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Original Researcher Article

Impact Of Thyroid Dysfunction on Lipid Metabolism and Cardiac Electrical Activity

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Abstracts: **Background**: Thyroid hormones play a crucial role in regulating lipid metabolism and cardiovascular physiology. Both hypothyroidism and hyperthyroidism are associated with significant alterations in serum lipid profile and cardiac electrical activity, predisposing patients to cardiovascular morbidity. However, data correlating thyroid dysfunction with simultaneous lipid abnormalities and electrocardiographic (ECG) changes in Indian patients remain limited. **Aim**: To evaluate the impact of thyroid dysfunction on lipid metabolism and cardiac electrical activity by assessing lipid profile parameters and electrocardiographic changes in patients with hypothyroidism and hyperthyroidism. Materials and Methods: This hospital-based observational study included 80 newly diagnosed patients with thyroid dysfunction, comprising 46 hypothyroid and 34 hyperthyroid cases, attending a tertiary care center. Patients aged above 13 years were evaluated. Thyroid function tests, fasting lipid profile, and 12-lead electrocardiography were performed in all patients. Echocardiography was done in selected cases. Patients with pre-existing cardiac disease, diabetes mellitus, metabolic syndrome, chronic smoking, or morbid obesity were excluded. Statistical analysis was performed using appropriate tests, and a p-value <0.05 was considered statistically significant. **Results**: Among the 80 patients, females predominated with a female-to-male ratio of approximately 4.3:1. Hypothyroid patients demonstrated significantly higher total cholesterol, triglycerides, and LDL cholesterol levels compared to hyperthyroid patients. Elevated serum cholesterol was observed in 73% of hypothyroid individuals, whereas 67.6% of hyperthyroid patients had cholesterol levels below 200 mg/dL. The most common ECG abnormality in hypothyroidism was ST–T segment changes (34%), followed by sinus bradycardia. In hyperthyroidism, sinus tachycardia (60.7%) and atrial fibrillation (21.4%) were predominant findings. Echocardiographic evaluation revealed reduced ejection fraction and fractional shortening in hypothyroid patients. **Conclusion**: Thyroid dysfunction significantly influences lipid metabolism and cardiac electrical activity. Hypothyroidism is associated with an adverse lipid profile and ischemic ECG changes, whereas hyperthyroidism shows characteristic tachyarrhythmias and reduced lipid levels. Routine lipid profiling and ECG assessment should be incorporated into the evaluation of patients with thyroid disorders for early detection of cardiovascular involvement.

Keywords: Thyroid dysfunction, Hypothyroidism, Hyperthyroidism, Lipid profile, Electrocardiography, Cardiovascular risk.

INTRODUCTION

Thyroid hormones are essential regulators of metabolic homeostasis and exert profound effects on multiple organ systems, particularly the cardiovascular system and lipid metabolism [1]. Triiodothyronine (T3) influences myocardial contractility, heart rate, systemic vascular

resistance, and lipid synthesis and degradation, thereby playing a pivotal role in maintaining cardiovascular health [2].

Thyroid dysfunction is one of the most common endocrine disorders worldwide, with hypothyroidism being more prevalent than hyperthyroidism and showing a marked female predominance [3]. In India, the burden of thyroid disorders is substantial, and a significant proportion of patients remain undiagnosed until complications arise. Both overt and subclinical thyroid dysfunction have been implicated in increasing cardiovascular morbidity and mortality [4].

Dyslipidemia is a well-recognized metabolic consequence of thyroid dysfunction, particularly hypothyroidism. Reduced thyroid hormone levels lead to decreased hepatic LDL receptor activity, diminished cholesterol clearance, and increased intestinal cholesterol absorption, resulting in elevated total cholesterol and low-density lipoprotein (LDL) cholesterol levels [5,6]. These lipid abnormalities contribute to accelerated atherosclerosis and an increased risk of coronary artery disease [7]. In contrast, hyperthyroidism is generally associated with reduced serum total cholesterol and LDL levels due to enhanced lipid turnover and increased LDL receptor expression [8].

In addition to metabolic effects, thyroid hormones exert significant influence on cardiac electrophysiology. Hypothyroidism is associated with sinus bradycardia, low-voltage QRS complexes, prolonged QT interval, ST-segment depression, and T-wave flattening or inversion, reflecting delayed myocardial repolarization and prolonged action potential duration [9,10]. These electrical changes increase susceptibility to ventricular arrhythmias, particularly in the presence of ischemic heart disease [11].

Hyperthyroidism, on the other hand, produces a hyperdynamic cardiovascular state characterized by sinus tachycardia, atrial fibrillation, increased left ventricular mass, and ST–T segment changes secondary to myocardial strain [12]. Atrial fibrillation is a particularly important complication, occurring in up to 15–20% of hyperthyroid patients, and is associated with increased risk of thromboembolic events [13].

Although several studies have independently evaluated lipid abnormalities and electrocardiographic changes in thyroid dysfunction, data integrating both metabolic and electrical cardiac alterations in a single cohort remain limited, particularly in the Indian population [14–16]. Understanding the combined impact of thyroid dysfunction on lipid metabolism and cardiac electrical activity is essential for early identification of cardiovascular risk and timely intervention.

Therefore, the present study was undertaken to assess lipid profile alterations and electrocardiographic changes in patients with hypothyroidism and hyperthyroidism and to evaluate their cardiovascular implications in a tertiary care hospital setting.

MATERIALS AND METHODS

Study Design and Study Population

This hospital-based observational study was conducted in a tertiary care teaching hospital over a study period of 12 months. A total of 80 newly diagnosed patients with thyroid dysfunction were enrolled, including 46 patients with hypothyroidism and 34 patients with hyperthyroidism. The diagnosis of thyroid dysfunction was established based on clinical evaluation and thyroid function tests. Both male and female patients aged above 13 years were included in the study.

Patients with pre-existing cardiac diseases such as rheumatic heart disease, congenital heart disease, ischemic heart disease, hypertensive heart disease, or cardiomyopathy were excluded. Individuals with diabetes mellitus, metabolic syndrome, morbid obesity, chronic smoking history, or other systemic illnesses affecting lipid metabolism were also excluded.

Clinical Evaluation and Investigations

All enrolled patients underwent a detailed clinical assessment with emphasis on cardiovascular symptoms suggestive of ischemic heart disease or arrhythmias. Laboratory investigations included serum triiodothyronine (T3), thyroxine (T4), free T3, free T4, thyroid-stimulating hormone (TSH), and fasting lipid profile comprising total cholesterol, triglycerides, high-density lipoprotein (HDL), and low-density lipoprotein (LDL) cholesterol.

A standard 12-lead electrocardiogram (ECG) was recorded for all patients using standard calibration and paper speed. ECGs were evaluated for heart rate abnormalities, rhythm disturbances, ST–T segment changes, QT interval prolongation, and evidence of ventricular hypertrophy. Two-dimensional echocardiography was performed in selected

patients to assess left ventricular dimensions, ejection fraction, and fractional shortening.

Statistical Analysis

Data were compiled and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Comparisons between hypothyroid and hyperthyroid groups were performed using the independent two-sample *t*-test for continuous variables and the Chi-square test for categorical variables. A *p*-value of less than 0.05 was considered statistically significant.

Observation and results

A total of 80 patients with thyroid dysfunction were included in the study, of whom 46 (57.5%) were diagnosed with hypothyroidism and 34 (42.5%) with hyperthyroidism. The study population showed a marked female predominance with a female-to-male ratio of 4.3:1. The age of patients ranged from 15 to 65 years, with the majority belonging to the third and fourth decades of life. **Table 1** summarizes the age and gender distribution of the study participants.

Table 1: Age and Gender Distribution of Study Participants

Variable	Hypothyroid (n = 46)	Hyperthyroid (n = 34)	Total (n = 80)
Age range (years)	15–65	16–62	15–65
Mean age (years ± SD)	38.6 ± 11.4	35.2 ± 10.1	37.1 ± 10.9
Females, n (%)	38 (82.6%)	28 (82.4%)	66 (82.5%)
Males, n (%)	8 (17.4%)	6 (17.6%)	14 (17.5%)
Female : Male ratio	4.75 : 1	4.6 : 1	4.3 : 1

Hypothyroid patients demonstrated a significantly adverse lipid profile compared to hyperthyroid patients. Elevated total cholesterol levels were observed in 73% of hypothyroid patients, of whom 36.6% had borderline-high values and 36.4% had high cholesterol levels. In contrast, 67.6% of hyperthyroid patients had total cholesterol levels below 200 mg/dL.

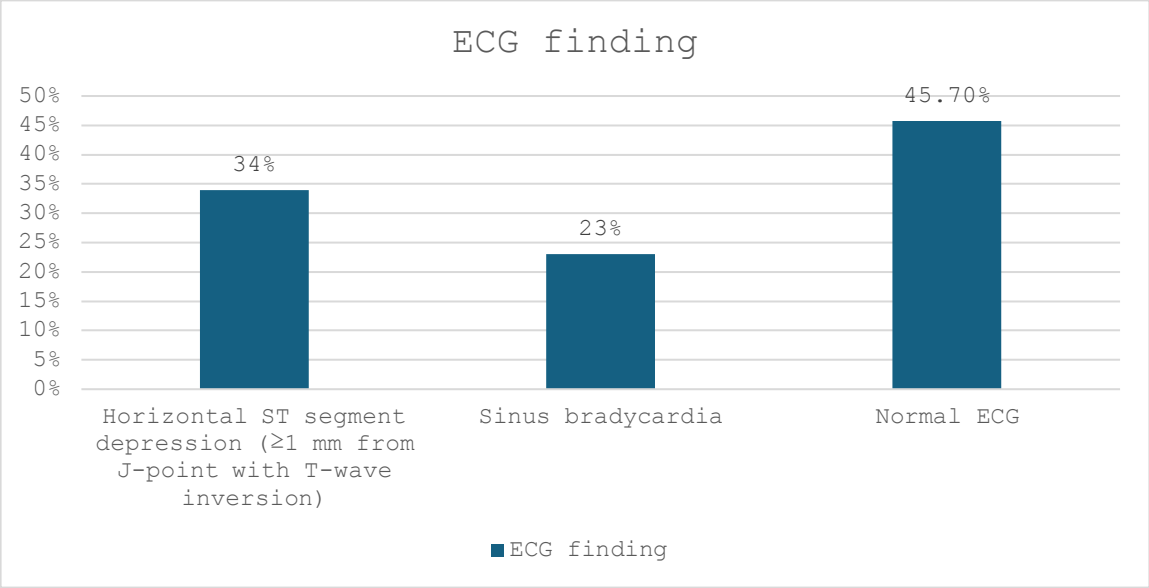
Mean serum total cholesterol, triglycerides, and LDL cholesterol levels were significantly higher in hypothyroid patients, while HDL cholesterol levels were comparatively lower. These differences were statistically significant ($p < 0.05$).

Table 2: Comparison of Lipid Profile between Hypothyroid and Hyperthyroid Patients

Lipid Parameter	Hypothyroidism (n = 46)	Hyperthyroidism (n = 34)	p-value
Total Cholesterol (mg/dL)	228.6 ± 32.5	162.4 ± 28.3	<0.001
Triglycerides (mg/dL)	176.3 ± 40.8	112.7 ± 34.5	<0.01
LDL Cholesterol (mg/dL)	142.8 ± 26.9	91.6 ± 22.1	<0.001
HDL Cholesterol (mg/dL)	38.2 ± 6.4	49.3 ± 7.2	<0.01
VLDL (mg/dL)	35.2 ± 9.8	22.5 ± 8.4	<0.05

Electrocardiographic abnormalities were observed in both groups, with distinct patterns.

In hypothyroid patients, the most frequent ECG abnormality was ST–T segment changes, observed in 15 patients (34%). These included horizontal ST-segment depression with T-wave inversion, predominantly involving inferolateral leads. Sinus bradycardia was noted in 10 patients (23%). All patients with ST–T changes had clinical features suggestive of stable angina.



In hyperthyroid patients, sinus tachycardia was the most common ECG finding, seen in 60.7% of cases. Atrial fibrillation was observed in 21.4% of patients, while left ventricular hypertrophy and left ventricular strain patterns were noted in 42.9% and 21.4% of cases, respectively (table 3).

Table 3: ECG Changes in Hyperthyroid Patients (n=34)

ECG Finding	Number (%)
Sinus tachycardia	21 (60.7)
Atrial fibrillation	7 (21.4)
LV hypertrophy	15 (42.9)
LV strain pattern	7 (21.4)

Echocardiographic evaluation revealed a significant reduction in ejection fraction (EF) and fractional shortening (FS) among hypothyroid patients compared to hyperthyroid patients, indicating depressed myocardial contractility. However, no statistically significant difference was observed in left ventricular internal dimensions during systole (LVESD) and diastole (LVEDD) between the two groups.

Table 4: Comparison of Echocardiographic finding between Hypothyroid and Hyperthyroid Patients

Parameter	Hypothyroidism (n = 46)	Hyperthyroidism (n = 34)	p-value
LVEDD (cm)	4.65 ± 0.52	4.59 ± 0.48	>0.05
LVESD (cm)	3.12 ± 0.41	3.08 ± 0.39	>0.05
Fractional Shortening (FS) (%)	28.4 ± 3.6	35.2 ± 4.1	<0.001

Ejection Fraction (EF) (%)	56.8 ± 5.4	68.6 ± 6.2	<0.001

DISCUSSION

Thyroid hormones exert a significant influence on cardiovascular physiology and lipid metabolism, and disturbances in thyroid function are known to predispose patients to adverse cardiovascular outcomes. The present study evaluated lipid profile alterations and cardiac electrical changes in patients with hypothyroidism and hyperthyroidism, highlighting distinct metabolic and electrocardiographic patterns associated with each condition.

In the present study, hypothyroidism was more prevalent than hyperthyroidism, with a marked female predominance, findings that are consistent with earlier epidemiological studies from India and other regions [3,13]. The majority of patients belonged to the third and fourth decades of life, reflecting the common age of presentation reported in previous studies [14,15].

A significant finding of this study was the presence of dyslipidemia in hypothyroid patients. Elevated total cholesterol, triglycerides, and LDL cholesterol levels were observed in a substantial proportion of hypothyroid individuals. These findings are in agreement with earlier studies by Balgi and Suneetha and Duntas and Brenta, who demonstrated that reduced thyroid hormone levels lead to decreased LDL receptor expression and impaired clearance of atherogenic lipoproteins [6,14]. The observed lipid abnormalities explain the increased risk of atherosclerosis and coronary artery disease in hypothyroid patients [5,7].

In contrast, hyperthyroid patients in the present study exhibited comparatively lower total cholesterol and LDL cholesterol levels, consistent with enhanced lipid turnover and increased hepatic LDL receptor activity seen in thyrotoxic states [8,10]. These findings corroborate observations reported in earlier Indian and international studies [15–17].

Electrocardiographic changes were frequent in both hypothyroid and hyperthyroid patients but differed in pattern. In hypothyroidism, ST–T segment changes were the most common ECG abnormality, observed in 34% of patients, followed by sinus bradycardia. Similar ECG findings have been reported by Udovcic et al. and Petrosyan et al., who attributed these changes to delayed myocardial repolarization, prolonged action potential duration, and underlying ischemic heart disease [9,10]. Notably, all hypothyroid patients with ST–T changes in the present study had clinical features of stable angina, underscoring the association between hypothyroidism, dyslipidemia, and coronary artery disease.

Hyperthyroid patients predominantly exhibited sinus tachycardia and atrial fibrillation, findings consistent with previous studies [12,16]. Atrial fibrillation was observed in over one-fifth of hyperthyroid patients, reflecting the increased adrenergic sensitivity and shortened atrial refractory periods associated with excess thyroid hormone levels [13]. Left ventricular hypertrophy and strain patterns seen on ECG in hyperthyroid patients can be explained by sustained volume overload and increased cardiac workload [17].

Echocardiographic evaluation further supported the adverse cardiovascular impact of hypothyroidism, with reduced ejection fraction and fractional shortening indicating impaired myocardial contractility. These findings align with previous reports demonstrating both systolic and diastolic dysfunction in untreated hypothyroid patients [4,16]. In hyperthyroid patients, preserved or increased myocardial contractility was observed, consistent with the hyperdynamic circulatory state characteristic of thyrotoxicosis.

Overall, the findings of this study emphasize that thyroid dysfunction, even at initial presentation, is associated with clinically relevant alterations in lipid metabolism and cardiac electrical activity. Early identification of these abnormalities is essential to prevent long-term cardiovascular complications.

CONCLUSION

Thyroid dysfunction has a significant impact on lipid metabolism and cardiac electrical activity. Hypothyroidism is associated with an adverse lipid profile characterized by elevated total cholesterol, triglycerides, and LDL cholesterol, along with ischemic electrocardiographic changes and impaired myocardial contractility. In contrast, hyperthyroidism is characterized by

reduced serum lipid levels and distinct electrocardiographic abnormalities, predominantly sinus tachycardia and atrial fibrillation, reflecting a hyperdynamic cardiovascular state.

The study highlights the importance of early cardiovascular evaluation in patients with thyroid dysfunction. Routine assessment of lipid profile and electrocardiography should be incorporated into the diagnostic workup of all patients with suspected or confirmed thyroid disorders to facilitate early detection and prevention of cardiovascular complications.

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