

Original article:

Electrocardiographic changes in female patients with altered thyroid status

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Abstract:

Introduction- Thyroid hormones can exert electrophysiological effects on heart. Thyroid dysfunction shows many electrographic changes which include different types of arrhythmias (sinus arrhythmias, atrial and ventricular arrhythmias), prolonged QRS complexes, alteration in QT interval and T wave. The aim of this study is to test the hypothesis that altered thyroid status produces changes in electrocardiogram.

Material and Methods- This study included 40 newly diagnosed female volunteer patients of altered thyroid status of which 20 were patients of hypothyroidism and 20 were patients of hyperthyroidism. All the patients were checked with thyroid profile and standard 12 lead ECG (Electrocardiogram) was recorded.

Results- In 60% patients of hypothyroidism heart rate was less than 70/min, while in 90% patients of hyperthyroidism heart rate was more than 90/min. In hypothyroid patients, the most common finding was ST-T changes (50%) followed by low voltage ECG (25%), sinus bradycardia (5%) and ventricular premature complex (5%). In hyperthyroidism the most common finding was sinus tachycardia (60%), followed by shortened QTc (15%) and atrial fibrillation (10%).

Conclusion- Hyperthyroidism and hypothyroidism both alter cardiac function, which is reflected in electrocardiogram of the patient.

Keywords: Hypothyroidism, Hyperthyroidism, Ventricular premature complex, Atrial Fibrillation.

Introduction:

Thyroid hormones produce various effects on heart and peripheral vascular system causing changes in heart rate and blood pressure, ventricular systolic and diastolic function of the heart.

Thyroid exerts its action on heart both directly as well as indirectly by modulating autonomic control.

It has been proved that altered thyroid status causes relevant cardiovascular derangements. Overt hyperthyroidism causes hyperdynamic state, which is associated with increased heart rate, enhanced left ventricular systolic and diastolic function, and increased chances of supra ventricular arrhythmias.

Whereas overt hypothyroidism has opposite

changes.^[1] Patients of overt hypothyroidism show many electrocardiographic changes like sinus bradycardia, low amplitude and prolonged QRS complexes, QT interval prolongation, and alteration in T wave morphology.^[2,3] Whereas hyperthyroidism can develop sinus tachycardia and atrial fibrillation.^[1,4] Notably, prolonged and shortened QT intervals have been reported in hyperthyroidism.^[5,6] With this background, this study was designed to test the hypothesis that altered thyroid status produces changes in electrocardiogram.

Aim and Objectives:

The aim of the present study was to compare the electrocardiographic changes in patients of hypothyroidism and hyperthyroidism.

Material and Methods:

This was cross sectional descriptive study. The study design was submitted to the institutional ethics committee and it was approved. In this study we included 20 newly diagnosed female volunteer patients of hypothyroidism and 20 of

hyperthyroidism. The patients having age ranging from 30 to 60 years were included. Those patients taking treatment or medicine for thyroid disorder, and those patients having other diseases like diabetes, cardiovascular diseases, renal diseases and patients on medications altering cardiac conductivity were excluded. The diagnosis was based on thyroid profile^[7] and clinical examination in the medicine department.

Table 1: Thyroid Hormone profile, Laboratory reference range by ELISA test

Tests (Parameters)	Expected normal Value
Total T3	56 to 188 ng/dl
Total T4	4.87-11.72 µg/dl
TSH	0.4-4.0µIU/ml

All the patients were explained verbally about the study and written consent was taken. Thyroid profile and standard 12 lead ECG (Electrocardiogram) were recorded. The ECG findings were confirmed from physician of medicine department. The findings of ECG of hypothyroid and hyperthyroid patients were compiled and analyzed for the comparison.

Results:

Table 2: Heart rate in patients of hypothyroidism.

Heart rate/ min.	No. of cases (20)	Percentage (100)
50-60	3	15
61-70	9	45
71-80	5	25
81-90	2	10
91-100	1	5

More than half patients of hypothyroidism had heart rate less than 70/min.

Table 3: Heart rate in patients of hyperthyroidism.

Heart rate/ min.	No. of cases (20)	Percentage (100)
<90	2	10
91-100	6	30
101-110	8	40
111-120	3	15
121- 130	1	5

90% patients of hyperthyroidism had heart rate more than 90/min.

Heart rate in patients of hypothyroidism and hyperthyroidism was determined by calculating R-R interval of ECG.

Table 4: ECG findings in patients of hypothyroidism.

Findings	No. of cases (20)	Percentage (100)
ST-T changes	10	50
Low voltage QRS complex	5	25
Prolonged QTc	3	15
Sinus bradycardia	1	5
VPC	1	5

VPC= Ventricular premature complex

ST-T changes in the form of ST segment depression and T wave inversion were seen in 50% patients.

Low voltage QRS complex electrocardiogram was seen in 25% patients.

Table 5: ECG findings in patients of hyperthyroidism.

Findings	No. of cases (20)	Percentage (100)
Sinus tachycardia	12	60
Shortened QTc	3	15
Prolonged QTc	2	10
ST-T changes	1	5
AF	2	10

AF= Atrial Fibrillation

Sinus tachycardia was the commonest electrocardiographic finding in patients of hyperthyroidism.

Discussion:

In this study we compared the ECG findings in patients of hypothyroid with hyperthyroid status.

We found 60% hypothyroid cases had resting heart rate (beats/min.) less than 70/min, while 90% cases of hyperthyroidism had heart rate more than 90/min. Most of the cases (45%) of hypothyroidism had heart rate in between 61 to 70/min, and in hyperthyroidism cases (40%) heart rate was in between 101 to 110/min. Our results are in agreement with similar studies done previously by Klein I et al, Fazio S et al and Fredlund BO et al.^[1,2,3] In brief, hypothyroidism cases had resting heart rate at lower side and in hyperthyroidism cases had heart rate on higher side. Most probably it is due to imbalance in autonomic function of the heart influenced by altered thyroid status.^[8]

Certain effects of thyroid hormone, such as increase in metabolic rate, heat production, heart rate and CNS excitation are also mediated by sympathetic nervous or adrenergic system and its catecholamines. Even though thyroid hormones also have these effects, its action is prolonged and slow as compared to catecholamines.^[9,10] Probably, thyroid hormone produces the catecholamine effect by increasing levels of cAMP (a beta adrenergic second messenger). An increased levels of cAMP were found in plasma, urine and muscle after T4 administration in various studies.^[9,11]

Thus, overall effect of thyroid hormone is to increase and potentiate sympathetic activity. Therefore in hypothyroidism as levels of thyroid hormones are less, the synergistic and potentiation action of thyroid hormone on sympathetic activity

is less, where as in hyperthyroidism sympathetic dominance is more.

In 20 cases of hypothyroidism the commonest finding we noted was ST-T changes. ST-T changes were seen in 10 patients (50%). The second most common finding was low voltage QRS complex electrocardiogram, which was seen in 5 patients (25%). Prolonged QTc interval was seen in 3 patients (15%), while sinus bradycardia and ventricular premature complex were observed in only one patient (5%) of hypothyroidism. Our findings were comparable with Osborn LA et al^[12] study. In their study commonest finding was ST-T changes followed by low voltage electrocardiogram. ST-T changes may attribute to risk of atherosclerotic coronary artery disease in hypothyroid patients due to increased electrical depression in myocardium. Low voltage electrocardiogram may be due to pericardial effusion, myocardial swelling, oedema seen in myxedema, interstitial fibrosis and impaired cardiac contractility in thyroid hormone deficiency.^[13] The prolonged QTc is due to reduction in some cardiac repolarizing K⁺ currents such as the transient outward potassium current (I_{to}) and increased L-type calcium current (I_{ca-L}) leading to increase in ventricular repolarization time in patients of hypothyroidism.^[14,15,16]

In 20 cases of hyperthyroidism the most common finding we noted was sinus tachycardia, seen in 12 cases (60%), followed by shortened QTc interval in 3 cases (15%). Also in 2 cases (10%) of hyperthyroidism we found prolonged QTc interval and atrial fibrillation. ST-T changes were the least

common finding noted in cases of hyperthyroidism. Our findings noted in hyperthyroid patients were similar to that of Fadel BM et al.^[17]

Experimental data suggested that the faster heart rate in hyperthyroidism was partly due to the regulatory effect of thyroid hormones on sodium pump density and enhancement of Na⁺ and K⁺ currents. Thyroid hormones can increase heart rate by increasing sinus node automaticity, decreasing the action potential duration and the refractory period of the atrial myocardium as well as the atrioventricular nodal refractory period, providing a substrate for atrial fibrillation.^[18] In addition, increased sympathetic and decreased vagal modulation in hyperthyroidism could also increase the heart rate leading to sinus tachycardia.^[19]

Conclusion:

Thyroid hormones exhibit their cardiovascular effects through different mechanisms. Thyroid exerts its action on heart both directly as well as indirectly by modulating autonomic control. The findings of the present study showed that hypothyroidism was associated with ST-T changes and ventricular arrhythmias, while hyperthyroidism was associated with sinus tachycardia and atrial fibrillation.

Thus we conclude that hyperthyroidism and hypothyroidism both alter cardiac function, which is reflected in electrocardiogram of the patient and early treatment for altered thyroid status can prevent impending cardiac complications.

Further research is needed to confirm these findings on large number of patients with altered thyroid status.

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