



VALIDITY OF 3 MINUTES STEP TEST TO MEASURE FUNCTIONAL EXERCISE CAPACITY IN PATIENTS WITH INTERSTITIAL LUNG DISEASE

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Abstract: **Background:** Interstitial lung diseases are a group of disorders that result in fibrous scarring of the lungs which can reduce the lung capacity and affect the functional exercise capacity. 3 minutes Step test is a valid test to assess the functional exercise capacity. However, its validity in patients with interstitial lung diseases has not been studied. Thus, this study aimed to assess the validity of 3 Minute Step test in patients with interstitial lung disease. **Methodology:** 45 out-patients with interstitial lung diseases were included in this study. Each patient performed 3 minutes step and 6 minutes walk test in a randomized sequence on two separate days. Vital parameters such as blood pressure, heart rate, respiratory rate were recorded pre and post-tests while rate of perceived exertion was tested post-tests. The primary outcomes were the number of steps completed in 3 minutes and the distance covered (in meters) in 6 minutes. **Results:** The correlation between steps completed and distance covered was done using Pearson's test while pre and post vital parameters were compared using paired t test. A moderate positive correlation was observed between 3 minutes step test and 6 minute walk test ($r = 0.671$, $p = <0.0001$). The post-test heart rate, respiratory rate and RPE were observed to be greater following 3 minutes step test as compared to 6 minutes walk test ($p = 0.0422$, 0.0001 , 0.0022 respectively). **Conclusion:** The 3 minutes step test can be considered as a valid measure to assess functional exercise capacity in patients with interstitial lung diseases.

Key words: 3 minute step test, interstitial lung disease

I. INTRODUCTION

Interstitial lung diseases (ILD) are a heterogeneous group of distinctive lung disorders characterized by fibrosis of the lung parenchyma. The spectrum of ILD varies from reversible disorders to progressive irreversible disorders.^[1,2] ILD results in restriction of lung expansion, cough, dyspnea, exercise induced hypoxia and eventual loss of lung function.^[1,3] All this ultimately results in reduced exercise capacity of the patient.

The ideal way to measure the functional exercise capacity in patients with cardiopulmonary conditions is Cardiopulmonary Exercise Testing (CPET). However, there are some limitations to the use of CPET in clinical settings; it is expensive, laboratory based, requires trained staff personnel and can be time consuming.^[4] These problems are overcome by the use of field test to measure exercise functional capacity. 6 minutes walk test (6MWT) is the most common field test used to assess functional exercise capacity in variety of pulmonary conditions. It is considered to help in global evaluation of submaximal exercise capacity in patients with ILD^[5] and is reported to be a valid and reliable measure of functional exercise capacity in ILD patients.^[6,7,8,9,10] 6MWT requires a 30 meters walking path on which this test can be conducted. Sometimes, the availability of this long walking path may place a hindrance in performance of this test. At such times, step tests can help overcome this problem.

The 3 minutes step test (3MST) is an inexpensive test and can be performed in a small space making it applicable in different settings such as in-patient, out-patient and at home. It is considered to be a valid measure to assess functional exercise capacity in pulmonary patients especially in COPD patients.^[11] However, its validity in patients with ILD is yet to be established. Thus, this study aimed to validate the use of 3 minutes step test in patients with interstitial lung disease

METHODOLOGY

Ethical approval was taken from the Institutional Ethics Committee prior to starting the study. Patients for this study were out-patients recruited from a Chest medicine clinic. Adult patients of both genders diagnosed with interstitial lung disease by a Pulmonologist and were clinically stable were included in the study. Patients with co-existing other pulmonary or cardiac diseases, recent acute exacerbations (< 3 months), on long term oxygen therapy, any musculoskeletal or neurological issues or with any contraindications to exercise performance were excluded. All included patients signed a written informed consent for participation in the study.

Every patient performed 6MWT and 3MST on 2 separate days with the same assessor. The sequence of performance of the tests was randomized for every patient. Vital parameters such as blood pressure, heart rate, respiratory rate and oxygen saturation were measured for all patients before, immediately after and after 3 and 6 minutes (recovery) of the performance of both the tests. Modified Borg CR10 RPE scale was used to assess the exertion level at the end of both the tests

6 minute walk test (6MWT): The 6 MWT was conducted as per the standard guidelines recommended by American Thoracic Society Statement.^[12] Patients were instructed to cover as much distance as possible in 6 minutes and the total distance covered (in meters) in 6 minutes was considered as the final reading for this test.

3 minutes Step test (3MST):^[11] A 15 cm height platform was used for the performance of 3 minute step test. The platform was placed at some distance from a wall for the patients to take support in case of loss of any balance. The patient was asked to stand in front of the platform and was instructed to step up and down with one leg at a time as many times as possible for 3 minutes duration. Number of steps completed in 3 minutes were considered as the outcome for this test.

Statistical tools

The sample size of 45 patients was determined for a power of 90%. The normality of distribution of variables was established using the Kolmogorov – Smirnov test.

Paired t-test was used to compare baseline vital parameters between the 3MST and 6MWT. The difference between the post-test values and baseline values between the two tests was also compared using the paired t-test. Correlation between both the tests test was measured using the Pearson's correlation coefficient.

RESULTS

The variables are represented as mean and standard deviation in the following tables.

Table 1 displays the demographic details of the included patients.

Table 1: Demographic details

Parameter	n = 45
Age (in years)	57.57 +/- 14.565
Gender male (%)	17 (37.7%)
Disease status	Hypersensitivity Pneumonitis: 26 Idiopathic Pulmonary Fibrosis: 19
BMI (kg/m ²)	26.41 +/- 5.145
3MST (number of steps)	47.44 +/- 13.852
6MWT (in metres)	267.133 +/- 65.46

The vital parameters were observed to be similar before performance of each test (Table 2). However, the difference between the post-test and baseline heart rate and respiratory rate was found to be significantly higher following 3MST. Similarly, the RPE was also perceived to be significantly higher after 3MST as compared to 6MWT. The difference in post-test and baseline blood pressures and oxygen saturation was not found to be statistically different between both tests.

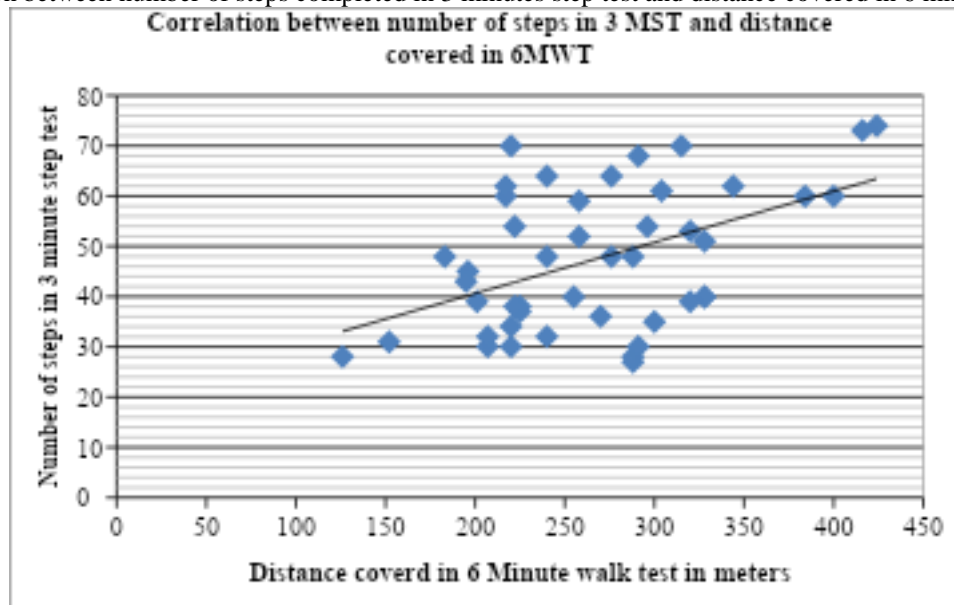
Table 2: Comparison of vital parameters between 3 minutes Step test (3MST) and 6 Minute Walk test (6MWT)

Parameters	3MST	6MWT	p-value
Baseline values			
SBP	117.73 +/- 12.84	117.24 +/- 12.68	0.4900
DBP	77.64 +/- 10.356	77.46 +/- 10.348	0.9345
HR	84.75 +/- 12.792	84.33 +/- 13.582	0.8803
RR	16.75 +/- 1.753	17.088 +/- 2.336	0.4396
SpO ₂	96 +/- 2.26	95.97 +/- 2.323	0.4819
Difference between post-test and baseline values			
SBP	18.44 +/- 10.548	15.77 +/- 9.42	0.2087
DBP	9.95 +/- 7.296	7.2 +/- 6.28	0.0586
HR	24.04 +/- 12.405	19.2 +/- 9.95	0.04428*
RR	8.15 +/- 3.189	5.42 +/- 2.398	0.0001*
SpO ₂	-6.13 +/- 3.448	-5.13 +/- 3.263	0.8294
Post RPE	3.066 +/- 1.143	2.33 +/- 1.064	0.0022*

Values expressed as mean +/- SD. SBP – Systolic Blood Pressure, DBP – Diastolic Blood Pressure, HR – Heart rate, RR -Respiratory rate, RPE – Rate of Perceived Exertion. *indicates significant difference

A moderate positive correlation was observed between 3MST and 6MWT ($r = 0.671$, $p = <0.0001$) (Fig 1)

Figure 1: Correlation between number of steps completed in 3 minutes step test and distance covered in 6 minute walk test



DISCUSSION:

6 minute walk test is considered to be a valid measure of functional exercise capacity in variety of pulmonary conditions such as asthma,^[13] COPD,^[14] cystic fibrosis^[15] etc. It is reported to correlate reasonably with cardiopulmonary exercise testing (CPET)^[16,17] and also with some measures of Quality of Life.^[18] The reproducibility of 6MWT is also well established for pulmonary conditions.^[19,20] 6MWT has several advantages: it can be performed with minimal equipment, it mimics the daily physical activity of walking and is suitable for a wide range of patients.^[19] However it also has some limitations: it requires a long walking passage, which may not be available in all set-ups such as out-patient clinics or at home, thus posing a problem in conducting the test. Variability due to different walking pace and turning around the cones may affect the distance covered in 6 minute walk test. These issues can be taken care of in step test. Also, in patients who are physiologically fitter, since running cannot be performed in 6MWT, there is a limitation to the distance that can be achieved by them. On the other hand, the step test can be modified by altering the step height to accommodate patients with different levels of functional capacities.^[4,21] Additionally monitoring of vital parameters may be easier due to relatively stationary position of the patient while performing the step test as against 6MWT. The test time for step test is also comparatively lesser than that required for 6MWT.

The current study aimed to validate the use of 3 Minute Step test to measure functional exercise capacity in patients with interstitial lung disease. In the current study, a moderate positive correlation was observed between 3MST and 6MWT which may confirm its validity for use in ILD patients. Studies in the past have shown mixed results, with correlations between the two tests ranging from no correlation^[22] to strong correlations^[11,22,23] in various cardiopulmonary conditions. We can fairly say that 3 minutes step test can be used in place of 6 minute walk test to assess the functional exercise capacity in patients with interstitial lung disease.

Some differences were however observed in the post-test vital parameters of the two tests. The post-test heart rate, respiratory rate and RPE were observed to be higher after performing 3MST as compared to that after 6MWT. A similar observation was reported in some other studies too.^[4,11,23,24] Stepping up and walking have different metabolic requirements. Stepping up involves greater work against gravity as compared to level walking, resulting in greater use of the quadriceps muscles, thus making the stepping activity more challenging physically. This probably resulted in the higher heart and respiratory rate and also the feeling of more exertion as observed by the higher RPE following 3MST. This factor needs to be taken into consideration when the patients have secondary or cardiac comorbidities as the higher heart rate and energy demand with 3MST may pose a risk to these patients.

We also need to take into account some limitations of the current study. Cardiopulmonary Exercise Testing (CPET) is regarded to be the gold standard for measurement of functional exercise capacity. Validity of 3 minute step test could not be assessed against CPET in ILD patients in the current study. Additionally, a single step height was used on this study. Several step tests exist in literature that use a variety of different step heights and speeds thus varying in the physical demand of the test. Thus validation 3 minute step test against CPET and also of other step tests may be contemplated as a future scope of study.

CONCLUSION:

3 minute step test can be considered as practical and valid tool to assess functional exercise capacity in patients with interstitial lung disease in place of 6 minute walk test. 3MST, though feasible, can be physically challenging in some patients which may limit its use

Conflict of interest: Nil

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