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Full Length Research Paper

Association between peripheral oxygen saturation during the shuttle walk test and quality of life in patients with chronic pulmonary obstructive disease

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The aim of the present study was to determine whether peripheral oxygen saturation (SpO_2) monitored in patients with chronic pulmonary obstructive disease (COPD) during a physical capacity test is correlated with quality of life components. The sample comprised 30 patients with COPD (16 men and 14 women). All participants were submitted to a spirometric evaluation. Quality of life was evaluated using the 36-item Short Form of the Medical Outcomes Study (SF-36). Functional capacity was evaluated using the Incremental Shuttle Walk Test (ISWT). SpO_2 was positively correlated to the physical functioning ($r = 0.37$; $p < 0.03$), role physical ($r = 0.37$. $p < 0.04$), general health state ($r = 0.39$; $p < 0.02$) and vitality ($r = 0.37$; $p < 0.04$) subscales of the SF-36. SpO_2 was also correlated with the distance walked on the ISWT ($r = 0.37$; $p < 0.04$), which, in turn, was positively correlated with the general health state subscale of the SF-36 ($r = 0.34$; $p < 0.05$). Desaturation during the evaluation of functional capacity using the ISWT was correlated with worse symptoms reported by patients with COPD, thereby demonstrating an association between SpO_2 and quality of life in these patients.

Keywords: Shuttle walk test, COPD mechanisms, hypoxemia, quality of life.

INTRODUCTION

Quality of life is a complex concept that generally refers to the perception one has regarding the effects of an adverse health condition on personal satisfaction as well as physical, functional, emotional and social wellbeing (Lana et al., 2007). Diminished exercise capacity, which is a common manifestation of chronic pulmonary obstructive disease (COPD), can exert a considerable

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impact on quality of life, as such individuals are commonly limited in their capacity to perform activities of daily living (Velloso and Jardim, 2006). Thus, it is important to consider perceptions regarding quality of life during physical activities or during a functional capacity test, especially when related to physiological variables, such as peripheral oxygen saturation (SpO_2).

Intolerance to physical exercise, weariness and muscle fatigue affect both the upper and lower limbs, limiting one's performance on functional activities (Cavalheiro, 2010). Some muscle participate in the movements of the arms and assist in both postural control and respiratory function (Celli, 1994), which can alter SpO_2. A change in SpO_2 greater than four percentage points is characterized as desaturation (Prefaut et al., 2000).

Outcomes related to quality of life, physical functioning and satisfaction have been explored in recent decades, allowing a more in-depth evaluation of a patient's health status both in terms of clinical aspects and the patient's own perceptions of health and illness (Lopes et al., 2007). However, scientific evidence grounded on such perceptions is scarce and evaluations are often limited to physiological and physiopathological findings.

Testing the hypothesis that desaturation may explain a possible worsening in the quality of life of patients with COPD, the aim of the present study was to determine whether SpO_2 monitored during physical capacity test is correlated with quality of life components.

METHODS

Forty-two individuals (23 men and 19 women) with a clinical diagnosis of COPD based on the criteria of the Global Initiative for Chronic Obstructive Lung Disease (GOLD, 2013) were screened and asked to participate in the study. The inclusion criteria were a clinically stable condition, sedentary lifestyle and body mass index (BMI) < 30 kg/m^2. Five individuals over 80 years of age, two with a recent history of exacerbation, one with uncontrolled hypertension, one under home oxygen therapy, one with cardiovascular disease and two with neurological and/or osteoarticular disease were excluded from the study. Thus, the final sample was made up of 30 individuals (16 men and 14 women).

All patients were given clarifications regarding the procedures of the study in compliance with Resolution 196/96 of the Brazilian National Health Board and signed a statement of informed consent. This study received approval from the Human Research Ethics Committee of the institution (process number: 346/2011).

Data were collected on personal and anthropometric (weight, height and BMI) characteristics as well as living habits and personal/family medical history (Table 1).

All participants were submitted to a spirometric evaluation for the classification of the severity of obstruction, involving the recording of slow vital capacity (SVC), forced vital capacity (FVC), forced expiratory volume in the first second (FEV_1), FEV_1/FVC ratio and FEV_1/SVC ratio. The test consisted of maximum inspiration and expiration maneuvers, which were performed on a previously calibrated spirometer (KoKo® PFT) until recording three reproducible maneuvers, as recommended by the American Thoracic Society (American Thoracic Society, 1995). The tests were performed in a climate-controlled setting. The reference values were those reported by Pereira et al. (Pereira et al., 1992).

On a separate occasion, (Figure 1) the 36-item Short Form (SF-36) generic quality of life questionnaire from the RAND Medical Outcomes Study was administered, which has eight subscales: physical functioning, role physical, bodily pain, general health state, vitality, role social, role emotional and mental health. The score ranges from 0 (worst health state) to 100 (best health state). The questionnaire was self-administered in the presence of the same examiner and questions regarding the items were clarified based on the application manual (Ciconelli et al., 1999).

The patients were then submitted to a functional capacity test: the Incremental Shuttle Walk Test (ISWT), which was administered by a duly trained examiner in a corridor in which a ten-meter track was marked. A cone was placed 0.5 meters from each end of the track to minimize abrupt changes in direction. The pace was determined by a sound device in the form of a beep, which dictated the progression of the test. The onset of the test was indicated by three beeps. The device then emitted a single beep at regular intervals, between which the subject was to leave one end of the track and arrive at the other end before the next beep went off. Each new cycle initiated with three beeps signaled an increase in speed, which was standardized based on Sing et al. 2008.

A standardized explanation and demonstration were given to each participant prior to the test. The subject was instructed to walk at a constant pace, walk around the cone and continue walking until he/she felt unable to maintain the necessary pace to reach the other end of the track before the next beep without becoming excessively breathless. Throughout the test, heart rate (HR), peripheral oxygen saturation (SpO_2), blood pressure (BP) and respiratory frequency (Rf) were monitored. Moreover, sensations of shortness of breath and lower limb fatigue were monitored using the Borg scales. These data were recorded for each new phase of the test. Oxygen supplementation could be provided if the patient exhibited a drop in SpO_2 below 80%. The test was

Table 1. Characteristics of population (n=30).

Variables	
Age (years)	66,6±6,4
Weight (Kg)	67,9±14,8
Height (m)	1,6±0,1
BMI (Kg/m^2)	25,9±5,1
SpO2	94,8±2,7
HR (bpm)	85,4±12,7
SAP (mmHg)	124,7±13,6
DAP (mmHg)	79,8±11,0
FVC (%)	86,1±21,6
FEV_1 (%)	55,3±18,4
FEV_1/FVC (%)	63,7±15,7

The values correspond to the mean ± standard deviation. BMI :body mass index; Peripheral oxygen saturation: SpO2; HR: heart rate; SAP: systolic blood pressure; DAP: diastolic blood pressure; FVC: forced vital capacity; FEV_1: forced expiratory volume in one second; VEF1CVF: Tiffeneau index.

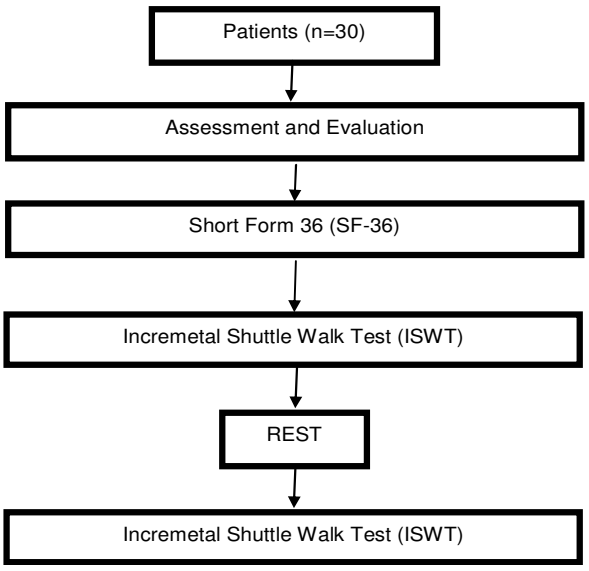

Figure 1. ConsortDiagram

performed twice to eliminate a possible learning effect, as recommended by Sing et al. 2008. A rest interval was granted between each test to allow the vital signs to return to baseline levels (Singh et al., 2008).

The Kolmogorov-Smirnov test was used to determine the distribution of the data. Pearson's correlation coefficients were calculated for parametric data and Spearman's correlation coefficients were calculated for nonparametric data. The level of significant was set to 5% ($p \leq 0.05$).

RESULTS

Table 1 displays the anthropometric data of the 30 patients with COPD. All participants were ex-smokers. None of the participants required oxygen supplementation during the ISWT.

Significant positive correlations were found between SpO_2 and the following SF-36 subscales: physical functioning ($r = 0.37$; $p < 0.03$ in Figure 2), role physical ($r = 0.37$. $p < 0.04$ in Figure 3), general health state (r =

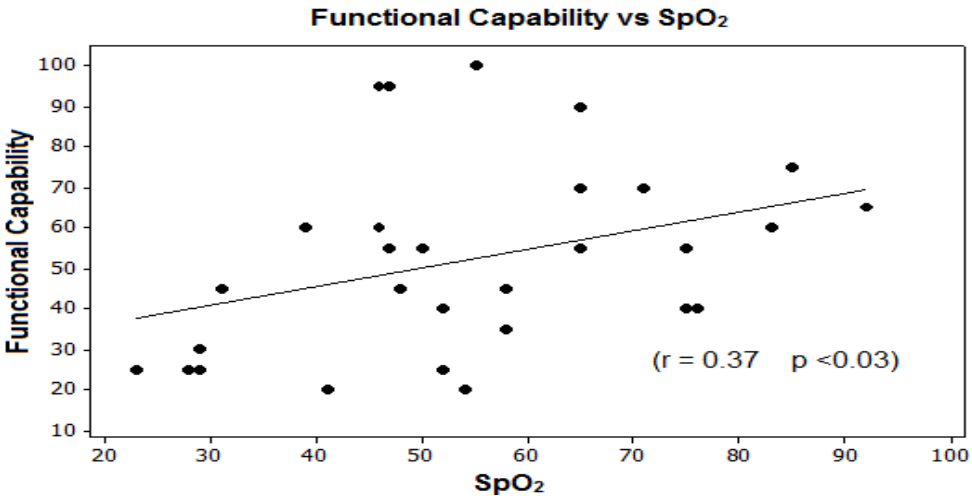

Figure 2. Correlation between Functional Capability and SpO_2

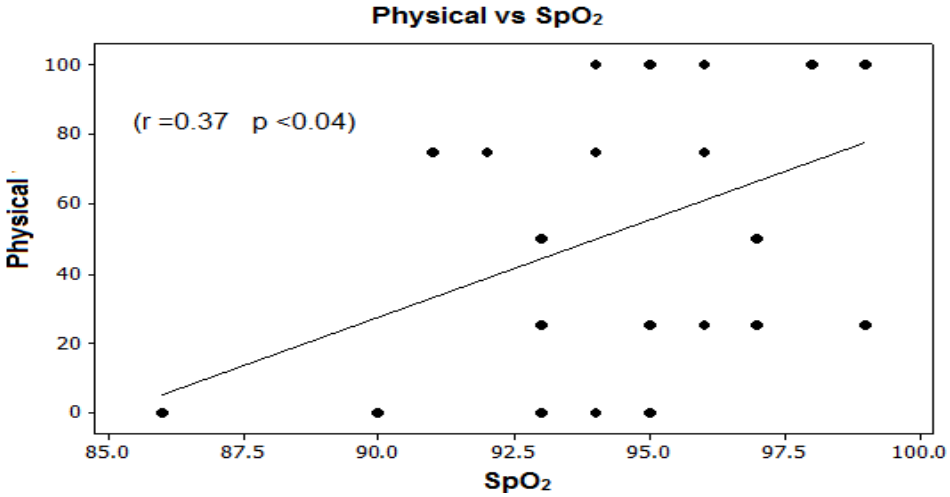

Figure 3. Correlation between Physical and SpO_2

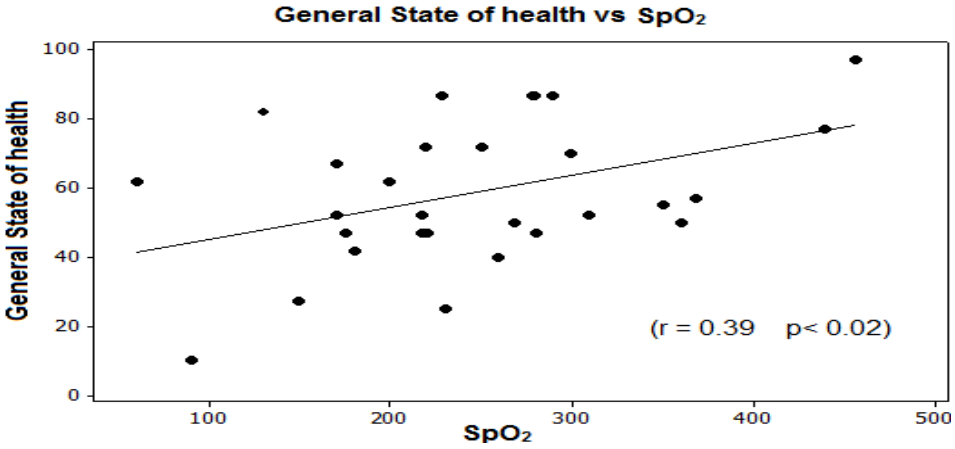

Figure 4. Correlation between General state of health and SpO_2

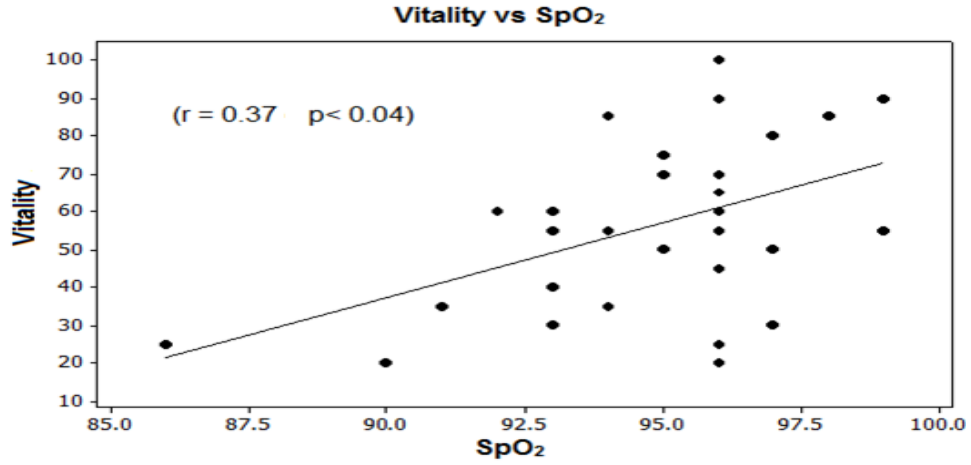

Figure 5. Correlation between Vitality and SpO_2

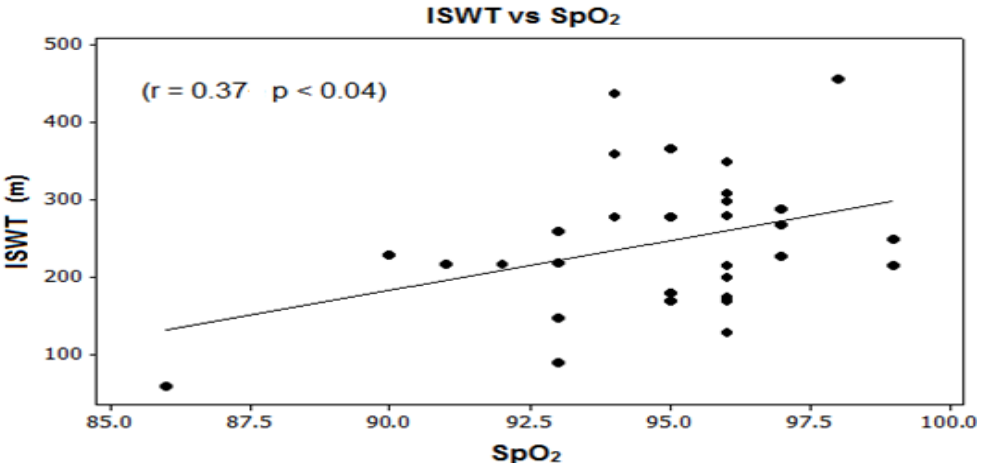

Figure 6. Correlation between ISWT and SpO_2

0.39; $p < 0.02$ in Figure 4) and vitality ($r = 0.37$; $p < 0.04$ in Figure 5). SpO_2 was also correlated with the distance walked on the ISWT ($r = 0.37$; $p < 0.04$ in Figure 6), which, in turn, was positively correlated with the general health state subscale of the SF-36 ($r = 0.34$; $p < 0.05$).

DISCUSSION

The ISWT was employed in the present study with the aim of determining whether desaturation could explain the poor quality of life reported by patients with COPD. Indeed, SpO_2 was correlated with different subscales of the SF-36 quality of life assessment questionnaire.

The SF-36 has been widely employed for the subjective evaluation of clinical symptoms in patients with COPD (Würtemberger and Hütter, 2001). Moreover, pulse oximetry is a valid, reliable measure with the accuracy necessary for the evaluation of hypoxemia during physical exercise for values > 85% (Smyth et al., 1986). In the present sample, the mean minimum SpO_2 was 94 ± 2%.

A correlation was also found between desaturation and a lesser distance travelled on the ISWT. This correlation may be explained by the reduction in the pulmonary capillary bed, culminating in the reduced transport of red blood cells, as hypoxemic blood that enters the systemic arterial system profoundly stimulates ventilation due to the low PaO_2 as well as the high $PaCO_2$ and high concentration of H^+ ions. Sun et al. 2001 evaluated gas exchange in patients with pulmonary hypertension during cardiopulmonary tests and found that the physiopathology of exercise was reflected in a reduction in peak SpO_2 in these patients.

In a review of the literature on this topic, Hütter and Würtemberger 1999 concluded that tolerance to physical exercise was more strongly correlated with quality of life than lung function *per se* and that methods for assessing quality of life constitute reliable tools. The authors stressed the positive correlations between exercise tolerance, as measured by desaturation during the ISWT, and different components of the quality of life questionnaire as well as some spirometric variables.

According to Stavem et al. 2000, PaO_2 is correlated with the components of two quality of life questionnaires – one specific (Respiratory Quality of Life Questionnaire [RQLQ]) and one generic (SF-36), with stronger correlations found with the RQLQ due to the fact that this questionnaire is more sensitive to the population studied. Although PaO_2 was not measured in the present study, it is possible to compare the findings of the two studies, as both report similarities in the results between mean SpO_2 and the age of the patients.

The present study has limitations that should be addressed, such as the lack of a comparison of the variables in this same group of patients with COPD when using oxygen supplementation. Moreover, the use of an additional questionnaire specifically for patients with COPD would have allowed a greater understanding of the correlation between desaturation and the perception of symptoms of the disease.

CONCLUSION

Desaturation during the evaluation of functional capacity using the ISWT was correlated with worse symptoms reported by patients with COPD, thereby demonstrating an association between SpO_2 and quality of life in these patients.

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