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BIOCHEMICAL RELATIONSHIP IN HYPOTHYROIDISM AND DIABETES MELLITUS

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ABSTRACT

Background: Hypothyroidism and diabetes mellitus are commonly seen endocrine disorders that are usually existence as a single entity in an individual and depict the coexistence further resulting in the complex metabolic interactions.

Aim: The present study was aimed to evaluate the biochemical relationship in hypothyroidism and diabetes mellitus by comparison of thyroid function parameters, HbA1c, PPBS (Postprandial Blood Sugar), and Fasting Blood Sugar (FBS) in different groups.

Methods: The study assessed 100 subjects from both the genders divided into 4 groups of 25 subjects each as coexisting diabetes with hypothyroidism, hypothyroidism without diabetes, diabetes without hypothyroidism, and controls. Biochemical parameters assessed were free thyroxine (FT4), free triiodothyronine (FT3), thyroid-stimulating hormone (TSH), HbA1c, PPBS, and FBS.

Results: The study results showed that levels of HbA1c, PPBS, and FBS were increased significantly in subjects with hypothyroid diabetes and diabetes groups when compared to subjects with hypothyroid and in control group with p-value of <0.05. The levels of TSH were significantly increased in subjects from hypothyroid diabetic and hypothyroid groups, whereas, FT4 and FT3 levels were significantly decreased with $p<0.05$. A significant intergroup difference was seen for hypothyroid diabetic group depicting the most significant biochemical alterations.

Conclusion: The present study concludes that there is a bidirectional interaction in hypothyroidism and diabetes in affected subjects with the exacerbation of metabolic dysregulation with the coexisting conditions. The study provides comparison of biochemical data that support integrated screening of thyroid function in diabetic patients and glycemic monitoring in hypothyroid individuals. Also, further prospective studies are needed to optimize personalized management strategies and to elucidate underlying mechanisms.

Keywords: Diabetes, Endocrine dysfunction, Glycemic control, Hypothyroidism, Thyroid function

INTRODUCTION

Diabetes mellitus along with thyroid dysfunction contribute in the most commonly seen endocrine disorders across the Globe and these disorders usually show the co-existence which has a significant effect on the systemic physiological functions and the metabolic hemostasis. There is substantial literature evidence that suggest a bidirectional and complex interaction in these conditions, where diabetes pose an effect on the metabolism of thyroid hormone, whereas, thyroid dysfunction results in impaired glucose regulation and insulin resistance. Type 2 diabetes mellitus has relative insulin deficiency and insulin resistance which is linked to alteration in the levels of thyroid hormone and affect both disease progression and metabolic control. It is vital to understand that this interplay is crucial to optimize patient management and improve the clinical outcomes. The association in thyroid disorder and diabetes is main affected by shared pathophysiological mechanisms such as hormone imbalance, alteration in glucose metabolism, and insulin resistance.[1]

Thyroid hormones including T4 (thyroxine) and T3 (triiodothyronine) has a vital role in regulation of lipid homeostasis, insulin sensitivity, and carbohydrate metabolism. On the contrary, insulin is an anabolic hormone that directly affect the thyroid function by modulation of hormone synthesis and iodine uptake. In type 2 diabetes mellitus, chronic hyperglycemia leads to inflammatory responses and induce oxidative stress resulting in impaired thyroid hormone synthesis and secretion and dysregulation in hypothalamic– pituitary–thyroid (HPT) axis. In subjects with type 2 diabetes mellitus, insulin resistance can decrease the peripheral conversion of T4 to biologically active T3 leading to altered TSH and decreased T3 levels. Also, diabetic complications like nephropathy can affect binding and transport of thyroid hormone leading to thyroid dysfunction. In thyroid disorders, hypothyroidism is highly significant in diabetes having characteristic feature of reduced T4 and T3 levels and increases TSH levels.[2]

Hypothyroidism has depicted a significant association with increased insulin resistance and impaired glucose metabolism. Reduction in the levels of thyroid hormone result in decreased expression of glucose transporter type 4 (GLUT4) in peripheral tissues and limit glucose utilization and uptake. This leads to increased cardiovascular risk, dyslipidemia, and hyperglycemia. Also, the deficiency of thyroid hormone affects energy homeostasis and lipid metabolism that further aggravate the metabolic function in diabetic subjects. Thyroid dysfunction has a prevalence of 10-30% in coexistence with type 2 diabetes mellitus with most common anomaly being hypothyroidism. Untreated or undiagnosed thyroid dysfunction in diabetics can result in elevated HbA1c levels, poor glycemic control, and increased risk of long-term complications such as metabolic syndrome and cardiovascular risk. Hence, routine monitoring and early detection in thyroid function in type 2 diabetes mellitus subjects are vital in effective management of the disease.[3]

Assessing the thyroid hormones, especially FT4, FT3, and TSH helps in crucial insight into metabolic dysregulation and also in guiding the therapeutic decision-making. Subclinical hypothyroidism has characteristic feature if normal FT3 and FT4 and raised TSH levels may result in increased cardiovascular risk and insulin resistance highlighting the vital role of early intervention and identification. Considering the significant overlapping in thyroid dysfunction and diabetes, an integrated approach to management and screening is vital. Despite a growing incidence of this inert-relationship, existing literature is scarce comparing biochemical parameters in different groups.[4] Hence, the present study was aimed to evaluate the biochemical relationship in hypothyroidism and diabetes mellitus by comparison of thyroid function parameters, HbA1c, PPBS (Postprandial Blood Sugar), and Fasting Blood Sugar (FBS) in different groups.

MATERIALS AND METHODS

The present cross-sectional clinical study was aimed to evaluate the biochemical relationship in hypothyroidism and diabetes mellitus by comparison of thyroid function parameters, HbA1c, PPBS (Postprandial Blood Sugar), and Fasting Blood Sugar (FBS) in different groups. The study subjects were from Department of Biochemistry of the Institute. Verbal and written informed consent were taken from all the subjects before study participation.

The study assessed 100 subjects from both the genders divided into 4 groups of 25 subjects each as coexisting diabetes with hypothyroidism, hypothyroidism without diabetes, diabetes without hypothyroidism, and controls. In Group I (included patients diagnosed with T2DM along with either subclinical or overt hypothyroidism), Group II (patients with Type 2 Diabetes Mellitus (T2DM) with normal thyroid function, excluding both subclinical and overt thyroid dysfunction), Group III (patients diagnosed with both subclinical and overt hypothyroidism), and In Group IV (control group), there were healthy subjects that were matched for age, euthyroid, and normoglycemic. In all the subjects, detailed clinical history was recorded followed by comprehensive clinical assessment.

The inclusion criteria for the study were subjects with either hypothyroidism, diabetes, or both, subjects from both the genders, and willing to participate in the study. The exclusion criteria for the study were subjects on medications that could affect the thyroid or lipid profile, on diuretics, hypertensives, gestational diabetes, Type 1 diabetes mellitus, secondary hypothyroidism, hypercholesterolemia on statins, and subjects with severe complications as cerebrovascular accidents or myocardial infarction.

After ensuring the overnight fasting in the subjects for 12 hours, nearly 5ml of intravenous blood was collected under strict aseptic and sterile condition. The centrifugation of sample was done for serum separation which was further used for biochemical analysis. Fasting and postprandial blood glucose levels were assessed with GOD-POD (glucose oxidase-peroxidase) method on an automated analyzer.[5] HbA1c levels were measured with HPLC (high-performance liquid chromatography). The parameters of thyroid function including thyroid-stimulating hormone (TSH), free thyroxine (FT4), and FT3 (free triiodothyronine) were assessed using CLIA (chemiluminescence immunoassay) on autoanalyzer.

Statistical analysis of the collected data was done with statistical tests using ANOVA, chi-square test, and student's t-test. The significance level was considered at a p-value of <0.05.

RESULTS

The present cross-sectional clinical study was aimed to evaluate the biochemical relationship in hypothyroidism and diabetes mellitus by comparison of thyroid function parameters, HbA1c, PPBS (Postprandial Blood Sugar), and Fasting Blood Sugar (FBS) in different groups. The study assessed 100 subjects from both the genders divided into 4 groups of 25 subjects each as coexisting diabetes with hypothyroidism, hypothyroidism without diabetes, diabetes without hypothyroidism, and controls. Biochemical parameters assessed were free thyroxine (FT4), free triiodothyronine (FT3), thyroid-stimulating hormone (TSH), HbA1c, PPBS, and FBS. The mean age of the study subjects in the 4 groups was 42.2±10l.6, 44±10.1, 42.1±9.9, and 41.5±8.6 years which was statistically comparable with p=0.69.

It was seen that for the comparison of HbA1c, PPBS, and FBS levels in the different study groups, HbA1c levels were significantly higher in diabetes group followed by hypothyroid diabetic group, hypothyroidism, and was least in subjects from the control group depicting a statistically significant difference with p-value of <0.05. Similar results were seen for post-prandial blood sugar levels where PPBS was highest in diabetes group followed by hypothyroid diabetic group, hypothyroidism, and was least in subjects from the control group presenting a statistically significant difference with p<0.05. For fasting blood sugar levels, it was also highest in subjects with diabetes group followed by hypothyroid diabetic group, hypothyroidism, and was least in subjects from the control group showing a statistically significant difference with p<0.05 (Table 1).

The study results showed that there was a significant alteration in the parameters of thyroid function in subjects with hypothyroidism and diabetes. Significantly higher levels of TSH were seen in subjects with hypothyroid diabetes and hypothyroidism group compared to subjects with diabetes and control group subjects with p-value of <0.05. Also, statistical analysis revealed that Hypothyroid Diabetic group showed significantly higher levels of TSH compared to other groups with p<0.05 depicting more significant thyroid function when diabetes coexisted (Table 2).

It was also seen that the levels of FT3 were significantly lesser in subjects with hypothyroidism and hypothyroid diabetes compared to subjects with diabetes and control group subjects with p=0.01. In an identical manner, the levels of FT4 were found to be highest in subjects from the control group followed by diabetes group subjects, hypothyroidism subjects, and were least in subjects with hypothyroid diabetes with least levels of FT4. These results were statistically significant with p=0.002.

DISCUSSION

The study assessed 100 subjects from both the genders divided into 4 groups of 25 subjects each as coexisting diabetes with hypothyroidism, hypothyroidism without diabetes, diabetes without hypothyroidism, and controls. Biochemical parameters assessed were free thyroxine (FT4), free triiodothyronine (FT3), thyroid-stimulating hormone (TSH), HbA1c, PPBS, and FBS. The mean age of the study subjects in the 4 groups was 42.2±10l.6, 44±10.1, 42.1±9.9, and 41.5±8.6 years which was statistically comparable with p=0.69. The study design was comparable to the design of the previous studies adopted by Jamatia M et al[6] in 2026 and Taylor PN et al[7] in 2018 where study design similar to the present study was also adopted by the authors in their studies.

The study results showed that for the comparison of HbA1c, PPBS, and FBS levels in the different study groups, HbA1c levels were significantly higher in diabetes group followed by hypothyroid diabetic group, hypothyroidism, and was least in subjects from the control group depicting a statistically significant difference with p-value of <0.05. Similar results were seen for post-prandial blood sugar levels where PPBS was highest in diabetes group followed by hypothyroid diabetic group, hypothyroidism, and was least in subjects from the control group presenting a statistically significant difference with p<0.05. For fasting blood sugar levels, it was also highest in subjects with diabetes group followed by hypothyroid diabetic group, hypothyroidism, and was least in subjects from the control group showing a statistically significant difference with p<0.05. These results were consistent with the findings of Chaker L et al[8] in 2017 and Mohammed Hussein SM et al[9] in 2021 where HbA1c levels were significantly higher in diabetes group followed by hypothyroid diabetic group, hypothyroidism, and was least in subjects from the control group as seen in the results of the present study.

It was seen that there was a significant alteration in the parameters of thyroid function in subjects with hypothyroidism and diabetes. Significantly higher levels of TSH were seen in subjects with hypothyroid diabetes and hypothyroidism group compared to subjects with diabetes and control group subjects with p-value of <0.05. Also, statistical analysis revealed that Hypothyroid Diabetic group showed significantly higher levels of TSH compared to other groups with p<0.05 depicting more significant thyroid function when diabetes coexisted. These findings were in agreement with the results of Jali MV et al[10] in 2016 and de Winter JC et al[11] in 2017 where similar to the present study, higher levels of TSH were seen in subjects with hypothyroid diabetes and hypothyroidism group compared to subjects with diabetes and control group were reported by the authors in their studies.

The study results also depicted that the levels of FT3 were significantly lesser in subjects with hypothyroidism and hypothyroid diabetes compared to subjects with diabetes and control group subjects with p=0.01. In an identical manner, the levels of FT4 were found to be highest in subjects from the control group followed by diabetes group subjects, hypothyroidism subjects, and were least in subjects with hypothyroid diabetes with least levels of FT4. These results were statistically significant with p=0.002. These results correlated with the findings of Luo X et al[12] in 2025 and Chaker L et al[13] in 2017 where results for FT3 and FT4 levels reported by the authors were comparable to the results of the present study.

CONCLUSION

Considering its limitations, the present study concludes that there is a bidirectional interaction in hypothyroidism and diabetes in affected subjects with the exacerbation of metabolic dysregulation with the coexisting conditions. The study provides comparison of biochemical data that support integrated screening of thyroid function in diabetic patients and glycemic monitoring in hypothyroid individuals. Also, further prospective studies are needed to optimize personalized management strategies and to elucidate underlying mechanisms.

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Parameter	Hypothyroid diabetic	Hypothyroidism	Diabetes	control	p-value
HbA1c(mg/dl)	6.90±1.06	5.56±0.95	7.51±1.89	5.14±0.78	**<0.05**
PPBS (mg/dl)	329.88±68.14	129.58±21.14	346.88±80.08	123.48±16.87	**<0.05**
FBS (mg/dl)	135.90±16.43	89.25±19.27	161.08±73.85	84.05±12.80	**<0.05**

Table 1: Comparison of HbA1c, PPBS, and FBS levels in the different study groups

Parameter	Hypothyroid diabetic	Hypothyroidism	Diabetes	control	p-value
HbA1c(mg/dl)	6.90±1.06	5.56±0.95	7.51±1.89	5.14±0.78	**<0.05**
PPBS (mg/dl)	329.88±68.14	129.58±21.14	346.88±80.08	123.48±16.87	**<0.05**
FBS (mg/dl)	135.90±16.43	89.25±19.27	161.08±73.85	84.05±12.80	**<0.05**

FT4 (ng/dl)	0.85±0.53	0.78±0.47	1.21±0.52	1.53±0.33	**<0.05**
FT3 (pg/ml)	2.22±0.74	1.80±0.42	2.83±0.95	2.93±0.52	**<0.05**
TSH (µIU/ml)	35.25±18.53	26.98±13.79	5.41±2.23	3.35±1.38	**<0.05**

Table 2: Comparison for thyroid function and glycemia parameters in study subjects