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Evaluation of the Echocardiographic Findings in cases of Thyroid Disorders

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ABSTRACT
Background: *Thyroid disorders are known to cause cardiac complications and increases risk of cardiac morbidity and mortality. This study aimed to identify echocardiographic changes in thyroid disorders.*
Methods: *Data was examined from 90 patients by dividing into three groups having 30 patients in each group as hyperthyroid, hypothyroid and control group respectively. Echocardiography was done before initiation of therapy and after 12 weeks of therapy.*
Result: *Diastolic dysfunction was seen in both Hyperthyroid (13.33%) and Hypothyroid (46.67%) with more prevalence in Hypothyroid group, MR was common in Hyperthyroid group (20%), Hypothyroid group (13%). The flow velocities with hypercontractile heart (20%), pulmonary hypertension (20%), concentric LVH (10%), irregular rhythm and mild pericardial effusion (3.3%) in Hyperthyroid group. In Hypothyroid group pericardial effusion (23.3%), concentric LVH (23.3%), asymmetric hypertrophyof septum (3.3%), dilated LV (3.3%) was seen. All changes reverted significantly after 12 weeks of therapy and it was statistically significant ($p<0.05$).*
Conclusion: *Early echocardiography in patients of thyroid disorders is helpful for early diagnosis of cardiac complications associated with it and timely prevention.*

Introduction

Thyroid disease is quite common it affects as many as 9% to 15% of the adult female population and a smaller population of adult males.[1] Hyperthyroidism and hypothyroidism are known to effect cardiovascular system in a number of ways.[2] In hyperthyroidism, excessive thyroid hormone production and thyrotoxicosis, subclinical hyperthyroidism are associated with palpitations, tachycardia, exercise intolerance, dyspnea on exertion, widened pulse pressure and sometimes atrial fibrillation. Cardiac contractility is enhanced and resting heart rate and cardiac output are increased. Cardiac output may be increased by 50%- 300% over that of the normal subjects as a result of combined effects of increased in resting heart rate, contractility, ejection fraction and blood volume with decrease

in systemic vascular resistance.[3,4] In hypothyroidism, cardiovascular signs and symptoms are dramatically opposite to those described for hyperthyroidism and may include bradycardia, mild hypertension (diastolic) narrowed pulse pressure, cold intolerance and fatigue.[5,6] Hypothyroidism is associated with increased systemic vascular resistance, decreased cardiac contractility, decreased cardiac output, accelerated atherosclerosis and coronary artery disease.[6-8]

The thyroid gland primarily secrets T_4 (=85%), which is converted to T_3 by 5-monodeiodination in the liver, kidney and skeletal muscle.[9,10] The heart relies mainly on serum T_3 because no significant myocyte intracellular deiodinase activity takes place, and it appears that T_3 and not T_4, is transported into myocyte.[11]Thyroid hormone effects on the cardiac myocyte are intimately associated with cardiac function via regulation of the expression of key structural and regulatory genes. The myosin heavy chain genes encode the 2 contractile protein isoforms of the thick filament in the cardiac myocyte. The sarcoplasmic reticulum Ca^{2+}-ATPase and its inhibitor, phospholamban, regulate intracellular calcium cycling. Together they are largely responsible for enhanced contractile function and diastolic relaxation in the heart.[12-14]

Thyroid hormone effects on heart and peripheral vasculature include decreased systemic vascular resistance and increased resting heart rate, left ventricular contractility and blood volume. Thyroid hormone causes decreased resistance in peripheral arterioles through a direct effect on vascular smooth muscle cells and decreased mean arterial pressure which sensed in the kidneys, activates rennin-angiotensin aldosterone system and increase renal sodium absorption. T_3also increases erythropoietin synthesis which increase red cell mass. These changes combine to promote and increase in blood volume and preload.

Echocardiography is the best modality to non invasively assess cardiovascular abnormalities in thyroid diseases. The use of 2 D echocardiography has shown that left atrial diameter, left atrial active emptying volume and fraction, left and right intra- atrial and interatrial electromechanical delay was significantly higher in hyperthyroid patients.[15] Serum TSH and free T_4 levels correlate with 2DE LV mass index 2DE longitudinal strain and 3DE LV area strain. TSH level and mitral Em / Am ratio were independent predictor of atrial electromagnetic delay.[16,17]

Material and Methods

The study was conducted on 90 recently diagnosed thyroid disorder patients not on any antithyroid or pro thyroid drugs attending outdoor department or admitted in various wards of Guru Nanak Dev Hospital Amritsar were taken.

Exclusion Criteria - include both type 1 and type 2 diabetic, patients having thyroiditis, other endocrine disorders, drug induced thyroid disorders, pregnant females, patients with chronic renal failure, liver failure, anaemic patients, patients with hyper dynamic state, patients of significant coronary artery disease or cardiomyopathy or valvular heart disease.

Patients fulfilling the above criteria were informed about the type of study, written informed consent was taken. After a detailed history of patientsand clinical examination routine investigations like Hb, TLC,DLC, RFTs, X-ray chest PA view for heart size were done.The patients were divided into 3 groups – Group 1- hyperthyroid patients, Group 2 – hypothyroid patients, Group 3 – control patients. All patients underwent Fasting thyroid function tests – T3,T4 and TSHby enzyme immunoassay using commercial available kits .

A Trans thoracic Echocardiography TTE examination was performed in all subjects using available portable colour Doppler echocardiography CDE machine with an adult transducer of 2.5 Hz (Sonosite USA). Parasternal long and short axis, apical 4 chamber and two chamber views were obtained. The parameters which were being checked are Aortic root diameter, Left atrial dimensions , Left ventricular dimensions, Left end diastolic dimensions, left ventricular end systolic dimensions, interventricular septum and diastole,

interventricular septum end systole. Left ventricular posterior wall end diastole, Left ventricular posterior wall end systole, LV mass index, Ejection fraction, Diastolic dysfunction and any other significant finding. Echo parameters were evaluated again after achieving euthyroid state subsequent to appropriate treatment. Results were tabulated, compared and analysed as per standard statistical protocols.

Statistical Analysis

All statistical analysis was performed using SPSS version 21.0 for windows. Frequency distribution, mean and standard deviation were calculated for various qualitative and quantitative variables respectively. Data was analysed to see the association of various variables using paired t test. A p value less than 0.05 considered to be significant.

Results

Thyroid dysfunction is more commonly seen in females. There were 23 (76%) females in group 1 and 25 (83%) in hypothyroid out of 30 patients in each group. T3, T4, TSH levels were earlier 2.32+-0.64, 17.09+- 6.65, 0.21+-0.12 respectively which were reduced to 0.93+-0.9, 56.44+-18.38, 2.06+- 0.68 respectively after treatment and it was statistically significant ($p<0.05$). In group 2 T3, T4, TSH levels were 0.25+-0.15, 14.76+-5.57, 21.19+-15.23 respectively which was increased to 1.07+-0.15, got normal to 0.73+-2.16, got normal to 2.18+-0.59 respectively and it was statistically significant ($p<0.05$). The mean heart rate was 101.47+-8.39 which was reduced to 80.61+-4.76 after 12 weeks of therapy in group 1. In group 2 mean heart rate earlier was 56.73+-5.32 which was increased to 73.85+-4.73. Mean systolic BP in group 1 before and after therapy were 127.00+-15.35 and 124.2+-11.01 respectively. Mean diastolic BP in group were 80.67+-9.07 and 80.77+-9.77 respectively before and after therapy. Mean pulse pressure in group 1 was 46.00+-13.02 before therapy and after therapy it was 43.46+-7.97. Mean SBP, DBP and PP in group 2 were 129.00+-12.41, 101+-8.85 and 27.67 +-6.79 respectively. After therapy of 12 weeks SBP,DBP and PP were 121.92+-10.21, 80.38+-7.20 and 41.4+-7.32 respectively. Diastolic dysfunction is seen more commonly in group2 patient. Among group 2 grade 1 DD was seen in 14 (46.67%) and grade 2 DD in 4(13.33%). In group 1 the prevalence of DD is less than group 2 that is 3(10%) after 12 weeks of therapy and among that 18.5% of patient showed grade 1 DD and 0% patient showed grade 2 DD and it was statistically significant ($p<0.05$). In this study most common lesion was MR seen in 20 % in group 1, 13% in group 2 and 3% in group 3. After giving the therapy the rate of MR was reduced to 6% from 20% in group 1 and 3% from 13% in group 2. Moderate or severe mitral or tricuspid regurgitation were present in 9 patients (23%) incidence of MR with TR in this study group was 6%. In group1 increased flow velocities with hypercontractile heart in 6(20%), pulmonary hypertension in 6(20%), concentric LVH in 3(10%), irregular rhythm and mild pericardial effusion in 1(3.3%) each. After 12 weeks of treatment increased velocities and hyper contra-ctile heart, pulmonary hypertension, irregular rhythm, MR were statistically significantly reduced to 0%, 0%, 0%, 6.67% ($p<0.05$) respectively. In group 2 mild pericardial effusion, significant pericardial effusion, concentric LVH, asymmetrical hypertrophy of septum, dilated LV were seen in 7(23.3%), 2(6.7%),7(23.3%), 1(3.3%) and 1(3.3%) respectively and after 12 weeks of treatment 0(0%),0 (0%), 2(6.67%), 0(0%), 0(0%) respectively and these findings were not statistically significant ($p>0.05$). In group 3 concentric LVH , mild pericardial effusion was seen in 3 (10%).

Mean Average of Cardiac function markers in Group I, Group II and Group III

	Group I	Group II	Group III
Heart Rate	101.47±8.39	56.73±5.32	74.53±7.89
Systolic BP	127.00±15.35	129.00±12.41	129.67±13.26
Diastolic BP	80.67±9.07	101.00±8.85	83.67±8.90
Pulse Pressure	46.00±13.02	27.67±6.79	45.67±10.40

Prevalence of Diastolic Dysfunction in Group I, Group II and Group III

Diastolic dysfunction	Group I		Group II		Group III	
	No.	%age	No.	%age	No.	%age
GD 1	3	10	14	46.67	2	7
GD 2	0	0	4	13.33	1	3.33

Prevalence of various valvular lesions in Group I, Group II and Group III

	Group I		Group II		Control Group	
Gender	No.	%age	No.	%age	No.	%age
AR	2	6.67	1	3.33	1	3.33
MR	6	20	4	13.33	1	3.33
TR	1	3.33	0	0	0	0
PR	0	0	2	6.67	0	0
MR, PR	1	3.33	0	0	0	0
MR, TR	2	6.67	0	0	0	0
MR, TR, AR	1	3.33	0	0	0	0
MR, TR, PR	3	10	0	0	0	0

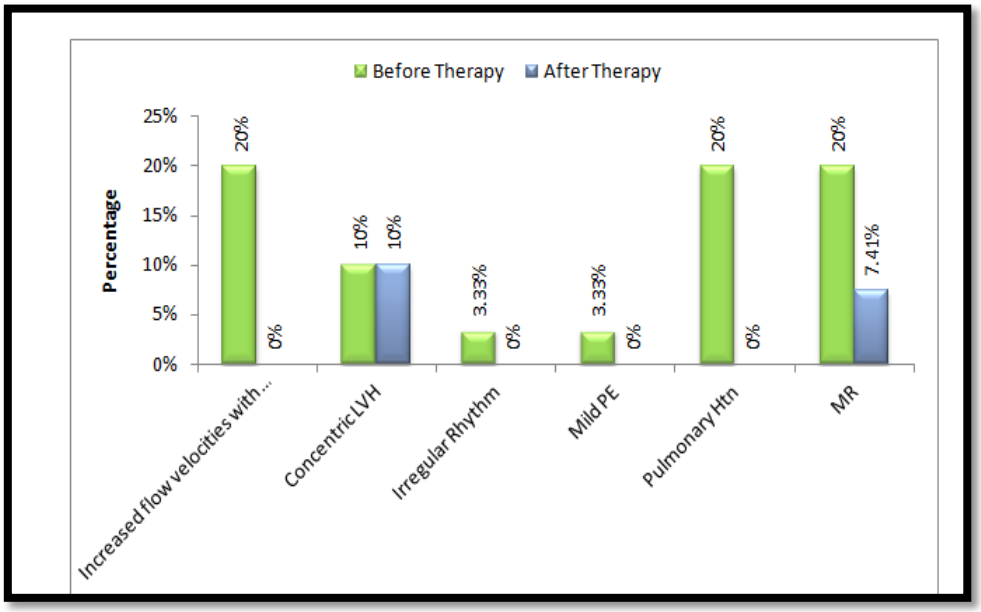
Effect of therapy on other echocardiographic findings in group I

AOSF	Hyper			
	Before Therapy		After Therapy	
Increased flow velocities with hypercontractile heart	6	20%	0	0
Concentric LVH	3	10%	3	10%
Irregular Rhythm	1	3.33%	0	0
Mild PE	1	3.33%	0	0
Pulmonary Htn	6	20%	0	0
MR	6	20%	2	6.67%
X^2	135.24			
p value	0.01			

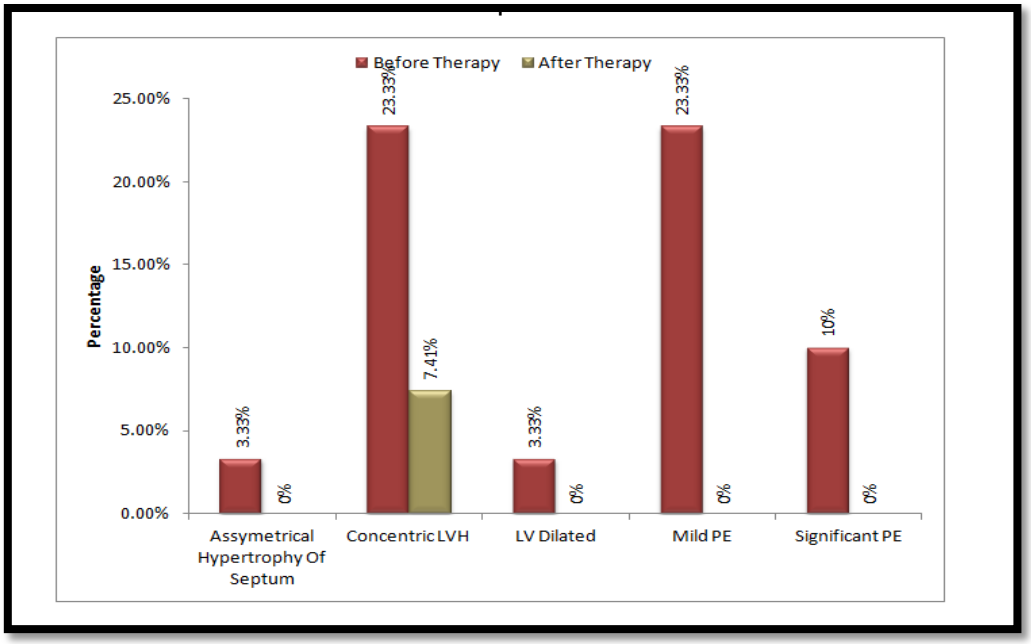
Effect of therapy on other significant echocardiographic findings in group II

Any other significant findings	Hypo			
	Before Therapy		After Therapy	
	N	%age	N	%age
Asymmetrical Hypertrophy Of Septum	1	3.33%	0	0%
Concentric LVH	7	23.33%	2	6.67%
LV Dilated	1	3.33%	0	0%
Mild PE	7	23.33%	0	0%
Significant PE	3	10%	0	0%
X^2	42.310			
p value	0.067			

Echocardiographic Findings in Group I Before and After Therapy



Echocardiographic Findings in Group II Before and After Therapy



Discussion

In this study, female preponderance was shown 23 (76%) in group 1 and 25 (83%) out of 30 patient in group 2. A study done by Vanderpump MPJ has shown symptomatic hypothyroid affects about 2% of adult women and about 0.1% to 0.2% of adult men.[18,19] The mean heart rate in our study group I was 101.47±8.39 which was reduced to 80.61±4.76 after the therapy. Study done by Cacciatori, V., et al. has shown that in hyperthyroid, patients had tachycardia with heart rates greater than 90 beats per minute, which was common at rest and during sleep; in addition, the normal increase in heart rate during exercise was exaggerated.[20] Bradycardia was found in our study group II with Mean heart rate of 56.73±5.32 and after 12 weeks of therapy heart rate was increased to 73.85±4.73. Leye A et al in a study of 19 cases of primary hypothyroidism had found bradycardia in 47.13% of cases.[21] Mean SBP and DBP in group I before and after therapy were 127.00±15.35 and 124.2±11.01, 80.67±9.07 and

80.77±9.77 respectively before and after therapy respectively. Mean pulse pressure in group I was 46.00±13.02 before therapy and after therapy it was 43.46±7.97 . So far no studies has been done to see effect of thyroid hormone on blood pressure. Mean SBP, DBP and pulse pressure in group II before therapy were 129.00±12.41, 101±8.85 and27.67±6.79 respectively. After therapy of 12 weeks SBP, DBP and pulse pressure were 121.92±10.21, 80.38±7.20 and 41.54±7.32 respectively. Klein, I. et al. has shown that the most common signs of hypothyroid are bradycardia, mild hypertension, a narrowed pulse pressure which were also observed in our study.[22]In this study most common lesion was mitral regurgitation seen in 20% ,13 % , 3 % in each group 1,2 , 3 respectively . After giving the therapy it was seen that the rate of MR was reduced to 6%, 3 % in group 1 and 2 respectively. The incidence of MR with TR in this study population was 6% . In a study done by Kage Ket al. the incidences of mitral regurgitation (MR), tricuspid regurgitation (TR) and MR plus TR were significantly higher in the patients with Graves' disease than in the age-matched control group of patients without this disease.[23]Increased flow velocities and hypercontractile heart on echocardiography has been associated with hyperthyroidism. In this study same findings were seen in 20% in group I. Merillon et al. and Freedberg AS.et al. has shown that thyroid hormones have positive chronotropic and inotropic effects on the heart, with the result that in hyperthyroidism cardiac rate and output rise, the maximum velocity of fiber shortening and myocardial excitability increase, the circulating blood volume expands.[24,25] After 12 weeks of therapy the flow velocities were normalized and heart was no more hypercontractile. Pulmonary hypertension was seen in 20% in this study in group I which was reversible after the therapy. Study done by Chung-Wah Siu et al. has shown that in patients with hyperthyroidism and normal LV systolic function, up to 47% had PHT due to either PAH with increased CO (70%) or PVH with elevated LV filling pressure (30 hyperthyroidism. In this study atrial fibrillation in form of irregular rhythm was found in 3% patients in group I. After giving therapy for 12 weeks the rhythm was found to be normal. Klein et al. has stated that atrial fibrillation occurs in 5% to 15% of hyperthyroid Patients.[22] Mild Pericardial effusion was present in 23% hypothyroid patients and significant pericardial effusion is seen in 6% of this study population which was resolved after the therapy of 12 weeks. Concentric LVH was predominantly seen in Group II (23%) rather than group I or group III. A study done on 20 overt hypothyroid patients also showed relatively increased thickness of IVS and LVPW as compared to the treated patients or control subjects. On age group analysis it was clear that this difference was more marked in older patients. Some increase in wall thickness in hypothyr-oidism is expected because of increased peripheral vascular resistance seen in these patients.[26] Study done by Sureshbabu KP et al on 100 patients of hypothyroid patients LVH was seen in 5% of patients.[27] Concentric LVH can be manifestation of presence of hypertension in the study subjects.

Summary and Conclusion

The present study concluded that thyroid dysfunction is more common in females. In hyperthyroid patients tachycardia was seen and in hypothyroid patients bradycardia was noted. After giving therapy for 12 weeks heart rate was normalized in both groups. Diastolic hypertension with narrow pulse pressure& diastolic dysfunction seen in hypothyroid group too improved after giving therapy. Most common valvular lesion seen in thyroid dysfunction was mitral regurgitation.In hyperthyroid patients flow velocities were increased and heart was hyper contractile, pulmo-nary hypertension and atrial fibrillation was seen which could be because of increased cardiac output or endothelial dysfunctionimproved after the therapy.

In hypothyroid patients, the most significant finding seen was pericardial effusion, concentric LVH which reversed with therapy.

Results of our study showed early echocardiographic approach in patients of thyroid disorders is helpful as diagnostic tool to assess various cardiac complications and thus timely prevention.

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