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INCREMENTAL SHUTTLE WALK TEST TO ASSESS THE FUNCTIONAL CAPACITY IN PATIENTS OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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Abstract

Background: COPD patients often exhibit reduced functional capacity in addition to impaired lung functions. Observation of the exercise response has therefore become the basis of objective assessment of disability both to stress the cardiorespiratory system and to evaluate reserve capacity. The incremental shuttle walk test is a standardized and externally paced field walking test, incorporating an incremental and progressive structure, to assess functional capacity in patients with chronic airways obstruction.

Objectives: To monitor functional capacity of the patients with chronic obstructive pulmonary disease by using a hospital based progressive 10-meter shuttle walking test.

Methods: The study was performed on 45 patients of various stages of COPD, recruited from the Chest medicine department of Jaslok Hospital and Research center, Mumbai. Patients were made to walk as per the study protocol and the audio signal. The total distance walked was recorded along with patients' baseline characteristics and was compared with patients FEV1 and MVV.

Results: the study done on 45 patients showed that there is a strong statistical correlation (p-0.002) between FEV1 and the ISWD. Also, a very strong statistical correlation between MVV and ISWD (p-3.81E-06) and vice a versa. Also, FEV1, MVV and the distance walked strongly correlate with each other.

Conclusion: The incremental shuttle walking test constitutes a standardized incremental field walking test that provokes a symptom limited maximal performance. It provides an objective measurement of disability and allows direct comparison of patients' performance.

Keywords: COPD, walking test, FEV1 and MVV

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Introduction

The incremental shuttle walking test was designed by Sally J. Singh in 1992.[1] The protocol was modified from that of a progressive, externally paced 20-meter shuttle running test, widely used as a field test of functional capacity in athletes. The test requires the patient to walk up and down a 10 m course, with the walking speed dictated by a prerecorded audio signal played on a cassette recorder. Defined speed of walking in the shuttle test ensures that the work load increase in the manner that provides an increment and quantitatively similar to cardiopulmonary stress for all patients.[2] Also gradual increase in exercise intensity makes it a safe test. The test can give an outcome that can be easily applied for exercise rehabilitation. In short, the incremental shuttle walk test is a standardized, externally paced, progressive and reproducible test which allows symptom limited maximum performance and direct comparison and hence it is used to assess the functional capacity in patients with chronic obstructive pulmonary disease.[3] Hence, the aim and objective of the study is to monitor functional capacity of the patients with chronic obstructive pulmonary disease by using a hospital based progressive 10 meter shuttle walking test. To compare FEV1, MVV and the distance walked in ISWT by patients of COPD

Material and method:

The study was performed on 45 patients of various stages of COPD, recruited from the Chest medicine department of Jaslok Hospital and Research center, Mumbai. Patients were made to walk as per the study protocol and the audio signal. The total distance walked was recorded along with patients' baseline characteristics and was compared with patients FEV1 and MVV.

Inclusion criteria:

1. Patients diagnosed with chronic obstructive pulmonary disease.

Exclusion criteria:

1. Patients with ischemic heart disease.
2. Cor pulmonale with hypoxia.
3. Patients with locomotor dysfunction.
4. Neuromuscular abnormalities.
5. Patients with cognitive disturbance.

A. PATIENTS:

Patients recruited from respiratory medicine clinics and were given full explanation before informed consent.

B. EQUIPMENTS:

A flat non slippery surface 10 m length
CD player and CD
Suitable footwear
Measuring tape
Marker cones

C. TEST PROCEDURE*:* The patient is required to walk between two cones in time to a set of auditory bleeps played on a CD. A triple bleep to start**.** Thereafter the CD emits a single

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bleep at regular intervals. The subject should aim to be at the opposite end by the next bleep. After every minute, the speed of walking is increased by a small increment. So, the patient walks progressively faster. The increment is indicated by a triple bleep. The first speed of walking is taken as level 1. The second as level 2. Each level lasts for 1 minute and the test continues for 12 levels. Each level contains no. of shuttles (10 m length)

Initially, the walking speed is very slow, but each minute the required walking speed progressively increases.

To help the patient to establish the very slow speed of walking, the operator walked alongside the patient for the first minute.

Only standardized instructions from the CD should be used. In contrast to the six-minute walking test, no encouragement was given throughout the ISWT.

A comfortable ambient temperature and humidity was maintained for all tests. The walking track must be the same for all tests for a patient:

Cones are placed nine metres apart.

The distance walked around the cones is 10 metres.

END POINT OF THE TEST:

- Determined by the patient, when he is too breathless to maintain the required speed.
- Operator discontinues the test when the patient is > 0.5m away from the cone and the patient fails to complete the shuttle.

Results

45 patients of our hospital already diagnosed with COPD were analyzed. Of the 45 patients studied, 34 were male while 11 female patients who agreed to perform incremental shuttle walk test

Out of these 45 patients, 28 patients (66.2%) had history of cigarette smoking while 17 (37.8%) were nonsmokers. (Table 2)

The following table shows the severity of COPD based on FEV1 staging in the given 45 patients. The highest number of patients 22 (48.9%) fall in stage 2- moderate COPD followed by 15 patients in stage 3, 6 patients in stage 4 and only 2 patients of stage one.

Table 1: comparison between FEV1 % staging and COPD stages

Variables	**FEV1 % staging**	**No.**	**Mean**	**SD**	**Median**	**P value**
Distance Walked (meters)	Stage I (Mild COPD)	2	285.00	332.34	285.00	0.17
	Stage II (Moderate COPD)	22	259.09	131.11	245.00	
	Stage III (Severe COPD)	15	194.00	96.20	200.00	
	Stage IV (V. Severe COPD)	6	148.33	103.04	125.00	

There is no significant correlation between total distance walked by the patients with various stages of FEV1.

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Table 2: Linear Regression between 'Distance Walked (meters)' as dependent variable with FEV1 and MVV %' as independent (Predictor) variable

	Unstandardized Coefficients		Standardized Coefficients	t-value	p-value
	B	**Std. Error**	**Beta**		
(Constant)	53.247	54.994		0.968	0.338
FEV1 %	3.283	1.004	0.446	3.270	0.002 (S)
MVV	0.580	0.110	0.628	5.296	0.01 (S)

A significant correlation found in linear regression between distance walked as dependable variable and FEV1 and MVV as independent and vice-versa

Table 3: Correlation between MVV, FEV1 % and Distance Walked (meters)

Variables		FEV1 %	MVV	Distance Walked (meters)
FEV1 %	Pearson Correlation	1	.628	.446
	p-value		0.001 (S)	0.002 (S)
MVV	Pearson Correlation	.628	1	.503
	p-value	0.001 (S)		0.004 (S)
Distance Walked (meters)	Pearson Correlation	.446	.503	1
	p-value	0.002 (S)	0.004 (S)	

Discussion

The performance of patients with chronic airways obstruction is limited by breathlessness that is due to a mixture of functional abnormalities. The limitation to individual performance cannot, however, be predicted by the measurement of these factors alone. Observation of the exercise response has therefore become the basis of objective assessment of disability both to stress the cardiorespiratory system and to evaluate reserve capacity.

Exercise testing is an important clinical assessment tool that provides complete assessment of the respiratory, cardiac, and metabolic systems. The current gold standard for the evaluation of functional capacity is cardiopulmonary exercise testing, which measures exercise capacity and provides information about physical limitation, disease prognosis, and responsiveness to treatment. Exercise capacity measurement using a simple walk test is well established.[2,3,4] A walk test measures the distance covered over a defined period of time. The six‐minute walk test is a commonly utilized self‐paced walking test as it is a simple, objective, reliable, valid, and sensitive tool that provides a reproducible measurement of functional capacity. Its principal advantages are its operational simplicity, cost‐effectivity, and relevance to functional activities. However, its disadvantages are that it allows the individual to set the speed of walking[4] and is affected by a variety of factors unrelated to cardiopulmonary status, such as motivation, age, gender, height, and weight. The incremental shuttle walk test (ISWT) overcomes these disadvantages of the six‐minute walk test, diminishes the effect of the operator's influence, and improves the standardization of walking tests. A shuttle walk test guides an individual to walk at

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a progressively faster pace every minute, achieved by prerecorded signals, and correlates more strongly with maximal oxygen uptake than the six‐minute walk distance.[5] It has proved to be simple, valid, reliable, reproducible, and safe when performed appropriately, and has been used in patients with heart disease, lung disease, rheumatoid arthritis, intermittent claudication, and advanced cancer.[6,7,8,9,10,11,12]

The present study was done in a tertiary care hospital over a period of one and a half year with an aim to study the incremental shuttle walk test to assess functional capacity in patients of COPD

45 patients of COPD performed the test. 11 patients were females and 34 males that corresponds to historical data that COPD is more common in males.

62.2% patients had previous history of cigarette smoking making it clearer that tobacco smoking is the most important risk factor for the development of COPD

On enquiring about symptoms, 80% of patient's complaint of dysponea on exertion (various grades) while 91% patients had mild to moderate, dry or productive cough. Other symptoms present were weakness, easy fatigability, insomnia and depression.

Only 62.2% patients were using bronchodilator and/or corticosteroid inhalers in the past. Rest 37.8% patients were not on any treatment – either they attended the out patients for the first time or discontinued the treatment started earlier.

As per GOLD guidelines staging, 22 patients out of 45 (49.8%) were fitting in stage 2, whereas stage 3 and 4 had 33% and 13% of patients respectively. Least number of patients (only 2) was seen in stage 1 COPD. We may infer from above data that most of the patients of COPD seek medical advice only after reaching stage 2 illness. The possible explanation being that either the patients are asymptomatic or have very mild symptoms which go unnoticed until they reach stage 2.

In our study we found no direct correlation between the staging of COPD and the distance walked in meters by the patients in ISWT. No such studies are recorded previously having comparison on staging of COPD and the distance walked in ISWT. Further studies are required to confirm our above observation.

A direct correlation is found between FEV1 and the distance walked and vice-versa using the model of linear regression. From the above findings we can infer that distance walked in ISWT can be used as a predictor of FEV1. Similar results were obtained by Dong Q, they reported that in a multivariate linear regression analysis, the variables significantly contributing to ISWT were age and FEV1 (% predicted).[13]

Also, there is a statistically significant association between distance walked and MVV and vice-versa. A study done by Pitta F et al in Aug 2008 clearly suggested that in patients with COPD, MVV better reflects the physical activity level in daily life than FEV1 (-). On comparing the above studies we can now postulate that ISWT can be used as a marker to assess the physical disability.[14]

So, the modified shuttle walking test is a reproducible, easily administered, standardized exercise test of functional capacity in patients with chronic airways obstruction.

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Conclusion

This study confirms the utility of the ISWT in the assessment of exercise capacity in patients with COPD of any stage. In addition, ISWT may provide a widely applicable surrogate for FEV1 or MVV estimation in this population. The shuttle walk test gives an incremental workload provoking maximal performance in the same way as a conventional walking test. Further large-scale studies are required, but if our results are confirmed, shuttle distance walked may allow the convenient, serial assessment of patients with COPD.

References

1 Singh SJ, Morgan MD, Scott S, Walters D, Hardman AE. Development of a shuttle walking test of disability in patients with chronic airways obstruction. Thorax. 1992;47(12):1019-24

2 Lim HJ, Jee SJ, Lee MM. Comparison of Incremental Shuttle Walking Test, 6-Minute Walking Test, and Cardiopulmonary Exercise Stress Test in Patients with Myocardial Infarction. Med Sci Monit. 2022;28:e938140.

3 Agarwal B, Shah M, Andhare N, Mullerpatan R. Incremental shuttle walk test: Reference values and predictive equation for healthy Indian adults. Lung India. 2016;33(1):36-41

4 Dechman G. Research Corner.Outcome measures in cardiopulmonary physical therapy: Focus on the shuttle walk test. Cardiopulm Phys Ther J 2005;16: 21

5 Solway S, Brooks D, Lacasse Y, Thomas S. A qualitative systematic overview of the measurement properties of functional walk tests used in the cardiorespiratory domain. Chest 2001;119:256‐70

6 Lewis ME, Newall C, Townsend JN, Hill SL, Bonster RS. Incremental Shuttle walk test in the assessment of patients for heart transplantation. Heart 2001;86:183‐7

7 Win T, Jackson A, Groves AM, Sharples LD, Charman SC, Laroche CM. Comparison of shuttle walk with measured peak oxygen consumption in patients with operable lung cancer. Thorax 2006;61:57‐60

8 Macsween A, Johnson NJ, Armstrong G, Bonn J. A validation of 10‐ meter incremental shuttle walk test as a measure of aerobic power in cardiac and rheumatoid arthritis patients. Arch Phys Med Rehabil 2001;82:807‐10

9 Jolly K, Taylor RS, Lip GY, Singh S; BRUM Steering Committee. Reproducibility and safety of the incremental shuttle walking test for cardiac rehabilitation. Int J Cardiol 2008;125:144‐5

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 06, 2023

10 Billings CG, Aung T, Renshaw SA, Bianchi SM. Incremental shuttle walk test in the assessment of patients with obstructive sleep apnea‐hypopnea syndrome. J Sleep Res 2013;22:471‐7

11 Benzo RP, Sciurba FC. Oxygen consumption, shuttle walking test and the evaluation of lung resection. Respiration 2010;80:19‐23

12 Dourado VZ, Guerra RL, Tanni SE, Antunes LC, Godoy I. Reference values for the incremental shuttle walk test in healthy subjects: From the walk to the physiological responses. J Bras Pneumol 2013;39:190‐7

13 Dong Q, Song T, Jiang C, Yao Q, Chen F. [Application of a multiple linear regression model of FEV1 in pulmonary function test]. Nan Fang Yi Ke Da Xue Xue Bao. 2020;40(12):1799-1803

14 Pitta F, Takaki MY, Oliveira NH, Sant'anna TJ, Fontana AD, Kovelis D, Camillo CA, Probst VS, Brunetto AF. Relationship between pulmonary function and physical activity in daily life in patients with COPD. Respir Med. 2008;102(8):1203-7