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A CROSS SECTIONAL STUDY OF ELECTROCARDIOGRAPHIC CHANGES IN PATIENTS WITH OVERT AND SUBCLINICAL THYROID DISORDERS

Internal Medicine

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ABSTRACT

Introduction: Thyroid dysfunction has been widely demonstrated to be associated with increased incidence of arrhythmia. But, only a few large scale studies have been done on effect of thyroid hormones on cardiac conduction system by evaluating ECG parameters in patients without arrhythmia. Our study aimed at evaluating ECG parameters in overt and subclinical thyroid disorders. **Methods:** We performed a observational cross sectional study of 125 patients without arrhythmia on ECG who visited our endocrinology OPD and they were divided into 5 subgroups based on thyroid function test i.e., overt hypothyroidism(A), sub-clinical hypothyroidism(B), euthyroid(C), sub-clinical hyperthyroidism(D), overt hypothyroidism(E) based on free T4 and TSH such that each group has 25 participants. The following ECG parameters were measured: Heart rate(HR), P wave duration, PR interval, QRS duration, QTc interval and analyzed statistically. **Results:** Out of 125 patients, 110(88%) were female and 15(12%) were male. Mean T4 was 1.79ng/dl and mean TSH was 14.3mIU/ml. Regression analysis with ANOVA revealed a significant association between TSH and HR, free T4 and HR, free T4 and P wave duration, free T4 and PR interval. The mean ECG parameters in euthyroid group were taken as controls and was compared with all other groups. In overt hypothyroid group, there was no statistical significance in ECG parameters when compared to controls. In sub-clinical hypothyroidism, PR interval and QRS interval were shortened (p value - 0.047 and 0.036). PR interval was also shortened in sub-clinical and overt hyperthyroidism (p - 0.013 and <0.001). Patients with overt hyperthyroidism also showed an increase in heart rate and prolonged P wave duration (p<0.001 and 0.03). **Conclusion:** This study revealed significant association between thyroid hormone and various ECG parameters. Subgroup analysis also revealed significant differences in ECG parameters in groups other than overt hypothyroidism.

KEYWORDS

electrocardiogram, thyroid, conduction system

INTRODUCTION:

Thyroid hormone exerts both electrophysiological and inotropic effects on the heart and may increase the risk of developing atherosclerosis[1]. Thyroid dysfunction has been widely demonstrated to be associated with various cardiovascular disorders and is associated with increased all-cause mortality, increased cardiovascular mortality as well as morbidity[2]. The disorders of the thyroid gland can either be due to decrease in secretion of T4 and T3 and increased TSH, which is referred to as hypothyroidism or due to increased secretion of T4 and T3 and decreased TSH which is referred to as hyperthyroidism. fined as abnormal thyroid-stimulating hormone (TSH) values with thyroxine (T4) and triiodothyronine (T3) levels within the normal range. Even these minor changes in the thyroid function in subclinical thyroid dysfunction are associated with various kinds of cardiovascular disorders, such as heart failure, atrial fibrillation and coronary artery disease[3].

Insel et al studied the effects of thyroid hormones on the adrenergic receptors and reported that β adrenergic receptor density, the formation rate of the receptors and the degradation rate are regulated by the levels of thyroid hormones[4]. Thyroid hormones can increase heart rate by increasing sinus node automaticity, decreasing the action potential duration and the refraction period of the atrial myocardium as well as the atrioventricular nodal refraction period[5].

Our study aimed at evaluating the effect of thyroid hormone on cardiac conduction system by looking at ECG parameters in overt and subclinical thyroid disorders.

METHODS:

This is an Observational cross-sectional type of study where 125 patients who visited endocrinology OPD in Government Stanley Medical College and Hospital, Chennai over a period of 2 months were included in the study. Children less than 12 years of age, pregnant women, patients with pre-existing coronary artery disease, chronic respiratory diseases, those who are taking drugs that could cause QTc prolongation and patients with ECG showing arrhythmias, all atrioventricular blocks except 1st degree block, bundle branch blocks, multiple premature ventricular complexes, and poor quality ECGs were excluded from the study.

After obtaining written consent from patients, demographic details were collected. After obtaining history and physical examination, patients were subjected to thyroid function test (free T4 and TSH). They were divided into 5 subgroups based on thyroid function test i.e., overt hypothyroidism(A) , sub clinical hypothyroidism(B), euthyroid(C), subclinical hyperthyroidism(D), overt hypothyroidism(E) based on free T4 and TSH such that each group has 25 participants. Standard 12 lead electrocardiogram was taken for all patients with a standard ECG machine within 7 days of TFT report. The following ECG parameters were measured and tabulated: Heart rate, P wave duration, PR interval, QRS duration, QTc interval (calculated by bazett's formula, $QTc = QT(ms) / [RR\ interval(ms)/1000]^{1/2}$).

The collected data were analyzed with IBM SPSS Statistics for Windows, Version 29.0. (Armonk, NY: IBM Corp). To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S.D were used for continuous variables. To find the significance in categorical data regression analysis with ANOVA was used. ECG parameters in the euthyroid group were taken as controls and all other groups were tested for significance against it with paired sample T test. In the above statistical tools the probability value .05 is considered as significant level.

RESULTS:

Out of 125 patients, 110(88%) were female and 15(12%) were male. Mean age was 41.76 years (range -18 to 80 years). Mean T4 was 1.79ng/dl and mean TSH was 14.3mIU/ml. Regression analysis with ANOVA (Table 1) revealed a significant association between TSH and HR (p value of 0.014) but P duration, PR, QRS and QTc intervals were not significantly associated with TSH (p>0.05). Regression analysis also revealed highly significant association between free T4 and HR (p<0.001), free T4 and P wave duration (p<0.001), free T4 and PR interval (p<0.001). QRS and QTc intervals were not significantly associated with free T4 levels. Gender-wise analysis also revealed similar results.

Table 1. Correlation and regression analysis between Free T4, TSH and ECG parameters.

		Heart rate	P duration	PR interval	QRS duration	QTc interval
Free T4	Pearson correlation	0.655	-0.357	-0.454	0.045	0.056
	ANOVA	<0.001	<0.001	<0.001	0.622	0.534
TSH	Pearson correlation	-0.220	0.047	0.087	0.001	-0.045
	ANOVA	0.014	0.599	0.334	0.990	0.308

The mean ECG parameters in euthyroid group were HR- 81.2 bpm, P duration- 95 msec, PR- 147.9 msec, QRS- 87 msec, QTc- 435.5 msec, taken as controls and were tested for significance by paired T test with all other groups (Table 2). In overt hypothyroid group, mean values were HR- 78 bpm, P- 97.6 msec, PR- 147.2 msec, QRS- 86 msec, QTc- 427.5 msec and no statistical significance was found when compared to controls (p>0.05). In subclinical hypothyroidism, mean values were HR- 80.8 bpm, P- 93.4 msec, PR- 139.1 msec, QRS- 82.9 msec, QTc- 427.9 msec. PR interval and QRS interval were shortened significantly (p value - 0.047 and 0.036). In group with subclinical hyperthyroidism, mean values were HR- 84.8 bpm, P- 93.2 msec, PR- 136.5 msec, QRS- 90.2 msec, QTc- 436.1 msec and PR interval was shortened significantly(p - 0.013). Patients with overt hyperthyroidism also showed an increase in heart rate (p<0.001), shortened P wave duration (p - 0.03), and shortened PR interval (p<0.001). Mean values were HR- 102.6 bpm, P- 87.9 msec, PR- 123.6 msec, QRS- 88.5 msec, QTc- 436.1 msec.

Table 2. Patient characteristics, thyroid function and ECG parameters with subgroup analysis

VARIABLE	OVERT HYPOTHYROID (n=25)	SUBCLINICAL HYPOTHYROID (n=25)	EUTHYROID (n=25)	SUBCLINICAL HYPERTHYROID (n=25)	OVERT HYPERTHYROID (n=25)
Age	42.6	43.5	45.3	41.1	36.3
Men	3	1	4	3	3
DM	4	2	3	1	2
SHTN	4	3	6	3	4
Free T4	0.58	0.99	1.12	2.06	4.2
TSH	61.4	7.54	2.4	0.11	0.04
Heart rate	78 (P-0.166)	80.8 (P-0.45)	81.2	84.8 (P-0.19)	102.6 (P<0.001)
p duration	97.6 (P-0.224)	93.4 (P-0.315)	95	93.2 (P-0.296)	87.9 (P-0.036)
PR interval	147.2 (P-0.455)	139.1 (P-0.047)	147.9	136.5 (P-0.013)	123.6 (P<0.001)
QRS duration	86 (P-0.313)	82.9 (P-0.026)	87	90.2 (P-0.071)	88.5 (P-0.27)
QTc interval	427.5 (P-0.101)	427.9 (P-0.125)	435.5	430.7 (P-0.255)	436.1 (P-0.465)

DISCUSSION:

Zhang et al[1] investigated electrocardiographic parameters and thyroid function in 5990 people and found a linear correlation between serum T4 level and heart rate in men and U shaped correlation between TSH levels and QRS interval in women. Our study also confirmed a linear correlation between t4 and heart rate in both sexes, but TSH did not show correlation with QRS interval.

A study of 132707 from danish national patient registry[6] investigating the effect of thyroid dysfunction on the ECG showed higher heart rate among men and women with both subclinical and overt hyperthyroidism. In our study, only patients who had overt hyperthyroidism had significantly increased heart rate.

A majority of animal and clinical studies have reported a prolonged heart rate-corrected QT interval (QTc) in hypothyroidism. Sarma et al[7] observed prolongation of corrected QT interval (QTc) and decrease in heart rate in hypothyroid subjects compared to controls. A study of 939 elderly men and women in Netherlands without clinical or subclinical hypothyroidism found no significant association between TSH and QTc, but they reported a positive linear association between free T4 and QTc duration in men but not in women[8]. In NHANES III study among 5990 men and women, men in the highest category of T4 had longer QT and JT intervals, although there was no clear graded association between thyroid hormone levels and QT or JT intervals[1]. Our study also failed to demonstrate any significant association between t4, TSH and QT interval.

In a study done by Tayal et al[9], P-wave duration was significantly shorter in overt hyperthyroidism and longer in subclinical hypothyroidism. Our study also showed a significantly shortened P wave duration in overt hyperthyroidism but not in subclinical hypothyroid group.

Zhang et al[1] found a U-shaped relationship between T4 and PR interval in both men and women. We too found that PR interval was significantly shortened in subclinical hypothyroidism, subclinical and overt hyperthyroidism when compared with the euthyroid group.

The major limitation in the study is that, it was a single centre study with small study population and it is not sufficient to represent the general population.

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CONCLUSION:

This study revealed significant association between thyroid hormone and various ECG parameters. Subgroup analysis also revealed significant differences in ECG parameters in groups other than overt hypothyroidism. Further studies are needed to explore more about the application of this knowledge on clinical practice.

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