Echocardiographic Evaluation of Cardiac Function in Hypothyroidism

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Abstract
Hypothyroidism is one of the most common hormonal disorders being associated with increased cardiovascular morbidity and mortality. Early detection of diastolic dysfunction of left ventricle by echocardiography helps in timely therapeutic intervention with thyroid hormone supplementation and amelioration of symptoms. The main objective of the present study was aimed at the cardiovascular involvement in hypothyroid patients. The present study was carried out in 64 patients of hypothyroidism who attended to the hospital between September 2013 and September 2014 including both outpatients and inpatients.

Echocardiography showed significant reduction in early diastolic filling (E) with augmented late diastolic filling (A) resulting in decreased E/A ratio suggesting significant diastolic dysfunction. Tissue Doppler imaging showed reduction in peak early diastolic velocity (E¹) and raised peak late velocity (A¹) with increased E/E¹ ratio which is again suggestive of diastolic dysfunction. LV diastolic dysfunction was impaired in patients with hypothyroidism. Doppler echocardiography might be considered a reliable method for its assessment & further management.

Keywords: Hypothyroidism, Cardiovascular changes, Echocardiography.

Introduction
Hypothyroidism is a common pathological state with deficiency of thyroid hormone. Primary hypothyroidism accounts for over 99.5% of cases of thyroid gland failure. Overt hypothyroidism refers to cases in which Serum TSH (Thyroid Stimulating Hormone) is elevated and Serum T₄ (Free thyroxine) is below the reference range.

Sub clinical hypothyroidism is associated with changes in several cardiac parameters¹²³.

Echocardiography reveals diastolic dysfunction and impaired systolic function on effort that results in poor exercise capacity⁴. The cardiac complications of long standing hypothyroidism are serious if not detected early and treated properly. A high index of suspicion is required for diagnosis of subclinical hypothyroidism as symptoms are vague. As a non-invasive method, echocardiography plays an important role in
determining abnormal cardiac function & facilitates early therapeutic intervention.

Materials & Methods

This was a case control observational study. Over a period from September 2013 to September 2014. The study population included 64 cases of newly diagnosed hypothyroidism & 30 healthy age and sex matched controls. Informed consent from study group & controls was taken prior to inclusion. Sixty four newly diagnosed and untreated hypothyroid patients were included in the study. Hypothyroidism was diagnosed based on hormone assessment i.e. high TSH Value & low T3 and T4 values. It included both subclinical and overt hypothyroidism patients. Patients with clinically evident cardiovascular disease, renal failure, chronic medical and surgical illness and Pregnancy were excluded. After clinical and laboratory diagnosis, hypothyroid patients were grouped into (1) Overt hypothyroid (2) Sub clinical hypothyroid (TSH 5.1 of 10 MIU, but with normal T3 and T4 values).

Echocardiographic evaluation was done with Phillips HD 11XE Machine with S4-2 Probe. Baseline M-Mode quantitative analysis was performed as per the guidelines laid down by the American Society of Echocardiography[6]. 2DE echocardiography was done to look for pericardiac effusion, regional motion abnormality (RWMA), ejection fraction (EF%) and valve abnormalities. Dopper echocardiography was done to assess LV diastolic dysfunction by analyzing Early (E) mitral inflow velocity, late atrial peak Velocity (A) & their ratio (E/A). Deceleration time (DT) & isovolumic relaxation time (IVRT) were also measured. Tissue Doppler imaging was done for imaging at the septal annulus for measurement of peak early diastolic velocity (E') & peak late diastolic velocity (A'). Finally the E/E' ratio if more than 8 was indicative of diastolic dysfunction.

Statistical Analysis

Continuous variables were presented as mean + SD. Categorical variables were expressed in actual numbers & percentage. Continuous variables were compared by performing unpaired t-test. Categorical variables were compared by chi – square test. P <0.05 was considered as statistically significant. Statistical Software STATA version 10 was used for statistical significance.

Results

The mean age of hypothyroid patients was 40.90 ± 8.73 years while for control it was 40.06 ± 9.68 years. Out of 64 patients 6.25% were males and 93.75% were females & in control group 13.33% were males and 86.66% were females. All patients of sub clinical hypothyroidism were females (56.2%) and 24 (37.5%) and 4 (6.25%) patients having overt hypothyroidism were females & males respectively. (Table – 1) Weight gain was the commonest symptom being present in 62.5% of patients followed by easy fatigability (59.37%), dry skin (40.62%), menstrual abnormality (34.37%) Neck swelling was the least common being present in only 6 (9.3%) patients. (Table 2)

As expected hypothyroid patients had significantly raised TSH (30.98 ± 33.06 mIU / ml) & low T3 (96.78 ± 42.06 mg/dl) and T4 (40.99 ± 1.85 mg/dl) as compared to controls (TSH – 3.25 ± 0.76 mIU/ml). Overt hypothyroid patients had significantly raised TSH and low T3 and T4 levels as compared to sub clinical hypothyroid. Abnormality of lipid profile was found with raised Serum total Cholesterol, triglycerides and low density lipoprotein (LDL) in hypothyroid patients compared to controls. (Table - 3)

Sinus bradycardia was the commonest abnormality being present in 28 (43.75%) hypothyroid patients followed by low voltage complexes in 12 (18.75%), ST-T changes in 10 (15.62%), right bundle branch block (RBBB) in 2 (3.1%) Patients (Table – 4)

There was no significant difference (P Value > 0.05) in left ventricular dimension between patients & controls. Hypothyroid patients showed significantly (P-Value < 0.001) raised IVS (9.6 ± 1.22 mm and posterior wall thickness (9.71 ±
1.08) mm as compared to controls. IVS (7.6 ± 0.63)mm & PW thickness (7.56 ± 0.67)mm]. (Table – 5)

On Doppler evaluation, hypothyroid patients showed significant (P-Value < 0.05) reduction in early diastolic filling E (71.19 ± 6.09 cm/sec) as compared to controls (81.53 ± 9.65). Conversely, hypothyroid patients showed significantly raised late diastolic filling A (64.32 ± 7.74 cm/sec) as compared to controls (50.53 ± 4.03) resulting in reduced E/A ratio in hypothyroid (1.11 ± 0.1) as compared to controls (1.62 ± 0.248) suggesting diastolic dysfunction. When tissue Doppler parameters were compared, hypothyroid patients showed significant (P-Value < 0.05) reduction in peak early diastolic velocity E\textsuperscript{1} (7.67 ± 1.32) as compared to controls (11.72 ± 0.976). Peak late velocity A\textsuperscript{1} was increased in hypothyroid patients (11.42 ± 0.82) as compared to controls (10.76 ± 1.07). Hypothyroid patients also showed significantly raised E/E\textsuperscript{1} (9.51 ± 1.59) as compared to controls (7.02 ± 1.07). (Table – 6)

**Table 1** Age & Sex Distribution of Controls and Cases

|                  | Controls          | Hypothyroid Patients |
|------------------|-------------------|----------------------|
| Age (Yr)         | 40.06 ± 9.68      | 40.90 ± 8.73         |
| Sex (M/F)        | 4 / 26            | 4 / 60               |

**Table 2** Clinical Presentation of Study Population

| Symptoms            | Male | Female | Total     |
|---------------------|------|--------|-----------|
| Weight Gain         | 4    | 36     | 40 (62.5%)|
| Fatiguability       | 2    | 36     | 38 (59.37%)|
| Dry Skin            | Nil  | 26     | 26 (40.62%)|
| Menstrual Irregulation | Nil   | 22     | 22 (34.37%)|
| Constipation        | 2    | 16     | 18 (28.1%)|
| Depressin           | 2    | 10     | 12 (18.75%)|
| Voice Change        | 2    | 6      | 8 (12.5%)|
| Neck Swelling       | Nil  | 6      | 6 (9.3%)|

**Table 3** Thyroid & Lipid Profile Parameters in Study Population Vs. Control

| Lab Parameter            | Hypothyroid   | Controls   | P Value   |
|--------------------------|---------------|------------|-----------|
| TSH (mIU/ml)             | 30.98 ± 33.06 | 3.25 ± 0.78| < 0.001   |
| T3 (mg/dl)               | 96.78 ± 42.06 | 12.6 ± 19.50| < 0.0001  |
| T4 (mg/dl)               | 4.99 ± 1.85   | 7.36 ± 0.87| < 0.0001  |
| Serum Cholesterol        | 245.34 ± 47.31| 142.86 ± 8.65| < 0.0001  |
| Serum Triglyceride       | 229.40 ± 50.58| 155.53 ± 6.64| < 0.0001  |
| Serum LDL                | 117.96 ± 21.75| 82.33 ± 8.65| < 0.0001  |

**Table 4** Electrocardiographic Changes in Hypothyroid

| ECG Changes            | Male | Female | Total     |
|------------------------|------|--------|-----------|
| Sinus Bradycardia      | 2    | 26     | 28 (43.75%)|
| Low Voltage Complex    | 2    | 10     | 12 (18.75%)|
| ST-T Changes           | Nil  | 10     | 10 (15.62%)|
| RBBB                   | Nil  | 2      | 2 (3.1%)  |
| Arrhythmias            | Nil  | Nil    | Nil       |
| Normal                 | Nil  | 12     | 12 (18.75%)|

**Table 5** Echocardiographic (M-Mode) Parameter

|                  | Hypothyroid   | Controls   | P Value   |
|------------------|---------------|------------|-----------|
| AO (mm)          | 26.35 ± 3.96  | 26.13 ± 2.66| 0.8424    |
| LA (mm)          | 30.22 ± 4.02  | 29.33 ± 3.06| 0.4497    |
| LVESD (mm)       | 29.46 ± 6.29  | 30.4 ± 3.71 | 0.5965    |
| LVEDD (mm)       | 41.07 ± 4.71  | 41.6 ± 4.54 | 0.7912    |
| IVS (mm)         | 9.61 ± 1.22   | 7.6 ± 0.63  | < 0.0001  |
| PW (mm)          | 9.71 ± 1.08   | 7.56 ± 0.67 | < 0.0001  |
Table 6 Doppler Echocardiographic Parameters of Left Ventricular Function in Hypothyroid patients & in normal controls

|                      | Hypothyroid          | Control          | P Value  |
|----------------------|----------------------|------------------|----------|
| E (cm/sec)           | 71.19 ± 6.09         | 81.53 ± 9.65     | <0.0001  |
| A (cm/sec)           | 64.32 ± 7.74         | 50.53 ± 4.03     | <0.0001  |
| E/A                  | 1.11 ± 0.1           | 1.62 ± 0.248     | <0.0001  |
| E' (cm/sec)          | 7.67 ± 1.32          | 11.72 ± 0.976    | <0.0001  |
| A' (cm/sec)          | 11.42 ± 0.82         | 10.76 ± 1.07     | 0.0243   |
| E/E'                 | 9.51 ± 1.59          | 7.62 ± 1.07      | <0.0001  |
| DT (sec)             | 186.9 ± 34.87        | 179.8 ± 12.35    | 0.4494   |
| IVRT (sec)           | 101.21 ± 13.28       | 81.26 ± 4.99     | <0.0001  |
| Systolic Velocity    | 9.06 ± 1.25          | 9.01 ± 0.73      | 0.9337   |
| EF%                  | 6.1 ± 7.1            | 6.1 ± 2.06       | 1.0      |

Discussion

In the present study comprising of 64 patients of hypothyroidism, the mean age for hypothyroid patients was 40.90 ± 8.73 years as compared to controls i.e. 40.06 ± 9.68 years. This is comparable to the study by C.L. Meena et al(7) 2012 and T.K. Mishra et al(8) 2005. There was female preponderance in hypothyroid patients. It is similar to other studies i.e. T.K. Mishra et al(8) 2005, having 90.62% females and 9.3% male patients in hypothyroid group. In our study, 36 (56.2%) patients were having sub clinical and 28 (43.75%) had overt hypothyroidism comparable to study by 1 Gon Zale Z, Vilchez F etal(9) 1998. Weight gain was the commonest symptom being present in 62.5% of patients followed by fatigueability (59.37%), dry skin (40.62%) and menstrual disturbance (34.37%).

Electrocardiographic (ECG) changes in our patients comprised of Sinus bradycardia (43.75%) followed by low voltage (18.75%), ST-T changes (15.62%) and normal in 18.75%. It is similar to the study by Al-Favtrosi et al(10).

Echocardiography study by M-Mode did not show significant difference (P Value > 0.05) in left ventricular dimensions other than interventricular septum (IVS) and posterior Wall (PW) thickness. That showed raised IVS (9.6 ± 1.22) and PW (9.71 ± 1.08) thickness as compared to control i.e. IVS (7.6 ± 0.63) & PW (7.56 ± 0.67) thickness. (P Value <0.0001). Our study finding are comparable to that of Rawat B et al(11) 2003 and Varma R et al(12) 1996. Doppler echocardiography showed significant (P Value < 0.05) reduction in early diastolic filling E wave (71.19 ± 6.09 cm/sec) as compared to controls (81.53 ± 9.65) and significantly raised late diastolic filling “A Wave” (64.32 ± 7.74) as compared to controls (50.53 ± 4.03) resulting in reduced E/A ratio in hypothyroid patients (1.11 ± 0.1) as compared to controls (1.62 ± 0.248). This suggested significant diastolic dysfunctions. There was significant prolongation of isovolumetric relaxation time (IVRT) in hypothyroidism patients (101.21 ± 13.28) as compared to controls (81.26 ± 4.99) though it was not statistically significant. Our study findings were similar to that of T.K. Mishra et al(8) 2005, C.L. Meena et al(7) 2012. Tissue Doppler imaging in hypothyroid patients had significant (P Value < 0.05) reduction in peak early diastolic velocity (E¹) (7.67 ± 1.32) as compared to controls (11.72 ± 0.97) Peak Late diastolic velocity (A¹) was increased in hypothyroid patients (11.42 ± 0.82) as compared to controls (10.76 ± 1.07). Hypothyroid patients also showed significantly raised E/E¹ (9.51 ± 1.59) ratio as compared to controls (7.02 ± 1.07). Our study findings are comparable to other studies like study by Gulbanu Erkan et al(13) 2011 & Fatma Alibaz oner et al(14) 2011. When subclinical and overt hypothyroid patients were compared there was significant increase in IVS thickness in overt (10.12 ± 1.29 mm) as compared to subclinical (9.33 ± 1.02) hypothyroid patients. Though diastolic dysfunction was present in both groups this was not statistically significant (P Value > 0.05).
Conclusion
The results of the present study showed that diastolic dysfunction of left ventricle is present in both subclinical and overt hypothyroid patients. Doppler echocardiography with tissue Doppler imaging may be considered a reliable method for a cross sectional and longitudinal assessment of left ventricular diastolic function in patients with hypothyroidism.

Limitation of Present Study
In our study the hypothyroid patients could not be followed up to look for the resolution of cardiac changes after achievement of euthyroid state. Free $T_3$ and $T_4$ level could not be measured due to financial constraints. Other parameters like myocardial performance index, left atrial volume index estimation would have added to better evaluation of cardiac function.

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