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# Association of Lipid Profile with Electrocardiographic Changes in Newly Diagnosed Hypothyroid Patients

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**KEYWORDS**

Hypothyroidism, Lipid profile, Electrocardiogram, Dyslipidaemia, Cardiovascular risk, Thyroid function, Endocrine disorders

**ABSTRACT:**

Background: Hypothyroidism, a common endocrine disorder, has a considerable impact on metabolic functions, including lipid metabolism and cardiovascular health.

Objective: To explore the relationship between lipid profile parameters and electrocardiogram (ECG) changes in newly diagnosed hypothyroid patients.

Methods: An observational study was conducted at Aarupadai Veedu Medical College and Hospital from June 2022 to June 2024. A total of 82 newly diagnosed hypothyroid patients were included, with those having significant comorbidities excluded. Data on demographics, thyroid function tests, fasting lipid profiles, and ECG findings were collected and analysed. Statistical analysis was performed using SPSS, with a significance level set at $p < 0.05$.

Results: The study cohort comprised 93.9% female participants, indicating a higher prevalence of hypothyroidism among women. The lipid profile revealed mean total cholesterol levels of 186.94 ± 27.33 mg/dL, LDL of 129.24 ± 30.13 mg/dL, and HDL of 34.96 ± 5.02 mg/dL. The most frequent ECG finding was normal sinus rhythm (81.71%), followed by low voltage complexes (15.85%). No significant correlation was observed between lipid parameters and ECG changes ($p > 0.05$). Conclusion: Dyslipidaemia is common in newly diagnosed hypothyroid patients; however, it does not appear to correlate with specific ECG abnormalities. These findings highlight the importance of a comprehensive cardiovascular assessment in such patients, extending beyond routine lipid and ECG evaluations.

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## Introduction

Hypothyroidism is a prevalent endocrine disorder characterized by inadequate production of thyroid hormones, which significantly affects various metabolic processes in the body, including lipid metabolism and cardiovascular function. Thyroid hormones regulate almost every bodily system and numerous metabolic factors, including the production, breakdown, and movement of lipids.(1) A primary concern in hypothyroid patients is the alteration of lipid profiles, which can increase the risk of cardiovascular diseases (CVD). It is well-established that changes in thyroid function affect lipoprotein composition and transit, thereby linking dyslipidaemia to thyroid dysfunction.(2) While hyperthyroidism is less common than hypothyroidism, both conditions are among the most prevalent endocrine disorders affecting the thyroid. Thyrotropin (TSH) receptors are highly expressed in adipocytes and function similarly to those in the thyroid, suggesting a role for TSH in regulating adipocyte functions.(3)

Thyroid hormones influence many bodily systems, with the heart and blood vessels being primary targets. Patients with thyroid dysfunction often experience noticeable alterations in these organs.(4) The effects of elevated or decreased thyroid hormone levels on the cardiovascular system are central to many of the symptoms observed in individuals with hyperthyroidism or hypothyroidism. In hypothyroidism, dyslipidaemia typically manifests as elevated total cholesterol, low-density lipoprotein cholesterol (LDL-C), and sometimes triglycerides, along with reduced high-density lipoprotein cholesterol (HDL-C) levels. Overt hypothyroidism is characterized by elevated cholesterol levels and a marked increase in LDL and apolipoprotein B, as noted in reference.(5) Reduced fractional clearance of LDL due to fewer liver LDL receptors and their lower activity is cited as the primary cause of hypercholesterolemia in hypothyroidism.(6) The combination of dyslipidaemia and other metabolic disturbances in thyroid disorders exacerbates insulin resistance and oxidative stress.(5, 6) Individuals with overt or subclinical hypothyroidism may be at increased risk of coronary artery disease (CAD) and cerebral ischemia due to these metabolic changes, along with thyroid hormone-induced hemodynamic alterations.(7) Research indicates that individuals with hyperthyroidism typically exhibit lower total and LDL cholesterol levels.(8)

The electrocardiogram (ECG) is a widely used diagnostic tool for detecting electrical abnormalities in the heart. ECG changes can signal underlying cardiovascular issues, including those arising from metabolic disturbances. In hypothyroid patients, ECG alterations may be associated with altered lipid profiles and increased cardiovascular risks. Hyperthyroidism is often characterized by ECG abnormalities such as tachycardia, arrhythmias, and non-specific T-wave changes, though ST segment alterations are less frequently recorded.(9-11) In hypothyroidism, common ECG findings include bradycardia, low voltage complexes, ST segment depression, flattened or inverted T waves (reflecting delayed cardiac action potentials), and increased QT dispersion. Due to greater electrical depression of the myocardium, hypothyroid patients are at higher risk of ventricular arrhythmias, particularly in the presence of ischemic heart disease. Other ECG abnormalities such as torsades de pointes, right bundle branch block, and QRS prolongation may also be observed.(12-14) Understanding the relationship between lipid profile abnormalities and ECG changes in newly diagnosed hypothyroid patients is crucial for early cardiovascular risk detection and guiding appropriate therapeutic interventions. This study aims to explore the correlation between lipid profile parameters and ECG changes in newly diagnosed hypothyroid patients.

## Materials and Methods

The observational study was conducted from June 2022 to June 2024 at the Department of General Medicine and Endocrinology, Aarupadai Veedu Medical College and Hospital, Kirumampakam, Puducherry, involving both outpatients (OPD) and inpatients (IPD). Written informed consent was obtained from all participants before their enrollment in the study, which received ethical approval (IHEC No. AV/IHEC/2022/084) from the Institutional Human Ethics Committee. Participants included male and female patients newly diagnosed with hypothyroidism who had been undergoing treatment for less than three months. Eligibility criteria required participants to be 18 years or older and willing to provide written consent. Exclusion criteria included patients

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under 18 years, those with chronic obstructive pulmonary disease (COPD), severe anemia, diabetes mellitus, other endocrine disorders, known cases of dyslipidemia, cardiac conditions, or those taking medications affecting thyroid function (such as beta-blockers, lithium, oral contraceptives, steroids) or with a history of alcohol use. All OPD and IPD cases of newly diagnosed hypothyroidism within three months were considered, with a sample size of 82 based on a previous study by Ghosh et al.(15) (2015) expecting an LDL and QRS complex correlation of 0.355, 5% significance, and 90% power. Consecutive sampling was used to select participants. Detailed demographic and clinical data, including thyroid function tests, fasting lipid profiles, and electrocardiograms, were collected. Statistical analyses, including descriptive statistics, ANOVA, and parametric tests, were performed using SPSS (IBM SPSS Statistics Version 26.0) and Excel, with a significance level of 5% ($p < 0.05$) considered statistically significant.

**Results**

The study was conducted over a period of two years, from June 2022 to June 2024, at Aarupadai Veedu Medical College and Hospital, encompassing both outpatient and inpatient services in the General Medicine and Endocrinology departments. The sample consisted of 96.3% male and 3.8% female participants.

Results showed that the majority of subjects (81.71%) had a normal sinus rhythm within standard limits. Low voltage complexes were observed in 15.85% of participants, while uncommon findings, such as a flat "T" wave in lead aVF and 'T' wave inversion in lead II, were each observed in one participant (1.22%).

Participants ranged in age from 18 to 52 years, with a mean age of 28.73 ± 6.16 years. Thyroid function test results showed Free T3 levels between 0.15 and 0.3 pg/mL, with a mean of 0.23 ± 0.05 pg/mL; Free T4 levels ranged from 0.5 to 4.94 ng/dL, averaging 2.45 ± 1.26 ng/dL; and TSH levels varied from 5.25 to 8.43 mIU/L, with a mean of 6.98 ± 0.64 mIU/L. For lipid profiles, total cholesterol ranged from 129 to 252 mg/dL, with a mean of 186.94 ± 27.33 mg/dL; triglyceride (TGL) levels ranged from 50 to 200 mg/dL, with an average of 112.89 ± 30.64 mg/dL; LDL cholesterol levels ranged from 59 to 199 mg/dL, with a mean of 129.24 ± 30.13 mg/dL; HDL cholesterol ranged from 25 to 50 mg/dL, with a mean of 34.96 ± 5.02 mg/dL; and VLDL cholesterol levels ranged from 20 to 56 mg/dL, averaging 33.84 ± 9.11 mg/dL.

The table provides mean values and standard deviations of thyroid parameters for various ECG findings. Mean Free T3 levels were highest among participants with a flat "T" wave in lead aVF (252.000), followed by 'T' wave inversion in lead II (211.000), low voltage complexes (189.538), and the lowest among those with normal sinus rhythm (185.104). For Free T4, the highest mean level was found in participants with 'T' wave inversion in lead II (155.000), followed by a flat "T" wave in lead aVF (129.000), low voltage complexes (121.308), and the lowest among those with normal sinus rhythm (110.388). TSH levels were highest in participants with a flat "T" wave in lead aVF (199.000), followed by 'T' wave inversion in lead II (146.000), low voltage complexes (129.923), and the lowest among those with normal sinus rhythm (127.821). The p-values for Free T3, Free T4, and TSH were 0.363, 0.563, and 0.569, respectively, indicating no statistically significant association between these thyroid parameters and different ECG findings.

The data further presents average values and standard deviations for lipid parameters across ECG findings. The mean total cholesterol level was highest among participants with a flat "T" wave in lead aVF (252.000), followed by 'T' wave inversion in lead II (211.000), low voltage complexes (189.538), and the lowest among those with normal sinus rhythm (185.104). Similar trends were observed for other lipid parameters. For TGL, the highest mean was also in participants with a 'T' wave inversion in lead II (155.000), while LDL levels were highest among those with a flat "T" wave in lead aVF (199.000). HDL levels were lowest in this group (27.000), suggesting potential dyslipidemia. VLDL levels were highest in participants with normal sinus rhythm (34.552). However, p-values for total cholesterol, TGL, LDL, HDL, and VLDL were 0.074, 0.313, 0.119, 0.465, and 0.3, respectively, indicating no statistically significant association between these lipid parameters and ECG findings in the study population.

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**Discussion**

The current study examines the relationship between ECG findings, thyroid function, and lipid profiles among patients newly diagnosed with hypothyroidism. Within this population, a significant majority of participants are female (93.9%), suggesting a higher prevalence or earlier diagnosis of hypothyroidism in females. The mean values for lipid parameters were as follows: total cholesterol at 186.94 ± 27.33 mg/dL, LDL at 129.24 ± 30.13 mg/dL, and HDL at 34.96 ± 5.02 mg/dL, indicating a dyslipidaemia profile commonly associated with hypothyroidism. A 2021 study by Prabin Khatri et al.(16) showed that 6.9% of overt hypothyroid patients had high LDL, 62.1% had low HDL, and 69% had elevated triglycerides, reflecting a more adverse lipid profile. In contrast, subclinical hypothyroid patients had a relatively better lipid profile, with 61.5% having normal total cholesterol and LDL levels, and 76.5% showing normal HDL levels. Additionally, research by Satpathy et al.(17) in 2013 found that hypothyroid patients exhibited significantly higher levels of total cholesterol, triglycerides, and LDL than hyperthyroid patients, with mean differences of 50.01 mg/dL, 28.83 mg/dL, and 21.71 mg/dL, respectively (all $P < 0.01$). HDL levels, however, were significantly lower in hypothyroid patients, with a mean difference of -11.28 mg/dL ($P < 0.001$). Another 2021 study by Snehal Mishra et al.(18) found that hypothyroid patients with elevated TSH had an average total cholesterol of 225.33 ± 115.05 mg/dL, mean serum LDL of 153 ± 31.75 mg/dL, and elevated mean triglyceride levels, alongside a high LDL/HDL ratio.

ECG findings in hypothyroid patients are varied. In this study, the most common finding was normal sinus rhythm (81.71%), followed by low voltage complexes (15.85%). Flat T waves and T wave inversions were relatively rare, each present in about 1.22% of the patients. Among those with low voltage complexes, the mean total cholesterol was 189.54 ± 23.46 mg/dL, while patients with normal sinus rhythm had a mean of 185.10 ± 27.19 mg/dL. Although cholesterol levels were higher in patients with low voltage complexes, the difference was not statistically significant ($p = 0.074$). Mean triglyceride levels were also elevated in patients with low voltage complexes (121.31 ± 42.59 mg/dL) compared to those with normal sinus rhythm (110.39 ± 27.78 mg/dL), though this was not statistically significant ($p = 0.313$). LDL levels were highest in patients with a flat T wave in lead aVF (199 mg/dL) but varied among groups with no significant differences ($p = 0.119$). HDL levels were similarly consistent across different ECG findings ($p = 0.465$), as were VLDL levels ($p = 0.3$).

A 2019 study by Bhupendar Tayal et al.(19) found a significant association between hyperthyroidism and increased heart rate. The presence of hyperthyroidism was strongly correlated with increased heart rate and prolonged QTc interval, with age ($p < 0.009$) and sex ($p < 0.001$) as influencing factors. This association was less marked in older patients. Females with subclinical hyperthyroidism showed elevated heart rates, as did males, while women with hypothyroidism exhibited lower heart rates and shorter QTc intervals. Patients with both subclinical and overt hypothyroidism also showed longer P-wave duration, PR interval, and low voltage, although low voltage was less common in older patients ($p = 0.001$).

A study conducted in Pune reported that ECG findings included low voltage complexes in 25% of cases and T wave inversion in 23.5%. Additional ECG findings included bradycardia (10.3%), right bundle branch block (7.4%), and extended QRS complex duration (2.9%). Echocardiography revealed grade 1 left ventricular diastolic dysfunction in 30.8% of patients, while pericardial effusion was present in 2.94%. These findings were associated with elevated TSH levels, similar to the current study. Agarwal et al.'s 2021 study further noted that hypothyroid patients had significantly lower heart rates at initial assessment (58 ± 11 beats per minute) than after thyroxine treatment (71 ± 9 beats per minute, $p = 0.0004$).(20) In the control group, the average heart rate was 74 ± 12 beats per minute. Three patients (15%) had frequent ventricular ectopics initially, while four patients (20%) showed ectopics post-treatment, compared to two (20%) in the control group. One patient experienced ventricular tachycardia with a prolonged QT interval, which resolved with thyroxine treatment. Additionally, 50% of patients exhibited supraventricular ectopics before and after thyroxine treatment, mirroring findings in 50% of controls. Of three patients, 15% had low voltage QRS complexes, and one (10%) showed non-specific T wave changes, which normalized after thyroxine replacement.

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**Conclusion**

In conclusion, this study underscores notable findings regarding the association between ECG findings, thyroid function, and lipid profiles in newly diagnosed hypothyroid patients. The study population was predominantly female (93.9%), reflecting the higher prevalence of hypothyroidism among women. The analysis demonstrated a dyslipidaemic profile characteristic of hypothyroidism, with elevated mean levels of total cholesterol and LDL, and reduced HDL levels. However, no statistically significant associations were observed between thyroid and lipid parameters and ECG findings, such as normal sinus rhythm or low voltage complexes. The most frequent ECG finding was normal sinus rhythm (81.71%), followed by low voltage complexes, with flat T waves and T wave inversions occurring infrequently. These findings indicate that while dyslipidaemia is common in hypothyroid patients, it does not necessarily correlate with specific ECG changes.

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**Table 1:** Gender distribution and ECG findings

| | | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Gender | Female | 77 | 93.9 |
| | Male | 5 | 6.1 |
| ECG Findings | Flat “T” wave in lead avF | 1 | 1.2 |
| | Low voltage complexes | 13 | 15.8 |
| | “Normal sinus rhythm, WNL” | 67 | 81.7 |
| | 'T' wave inversion in lead II | 1 | 1.2 |

**Table 2:** Mean and standard deviation of all measurable variables

| | **Minimum** | **Maximum** | **Mean ± SD** |
|---|---|---|---|
| Age | 18 | 52 | 28.73 ± 6.16 |
| Free T3 | 0.15 | 0.3 | 0.23 ± 0.05 |
| Free T4 | 0.5 | 4.94 | 2.45 ± 1.26 |
| TSH | 5.25 | 8.43 | 6.98 ± 0.64 |
| Total cholesterol | 129 | 252 | 186.94 ± 27.33 |
| TGL | 50 | 200 | 112.89 ± 30.64 |
| LDL | 59 | 199 | 129.24 ± 30.13 |
| HDL | 25 | 50 | 34.96 ± 5.02 |
| VLDL | 20 | 56 | 33.84 ± 9.11 |

**Table 3:** Association between thyroid parameters and ECG findings

| | **ECG findings** | **Frequency** | **Mean** | **SD** | **P value** |
|---|---|---|---|---|---|
| Free T3 | Flat "T" wave in lead avF | 252.00 | | | 0.363 |
| | Low voltage complexes | 189.54 | 23.46 | 6.51 | |
| | Normal sinus rhythm, WNL | 185.10 | 27.19 | 3.32 | |
| | 'T' wave inversion in lead II | 211.00 | | | |
| Free T4 | Flat "T" wave in lead avF | 129.00 | | | 0.563 |
| | Low voltage complexes | 121.31 | 42.59 | 11.81 | |
| | “normal sinus rhythm, WNL” | 110.39 | 27.78 | 3.39 | |
| | 'T' wave inversion in lead II | 155.00 | | | |

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| | | | | | |
|---|---|---|---|---|---|
| TSH | Flat "T" wave in lead avF | 1 | 199.00 | | 0.569 |
| | Low voltage complexes | 13 | 129.92 | 27.73 | |
| | Normal sinus rhythm, WNL | 67 | 127.82 | 29.91 | |
| | “T” wave inversion in lead II | 1 | 146.00 | | |

**Table 4:** Association between lipid parameters and ECG findings

| | **ECG findings** | **Frequency** | **Mean** | **SD** | **P value** |
|---|---|---|---|---|---|
| Total Cholesterol | Flat "T" wave in lead avF | 1 | 252.00 | | 0.074 |
| | Low voltage complexes | 13 | 189.54 | 23.46 | |
| | Normal sinus rhythm, WNL | 67 | 185.10 | 27.19 | |
| | 'T' wave inversion in lead II | 1 | 211.00 | | |
| TGL | Flat "T" wave in lead avF | 1 | 129.00 | | 0.313 |
| | Low voltage complexes | 13 | 121.31 | 42.59 | |
| | Normal sinus rhythm, WNL | 67 | 110.39 | 27.78 | |
| | 'T' wave inversion in lead II | 1 | 155.00 | | |
| LDL | Flat "T" wave in lead avF | 1 | 199.00 | | 0.119 |
| | Low voltage complexes | 13 | 129.92 | 27.74 | |
| | Normal sinus rhythm, WNL | 67 | 127.82 | 29.91 | |
| | 'T' wave inversion in lead II | 1 | 146.00 | | |
| HDL | Flat "T" wave in lead avF | 1 | 27.00 | | 0.465 |
| | Low voltage complexes | 13 | 35.15 | 6.74 | |
| | Normal sinus rhythm, WNL | 67 | 35.06 | 4.65 | |
| | 'T' wave inversion in lead II | 1 | 34.00 | | |
| VLDL | Flat "T" wave in lead avF | 1 | 31.00 | | 0.3 |
| | Low voltage complexes | 13 | 31.46 | 9.96 | |
| | Normal sinus rhythm, WNL | 67 | 34.55 | 8.90 | |
| | 'T' wave inversion in lead II | 1 | 20.00 | | |