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Original Research Article

CORRELATION BETWEEN THYROID PROFILE AND TYPE II DIABETES MELLITUS

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ABSTRACT

Background: Thyroid dysfunction and type 2 Diabetes Mellitus are metabolic disorders with complex interrelationships and mutual influence. Thyroid abnormalities can exacerbate glycemic control in patients with T2DM, whereas chronic hyperglycaemia may impair thyroid function. This study aimed to assess the correlation between thyroid dysfunction and T2DM by analysing thyroid hormone levels and their relationship with disease duration. **Materials and Methods:** This case-control study was conducted at Trichy SRM Medical College over six months and included 80 participants. Group A (cases) consisted of 40 T2DM patients, and Group B (controls) included 40 healthy individuals. Thyroid hormone levels (T3, T4, and TSH) were measured using Chemiluminescence Immunoassay. **Result:** There was no significant difference in age or gender between the groups (p=0.726 and p=0.809, respectively).Thyroid dysfunction was observed in 22.5% of T2DM patients, which was significantly higher than that in controls (0%, p=0.001). TSH levels were elevated in Group A compared to those in Group B (Median: 2.75 vs. 3.05, p=0.002), while no significant differences in T3 or T4 levels were noted (p=0.538 and p=0.433, respectively). The prevalence of abnormal thyroid function increased with diabetes duration from 0% in patients with 4–5 years of diabetes to 40% in those aged >11 years (p=0.078). **Conclusion:** Thyroid dysfunction, especially elevated TSH levels, is significantly associated with T2DM and a longer disease duration. Routine thyroid screening in T2DM patients can improve early detection and reduce complications.

INTRODUCTION

Millions of people worldwide are affected by type 2 Diabetes Mellitus (T2DM), a chronic and progressive metabolic disorder that poses substantial challenges to both public health and the economy. Characterized by persistent hyperglycemia due to defects in insulin secretion, insulin action, or both, T2DM is a leading cause of morbidity and mortality worldwide.[1] The global prevalence of diabetes has grown significantly over the past decades, with the International Diabetes Federation reporting that over 463 million people were affected by diabetes in 2019, and this number is expected to rise substantially by 2045.[2] T2DM is a precursor to severe complications, including cardiovascular disease, neuropathy, nephropathy, and retinopathy, underscoring the importance of comprehensive management strategies.[3]

The thyroid gland plays a vital role in regulating metabolism through the secretion of the thyroid hormones triiodothyronine (T3) and thyroxine (T4). These hormones are essential for glucose metabolism, lipid homeostasis, and overall energy expenditure.[4] Thyroid dysfunction, either hypothyroidism or hyperthyroidism, can significantly influence glycemic control and insulin sensitivity.[5] The relationship between T2DM and thyroid disorders is complex and potentially bidirectional, with studies suggesting that subclinical hypothyroidism and hyperthyroidism may predispose individuals to the development of T2DM, while diabetes itself may alter thyroid function through various mechanisms, including insulin resistance and autoimmunity.[6]

This study sought to address the following question: Is there a significant correlation between thyroid function (measured through Thyroid Stimulating Hormone (TSH), T3, and T4 levels) and the presence or severity of T2DM in patients in a tertiary care setting? Understanding the interplay between thyroid dysfunction and T2DM is vital for

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improving clinical outcomes. Often undiagnosed in T2DM patients, thyroid dysfunction has been associated with poor glycemic control and an increased risk of complications.[7] Detection of thyroid dysfunction in early stages can improve clinical decision-making and the implementation of focused interventions, such as optimized hormone replacement therapy or individually tailored glycemic management strategies.

The objective of our study was to assess the association between thyroid hormone levels and T2DM to help improve clinical management, optimize glycemic control, and minimize complications associated with thyroid dysfunction in patients with diabetes.

Review of Literature

Srividya et al. (2010) studied thyroid dysfunction in T2DM patients and reported that 20% of the participants had abnormal thyroid profiles. Among them, 55% had subclinical hypothyroidism, whereas 25% showed subclinical hyperthyroidism. The study also reported that thyroid dysfunction was more common in females (70%) than in males (30%), and that its occurrence was related to diabetes duration and family history. However, no significant correlation was found between thyroid dysfunction and glycemic control indicators like glycated Haemoglobin (HbA1c).[8]

Gupta et al. (2013) carried out a study that analyses the correlation between lipid and thyroid profiles in T2DM patients. The study revealed that hypothyroidism and hyperlipidemia were present in patients with diabetes, and 23% of the cohort exhibited hypothyroidism. T3 levels were negatively correlated with cholesterol levels, whereas TSH levels were positively correlated. These results stress the complicated interrelation between thyroid dysfunction and lipid metabolism in T2DM patients.[9]

Sontakke et al. (2018) studied the correlation of thyroid profiles with glycemic control in patients with T2DM. The authors found that the mean serum T3 and T4 levels decreased, whereas TSH levels increased in patients with diabetes. T3 levels were inversely correlated with HbA1c levels, whereas TSH levels were positively correlated. Moreover, hypothyroidism was found in 33% of participants, indicating a high prevalence in the diabetic population.[10]

Pangajam et al. (2021) focused on the relationship between T2DM patients and thyroid hormone levels and lipid profiles. According to the authors, there was a significant increase in TSH levels, with reduced levels of T3 and T4. The elevated level of TSH also showed a direct correlation with dyslipidemia, such as increased cholesterol and triglycerides, which created a need for the regular screening of diabetic patients for routine checking of their thyroid levels to counteract any potential associated risks.[11]

Malek et al. (2024) studied the thyroid profiles in 100 T2DM patients and reported that thyroid dysfunction was highly prevalent with a prevalence of 31%, mostly subclinical hypothyroidism. The study established a positive correlation between TSH and HbA1c levels and negative correlations between T3 and T4 concentrations and HbA1c levels. This suggests thyroid dysfunction to impair glycemic control.[12]

Aim

This study aimed to explore the association between thyroid dysfunction and T2DM by assessing thyroid hormone levels (TSH, T3, and T4) and their relationship with glycemic control and metabolic parameters in T2DM patients.

MATERIALS AND METHODS

This case-control observational analysis was conducted over 6 months at the Trichy SRM Medical College Hospital. The study population included 80 participants divided into two groups: 40 T2DM patients on treatment with no known thyroid disorders (cases) and 40 healthy individuals without a history of diabetes or systemic disorders (controls).

Patients aged 30–80 years with a diagnosis of T2DM confirmed through clinical history and blood investigations, who were currently undergoing treatment (oral hypoglycaemic agents, insulin, or diet control) without a history of thyroid disorders (cases), and healthy individuals aged 30–80 years without any history of T2DM or thyroid disorders (controls) were included. Exclusion criteria comprised Individuals with a history of thyroid disease or medications affecting thyroid function, pregnant individuals, and those with diabetic complications such as nephropathy or neuropathy were excluded.

Methods

All participants underwent a comprehensive evaluation that included demographic data collection, detailed medical history, and clinical examination. Information recorded for patients with diabetes included the age of onset, duration of diabetes, type of treatment, and comorbidities such as hypertension or cardiovascular disease.

Venous blood samples were collected after overnight fasting and analyzed for thyroid function (T3, T4, and TSH levels) using Chemiluminescence Immunoassay (CLIA). Fasting plasma glucose (FBS) was measured using the GOD-POD method. Data on glycemic control, such as HbA1c levels, were obtained.

Statistical Analysis

Data are presented as mean, standard deviation, median, interquartile range, frequency, and percentage. Continuous variables were compared using the independent sample t-test and analysis of variance (ANOVA), while the Mann-Whitney U test and Kruskal-Wallis test were used to compare non-normally distributed continuous data between independent groups. Categorical variables were

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compared using the Pearson chi-square test. Significance was defined by P values less than 0.05 using a two-tailed test. Data analysis was performed using IBM-SPSS version 25.0 (IBM-SPSS Science Inc., Chicago, IL).

RESULTS

The age distribution between groups A (case group) and B (control group) was not significant (p = 0.726). In Group A, 25% were aged 35–40 years, 37.5% were aged 41–50 years, 27.5% were aged 51–60 years, and 10% were older than 61 years. In Group B, 17.5% were aged 35–40 years, 47.5% were aged 41–50 years, 22.5% were aged 51–60 years, and 12.5% were older than 61 years. The gender distribution was also not significantly different between the groups (p = 0.809). In Group A, 67.5% were female and 32.5% were male, whereas in Group B, 70% were female and 30% were male.

Table 1: Demographic Characteristics of the Study Population

		Group A	Group B	P value
Age (years)	35-40	10 (25%)	7 (17.5%)	0.726
	41-50	15 (37.5%)	19 (47.5%)	
	51-60	11 (27.5%)	9 (22.5%)	
	>61	4 (10%)	5 (12.5%)	
Gender	Female	27 (67.5%)	28 (70%)	0.809
	Male	13 (32.5%)	12 (30%)	

The T3 levels were not significantly different between the groups (p = 0.538). In Group A, the 25th percentile, median, and 75th percentile values were 0.96, 1.32, and 1.60, and 0.99, 1.30, and 1.86 in Group B. T4 levels were also not significantly different (p = 0.433), with 25th percentile, median, and 75th percentile values of 5.65, 7.73, and 9.65 in Group A, compared to 5.24, 6.65, and 10.24 in Group B. TSH levels differed significantly between the groups (p = 0.002). The 25th percentile, median, and 75th percentile values were 3.75, 2.75, and 4.45 in Group A, and 2.00, 3.05, and 3.40 in Group B. Thyroid function showed a significant difference between the groups (p = 0.001). In Group A, 22.5% had abnormal thyroid function, while 77.5% had normal thyroid function. In Group B, 100% of the patients had normal thyroid function.

Table 2: Comparative Analysis of Thyroid Hormone Parameters

Parameter		Group A	Group B	P-Value
T3	25th Percentile	0.96	0.99	0.538
	Median	1.32	1.30	
	75th Percentile	1.60	1.86	
T4	25th Percentile	5.65	5.24	0.433
	Median	7.73	6.65	
	75th Percentile	9.65	10.24	
TSH	25th Percentile	3.75	2.00	0.002
	Median	2.75	3.05	
	75th Percentile	4.45	3.40	
Thyroid Function	Abnormal N (%)	9 (22.5%)	0 (0.0%)	0.001
	Normal N (%)	31 (77.5%)	40 (100.0%)	

The distribution of thyroid parameters among patients across the different age groups (35–40, 41–50, 51–60, and >61 years) showed no significant differences. The mean T3 levels were 1.44, 1.48, 1.19, and 1.39, respectively (p = 0.594). Similarly, the mean T4 levels were 8.62, 7.24, 8.07, and 8.24, with no significant variation (p = 0.719). The mean TSH levels across age groups were 3.02, 4.03, 2.55, and 4.88, respectively, which also showed no significant difference (p = 0.347). Regarding thyroid function, the percentage of abnormal thyroid function increased in the middle-aged group, with 0.0%, 26.7%, 36.4%, and 25.0% of participants showing abnormal function across the respective age groups, while normal thyroid function was observed in 100%, 73.3%, 63.6%, and 75.0%, respectively. However, the association between age and thyroid function was not significant (p = 0.233).

Table 3: Age-Wise Distribution of Thyroid Parameters Among Cases

Parameter	35-40	41-50	51-60	>61	P-Value
T3 (Mean ± SD)	1.44 ± 0.78	1.48 ± 0.56	1.19 ± 0.28	1.39 ± 0.15	0.594
T4 (Mean ± SD)	8.62 ± 2.76	7.24 ± 2.50	8.07 ± 3.84	8.24 ± 3.24	0.719
TSH (Mean ± SD)	3.02 ± 1.18	4.03 ± 2.55	4.46 ± 2.07	4.88 ± 2.05	0.347
Thyroid Function - Abnormal N (%)	0 (0.0%)	4 (26.7%)	4 (36.4%)	1 (25.0%)	0.233
Thyroid Function - Normal N (%)	10 (100.0%)	11 (73.3%)	7 (63.6%)	3 (75.0%)	

The analysis of thyroid parameters based on gender revealed no significant differences. The mean T3 levels were 1.35 ± 0.57 in females and 1.45 ± 0.50 in males, with a p-value of 0.606. Similarly, the

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mean T4 levels were 7.81 ± 2.60 in females and 8.13 ± 3.78 in males, with a p-value of 0.757.TSH levels were not significantly different between females and males (p = 0.648). In females, the 25th percentile, median, and 75th percentile values were 1.90, 3.50, and 4.40, respectively. In males, the 25th percentile was 3.00, with a median of 3.90 and the 75th percentile was 4.40.

Table 4: Gender-Wise Distribution of Thyroid Parameters Among Cases

Parameter	Female (Mean ± SD or Percentile)	Male (Mean ± SD or Percentile)	P-Value
T3 (Mean ± SD)	1.35 ± 0.57	1.45 ± 0.50	0.606
T4 (Mean ± SD)	7.81 ± 2.60	8.13 ± 3.78	0.757
TSH (25th Percentile)	1.90	3.00	0.648
TSH (Median)	3.50	3.90	
TSH (75th Percentile)	4.40	4.40	
Thyroid Function - Abnormal N (%)	6 (22.2%)	3 (23.1%)	0.952
Thyroid Function - Normal N (%)	21 (77.8%)	10 (76.9%)	

Analysis of thyroid parameters based on the duration of diabetes revealed no significant differences in T3 and T4 levels across the groups. Mean T3 levels decreased slightly with longer durations of diabetes, from 1.53 ± 0.81 in the 4–5 years group to 1.29 ± 0.25 in the >11 years group (p = 0.546), while T4 levels showed a similar trend, with mean values of 8.75 ± 2.65, 7.56 ± 2.88, and 7.67 ± 3.60 for the 4–5 years, 6–10 years, and >11 years groups, respectively (p = 0.562). TSH levels increased with the duration of diabetes, with the 25th percentile rising from 1.8 in the 4–5 years group to 3.9 in the >11 years group, and the median TSH increased from 3.0 to 4.35 (p = 0.057). Similarly, the proportion of patients with abnormal thyroid function increased from 0% in the 4–5 years group to 26.3% in the 6–10 years group and 40% in the >11 years group, while normal thyroid function decreased (p = 0.078).

Table 5: Thyroid Parameters and Function Across Duration of Diabetes Mellitus

Parameter	4-5 Years	6-10 Years	>11 Years	P-Value
T3 (Mean ± SD)	1.53 ± 0.81	1.34 ± 0.47	1.29 ± 0.25	0.546
T4 (Mean ± SD)	8.75 ± 2.65	7.56 ± 2.88	7.67 ± 3.60	0.562
TSH (25th Percentile)	1.8	1.8	3.9	0.057
TSH (Median)	3.0	3.3	4.35	
TSH (75th Percentile)	4.1	6.9	6.7	
Thyroid Function - Abnormal N (%)	0 (0.0%)	5 (26.3%)	4 (40.0%)	0.078
Thyroid Function - Normal N (%)	11 (100.0%)	14 (73.7%)	6 (60.0%)	

DISCUSSION

Our study aimed to evaluate the correlation between thyroid dysfunction and T2DM by analysing thyroid hormone levels and their relationship with glycemic control and metabolic parameters. The findings indicated a significant association between thyroid dysfunction, mainly elevated TSH levels, and the duration of diabetes, thereby supporting the hypothesis of a complex relationship between the two endocrine conditions.

Our study showed that 22.5% of T2DM patients had thyroid dysfunction and increased TSH levels. The prevalence of thyroid dysfunction in T2DM patients was increased with the duration of diabetes, ranging from 0% in the 4–5 years group to 40% in the >11 years group. TSH levels were significantly higher in patients than in controls (p = 0.002), whereas T3 and T4 levels were not significantly different. These results are in accordance with Vamshidhar and Rani (2020), who found that 16% of T2DM patients had thyroid dysfunction, which revealed a strong positive correlation between TSH levels, fasting blood sugar, and HbA1c levels; r = +0.70 for FBS and r = +0.76 for HbA1c.[13]

Similarly, a meta-analysis conducted by Rong et al. (2021) of 12 prospective studies observed that high TSH levels increased the risk of T2DM by 17% (RR 1.17; 95% CI 1.01–1.36). Conversely, reduced levels of FT3 and FT4 were seen to have greater risk of developing T2DM (RR 1.40 and 1.33 respectively).[14] Prevalence of thyroid dysfunction among T2DM patients was at 17.5% and hypothyroidism was found predominantly in females by Vadivelan et al. (2020). However, their study found no correlation between thyroid dysfunction and diabetic complications.[15]

A major strength of our study is its case-control design, which allows direct comparison between T2DM patients and healthy controls. The addition of thyroid profiles, which included T3, T4, and TSH levels, strengthens our results. However, the small sample size and the fact that this was a single-centre study limit the generalizability of our results. Moreover, the cross-sectional nature of our study prevents causation. These are some of the limitations pointed out by Chaoxun Wang's (2013) study that emphasized the necessity of longitudinal studies to elucidate the mechanisms involved in the link between T2DM and thyroid dysfunction.[16]

Our results are in agreement with those of other studies showing a relationship between thyroid hormones and glucose homeostasis. Khassawneh et al. (2020) reported a prevalence of thyroid

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dysfunction of 26.7% in T2DM patients, which was highly significant compared to controls (13.7%, $p < 0.001$). The most common abnormality found was subclinical hypothyroidism, predominantly among females and poor glycemiccontrol.[17]

A common controversy is that in our study, the case and control groups did not differ significantly in T3 and T4 levels. Sontakke et al. (2018) found significantly decreased T3 and T4 levels in T2DM patients with compared to controls, with a positive correlation between TSH levels and HbA1c.[10] These results may vary because of the differences observed among the populations, study design, and sample size.

Further studies should focus on large multicenter longitudinal studies to confirm the association between thyroid dysfunction and T2DM. Studying the effects of thyroid hormone replacement therapy on glycemic control and diabetic complications might provide clues as to how better patient outcomes may be achieved. Moreover, research has focused on the molecular mechanisms underlying the association between thyroid dysfunction and insulin resistance. This study underscores the significant prevalence of thyroid dysfunction among patients with T2DM, and its association with glycemic control and disease duration. Thus, routine screening for thyroid disorders is important to facilitate early detection and management, which might avoid complications and enhance patient outcomes.

CONCLUSION

There is an apparent relationship between thyroid dysfunction and T2DM. Higher TSH levels were common in patients with T2DM, especially in those with a longer duration of diabetes. However, T3 and T4 levels did not show any significant differences between cases and controls. This again points to the routine checking of thyroid dysfunction in all patients with T2DM so that the detection time can be reduced, and hence, better management of complications may be established. In conclusion, these results demonstrate the complex relationship between thyroid health and diabetes, which warrants further research and clinical attention.

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