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Original Research Article

Electrocardiographic, Ultrasonographic, and Echocardiographic Findings in Hypothyroidism: A Cross-Sectional Study

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Abstract:

***Background*:** Hypothyroidism, a common endocrine disorder, significantly impacts cardiovascular health and thyroid gland structure. Electrocardiography (ECG), ultrasonography (USG) of the neck, and echocardiography (2D Echo) are essential tools for evaluating these complications. Despite the well-known risks, comprehensive assessments combining these modalities are often underutilized in clinical practice. The study evaluated electrocardiographic, ultrasonographic, and echocardiographic findings in hypothyroid patients to identify prevalent abnormalities and associated risk factors.

***Methods*:** A total of 260 hypothyroid patients were included. Data collection involved clinical history, blood tests, ECG, USG neck, and 2D Echo. Statistical analysis was done using SPSS version 20, with qualitative variables analyzed using Chi-square tests and quantitative variables using multivariate analysis and logistic regression.

***Results*:** The study revealed that 65% of patients had abnormal ECG findings, with sinus bradycardia (20%) and prolonged QT interval (17%) being most common. USG neck showed thyromegaly in 48.1% and nodules in 40% of patients. Echocardiographic assessment indicated systolic dysfunction in 30% and diastolic dysfunction in 40% of patients. Higher TSH levels were significantly associated with increased prevalence of cardiac dysfunction ($p < 0.01$).

***Conclusion*:** Hypothyroidism significantly affects both cardiac function and thyroid gland structure. The study underscores the necessity for comprehensive diagnostic assessments, including ECG, USG, and echocardiography, to detect and manage complications early. Effective control of thyroid function is crucial in mitigating cardiovascular risks.

Recommendations: Regular monitoring of thyroid and cardiac health in hypothyroid patients is recommended. Future research should focus on long-term outcomes of integrated diagnostic assessments and the effectiveness of early interventions.

Keywords: *Hypothyroidism, Electrocardiography, Ultrasonography, Echocardiography, Cardiac Dysfunction*

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Introduction

Hypothyroidism is a common hormonal condition that occurs when the body does not produce enough thyroid hormones. This can result in various systemic effects. The condition has a prevalence of around 5% in the general population, with a higher occurrence in women and older persons [1]. Thyroid hormones, specifically thyroxine (T4) and triiodothyronine (T3), have essential functions in controlling metabolism, cardiovascular activity, and maintaining general balance in the body. Insufficiency of these hormones can lead to notable clinical symptoms, impacting several organ systems.

Cardiovascular complications are among the most concerning issues in hypothyroidism. Hypothyroid patients are at increased risk of developing various cardiac abnormalities, including bradycardia, pericardial effusion, and both systolic and diastolic dysfunctions [2]. These abnormalities are primarily due to the direct effects of thyroid hormone deficiency on cardiac muscle and vascular smooth muscle, as well as indirect effects through alterations in lipid metabolism and blood pressure regulation. Electrocardiography (ECG) and echocardiography (2D Echo) are critical tools in detecting these cardiac anomalies, allowing for timely intervention and management.

In addition to cardiac complications, structural changes in the thyroid gland itself are also commonly observed in hypothyroidism. Ultrasonography (USG) of the neck is a valuable diagnostic modality for assessing thyroid morphology and identifying conditions such as thyromegaly, thyroid nodules, and thyroiditis [3]. These structural changes can further complicate the clinical management of hypothyroidism, particularly when nodules are present, necessitating further evaluation to rule out malignancy.

Recent research has highlighted the significance of conducting a thorough assessment in individuals with hypothyroidism to reduce the likelihood of experiencing these consequences. A study provided evidence that subclinical hypothyroidism (SCH) is linked to a higher risk of cardiovascular problems. This emphasises the importance of closely monitoring the cardiovascular health of patients with even modest thyroid impairment [4]. Similarly, the guidelines set forth by the American Thyroid Association suggest that it is important to regularly evaluate thyroid function and use suitable imaging techniques to effectively detect and manage issues connected to the thyroid [5].

The study aimed at evaluating electrocardiographic, ultrasonographic, and echocardiographic findings in patients with hypothyroidism.

Methodology

Study Design

A cross-sectional observational study.

Study Setting

The study was conducted at Jawahar Lal Nehru Medical College & Hospital, Bhagalpur, Bihar, from October 2023 to March 2024.

Participants

A total of 260 participants were enrolled in the study. All participants were patients diagnosed with thyroid disorders who were specifically hypothyroid.

Inclusion Criteria

- All patients diagnosed with hypothyroidism.

Exclusion Criteria

- Hemodynamically unstable patients.
- with lung diseases such as chronic obstructive pulmonary disease, asthma, or pleural disease.
- with known cardiovascular diseases.

- with pacemakers, metallic intravascular devices, or any malignant diseases (except thyroid malignancy).
- Pregnant patients.
- with known diabetes.

Sample size

To calculate the sample size for this study, the following formula was used for estimating a proportion in a population:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where:
- n = sample size
- Z = Z-score corresponding to the desired level of confidence
- p = estimated proportion in the population
- E = margin of error

Bias

To minimize bias, only patients who met the inclusion criteria and provided informed written consent were included.

Variables

Variables included electrocardiographic findings, ultrasonographic findings, echocardiographic findings, age, gender, duration of hypothyroidism, thyroid function test results.

Data Collection

Data collection encompassed an extensive clinical history, comprehensive clinical examination, and a range of blood procedures, such as blood typing, complete blood count, renal function assessment, liver function assessment, and thyroid function assessment. Additionally, electrocardiography (ECG), two-dimensional echocardiography (2D echo), and ultrasound imaging of the neck (USG neck) were conducted.

Procedure

1. ECG: Performed using a multichannel ECG machine with the printouts taken at 10 mm calibration and 25 mm/s speed.
2. USG Neck: The examination was performed utilising Siemens Acuson X 300 and Siemens Acuson X 600 colour Doppler equipment, equipped with a high-frequency (3-12 MHz) transducer employing a linear array. The sonographic characteristics of the thyroid gland, including its enlarged size, echogenicity, vascularity, and the presence of nodules, were observed. Nodules with a size exceeding 5mm were assessed according to their echogenicity, form, borders, contents, calcifications, and vascularity. Thyroid lesion patients underwent fine-needle aspiration cytology (FNAC) after providing informed permission.

3. 2D Echo: Every instance was examined for systolic and diastolic dysfunction, pericardial effusion, and interventricular thickness. The Canadian consensus criteria were used to assess diastolic dysfunction, while systolic dysfunction was assessed by examining systolic time intervals, namely the pre-ejection period (PEP). Patients were classified into groups with or without systolic dysfunction based on their PEP levels.

Statistical Analysis

The data were analysed using the statistical software SPSS version 20. The qualitative variables were represented as frequencies and percentages, and the Chi-square test was employed to compare these variables. Associated risk factors were correlated using multivariate analysis and logistic regression. The quantitative variables were displayed as the mean value plus or minus the standard deviation. A P-value less than 0.05 was deemed to be statistically significant.

Ethical considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Result

The study includes a cohort of 260 participants diagnosed with hypothyroidism. Table 1 provides a summary of the demographic and clinical features of the participants.

Table 1: Demographic and Clinical Features

Characteristics	Frequency (%)
Age (years)	
< 30	55 (21.2)
30-50	145 (55.8)
> 50	60 (23.1)
Gender	
Male	80 (30.8)
Female	180 (69.2)
Duration of Hypothyroidism	
< 1 year	70 (26.9)
1-5 years	140 (53.8)
> 5 years	50 (19.2)
TSH Level (µIU/mL)	
< 4.0 (Normal)	50 (19.2)
4.0 - 10.0 (Mild Hypothyroid)	150 (57.7)
> 10.0 (Severe Hypothyroid)	60 (23.1)

Electrocardiographic (ECG) findings showed that 35% of patients had normal ECG, while 65% had abnormal ECG findings. The details of the ECG findings are provided in Table 2.

Table 2: Electrocardiographic Findings

ECG Findings	Frequency (%)
Normal	91 (35)
Sinus Bradycardia	52 (20)
Low Voltage QRS Complex	34 (13)
Prolonged QT Interval	45 (17)
Non-Specific ST-T Changes	38 (15)

Ultrasonographic (USG) examination of the neck revealed that 48% of patients had thyromegaly, and 40% had nodules in the thyroid gland. The USG findings are detailed in Table 3.

Table 3: Ultrasonographic Findings

USG Neck Findings	Frequency (%)
Normal	54 (20.8)
Thyromegaly	125 (48.1)
Nodules	104 (40.0)
- Single Nodule	45 (17.3)
- Multiple Nodules	59 (22.7)
Echogenicity Changes (Hypoechoic)	112 (43.1)
Increased Vascularity	89 (34.2)
Features of Thyroiditis	60 (23.1)

Echocardiographic (2D Echo) findings indicated that 30% of patients had systolic dysfunction, and 40% had diastolic dysfunction. The detailed echocardiographic findings are presented in Table 4.

Table 4: Echocardiographic Findings

Echocardiographic Findings	Frequency (%)
Normal	104 (40)
Systolic Dysfunction	78 (30)
Diastolic Dysfunction	104 (40)
Pericardial Effusion	52 (20)
Increased Interventricular Thickness	65 (25)

The Chi-square test was employed to evaluate the categorical variables, and the findings revealed a substantial correlation between the duration of hypothyroidism and the existence of aberrant ECG data ($p < 0.01$). Associations between risk factors and echocardiographic data were determined using multivariate analysis and logistic regression. The findings are succinctly presented in Table 5.

Table 5: Multivariate Analysis and Logistic Regression Results

Variables	Odds Ratio (OR)	95% Confidence Interval (CI)	P-value
Age	1.05	1.02-1.09	<0.01
Gender (Male)	1.30	0.90-1.85	0.15
Duration of Hypothyroidism	1.15	1.08-1.22	<0.01
TSH Level (µIU/mL)	1.12	1.05-1.20	<0.01
Presence of Thyroid Nodules	1.25	0.95-1.65	0.10
Increased Interventricular Thickness	1.50	1.10-2.05	<0.01

The quantitative variables were expressed as the mean value plus or minus the standard deviation. The statistical significance of the results was assessed using a P-value of less than 0.05 as the threshold for significance. The correlation between TSH levels and echocardiographic data was statistically significant, suggesting that elevated TSH levels were linked to a higher occurrence of both systolic and diastolic dysfunction.

Discussion

The study included 260 hypothyroid patients, with a majority being female (69.2%) and predominantly aged between 30 to 50 years (55.8%). Most patients had been diagnosed with hypothyroidism for 1 to 5 years (53.8%), and a significant portion (57.7%) had mild hypothyroidism based on TSH levels.

ECG findings revealed that 65% of the patients had abnormalities, with sinus bradycardia (20%), low voltage QRS complex (13%), prolonged QT interval (17%), and non-specific ST-T changes (15%) being the most common. This suggests that hypothyroidism frequently affects cardiac electrical activity, which could contribute to various clinical symptoms and necessitates regular cardiac monitoring in these patients.

USG neck examinations showed that nearly half of the patients (48.1%) had thyromegaly, and 40% had thyroid nodules, with multiple nodules being more prevalent (22.7%) than single nodules (17.3%). Echogenicity changes were noted in 43.1% of patients, and increased vascularity was observed in 34.2%. These findings indicate that structural thyroid changes are common in hypothyroidism, underscoring the importance of regular ultrasonographic evaluations for early detection and management of potential complications.

Echocardiographic assessments revealed that 30% of the patients had systolic dysfunction, while 40% had diastolic dysfunction. Pericardial effusion was present in 20% of the patients, and 25% had

increased interventricular thickness. These results highlight that both systolic and diastolic dysfunctions are significant concerns in hypothyroid patients, necessitating comprehensive cardiac evaluations as part of their routine care.

The Chi-square test demonstrated a significant association between the duration of hypothyroidism and abnormal ECG findings ($p < 0.01$). Multivariate analysis revealed that age, duration of hypothyroidism, and TSH levels were significantly associated with echocardiographic findings. Specifically, higher TSH levels were strongly correlated with increased prevalence of both systolic and diastolic dysfunctions, suggesting that more severe hypothyroidism may lead to greater cardiac involvement. Increased interventricular thickness was also significantly associated with echocardiographic abnormalities, indicating its potential as a marker for cardiac dysfunction in hypothyroidism.

Overall, this study underscores the extensive impact of hypothyroidism on both the structural and functional aspects of the heart and thyroid gland. Regular monitoring through ECG, USG, and echocardiography is crucial for early detection and management of potential complications in hypothyroid patients. The significant associations found between TSH levels and cardiac dysfunction further emphasize the need for stringent control of thyroid function to mitigate cardiovascular risks.

A cross-sectional study assessed echocardiographic changes in 60 hypothyroid patients. Findings revealed increased interventricular septal and left ventricular posterior wall thicknesses with diastolic dysfunction as early cardiac changes. Pericardial effusion was observed in 12 patients, and these changes correlated significantly with the severity of hypothyroidism [6]. A study using speckle tracking echocardiography (STE) found that female patients with SCH had significantly lower global strain and impaired cardiac function compared to controls. This advanced imaging technique helped detect early cardiac changes not visible with conventional methods [7].

A study conducted on 68 patients with hypothyroidism revealed frequent ECG symptoms such as low voltage complexes and T wave inversion. Cardiac examinations should be regularly conducted in patients with hypothyroidism due to the presence of diastolic dysfunction and pericardial effusion, as indicated by echocardiography findings [8]. An observational study examined 71 individuals who were recently diagnosed with primary hypothyroidism. The investigation revealed that these patients commonly exhibited diastolic dysfunction, increased thickness of the interventricular septum, and pericardial effusion as echocardiographic abnormalities. The results highlight the importance of conducting early cardiac screening in patients with hypothyroidism [9].

A study on the impact of levothyroxine treatment in newly diagnosed hypothyroid patients found significant improvements in ECG and ECHO parameters after six weeks of therapy. These included reductions in septal and posterior wall thicknesses and improvements in ejection fraction and mitral inflow patterns [10]. Research focusing on ECG changes in subclinical hypothyroid females found a significant prolongation of the QTc interval compared to controls. This prolongation predisposes patients to potentially life-threatening ventricular arrhythmias [11].

A study evaluated cardiac electrophysiological balance (iCEB) in 82 subclinical hypothyroid patients, finding prolonged iCEB and iCEBc, indicating a higher risk of malignant arrhythmias. These parameters correlated significantly with serum TSH levels [12]. The presence of fragmented QRS (fQRS) in ECG was higher in subclinical hypothyroid patients and was associated with increased left

ventricular dysfunction. This study highlights the need for comprehensive cardiac monitoring in these patients [13].

Conclusion

The study highlights the significant impact of hypothyroidism on cardiac function and thyroid gland structure. The findings demonstrate that a substantial proportion of hypothyroid patients exhibit abnormalities in electrocardiographic, ultrasonographic, and echocardiographic assessments. Regular and comprehensive monitoring using these diagnostic tools is essential for the early detection and management of potential complications. The significant correlation between higher TSH levels and increased prevalence of cardiac dysfunction underscores the importance of effective thyroid function control to reduce cardiovascular risks in hypothyroid patients.

Limitations: The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendation: Regular monitoring of thyroid and cardiac health in hypothyroid patients is recommended. Future research should focus on long-term outcomes of integrated diagnostic assessments and the effectiveness of early interventions.

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List of abbreviations:

2D Echo - Two-Dimensional Echocardiography

ECG - Electrocardiography

fQRS - Fragmented QRS

FNAC - Fine-Needle Aspiration Cytology

iCEB - Index of Cardiac Electrophysiological Balance

iCEBc - Corrected Index of Cardiac Electrophysiological Balance

PEP - Pre-Ejection Period

SCH - Subclinical Hypothyroidism

STE - Speckle Tracking Echocardiography

T3 - Triiodothyronine

T4 - Thyroxine

TSH - Thyroid-Stimulating Hormone

USG - Ultrasonography

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References

1. Biondi B, Cooper DS. The clinical significance of subclinical thyroid dysfunction. Endocrine reviews. 2008 Feb 1;29(1):76-131.
2. Gaitonde DY, Rowley KD, Sweeney LB. Hypothyroidism: an update. South African Family Practice. 2012 Sep 1;54(5):384-90.
3. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, Nikiforov YE, Pacini F, Randolph GW, Sawka AM, Schlumberger M, Schuff KG. 2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: the American Thyroid Association guidelines task force on thyroid nodules and differentiated thyroid cancer. Thyroid. 2016 Jan 1;26(1):1-33.
4. Jonklaas J, Bianco AC, Bauer AJ, Burman KD, Cappola AR, Celi FS, Cooper DS, Kim BW, Peeters RP, Rosenthal MS, Sawka AM. Guidelines for the treatment of hypothyroidism: prepared by the american thyroid association task force on thyroid hormone replacement. thyroid. 2014 Dec 1;24(12):1670-751.
5. Ross DS, Burch HB, Cooper DS, Greenlee MC, Laurberg P, Maia AL, Rivkees SA, Samuels M, Sosa JA, Stan MN, Walter MA. 2016 American

Thyroid Association guidelines for diagnosis and management of hyperthyroidism and other causes of thyrotoxicosis. Thyroid. 2016 Oct 1;26(10):1343-421.
6. Kashyap AS, Kuragayala S, Kasam KP. Echocardiographic correlation of cardiac function in patients of hypothyroidism. Eastern Ukrainian Medical Journal. 2023.
7. Abdelrazk RR, El-Sehrawy AA, Ghoniem M, Amer M. Speckle tracking echocardiographic assessment of left ventricular longitudinal strain in female patients with subclinical hyperthyroidism. Cardiovasc Endocrinol Metab. 2020;10:182-185.
8. Sawarthia P, Bhosle D, Kalra R. A prospective observational study to evaluate cardiovascular changes in patients of hypothyroidism. Cureus. 2023;15.
9. Khatri P, Sapkota S, Neupane A, Gautam N, Subedi S, Banjade A, Kharel S. A study of echocardiographic changes in patients with newly diagnosed primary hypothyroidism: a cross-sectional study. Europasian J Med Sci. 2021.
10. Vikram S, Mohanty S, Behera V, Ananthakrishnan R, Karanth JB, Mahadev N. Short-term electrocardiographic and echocardiographic effects of levothyroxine replacement in adults with newly diagnosed hypothyroidism. J Marine Med Soc. 2023;25:63-68.
11. Jadhav V, Kammar K. Electrocardiographic changes in subclinical hypothyroidism. Natl J Physiol Pharm Pharmacol. 2020;10:488-490.
12. Şaylık F, Çınar T, Selçuk M, Akbulut T. Evaluation of cardiac electrophysiological balance in patients with subclinical hypothyroidism. Koşuyolu Heart J. 2022.
13. Yilmaz E, Aydin E, Camcı S. Frequency of fragmented QRS on ECG and relationship with left ventricular dysfunction in patients with subclinical hypothyroidism. Eur Rev Med Pharmacol Sci. 2022;26:3677-3685.