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Original Research Article

Study of ECG changes in different thyrotoxic states and their correlation with thyroid hormone levels

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ABSTRACT

Background: Thyroid hormone has many recognized effects on the cardiovascular system that results in significant comorbidity and may also affect the quality of life of diseased person.
Objectives: To assess the ECG changes in thyrotoxicosis with thyroid hormone level and secondary objectives are to compare different ECG pattern in thyrotoxicosis patients (Graves' disease, Toxic multinodular goiter, Thyroid adenoma) with healthy individual taken as controls after exclusion of cardiovascular disorder, Hypertension.
Materials and Methods: Observational prospective case-controlled study include minimum 50 thyrotoxicosis patients and 50 control, done at Department of General Medicine MGM Medical college and MY Hospital Indore (MP).
Results: In the present study peak incidence of thyrotoxicosis was observed in the age group of 35-50 years (50%), followed by in the age group of 20-34 years (36%). The female: male ratio in thyrotoxic group is 5.25:1. In this study Graves' disease accounts most of the cases of thyrotoxic patients i.e., 84%. Sinus tachycardia was observed in 88.09% of Graves' disease, 40% of toxic multinodular goiter, and 100% of thyroiditis. Atrial fibrillation was observed in 7.1% of Graves' disease and 60 % of toxic multinodular goiter. Also, sinus tachycardia was observed in 63% of thyrotoxic patients who had free T3 level >2.4 ng/ml, in 100% of thyrotoxic patients who had free T3 level from 1.39-2.4 ng/ml, and in 81.8% of thyrotoxic patients who had free T3 level from 0.486-1.38 ng/ml. Atrial fibrillation was observed in 31.5% of thyrotoxic patients who had free T3 level >2.4 ng/ml. The patients having free T3 level from 1.39-2.4 ng/ml and 0.486-1.38 ng/ml does not show atrial fibrillation in ECG.
Conclusion: The peak incidence of the thyrotoxicosis was found in the age group of 35-50 years (50%), younger patients age group of 20-50 years accounts 86% of total thyrotoxic patients and females were more affected than male. Graves' disease accounts 84% cases of thyrotoxicosis. Thyrotoxic group and euthyroid group shows statistically significant ECG changes in terms of sinus tachycardia (<0.0001) and atrial fibrillation (0.0256). In the thyrotoxic group 82% of patient shows sinus tachycardia and 12% of patient shows atrial fibrillation. The association between sinus tachycardia, atrial fibrillation and total T3 level and free T3 level was found statistically significant (P=0.007).

1. Introduction

It has long been recognized that some of the foremost characteristic and common signs and symptoms of thyroid

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gland disorder are those that result from the effects of thyroid hormone on the heart and cardiovascular system. The hormone can increase myocardial contractility and heart rate and dilate peripheral arteries to increase cardiac output.[1] Thyroid diseases are quite common. Current estimates suggest that it affects 9% to 15% of the adult female population and a smaller percentage of adult males.[2] Thyrotoxicosis is defined as the state of thyroid hormone excess and is not synonymous with hyperthyroidism, which is the result of excessive thyroid function. However, the major aetiologies of thyrotoxicosis are hyperthyroidism caused by Graves' disease, toxic multinodular goiter, and toxic adenomas. Grave's disease accounts for about 60-80% of cases of thyrotoxicosis. [3] Cardiovascular manifestations of hyperthyroidism include palpitations, tachycardia, exercise intolerance, dyspnoea on exertion, widened pulse pressure, and sometimes rhythm disturbances in the form of atrial fibrillation. In hyperthyroidism cardiac contractility is enhanced, and resting heart rate and cardiac output are increased. Cardiac output may be increased by 50% to 300% over that of normal subjects as a result of the combined effect of increases in resting heart rate, contractility, ejection fraction, and blood volume with a decrease in vascular resistance.[3] Thyroid hormone is a prime regulator of cardiac gene expression and, many of the cardiac manifestations of thyroid disorder are associated with alterations in T3-mediated gene expression.[4] Hyperthyroidism in both humans and in experimental animals leads to cardiac hypertrophy. This cardiac hypertrophy is primarily the result of increased work imposed on the heart through increases in hemodynamic load.[5] Sinus tachycardia is the most common rhythm disturbance and is recorded in almost all patients with excess thyroid hormone level.[6] Atrial fibrillation that is most commonly identified with thyrotoxicosis.[7] Regarding the high incidence of AF in older patients with hyperthyroidism, it is also important to detect subclinical hyperthyroidism since it carries the same relative risk for atrial fibrillation as does overt disease,[8] thus warranting the measurement of the serum TSH concentration for early recognition and treatment. Most of the cardiac abnormalities return to normal once a normal thyroid hormone level has been achieved, although AF may persist in a some of patients. Treatment of hyperthyroidism can result in conversion of AF in to sinus rhythm in up to two-thirds of patients. Beta-blockers reduce left ventricular hypertrophy and also show a reduction of atrial and ventricular arrhythmias in patients with hyperthyroidism.[9] Incidence of cerebral embolism is more in atrial fibrillation, an indication of anticoagulation in hyperthyroid is controversial.[10] According to the recent guidelines since hyperthyroidism is an independent risk factor for the development of thrombosis and stroke, patients should receive anticoagulation regardless of CHA2DS2-VASC score.[11]

2. Objectives of the Study

Primary objective of the study is to assess the ECG changes in thyrotoxicosis with thyroid hormone level and secondary objectives are to compare different ECG pattern in thyrotoxicosis patients (Graves' disease, Toxic multinodular goiter, Thyroid adenoma) with healthy individual taken as controls after exclusion of cardiovascular disorder, Hypertension.

3. Background

3.1. Physiologic effects of thyroid hormone

Thyroid hormone receptors (TRs) are expressed in almost all tissues of the body, although the relative expression of TR isoforms may vary among tissues, justifies the role of thyroid hormone can vary in different tissues.[12,13]

3.2. Effects of thyroid hormone on cardiovascular hHemodynamic

Increased action of T3, T4 to certain molecular pathways in the Cardio vascular system produces marked cardiovascular derangements. The cardiovascular manifestation of TH excess, including tachycardia, a widened pulse pressure, a hyperkinetic precordium, and a loud first heart sound.[14]

3.3. Thyroid hormone and heart rate

Thyroid hormone has a positive chronotropic effect on the heart. Resting sinus tachycardia is the most common cardiovascular sign of thyrotoxicosis.[15] The circadian variation is preserved and is even more pronounced than in normal subjects.[16] An unbalanced sympathetic vagal tone due to relative adrenergic overdrive is responsible for increased chronotropism and bathmotropic in hyperthyroid pateints.[6] Correlation between thyroid hormone level and nocturnal heart rate in hyperthyroid patients, suggests that thyroid hormone may directly affect sino-atrial node firing.[17]

3.4. Thyroid hormone and preload

Thyroid hormone has been shown to up-regulate erythropoietin secretion, and, in turn, red blood cell mass, which may also contribute to the increase in total blood volume and cardiac preload.[18] Renin–angiotensin-aldosterone system is also activated in hyperthyroid patients.

3.5. Thyroid hormone and afterload

Thyroid hormone promotes arterial smooth muscle relaxation, which leads to reduction in systemic vascular

resistance, which in turn reduces the ventricular afterload.[19]

3.6. Thyroid hormone and blood pressure

Thyroid hormone increases basal metabolic rate in the body, and the increased metabolic demands lead to changes in cardiac output, systemic vascular resistance, and blood pressure.[19] In many instances, these changes are similar to the physiological response to exercise.

3.7. Hyperthyroidism and the cardiovascular system

Excess thyroid hormone causes palpitations, tachycardia, exertional dyspnoea, widened pulse pressure. Cardiovascular signs and symptoms of hyperthyroidism includes Palpitations, Exercise intolerance, Exertional dyspnoea, Systolic hypertension, Hyperdynamic precordium, Anginal chest pain, Atrial fibrillation, Cardiac hypertrophy, Peripheral edema, Congestive heart failure. In hyperthyroidism myocardial contractility is enhanced, which results in increased heart rate and increased cardiac output. In hyperthyroid patients, exercise intolerance may result from an inability to further increase heart rate and ejection fraction or lower systemic vascular resistance as would normally occur with exercise.[20] In severe or chronic diseases or in the elderly, respiratory and skeletal muscle weakness may be the predominant cause of exercise intolerance.[21] In rare cases, thyrotoxic patients can present with chest pain and ECG changes suggestive of cardiac ischemia,[22] it is mostly seen in elderly with known or suspected underlying heart disease. Very rare young patients with no cardiac history can manifest similar findings.[22] In such patients the cardiac ischemia is due to coronary vasospasm,[3] and it is reversible if hyperthyroidism treated successfully.[23] Recent reports have documented the occurrence of cerebrovascular ischemic manifestations in young women with Graves' disease.[24]

3.8. Atrial fibrillation

Though atrial fibrillation occurs in 9 -22% of hyperthyroid patients, sometimes it is the only presenting complain in some of them. Prevalence of atrial fibrillation is higher in elderly and in those with other coexisting medical problems. In the study it is found that 25% of thyrotoxic patients older than 60 years had atrial fibrillation compared to 5% in patients less than 60 years of age.[25] In another large study thyrotoxicosis accounted for <1% cases of new onset atrial fibrillation, although serum TSH should be measured in all patients with new onset atrial fibrillation.[26] The risk factors for atrial fibrillation in patients with hyperthyroidism are age, male sex, ischemic heart disease, congestive cardiac failure and valvular heart disease.[27] Sub clinical hyperthyroidism is defined as low serum thyrotropin concentration with normal serum T3 and T4 concentration. The prevalence of atrial fibrillation in sub clinical hyperthyroidism is 13.3% compared to 2.3% in persons with normal values. Thus, low serum TSH concentration is associated with >5-fold higher likelihood for atrial fibrillation with no significant difference between overt and subclinical hyperthyroidism.[8] Approximately 15% of cases in thyrotoxicosis are complicated by thromboembolism. The most important risk factor for embolism is advanced age rather than the presence of atrial fibrillation.

Mainstay of treatment in patients with atrial fibrillation and thyrotoxicosis is restoration of euthyroid status by using beta blocker and anti-thyroid agents (propyl thiouracil, methimazole, carbimazole, or radio-iodine). Restoration of euthyroid status is frequently associated with conversion to sinus rhythm.

3.9. Heart failure

In hyperthyroidism sinus tachycardia or atrial fibrillation can produce rate-related left ventricular dysfunction and cardiac failure.[28] Co-existing ischemic and hypertensive heart diseases are risk factors for heart failure in hyperthyroid patients. The term "high-output failure" is not appropriate in the settings of thyrotoxicosis, however, because the ability of the heart to maintain increased cardiac output at rest and with exercise is preserved. Although initially thought to be contraindicated, treatment of the thyrotoxic cardiac patient with beta-blocker to reduce heart rate should be first-line therapy.[29]

3.10. Electrocardiographic abnormalities in thyrotoxicosis

Sinus tachycardia is the most common rhythm disturbance seen in thyrotoxic patients. Incidence of sinus tachycardia decrease with age.[30] Atrial Fibrillation, Incidence of atrial fibrillation increases with age. Frequency of atrial fibrillation may be greater in T3 toxicosis compared to when both T3 and T4 are increased.[31] Atrial flutter, paroxysmal supraventricular tachycardia, and ventricular tachycardia are also less frequent rhythm disturbances observed in hyperthyroid patients. Conduction disturbances, Incomplete right bundle branch block followed by left anterior fascicular block are the most common conduction disturbances seen in hyperthyroid patients.[32] Prolonged PR interval in the form of A-V blocks is less commonly observed.[33] In hyperthyroid patients the incidence of Wolff-Parkinson- White (WPW) syndrome is higher than the general population.[34]

3.11. Echocardiographic abnormalities in thyrotoxicosis

As compared with age-related normal subjects the left ventricular contractility is enhanced in hyperthyroid patients. Echocardiographic findings in thyrotoxicosis include cardiomegaly, diastolic dysfunction, left ventricular

hypertrophy, dilated cardiomyopathy, mitral regurgitation, and mitral valve prolapse.[35]

4. Materials and Methods

4.1. Study design

Observational, prospective case-controlled study.

4.2. Sample size

Minimum 50 Thyrotoxic patients attending medicine outdoor and indoor clinic and patients admitted in wards of M.Y. Hospital, were included in the study. Minimum 50 healthy individuals were taken as control. This study is conducted in the Department of Medicine, M.G.M. Medical College and M.Y. Hospital, Indore (M.P.), during the period from April 2019 to March 2020. The study was approved by the Ethics Committee of the institute.

4.3. Inclusion criteria

Newly diagnosed case of thyrotoxicosis including Graves' disease, Toxic multinodular goitre, Thyroid adenoma.

4.4. Exclusion criteria

Include Patients with known case of Diagnosed cases of thyrotoxicosis who are on treatment, and Cardiovascular disease, COPD, Diabetes Mellitus, Hypertension, Chronic liver disease and Chronic kidney disease.

5. Results

This study is done in department of medicine MGM Medical College and MY hospital Indore; patient is divided in two group thyrotoxicosis and euthyroid group. Observation of the study is blow mentioned tables.

The above Table 1 shows distribution of thyrotoxic group and euthyroid group based on their age group. The highest percentage of thyrotoxic group i.e., 50% and of euthyroid group i.e., 48% belonged to 35-50 years of age group, followed by 36% and 42% belonged to 20-34 years, followed by 14% and 10% belonged to 51-65 years of age group.

The above Table 2 shows distribution of TFT parameters in thyrotoxic group and euthyroid group.

The mean serum total T3 level in thyrotoxic group is 5.25 ± 2.83 ng/ml and in euthyroid group is 1.1768 ± 0.29 ng/ml and the difference was statistically significant (P=0.0001).

The mean serum total T4 level in thyrotoxic group is 22.82 ± 11.65 microgm/dl and in euthyroid group is 9.73 ± 1.97 microgm/dl and the difference were statistically significant (P=0.0001). The mean serum TSH level in thyrotoxic group is 0.17±0.09 microIU/ml and in euthyroid group is 3.05 ± 0.98 microIU/ml and the difference were statistically significant (P=0.0001).

The above Table 3 shows distribution of sinus tachycardia in thyrotoxic group and in euthyroid group. Sinus tachycardia was observed in 82% of thyrotoxic group while in 12% of euthyroid group. Sinus tachycardia was not observed in 18% of thyrotoxic group while in 88% of euthyroid group. This association was found statistically significant (P=0.00001).

The above Table 4 shows distribution of atrial fibrillation in thyrotoxic group and in euthyroid group. Atrial fibrillation was observed in 12% of thyrotoxic group while not observed in euthyroid group. Atrial fibrillation was not observed in 88% of thyrotoxic group. This association was found statistically significant (P=0.0256).

The above Table 5 shows distribution of ECG in thyrotoxic states. In Graves' disease 88.09% patients shows sinus tachycardia, 7.1% shows atrial fibrillation and 4.7% shows ST-T abnormalities. In toxic multinodular goiter 40% patients shows sinus tachycardia, 60% shows atrial fibrillation and no ST-T abnormalities were observed. In thyroid adenoma all patients show ST-T abnormalities. Sinus tachycardia and atrial fibrillation were not observed. In thyroiditis all patients show sinus tachycardia. ST-T abnormalities and atrial fibrillation were not observed.

The above Table 6 shows association between free T3 and ECG changes in thyrotoxic group. In thyrotoxic patients having free T3 level from 0.486-1.38 ng/ml, 9 patients (81.8%) shows sinus tachycardia, 2 (18.1%) patients show ST-T abnormalities while atrial fibrillation was not observed with this level of free T3. In thyrotoxic patients having free T3 level from 1.39-2.4 ng/ml, 20 patients (100%) show sinus tachycardia, ST-T abnormalities and atrial fibrillation were not observed with this level of free T3. In thyrotoxic patients having free T3 level from >2.4 ng/ml, 12 patients (63.1%) show sinus tachycardia, 6 (31.5%) patients show atrial fibrillation and 1 (5.26%) patient show ST-T abnormalities.

The above Table 7 shows association between free T4 and ECG changes in thyrotoxic group. In thyrotoxic patients having free T4 level from 0.29-0.45 mcg/dl, 11 patients (84.6%) show sinus tachycardia, 2 (15.3%) patients show ST-T abnormalities while atrial fibrillation was not observed with this level of free T4. In thyrotoxic patients having free T4 level from 0.46-0.60 mcg/dl, 17 patients (100%) show sinus tachycardia, ST-T abnormalities and atrial fibrillation were not observed with this level of free T4. In thyrotoxic patients having free T4 level from >0.60 mcg/dl, 13 patients (65%) show sinus tachycardia, 6 (30%) patients show atrial fibrillation and 1 (5%) patient show ST-T abnormalities.

The above Table 8 shows association between TSH and ECG changes in thyrotoxic group. In thyrotoxic patients having TSH level <.01 mcIU/ml, 10 patients (58.8%) show sinus tachycardia, 6 (35.2%) patients show atrial fibrillation and 1 (5.8%) patient show ST-T abnormalities. In thyrotoxic

Table 1: Distribution of age in thyrotoxic group and euthyroid group.

Age (years)	Thyrotoxic Group		Euthyroid Group		P Value
	Frequency	Percentage	Frequency	Percentage	
20-34	18	36%	21	42%	
35-50	25	50%	24	48%	0.74
51-65	7	14%	5	10%	

Table 2: Distribution of TFT parameters in thyrotoxic group and euthyroid group

TFT parameters	Thyrotoxic Group Mean ± SD	Euthyroid Group Mean ± SD	P Value
Total T3 (ng/ml) (Normal- 0.58 -1.62)	5.25 ± 2.83	1.17 ± 0.29	0.0001
Total T4 (microgm/dl) (Normal- 5-14.50)	22.82 ± 11.65	9.73 ± 1.97	0.0001
TSH (microIU/ml) (Normal-0.350-5.10)	0.17 ± 0.09	3.05 ± 0.98	0.0001

Table 3: Distribution of sinus tachycardia in thyrotoxic group and euthyroid group

Sinus Tachycardia	Thyrotoxic Group		Euthyroid Group		P Value
	Frequency	Percentage	Frequency	Percentage	
Yes	41	82%	6	12%	**0.00001**
No	9	18%	44	88%	

Table 4: Distribution of atrial fibrillation in thyrotoxic group and euthyroid group

Atrial Fibrillation	Thyrotoxic Group		Euthyroid Group		P Value
	Frequency	Percentage	Frequency	Percentage	
Yes	6	12%	0	0%	**0.0256**
No	44	88%	0	0%	

Table 5: Distribution of ECG changes in thyrotoxic states

Thyrotoxic State	Sinus Tachycardia		Atrial fibrillation		ST-T Abnormalities		Total n=50
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
Graves' Disease	37	88.09%	3	7.1%	2	4.7%	42
Toxic Multinodular Goitre	2	40%	3	60%	0	0%	5
Thyroid Adenoma	0	0%	0	0%	1	100%	1
Thyroiditis	2	100%	0	0	0	0	2

Table 6: Association between free T3 and ECG changes in thyrotoxic group

Free T3 Level (ng/ml)	Sinus Tachycardia (n=41)		Atrial fibrillation (n=6)		ST-T Abnormalities (n=3)	
	Yes	No	Yes	No	Yes	No
0.486-1.38	9	2	0	11	2	9
1.39-2.4	20	0	0	20	0	20
>2.4	12	7	6	13	1	18
P value	0.007		0.002		0.11	

Table 7: Association between free T4 and ECG changes in thyrotoxic group

Free T4 Level (mcg/dl)	Sinus Tachycardia (n=41)		Atrial fibrillation(n=6)		ST-T Abnormalities(n=3)	
	Yes	No	Yes	No	Yes	No
0.29-0.45	11	2	0	13	2	11
0.46-0.60	17	0	0	17	0	17
>0.60	13	7	6	14	1	19
P value	0.018		0.006		0.25	

Table 8: Association between TSH and ECG changes in thyrotoxic group

TSH Level (mcIU/ml)	Sinus Tachycardia (n=41)		Atrial fibrillation (n=6)		ST-T Abnormalities (n=3)	
	Yes	No	Yes	No	**Yes**	**No**
<.01	10	7	6	11	1	16
0.11-0.150	21	0	0	21	0	21
0.151-0.350	10	2	0	12	2	10
P value	0.001		0.008		0.10	

patients having TSH level from 0.11-0.150 mcIU/ml, 21 patients (100%) show sinus tachycardia, ST-T abnormalities and atrial fibrillation were not observed with this level of TSH. In thyrotoxic patients having TSH level from 0.151-0.350 mcIU/ml, 10 patients (83.3%) show sinus tachycardia, 2 (16.6%) patients show ST-T abnormalities while atrial fibrillation was not observed with this level of free T4.

6. Discussion

All the subjects in both the thyrotoxic and the euthyroid groups were in the age group of 20-65 years and the mean age of thyrotoxic group is 39.42 ± 10.91 years and that of euthyroid group is 38.02 ± 10.40 years and the difference was statistically not significant (P=0.51). Our study is comparable with study findings of Zargar[36] et al conducted on 203 hyperthyroid patients with mean age 39.98 ± 14.4. Our study is also comparable with study findings of Ishtiaque Hussain Baladi[37] et al conducted study in 103 hyperthyroid patients with mean age 30.09 ± 5.57 years. The peak incidence of thyrotoxicosis was observed in the age group of 35-50 years (50%), followed by in the age group of 20-34 years (36%). The younger patients (age group of 20-50 years) constituted 86% of the total thyrotoxic patients. The peak incidence of Graves' disease was observed in the age group of 35-50 years (54.76%), followed by in the age group of 20-34 years (40.47%), followed by in the age group of 51-65 years (4.76%). The female: male ratio in thyrotoxic group is 5.25:1. The female: male ratio in patients with Graves' disease was 6:1, in patients with toxic multinodular goiter was 4:1, and in patients with thyroiditis was 2:1. These results are also comparable with existing literature.[38] In this study Graves' disease accounts most of the cases of thyrotoxic patients i.e., 84%. This result is comparable to the reported incidence of 60-80%.[38]

Toxic multinodular goiter, thyroiditis, and toxic adenoma accounts 10%, 4%, and 2% patients of thyrotoxicosis respectively. In this study 82% of thyrotoxic group shows sinus tachycardia as compared to 12% of euthyroid group which is statistically significant (P<0.0001). Similarly, 12% of thyrotoxic group shows atrial fibrillation with statistically significance from euthyroid group (P=0.0256). In terms of ST-T changes no significant difference was observed in both the groups (P=0.242). Zargar A.H. et al[36] studied 203 hyperthyroid subjects and found sinus tachycardia in 63.5% of hyperthyroid subjects as the most common ECG abnormality (63.5%), and found atrial fibrillation in 8.9% of hyperthyroid subjects. Ishtiaque Hussain Baladi et al[37] studied 103 cases of hyperthyroidism and concluded that sinus tachycardia was observed in 60.19% (62/103) patients whereas atrial fibrillation was found in 11.65 (12/103) of cases.

Archana sonawale et al[39] studied 40 hyperthyroid patients and found that Sinus tachycardia was the most common clinical sign as observed in ECG findings (67%) followed by atrial fibrillation. Goyal[40] and his colleagues studied 24 cases of hyperthyroidism and concluded that Sinus tachycardia was the commonest abnormality in hyperthyroidism seen in 19 (79.2%) cases. Atrial fibrillation was seen in three (12.5%) cases and ST-T changes in 2 (8.3%) cases.

Sinus tachycardia was observed in 88.09% of Graves' disease, 40% of toxic multinodular goiter, and 100% of thyroiditis. Atrial fibrillation was observed in 7.1% of Graves' disease and 60% of toxic multinodular goiter. ST-T abnormalities were observed in 4.7% of Graves' disease and 100% of toxic adenoma. Our study is comparable with study findings of E. Turan et al[41] studied 20 patients with toxic nodular goiter and 16 patients with Graves' disease who had overt hyperthyroidism and concluded that atrial fibrillation rates were significantly higher in the toxic nodular group compared to Graves' disease group. In this study sinus tachycardia was observed in 63% of thyrotoxic patients who had free T3 level >2.4 ng/ml, in 100% of thyrotoxic patients who had free T3 level from 1.39-2.4 ng/ml, and in 81.8% of thyrotoxic patients who had free T3 level from 0.486-1.38 ng/ml. The association between sinus tachycardia and free T3 level was found statistically significant (P=0.007). Atrial fibrillation was observed in 31.5% of thyrotoxic patients who had free T3 level >2.4 ng/ml. The patients having free T3 level from 1.39-2.4 ng/ml and 0.486-1.38 ng/ml does not show atrial fibrillation in ECG. The association between atrial fibrillation and free T3 level was found statistically significant (P=0.002). ST-T abnormalities was found in 5.26% of thyrotoxic patients who had free T3 level>2.4 ng/ml, in 18.18% of thyrotoxic patients who had free T3 level from 0.486-1.38 ng/ml. The patients having free T3 level from 1.39-2.4 ng/ml does not show ST-T abnormalities. The association between ST-T

abnormalities and free T3 level was found statistically not significant (P=0.11). No comparable data was available in the literature on ECG changes with free T3 level. In this study sinus tachycardia was observed in 65% of thyrotoxic patients who had free T4 level >0.60 mcg/dl, in 100% of thyrotoxic patients who had free T4 level from 0.46-0.60 mcg/dl, and in 84.6% of thyrotoxic patients who had free T4 level from 0.29-0.45 mcg/dl. The association between sinus tachycardia and free T4 level was found statistically significant (P=0.018). Atrial fibrillation was observed in 30% of thyrotoxic patients who had free T4 level >0.60 mcg/dl. The patients having free T4 level from 0.46-0.60 mcg/dl and 0.29-0.45 mcg/dl does not show atrial fibrillation in ECG. The association between atrial fibrillation and free T4 level was found statistically significant (P=0.006). ST-T abnormalities was found in 5% of thyrotoxic patients who had free T4 level>0.60 mcg/dl, in 15.3% of thyrotoxic patients who had total T4 level from 0.29-0.45 mcg/dl. The patients having free T4 level from 0.46-0.60 mcg/dl does not show ST-T abnormalities. The association between ST-T abnormalities and free T4 level was found statistically not significant (P=0.25). No comparable data was available in the literature on ECG changes with free T4 level.

In this study sinus tachycardia was observed in 58.8% of thyrotoxic patients who had free TSH <0.01 mcIU/ml, in 100% of thyrotoxic patients who had TSH level from 0.11-0.150 mcIU/ml, and in 83.3% of thyrotoxic patients who had TSH level from 0.151-0.350 mcIU/ml. The association between sinus tachycardia and TSH level was found statistically significant (P=0.001). Atrial fibrillation was observed in 35.2% of thyrotoxic patients who had TSH level <0.01 mcIU/ml. The patients having TSH level from 0.11-0.150 mcIU/ml and 0.151-0.350 mcIU/ml does not show atrial fibrillation in ECG. The association between atrial fibrillation and TSH level was found statistically significant (P=0.008). ST-T abnormalities was found in 5.8% of thyrotoxic patients who had TSH level<0.01 mcIU/ml, in 16.6% of thyrotoxic patients who had TSH level from 0.151-0.350 mcIU/ml. The patients having TSH level from 0.11-0.150 mcIU/ml does not show ST-T abnormalities. The association between ST-T abnormalities and TSH level was found statistically not significant (P=0.10). No comparable data was available in the literature on ECG changes with TSH level.

7. Conclusion

The peak incidence of the thyrotoxicosis was found in the age group of 35-50 years (50%). The younger patients (age group of 20-50 years) accounts 86% of total thyrotoxic patients. In thyrotoxicosis the females were more affected than male. Graves' disease accounts 84% cases of thyrotoxicosis. Thyrotoxic group and euthyroid group shows statistically significant ECG changes in terms of sinus tachycardia (<0.0001) and atrial fibrillation (0.0256), but it is statistically not significant in terms of ST-T changes (0.242). In the thyrotoxic group 82% of patient shows sinus tachycardia and 12% of patient shows atrial fibrillation. In Graves' disease 88.09% patients had sinus tachycardia 7.1% had atrial fibrillation and 4.7% had ST-T abnormalities. In toxic multinodular goiter 40% patients had sinus tachycardia and 60% had atrial fibrillation. The association between sinus tachycardia, atrial fibrillation and total T3 level and free T3 level was found statistically significant (P=0.007).

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9. Conflict of Interest

The authors declare they have no conflict of interest

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