

Research

ECG changes in patients with primary hyperthyroidism



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Abstract

Introduction: Thyroid hormones play a key role in regulating the cardiovascular system. Its imbalance leads to various electrophysiological changes in the cardiovascular system. This study was done to determine the frequency of electrocardiographic (ECG) changes in patients with primary hyperthyroidism. **Methods:** It was a descriptive cross-sectional study conducted in the Department of Medicine, Medical Unit III, Ward-7, Jinnah Postgraduate Medical Centre, Karachi, from October 2013 to April 2014. A total of 103 patients newly diagnosed with primary hyperthyroidism were included in this study. Venous blood samples were collected for T₃, T₄, TSH analyzed by radioimmunoassay. ECG was performed. Outcome variables were the ECG changes i.e. sinus tachycardia and atrial fibrillation. **Results:** The average age of the patients was 30.09±5.57 years (95%CI: 29 to 31.18). Out of 103 cases, 19 (18.45%) were male and 84 (81.55%) were female. Sinus tachycardia was observed in 60.19% (62/103) patients whereas atrial fibrillation was found in 11.65 (12/103) of cases. **Conclusion:** In this study, the frequency of electrocardiographic changes in terms of sinus tachycardia was high. This report emphasizes the importance of thyrotoxicosis as a cause of cardiac morbidity and mortality in patients with thyrotoxicosis. These cardiac complications are readily reversible if timely optimal treatment is offered.

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Introduction

The cardiovascular system is very sensitive to thyroid hormone [1]. Thyroid hormone exerts both electrophysiological and ionotropic effects on the heart and may increase the risk of developing atherosclerosis [2]. Patients with hyperthyroidism can develop atrial arrhythmias such as sinus tachycardia, atrial flutter, atrial fibrillation, both prolonged and shortened QT interval [2]. It is also linked with angina, rarely myocardial infarction and sudden death [3]. Hyperthyroidism results in systemic cardiovascular hemodynamic changes [1] which is associated with enhanced sympatho-adrenal activity due to increase adrenergic receptor number and sensitivity, consequently leads to coronary artery spasm [1]. Clinical signs and symptoms suggestive of diagnosis include type of chest pain, palpitation, weight loss, diaphoresis and agitation [4]. Incidence of cardiac disease in thyrotoxicosis is 27% with male to female ratio of 1:5 [5], frequency of hypertension 53%, arrhythmia 25% and heart failure 42% [6]. Angina has been reported in 20% of the patients with thyrotoxicosis [4]. Several studies have reported that prolonged QT interval is associated with increased risk of ventricular dysarrhythmia and sudden death [4]. Heart is one of the main target organs of thyroid hormone and its morphology and function are investigated by means of standard 12-lead ECG [7].

Generally, the prognosis for hyperthyroidism-associated coronary vasospasm is good [1]. Antithyroid drugs remained cornerstone in the management of hyperthyroidism [1]. Recognition and proper interpretation of ECG changes in hyperthyroidism is helpful in diagnosis, prognosis and therapy of hyperthyroidism [8]. Napoli et al. reported that a reasonable treatment approach might be to continue nitrates and/or calcium channel blocker like diltiazem, for 6-12 months after a euthyroid state is achieved [1, 9]. The purpose of this study is to identify electrocardiographic (ECG) changes in patients with primary hyperthyroidism in order to diagnose, treat and avoid morbidity and mortality related to cardiovascular system. To date no study has been done in our country on patients having cardiac disease secondary to hyperthyroidism.

Methods

This descriptive cross-sectional study with non-probability purposive sampling was conducted at Medical Unit III ward 7, Jinnah Postgraduate Medical Centre (JPMC) Karachi from October 2013 to April 2014 after reviewed by Ethical Review Committee of JPMC Karachi. A total of 103 patients between ages 20-40 years regardless of gender visiting out-patient department of ward 7 were enrolled who were recently diagnosed with primary hyperthyroidism. Subjects with presence of all the following levels of thyroid hormones ($T_3 > 6.5$ pmol/L, $T_4 > 20$ pmol/L, TSH < 0.5 mIU/L) was considered as primary hyperthyroidism. The duration of diagnosis was taken less than a week. Patients already taking antithyroid drugs, e.g: propylthiouracil, carbimazole, methimazole, subjects with actual and impending thyrotoxic crisis, pregnant and lactating mothers were excluded from study. Patients with previously known co morbidities like ischemic heart disease or with certain chronic illness like diabetes mellitus (FBS > 100 mg/dl), renal failure (serum creatinine > 1.4 mg/dl) were also excluded from the study to eliminate bias.

After taken the informed consent, detailed history, examination and investigation was done to rule out exclusion criteria. Venous blood samples were collected for T_3 , T_4 , TSH analysed by radioimmunoassay. ECG was performed using Nihon Kohden device, model # 9 > 620L, 2005. Proforma was used for data collection and single laboratory was used to prevent laboratory bias. Outcome

variables were ECG changes including sinus tachycardia (heart rate > 100 beat/min) and Atrial fibrillation (absent P-wave, irregular heart rate) [6]. Data was entered and analyzed in statistical software (SPSS-17). Frequencies and percentages were computed for qualitative variables like gender and ECG changes in primary hyperthyroidism. Mean \pm SD were computed for quantitative variables like age. Effects modified were controlled by stratification of age, gender to see the impact of outcome. Post stratification chi-square test was applied. $P < 0.05$ was considered as significant.

Results

A total of 103 patients newly diagnosed with primary hyperthyroidism were included in this study. The average age of the patients was 30.09 ± 5.57 years (95%CI: 29 to 31.18) as shown in Table 1. Out of 103 cases, 19(18.45%) were male and 84(81.55%) were female. Frequency of electrocardiographic in term of sinus tachycardia and atrial fibrillation in patients with primary hyperthyroidism are presented in Table 2. Sinus tachycardia was observed in 60.19% (62/103) patients and atrial fibrillation was 11.65(12/103) cases. Rate of sinus tachycardia was observed above 50% cases in all age groups which is not statistically significant among different age groups ($p = 0.68$) as shown in Table 2 while rate of atrial fibrillation was significantly high in above 30 years of age patients ($p=0.02$) as presented in Table 2. Similarly rate of sinus tachycardia and atrial fibrillation was not statistically significant between male and female as presented in Table 1.

Discussion

It is well known that one of the main complications of thyrotoxicosis is heart disease, including heart rhythm abnormalities. Thyroid hormones are known to affect the cardiovascular system both directly and indirectly [9] and results in increased cardiac contractility, enhanced cardiac output and reduced systemic vascular resistance. Incidence of thyrotoxic heart disease in sub-Saharan Africa ranged from 6.2-8% [10-12].

Incidence of cardiac disease in thyrotoxicosis is 27% with male to female ratio of 1:5 [5], frequency of hypertension 53%, arrhythmia 25% and heart failure 42% [6]. Angina has been reported in 20% of the patients with thyrotoxicosis [4]. Several studies have reported that prolonged QT interval is associated with increased risk of ventricular dysrhythmia and sudden death [4]. Heart is one of the main target organs of thyroid hormone and its morphology and function are investigated by means of standard 12-lead ECG [7]. In this study only two ECG changes were recorded sinus tachycardia and atrial fibrillation.

Though cardiac complications of thyrotoxicosis had been reported to be more common in the elderly [13] but Nigerians had reported contrary to this observation [10-12]. The mean age of occurrence of cardiac complications of thyrotoxicosis as seen from this report is 40.8 years. The mean age of this group of people in this report though lower than that reported by Famuyiwa [10] is comparable to the more recent report by Danbauchi *et al.* [14]. In this report, cardiac complications of thyrotoxicosis were noted 30.09 ± 5.57 years. Out of 103 cases, 19(18.45%) were male and 84(81.55%) were female. In Ogbera *et al.*, [5] study the Male: Female ratio of the subjects with thyrocardiac disease was 1:5.

Thyrotoxicosis is associated with arrhythmias; of which atrial fibrillation is the most commonly encountered arrhythmia [14]. The incidence of atrial fibrillation ranges from about 10-21% in patients

with thyrotoxicosis [15], compared with 0.4% in the overall adult population [16, 17]. Though atrial fibrillation has been noted to occur more commonly in males with thyrotoxicosis [18, 19], this report shows a female preponderance which is in line with previous Nigerian reports [10, 20]. In this study frequency of electrocardiographic in term of sinus tachycardia was observed in 60.19% (62/103) patients and atrial fibrillation was 11.65 (12/103) cases.

Similar result was also observed in Rotman-pikieln [21]. In this study sinus tachycardia and atrial fibrillation occurred in 65.5 and 15.5% of the patients, more common in those with hyperthyroidism. Thyroid hormones affect cardiovascular system by increasing stroke volume and heart rate [22]. Excessive thyroid hormones are linked to many heart diseases such as angina, myocardial infarction, arrhythmia and sudden death [23]. The possible mechanisms of coronary occlusion with thyrotoxicosis include: significant underlying coronary atherosclerosis, direct damage to coronary artery and coronary embolization [24].

Several hypothesis have been proposed for the mechanism of thyroid hormone and coronary artery spasm. The basic idea is that a higher sensitive state of coronary artery to vasoconstrictive agents and a decreased level of vasodilator under thyrotoxic state [25]. In additional, coronary spasm produces a higher chance of atherosclerotic events owing to thrombus formation accelerating and fibrinolysis delaying. Thyrotoxicosis also leads to a hypermetabolic state and causes imbalance between blood supply and oxygen demand, resulting in cardiac symptoms [26].

There have been only a few cases reported for hyperthyroidism related coronary spasm. The diagnosis of hyperthyroidism may be overlooked or delayed in patients without typical symptoms. Lee *et al.* [27] reported a patient who complained of chest pain without specific symptoms of thyrotoxicosis. She was treated with emergent coronary artery bypass graft surgery due to ostial stenosis of coronary arteries on angiography. The patient had thyrotoxic storm postoperatively.

Conclusion

In this study frequency of electrocardiographic in term of sinus tachycardia was high. This report has emphasized the importance of thyrotoxicosis as a cause of cardiac morbidity and mortality in patients with thyrotoxicosis hence cardiologist should lower down the threshold of diagnosing hyperthyroidism. These cardiac complications are readily reversible if there is timely optimal treatment offered.

What is known about this topic

- ECG changes in hyperthyroidism are already known;
- Consequences of cardiac problems secondary to hyperthyroidism.

What this study adds

- This is the first study done in our country about the ECG trends in patient suffering from hyperthyroidism;
- Cardiologist should lower there threshold of diagnosing hyperthyroidism in patient with such ECG changes.

Competing interests

All authors declare no competing interests.

Authors' contributions

Ishtiaque Hussain Baladi: collected data and also wrote manuscript; Ayesha Aslam Rai: analyzed data and also contributed in write up of manuscript; Syed Masroor Ahmed: wrote manuscript and also critically analyzed whole study.

Tables

Table 1: Frequency of electrocardiographic changes in patients with primary hyperthyroidism with respect to age groups

Table 2: Frequency of electrocardiographic changes in patients with primary hyperthyroidism by gender

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Table 1: Frequency of electrocardiographic changes in patients with primary hyperthyroidism with respect to age groups

Age (years)	Sinus tachycardia		Atrial fibrillation		Total (n=103)
	Yes	No	Yes	No	
<25	13 (54.2%)	11 (45.8%)	1 (4.2%)	23 (95.8%)	24 (23.3%)
26-30	19 (63.3%)	11 (36.7%)	1 (3.3%)	29 (96.7%)	30 (29.13%)
31-35	13 (54.2%)	11 (45.8%)	3 (12.5%)	21 (87.5%)	24 (23.30%)
36-40	17 (68%)	8 (32%)	7 (28%)	18 (72%)	25 (24.27%)
χ^2	1.48		9.83		
p-value	0.68		0.02		

Table 2: Frequency of electrocardiographic changes in patients with primary hyperthyroidism by gender					
Gender	Sinus tachycardia		Atrial fibrillation		Total (n=103)
	Yes	No	Yes	No	
Male	14 (73.7%)	5 (26.3%)	0 (0%)	19 (100%)	19 (18.44%)
Female	48 (57.1%)	36 (42.9%)	12 (14.3%)	72 (85.7%)	84 (81.56%)
χ^2	1.76		3.07		
p-value	0.18		0.08		