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RESEARCH ARTICLE

Electrocardiographic changes in hypothyroidism – A cross-sectional study

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ABSTRACT

Background: Thyroid problems are on the rise among Indians. Over 4.2 crores people in India are estimated to suffer from such disorders making it increasingly important for people to pay attention to this often overlooked health problem. **Aims and Objectives:** The present study was undertaken to compare electrocardiogram (ECG) profile in newly diagnosed hypothyroid subjects and hypothyroid subjects who were already receiving treatment for >5 years and to find out if there was any improvement in these parameters with thyroxine supplementation therapy. **Materials and Methods:** A cross-sectional case–control study was carried out among 90 adults (males and females) of the age group of >30 years. The participants divided into three equal groups of 30 subjects (28 females and 2 males) each belonging to the same socioeconomic status. Individual with diabetes, hypertension, cardiovascular, pulmonary, renal or liver diseases, pregnancy, and other endocrine disorders was excluded from the study. Statistically significant variation in three groups determined by one-way ANOVA test and multiple comparisons between Group I versus Group II, Group I versus Group III, and Group II versus Group III done by Tukey test. **Results:** Significantly decreased heart rate was seen in Group II as compared with Group I. No significant difference was found in Group I and Group III. In Group III, heart rate was high as compared with Group II. Significant prolongation of P-R interval was found in Group II as compared to Group I. No statistically significant difference was found in Group I and Group III. Mean value of PR interval was decreased in Group III as compared to Group II. Low-voltage QRS complex was seen in 8 of 30 patients and T-wave inversion in 5 of 30 patients, whereas these changes were absent in Groups I and III. ECG changes were all normal in Group III as this group was already on thyroid replacement therapy. Studies done by Tajiri *et al*., Sureshbabu *et al*., and Tudoran *et al*. documented similar findings. **Conclusions:** Substitution therapy with levothyroxine significantly improves ECG changes in hypothyroidism.

KEY WORDS: Heart Rate; PR interval; QRS Voltage and T-Wave Inversion

INTRODUCTION

Thyroid problems are on the rise among Indians. Over 4.2 crores people in India are estimated to suffer from such disorders making it increasingly important for people to pay attention to this often overlooked health problem.[1] Gender-wise hypothyroidism is the most prevalent disorder affecting one in every eight women, women being 5–8 times more susceptible to the disease.

Hypothyroidism is common worldwide, especially in iodine-deficient areas like India, characterized by a cluster of clinical manifestations resulting from thyroid hormone deficiency or more rarely from their impaired activity at tissue level.[2]

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Hypothyroidism causes symptoms that reduce the functional status and quality of life.[3] Cardiovascular effects of the thyroid hormones are quite dramatic and the cardiac abnormalities associated with thyroid dysfunction have attracted a great deal of investigative effort.[4]

Electrocardiographic changes such as bradycardia, low-voltage complexes, and varying degrees of heart block are commonly recognized in hypothyroid patients.[5] Studies done by authors in various parts of the world have documented CVS manifestations of hypothyroidism such as decreased total volume, contractility, heart rate (all leading to decreased cardiac output), increased systemic vascular resistance (leading to increased diastolic blood pressure), and increased capillary permeability (leading to pericardial effusion).

These changes can be easily detected by simple investigative technique like electrocardiogram (ECG) and complications developing at later stages of hypothyroidism can be prevented, thus reducing deaths from cardiac mortality and morbidity in these patients.

Hence, the present study was undertaken to compare ECG profile, i.e. heart rate (beats/min), P-R interval (sec), voltage of QRS complex (mv), and S-T segment changes (T-wave inversion) (mv) in newly diagnosed hypothyroid subjects and hypothyroid subjects who were already receiving treatment for >5 years and to find out if there was any improvement in these parameters with thyroxine supplementation therapy.

Aims and Objectives

The objectives of this study were as follows:

1. To study ECG profile, i.e., heart rate (beats/min), P-R interval (sec), voltage of QRS complex (mv), and S-T segment changes (T-wave inversion) (mv) in newly diagnosed hypothyroid patients, hypothyroid patients taking treatment for >5 years and control group.
2. To compare the effect of levothyroxine therapy on ECG profile in newly diagnosed hypothyroid patients, patients who were already getting treatment for >5 years with that of euthyroid control group.

MATERIALS AND METHODS

The present study was carried out in the Department of Physiology in collaboration with medicine department of Indira Gandhi Government Medical College and Mayo Hospital, Nagpur, during the period from February 2013 to October 2014.

The study protocol was approved by the Institutional Ethics Committee and informed written consent was obtained from all the study subjects enrolled in the study.

Methodology

The present study is a cross-sectional case–control study.

Definition and Selection of Study Subjects

Sample size of 90 adults (males and females) having age >30 years was divided into three equal groups of 30 subjects each.

- Group I: Euthyroid subjects (control group)
- Group II: Newly diagnosed and untreated hypothyroid patients
- Group III: Hypothyroid patients taking synthetic thyroid hormone for >5 years.

Group I: This group of 30 subjects (28 females and 2 males) was selected randomly from healthy volunteers from general population. These subjects were not having any known or diagnosed illness and their thyroid profiles were within normal range.

Group II: This group included 30 (28 females and 2 males) patients recently diagnosed as having hypothyroidism (either raised thyroid-stimulating hormone [TSH] above normal with total T4 and T3 within normal range or raised TSH with below normal total T4 and T3) and was not started with hormone replacement therapy.

Group III: This group included 30 (28 females and 2 males) hypothyroid patients who were already taking synthetic thyroid hormone replacement therapy for >5 years.

All the study subjects were selected from the outpatient department of Indira Gandhi Government Medical College and Mayo Hospital, Nagpur, which were having same socioeconomic status. Study subjects suffering from diabetes, hypertension, pregnancy, endocrine abnormalities other than hypothyroidism and chronic disorders of cardiovascular, pulmonary, renal and hepatic system were strictly excluded from the study groups.

Procedure

Before starting the study work, all participants were given detailed information about the study and every effort was taken to solve their queries. This was an attempt to establish a good rapport with the participants and relieve their anxiety.

After taking detailed history with set of screening questions referring to the principal sign and symptoms of thyroid disease through general and systemic examination was done and recorded in case report form.

ECG[6]

ECG was recorded in standard limb leads, augmented leads, and chest leads by VESTA 101 RMS machine. ECG was recorded in all the patients, in all the 12 standard leads, at a paper speed of 25 mm/s. At normal standardization, QRS

Table 1A: Comparison of ECG in three groups

Parameters	Group I, *n*=30, Mean±SD	Group II, *n*=30, Mean±SD	Group III, *n*=30, Mean±SD	F-value	*P*-value
Heart rate (beats/min)	85.40±5.94	54.90±4.50	83.23±3.72	375.09	0.0006***
PR interval (sec)	0.12±0.00	0.13±0.01	0.12±0.008	9.72	0.0001***

***P<0.001 very highly significant. Group I: Controls (Euthyroid), Group II: Newly diagnosed untreated hypothyroid patients, Group III: Hypothyroid patients taking treatment for>5 years, ECG: Electrocardiogram

Table 1B: Multiple comparison: Tukey test

Parameters	Group		Mean difference	Std. Error	*P*-value	95% confidence interval
Heart rate (beats/min)	Group I	Group II	30.50	1.24	0.000***	27.53–33.46
		Group III	2.16	1.24	0.195	−0.79–5.12
	Group II	Group III	−28.33	1.24	0.000***	−31.29–25.37
PR interval (sec)	Group I	Group II	−0.012	0.002	0.000 ***	−0.019–−0.005
		Group III	−0.004	0.002	0.303	−0.011–0.002
	Group II	Group III	0.008	0.002	0.015 *	0.0014–0.015

***P<0.001 very highly significant. Group I: Controls (Euthyroid), Group II: Newly diagnosed untreated hypothyroid patients, Group III: Hypothyroid patients taking treatment for >5 years

Table 2: Percentage of occurrence QRS complex and ST-T changes in three groups

ECG parameters	Group I, *n*=30 (%)	Group II, *n*=30 (%)	Group III, *n*=30 (%)
Low-voltage QRS complex (mv)	0 (0)	8 (26.67)	0 (0)
ST-T changes (T-wave inversion) (mv)	0 (0)	5 (16.67)	0 (0)

Group I: Controls (Euthyroid), Group II: Newly diagnosed untreated hypothyroid patients, Group III: Hypothyroid patients taking treatment for>5 years

complexes of <5 mm in limb leads and <10 mm in chest leads were taken as low-voltage complexes.

Statistical Methods

Statistically significant variation in three groups determined by one-way ANOVA test and multiple comparisons between Group I versus Group II, Group I versus Group III, and Group II versus Group III done by Tukey test.

The software used in the analysis was SPSS 17.0 and GraphPad Prism 5.0 version. Significant level was set at $P > 0.05$ as no significant, $P < 0.05$ as significant, $P < 0.01$ as highly significant, and $P < 0.001$ as very highly significant.

RESULTS

Using one-way ANOVA, statistically significant variation was found in heart rate, PR interval in between three groups and the result of multiple comparisons done by Tukey test.

The mean value of heart rate was found significantly low in Group II as compared to Group I. There was no statistically significant difference of heart rate found in Group I as compared to Group III. It was observed from results that in Group III, heart rate was significantly increased in comparison with Group-II [Table 1A].

The mean value PR interval in Group II was significantly high as compared with Group I. No statistically significant difference in P-R interval was found in Group I as compared to Group III. In Group III, PR interval was found to be decreased significantly as compared with Group II [Table 1B].

The voltage of QRS complex and T wave found to be normal in Group I and Group III. Low-voltage QRS complexes were present in 8 of 30 patients (26.67%) in Group II and T-wave inversion was found in 5 of 30 patients (16.7%) in Group II [Table 2].

DISCUSSION

Significantly decreased heart rate was seen in Group II as compared with Group I. No significant difference in mean value of heart rate was found in Group I and Group III. In Group III, heart rate was high compared with Group II. Mean value of P-R interval in Group II showed significant prolongation as compared to Group I. No statistically significant difference in mean value P-R interval was found in Group I and Group III. Mean value of PR interval was found decreased in Group III as compared to Group II. Low-voltage QRS complex was present in 8 (26.66%) cases and T-wave inversion in 5 (16.66%) cases of hypothyroidism. No low-voltage QRS complexes and T-wave inversion were found in Groups I and III.

Sinus bradycardia was observed in 31% of patients of hypothyroidism as compared with euthyroid subjects in the study done by Roos *et al*.[7] Similarly, Satpathy *et al*.[8] reported sinus bradycardia as the second most common ECG abnormality following ST segment changes in hypothyroid patients.

Kweon *et al*.[9] found that after the L-thyroxine treatment, there were no significant changes in the PR interval. Findings similar to our study were observed in the study done by Sisodiya *et al*.[10] in which ST-T wave changes were observed in 77.61% and low-voltage complexes in 37.31% of cases of hypothyroidism. Flatting or inversion of T waves in 8% of cases and low-voltage of P, QRS, and T waves in 10% of cases of hypothyroidism by Roos *et al*.[7] Horizontal ST-segment depression from the J-point with T-wave inversion was the most common ECG finding in 34% of cases in the study done by Satpathy *et al*.[8] ST-T changes in the form of flat or inverted T wave were the most common abnormality in ECG in 14% of cases followed by sinus bradycardia in 4% of cases in the study done by Garg *et al*.[11]

In contrast to our study, a prospective study from Japan showed an increase risk of ischemic heart disease in men but not women with subclinical hypothyroidism.[12] A prospective study in the United States followed up men and women age 65 or older for >10 years showed no influence of hypothyroidism (overt or subclinical) on cardiovascular outcome and mortality.[13]

Findings of ECG profile in our study were in accordance with studies of Tajiri *et al*.,[14] Sureshbabu *et al*.,[15] and Tudoran *et al*.[16]

Electrocardiographic findings in hypothyroidism are sinus bradycardia, QT prolongation, decreased amplitude of P waves, low-voltage complexes, atrioventricular and interventricular block, incomplete or complete right bundle branch block, and atrial fibrillation.[17] ECG changes in hypothyroidism are due to increased water imbibition, hypertonicity of the heart due to abnormal vagal tone, and associated pericardial effusion.

It has been found that only a minor shift in the intracellular and extracellular water exchange of the cardiac muscle was required to produce ECG changes. It is hardly possible that small amounts of thyroid hormone producing electrocardiographic alteration in a short period of time would have had appreciable effect in cases of hypothyroidism.

Strength and Limitations of Study

ECG is simple, less expensive and reliable methods for the assessment of systolic-diastolic dysfunction of the left ventricle. Its reproducibility is an additional advantage. The study was carried out in small sample size, but ECG can be very useful as screening tool on large population for preventing cardiac morbidity and mortality. Early diagnostic approach with ECG and follow-up in hypothyroid patients surely diminishes the extent of cardiac complications.

CONCLUSIONS

Thyroid hormone is very important for normal cardiovascular function, so when thyroid hormone is insufficient neither the heart nor the blood vessels function normally. Hypothyroidism has been found to be associated with increased cardiovascular morbidity and mortality. Hence, it is important to investigate ECG profile in hypothyroid patients and hypothyroid patients to evaluate whether the ECG changes revert back to normal with timely and regular levothyroxine therapy.

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