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CORRELATION OF SERUM TSH VALUES WITH ELECTROCARDIOGRAPHIC CHANGES AMONG HYPOTHYROID PATIENTS

Internal Medicine

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ABSTRACT

Introduction: Hypothyroidism is one of the most frequently encountered endocrine disorders in clinical practice; and its manifestations are highly variable. As thyroid hormones play an important role in normal functioning of virtually all tissues in the body, especially the cardiovascular system; its deficiency can lead on to cardiac dysfunction causing electrocardiogram (ECG) changes. **Aims:** To study the pattern of ECG changes in hypothyroidism and to correlate with serum TSH values. **Materials and methods:** This cross-sectional observational study was done among 60 hypothyroid subjects at a tertiary care centre in Southern India. Thyroid Function Tests (TFT) and ECG were obtained and analysed using SPSS software v20. **Results:** Among 60 hypothyroid subjects, 54 (90%) were females and 6 (10%) were males. Twenty-eight subjects (46.66 %) had ECG changes with sinus bradycardia as the most common finding. Statistically significant correlation was noted with pattern of ECG changes and serum TSH values; except for QTc prolongation. **Conclusions:** ECG changes were common among hypothyroid patients as compared to patients who were currently euthyroid. Early identification and treatment of hypothyroidism could prevent or revert the ECG changes; thus, reducing associated cardiovascular morbidity and mortality.

KEYWORDS

Hypothyroidism, electrocardiogram, thyroid function tests, sinus bradycardia, low voltage QRS complex, ST-segment depression, T wave inversion, ECG

INTRODUCTION:

Thyroid hormones play a pivotal role in various metabolic and systemic functions of the body. The deficiency of these hormones can lead to hypothyroidism producing multiple systemic manifestations. Indian studies have shown a prevalence of 10.95% hypothyroidism in the general population.[1]

Thyroid hormones play a major role in the normal development, differentiation and physiological function of virtually all tissues in the body; especially the cardiovascular system.[2] Various mechanisms have been postulated for cardiac dysfunction in hypothyroidism. It can be a direct effect of thyroid hormone on the heart or an indirect effect through alterations in the autonomic outflow.[3] Characteristic cardiovascular findings include bradycardia, decreased cardiac contractility, narrow pulse pressure and diastolic hypertension.[4] ECG is an easily available and affordable tool to monitor cardiac function in hypothyroid patients. Common electrocardiographic changes in hypothyroidism are bradycardia, low voltage QRS complexes, prolonged QT interval, ST-segment depression, inverted or flat T waves and conduction blocks.[5]

Cardiovascular autonomic dysfunction can lead to malignant ventricular arrhythmias and sudden cardiac death in hypothyroidism.[6][7] Complete reversal of these complications is documented with standard/optimal thyroxine replacement therapy.[8][9] Hence, early detection and initiation of hormone replacement therapy can reduce associated cardiovascular outcomes. This study attempts to identify the pattern of changes in ECG among patients with hypothyroidism and to relate it with serum TSH levels.

Subjects and Methods:

Methodology:

This cross-sectional observational study was done among hypothyroid patients attending the in-patient or out-patient services of a tertiary care centre in Southern India. After obtaining Institutional Ethics Committee approval, the study was done over one year from June 2019. Sample size was calculated as 60 with 95% power using the following formula, $n = 2(z\alpha+z\beta/c)2 +3$ *where* $z\alpha$ =relative deviate (at 95% confidence interval) i.e. 1.96; $Z\beta$ =1.6449 at 95% power; C = 0.5 ln (1+r/1-r) and; r = -0.454 (based on Mahajan et al [10]). Those 60 subjects fulfilling the selection criteria were included in the study, after taking a written informed consent. The details including the clinical history, treatment, TFT, and ECG findings were recorded on a pre-formatted datasheet.

Selection criteria:

The Inclusion criteria for the patients were: (1) age above 18 years; and (2) hypothyroidism on adequate or inadequate treatment. The Exclusion criteria were patients having: (1) history of diabetes mellitus, chronic airway disease, ischemic heart disease, or arrhythmias; (2) acute febrile illness; (3) subclinical hypothyroidism; and (4) admission in intensive care units.

Based on serum TSH value, subjects were divided into following 4 groups: (1) serum TSH values < 4.2 uIU/ml; (2) serum TSH values 4.2-10 uIU/ml; (3) serum TSH values 10-20 uIU/ml; and (4) serum TSH values > 20 uIU/ml.

TFT was estimated by modified Electro-chemi-luminescence Immuno-assay using COBAS 6000 analyzer and 12-lead ECG was recorded using BPL CARDIART 6108T ECG machine.

Statistical Analysis:

Statistical analysis was performed using SPSS software v20. Results were reported as mean ± standard deviation (SD) for quantitative variables and percentages for categorical variables. Appropriate statistical tests were used to evaluate the significance of differences among various groups. p-value of less than 0.05 was considered significant.

RESULTS:

The study included 60 hypothyroid patients on replacement therapy. At the time of inclusion, 29 (48%) patients had normal serum TSH levels (euthyroid state) and 31 (52%) patients had high serum TSH levels (hypothyroidism). The mean age of the study population was 40.38±11.78 years, with most belonging to the age-group of 31 to 40 years (n=17 subjects). Among the total subjects, 54 (90%) were females and 6 (10%) were males at a ratio of 1:9.

Thirty-two patients (53.33%) in the study population had normal sinus rhythm in ECG. Twenty-eight patients (46.66 %) had ECG changes; among whom 8 patients had at least 2 abnormal patterns; 4 patients had 3 abnormal patterns and one patient (with serum TSH of 41.37 uIU/ml) had 4 abnormal patterns. The most common abnormality noted was sinus bradycardia (n=15); followed by low voltage QRS complex and T wave inversions (n=9); QTc prolongation and ST-segment depression (n=7). Table-I depicts patterns of ECG changes in the study population.

Table-I: ECG changes observed in the study population.

ECG changes	Number of subjects (n)
Sinus bradycardia	15
Low voltage QRS complex	9
QTc prolongation	7
ST segment depression	7
T wave inversion	9

Further, the study population was subdivided into 4 subgroups based on serum TSH values. Among 15 subjects with sinus bradycardia, most

of them had serum TSH above 10 uIU/ml (12 subjects) and the results were highly significant with a 'p' value of <0.001. Abnormal ECG patterns such as low voltage QRS complexes, ST-segment depressions, and T wave inversions were more common in subjects with elevated TSH. However, there was no significant correlation between QTc prolongation and serum TSH values. Table-II depicts the distribution of patterns of ECG changes among subgroups based on serum TSH values.

Table-II: Pattern of ECG changes in subgroups based on serum TSH values.

ECG CHANGES		SERUM TSH LEVEL (uIU/ml)				p VALUE (Significance)
		<4.2	4.2-10	10.1-20	>20	
		Count (%)	Count (%)	Count (%)	Count (%)	
RHYTHM	Normal	28(96.6%)	13(86.7%)	4(40%)	0(0%)	<0.001 (Highly Significant)
	Sinus Bradycardia	1(3.4%)	2(13.3%)	6(60%)	6(100%)	
QRS COMPLEX VOLTAGE	Normal	26(89.7%)	15(100%)	7(70%)	3(50%)	0.014 (Significant)
	Low Voltage	3(10.3%)	0(0%)	3(30%)	3(50%)	
QTc INTERVAL	Normal	27(93.1%)	13(86.7%)	8(80%)	5(83.3%)	0.682 (Not Significant)
	Prolonged	2(6.9%)	2(13.3%)	2(20%)	1(16.7%)	
ST SEGMENT	Normal	28(96.6%)	14(93.3%)	7(70%)	4(66.7%)	0.041 (Significant)
	Depression	1(3.4%)	1(6.7%)	3(30%)	2(33.3%)	
T WAVES	Normal	27(93.1%)	13(86.7%)	9(90%)	2(33.3%)	0.003 (Significant)
	Inversion	2(6.9%)	2(13.3%)	1(10%)	4(66.7%)	

DISCUSSION:

Thyroid hormones are necessary for the normal cellular functioning of the cardiovascular system.[11] Even a minimal reduction in circulating thyroid hormones can produce manifestations which could adversely affect cardiovascular morbidity and mortality.[3] In the heart, it causes slow conduction of electrical impulses leading to a decrease in heart rate and contractility. Common electrocardiographic changes in hypothyroidism are sinus bradycardia, low voltage QRS complexes, prolongation of QT interval, ST-segment depression and inverted or flat T waves.[5] The other uncommon ECG changes in hypothyroidism include atrio-ventricular block, ventricular premature complexes and ventricular tachyarrhythmias with prolonged QT interval.[5] Twenty-eight patients (46.66 %) in the present study had ECG changes. Shrivastava et al noted 66.66% of the 90 subjects to have shown ECG changes.[12]

Sinus bradycardia was the most common ECG finding in this study which were similar in studies by Shrivastava et al, Ramesh et al, and Saxena et al. [12][13][14] In this present study, 75% (n=12) subjects with serum TSH values more than 10 uIU/ml had sinus bradycardia (table-II). This was statistically significant with a p-value of less than 0.001. The bradycardia seen in hypothyroidism is attributed to prolonged cardiac action potential occurring due to slow depolarization.[11]

Low voltage QRS complexes were seen in 9 subjects (15%) in the study; 6 of them had serum TSH values more than 10 uIU/ml and were statistically significant (p=0.014). Studies by Ramesh et al (30%) and Ohal et al (26%) showed a slightly higher percentage of low voltage QRS complexes in hypothyroid subjects.[13][15] Pericardial effusion, cardiac atrophy and altered myocyte ion conduction associated with hypothyroidism are the possible causes for low voltage QRS complexes.[16]

Seven subjects (11.67%) included in the study had QTc prolongation. There was no statistically significant correlation between serum TSH levels and QTc prolongation. Studies done by Shrivastava et al (2.2%) and Goyal et al (3.8%) showed a lesser incidence of QTc prolongation.[12][17] It can be due to prolonged cardiac action potential and delayed iso-volumetric relaxation phase in hypothyroidism.[18]

In this study, T wave inversions and ST-segment depressions were considered separately. There was a statistically significant correlation between serum TSH and T wave inversions (p=0.003) and ST depressions (p=0.041). Study done by Goyal et al (26.9%) showed ST-T changes as the most common ECG change in hypothyroidism followed by bradycardia.[17] T wave inversion is attributed to myxedematous infiltration of the myocardium in hypothyroid individuals.[19] ST-segment depression can be due to accelerated atherosclerosis and coronary artery disease which may be secondary to hypercholesterolemia and diastolic hypertension seen in hypothyroidism.[20]

Abnormal ECG patterns were more common in subjects with elevated serum TSH values in this study; which in turn can lead to cardiac complications. Early initiation of thyroxine replacement therapy has shown complete reversal of these complications.[8][9]

CONCLUSION:

Hypothyroidism has been associated with significant cardiovascular morbidity and mortality. Early detection of ECG changes in hypothyroidism and initiation of thyroxine replacement therapy could reduce associated cardiac complications.

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