Assessment of Lung Dysfunction with Spirometry in Patients with Thyroid Disorders

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1. INTRODUCTION

Hyperthyroidism and hypothyroidism can cause disorders of respiratory function and disturbances of ventilation. Hyperthyroidism is characterized by hypoventilation, while dyspnoea and hyperventilation are typical symptoms of hyperthyroidism. Ventilation responses to hypoxia and hypercapnia are reduced in hypothyroidism and increased in hyperthyroidism (1, 2).

Hyperthyroidism is associated with respiratory dysfunction, leading to an increase in respiratory rate, respiratory muscle weakness and pulmonary hypertension. The mechanism responsible for reduced pulmonary compliance in patients with hyperthyroidism is not clear, but there are several proposed theories: changes in functional residual capacity, pulmonary congestion and oedema, increased intrathoracic blood volume and changes in the recoil of alveolar septa. Also, in patients with hyperthyroidism a significant reduction in respiratory muscle strength particularly involving the diaphragm is common, which leads to reduced ventilation, especially during exercise (3).

The prevalence of pulmonary arteriovenous shunting in patients with hyperthyroidism is 35%–65% (4, 5). Studies that evaluated the static and dynamic parameters of pulmonary function with spirometry are inconsistent whether there is thyroid disease disorders lead to lung dysfunction. In patients with hyperthyroidism and hypothyroidism decreased values of vital capacity have been observed, while the values of forced vital capacity, forced expiratory volume were inconsistently decreased compared to healthy subjects (6, 7, 8). Assessment of pulmonary function with spirometry in patients with thyroid disorders are particularly important, considering the fact that low levels of thyroid hormones can trigger bronchial hyperreactivity and obstructive pulmonary disorders. Although studies have shown that patients with hyperthyroidism are more prone to asthma exacerbation, it is not clear whether and to what extent the obstructive pulmonary disorder is present in patients with hyperthyroidism. Obstructive disease in patients with dysfunctional thyroid states may be due to direct effect of hormones on the lung function, but might also be due to the present cardiac diseases that often accompany thyroid disorders. The aim of this study was to evaluate the lung ventilation in patients with thyroid disorders.

2. SUBJECTS AND METHODS

All participants of our study were selected from the subjects who performed control of thyroid hormone level and FVC% (r=0,51; p<0,05), while in patients with hypothyroidism a significant, negative correlation was observed between serum TSH level and VC% (r = -0,627; p<0,01) and between serum TSH level and FVC% values (r = -0,514; p<0,01). Our study confirmed significantly lower VC% and FVC% in patients with dysfunctional thyroid states compared to healthy subjects. In our study a significant association between VC%, FVC% and serum TSH levels suggest that duration and a degree of thyroid disorders lead to reduced ventilator lung function in patients with thyroid dysfunction.

Key words: thyroid dysfunction, spirometry, lung function
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t was obtained by the local Ethics Committee. All procedures on human subjects were performed in accordance with the latest version of Helsinki Declaration. All subjects included in the study signed an informed consent with careful explanation of the study procedures.

Blood samples were taken from all patients to determine their serum FT3, FT4 and TSH which were determined using electrochemiluminescence immunoassay “ECLIA” on Elecsys 2010 (Roche Diagnostic). All measurements were performed at the Institute of Nuclear Medicine, University of Sarajevo Clinics Centre. The analytic range extends from 5–35,00 pg/mL. Lung function parameters were analysed using portable Spir-oUSB spirometer (Micro Medical, Auburn, Main, USA) connected to portable computer using the Spida 5 software (Micro Medical, Auburn, Main, USA). We determined the parameters of the dynamic spirometry: VC–vital capacity, FVC–forced vital capacity, FEV1–Forced expiratory volume in the 1st second, the FVC/FEV1 ratio. Using Spida 5 software, predicted values and the percentage of predicted values were calculated for VC–VC%, FVC–FVC%, FEV1–FEV1% and FVC/FEV1–FVC/FEV1% for each subject based on the subjects height, age and sex. For normal distributed variables, values are expressed as mean ± SEM. Differences in mean between groups were tested using a t-test. Correlation between continuous variables was tested with Spearman’s rank correlation analysis. Two-tailed p values < 0.05 were considered statistically significant. Statistical analysis was performed using SPSS statistical software system (version 16.0, SPSS Inc., Chicago, Illinois, USA).

3. RESULTS

Average VC%, FVC% and FEV1% values were significantly lower in subjects with hyperthyroidism and in subjects with hypothyroidism compared to euthyroid subjects.

In hyperthyroid group of subjects a significant positive correlation between TSH and VC% values (r = 0.51, p < 0.05) (Table 2). In the group of subjects with hypothyroidism a significant positive correlation between serum FT3 levels and VC% (r = 0.54, p < 0.05) was observed. There was also a negative correlation between serum TSH levels and VC% (r = -0.627, p < 0.01) and between serum TSH levels and FVC% (r = -0.514, p = 0.01) (Table 2) in subjects with hypothyroidism. In euthyroid group of subjects there was no significant correlation between thyroid hormones, TSH and the ventilation parameters.

4. DISCUSSION

Examining the dynamic parameters of lung function we found a significantly lower values of VC%, FVC% and FEV1% and FVC/FEV1% and FVC/FEV1–FVC/FEV1% for each subject based on the subjects height, age and sex. For normal distributed variables, values are expressed as mean ± SEM. Differences in mean between groups were tested using a t-test. Correlation between continuous variables was tested with Spearman’s rank correlation analysis. Two-tailed p values < 0.05 were considered statistically significant. Statistical analysis was performed using SPSS statistical software system (version 16.0, SPSS Inc., Chicago, Illinois, USA).

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### Table 1. Spirometry parameters in patients with thyroid dysfunction

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Hyperthyroid group</th>
<th>Hypothyroid group</th>
<th>Euthyroid group</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC%</td>
<td>94.18 ± 1.24</td>
<td>96.13 ± 1.09</td>
<td>98.54 ± 0.93*</td>
</tr>
<tr>
<td>FVC%</td>
<td>92.5 ± 1.47</td>
<td>94.08 ± 1.42</td>
<td>99.16 ± 1.15*</td>
</tr>
<tr>
<td>FEV1%</td>
<td>90.97 ± 2.07</td>
<td>87.59 ± 1.4</td>
<td>93.48 ± 1.1*</td>
</tr>
<tr>
<td>FEV1/FVC%</td>
<td>94.9 ± 2.14</td>
<td>92.0 ± 1.5</td>
<td>93.9 ± 1.25</td>
</tr>
</tbody>
</table>

*–significant difference between euthyroid and hyperthyroid and hypothyroid group

### Table 2. Correlation coefficients between thyroid hormones and lung function parameters in hyperthyroid and hypothyroid group

<table>
<thead>
<tr>
<th>Parameter</th>
<th>FV3</th>
<th>FT4</th>
<th>TSH</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC%</td>
<td>r = -0.46</td>
<td>r = 0.54*</td>
<td>r = -0.305</td>
</tr>
<tr>
<td>FEV1%</td>
<td>r = 0.245</td>
<td>r = 0.349</td>
<td>r = -0.213</td>
</tr>
<tr>
<td>FVC%</td>
<td>r = -0.218</td>
<td>r = -0.375</td>
<td>r = -0.28</td>
</tr>
<tr>
<td>FEV1/FVC%</td>
<td>r = 0.278</td>
<td>r = 0.122</td>
<td>r = -0.145</td>
</tr>
</tbody>
</table>

r–Spearman correlation coefficients; *p < 0.05
that the hypothyroidism is associated with decreased vital capacity, FEV1, FVC and total lung capacity. The authors suggested that alveolar hypoventilation and decreased inspiratory muscle strength might be a possible explanation. Martinez et al. (10) have confirmed that patients with hypothyroidism develop diaphragmatic dysfunction, which can vary from mild forms associated with reduced tolerance to physical effort, to very severe forms of diaphragmatic weakness which even might imitate diaphragmatic paralysis. The authors of the study showed that these changes are reversible with Levothyroxin therapy even after only 8 weeks (10, 11).

The most common respiratory symptoms in patients suffering with hypothyroidism are cough, shortness of breath and increased production of sputum (12). In patients with hypothyroidism the respiratory rate is decreased with subsequent hypventilation which leads to mild hypercapnia. Hypercapnia stimulates the respiratory centre, which cannot respond to an increased need for ventilation due to the decreased levels of thyroid hormones (12). In addition, decreased levels of thyroid hormones lead to decreased expression of β-adrenergic receptors which often causes bronchial tree hyper reactivity. Birring et al (12) noted that in patients with low levels of thyroid hormone there is an increased sensitivity of the cough reflex, and increased airway hyper responsiveness, and an increased number of inflammatory cells in sputum. Obstructive sleep apnoea is a common symptom in patients with hypothyroidism. In hypothyroidism, deposits of mucopolysaccharides and protein extravasations lead to oedema favouring pulmonary congestion and oedema. In patients with subclinical hypothyroidism we found significant positive correlation between serum levels of TSH and FVC% in hyperthyroid subjects. Low TSH levels suggest longer duration of disease, and in these subjects FVC% were significantly lower. In hypothyroid subjects we also found negative correlation between serum levels of TSH and FVC%, and between TSH and VC%. In our hypothyroid group of subjects serum TSH levels ranged from 5 mIU / L to 20mIU / L. These findings suggest that the higher levels of TSH, the longer duration of illness, is associated with lower FVC% values. In patients with hypothyroidism we found statistically significant positive correlation between FT3 and VC%. However, in euthyroid subjects we found no significant correlation between thyroid hormones and parameters of lung function. Our results therefore support the thesis that the degree and the duration of thyroid disorder is associated with lower FVC% values and poor pulmonary function. Cakmak et al. (13) in group of patients with clinical hypothyroidism, found a significant negative correlation between TSH and FVC%. Also, in their study a significant positive correlation between FT3 and FEF25-75, FEF25-75%, PEF and% PEF values was observed. In patients with subclinical hypothyroidism the authors also found a significant positive correlation between FT4 and FEF25-75, FVC and FVC% values. The causes for the above association between thyroid dysfunction and ventilation can be numerous. In patients with hypothyroidism the causes for reduced respiratory function are decreased inspiratory muscle strength, hypventilation, hypercapnia, increased bronchial reactivity, pleural effusion and protein extravasations into the tissue which can lead to oedema. In patients with hyperthyroidism, possible mechanisms responsible for reduction in respiratory function are increased respiratory rate, respiratory muscle weakness, reduced lung compliance, pulmonary congestion and oedema, increased intrathoracic blood volume, and pulmonary hypertension.

5. CONCLUSION

Our study showed that a thyroid disorders causing hyperthyroidism and hypothyroidism could cause disorders of respiratory function and ventilation.

REFERENCES


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