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Thyroid Dysfunction and Insulin Resistance

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Authors' contributions

This work was carried out in collaboration between all authors. Author MM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MAG and HE managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: Insulin resistance is a state in which a given concentration of insulin produces biological effect less than expected. The syndrome of insulin resistance involves a broad clinical spectrum, which includes obesity, glucose intolerance, diabetes, and metabolic syndrome. Many of these disorders are associated with various endocrine, metabolic, and genetic conditions. They may also be associated with some immunological diseases and may exhibit distinct phenotypic characteristics.
Aim of the Work: This study aimed to determine the association between altered thyroid hormones and insulin resistance.
Patients and Methods: This study was conducted at Fayoum University Hospital in the period from February to June 2015. It included 90 age and sex-matched non diabetic individuals; they were divided to 3 groups; 30 patients with uncontrolled hypothyroidism, 30 patients with uncontrolled hyperthyroidism according to their thyroid stimulating hormone levels (TSH) and 30 healthy volunteers as a control group. Thyroid stimulating hormone level (TSH) was measured for the control group. For the 3 groups, fasting plasma glucose (FPG) and fasting plasma insulin concentration (FPI) were done. Homeostatic model assessment of insulin resistance was calculated using the formula: HOMA-IR= (FPI× FPG/22.5).

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Results: It was found that 50% of hypothyroid patients, 36% of hyperthyroid patients and only 16.5% of the control group had insulin resistance (IR), and the difference was statically significant (p=0.024).
Conclusion: It was found that 50% of hypothyroid and 36% of hyperthyroid had insulin resistance and only 17% of the control group had insulin resistance and this was not correlated to either body weight, BMI, as well as waist circumference.

Keywords: Insulin resistance; TSH; HOMA / IR; fasting plasma insulin; thyroid dysfunction.

1. INTRODUCTION

Insulin resistance syndrome is a cluster of risks including increased blood pressure, abdominal obesity and impaired glucose metabolism. Individuals with insulin resistance syndrome (IRS) have much higher risk for cardiovascular diseases. There is an association of IRS or its related components with thyroid functional abnormalities. Evidence for a relationship between T4 and T3 and glucose metabolism appeared over 100 years ago when the influence of thyroid hormone excess in the deterioration of glucose metabolism was first noticed. Since then, it has been known that hyperthyroidism is associated with insulin resistance [1]. More recently, hypothyroidism has also been linked to decrease insulin sensitivity. The explanation to this apparent paradox may lie in the differential effects of thyroid hormones at the liver and peripheral tissues. Thyroid hormones exert both insulin agonistic and antagonistic actions in different organs. However, this occurs in a fine balance necessary for normal glucose metabolism. Deficit or excess of thyroid hormones can break this equilibrium leading to alterations of carbohydrate metabolism. Overt hyperthyroidism has been related to glucose intolerance and even ketoacidosis, so the aim of this study is to determine the association between altered thyroid hormone levels and insulin resistance.

2. PATIENTS AND METHODS

This study included ninety sex and age matched non diabetic patients. They were divided to 3 groups; 30 patients with uncontrolled hypothyroidism, 30 patients with uncontrolled hyperthyroidism according to their thyroid stimulating hormone levels obtained from their files and 30 healthy volunteers as a control group. This study was conducted at Fayoum University Hospital in the period from February to June 2015. Inclusion criteria were adult non diabetic male or female their ages more than 18 and less than 70 years old, known to have either hypothyroidism or hyperthyroidism uncontrolled by medications according to their thyroid stimulating hormone levels (TSH). The control group was healthy volunteers. Exclusion criteria were patients less than 18 or more 70 years old, patients with renal, hepatic or any other endocrinal disorders as diabetes mellitus or pre diabetics, patients using drugs that may affect either the thyroid function tests or Homeostatic model assessment of insulin resistance (HOMA/IR) as amiodarone or interferone). All the participants were subjected to full medical history and clinical examination including weight, height, body mass index calculation (BMI) and waist circumference measurements. For the control group TSH level was done. For all the participants fasting blood sample (after 8 hours of fast) was collected on plain vacutainers for: plasma glucose and insulin levels. Fasting plasma glucose (FPG) was performed immediately after sample collection while for fasting plasma insulin (FPI) level serum was separated and stored at -80°c until analysis was done. It was done by ELISA technique (sandwiched) using Bioteck (USA). Homeostatic model assessment of insulin resistance (HOMA-IR) was calculated using the formula: HOMA-IR= (FPI × FPG /22.5). Insulin concentration was reported in μU/L and glucose in mmol/L. The output of HOMA/IR was calibrated to give a normal HOMA/IR of 1 and its reciprocal is HOMA %S (expressed as a percentage). If IR is more than 1 in normoglycemic subjects, one cannot conclude that there is necessarily a metabolic defect, although it would not exclude the possibility [2]. The HOMA/IR is useful in comparing the degree of insulin resistance between or within groups in clinical studies and its value may be affected by a number of factors including non-standardized insulin assays and normal pulsatile insulin secretion patterns. The optimal HOMA/-IR cut-off for the diagnosis of insulin resistance in non-diabetic individuals were 1.775 while the optimal cut-offs in diabetic individuals were 3.875 [3].

2.1 Statistical Analysis

Data were collected, checked, coded and analyzed using the statistical package for social science (SPSS version 16). Data was summarized as mean, standard deviation and rang for quantitative variables and percent for qualitative variables. Comparison between groups was done using independent sample t-test, ANOVA (analysis of variants). P-values < 0.05 were considered as statistically significant.

3. RESULTS

This study included 90 subjects, 30 hypothyroid, 30 hyperthyroid and 30 euthyroid control group, their ages ranged from 20-45 years old. There was a statistically significant increase in number of females in the 3 studied groups and this increase was highest in the hypothyroid group of patients as shown in Table 1.

There was a statistically highly significant increase in weight, BMI and waist circumference (P<0.0001) in the hypothyroid group of patients compared to the hyperthyroid patients and the control group as shown in Fig. 1.

We found that 50% of hypothyroid patients had IR, compared to 36% of hyperthyroid patients and only 16.5% of the euthyroid control subjects and this difference were statically significant as shown in Table 2.

4. DISCUSSION

In this study was found that insulin resistance was more prevalent in patients with uncontrolled hypothyroidism (50%) measured by HOMA/ IR. Our results were consistent with El-Eshmawy et al. [4], who reported that there was a significant association between HOMA/IR and hypothyroidism. Also, with Arduc et al. [5], who reported that there was a relation between elevated TSH levels and HOMA/IR in patients with polycystic ovary syndrome, also our results were consistent with the results of Li et al. [6] who reported that there was a correlation between elevated serum TSH level and HOMA/IR. These results are also in agreement with those of Ning et al. [7], who documented a significant correlation between HOMA/IR and hypothyroidism and this was explained by impairment in the ability of insulin to increase the blood flow rate to the hypothyroid tissues and hypothyroidism can induce lower glucose disposal and the increased prevalence of obesity in hypothyroid patients. These results were not consistent with those of Tina et al. [8], who reported that there was no significant association between hypothyroidism and HOMA/IR in hypothyroid patients under levothyroxine therapy. This may be explained by the presence of other contributing factors as obesity and dyslipidemia and also ethnic, gender and age variations as our study included both females and males. Moreover, Cinar et al. [9] did not find a significant correlation between hypothyroidism and HOMA/IR but their work was conducted on males only while our study included both sexes.

The results of this work showed that there was insignificant correlation between the euthyroid state and HOMA /IR as only 16% of the control euthyroid group had insulin resistance. These results are not consistent with the results of Ozen et al. [10] who reported that there was a significant association between euthyroidism and HOMA/IR and with Roos et al. [11] who reported that there was a significant correlation between euthyroid state and HOMA/ IR. This discrepancy may be explained by the small number of euthyroid individuals in our study (30 subjects) which were selected randomly from the outpatient clinic of Fayoum university hospital, while Roos et al. [11] study included 2703 euthyroid cases.

Table 1. Demographic characteristics among the study groups

Variable	Hypothyrodism (N=30)	Hyperthyrodism (N=30)	Euthyroid control (N=30)	P-value
		Mean±SD		
Age (years)	33.9±5.7	32.2±4.9	35.1±5.7	0.124
Variable		N (%)		
Sex:				
Male	4 (13.3%)	11 (36.7%)	13(43.3%)	0.031*
Female	26 (86.7%)	19 (63.3%)	17(56.7%)	

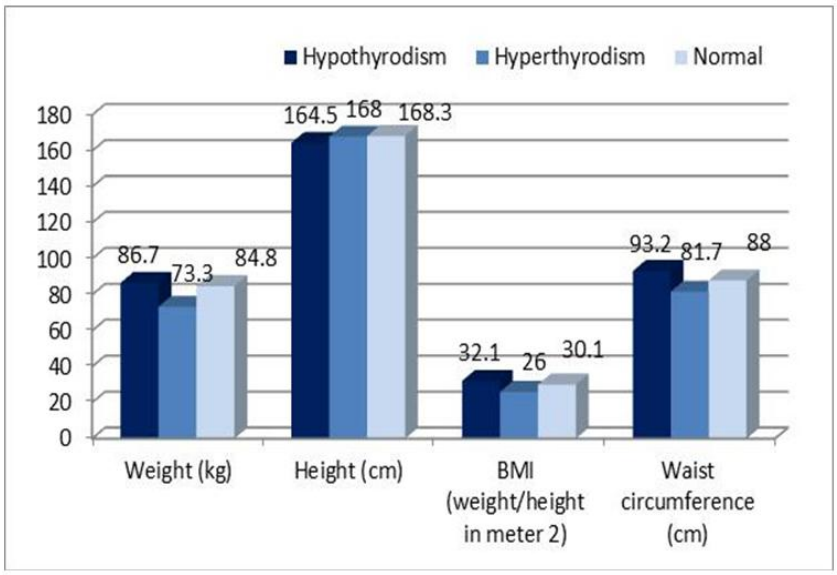

Fig. 1. Anthropometric measurement among study groups

Table 2. Prevalence of Insulin resistance among different study groups

IR	Hypothyrodism (N=30)	Hyperthyrodism (N=30)	Euthyroid controls (N=30)	P-value
		N (%)		
Had Insulin Resistance	15 (50%)	11 (36.7 %)	5 (16.7%)	
No insulin resistance	15 (50%)	19 (63.3 %)	25 (83.3%)	0.024*

In our study we have found no significant correlation between BMI, weight or waist circumference and HOMA/IR in hypothyroid group. Our results are consistent with the results of Cinar et al. [11] who reported that there was no significant correlation between BMI and HOMA/IR in hypothyroid patients and also were consistent with El-Eshmawy et al. [4], who reported that that there were no relations between HOMA/ IR, BMI, weight and waist circumference in hypothyroid patients. While Tina et al. [8] had reported that significant correlations between HOMA/IR, weight and BMI in hypothyroid group. Also, Li et al. [6] reported that there were significant correlations between HOMA/IR, weight and BMI and waist circumference in hypothyroid patients. Anna et al. [12] also reported that there were significant correlations between HOMA/IR, BMI, weight and waist circumference in young active men and in the same year Ozen et al. [10] found that there were significant correlations between HOMA/IR, BMI, weight and waist circumference in hypothyroid group of patients and again the discrepancy can be explained by the difference in patients selection.

5. CONCLUSION

It was found that 50% of hypothyroid and 36% of hyperthyroid had insulin resistance and only 17% of the control group had insulin resistance and this was not correlated to either body weight, BMI, as well as waist circumference.

CONSENT

As per international standard or university standard written patient consent has been collected and preserved by the authors.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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