) were recorded in the serum of VLDL patients before and after treatment compared to the control groups.

Table (2): Comparison of the TC, TG, LDL , HDL, and VLDL in the sera of patients with hypothyroidism before and after treatment with the control groups.

Study groups	No	Mean ± SD				
		Cholesterol mg/dl	TG mg/dl	LDL mg/dl	VLDL mg/dl	HDL mg/dl
Before treatment	60	223.10± 11.72	132.03±36.58	152.87±13.79	26.40±7.31	35.51±1.90
After treatment	60	203.77± 9.09	121.05± 4.25	128.57±10.41	24.08±1.15	50.55±3.32
Control	30	175.53± 9.44	106.40± 8.93	106.84±10.46	21.28±1.78	47.93±2.80
P. value		0.01	0.01	0.01	0.06	0.01

Thyroid hormone levels (TSH, T4, and T3) were measured in the serum of hypothyroid patients before and after treatment compared with the control groups. The results were shown in Table (3) with a significant difference (P-value = 0.01).

Table (3) Comparison of thyroid hormones (TSH, T4, and T3) in the serum of hypothyroid patients before and after treatment compared with the control groups.

Study groups)	**No**	**Mean ± SD**		
		TSH mU/L	**T4 ng\dl**	**T3 ng\dl**
Before treatment	60	15.66± 3.66	7.18± 3.59	1.46 ±0.42
After treatment	60	3.29± 0.76	11.80± 2.05	3.18 ±0.77
Control	30	2.91±0.48	13.14± 1.14	3.30±0.37
P. value		0.01	0.01	0.01

Oxidative stress is a condition characterized by an imbalance between oxidative and antioxidant levels. This phenomenon is prevalent in various illnesses, including pre-treatment thyroid dysfunction, and can result in increased quantities of reactive oxygen species, such as hydrogen peroxide, which induce protein degradation and contribute to disease. In individuals with hypothyroidism, the likelihood of dyslipidemia, metabolic syndrome, and atherosclerosis is heightened due to elevated oxidative stress (12). The present investigation revealed a favorable correlation between hypothyroidism and MDA levels prior to treatment. This conclusion aligns with research by (13) indicating that reactive oxygen species induce lipid peroxidation, resulting in MDA formation, which contributes to oxidative damage and oxidative stress in hypothyroid individuals. MDA can be utilized to detect oxidative stress linked to hypothyroidism and to monitor the condition post-treatment with L-thyroxine, as its levels diminish with therapy, as evidenced by multiple research.

The present investigation demonstrated that GSH levels in hypothyroid patients are markedly lower than in healthy controls, corroborating findings from (14). The significance of thyroid hormone in the production of antioxidant agents, such as GSH, indicates that diminished thyroid hormone levels result in a reduction of GSH biosynthesis. Additionally, diminished GSH levels may result from several reasons, including reduced superoxide dismutase levels, which contribute to superoxide buildup, superoxide oxidation, and GSH oxidation. A study conducted by (15) revealed that increasing oxidative stress correlates with a reduction in the antioxidant activity levels of superoxide dismutase and GSH-PX in patients with hypothyroidism.

Hypothyroidism plays a role in the development of metabolic syndrome. It is likely that thyroid hormones influence body fat percentage, causing elevated blood lipids, and

that excess fat acts as a substrate for T3. As a result, T3 consumes oxygen at a faster rate, leading to increased production of reactive oxygen species (ROS), increased cellular antioxidant consumption, and inactivation of antioxidant enzymes(16). The metabolic depression caused by hypothyroidism reduces the production of reducing oxidants, thus protecting tissues from their resulting damage (17).

Estradiol plays a role in the pathophysiology of hypothyroidism and has an antagonistic effect on the activity of the antagonistic hormones T3 and T4 by competing with them for their binding receptors. Therefore, there may be a decrease in circulating T3 and T4 activity, which could lead to hypothyroidism. These findings are consistent with the previous study by (18). The current findings indicated a notable reduction in T3 and T4 thyroid hormone levels, alongside a considerable elevation in TSH levels in obese and overweight patients prior to treatment, in comparison to the healthy control group. This result aligns with the conclusions of (19).Marginally raised serum TSH levels correlated with a heightened prevalence of obesity. The thyroid gland exerts a significant biological influence on various bodily functions, including growth, reproduction, and metabolic regulation (20). Thyroxine-induced thermogenesis is ascribed to an elevated demand for ATP due to heightened cellular activity and diminished efficiency in ATP production. Consequently, hypothyroid patients have diminished and delayed metabolic activity, frequently resulting in an elevated body mass index (BMI). Prior studies have associated hypothyroidism with elevated oxidative stress; it was found that heightened oxidative stress may adversely impact the thyroid follicular cells responsible for secreting T3 and T4, resulting in decreased blood levels of these hormones and higher TSH levels (21). A study indicated that elevated blood TSH levels and higher T4 levels were correlated with hypothyroidism in relation to advancing age (22).

Conclusion

The current study concluded increase MDA in patient with hypothyroidism before treatment, while decrease after treatment. Incontrast decrease both GSH, GSH-PX, and HDL in in patient with hypothyroidism before treatment, while increase after treatment.

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