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Original Article

An echocardiographic study of cardiac changes in hypothyroidism and the response to treatment

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Abstract
Introduction: Thyroid Hormones exert a direct cellular effect on almost all the tissues of the body including heart. Limited studies are available in the country to assess the various CVS parameters in hypothyroid patients and none have defined the impact of treatment on these parameters.
Aim and Objectives: To do an echocardiographic study of the cardiac changes in hypothyroidism and response to treatment
Methodology: 20 overt hypothyroid patients were selected , 12 males and 8 females and subdivided into 4 groups : untreated patients –A (14) , patients on L-thyroxin >=4 months –B(6) , control subjects matched by age and sex –C (10) , patient after treatment –D(6)-a subset of group A. Total T3 T4 was measured by RIA and TSH by IRMA. Echocardiography was done according to the standard protocols.
Results: With replacement therapy hypothyroid patients showed a decrease in wall thickness, decrease or disappearance of pericardial effusion and improvement in cardiac output. However no change in systolic function or size of various chambers were noted. Decreased cardiac output seen in untreated patients was mainly due to decreased heart rate.
Discussion: Present study showed relatively increased thickness of IVS and LVPW in untreated patients with marked difference in older patients consistent with other studies. There is a striking correlation between severity of disease and pericardial effusion. Following thyroid hormone replacement it was reported to resolve within few months.
Conclusion: All patients with unexplained PE should be screened for hypothyroidism. Echocardiography is useful in assessing the response to replacement therapy. With replacement therapy hypothyroid patients showed a decrease in wall thickness.

Key words: echocardiographic study, hypothyroidism

It has been recognized for several decades that thyroid hormones exerts direct cellular effects on almost all the tissues of the body including heart.
Cardiovascular effects of the thyroid hormones are quite dramatic and the cardiac abnormalities associated with thyroid dysfunction have attracted a great deal of investigative effort. The available data suggests that the direct effect of thyroid hormone on the heart is primarily via a change in protein synthesis. The effect on cardiac contractility also appears to be mediated in part by changes in intracellular calcium handling. The CVS manifestations of hypothyroidism include the following:

a) Decreased total volume
b) Decreased contractility
c) Decreased heart rate
(All leading to decreased cardiac output)
d) Increased systemic vascular resistance (leading to increased diastolic blood pressure)
e) Increased capillary permeability (leading to pericardial effusion)

Whether the increased CVS morbidity or mortality in these patients is due to functional or structural alteration in cardiovascular system is not clear. There are only a few studies done in our country to assess the various CVS parameters in hypothyroid patients and none of these studies defines the impact of treatment on these parameters

Material and methods

Twenty overt hypothyroid patients were selected from endocrinology outdoor, 12 females, and 8 males. All the subjects were divided into the following groups:

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Group A: Untreated patients (total 14)
Group B: Patients on L-thyroxin for four months or longer (total 6)
Group C: Patients reassessed after treatment (a subset of group A, total 6)
Group D: Control subjects (total 10)

Exclusion criteria

Following patients were excluded from the study:
1. Patients with known primary cardiac disease
2. Patients with chronic pulmonary disease, severe anemia, diabetes mellitus or any other endocrinal disorder.
3. Patients taking medicines that could alter cardiac functions like amiodarone, beta blockers, calcium channel blockers, etc

Control study

Ten age and sex matched subjects not suffering from thyroid disease or any other disease which could alter the echocardiographic features were selected.

Methods of study

A). Laboratory procedures

Measurement of total T3 and T4 were done by radioimmunoassay (RIA) technique and TSH levels were measured by Immuno-radiometric assay (IRMA). It was done as per protocol of RIA and IRMA kits supplied by Board of Radiation and Isotope Technology, Bhabha Atomic Research Centre (BARC), Bombay.

B). Echocardiography

It was performed on commercially available 2D and Aloka -630 echo machine using 3.5 MHz phased array transducer. Multiple views i.e. parasternal, apical and sub costal were taken to visualize all 4 chambers clearly. Measurements were taken as per the recommendations of the American Society for Echocardiography.

Results

Table 1 Severity of hypothyroidism according to tsh levels

Severity of hypothyroidism	TSH levels (mU /L)	No. of patients
(a) Mild	0.5-20	2
(b) Moderate	20-50	8
(c) Severe	>50	4

Most of the patients had moderately severe hypothyroidism.

TABLE 2 Myocardial wall thickness (mm) in hypothyroid patients and controls

	Untreated patients (group A)	Treated patients (Group B+C)	Control group (Group D)
No. of subjects	14	12	10
LVPW (S)	16	14	12
(D)	11	10	07
IVS (S)	17	13	13
(D)	12	08	08

Untreated (Group A) patients had increased thickness of IVS as well as LVPW as compared to treated patients or controls.

TABLE 3 Cardiac chamber size (cm) in hypothyroid patients and controls

	Untreated patients (group A)	Untreated patients (group A)	Control group (Group D)
No. of subjects	14	06	10
LA	3.1	3.0	3.2
LVID (ED)	5.5	5.0	4.8
LVID (ES)	4.0	3.5	3.5

There was no significant difference in size of various chambers in different groups.

TABLE 4 LV systolic functions in hypothyroid patients and controls

	Untreated patients (group A)	Treated patients (Grp. B)	(Grp. C)	Control group (Group D)
No. of subjects	14	6	6	10
EPSS (cm)	0.5	0.6	0.5	0.5
FS (%)	27.3	30	27	27
EF (%)	59	64	59	59
Global Hypokinesia	-	-	-	-
RWMA	-	-	-	-

There was no significant difference in LV systolic functions in different groups. None of the patients had regional or global wall motion abnormalities.

TABLE 5 Stroke volume and cardiac output in hypothyroid patients and controls

	Untreated patients (group A)	Treated patients (Grp. B)	(Grp. C)	Control group (Group D)
No. of subjects	14	6	6	10
Heart rate (bpm)	58	66	72	86
Stroke volume (ml)	56	60	62	60
Cardiac output (ml)	3248	3960	4464	5160

Decreased cardiac output seen in untreated (group A) patients was mainly due to decreased heart rate.

TABLE 6 Pericardial involvement in hypothyroid patients and control

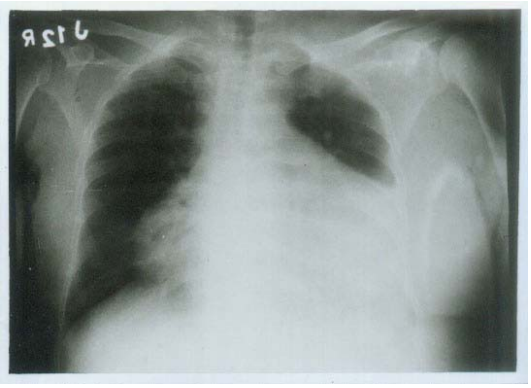
	Group A	Group B	Group C	Group D
No. of subjects	14	6	6	10
No involvement	4	5	5	10
Mild PE	2	1	0	0
Moderate PE	6	0	1	0
Large PE (Pericardial tamponade)	2	0	0	0
Pericardial thickening	4	2	0	0
Constrictive physiology	0	0	0	0

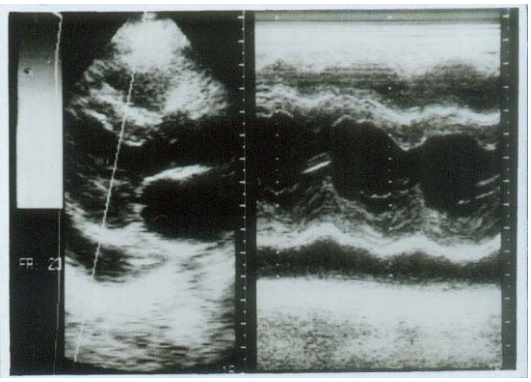
Pericardial effusion was seen in 72% of the untreated patients. The incidence was 16%in treated patients and none in the control group.

TABLE 7 Age and Pericardial wall thickness (mm) in treated (Group B+C) and untreated (Group A) patients of hypothyroidism and controls

Age In years	Untreated patients (Group A)					Treated patients (Group B+ C)					Control subjects (Group D)				
	IVS			LVPW		IVS			LVPW		IVS			LVPW	
	No.	(D)	(S)	(D)	(S)	No.	(D)	(S)	(D)	(S)	No.	(D)	(S)	(D)	(S)
20-29	2	1.1	1.6	1.0	1.5	1	0.8	1.2	0.8	1.3	1	0.7	1.2	0.6	1.1
30-39	5	1.2	1.7	1.1	1.6	4	0.8	1.3	0.9	1.4	3	0.8	1.3	0.7	1.2
40-49	6	1.3	1.7	1.2	1.6	5	0.9	1.4	1.0	1.4	5	0.8	1.3	0.7	1.2
50-59	1	1.3	1.8	1.2	1.7	2	0.9	1.4	1.0	1.5	1	0.9	1.4	0.8	1.2

There was a trend of increasing wall thickness with age in all age groups of the patients.





The study showed

Age and systolic LV function in treated and untreated patients of hypothyroidism and controls:

There was no age related variation in systolic function in various age groups. Moreover systolic function did not vary in treated or untreated patients.

Age and Pericardial Effusion in treated and untreated groups:

- Pericardial effusion was not present in patients of hypothyroidism under 30 years of age.
- No correlation could be demonstrated between severity of disease and myocardial wall thickness.
- Also no correlation was found between severity of disease and LV systolic function.
- There was no difference in stroke volume in different subgroup of patients. However, cardiac output was found to be significantly decreased in severely hypothyroid patients. This was attributable to decreased heart rate.
- No correlation could be demonstrated between chamber size and severity of disease.

TABLE 8 Severity of disease and pericardial effusion in 14 patients of hypothyroidism.

Severity of disease	Group A Patients				
	No.	No PE	Mild PE	Mod. PE	Large PE
Mild	2	2	0	0	0
Moderate	8	2	1	5	0
Severe	4	0	1	1	2

Pericardial effusion was present in all 4 patients with severe hypothyroidism, while it was present in only 75% of moderate disease.

TABLE 9 Effect of treatment in patients of hypothyroidism.

	Untreated Patients (Grp A)	Treated patients (Grp B+C)
A). Myocardial wall thickness (mm)		
IVS (D)	1.2	0.9
(S)	1.7	1.4
LVPW (D)	1.1	1.0
(S)	1.6	1.4
B). Systolic functions		
FS (%)	27.3	29
EF (%)	59	61
C). Chamber size (cm)		

LA LV (ED) (ES)	3.1 5.5 4.0	3.1 4.9 3.5
D). Pericardial involvement Mild PE Moderate PE Severe PE	 2 6 2	 1 1 0
E). Cardiac output (ml/min.)	3248	4312

With treatment patients showed

- *A decrease in wall thickness*
- *No change in systolic function or size of various chambers*
- *Decreased or disappearance of pericardial effusion*
- *An improvement in cardiac output*

Discussion

Various studies have shown alteration in myocardial wall thickness in patients of hypothyroidism. The literature shows significantly high incidence of asymmetrical septal or concentric hypertrophy in these patients. However, it was pointed out later that most of the patients were relatively old and many might be having a normal age related thickening of IVS. Thus Bennet et al. (1983), Lee et al. (1990) and Bernstein et al. (1995) did not find similar incidences in younger patients. The present also showed relatively increased thickness of IVS and LVPW (1.2/1.7 and 1.1/1.6 cm respectively) as compared to the treated patients (0.9/1.4 and 0.9/1.3 cm) or control subjects (0.8/1.3 and 0.7/1.2 cm). On age group analysis it was clear that this difference was more marked in older patients. Some increase in wall thickness in hypothyroidism is expected because of increased peripheral vascular resistance seen in these patients.

Pericardial effusion is reported to occur in 30 % to 80% of patients with hypothyroidism. Our study showed it in 11 out of 20 patients (55%) of cardiac tamponade. There was a striking correlation between severity of disease and pericardial effusion. 8 out of 12 patients with moderately severe disease had pericardial effusion. Both patients with cardiac tamponade had severe hypothyroidism. This is in accordance with findings of Verma et al. 1995. Following institution of thyroid hormone replacement therapy, PE has been reported to resolve within a few months. In our study PE disappeared in all but one of the six patients after 4 to 6 months of treatment. Fouron et al. (1982) and Kabadi et al. (1990) pointed out significantly low incidence of PE in young patients. Present study also showed no PE in patients younger than 30 years.

Heart failure in patients with hypothyroidism generally represents exacerbation of some intrinsic cardiac disease by the super imposed homodynamic effects of the thyroid hormone deficiency. Forfar et al. (1982) and others have described low systolic function indices in hypothyroid patients. However Smallridge et al. (1987) have argued that this could be related to relatively elderly patients included in the above studies. They found no such alteration in systolic function in their younger patients (aged 20-48 years). This was further supported by Fouron et al. (1982), Grossman et al. (1994) and Verma et al. (1995) who did not find any evidence of systolic dysfunction in hypothyroid patients. Present study also did not show any significant change in LV systolic patients of hypothyroidism.

Bradycardia and decreased stroke volume both account for decreased cardiac output in patients of hypothyroidism. Kral et al (1992) studied 19 patients of hypothyroidism and documented decreased cardiac index in these patients which was reversible with thyroid hormone replacement. In the present study , although untreated group had lower cardiac output (mean: 3248 ml) as compared to treated (mean :4312ml) or control group (mean :5160ml) this was to a large extent due to slower heart rate(mean : 58 bpm) in untreated patients as compared to treated (mean: 69bpm) or control (mean 86 bpm) group. Stroke volume on the other hand was not different in different groups.

Conclusion

Although increased symmetrical wall thickness is common, increased incidence of asymmetrical hypertrophy in hypothyroidism reported by a few investigators requires further confirmation. Pericardial effusion is a common cardiac manifestation in hypothyroid subjects and al patients with unexplained pericardial effusion should be screened for hypothyroidism.

Echocardiography is useful in assessing the response to replacement therapy in patients with pericardial effusion. Low cardiac output in hypothyroid patients is largely due to decreased heart rate. Systolic dysfunction in the absence of any other underlying cardiac disease is uncommon in these patients.

However, small number of subjects limits the statistical power of the study. Doppler study for assessment of diastolic parameters would be of interest in these hypothyroid patients.

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