ORIGINAL ARTICLE

Oxygen Saturation Status of Female Hyperthyroid Patients in Dhaka

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ABSTRACT

Introduction: Hyperthyroidism is a common hormonal disorder which affects multiple organ system in the body including lungs. It causes public health problem worldwide as well as in our country. Thyroid hormones accelerate basal metabolic rate and increase tissue oxygen demand. Despite increased oxygen consumption the effect of hyperthyroidism on arterial oxygen saturation and hemoglobin oxygen binding dynamics remains under investigation. The aim of this study was to assess the tissue oxygenation status in female hyperthyroid patients.

Materials and methods: This cross-sectional study was conducted in the Bangladesh Medical University (BMU) (former Bangabandhu Sheikh Mujib Medical University, BSMMU) Dhaka, Bangladesh in 2017. A total of 90 female subjects, 25-45 years of age were randomly selected. Among them, 60 were hyperthyroid patients and 30 were apparently healthy subjects for comparison. On the basis of receiving treatment, those 60 hyperthyroid patients were divided into 30 untreated hyperthyroid and 30 treated hyperthyroid patients, receiving treatment for 6 months or more. The oxygen saturation status of blood was measured by pulse oximeter.

Result: Mean±SD of oxygen saturation of healthy group was 98.30±3.07%, that of untreated hyperthyorid was 95.30±29.7% and of treated hyperthyroid was 98.00±5.53%. The oxygen saturation was significantly lower in all study groups in comparison to the healthy controls and also significantly higher in treated group than those of untreated group. In untreated group (n=30), though the saturation was significantly low, all the cases but only 2 was above 95% saturation.

Conclusion: It may be concluded that the oxygen saturation is a bit low in untreated hyperthyroid patients and this may return to normal after adequate antithyroid treatment.

Key words: Hyperthyroidism, oxygen saturation status

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INTRODUCTION

Hyperthyroidism is characterized by excessive secretion of thyroxine (T4) and triiodothyronine (T3), leading to a hypermetabolic state[1]. Thyroid dysfunction is one of the most commonly encountered endocrine disorder affecting about 300 million people worldwide and half of them are presumed to be unaware of their condition[2]. Hyperthyroidism can have a significant impact on public health problem and can even shorten the life span of individual of any age[3]. Worldwide the prevalence of hyperthyroidism in woman is between 0.5 to 2% and ten times more common in women than men in iodine replete communities[4]. In Bangladesh there is no study of exact prevalence of hyperthyroidism. But a community-based study performed among the people of Khulna district reported the incidence of hyperthyroidism to be 0.86% and of subclinical hyperthyroidism to be 0.65% [5]. In different study the prevalence is increasing day by day[6].

The cardiovascular system plays a compensatory role in meeting this increased metabolic demand and associated with increased heart rate, enhanced stroke volume, widened pulse pressure, and elevated cardiac output, all of which augment systemic oxygen delivery[7]. However, the increased metabolic requirement may also predispose patients to relative tissue hypoxia, especially during stress or exercise[8].

Pulmonary function is also influenced by hyperthyroidism, as increased metabolic activity leads to hyperventilation and changes in respiratory drive[9]. Despite these alterations, most hyperthyroid patients demonstrate normal or near-normal arterial oxygen tension under resting conditions.[10] This observation suggests that compensatory cardiopulmonary mechanisms preserve arterial oxygen saturation even in the increased oxygen demand[11].

Hemoglobin's affinity for oxygen is modulated by several factors, including temperature, pH, and the

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concentration of 2,3-bisphosphoglycerate (2,3-BPG)[12]. In hyperthyroid states, elevated body temperature, increased 2,3-BPG levels, and a tendency toward respiratory alkalosis result in a rightward shift of the oxyhemoglobin dissociation curve (ODC), thereby promoting oxygen unloading to the tissues[13].

Oxygen saturation is an indicator of the percentage of hemoglobin saturated with oxygen at the time of measurement. Oxygen saturation values obtained from pulse oximetry (SpO_2) are one part of a complete assessment of the patient's oxygenation status. Normal oxygen saturation values are 97% to 99% in the healthy individual and of 95% is clinically accepted in a patient with a normal hemoglobin level. However, oxygen saturation does not reflect the patient's ability to ventilate[14].

MATERIALS & METHODS

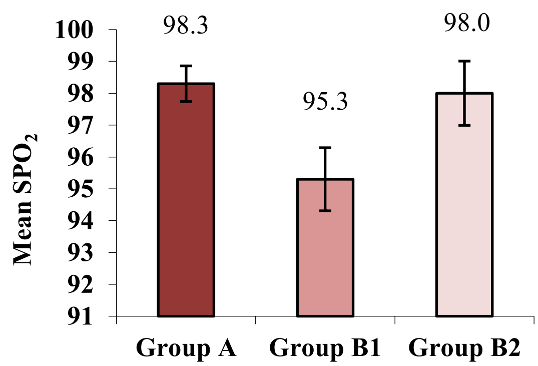
This cross-sectional study was carried out at the Department of Physiology in Bangladesh Medical University (BMU) (former Bangabandhu Sheikh Mujib Medical University, BSMMU) in 2017. A total of 90 female subjects age ranged from 25 to 45 years was purposively selected for this study. Among them 60 female hyperthyroid subjects were taken as study group (Group B) and they were again subdivided into 30 newly diagnosed untreated hyperthyroid patient (Group B_1) and 30 patients treated with carbimazole for 6 months (Group B_2). Age matched 30 healthy female subjects were taken as control (Group A).

Ethical clearance for the study was granted from the institutional review board (IRB) of BMU (Former BSMMU). Patients were fully informed about the study using their own language properly. Written consent was taken from each participant. History was taken from all the respondents using structured questionnaire and a check list was filled up collecting data from the patients. Clinical examination of the patient was also done and recorded. In this study serum TSH and FT_4 level were measured in all subjects in order to determine their thyroid function status. All these variables were also studied in 30 apparently healthy age, BMI, Socioeconomic status and occupation matched female control subjects for comparison. Again, both groups (control and study) were comparable in their demographical characteristics as there was no significant difference in the confounding variables such as age, BMI, socioeconomic status and occupation. In addition, serum glucose and creatinine levels were estimated in all the study subjects in order to exclude presence of diabetes mellitus and chronic kidney disease.

Percent saturation of oxygen was estimated by pulse oximeter. The reading obtained through pulse oximetry uses a light sensor containing two sources of light (red and infrared) that are absorbed by hemoglobin and transmitted through tissues to a photo detector. The amount of light transmitted through the tissues is then converted to a digital value representing the percentage of hemoglobin saturated with oxygen. Data were expressed as mean ± SD and statistical analysis was done with the help of SPSS (Statistical Package for Social Science) version 16.

RESULTS

In this study, the mean ± SD of measured values of SpO_2% were 98.30±3.07, 95.30±29.7, 98.00±5.53 in group A, B_1 and B_2 respectively.
In this study the mean difference of measured values of SpO_2% among the groups were statistically significant ($P<0.001$).
Although the mean values of SpO_2% were significantly ($p \leq 0.001$) lower in group B_1 in comparison to that of group A. However, the mean measured values of SpO_2% were lower in group B_1 in comparison to that of group B_2, the difference was statistically significant.
Though the value of this variable in group B_2 was lower than group A. But the difference was statistically not significant.



Values are expressed as mean ± SE
Group A : Apparently healthy euthyroid (control)
Group B_1 : Untreated hyperthyroid (study group)
Group B_2 : Treated hyperthyroid (study group)
% PV : Percentage of predicted value
n : Number of subjects

Figure 1: Mean oxygen saturation (SPO_2) in different groups (n=90)

Table I: Mean oxygen saturation (SPO_2) in different groups (n=90)

Groups	N	Percent saturation of O_2
A	30	98.30±3.07 (97-99)
B1	30	95.30±29.7 (75-99)
B2	30	98.00±5.53 (75-99)

Statistical analysis:

Group	p value
A vs B_1 vs B_2^{a}	0.001***
A vs B_1 ^{b}	0.003**
A vs B_2^{b}	0.160^{ns}
B_1 vs B_2^{b}	0.006**

Data were expressed as Mean ± SD. Figures in parentheses indicate ranges.
Statistical analysis was done by one way ANOVA (a) independent sample t-test (b)
Group A : Apparently healthy euthyroid (control)
Group B_1 : Untreated hyperthyroid (study group)
Group B_2 : Treated hyperthyroid (study group)
*** : $p<0.001$
** : $p< 0.01$
ns : non-significant ($p > 0.05$)
n : number of subjects

Frequency percentage of all subjects by SpO_2% (normal/abnormal) in different groups (n=90):

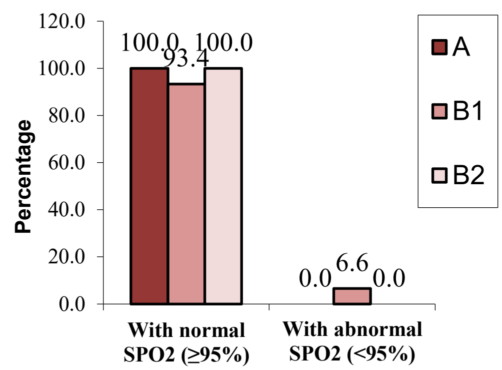
The results are shown in Table II and Figure 16.
In this study, all the group A (control) subjects 30 (100.0%) were with normal SpO_2%.
On the other hand, in study group B_1 28(93.4%) subjects were with normal SpO_2% and 2 (6.6%) subjects were with abnormal SpO_2%.
However, in study group B_2 30 (100.0%) subjects were with normal SpO_2%.

Table II: Frequency percentage of all subjects by SpO_2% (normal/abnormal) In different groups (n=90)

Groups	N	With normal SpO_2 (≥95%) n (%)	With abnormal SpO_2 (<95%) n (%)
A	30	30(100.0)	0(0.00)
B_1	30	28(93.4)	2(6.6)
B_2	30	30(100.0)	0(0.0)

Group A : Apparently healthy euthyroid (control)
Group B_1 : Untreated hyperthyroid (study group)
Group B_2 : Treated hyperthyroid (study group)
n : number of subjects
F : Frequency
% : Percentage
SpO_2 : Oxygen saturation
SpO_2 : $>95\%$ (Schutz 2001)

Figure 2: Frequency percentage of all subjects by SpO_2% (normal/abnormal) In different groups (n=90)



Group A : Apparently healthy euthyroid (control group)
Group B_1 : Untreated hyperthyroid
Group B_2 : Treated hyperthyroid (study group)
% PV : Percentage of predicted value
n : Number of subjects

DISCUSSION

The present study has been undertaken to observe the oxygen saturation status in hyperthyroid patients. For these 60 diagnosed hyperthyroid female patients were selected to observe the oxygen saturation status. Among them 30 were newly diagnosed hyperthyroid patients and 30 hyperthyroid patients were treated with oral carbimazole for six months or more by the endocrinologist.

In this study SpO_2% in untreated hyperthyroid patients were significantly lower in comparison to that of treated hyperthyroid patients and control group. Similarly, also found significantly lower SpO_2 in untreated hyperthyroid patients than that of treated hyperthyroid[15]. Furthermore, SpO_2% was lower in treated hyperthyroid patients than that of control group but the difference was statistically non-significant.

Almost all the organs of human body including lungs are affected by hyperthyroidism. Several investigators of different countries made various suggestions about the pulmonary involvement in this specific group of patients. [16,17,18,19,20,21,22]

Thyroid hormones affect virtually every cell in the body and stimulate the O_2 consumption and heat production of most of the cells in the body which is necessary for normal growth and maturation[23]. Thyroid hormones act at the cellular level to increase mitochondrial oxidative phosphorylation, stimulate protein synthesis, and up-regulate Na^+/K^+ ATPase activity, thereby increasing basal metabolic rate (BMR)[24]. As a result, patients with hyperthyroidism exhibit increased oxygen consumption and carbon dioxide production compared to euthyroid individuals[25].

It has been suggested that thyroid hormones play critical roles in the lung development, surfactant synthesis and also in lung defense (Kendrick et al.1998).[24] They are also associated with myopathy of both inspiratory and expiratory muscles, which reduce smooth muscle contractility, respiratory muscle weakness and eventually cause respiratory failure[27]. This respiratory muscle weakness causes faster and shallower breathing in hyperthyroid patients [28]. On the other hand, elevated thyroid hormone causes lack of adequate surfactant by reducing critical surfactant protein expression in human lung cells, which results in reduced pulmonary compliance and reduced gas exchange.

Several mechanisms may explain the reduced SpO_2 observed in hyperthyroid patients. Hyperthyroidism markedly increases basal metabolic rate and oxygen consumption due to the stimulatory effects of thyroid hormones on mitochondrial respiration[29]. When the rate of tissue oxygen utilization exceeds the capacity of pulmonary oxygen uptake and cardiovascular delivery, a relative desaturation may occur, particularly in the periphery[30]. In some individuals, ventilation–perfusion mismatch may occur, leading to impaired arterial oxygenation[31]. Additionally, increased pulmonary blood flow due to high cardiac output may shorten pulmonary capillary transit time, reducing the efficiency of oxygen diffusion across the alveolar-capillary membrane [32].

Hyperthyroidism is associated with increased body temperature, metabolic acidosis, and elevated levels of 2,3-bisphosphoglycerate (2,3-BPG), all of which shift the oxyhemoglobin dissociation curve to the right[27]. While this adaptation enhances oxygen unloading at the tissue level, it may reduce oxygen saturation in arterial blood samples and peripheral oximetry measurements[33]. Thus, the lower SpO_2 observed in this study likely reflects both increased tissue extraction and reduced hemoglobin affinity for oxygen.

The mechanism by which the respiratory muscle strength is improved when patients become euthyroid is not known. Other investigator found decrease in BMI, 20% reduction in skeletal muscle mass and 40% in muscle strength were observed during hyperthyroidism, reversed after 9 months of carbimazole therapy[34]. Hyperthyroid myopathy caused by both hormonal and adrenergic effects and it rapidly responds to restoration of euthyroid state by antithyroid drugs[35, 36]. Pulmonary function may increase after treatment. The possible mechanisms of this increase may be improvement of respiratory muscle weakness and also a significant increase in diaphragmatic muscle excursion on deep respiration after carbimazole therapy[37].

In the present cross sectional observational study, the mechanisms involved for the lower lung function variables in hyperthyroid patients cannot be explained exactly. However, it is assumed that all the above-mentioned mechanisms may influence the deterioration of these variables and treatment of hyperthyroidism can result in improvement of respiratory function. Hollowell and Staub (1968)[31] reported that patients with untreated hyperthyroidism exhibited reduced pulmonary diffusing capacity, which could contribute to decreased arterial oxygen saturation. Their results provide early physiological evidence that hyperthyroidism affects alveolar–capillary oxygen transfer, supporting the present study's observation of lower SpO_2. Most patients in the treated group demonstrate normalization of SpO_2 after achieving a euthyroid state[38].

Conclusion

From this study, it may be concluded that the oxygen saturation status is significantly lower in untreated hyperthyroid patients and this oxygen saturation status may return to normal after adequate antithyroid treatment. In addition, the alteration in this group of patients may be associated with silent pulmonary disorders without presenting any pulmonary symptoms.

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