Original Article

Zahedan Journal of Research in Medical Sciences

Journal homepage: www.zjrms.ir

Impact of Thyroid Dysfunction on Antioxidant Capacity, Superoxide Dismutase and Catalase Activity

Saeed Naazeri,[1] Mosayeb Rostamian,[2] Mehdi Hedayati*[3]

1. Obesity Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran
2. Department of Biotechnology and Biochemistry, Pasteur Institute of Iran, Tehran, Iran
3. Cellular and Molecular Endocrine Research Center, Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Article information

Article history:
Received: 10 July 2012
Accepted: 10 Oct 2012
Available online: 2 June 2013
ZJRMS 2014; 16(1): 51-54

Keywords:
Hyperthyroidism
Hypothyroidism
Total antioxidant capacity
Catalase
Superoxide dismutase

*Corresponding author at:
Endocrine Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran
E-mail:
Hedayati@endocrine.ac.ir

Abstract

***Background*:** In hypothyroidism and hyperthyroidism, disturbance of oxidant/antioxidant balance leads to reactive oxygen species (ROS) generation. The aim of this study is assaying total antioxidant capacity and superoxide dismutase and catalase activities in patients with hypo-and hyperthyroidism in order to control the progression of its pathology and health care.

***Materials and Methods*:** This case-control study was performed on 85 patients with hypothyroidism, 66 patients with hyperthyroidism and 74 normal individuals as control that referred to the clinic of the Research Institute for Endocrine Sciences of Shahid-Beheshti University in year 2010. Serum enzymatic activity of catalase, superoxide dismutase and total antioxidant capacity was measured in the fasting state. Data was described as mean±SD and data means of the two groups was compared by independent *t*-test. Data was analyzed by SPSS-18 application.

***Results*:** The total antioxidant capacity in individuals with hyperthyroidism decreased compared to healthy controls, but individuals with hypothyroidism compared to the healthy control group showed no significant difference. Catalase and superoxide dismutase activity in hypo-and hyperthyroidism were significantly increased compared with healthy controls (p=0.005).

Conclusion: Decreasing of antioxidant capacity in hyperthyroid patients is probably because of increased production of free radicals. There was not observed significant difference in total antioxidant capacity in hypothyroid patients. Also in hypo-and hyperthyroidism patients, increasing of enzymes activity is probably due to increasing of the production of ROS.

Introduction

Thyroid hormones are necessary for normal growth of our body and assumed as one of the most important involved hormonal factors in regulation of basic metabolic rate of target organs such as liver, heart, kidney and brain [1]. Oxygen free radicals (ROS) are produced from normal metabolic reactions after several steps. Although free radicals are potentially dangerous for organisms, their production is inevitable. Microsomal-membrane and mitochondrial electron transfer chains and also auto oxidation reactions are the main sources of free radicals [2-4]. Both superoxide anion and hydrogen peroxide produce highly reactive hydroxyl radicals via Haber-Weiss reaction. Hydroxyl radical can initiate lipid peroxidation, which leads to damage of membrane structure and function [5]. Oxidation reactions can produce free radicals to launch chain reactions that damage cells. Antioxidants terminate these reactions by eliminating of free radical mediators, and inhibit oxidation reactions by their auto oxidiation [6]. Thyroid hormones sustain the oxidant/ antioxidant balance to protect the cells [1]. It is proposed that the increase in ROs induced by thyroid hormone deficiency may result in oxidative stress in liver, heart and skeletal muscles with some lipid peroxidative response [4]. ROS include partially revived forms such as superoxide anion, hydrogen peroxide, hydroxyl radical and also organic counterparts such as lipid peroxides as a result of oxidative metabolism of cells [7]. High levels of thyroid hormone, that causes thyrotoxicosis, leads to accelerated metabolic reactions and increased oxygen consumption and oxidative reactions. Accordingly changes in measurable parameters of antioxidant factors and increased anti-oxidative free radicals are observed [8-10]. Primary hypothyroidism occurs when the hormone reduced. In secondary hypothyroidism hypothalamus-pituitary-thyroid axis is defective. Hypothyroidism can also occur due to lack of iodine in the diet, which leads to produce insufficient hormone, or as a side effect of special drugs such as lithium [11]. Lipid peroxidation and oxidative stress induced by hypothyroidism are the results of both increased production of free radicals and reduced capacity of antioxidative defense [12-14]. The malfunction of respiratory chain in the mitochondria, that is induced by hypothyroidism, leads to accelerated

production of free radicals, which subsequently leads to oxidative stress [4, 15]. Metabolic disorder caused by an autoimmune hypothyroidism can also increase oxidative stress [16].

Given the involved geography, genetic and nutritional factors in total antioxidant capacity, there is little information about antioxidant status in hypo- and hyperthyroidism patients of different races. Erdamar et al. mentioned the direct association between hypo- and hyperthyroidism complications by reducing the activity of the antioxidant system components. These findings suggest that thyroid hormones have a strong effect on oxidative stress and antioxidant systems [17].

The aim of this study is assaying total antioxidant condition and an important part of enzymatic defense system, and also assaying if hypo- and hyperthyroidism has effect on antioxidant defense system. Thus in this study, the activity of catalase (CAT), super oxide dismutase (SOD), and total antioxidant capacity in iranian patients with hypothyroidism and hyperthyroidism were assayed.

Materials and Methods

This cross-sectional case-control study was conducted on referred patients with thyroid disorders to the clinic of the Research Institute for Endocrine Sciences of Shahid-Beheshti University, in 2010. Eighty five patients with hypothyroidism (46 women and 39 men), 66 patients with hyperthyroidism (36 women and 30 men) and 74 healthy volunteers (40 females and 34 males) that were suitable for our study based on clinical and biochemical criteria, were evaluated. The people were selected by convenience sampling. At least 32 patients in each group were determined as the sample size based on similar studies and using proper formula. TSH level of >10 IU/L and <0.2 IU/L were considered as hypothyroidism and hyperthyroidism respectively. In order to more confirmation, the thyroxin level of first and second group were <0.4 µg/dL and >13.5 µg/dL respectively. Written informed consent was obtained from each person before entering the study.

Demographic data collection form was completed for each of the participants in the study. In sitting position, 3 ml of blood was collected from volunteers in the Cubital vein of the left hand. After 5 minutes coagulation, the samples were centrifuged 3000 rpm for 10 min and the obtained sera were stored at -80ºC until use. Serum samples were examined to measure total antioxidant capacity and the activity of CAT and SOD. Superoxide dismutase and CAT activities were measured using commercial kit (Cayman, US). Total antioxidant capacity was measured using a kit from Randox England. Data Processing was conducted using SPSS-18 statistical software, which shows the normal distribution as a mean±SD. Comparison of data mean-values of the three groups was evaluated by independent *t*-test. Significance level was set at 5% (p =0.005).

Results

In the control group (group 1), 34 were male and 40 were female. The mean age of women was 57±18 years and the mean age of men was 55±20 years. Forty six women and 39 men were hypothyroid (Group 2) and 36 women and 30 men were hyperthyroid (Group 3). The mean age for both men and women in this group was 32±12 years. CAT and SOD activity in hypo-and hyperthyroidism compared with the control group showed a significant increase. Total antioxidant capacity was significantly reduced in hyperthyroid but no significant difference for hypothyroid (p=0.005; Fig. 1, 2, 3).

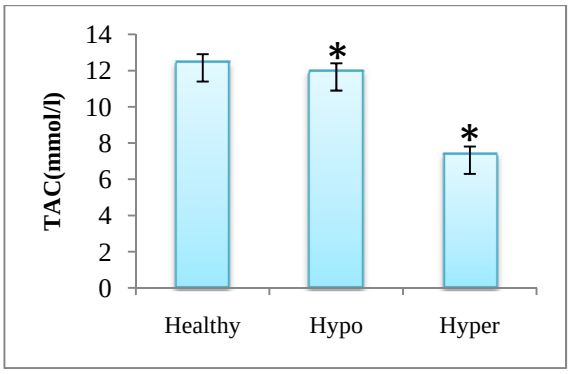

Figure 1. The level of total antioxidant capacity (mmol/l) of hyperthyroid, hypothyroid and healthy individual's sera.* Difference is meaningful (p=0.005)

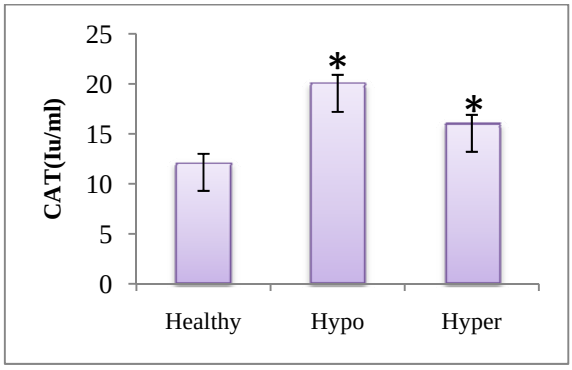

Figure 2. Catalase activity (Iu/ml) of hyperthyroid, hypothyroid and healthy individual's sera. * Difference is meaningful (p=0.005)

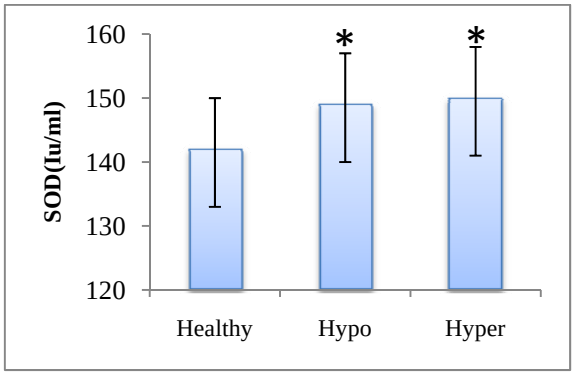

Figure 3. Superoxide dismutase activity (Iu/ml) of hyperthyroid, hypothyroid and healthy individual's sera. * Difference is meaningful (p=0.005)

Discussion

Previous studies showed significant changes in T_3, T_4 and TSH level in the different thyroid state of oxidative stress. Therefore thyroid hormones have an important role in general oxidative stress creation [11]. High metabolic state in hyperthyroidism is alongside increasing of free radical production and lipid peroxide levels [10]. Chronic hypothyroidism is characterized by failure of the redox potential that leads to free radicals chain reaction and metabolic suppression of antioxidant capacity. The observed antioxidant depletion in hypothyroidism may refer to increased production of free radical in the mitochondrial inner membrane electron transfer chain. The patient's cells are damaged due to prolonged oxidative stress that overpasses the patient's organs capacity for antioxidant molecules synthesis or their synthesis from extracellular sources [7].

The result of our study showed that total antioxidant capacity in hyperthyroid patients is less than healthy controls, while in hypothyroid patients there was no significant difference with healthy controls .The results of some studies are different with our study. Among previous studies, the results of Kumari et al. and Messarah et al. about the total antioxidant capacity in hypo- and hyperthyroidism are consistent with our findings [6-18]. In both studies, the total antioxidant capacity in hypothyroid patients did not have significantly changes in comparison with healthy controls, while in hyperthyroid patients the total antioxidant capacity was less than healthy individuals. Since the total antioxidant capacity is made up of components, study on these components has been also interesting for researchers that have been led to new information on this issue as well.

Two main components of the antioxidant capacity are SOD and CAT. In this study, CAT activity in hypo- and hyperthyroidism showed a significant increase compared to the control group. The results of Vassev et al. and Bednarek et al. studies showed that CAT activity is increased in patients with hyperthyroidism [19, 20].

This study was consistent with our study. However Pasupathi et al. and. Sahoo et al. studies showed that the CAT activity is reduced in patients with hypothyroidism [21, 22], that is inconsistent with the present study. In Carmeli et al. study the CAT activity was decreased in patients with hypo- and hyperthyroidism. In Carmeli et al. study, SOD activity was increased in hypo- and hyperthyroidism [16]. This finding is consistent with Dave et al. about the increase in SOD activity in hypo-and hyperthyroidism [23], and also was consistent with Vassev et al., Bednarek et al., and Janusz et al. findings about increasing of SOD activity in patients with hyperthyroidism [19-24]. According to Pasupathi et al. and Sahoo et al. studies, SOD activity in patients with hypothyroidism was decreased as compared to healthy controls [21, 22].

In Iranian hyperthyroid patients, total antioxidant capacity is reduced. This is probably due to increased metabolism associated with increased production of free radicals. There was no significant difference in total antioxidant capacity in hypothyroid patients. In Iranian hypo-and hyperthyroidism, the increased activity of SOD and CAT are also observed that is probably due to increased production of reactive oxygen species and increased oxidative stress.

Acknowledgements

The authors thank Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences for financial support and laboratory facilities.

Authors' Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing

Conflict of Interest

The authors declare no conflict of interest.

Funding/Support

Shahid Beheshti University of Medical Sciences, Tehran.

References

1. Guerrero A, Pamplona R, Postero-Otin M, et al. Effect of thyroid status on lipid composition and peroxidation in the mouse liver. Free Rad Biol Med 1999; 26(1-2): 73-80.
2. Mates JM, Perez-Gomez C, Nunez de Castro, I. Antioxidant enzymes and human diseases. Clin. Biochem 1999; 32(8): 595-603.
3. Hauck SJ, Bartke A. Effects of growth hormone on hypothalamic catalase and Cu/Zn superoxide dismutase. Free Radic Biol Med. 2000; 28(6): 970-8.
4. Yilmaz S, Ozan S, Benzer F and Canatan H. Oxidative damage and antioxidant enzyme activities in experimental hypothyroidism. Cell Biochem Funct 2003; 21(4): 325-30.
5. Halliwell B, Gutteridge JM. Role of free radicals and catalytic metal ions in human disease: An overview. Methods Enzymol 1990; 186: 1-85.
6. Kumari S, Gowda S, Gowda KMD. Oxidative stress in hypo and hyperthyroidism. Al Ameen J Med sci 2001; 4(1): 49-53.
7. Komosinska-Vassev K, Olczyk K, Kucharz EJ, et al. Free radical activity and antioxidant defense mechanisms in patients with hyperthyroidism due to Graves' disease during therapy. Clin Chim Acta 2000; 300(1-2): 107-17.
8. Dariyerli N, Toplan S, Akyolcu MC, et al. Erythrocyte osmotic fragility and oxidative stress in experimental hypothyroidism. Endocrine 2004; 25(1): 1-5.
9. Mayer L, Romic Z, Skreb F, et al. Antioxidants in patients with hyperthyroidism. Clin Chem Lab Med 2004; 42(2): 154-8.
10. Efe H, Kirci D, Deger O, et al. Erythrocyte antioxidant enzyme activities and lipid peroxidation in patients with types IIb and IV hyperlipoproteinemias. Tohoku J Exp Med 2004; 202(3): 163-72.
11. Kale MK, Bhusari KP, Umathe S.N. Role of thyroid hormones in the generation of widespread oxidative stress. J Cell Tissue Res 2007; 7(1): 871-876.

12. Das K, Chainy GB. Thyroid hormone influences antioxidant defense system in adult rat brain. Neurochem Res 2004; 29(9): 1755-1766.
13. Sarandol E, Tas S, Dirican M, and Serdar Z. Oxidative stress and serum paraoxonase activity in experimental hypothyroidism: Effect of vitamin E supplementation. Cell Biochem Funct 2005; 23(1): 1-8.
14. Resch U, Helsel G, Tatzber F and Sinzinger H. Antioxidant status in thyroid disfunction. Clin Chem Lab Med 2002; 40(11): 1132-1134.
15. Venditti P, Balestrieri M, Di Meo S, and De Leo T. Effect of thyroid state on lipid peroxidation, antioxidant defenses, and susceptibility to oxidative stress in rat tissues. J Endocrin 1997; 155(1): 151-157.
16. Carmeli E, Bachar A, Barchad S, et al. Antioxidant status in the serum of persons with intellectual disability and hypothyroidism: A pilot study. Res Development Disab 2008; 29(5): 431-438.
17. Erdamar H, Yaman H, Erbil MK, et al. The effect of hypothyroidism, hyperthyroidism and their treatment on parameters of oxidative stress and antioxidant status. Clin Chem Lab Med 2008; 46(7): 1004-10.
18. Messarah M, Boumendjel A, Chouabia A, et al. Influence of thyroid dysfunction on liver lipid peroxidation and antioxidant status in experimental rats. Exp Toxicol Pathol 2010; 62(3): 301-310.
19. Vassev KK, Olczyk K, Kucharz EJ, et al. Free radical activity and antioxidant defense mechanisms in patients with hyperthyroidism due to Graves' disease during therapy. Clin Chim Acta 2000; 300(1-2): 107-117.
20. Bednarek J, Wysocki H, Sowinski J. Oxidation products and antioxidant markers in plasma of patients with graves disease and toxic multinodular goiter: Effect of methimazole treatment. Free Radic Res 2004; 38(6): 659-664.
21. Pasupathi P, Latha R. Free radical activity and antioxidant defence mechanisms in patients with Hypothyroidism. Thyroid Sci 2008; 3(12): 1-6.
22. Sahoo DK, Roy A, Bhanja S and Chainy GB. Hypothyroidism impairs antioxidant defence system and testicular physiology during development and maturation. Gen Comp Endocrinol 2008; 156(1): 63-70.
23. Dave BN, Paradkar NM. Total superoxide dismutase, Cu/Zn superoxide dismutse and glutathione peroxidase in untreated hyperthyroidism and hypothyroidism. J K Sci 2009; 11(1): 6-10.
24. Janusz B, Henryk W, Jerzy S. Oxidation products and antioxidant markers in plasma of patients with Graves' disease and toxic multinodular goiter: effect of methimazole treatment. Free Radic Res 2004; 38(6): 659-64.

Please cite this article as: Naazeri S, Rostamian M, Hedayati M. Impact of thyroid dysfunction on antioxidant capacity, superoxide dismutase and catalase activity. Zahedan J Res Med Sci (ZJRMS) 2014; 16(1): 51-54.