Noninvasive Evaluation of Left Ventricular Function in Patients with Hyper and Hypothyroidism

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Noninvasive Evaluation of Left Ventricular Function in Patients with Hyper and Hypothyroidism

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Abstract

Purpose: To evaluate left ventricular function prospectively and comparatively to healthy controls and prospectively short term on standard treatment in patients with thyroid dysfunction function.

Material and methods: We investigated 39 patients with hyperthyroidism, 24 patients with hypothyroidism and 40 controls by echocardiography and systolic time intervals (STI) at beginning of treatment and six weeks later after initiation of treatment. Heart rate (HR), pre-ejection period (PEP) and its corrected value PEPc, ejection time (ET) and its corrected value (ETc) and PEP/ET ratio were studied. End-diastolic, end-systolic dimensions (EDD, ESD), shortening fraction (SF), mean velocity of circumferential fiber shortening (MVCFS), systemic vascular resistance (SVR) and left ventricular mass index (LVMi) were examined.

Results: STI in hyperthyroidism were significant different: HR was increased, ET, ETc, PEP, PEPc and PEP/ET was decreased. CI was greater, MVCFS was greater and SF was higher, SVR was decreased and LVMi was greater. In follow-up treatment significant recovery in HR, ET, ETc and MVCFS was found. STI in hypothyroid patients were significant different: HR was increased, ET, ETc and MVCFS was greater. CI was lower and SVR was increased. MVCFS was decreased and LVMi was greater, SF and ESD were changed too. When on standard hormone replacement treatment for 6 weeks no changes in indices studied were found. High correlations were seen when plotting thyroxin hormone levels against MVCFS and between MVCFS and SVR.

Materials and Methods

Patients included in the study were: i) a group of 39 patients with newly diagnosed or relapsed and untreated diffuse or multinodular goiter with clinical and biochemical evidence of increased secretion of thyroid hormones; ii) a second group of 24 patients with autoimmune, idiopathic, postoperative or drug induced hypothyroidism with clinical and biochemical evidence of decreased secretion of thyroid hormones and iii) control group of 40 healthy volunteers without a history, clinical, radiographic, electrocardiographic, echocardiographic evidence of cardiovascular disease. Inclusion for both groups of patients with thyroid dysfunction were normal blood pressure, normal renal function - blood urea nitrogen and creatinine and normal hemoglobin.

According to the recommendations of AAE M-mode echocardiographic indices were as follows: end-systolic (ESD), end-diastolic dimensions (EDD), interventricular septum thickness (IVST) and posterior left ventricular wall thickness (PLVWT) in mm, shortening fraction in %, ejection fraction in %, mean circumferential fibre shortening (MCFS)-fractional shortening/left ventricular ejection time in circ/s, left ventricular mass index (LVMi) in g/m2 and cardiac index( CI) l/min/m2 , systemic vascular resistance (SVR) - (80 ? MAP(mean arterial pressure)/CO) in ???/s/l. Systolic time intervals with the addition of phonocardiography and carotis sphigmography were also investigated as follows and were corrected for heart rate: ejection time (ETc), pre-ejection time interval PET and the ration PEP/ET. Laboratory investigations included: Triiodothyronine hormone (T3) – reference limits 1.2 - 3.5 nmol/ l and thyroxin (T4) reference limits 50 to 155 nmol/ l by radio-immunoassay and protein bound iodine / PBI / normal reference limits 4-8 mg%. Non-invasive tests were performed at the start of treatment and 6 consecutive weeks afterwards after initiation of treatment.

Results

Hyperthyroid patients compared to control group

Systolic time intervals: Patients with hyperthyroidism compared to control group were identified to have the following statistically significant differences: heart rate was increased, ejection time / corrected value and pre-ejection period and its corrected value were all shorter, and PEP/ET was decreased (p< 0.001). Echocardiography: examination of both groups revealed statistically significant differences in the following parameters: the cardiac index was greater (p< 0.001), MVCFS was greater with p < 0.02 and shortening fraction was higher ( p <0. 05), total peripheral resistance was decreased and left
ventricular mass index was greater \( (r < 0.01) \) (Table 1)

**Hypothyroid patients compared to control group**

Systolic time intervals: Patients with hypothyroidism compared to control group were identified by following statistically significant differences: pre-ejection period and PEP/ET were increased \( (p < 0.01) \). In echocardiography cardiac index was lower and total peripheral resistance was higher \( (?<0.001) \), MCFS was decreased and left ventricular mass index was greater \( (? < 0.01) \), shortening fraction, ejection fraction and end systolic diameter were changed too \( (?<0.02 \) (Table 1)

**Six-weeks follow-up of patients with hyper and hypothyroidism on standard treatment**

For patient with hyperthyroidism on standard treatment followed-up for 6 weeks the significant changes were: for heart rate and PEP \( (p < 0.01) \) and ET and ETC \( (p < 0.02) \) and MVCFS \( (p<0.05) \). For patients with hypothyroidism 6-weeks of dynamic monitoring during standard hormone replacement treatment did not lead to statistical changes in indices studied. (Table 2)

**Additional echocardiographic findings**

a. mitral valve prolapse - in 10% (4) patients with hyperthyroidism mitral valve prolapse was found.

b. asymmetric septal hypertrophy - in 8% (2) patients with a severe long-term hypothyroidism asymmetric septal hypertrophy with an index of septal asymmetry of more than 2.4 and hypertrophic subaortic stenosis with systolic anterior motion of the anterior mitral leaflet was found.

c. pericardial effusion - in 50% (12) patients with long-lasting and severe hypothyroidism small (up to 300 ml) pericardial effusion was found.

**Correlations of hemodynamic variables and thyroid hormones**

High correlations were found when plotting thyroxin levels against mean velocity of circumferential fiber shortening (MVCFS) of a joint group of hyperthyroid and hypothyroid patients \( (r= + 0.75) \) and between against mean velocity of circumferential fiber shortening (MVCFS) and total peripheral resistance \( (r= -0.45) \) of a group of controls and patients with hyper- and hypothyroidism.

**Discussion**

The cardiovascular echocardiographic indices and systolic time intervals of two groups of patients with thyroid involvement and clinical and biochemical signs and symptoms of deranged thyroid hormone secretion with various underlying etiologies were studied only on the basis of thyroid hormone status. The average age of both groups of patients (40 years in the group with hyperthyroidism and 44 in the group with hypothyroidism) is most commonly found in the literature. There was a change in heart rate and systolic time intervals which were partially reverse on the six-week of follow-up treatment. Echocardiographic parameters cardiac index, total peripheral resistance and left ventricular mass index were also changed. Contractility parameters shortening fraction and mean velocity of circumferential fiber shortening were also increased and MVCFS underwent some normalization on a six week follow-up period. There were changes in PEP, which did not undergo some partial, but statistical significant reversal on the six week of follow-up. Cardiac output, peripheral resistance and left ventricular mass index were also changed, as were indices of cardiac and myocardial performance shortening fraction mean velocity of circumferential fiber shortening were decreased but did not go significant change on the six week of replacement hormonal therapy.

The mechanism of hyper-dynamic high-output state of the cardiovascular system in hyperthyroidism is characterized by a significant increase in cardiac index secondary to increased heart rate, unchanged stroke volume and ejection fraction with no significant change in mean arterial pressure but at the expense of significantly reduced peripheral vascular resistance achieved by high speed ejection with shortened systolic time intervals and shorter and quicker diastolic filling. The above data do not speak in favor of an increased contractility of left ventricular myocardium under the influence solely of thyroid hormones. When analyzing the potential factors influencing cardiac function in hyperthyroidism they include reduced peripheral resistance, increased contractility, increased blood volume, increased heart rate. (5-12)

The mechanisms of hypo-dynamic low-output state of the cardiovascular system in hypothyroidism are characterized by a significant reduction in cardiac index, unchanged heart rate at the expense of reduced stroke volume and ejection fraction with a significant change in mean arterial pressure and a significant increase in total peripheral resistance. And increased total peripheral resistance plays a major role in reduction of contractile indices of the left ventricle-fractional shortening and mean velocity of circumferential fiber shortening. The decrease in cardiac output is reached at the expense of increased end-systolic dimension and by reducing the speed of
ejection with increased systolic time intervals and prolongation of the time of diastolic filling. (13-17, 18-22)

References

10. Lewis BS, Ehrenfeld EN, Lewis N, Gotsman MS; Echocardiographic LV function in thyrotoxicosis. Am Heart J 1979 97/4:460,
14. Bough EW, Crowley WF, Ridgway EC; Myocardial function in hypothyroidism. Arch Intern Med 1978. 138:1476,
Illustrations

Illustration 1

Table 1

<table>
<thead>
<tr>
<th>PATIENTS</th>
<th>Age</th>
<th>HR</th>
<th>PBI</th>
<th>ET ms</th>
<th>ETcms</th>
<th>PEP ms</th>
<th>PEPc ms</th>
<th>PEP/ET</th>
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</thead>
<tbody>
<tr>
<td>Hyperthyroid</td>
<td>40 ± 8</td>
<td>96 ± 12*</td>
<td>11.3 ± 1.6</td>
<td>255 ± 15*</td>
<td>260 ± 15*</td>
<td>65 ± 10*</td>
<td>95 ± 5*</td>
<td>0.266 ± .30*</td>
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<tr>
<td>Controls</td>
<td>39 ± 5</td>
<td>70 ± 8</td>
<td>-</td>
<td>285 ± 10</td>
<td>300 ± 10</td>
<td>95 ± 5</td>
<td>105 ± 5</td>
<td>0.332 ± .20</td>
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<tr>
<td>Hypothyroid</td>
<td>44 ± 11</td>
<td>69 ± 12 NS</td>
<td>2.3 ± 0.9</td>
<td>280 ± 55 NS</td>
<td>305 ± 15 NS</td>
<td>125 ± 40</td>
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<td>0.409 ± .40</td>
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<table>
<thead>
<tr>
<th>PATIENTS</th>
<th>EDD mm</th>
<th>ESD mm</th>
<th>EF %</th>
<th>SF %</th>
<th>MVCFS</th>
<th>CI</th>
<th>SVR kPa.s/l</th>
<th>LVMi g/m2</th>
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</thead>
<tbody>
<tr>
<td>Hyperthyroid</td>
<td>49 ± 5 NS</td>
<td>29 ± 4 NS</td>
<td>71 ± 9 NS</td>
<td>41 ± 5 □</td>
<td>1.6 ± 0.3 △</td>
<td>4.47 ± 0.57 *</td>
<td>121.2 ± 21 ▲</td>
<td>114 ± 34 ▲</td>
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<tr>
<td>Controls</td>
<td>48 ± 4</td>
<td>30 ± 3</td>
<td>68 ± 4</td>
<td>38 ± 3</td>
<td>1.32 ± 0.11</td>
<td>2.9 ± 0.26</td>
<td>144.4 ± 18</td>
<td>85 ± 9</td>
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<tr>
<td>Hypothyroid</td>
<td>48 ± 4 NS</td>
<td>33 ± 3 □</td>
<td>61 ± 13 □</td>
<td>31 ± 5 □</td>
<td>1.04 ± 0.28 ▲</td>
<td>2.4 ± 0.44 *</td>
<td>193.6 ± 36 *</td>
<td>96 ± 16</td>
</tr>
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</table>

* - p < 0.001; ▲ – p < 0.01; □ – p < 0.02; △ - p < 0.05; NS – not significant- all compared to controls
Illustration 2

Table 2

<table>
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<tr>
<th></th>
<th>HR</th>
<th>ET</th>
<th>ETc</th>
<th>PEP</th>
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<th>EF</th>
<th>MVCFS</th>
<th>PEP/ET</th>
<th>SF</th>
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<td>92</td>
<td>255</td>
<td>269</td>
<td>66</td>
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<td>72</td>
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<td>Week 2</td>
<td>74</td>
<td>280</td>
<td>300</td>
<td>78</td>
<td>101</td>
<td>69</td>
<td>1.33</td>
<td>0.28</td>
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<tr>
<td>Week 4</td>
<td>69</td>
<td>290</td>
<td>308</td>
<td>92</td>
<td>106</td>
<td>69</td>
<td>1.28</td>
<td>0.29</td>
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<tr>
<td>Week 6</td>
<td>72●</td>
<td>290□</td>
<td>301□</td>
<td>90●</td>
<td>101 NS</td>
<td>68 NS</td>
<td>1.30Δ</td>
<td>0.31 NS</td>
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<tr>
<td>Hypothyroid</td>
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<td>288</td>
<td>313</td>
<td>132</td>
<td>108</td>
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<td>0.47</td>
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<tr>
<td>Week 2</td>
<td>67</td>
<td>276</td>
<td>312</td>
<td>133</td>
<td>104</td>
<td>57</td>
<td>0.93</td>
<td>0.45</td>
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<tr>
<td>Week 4</td>
<td>64</td>
<td>276</td>
<td>310</td>
<td>127</td>
<td>106</td>
<td>60</td>
<td>0.97</td>
<td>0.41</td>
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<tr>
<td>Week 6</td>
<td>67 NS</td>
<td>280 NS</td>
<td>301 NS</td>
<td>145 NS</td>
<td>106 NS</td>
<td>61 NS</td>
<td>0.99 NS</td>
<td>0.43 NS</td>
<td>29 NS</td>
</tr>
</tbody>
</table>

* - p < 0.001; ● – p < 0.01; □ – p < 0.02; Δ - p < 0.05; NS – not significant- all compared to beginning of treatment
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