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Association of adiponectin with thyroid dysfunction in diabetes mellitus type II

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Abstract

The two most prevalent endocrine-related conditions seen in clinical practice are thyroid diseases (TD) and diabetes mellitus (DM). Diabetes mellitus and thyroid dysfunction are strongly related conditions. Numerous research investigations have reported that individuals with diabetes mellitus are more likely to have thyroid issues, and vice versa.

Compared to individuals without diabetes, Type 2 Diabetes Mellitus (T2DM) patients have higher rates of both hypothyroidism and hyperthyroidism. Thyroid hormones are circulating hormones that impact various organs and tissues, have a vital role in the metabolism of proteins, fats, and carbohydrates, and can exacerbate glycemic control in individuals with Type II Diabetes Mellitus (T2DM).

At the Specialized Center for Endocrinology and Diabetes – Al-Kindi Teaching Hospital in Baghdad, a case-control research was carried out. The samples were gathered between January 1, 2021, and April 1, 2021.

The current study had one hundred twenty (120) volunteers, all of whom fasted for eight to twelve hours before to the test:

- Thirty (30) patients suffered from diabetic mellitus type II seventeen (17) females and thirteen (13) males.
- Thirty (30) were control with, sixteen (16) females and fourteen (14) males.
- Thirty (30) patients had thyroid dysfunction eighteen (18) females and twelve (12) males.
- Thirty (30) patients had thyroid dysfunction and diabetes mellitus type II, sixteen (16) females and fourteen (14) males.

Variables such as gender, age, Body Mass Index (BMI), thyroid hormones ,Fasting Blood Sugar (FBS), Glycated Hemoglobin (HbA1c), lipid profile (TG, CHOL, LDL-C, HDL-C, VLDL-C), Adiponectin (ADP)were measured and documented from participants included in this study.

According to the results of hormones, there were substantial variations in all of the hormone levels. Thyroid Stimulating Hermon (TSH) was the highest level in Thyroid Dysfunction with Diabetes Mellitus type II: Hypothyroidism patients(0.46 ± 6.26) µIU/mL. T3 hormone was (187.84 ± 6.12) ng/dL, the highest resultin Thyroid Dysfunction with Diabetes Mellitus type II: Hyperthyroidism patients. T4 was highest hormonal level in Thyroid Dysfunction with Diabetes Mellitus type II: Hyperthyroidism patients which was (14.02 ± 0.56) ng/dL.

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Fasting blood sugar (serum) measured a highly significant differences and highest level in patients who suffered from thyroid Dysfunction with Diabetes Mellitus type II: Hypothyroidism with (190.50 ± 12.72) mg/dL. Glycated hemoglobin (HbA1c) measured high significant differences with (11.13 ± 0.55) mmoL/L in patients of diabetes type II.

Cholesterol, Triglyceride, LDL-C and VLDL-C high significant differences and highest levels were among patients with Thyroid Dysfunction with Diabetes Mellitus type II: Hypothyroidism with (209.45 ±12.29, 268.18 ±31.57, 114.24 ±13.74 and 55.98 ±5.63) mg/dL respectively, while HDL-C was significantly higher in control group.

The Adiponectin had high significant differences among Thyroid Dysfunction: Hyperthyroidism patients with (17.98 ±1.43) ng/mL.

In conclusion this data backs up the theory that inducing or suppressing adiponectin in individuals with thyroid dysfunction can help them in losing weight. Hypothyroid individuals with DM Type II and lipid abnormalities in their blood. This data is attributed to the idea that inducing or suppressing adiponectin in individuals with thyroid dysfunction might be a promising new treatment strategy.

Adiponectin has been shown that's involved in numerous physiological and pathological processes, including as inflammation and tissue remodeling. They may be crucial in the formation of adipose tissue and insulin resistance, and they have been linked to a number of inflammatory illnesses.

Keywords: Thyroid; Diabetes; BMI; Lipid profile; Adiponectin

1. Introduction

It is fairly uncommon for someone to have both thyroid problems and diabetes. If a patienthas type 1 diabetes, type 2 diabetes, insulin resistance, or metabolic syndrome, that patient is more prone to get thyroid illness. Thyroid disease increases the chances of developing metabolicsyndrome and type 2 diabetes. This relationship is even greater if someone is overweight orobese(Wang,2013).

Thyroid disease (TD) and diabetes mellitus (DM) are two of the most prevalent endocrine illnesses seen in clinical practice (Aggarwal and Razvi,2013). Thyroid disease and diabetes mellitus are inextricably connected. Thyroid problems are more common in people with diabetes mellitus, according to several research, and vice versa (Biondi *et al*.,2019).

Hypothyroidism and hyperthyroidism are more common in people with type 2 diabetesmellitus (T2DM) than in people who are not diabetic. Blood thyroid hormones affect many organs and tissues, have a major role in the metabolism of proteins, lipids, and glucose, and can worsen the state of glycemic control in people with type 2 diabetes (T2DM) (Kalra *et al*.,2019).

Insulin is one way that thyroid function influences how carbohydrates are metabolized. Ifthyroid and insulin function are both abnormal, type 2 diabetes mellitus (T2D) may result. The metabolism of carbohydrates is influenced by thyroid hormones (Gierach *et al*.,2014).

Hyperglycemia can be caused by hyperthyroidism (high thyroid hormone), which can affect many other aspects of glucose metabolism including insulin secretion, action, andclearance. Conversely, hypothyroidism, or low thyroid hormone, can also cause insulin resistance by interfering with insulin's ability to function and be metabolized (Maratou *et al*.,2010).

Over time, many diabetic people develop symptoms of thyroid dysfunction. Insulin resistance is a key factor in the development of hypothyroidism in those who have type 2 diabetes. Hypothyroidism exacerbates dyslipidemia, hypertension, and cardiovascular disease in diabetic patients (Demitrost and Ranabir,2012).

Diagnosing and treating hypothyroidism in diabetic individuals is essential to prevent theprogression of diabetes complications. There is a readily available, straightforward blood test that can be used to identify hypothyroidism (Ghazali and Abbiyesuku,2010).

Diabetes One of the non-communicable metabolic syndromes with the greatest rate of growth is diabetes, which is defined by raised blood glucose levels mostly brought on by insulinsecretion or action inhibition (Nankar *et al*.,2017).

Being overweight or obese is referred to as obesity, and type 2 diabetes is probably the biggest epidemic in human history (Zimmet,2017).

Adiponectin (ADP) is the most abundant peptide hormone that is released by adipocytes (Achari and Jain). An adipokine is linked to insulin sensitivity, reduces hepatic gluconeogenesis, and increases fatty acid oxidation and glucose absorption (Przybyciński *et al*.,2020). As a result, researchers must have a thorough grasp of adiponectin. As a consequence of this knowledge, new treatment methods for diseases such as type2 diabetes, metabolic syndrome, cardiovascular disease, and obesity may be created (Magkos and Sidossis,2007).

Aims of the Study

The current study aims at fulfilling the following points:

- To find and assessment the Adiponectin (ADP)levels as a new biomarker to patient of thyroid dysfunction.
- To find the relation between Type Π diabetes mellitus patient and (ADP)by Following steps:
  - Studying the body mass index (BMI).
  - Determining lipid profile (TG, CHOL, HDL, LDL-C, VLDL-C).
  - Determining the value of T3, T4, TSH.
  - Determining (HbA1c), (FBS).
- Attempted to assess Adiponectin.
- To study the statistical correlation of above parameters.

1.1. Subjects

The Specialized Center for Endocrinology and Diabetes at Al-Kindi Teaching Hospital in Baghdad was the site of a case-control research. Sample collection took place between October 1, 2021, and March 1, 2022. ADP, lipid profile, BMI, age, thyroid hormones, FBS, HbA1c, and gender were among the variables that were assessed, noted, and recorded from study participants.

1.2. The inclusion criteria

Subjects' age range 20 – 48 years.

- 60subjects with Thyroid Dysfunction and Thyroid Dysfunction with T2DM. Some of the subjects were under treatment.
- 30 control subjects.

1.3. The exclusion criteria

- Subjects suffered from other chronic diseases or/and had high ESR levels.
- Pregnant women.

Included in this study a total of one hundred twenty (120) subjects:

- Thirty (30) subjects suffer from Diabetic Mellitus type 2, thirteen (13)males and seventee (17)females.
- Thirty (30) were control subjects with matched gender and age, sixteen (16) females and fourteen (14) males.
- Thirteen (30) subjects had thyroid dysfunction, twelve (12) males andeighteen (18) females.

Thirty (30) subjects had Thyroid Dysfunction and Diabetes MellitusType 2 about fourteen (14) males and sixteen (16) females.

1.4. Ethical Issues

A scientific committee at the Department of Chemistry / Collage of Science for Women / University of Baghdad authorized this work to detect the effect of different components in research parameters.

The tool used was the Statistical Analysis System- SAS (2012) (105). The Least Significant Difference –LSD test (ANOVA) was run in order to compare means in a meaningful way. The Chi- square test was used to compare likelihoods (0.05 and 0.01 percentages). The correlation coefficient between the variables was calculated in this investigation.

A person's height and weight are used to calculate their Body Mass Index (BMI). The body mass divided by the square of the body height yields the BMI. With mass measured in kilograms and height measured in meters, BMI is expressed as kilograms per square meter (kg/m2). The frequently recognized BMI categories are underweight (less than 18.5 kg/m2), normal weight (18.5 to 25 kg/m2), overweight (25 to 30 kg/m2), and obese (greater than 30 kg/m2). (above 30) (106).

2. Materials and methods

2.1. Materials

In our study we used the following kits:

- Human adiponectin (ADP) ELISA kit, by CUSABIO/ USA.
- COBAS C1-11 reader, by Roche/ Germany.
- COBAS E4-11 reader, by Roche/ Germany.

2.2. Samples

10 ml of blood were taken from each person in all of the groups, the blood samples were collected in plane tube, EDTA tube and gel tube,which allowed clotting at room temperature for 2 hours then be analyzed. Thesewere labeled and stored deep freeze (-20 °C). All subjects enrolled in this study fasted for 8-12 hours before taking the bloodsamples. All subjects agreed to enroll after knowing the aim of the study. Each participant was given a form of essential information, which included a clinical features evaluation and laboratory examinations.

3. Results and Discussion

The outcomes reported in this chapter are based on an analysis of the data from one hundred and twenty (120) participants in the current study, which was divided and classified into thirty (30) patients with type 2 diabetes and thirty (30) controls. Thirty (30) patients had thyroid dysfunction, and thirty (30) more participants, including patients with diabetes mellitus type II, also had thyroid dysfunction.

3.1. Comparison of All Groups in Age and BMI

As it clear in **Table (1)**, there are significant differences in all study groupsconcerning age as well as BMI.

Table 1 Comparison of studied groups in Age and BMI

Group	**Mean ± SE**	
	Age (year)	**BMI (kg/m^2)**
Control	25.05±2.05	24.30±1.20
Diabetes Type II	46.06 ±1.12	29.59 ±0.87
Thyroid Dysfunction: Hyper	34.07±2.83	28.01 ±0.99
Thyroid Dysfunction: Hypo	33.81 ±2.27	35.07 ±2.76
Thyroid Dysfunction with Diabetes Mellitus: Hyper	40.91 ±3.21	29.57 ±0.79
Thyroid Dysfunction with Diabetes Mellitus: Hypo	47.16 ±1.19	37.36 ±1.38
LSD value	6.018 **	4.241 **
P-value	0.0001	0.0001
**(P≤ 0.01)		

The highest rate by age was among Thyroid Dysfunction with Diabetes Mellitus: Hypo (47.16±1.19) year in comparison with control group (25.05±2.05) year, as in **Table (1)**. Many results agreed with current result, like: (Schweitzer *et al* .,2017; Davies *et al* .,2018; Abusaib *et al* .,2020), while (Abdulrazaq *et al*.,2009) said that the patients with TDs in T2DM (median age was 45). Biological function decline occurs once an organism has reached its maximal reproductive

potential and is defined as a sequence of morphological and functional changes that occur over time and reflect the decline of an organism's biological function (Guarner-Lans *et al*.,2011). Hormones in the body go haywire after childbirth, and it takes time for them to settle down. Women receive the short end of the stick because postpartum thyroiditis, or thyroid disease following childbirth, affects 5% to 9% of women after childbirth. Men, at the very least, are unaffected by thyroid disease.

Thyroid dysfunctions are more likely to develop as people get older, a condition that affects both men and women. Autoimmunity and habitual habits also work together to enhance the risk of thyroid diseases. Thyroid dysfunctions appear to be more common among persons in their middle age or old years, according to research (Zhang *et al*.,2021). Aging causes a natural reduction in pituitary TSH secretion and T4 deiodination, whereas anti-thyroglobulin and anti-thyroperoxidase become more common (Katsiki *et al*.,2015). The results of current study may be explained due to the fact that the prevalence of type 2 DM and thyroid dysfunctions increase with age as many studies approved that, like (Ogbonna and Ezeani,2019).

The results of BMI in this study were highest in Thyroid Dysfunction with Diabetes Mellitus: Hypo (37.36 ±1.38) kg/m^2 in comparing to control group as shown in Table (1).

The findings of the study are similar with those of (Kouidhi *et al*.,2013) who identified a connection between obesity and metabolic repercussions, as well as thyroid function, albeit the underlying etiologyis still unclear at this time. In another study (Aziz and Chlimeran,2013), researchers compared thyroid function in obese and/or diabetic individuals to that of healthy normal weight counterparts with untreated or subclinical hypothyroidism to see if there is a relationship between components of the metabolic syndrome and thyroid function .

Is connected to insulin resistance and obesity. Additionally, another study (Song *et al*.,2019), found that obesity is significantly linked to an increased incidence of hypothyroidism.

Being obese increases he risk of developing hyperglycemia, which is closely related to the development of insulin resistance. Additionally, an increase in body weight is associated with an increased risk of type 2 diabetes. Adults with obesity have a 3–7-fold increased risk of type 2 diabetes compared to those of normal weight, and a 20–fold increased risk in those whose BMI is greater than 35 kg/m2. (Zhao *et al*.,2017), this was comparable to earlier research on (Jun *et al*.,2018; Leitner *et al*.,2017). Thyroid issues and obesity are two common conditions that have an interesting connection. Despite the fact that previous studies have linked thyroid dysfunction to body weight. For instance, some studies have indicated that blood TSH levels are higher in obese individuals, whereas other investigations have not identified any discernible differences (Song *et al*.,2019).

3.2. Hormone Levels Compared in Different Studied Groups

Table 2 Hormone levels in studied groups**.**

Group	**Mean ± SE**		
	TSH (µIU/mL)	**T3(ng/dL)**	**T4 (ng/dL)**
Control	1.811±0.18	121.06±3.18	8.52±0.25
Diabetes Type II	1.496±0.14	114.48±4.33	8.63±0.36
Thyroid Dysfunction: Hyper	0.241±0.03	181.91±5.43	13.88±0.27
Thyroid Dysfunction: Hypo	5.77 ±0.62	79.43 ±10.63	5.02 ±0.79
Thyroid Dysfunction with Diabetes Mellitus: Hyper	0.998 ±0.75	187.84 ±6.12	14.02 ±0.56
Thyroid Dysfunction with Diabetes Mellitus: Hypo	6.26 ±0.46	67.12 ±7.95	5.14 ±0.84
LSD value	1.045 **	17.79 **	1.528 **
P-value	0.0001	0.0001	0.0001
**(P≤ 0.01)			

Table (2) shows the results of hormone levels testing. There were substantial variations in all of the hormone levels. TSH hormone was highest level in Thyroid Dysfunction with Diabetes Mellitus: Hypo patients (6.26 ± 0.46)µIU/mL in

comparison with control group. T3 hormone was (187.84 ± 6.12) ng/dL the highest result in Thyroid Dysfunction with Diabetes Mellitus: Hyper patients in comparison with control group. While T4 was highest hormonal level in Thyroid Dysfunction with Diabetes Mellitus: Hyper patients which was (14.02 ± 0.56) ng/dL in comparison with control group. The control results of TSH, T3 and T4 were (1.811 ± 0.18 µIU/mL; 121.06 ±3.18 ng/dL; 8.52 ± 0.25 ng/dL) respectively.

This result is in agreement with (Song *et al*.,2019; Hage *et al*.,2011) who got the result that in diabetic patients and hypothyroidism, the TSH is peak in this situation. Diabetic patients seem to influence thyroid function in level of hypothalamic control of TRH release and at peripheral tissue by converting T4 to T3 (Gursoy *et al*.,1999).

Hypothyroidism affects glucose metabolism through a variety of ways. Hypothyroidism causes a reduction in hepatic glucose production, which accounts for the lower insulin need in hypothyroid diabetes individuals (Shivanada,2008).

Excess sugar cannot be shuttled out of the circulation and into the cells to be used when insulin is decreased owing to insufficient thyroid hormone. The link between thyroid function and T2DM might be explained by a variety of processes. T3, on the other hand, inhibits insulin action and controls hepatic gluconeogenesis (Okajima and Ui,1979), even in the euthyroid state (Kravets,2016). Increases in plasma T3levels also decrease insulin's capacity to inhibit hepatic glucose synthesis and enhance glucose absorption in muscle. It is interesting to note that even small increases in T3 or T4 levels within the physiological range have been found to cause insulin resistance (Park *et al*.,2011).

Triiodothyronine (T3) results in current study are explained in Table (2) Which agree with (Nunez *et al*.,2008).

Thyroxine (T4) results, shown in Table (2), agree with other studies done by(Maaroof *et al*.,2021). These effects of elevated T4 levels may be explained by the fact that elevatedT4 levels result in hyperthyroidism, which leads in accelerated glycogen breakdown, resulting in decreased glycogen levels. The absorption, use, and production of glucose are all facilitated. Peripheral tissues absorb glucose at a faster pace than central tissues, which may account for the exaggerated glucose peak seen during a timed glucose test (Johnson and Duick,2002).

3.3. Comparison of FBS and HbA1c in All Groups

As in **Table (3)**, Fasting Blood Sugar (fasting serum glucose) measured a highly significant differences and highest level in patients who suffer from thyroid Dysfunction with Diabetes Mellitus: Hypo patients with (208.78 ± 28.39)mg/dL and glycolytic hemoglobin records also high significant differences with (11.13 ± 0.55) mmoL/L in patients diabetes type II who enrolled in current study.

Table 3 Comparison of studied groups in FBS and HbA1c

Group	**Mean ± SE**	
	FBS (mg\dl)	**HbA1c (%)**
Control	89.56 ±2.06	4.88 ±0.13
Diabetes Type II	207.96 ±13.53	11.13±0.55
Thyroid Dysfunction: Hyper	91.36 ±2.10	4.94 ±0.18
Thyroid Dysfunction: Hypo	92.58 ±3.11	5.06 ±0.18
Thyroid Dysfunction with Diabetes Mellitus: Hyper	190.50 ±12.72	8.55 ±0.46
Thyroid Dysfunction with Diabetes Mellitus: Hypo	208.78 ±28.39	10.11 ±0.69
LSD value	41.13 **	1.360 **
P-value	0.0001	0.0001
**(P≤ 0.01)		

Fasting blood sugar (FBS) results are shown in Table (3). The results of current study are in agreement with (Vigersky *et al*.,2006). It is critical to spot TD in diabetic individuals. However, because DM might influence the assessment of a concurrent TD, this diagnosis can be challenging. Poor gastrointestinal absorption of glucose, delayed peripheral glucose assimilation, reduced or normal hepatic glucose synthesis, and impaired gluconeogenesis and glycogenolysis in the liver and muscles are all indicators of hypothyroidism. (Cettour-Rose *et al*.,2005).

Alterations in thyroid hormones, on the other hand, have been reported in diabetic patients, particularly those with poor glycemic control. The nocturnal TSH peak is attenuated or absent in diabetes individuals, and the TSH responseto TRH is reduced. T3 levels have been found to be lower in uncontrolled diabetes individuals. This "low T3 state" might be explained by a problem with peripheral T4 to T3 conversion that improves with better glycemic management(Papazafiropoulou *et al*.,2010).

HbA1c results in current study were highest in diabetic patients with type II followed by Thyroid Dysfunction with Diabetes Mellitus: Hypo as Table (3) shows. It is in agreement with(Yun and Ko,2016; Hayashino *et al*.,2017). The amount of HbA1c in the blood is determined by the red blood cell's lifetime as well as the amount of glucose in the blood (Al-Attaby and Al-Lami,2019). As a result, the duration of T2DM affects the substantial increase in HbA1c levels, which is consistent with a prior study.

This discovery might be linked to the attending physician's inertia, since treatment adjustments are occasionally made after years of uncontrolled HbA1c levels (Al-Attaby and Al-Lami,2019).

Serum might be used instead of plasma for blood glucose testing; however, it should be noted that glucose serum values are typically 5 mg/dL (0.2 mmol/L) lower than plasma (Frank *et al*.,2012).

The expert panel suggested that fluoride-containing tubes be used to reduce glycolysis, and that they be widely accessible in all settings to ensure that they are utilized. When utilizing HbA1c to diagnose T2DM, one should keep in mind that the amount of HbA1c in some patients may not be directly linked with blood glucose (Łojko *et al*.,2019). Anemia, asplenia, uremia, severe hypertriglyceridemia or hyperbilirubinemia, chronic salicylate or opiate or vitamin E or C intake, splenomegaly, pregnancy, and other diseases can all have an effect on HbA1c levels in the blood. As a result, blood glucose levels should be checked for T2DMdiagnosis under these circumstances (Shepard *et al*.,2015).

3.4. Lipid Profile and Study Groups

The results of lipid profile presented in Table (4), Cholesterol, Triglyceride, LDL-C and VLDL-C recorded a high significant differences and highest levels were among patients with Thyroid Dysfunction with Diabetes Mellitus: Hypo with (209.45 ± 12.29, 268.18 ± 31.57, 114.24 ±13.74 and 55.98 ± 5.63) mg/dL respectively, while HDL-C was high significant in control group. Cholesterol, Triglyceride, LDL-C and VLDL-C levels are shown clearly in **Table (4)**. Patients increased levels of cholesterol and triglycerides (TG), according to (Ahmed *et al*., 2020) and (Aljaff *et al*., 2023) said that hypothyroidism is a common cause of secondary dyslipidemia.

Given elevated lipid profile levels have been linked to obesity, which has been shown to be associated with the development of the metabolic syndrome and tends to come before the other components of the syndrome. The subjects' eating habits, particularly a high carbohydrate, high cholesterol, and excess salt diet, as well as a sedentary lifestyle, can be blamed for high blood pressure, increased Triglycerides, and decreased HDL cholesterol levels (Ahmed, 2023).

Table 4 Comparison of studied groups in Lipid profile

Group	**Mean ± SE**				
	Cholesterol	**Triglyceride**	**HDL**	**LDL**	**VLDL**
Control	154.99±4.85	133.18±5.20	42.79±1.92	75.57±2.32	26.89±1.06
Diabetes Type II	183.72±8.13	231.55±14.35	33.64±1.46	101.53±7.16	26.89±1.06
Thyroid Dysfunction: Hyper	179.58±8.83	185.46±19.09	41.3±3.52	97.08±8.87	36.29±4.02
Thyroid Dysfunction: Hypo	173.27±10.76	192.49±19.37	37.28±2.24	91.65±10.46	43.27±9.97
Thyroid Dysfunction with Diabetes Mellitus: Hyper	150.01±11.69	133.97±11.65	41.32±2.52	73.68±4.19	36.83±10.23
Thyroid Dysfunction with Diabetes Mellitus: Hypo	209.45±12.29	268.18±31.57	24.22±0.88	114.24±13.74	55.98±5.63
LSD value	26.80 **	51.55 **	6.129 **	24.18 **	12.72 **
P-value	0.0002	0.0001	0.0001	0.0041	0.0001
**(P≤ 0.01)					

3.5. Adiponectin Results with Study Groups

Table (5) expresses the results of this study. The ADP increased among Thyroid Dysfunction: Hyper patients with (17.98 ±1.43) ng\ml and OPN also increased with Thyroid Dysfunction with Diabetes Mellitus: Hyper patients (17.93 ±0.36) ng\ml.

Adiponectin (ADP) results in this study are conflicting as shown in **Table (5)**, and this result is similar to other study done by (Cinar and Gurlek,2013). According to Kamar'sstudy, Adiponectin is a fat cell- derived hormone that protect against atherosclerotic cardiovascular diseases through its enhancing effect on insulin sensitivity where his results were conflicting too, refer to Summary of previous studies of ADP and TD in Appendix (2). The findings are also consistent with those of (Schultz *et al*.,2011), who found that investigations of the interaction between thyroid hormones and ADP in people produce contradictory results. Too far, there have been limited investigations on the effects of thyroid malfunction on ADP release.

Table 5 Comparison of studied groups in ADP

Group	**Mean ± SE**
	ADP (ng\ml)
Control	13.92 ±0.14
Diabetes Type II	2.51±0.09
Thyroid Dysfunction: Hyper	17.98 ±1.43
Thyroid Dysfunction: Hypo	8.73±0.65
Thyroid Dysfunction with Diabetes Mellitus: Hyper	6.98±0.34
Thyroid Dysfunction with Diabetes Mellitus: Hypo	2.73±0.31
LSD value	1.460 **
P-value	0.0001
**(P≤ 0.01)	

Many previous studies about (ADP) were collected by (Cinar and Gurlek,2013) as shown in Table (5) which depicts a few trials in which the influence of thyroid hormones on ADP levels yielded contradictory findings, making it impossible to make any firm conclusions. This might be related to variations in patient characteristics, the severity and duration of thyroid hormone insufficiency, other hormone metabolic effects, and potential intermediary metabolism effects (Schultz *et al*.,2011).

In hypothyroid, the expression of the ADP (ADIPOQ) gene is associated with lower LDL cholesterol and triglyceride levels, whereas glucose and HDL levels are favorably correlated in hyperthyroid. Thyroid hormones may influence lipid and carbohydrate metabolism through changes in ADP receptor expression in adipose tissue when taken combined. Hypothyroidism is associated with atherosclerosis, dyslipidemia, diastolic hypertension, impaired endothelial dysfunction, and insulin resistance, to name a few conditions (Kyriazi *et al*.,2011).

3.6. Correlation coefficient between ADP and other parameters

Adiponectin recorded a reverse proportion with BMI in Thyroid Dysfunctionwith Diabetes Type II which was significantly different (- 0.36); (P ≤ 0.05), as well as a reverse proportion with TSH which was highly significantly different (- 0.73); (P ≤ 0.01). ADP was highly significantand direct proportion with HDL in Diabetes Type II (0.46); (P ≤ 0.05).

Adiponectin was reverse proportion with (LDL) significant differences in Thyroid Dysfunction which was (-0.36), as shown in Table (3-6).

Table 6 Correlation coefficient between ADP and other parameters

PARAMETERS	Correlation coefficient-r with ADP		
	Diabetes Type II	Thyroid Dysfunction	Thyroid Dysfunction with Diabetes
BMI	-0.16NS	0.04NS	- 0.36*
TSH	0.12NS	0.03NS	- 0.73**
T3	-0.22NS	-0.25NS	0.69**
T4	-0.23NS	-0.28NS	0.72**
FBS	0.11NS	-0.18NS	-0.05NS
HbA1c	0.31NS	-0.22NS	-0.02NS
Cholesterol	-0.09NS	-0.17NS	0.03NS
Triglyceride	0.09NS	0.14NS	0.11NS
HDL	0.46**	-0.21NS	0.02NS
LDL	0.29NS	-0.36*	-0.007NS
VLDL	0.02NS	0.11NS	-0.002NS
(P≤0.05), ** (P≤0.01), NS: Non-Significant.			

4. Conclusion

From all previous results, it can be concluded that:

- The (ADP) had high significant differences among Thyroid Dysfunction: Hyperthyroidism patients.
- There is a highly significant differences among studied groups in BMI in comparison to control group.
- According to the results of hormones, there were substantial variations in all of the hormone levels.
- TSH hormone had highest level in Thyroid Dysfunction with Diabetes Mellitus type II: Hypothyroidism patients.
- T3 and T4 hormone had the highest result in Thyroid Dysfunction with Diabetes Mellitus

Statement of informed consent

Not applicable because this manuscript does not contain any individual personal data.

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