INTRODUCTION

It is known that patients with chronic obstructive pulmonary disease (COPD) present harm in their quality of life due to progressive worsening in pulmonary function, which determines lower tolerance to exercise and consequent decrease in performance in activities of daily living (ADLs)1.

During exercise, the active musculature receives blood flow higher than when at rest, and therefore, the oxygen consumption (VO₂) is higher and is able to lead to early muscular fatigue, limiting physical activity2. An individual when walking performs a well-defined task, since it transports its own body for a given distance and during a certain period of time. The six-minute walk test (TC6’) has been used in the dynamic evaluation of COPD patients, analyzing the behavior of the physiological variables, significantly described in 1955, has not been suitably standardized until now7. Both the TC6’ and the SCT are considered submaximal tests, partially described in 1955, which produces more effects on pulmonary function, which determines lower tolerance to exercise and consequent decrease in performance in activities of daily living (ADLs)1.

In a study which evaluated physical aptitude in patients with cystic fibrosis, the authors observed that the SCT produced more remarkable increase in BP and in the adapted Borg scale for dyspnea when compared with the TC6’. In the same study, the decrease in SpO₂ was similar between tests, and the authors concluded that both the SCT and the TC6’ are considered submaximal tests which evaluate the capacity of the patient to perform daily tasks6.

Despite being a low cost test of easy application, the SCT, initially described in 1955, has not been suitably standardized until now7. Both the TC6’ and the SCT are considered submaximal tests, since the patient is told to perform the activity at the highest velocity possible, with standard verbal encouragement7,8.

The present study had the aim to compare the TC6’ and the SCT in COPD patients, analyzing the behavior of the physiological variables, the distance completed and the dyspnea perception in both tests.

METHODS

Twenty-one COPD patients whose diagnosis was established according to the GOLD (Global Initiative for Chronic Obstructive Lung Disease)9 using their clinical history, physical examination and pulmonary function test were invited to participate in the study.

Spirometry was performed with a spirometer (Microlab®, Micromedical, Kent E4 England) following the criteria recommended by the Brazilian Guidelines of Pulmonary Function 10. Confirmation of obstruction of air flow was performed through the ratio of forced expiratory volume on the first second (FEV₁) by the forced vital capacity (FVC) lower than 70% of the expectation, obtained through spirometry after the use of bronchodilator. All patients from the study presented moderate to severe COPD defined by a FVC1 < 60% than the expected value. Patients with development of acute signs who used home oxygenotherapy, and those with osteoarticular comorbidities which stopped them from performing the tests, were excluded from the study.

ABSTRACT

Introduction: Exercise intolerance interposes daily life activities in chronic obstructive pulmonary diseases (COPD); hence, the evaluation of this functional limitation becomes fundamental. Objective: To compare the six-minute walk test (HR₆peak) with the stair-climbing test (SCT) in patients with COPD. Methods: prospective analysis of twenty-one patients with COPD who were part of the - Pulmonary Rehabilitation Program - (PRP). Patients were evaluated from July to October, 2008 when they performed the HR₆peak and SCT, analyzing the physiological variables (HR, PSO₂), and the modified Borg scale before and after each test. The distance was measured at the end of the tests. Results: Comparing the timing (early versus late) of physiological and subjective perception of exertion (RPE) from Borg, we can observe that all changes were statistically significant (p < 0.001) tests. However, when the physiological changes were compared, the PSO₂ obtained presented similar reduction (p = 0.912) in both tests, the HR increased significantly in SCT (p = 0.006) and on Borg RPE (p < 0.001). Regarding the walking distance performed, the HR₆peak (p < 0.001), allowed participants to advance to a distance significantly longer than the SCT. Conclusion: the tests expressed important physiological and subjective perception of effort (RPE) from Borg (p < 0.001).

Keywords: dyspnea, psychological adaptation, respiratory disorders.
The TC6’ consisted in walking as fast as possible during 6min on a 30-meter long corridor of flat surface and marks at every 10 meters, under standard verbal encouragement. The HR and SpO₂ were measured with a wrist oximeter brand name Oximetro (Morrya® model 1001 Ipiranga São Paulo, Brazil). Moreover, the subjective perceived exertion (RPE) was rated through the modified Borg scale. It is a scale of 10 points where the dyspnea sensation is felt at the moment of investigation from “no breathlessness” to “maximal breathlessness”. During the TC6’ test the researcher always walked behind the volunteer, following the rhythm determined by him/her. At the end of the six minutes, the variables were taken not of through the measurement of the distance completed in meters with the use of a measuring tape open at 20m.

The SCT was applied on a ladder with 15 steps, rubber platform and side handles. The patient was told to climb up and down all the steps during the time set, under verbal encouragement so that he/she continued the test and the same parameters of TC6 were measured. Each step was 27cm deep and 13cm high. In order to calculate the distance completed the Pythagoras’ theorem was used (hypotenuse² = a² + b²), where: step area = (step height)² + (step depth)² (figure 1).

The volunteers were individually told to wear proper clothes, avoiding hence any discomfort which could interfere in the test during the activities performed. All individuals performed the two tests, with interval of 48 hours between them in order to provide rest to the patient. Had one of the tests been interrupted, it was he/she continued the test and the same parameters of TC6 were measured. Each step was 27cm deep and 13cm high. In order to calculate the distance completed the Pythagoras’ theorem was used (hypotenuse² = a² + b²), where: step area = (step height)² + (step depth)² (figure 1).

The volunteers were individually told to wear proper clothes, avoiding hence any discomfort which could interfere in the test during the activities performed. All individuals performed the two tests, with interval of 48 hours between them in order to provide rest to the patient. Had one of the tests been interrupted, it was repeated 48 hours later and in case any problem occurred, he/she was excluded from the study.

The study protocol was approved by the Ethics Committee of the Institution under the number 4.08.03.08.990 and all patients signed the Free and Clarified Consent Form added to instructions about the proposed protocol.

Descriptive Statistics was used to present the results through arithmetic means and their respective standard deviations. The intragroup comparisons (initial versus final) were performed with the Student’s t test for paired samples, while the intergroup comparisons (stair climbing test versus walk test) were performed with the Student’s t test for independent samples. All statistical procedures were performed in the SPSS software (version 11.5), with critical level set in p ≤ 0.05.

![Figure 1. Pythagoras’ theorem for calculation of the completed distance in the SCT.](image)

### RESULTS

The 21 patients with COPD diagnosis had mean age of 62 ± 5.75 years and were predominately women 14 (67%) versus seven (33%) men. The majority of the patients presented moderate to severe disease (table 1).

Table 2 describes the physiological variables measured in the beginning and end of the TC6’ and SCT. It can be observed that in the TC6’ performance the patients presented decrease in the SpO₂ variable similar to in the SCT, demonstrating hence that both tests caused desaturation. BP analysis demonstrates that, in both tests this variable significantly increased; however, in a more intense manner in the SCT. The Borg RPE during the tests presented very close values, evidencing increase in the dyspnea sensation during its performance; however, a more significant variation was observed in the SCT. Nevertheless, when the delta of the alterations of the physiological alterations and of the RPE between the SCT and the TC6’ was compared, it was observed that the heart rate variation, of the RPE by the Borg scale and the completed distance, obtained statistically significant alterations (p < 0.001).

Figure 2 demonstrates the results obtained in the variation of the completed distance in the TC6’and in the SCT, in which the patients completed a longer distance in the TC6’ when compared with the distance completed in the SCT and this difference being statistically significant (p < 0.001).

| Table 1. Basal characteristics of the 21 COPD patients. |
|-----------------|----------------|
| Sex             | Mean ± SD      |
| Male            | 14 (67%)       |
| Female          | 7 (33%)        |
| Age             | 62 ± 5.75      |
| Pulmonary function |            |
| FVC (L)         | 2.03 ± 1.13    |
| FVC (%)         | 67.25 ± 20.15  |
| FEV₁ (L)        | 0.87 ± 0.07    |
| FEV₁ (%)        | 41.33 ± 17.6   |
| SpO₂            | 94.9 ± 2.2     |
| HR              | 81.1 ± 2.6     |
| RPE Borg        | 0.5 ± 0.8      |

| Table 2. Comparison between the moments (initial versus final) of the physiological variables and Borg’s rating of perceived exertion (RPE). |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Test            | Variables       | Moment          | t               | p               |
|                 |                 | Initial         | Final           |                 |
| TC6’            | SpO₂            | 94.9 ± 2.2      | 90.4 ± 5.0      | 4.774           | < 0.001         |
|                 | HR              | 81.1 ± 2.6      | 98.4 ± 4.4      | 4.779           | < 0.001         |
|                 | RPE Borg        | 0.5 ± 0.8       | 3.6 ± 2.5       | 5.857           | < 0.001         |
| SCT             | SpO₂            | 94.7 ± 2.5      | 90.1 ± 4.5      | 6.741           | < 0.001         |
|                 | HR              | 86.9 ± 18.8     | 119.3 ± 14.5    | 6.568           | < 0.001         |
|                 | RPE Borg        | 0.2 ± 0.4       | 7.0 ± 2.3       | 14.099          | < 0.001         |

SpO₂ = oxygen saturation; HR = heart rate; RPE Borg = Borg’s rating of perceived exertion; t = variation between the beginning and end of each variable; TC6’ = six-minute walk test, SCT = stair-climbing test.
DISCUSSION

The present study compared the physiological responses of patients with COPD when submitted to two tests considered submaximal, one very much applied – namely the six-minute walk test – and another less frequently applied – namely the stair climbing test. It was possible to observe that both tests promoted significant physiological alterations, but that the SCT, even with a significantly shorter distance, imposed significantly higher overload and work perception.

Considering that the presence of COPD decreases the exercise capacity, climbing stairs is one of the initial limitations in the activities of daily living reported by the patients. Studies published show that the SCT is characterized as an incremental test which presents values very close to the maximal ones when compared with maximal incremental tests which use ergometers.

When we analyze the SpO2 alterations, it is verified that mean was of 93% in the TC6' and 92% in the SCT, where significant decrease was not observed during the test or at resting basal situation. A study conducted with COPD patients of moderate to severe obstruction demonstrated that they can develop transitory decrease in SpO2 (SpO2 < 90%) during the activities of daily living, associated to physical exertion or dyspnea sensation, in many factors which may influence on the oxygen consumption values.

Significant decrease in the circulating levels of oxygen during exertion may be associated with alveolar hypoventilation, limitation in the diffusion, pulmonary shunt, non-homogeneous ventilation/perfusion ratio, or by the low oxygen pressure.

The data in the present study evidenced that the BP variation was very strong by the dyspnea subjective scale; however, in the TC6', they obtained mean of 3.6 ± 2.5, which is considered not very strong.

Concerning the exertion perception, our patients when performing the SCT obtained mean of 7 ± 2.3, which is considered very strong by the dyspnea subjective scale; however, in the TC6', they obtained mean of 3.6 ± 2.5, which is considered not very strong. The dyspnea present in these patients limits tolerance to exercise, determining interruption of exertion at lower workloads, leading to progressive deconditioning, harming performance of the peripheral and respiratory muscles.

Casas et al. (2005) conducted a study which compared four test protocols with eight patients with moderate to severe COPD (all with walks, among these, the TC6' and the SCT) and concluded that the physiological alterations which occurred were similar and corresponded to approximately 90% of maximum VO2 of these patients. Nevertheless, another study which assessed 20 COPD patients, compared the results of the same physiological variables in the TC6' and SCT, verifying that performance in both was similar, concluding hence that the SCT could substitute the TC6' when it was not possible to perform it in hospitals or even for space suitability. When the physiological variations obtained in our study are verified, it was possible to observe that the alterations between methods (initial versus final) of the HR, SpO2 variables and of the Borg rating of perceived exertion (RPE) were significantly at the end of the test. However, when the deltas of the variations of the analyzed parameters are considered, both in the TC6' and the SCT, despite the differences completed in the TC6' having been significantly higher than in the SCT (404.4 ± 58.3m versus 153.2 ± 37.9, p < 0.001), the HR variations and of the perceived exertion were significantly higher in the SCT. The mean of the completed distance in the TC6' by the patients of the present study was similar to the one verified in another study with COPD patients, whose mean was 499.37 ± 44.59m.

However, in the SCT this distance is not defined, since the test is not standardized concerning the number of steps climbed nor the time of application, variables which have been well-established in the TC6'. Nevertheless, in this same study, the mean of completed steps in the SCT was 147.5 ± 33.5m, a value very close to the one found in the present study which was 153.2 ± 37.9m. A fact to be considered is the use of motivational phrases by the examiner, which may have positively influenced on the patients’ performance. However, the walk tests inform on the real completed distance, an important variable to be discussed and which has significant correlation with the maximal VO2. On the other hand, the SCT does not evidence this fact due to its vertical component to be considered.

CONCLUSION

The data of the present study evidence that the SCT may be used in the evaluation of exercise capacity in COPD patients, being an incremental, submaximal test of easy application and low cost which does not require the use of sophisticated devices. However, further investigation is still necessary in order to standardize it.

All authors have declared there is not any potential conflict of interests concerning this article.
REFERENCES


