

<https://doi.org/10.48047/AFJBS.5.3.2023.9-20>



African Journal of Biological Sciences



Research Paper

Open Access

Study of cardiac troponin I and many physiological parameters in women with thyrotoxicosis in Kirkuk city

Zainab Emad Abood Mahdi , Iktefa Abdul Hamid Mohammed Saeed

Department of Biology ,College of Education for Women Tikrit university ,Iraq

Wedad Mohmood Lahmood AL- Obaidi

Department of Biology , College of Science for Kirkuk university ,Iraq

Mohammed.alsad3@gmail.com

Article Info

Volume 5, Issue 3, July 2023

Received:18 May 2023

Accepted :15 June 2023

Published: 11 July 2023

doi:10.48047/AFJBS.5.3.2023.9-20

Abstract

Background: Thyroid diseases are common, especially in women, and the incidence increases with age, so that about 10 % of the population over the age of 65 suffers from thyroid dysfunction

Aim: The current study aims was to evaluate the serum levels of cardiac troponin, high-sensitivity C-reactive protein, T3 and T4 with TSH, LDH and creatine kinase in women with thyrotoxicosis and hyperthyroidism

Materials and methods: This study was conducted in Kirkuk, involving Kirkuk Teaching Hospital, Azadi Teaching Hospital, and private laboratories from December 2022 to April 2023. A total of 110 blood samples were collected from women aged 25 to 45 years, divided into five groups: untreated hyperthyroidism women (25 samples), hyperthyroid women undergoing treatment (20 samples), untreated thyrotoxic women (25 samples), women with thyrotoxicity undergoing treatment (20 samples), and healthy women without thyroid disorder (20 samples as control group). Blood samples were collected from each patient for determination of cardiac troponin, high-sensitivity C-reactive protein, T3 and T4 hormone levels, thyroid-stimulating hormone (TSH), lactate dehydrogenase (LDH), and creatine kinase (CK), which were analyzed to assess their association with thyrotoxicosis and hyperthyroidism.

Results: The thyrotoxicity and hyperthyroidism groups demonstrated a statistically significant decrease in TSH levels compared to the control group (0.817 ± 0.24 nmol/L and 0.847 ± 0.34 nmol/L vs. 2.776 ± 0.74 nmol/L). After treatment, there was a significant improvement in TSH levels (2.383 ± 0.69 nmol/L and 2.056 ± 0.51 nmol/L), although they remained higher than the control group. Moreover, the thyrotoxicity and hyperthyroidism groups exhibited a significant increase in T3 (4.849 ± 1.07 nmol/L and 4.244 ± 1.06 nmol/L vs. 1.745 ± 0.55 nmol/L) and T4 (194.00 ± 13.7 nmol/L and 160.70 ± 12.1 nmol/L vs. 92.81 ± 9.14 nmol/L) levels compared to the control group. Following treatment, there was a significant improvement in T3 (4.479 ± 0.89 nmol/L and 3.733 ± 0.91 nmol/L) and T4 (150.8 ± 10.69 nmol/L and 103.34 ± 10.51 nmol/L) levels, although they remained higher than the control group. Highly sensitive troponin, C protein, lactate dehydrogenase, and creatine kinase levels were also significantly altered in the patient groups compared to the control group, with some improvement observed after treatment, but they still differed from the control group.

Conclusions: These findings emphasize the complex hormonal and cardiac changes associated with thyrotoxicity and hyperthyroidism in women, highlighting the need for further research and clinical consideration.

Keywords: cardiac troponin; C-RP, LDH; creatine kinase; thyrotoxicosis.

© 2023 Zainab Emad Abood Mahdi, This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made

Introduction

Thyroid diseases are common, especially in women, and the incidence increases with age, so that about 10% of the population over the age of 65 suffers from thyroid dysfunction. Hyperthyroidism is an overactive thyroid tissue that causes overproduction of thyroid hormones (thyroxine, or "T4", and triiodothyronine, or "T3") (Devereaux and Tewelde, 2014). Hyperthyroidism is the cause of thyrotoxicosis, a pathological condition caused by increased secretion of thyroid hormones in the blood, and it is important to note that hyperthyroidism and thyrotoxicosis are not synonymous; for example, thyrotoxicosis can occur due to taking thyroid hormone from outside the body or because of thyroiditis, which leads to the secretion of thyroid hormones (De Guzman *et al.*, 2021). Thyroid hormone is important at the cellular level, affecting almost all types of tissue in palpation, and thyroid activity may cause increased metabolic speed, resulting in unintentional weight loss and an irregular heartbeat (Yahya *et al.*, 2023). Clinically, Plummer's disease and thyroiditis, and patients with increased thyroid hormone, are at increased risk of heart disease, especially in patients aged 60 years. The most characteristic features of hyperthyroidism are those that result from the effects of triiodine and thyronine (T3) on the heart and cardiovascular system, such as decreased systemic vascular resistance, increased resting heart rate, and left ventricular contraction (Devereaux *et al.*, 2014). Some studies also indicate that about 6% of individuals with thyrotoxicosis show symptoms of heart failure and that less than 1% of them may develop dilated cardiomyopathy with impaired left ventricular contraction function. There are many factors that increase the risk of the disease and further aggravate the condition of those who suffer from thyrotoxicity, such as lipid profile levels and oxidative stress factors. Patients with thyrotoxicosis are characterized by hypercholesterolemia and a marked increase in low-density lipoproteins (Jafarzadeh *et al.*, 2010). Some studies have also found that cardiac troponin, which is a protein with high myocardial specificity and is used as a marker of myocardial damage, and C-reactive protein, which is significantly higher in patients, and high-sensitivity C-reactive protein (hs-CRP) are acute-phase proteins (Czarnywojtek *et al.*, 2014) that are synthesized by the liver in response to infection and chronic inflammation, as well as an indicator of a malfunction of cardiovascular muscle cells that causes atherosclerosis by activating endothelial cells and coronary artery smooth muscle cells. (Ahmad *et al.*, 2018) The current study aims to evaluate the serum levels of cardiac troponin, high-sensitivity C-reactive protein, T3 and T4, TSH, LDH, and creatine kinase in women with thyrotoxicosis and hyperthyroidism.

Materials and methods

This study was conducted in the city of Kirkuk, involving Kirkuk Teaching Hospital, Azadi Teaching Hospital, and private laboratories from December 2022 to April 2023. A total of 110 blood samples were collected from women aged 25 to 45 years. The participants were divided into five groups: untreated hyperthyroidism women (25 blood samples), hyperthyroid women undergoing treatment (20 blood samples), untreated thyrotoxic women (25 blood samples), women with thyrotoxicity undergoing treatment (20 blood samples), and healthy women without thyroid disorder (20 blood samples, serving as the control group). Five milliliters of blood were collected from each participant

and control person using a 5 ml syringe via vein puncture. The blood samples were collected in plain tubes and allowed to clot for 30 minutes at 37 °C. After clotting, the tubes were centrifuged at 3000 rpm for 15 minutes. The resulting sera were carefully aspirated and transferred into Eppendorf tubes for further analysis. The variables measured included cardiac troponin, high-sensitivity C-reactive protein, T3 and T4 hormone levels, thyroid-stimulating hormone (TSH), lactate dehydrogenase (LDH), and creatine kinase (CK). These variables were analyzed to assess their association with thyrotoxicosis and hyperthyroidism.

Statistical Analysis:

Descriptive statistics, such as means, standard deviations, and percentages, were used to summarize the data. Inferential statistics, such as t-tests or analysis of variance (ANOVA), may be employed to compare the variable levels among different groups.

Results

The results of the current study shown in Figure 1 showed that the thyrotoxicity and hyperthyroidism groups exhibited a statistically significant decrease compared to the control group (0.817 ± 0.24 nmol/L and 0.847 ± 0.34 nmol/L vs. 2.776 ± 0.74 nmol/L). Following treatment, the thyrotoxicity and hyperthyroidism groups showed significant improvement in TSH levels (2.383 ± 0.69 nmol/L and 2.056 ± 0.51 nmol/L) but remained higher than the control group.

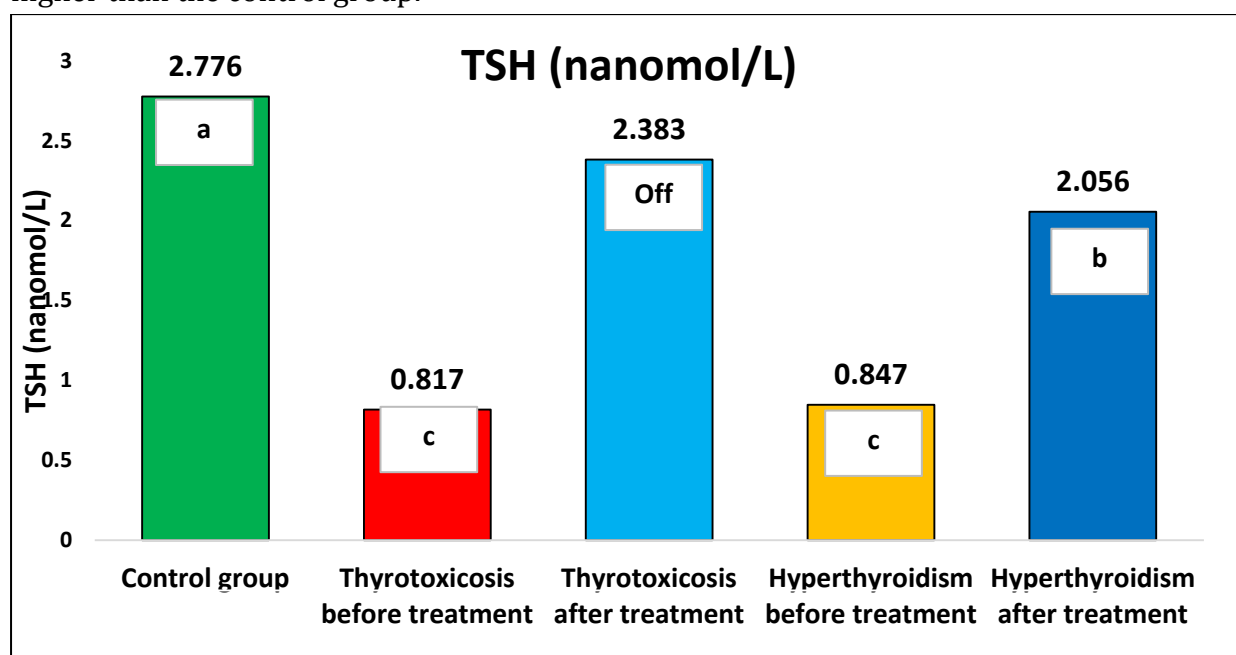


Figure 1: TSH levels in studied groups

. Regarding T3 hormone, the thyrotoxicity and hyperthyroidism groups showed a significant increase compared to the control group (4.849 ± 1.07 nmol/L and 4.244 ± 1.06 nmol/L vs. 1.745 ± 0.55 nmol/L). After treatment, the thyrotoxicity and hyperthyroidism groups demonstrated a significant improvement in T3 levels (4.479 ± 0.89 nmol/L and 3.733 ± 0.91 nmol/L) while still surpassing the control group.

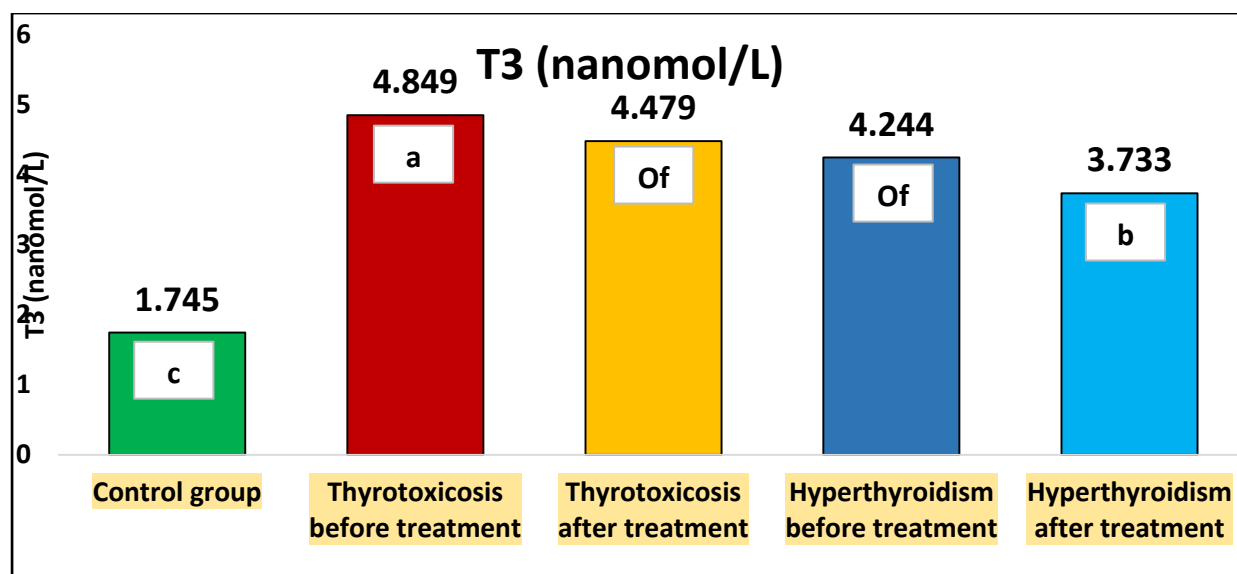


Figure 2: Level of T3 hormone in the studied groups

For T4 hormone, the thyrotoxicity and hyperthyroidism groups exhibited a statistically significant increase compared to the control group (194.00 ± 13.7 nmol/L and 160.70 ± 12.1 nmol/L vs. 92.81 ± 9.14 nmol/L). After treatment, the thyrotoxicity and hyperthyroidism groups showed a significant improvement in T4 levels (150.8 ± 10.69 nmol/L and 103.34 ± 10.51 nmol/L) while remaining higher than the control group.

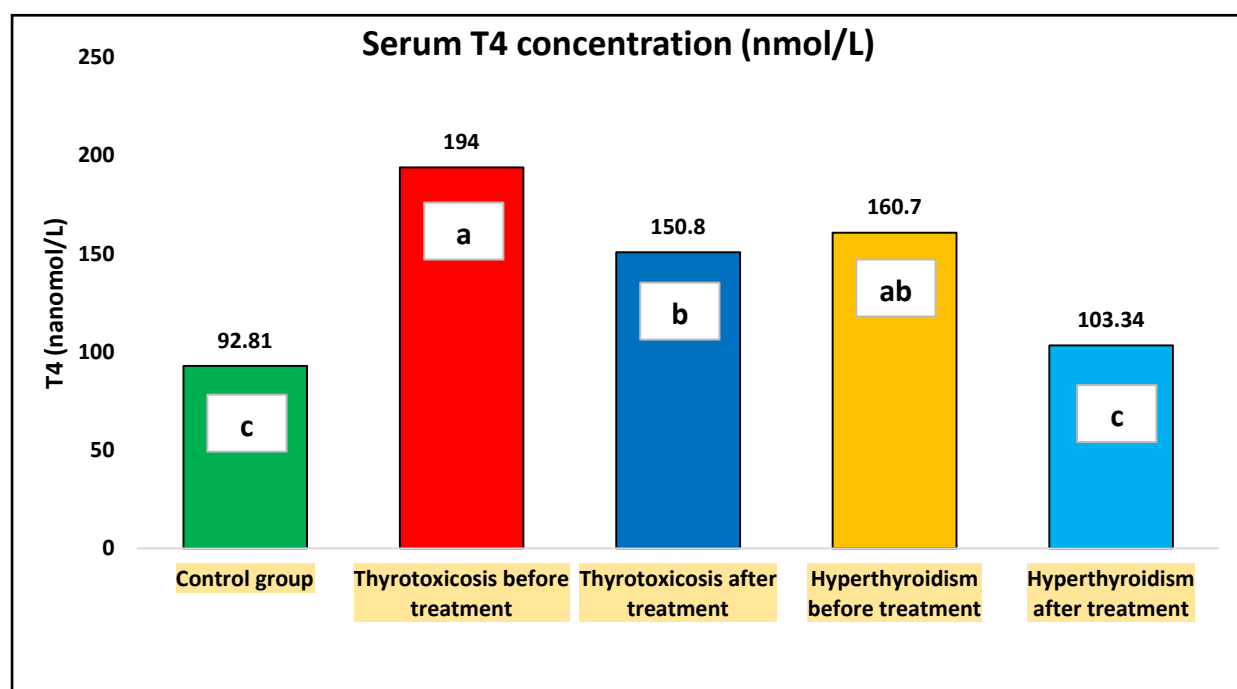


Figure 3: T4 levels in studied groups

Highly sensitive troponin levels were significantly higher in the thyrotoxicity and hyperthyroidism groups compared to the control group (1.47 ± 0.12 ng/ml and 1.29 ± 0.97

ng/ml vs. 0.49 ± 0.06 ng/ml). Following treatment, both groups showed significant improvement in highly sensitive troponin levels (0.88 ± 0.19 ng/ml and 1.20 ± 0.32 ng/ml) but remained elevated compared to the control group.

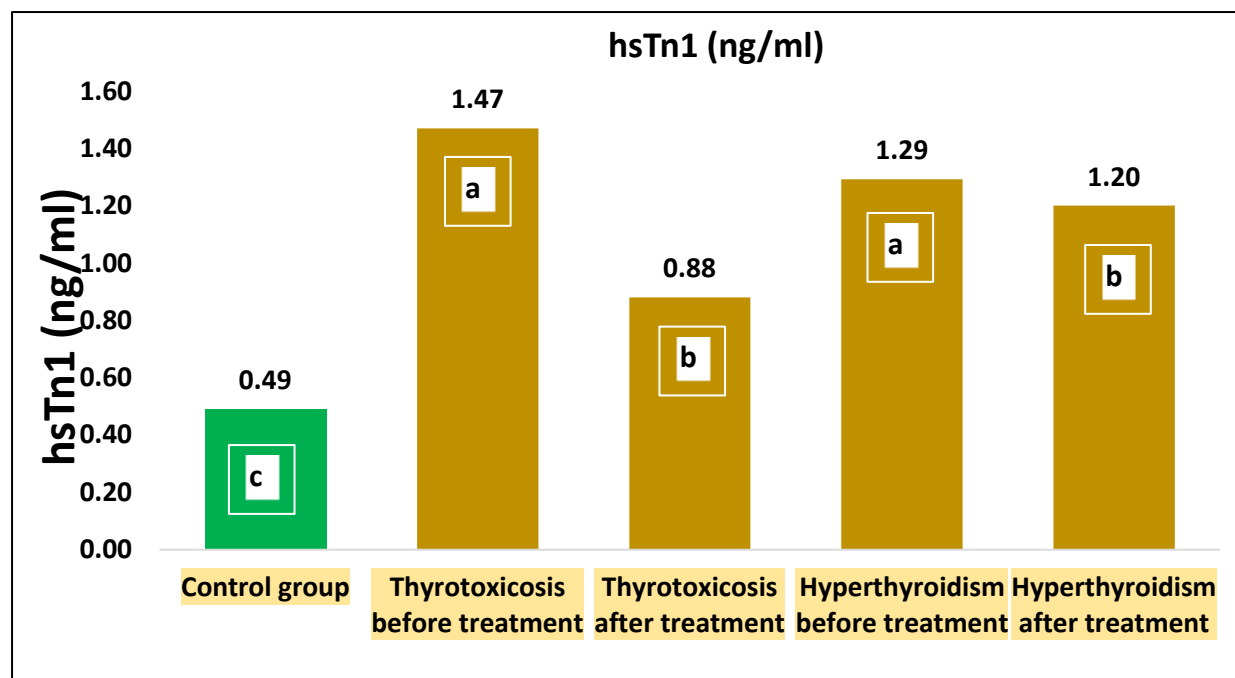


Figure 4: Level hsTnI in the studied groups

C protein levels were significantly elevated in the thyrotoxicity and hyperthyroidism groups compared to the control group (6.82 ± 0.19 mg/dL and 6.73 ± 0.17 mg/dL vs. 4.02 ± 0.13 mg/dL). After treatment, significant improvement was observed in C protein levels (6.17 ± 0.13 mg/dL and 6.04 ± 0.12 mg/dL) but remained higher than the control group.

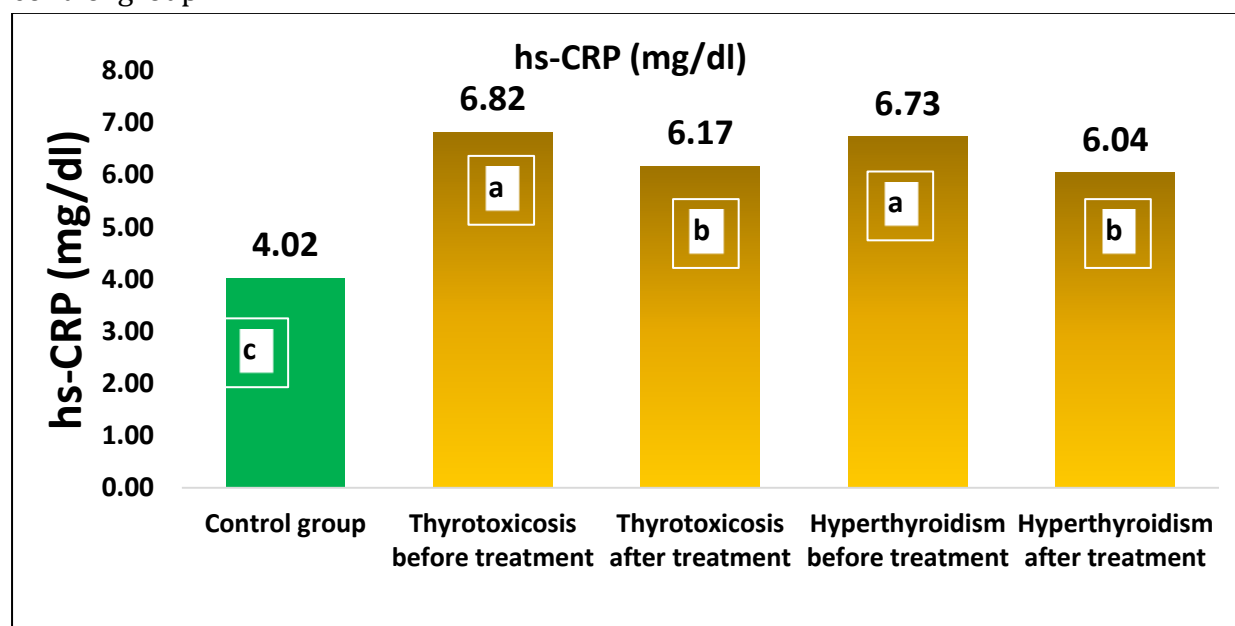


Figure 5: Level of hs-CRP in studied groups

Lactate dehydrogenase levels were significantly increased in the thyrotoxicity and hyperthyroidism groups compared to the control group (447.4 ± 23.79 IU/L and 436.5 ± 23.47 IU/L vs. 211.8 ± 14.11 IU/L). After treatment, a slight improvement was observed in lactate dehydrogenase levels (442.1 ± 19.33 IU/L and 249.1 ± 18.42 IU/L) but remained higher than the control group.

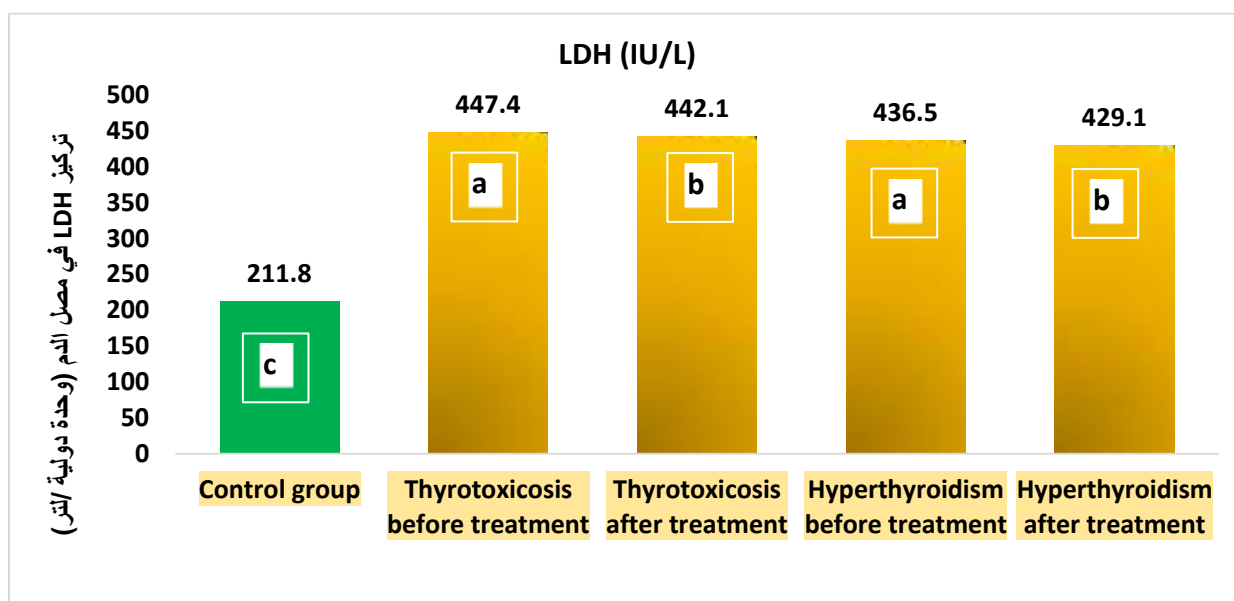


Figure 6: Level LDH in the studied groups

Creatine kinase levels were significantly decreased in the thyrotoxicity and hyperthyroidism groups compared to the control group (50.50 ± 6.59 IU/L and 52.14 ± 6.34 IU/L vs. 78.68 ± 9.41 IU/L). Following treatment, a significant improvement in creatine kinase levels was observed (58.24 ± 5.11 IU/L and 66.28 ± 4.55 IU/L) but remained lower than the control group.

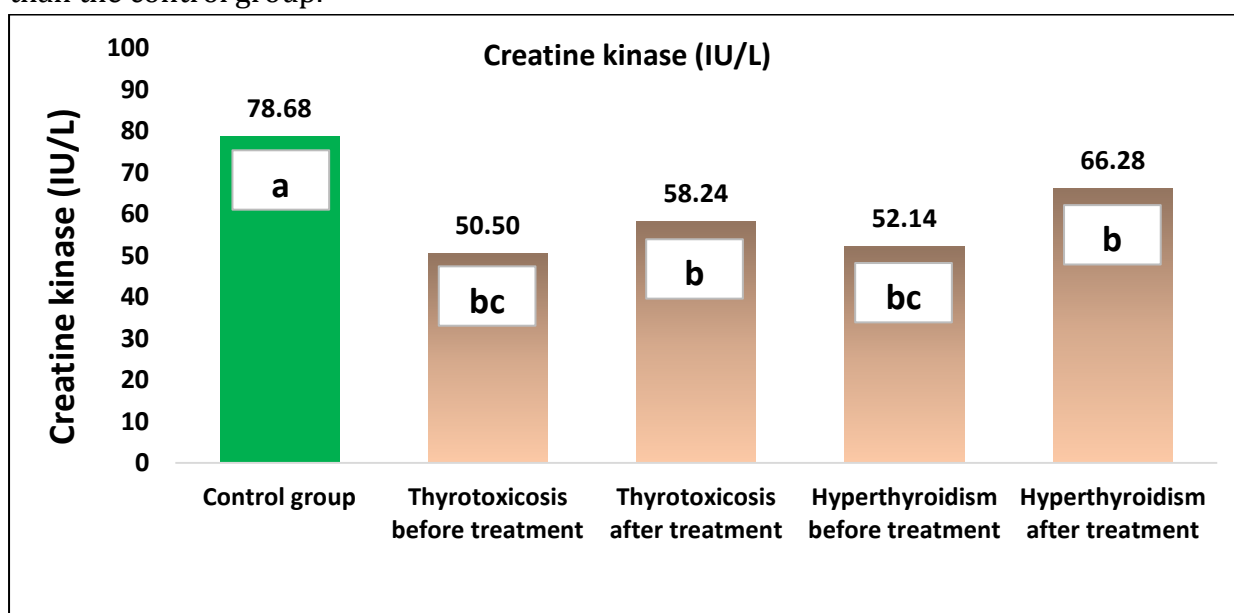


Figure 7: Level of CK in the studied groups

Discussion

The results of the current study showed a statistically significant increase ($P \leq 0.01$) in the concentration of T3 hormone in the groups of women with thyrotoxicity and hyperthyroidism (4.849 ± 1.07 nmol/L), (4.244 ± 1.06 nmol/L) Compared respectively with the control group of healthy women (1.745 ± 0.55 nmol/L), a significant improvement in the level of T3 hormone after treatment was observed in the thyrotoxicity group and the hyperthyroidism group ($4.479 \pm (0.89$ and $(3).733 \pm (0.91$ nmol/L) when compared with the two groups of patients before treatment with higher levels than in the control group.

Our study was consistent with several studies conducted by Jafarzadeh and his group (2010) and Alqahtani (2021) who showed in their studies that the level of thyroxine hormone was relatively high in the thyrotoxicosis group and the hyperthyroidism group compared to control groups. In case of thyrotoxicosis and hyperthyroidism A rise in hormone can occur Thyroxine (T4) And not necessarily a trihormone Iodoheroine (T3)

Another study showed that hyperthyroidism patients are characterized by increased secretion of thyroid hormones and an increase in thyroxine (T4) and triiodothyronine (T3) occurs as a result of stimulating the thyroid gland by activated immune bodies that target the gland and these immune bodies cause a change in the function of the thyroid gland, which leads to an increase in the secretion of thyroid hormones (Devereaux and Tewelde, 2014).

Another study showed that there is often arise in the secretion of thyroid hormones, including thyroxine (T4) in some cases of hyperthyroidism, and this rise is relatively high in the early stages of the disease, especially if inhibitory treatments are not used, and this occurs when there is an inflammatory reaction or clotting inside the thyroid gland, which leads to the secretion of hormones stored in the gland excessively (Smithson *et al.*, 2019) In general, the level of T4 hormone is used as an indicator of thyroid function, where its elevation in the thyrotoxic group is considered an indication of increased thyroid activity, while its decrease in the hyperthyroidism group after treatment may indicate the effectiveness of treatment as shown by various studies in this field (De Guzman *et al.*, 2021; Yahya *et al.*, 2023). In line with the results of our current study, many studies have reported elevated levels of high-sensitivity troponin I (hsTnI) in individuals with thyrotoxicosis, which is an excessive production of thyroid hormones, and these results indicate that there may be a relationship between thyrotoxicosis and myocardial injury, as the recent study conducted by the researcher Watanabe *et al* (2021) found that there is a significant increase in the level of high-sensitivity troponin examination (hsTnI). In patients with thyrotoxicosis and hyperthyroidism compared to the control group, this increase may indicate the presence of damage to the heart muscle in those patients, and this damage may be minor and not clinically apparent, but it can be an indication of an effect on the heart in cases of thyrotoxicosis and hyperthyroidism, while another study conducted by Choi *et akl* (2005) found that the levels of Thyroid hormones play an important role in regulating heart function and an excess of these hormones can lead to various cardiovascular effects and he observed in his study that elevated hsTnI levels in thyrotoxicity patients led to a slight injury to the heart muscle or strain on the heart

muscle. The study conducted by Keller et al in the year (2009) found a significant increase in the level of high-sensitivity troponin examination hsTnI in the thyrotoxicosis group at the beginning of and then the study noticed a slight decrease in the level of troponin in patients after receiving treatment and it is also believed that the regulation of thyroid hormones and the treatment of the condition contribute to improving heart function and reducing the negative impact on the heart muscle and this can be manifested in reducing the level of high sensitivity troponin hsTn1 After receiving treatment. In contradiction to our study, a study conducted by De Lemos et al. (2010) found that there is no effect of taking inhibitory therapies for hyperthyroidism and thyrotoxicosis on the decline of high sensitivity troponin levels hTnI after receiving treatment, and it is necessary to take into account that there is a contradiction in the results published in various researches and this may be due to multiple factors such as the design of the study, the study sample and the methods of analysis used. (Tolu-Akinnawo *et al.*, 2022). C-reactive protein is an inflammation marker used to assess the presence of inflammation in the body and several studies have shown that adnexitis and hyperthyroidism can contribute to higher levels of C-reactive protein levels than healthy people (Czarnywojtek *et al.*, 2014). Ahmad et al. (2018) demonstrated a significant increase in the level of high-sensitivity C-reactive protein examination (hs-CRP) in thyrotoxic patients and hyperthyroidism patients, while Sütken et al. (2010) indicated that the level of high-sensitivity C-reactive protein examination was high in thyrotoxicity and hyperthyroidism patients before treatment and decreased slightly after treatment, but there was no significant difference between patients before and after treatment. Burggraaf et al. (2001) indicated that the level of high-sensitivity C-reactive protein screening was high in thyrotoxicity and hyperthyroidism patients before treatment and decreased slightly after treatment, but there was no significant difference between patients before and after treatment as shown by another study.(Sethi *et al.*, 2022). Lactate dehydrogenase refers to the level of acidity of the blood due to the accumulation of lactate in it according to the study conducted by McGrowder et al (2011) a n the presence of a high level of lactate dehydrogenase in patients with thyrotoxicosis and hyperthyroidism compared to healthy individuals where thyrotoxicosis is a condition caused by excessive secretion of thyroid hormones from the thyroid gland, which leads to an increase in the level of thyroid hormones in the body and This rise in the level of thyroid hormones affects the body's metabolism and can lead to increased lactate production and accumulation in the blood (Khan et al. 2020). Lactate is a natural product of the body's sugar metabolism and lactate is usually converted into carbon dioxide and water in the presence of oxygen however in some cases such as thyrotoxicosis and hyperthyroidism lactate can accumulate due to insufficient oxygen supply in the body or sugar flow (Omi, and Anan 2017). Our current study agreed with a study conducted by Prakash and his group in 2007 that the average enzyme creatine kinase CK was significantly lower in patients with thyrotoxicosis and hyperthyroidism while the highest rate of creatine kinase CK was recorded in the healthy group ($P \leq 0.01$) by agreement. Some studies have shown that serum CK activity has been recorded at low rates in hyperthyroid patients (Pandey et al., 2013). It is known that hyperthyroidism has different effects on muscle metabolism and can increase the process

of catabolism and muscle protein building, which leads to an increase in the turnover rate of muscle proteins and this increased turnover may lead to a decrease in CK activity as more CK is used to metabolize muscle energy instead of releasing it into the bloodstream and hyperthyroidism can also affect muscle formation leading to changes in the type of fiber. Muscular and muscle mass and these changes may further affect CK activity levels. The observed decrease in CK activity in hyperthyroid patients can reflect changes in muscle metabolism and composition associated with the condition (Shaker and Younis, 2023).

Conclusions: These findings emphasize the complex hormonal and cardiac changes associated with thyrotoxicity and hyperthyroidism in women, highlighting the need for further research and clinical consideration.

References

- Abdulazeez, M., Hussein, A. A., Hamdi, A. Q., & Mustafa, M. A. (2020). Estimate the Complications That Resulting from Delayed Management of Dental Trauma in Tikrit City. *Journal of Cardiovascular Disease Research*, 11(2), 80-82.
- Abdulqader, A. T., Al-Sammarie, A. M. Y., & Mustafa, M. A. (2022, May). A comparative environmental study of aqueous extracts of ginger and grapes to protect hepatocytes in Albino rabbits and a comparison of extracts in preserving Awassi lamb meat from oxidation. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1029, No. 1, p. 012001). IOP Publishing.
- Ahmad, N., Nagtilak, S., Sharma, A. K., Parashar, P., & Rastogi, A. (2018). Role of Circulating C Reactive Protein in Thyroid Disorders. *Journal of Medical Science And clinical Research*, 6(2), 485-89.
- Ali, A., Jassim, A.F., Muhsin, S.N., & Mustafa, M.A. (2020). Study of Lycium Shawii Phenolic Compounds in Treatment of Hyperlipidemia. *Journal of cardiovascular disease research*, 11, 196-199.
- Ali, A., Jassim, A.F., Muhsin, S.N., & Mustafa, M.A. (2020). Study of Lycium Shawii Phenolic Compounds in Treatment of Hyperlipidemia. *Journal of cardiovascular disease research*, 11, 196-199.
- Ali, S. H., Armeet, H. S., Mustafa, M. A., & Ahmed, M. T. (2022, November). Complete blood count for COVID-19 patients based on age and gender. In *AIP Conference Proceedings* (Vol. 2394, No. 1). AIP Publishing.
- Alqahtani, S. A. M. (2021). Prevalence and characteristics of thyroid abnormalities and its association with anemia in ASIR region of Saudi Arabia: a cross-sectional study. *Clinics and practice*, 11(3), 494-504.
- Burggraaf, J., Lalezari, S., Emeis, J. J., Vischer, U. M., De Meyer, P. H. E. M., Pijl, H., & Cohen, A. F. (2001). Endothelial function in patients with hyperthyroidism before and after treatment with propranolol and thiamazol. *Thyroid*, 11(2), 153-160.
- Choi, Y. H., Chung, J. H., Bae, S. W., Lee, W. H., Jeong, E. M., Kang, M. G., ... & Park, J. E. (2005). Severe coronary artery spasm can be associated with hyperthyroidism. *Coronary artery disease*, 16(3), 135-139.
- Czarnywojtek, A., Owecki, M., Zgorzalewicz-Stachowiak, M., Woliński, K., Szczepanek-Parulska, E., Budny, B., ... & Ruchala, M. (2014). The role of serum C-reactive protein

measured by high-sensitive method in thyroid disease. *Archivum immunologiae et therapeuticae experimentalis*, 62, 501-509.

De Guzman, E., Shakeel, H., & Jain, R. (2021). Thyrotoxicosis: a rare presentation of molar pregnancy. *BMJ Case Reports CP*, 14(7), e242131.

De Lemos, J. A., Drazner, M. H., Omland, T., Ayers, C. R., Khera, A., Rohatgi, A., ... & McGuire, D. K. (2010). Association of troponin T detected with a highly sensitive assay and cardiac structure and mortality risk in the general population. *Jama*, 304(22), 2503-2512.

Devereaux, D., & Tewelde, S. Z. (2014). Hyperthyroidism and thyrotoxicosis. *Emergency Medicine Clinics*, 32(2), 277-292.

Fadhil, K. B., Majeed, M. A. A., & Mustafa, M. A. (2019). Electronic study of fresh enzyme complexes of antifungal drugs-P450 and *Aspergillus kojic acid* biosynthesis. W: w saccharose flavus: fructose as a substratum. *Annals of Tropical Medicine and Health*, 22, 65-72.

Govindarajan, S., Mustafa, M. A., Kiyosov, S., Duong, N. D., Raju, M. N., & Gola, K. K. (2023). An optimization based feature extraction and machine learning techniques for named entity identification. *Optik*, 272, 170348.

Hama Hasan, T. A., Erzaiq, Z. S., Khalaf, T. M., & Mustafa, M. A. (2020). Effect of Equisetum Arvense Phenolic Extract in Treatment of Entamoeba Histolytica Infection. *Systematic Reviews in Pharmacy*, 11(11).

Hama Hasan, T. A., Erzaiq, Z. S., Khalaf, T. M., & Mustafa, M. A. (2020). Effect of Equisetum Arvense Phenolic Extract in Treatment of Entamoeba Histolytica Infection. *Systematic Reviews in Pharmacy*, 11(11).

Hama Hasan, T. A., Erzaiq, Z. S., Khalaf, T. M., & Mustafa, M. A. (2020). Effect of Equisetum Arvense Phenolic Extract in Treatment of Entamoeba Histolytica Infection. *Systematic Reviews in Pharmacy*, 11(11).

Hassan, J. A., & Rasheed, M. K. (2022, November). Synthesis and characterization of some benzimidazole derivatives from 4-methyl ortho-phenylene diamine and evaluating their effectiveness against bacteria and fungi. In *AIP Conference Proceedings* (Vol. 2394, No. 1). AIP Publishing.

Ibrahim, H. M., Jumaah, L. F., Khalaf, S. A., & Mustafa, M. A. (2021). KNOWLEDGE AND PRACTICE OF BREASTFEEDING AND WEANING IN MOTHERS LIVES SAMARRA CITY, IRAQ. *Biochemical & Cellular Archives*, 21.

Ibrahim, H. M., Jumaah, L. F., Khalaf, S. A., & Mustafa, M. A. (2021). KNOWLEDGE AND PRACTICE OF BREASTFEEDING AND WEANING IN MOTHERS LIVES SAMARRA CITY, IRAQ. *Biochemical & Cellular Archives*, 21.

Jafarzadeh, A., Poorgholami, M., Izadi, N., Nemati, M., & Rezayati, M. (2010). Immunological and hematological changes in patients with hyperthyroidism or hypothyroidism. *Clinical and Investigative Medicine*, E271-E279.

Kadham, S. M., Mustafa, M. A., Abbass, N. K., & Karupusamy, S. (2022). IoT and artificial intelligence-based fuzzy-integral N-transform for sustainable groundwater management. *Applied Geomatics*, 1-8.

Karupusamy, S., Mustafa, M. A., Jos, B. M., Dahiya, P., Bhardwaj, R., Kanani, P., & Kumar, A. (2023). Torque control-based induction motor speed control using Anticipating Power

Impulse Technique. *The International Journal of Advanced Manufacturing Technology*, 1-9.

Keller, T., Zeller, T., Peetz, D., Tzikas, S., Roth, A., Czyz, E., ... & Blankenberg, S. (2009). Sensitive troponin I assay in early diagnosis of acute myocardial infarction. *New England Journal of Medicine*, 361(9), 868-877.

Khan, A. A., Allemailem, K. S., Alhumaydhi, F. A., Gowder, S. J., & Rahmani, A. H. (2020). The biochemical and clinical perspectives of lactate dehydrogenase: an enzyme of active metabolism. *Endocrine, Metabolic & Immune Disorders-Drug Targets (Formerly Current Drug Targets-Immune, Endocrine & Metabolic Disorders)*, 20(6), 855-868.

McGrowder, D. A., Fraser, Y. P., Gordon, L., Crawford, T. V., & Rawlins, J. M. (2011). Serum creatine kinase and lactate dehydrogenase activities in patients with thyroid disorders. *Nigerian journal of clinical practice*, 14(4), 454-459.

Mustafa, H. A., Al-Rahmanny, A. H. J., Shamani, J. A. H., & Mustafa, M. A. (2022). THE EFFECT OF DIFFERENT CONCENTRATIONS OF SOLANUM NIGRUM AQUEOUS EXTRACT AND ASPERGILLUS FLAVUS ON TRIBOLIUM CASTANEUM OR COLEOPTERA AFTER 24 HOURS AND 48 HOURS OF TREATMENT IN SAMARRA/IRAQ. *International Journal of Agricultural & Statistical Sciences*, 18.

Mustafa, H. A., Majid, H. H., Abdulqader, A. T., Mustafa, M. A., & Salih, A. A. (2019). Study On Some Physiological, Biochemical And Hormonal Parameters Of Seminal Fluid Of Infertile Men. *Biochem. Cell. Arch*, 19(Supplement 1), 1943-1947.

Mustafa, M. A., Qasim, Q. A., Mahdi, A. B., Izzat, S. E., Alnassar, Y. S., Abood, E. S., ... & Al-Salman, H. N. K. (2022). Supercapacitor performance of Fe₃O₄ and Fe₃O₄@ SiO₂-bis (aminopyridine)-Cu hybrid nanocomposite. *International Journal of Electrochemical Science*, 17(10), 221057.

Nijris, O. N., Khaleel, Z. I., Hamady, S. Y., & Mustafa, M. A. (2020). The effectiveness of Aqueous Extract of Grape Seeds *Vitis vinifera* as an antibiotic for some microorganisms and its Protective Role Histology for Liver, Kidney in Mice. *Indian Journal of Forensic Medicine & Toxicology*, 14(2), 1838-1845.

Nijris, O. N., Khaleel, Z. I., Hamady, S. Y., & Mustafa, M. A. (2020). The effectiveness of Aqueous Extract of Grape Seeds *Vitis vinifera* as an antibiotic for some microorganisms and its Protective Role Histology for Liver, Kidney in Mice. *Indian Journal of Forensic Medicine & Toxicology*, 14(2), 1838-1845.

Nijris, O. N., Khaleel, Z. I., Hamady, S. Y., & Mustafa, M. A. (2020). The effectiveness of Aqueous Extract of Grape Seeds *Vitis vinifera* as an antibiotic for some microorganisms and its Protective Role Histology for Liver, Kidney in Mice. *Indian Journal of Forensic Medicine & Toxicology*, 14(2), 1838-1845.

Omi, Y., & Anan, F. K. (2017). Lactate dehydrogenase isozymes of thyroid tissue in various thyroid gland diseases. *Enzymologia biologica et clinica*, 11(3), 224-230.

Pandey, R., Jaiswal, S., Sah, J. P., Bastola, K., & Dulal, S. (2013). Assessment of serum enzymes level in patients with thyroid alteration attending manipal teaching hospital, Pokhara. *Thyroid*, 10, 12.

- Sethi, Y., Uniyal, N., Maheshwari, S., Sinha, R., & Goel, A. (2022). Thyroid function abnormalities in the acute phase of COVID-19: a cross-sectional hospital-based study from North India. *Cureus*, 14(5).
- Shaker, R. N., & Younis, N. T. (2023). Biochemical study on Anti Thyroid Peroxidase Antibody Enzyme in Serum Blood of women with Thyroid Disease. *Research Journal of Pharmacy and Technology*, 16(1), 205-208.
- Smithson, M., Asban, A., Miller, J., & Chen, H. (2019). Considerations for thyroidectomy as treatment for Graves disease. *Clinical Medicine Insights: Endocrinology and Diabetes*, 12, 1179551419844523.
- Sudha, I., Mustafa, M. A., Suguna, R., Karupusamy, S., Ammisetty, V., Shavkatovich, S. N., ... & Kanani, P. (2023). Pulse jamming attack detection using swarm intelligence in wireless sensor networks. *Optik*, 272, 170251.
- Sütken, E., Akalin, A., Özdemir, F., & Çolak, Ö. (2010). Lipid profile and levels of homocysteine, leptin, fibrinogen and C-reactive protein in hyperthyroid patients before and after treatment. *Dicle Tıp Dergisi*, 37(1), 1-7.
- Watanabe, N., Noh, J. Y., Hattori, N., Iwaku, K., Suzuki, N., Yoshihara, A., ... & Ito, K. (2021). Cardiac Troponin Is Elevated in Patients with Thyrotoxicosis and Decreases as Thyroid Function Improves and Brain Natriuretic Peptide Levels Decrease. *European Thyroid Journal*, 10(6), 468-475.
- Yahya, M. Y. A. H., Putra, M. M. R., & Ummah, K. (2023). Thyroid Heart Disease Presenting Thyrotoxic Crisis with Jaundice. *Clinical and Research Journal in Internal Medicine*, 4(1), 426-433.

Cite this article as: Zainab Emad Abood (2023).

Study of cardiac troponin I and many physiological parameters in women with thyrotoxicosis in Kirkuk city, African Journal of Biological Sciences. 5(3), 9-20. doi: 10.48047/AFJBS.5.3.2023.9-20