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Original Research Article

Medical research council dyspnoea score and forced expiratory volume in one second as the predictors of vertical climbing in chronic obstructive pulmonary disease patients

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ABSTRACT

Background: Chronic obstructive pulmonary disease is a leading cause of chronic morbidity and mortality throughout the globe. MRC and FEV_1 are related with 6MWD in COPD. But stair climbing is mechanically and physiologically different from walking. Dyspnoea is most often the limiting factor to staircase climbing. Hence the study is designed to correlate MRC dyspnoea score and FEV1 with vertical height climbed in COPD patients and to find out whether they are the predictors of vertical climbing in COPD patients.
Methods: It was Prospective Cross sectional study. 50 COPD patients satisfying the inclusion criteria were underwent a stair climb test after recording their MRC dyspnoea score and FEV_1. FEV_1 was measured with mini Wright peak flow meter in sitting position. Vertical height of floor climbed, time taken to climb and recovery time was recorded.
Results: A significant negative correlation and positive correlation was observed between vertical height climbed and MRC dyspnoea score ($r= -0.76$, $p=0.001$) and between vertical height climbed and FEV_1 ($r=0.59$, $p<0.001$) respectively. On Multiple linear regression analysis, both are found to be the independent predictors of vertical height climbed by COPD.
Conclusions: MRC and FEV_1 correlated with vertical height climbed and found to be the independent predictors of vertical climbing in COPD patients. Vertical height climb (m) can be predicted with equation 12.94+5.58(FEV1) – 3.35(MRC).

Keywords: 6MWD, COPD, FEV_1, MRC, Stair climbing

INTRODUCTION

Chronic obstructive pulmonary disease is one of most important cause of chronic morbidity and mortality and currently the fourth leading cause of death in world.[1] It produces an economic and social burden that is both substantial and raising.[1-3] It is characterized by airflow obstruction and persistent respiratory symptoms.[1] The most common symptoms includes dyspnoea, cough and/or sputum production.[1] Spirometry is the most reproducible and objective measurement of airflow obstruction. Although it has good sensitivity, peak expiratory flow measurement alone cannot be reliably used as the diagnostic test as it has weak specificity.[1,4] There is only a weak correlation between FEV_1, symptoms and health status impairment.[1,5,6] Medical research council dyspnoea scale has been in use for many years for grading the effect of breathlessness on daily activities.[7] The MRC dyspnoea scale is simple to administer which allows the patients to indicate the extent of impact of breathlessness on their functional mobility.[7] GOLD classifies COPD severity based on % predicted

FEV_1 and also uses MRC dyspnoea scale for comprehensive symptomatic assessment.[1,7]

Impaired exercise tolerance is a cardinal feature in COPD. Physical activity level in COPD is associated with mortality and exacerbation. Stair climbing is an integral component of daily living which is limited in COPD. Stairs present a common daily obstacle appearing in and beyond home.

To best of our knowledge, till date FEV_1 and MRC scale has been related with six-minute walk distance.[8,9] But not related to vertical climbing. It is unclear whether 6 minute walk test can predict performance during stair climbing.[10] Stair climbing differs mechanically from walking which includes an increase in range of motion of lower limb joints and more intense muscular activity, generating larger forces and movements especially in vertical direction, against gravity.[11]

It is found that pathophysiological changes during walking do not anticipate those during stair climbing in COPD as there are physiological differences in walking and stair climbing.[10] To date, it remains unclear whether and to what extent FEV_1 and MRC score are related to vertical climbing in COPD. Hence the present study is designed to identify the clinical determinants of vertical climbing performance which may allow clinician to better monitor and improve functional capacity in COPD.

METHODS

The study was approved by the Ethics Committee for research on human subjects (ECRHS) of the institute. It was a prospective cross sectional study which was conducted at the physiotherapy center of a multispecialty tertiary care hospital.

Inclusion criteria for the study was Patients diagnosed as COPD in accordance to spirometric classification of GOLD guideline who were Stable diagnosed by chest physician, defined as no acute exacerbations of pulmonary or cardiac disease for 6 weeks prior to entry into study between Age 30-70 years, ambulatory, who can climb independently, not undergoing rehabilitation. Patients answered 'No' to all questions in physical activity readiness questionnaire. Individuals with known case of cardiac disease, other lung disease, neuro-musculoskeletal disease, vision problems or any other known medical illness was exclusion criteria.

Total 50 patients, referred by the chest physician to physiotherapy outdoor patient department at tertiary care hospital during a six-month period for the study, satisfying inclusion criteria were included in the study. Convenient sampling method was used. Written informed consent was taken from patients, explaining the study procedure, possible benefits of the study, risks and discomfort of participating, compensation for participation and right to withdraw from the study.

Dyspnoea was graded by Medical Research Council (MRC) scale graded as 1-5 and FEV_1 were noted prior to test. Mini Wright peak expiratory flow meter was used to measure FEV_1. FEV_1 was taken thrice in upright position and wearing nose clip. A best reading of the three of FEV_1 was used for analysis.

Resting parameters [Respiratory rate, Oxygen saturation (SpO2), Rate of perceived dyspnoea, and heart rate] were recorded in sitting position. Then patients underwent a stair climb test. They were instructed to climb as far as possible (maximum 12 flights) at maximal comfortable self-pace, without the use of railings, maintaining speed during ascent and landing and to stop at their maximum, if they complete 12 flights or if they develop symptoms like dyspnoea, leg fatigue, dizziness or chest pain. First, a practice test was carried out. On next day, stair climbing test was performed. A resting chair was placed on every landing near the stair, where testing was done. Emergency equipment and care were available during test. The test was supervised at all time and a continuous verbal interaction with the patient was maintained to assess the patient's dyspnoea and other symptoms. During the test, pulse rate and oxygen saturation were monitored continuously by means of hand held pulse oximeter with finger probe. Time of climb was monitored with stopwatch.

When the patient stopped, number of steps climbed, time taken to complete the test (in seconds), reason for stopping were noted. Oxygen saturation (SpO2), Rate of perceived dyspnoea, respiratory rate, heart rate were recorded immediately post climb and Recovery time was noted down.

Vertical height of floor climbed by patients was calculated by multiplying number of stairs climbed to height of step. Each step of the staircase used for the study was measured 16cm high and 174cm wide. A climb of 11 steps constituted one flight of stairs which was 1.76 m of vertical height.

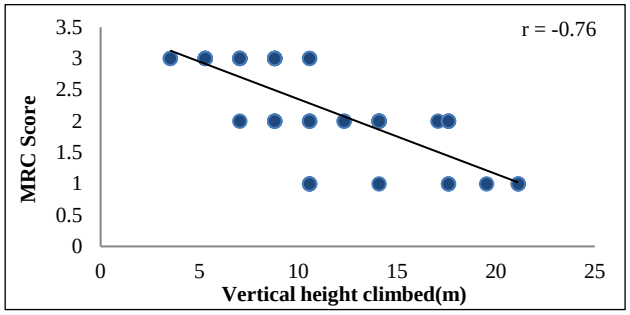
RESULTS

Data was analysed using the statistical package for social science version 17.0. Spearman co-efficient of correlation test was used to correlate MRC dyspnoea score and FEV_1 with vertical height climbed. A p-value of <0.05 was considered statistically significant.

Table 1: The characteristic of the patients enrolled in the study.

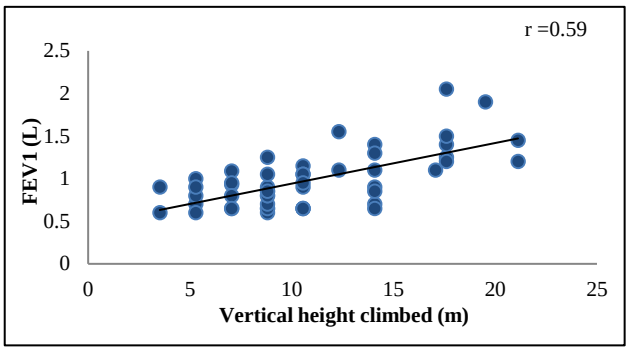
Age (years)		Sex (%)		BMI (Kg/m^2)	FEV_1(L)	MRC score
Mean (±SD)	Range	Male	Female	Mean (± SD)	Mean (±SD)	Median
50.7(±9.87)	35 – 70	43(86%)	7(14%)	20.41 (± 3.31)	0.98 (±0.33)	2 (1 - 3)

The mean age of patients was 50.7 years. 86% of the total patients were male. All patients had COPD with mean (±SD) FEV_1 of 0.98L (±0.33L). Two patients were able to climb full vertical height of 21.12 m in mean (±SD) time 113 (±38.18) sec. There was no difference between practice test and second stair climbing maneuver in terms of number of stairs climbed and time taken to climb. All patients stopped because of because of dyspnoea and/or leg fatigue. Median recovery time was 6 minute. No patients needed emergency care during and after the test. There were 9 patients with MRC score 1, had mean FEV_1 1.34±0.42L and climbed 15.84±4.50m. There were 20 patients with MRC score 2, had mean FEV_1 0.94±0.31L and climbed 12.64±3.31 m. There were 21 patients with MRC score 3, had mean FEV1 0.87±0.16L and climbed 7.13±2.03m.



It shows significant correlation between Baseline MRC dyspnoea score to vertical height climbed.

Figure 1: Correlation of baseline MRC dyspnoea score to vertical height climbed.



It shows significant correlation between baseline FEV_1 to vertical height climbed.

Graph 2: Correlation of baseline FEV_1 to vertical height climbed.

As showed in Figure 1 that median (range) MRC dyspnoea score is 2 (1-3) and mean vertical height climbed is 10.93±4.57 where the negative correlation between them is statistically significant (r=-0.76, p=0.001). Figure 2 showed that mean is FEV_1 is 0.98±0.33 and mean vertical height climbed is 10.93±4.57 where the positive correlation between them is statistically significant (r =0.59, p<0.001). On multiple linear regression analysis, baseline medical research council dyspnoea score and FEV_1 are found to be the independent predictors of vertical height climbed by chronic obstructive pulmonary disease patients. The vertical height climbed can be predicted as by the equation- Vertical height (m) = 12.94 + 5.58 (FEV1) – 3.35 (MRC).

Table 2: Multiple regression analysis of vertical height climbed with baseline MRC and FEV_1.

R			R2	Adjusted R2	Std. error of the estimate	
0.81			0.66	0.65	2.69	
Source of Variation	**Sum of squares**	**Df**	**Mean square**	**F**	**p-value**	
Regression	684.78	2	342.39	47.15	0.001 S, p<0.05	
Residual	341.24	47	7.26			
Total	1026.02	49				
	Unstandardized coefficients		**Standardized coefficients**		**T**	**p-value**
	B	**Std. error**	**Beta**			
Vertical Height Climbed (constant)	12.94	2.27				
MRC	-3.35	0.58	-0.54		-5.72	0.001 p<0.05
FEV_1	5.58	1.31	0.40		4.23	0.001 p<0.05

Baseline MRC scores and Baseline FEV1 found to be independent predictors of vertical height climbed.

DISCUSSION

The result of this study showed that the vertical height climbed was correlated significantly with medical research council (MRC) dyspnoea score and forced expiratory volume in one second (FEV_1). Using statistical methods, in linear regression analysis, score on medical research council (MRC) dyspnoea scale and forced expiratory volume in one second (FEV_1) were found to be independent predictors of vertical height climbed.

There is strong correlation found between MRC score and vertical height climbed (r=-0.76, p=0.001). MRC breathlessness score does not quantify breathlessness rather it quantifies the disability associated with breathlessness by quantifying that breathlessness occurs when it should not (grade 1 and 2) or by quantifying the associated exercise limitation (grade 3-5).[12] Jons NL et al established a significant correlation between the grade of dyspnoea on MRC scale and work capacity in chronic airway obstruction.[13] To our knowledge till now MRC score is not correlated with vertical height climbed (number of stairs climbed).

Bestall JC et al found the MRC dyspnoea scale is a simple and valid method of categorizing patients with COPD in terms of their disability. In this study, they found significant association between MRC grade and shuttle distance, St George's respiratory questionnaire (SGRQ) score, chronic respiratory disease (CRDQ) score, and mood state score. Between the MRC grade 3 and 4, exercise performance, SGRQ and depression score were major determinants of disability. Between grade 4 and 5, exercise performance and age are the major determinants of disability.[14] MRC is also found to be correlated with lung function measurements, 6-minute walk distance.[15] It can predict survival.[15]

The study gave a strong correlation of vertical height climbed to MRC suggest that the patients actual performance on stair is in proportional with the patient's perception of their functional disability. Hence it can be said that the patient's perception of their illness, may have a more substantial effect in determining exercise capacity.

We also found a strong correlation between forced expiratory volume in 1 second and vertical height climbed (r=0.59, p=0.001). This result in accordance with the study done by Bolton JW found the strong correlation between forced expiratory volume in 1 second and number of stairs climbed found to be independent predictor.[16]

Pulmonary function measurement is the most important indicator of respiratory impairment in COPD, yet it is surprisingly weak predictor of disability in terms of daily activity restriction.[17] For this apparent finding, Eisner MD et al studied and found greater pulmonary function impairment, as evidenced by lower forced expiratory volume in 1 second was associated with poor physical performance battery score, less 6 minute walk distance, weaker muscle strength and with a greater risk of self-reported functional impairment. He concluded that pulmonary function impairment was related to a broad array of physical functional limitation among patients with COPD, includes functioning of lower extremity, exercise performance, muscle strength and self-reported limitation in basic physical activity. These finding consistent with the theory that the central pulmonary function impairment of COPD translates into diverse impact on body system that ultimately comprise physical functioning.[17]

This finding hold true with our study, the patients (n=21) with greater lung impairment, with low forced expiratory volume in 1 second (FEV_1) had high MRC grade (2, 3) stopped because of development of dyspnoea and leg fatigue which may indicate the additional skeletal muscle deconditioning.

A strong correlation of MRC and FEV_1 with vertical height suggested that the patients performance on the stair case influenced by the extent of lung impairment and their perception functional disability. It is studied that the degree of dyspnoea, forced expiratory volume in 1 second (FEV_1) and exercise performance provide independent information regarding degree of compromise in COPD.[18-20] In some cases, patients may endorse minimal symptoms despite demonstrating severe airflow limitations. Adapting to the limitations induced by COPD, these patients may reduce their level of physical activity in a way that result in an underestimation of the symptom load. In these cases, test like 6MWD may reveal the patients are severely constrained and do need more intense treatment than initial evaluation would have suggested.[1] There are mechanical and physiologic difference in stair climbing and walking.[10,11] Most important are, stair climbing resulted in pronounced hypoxemia, lung hyperinflation, blood lactate production and dyspnoea when compared to walking.[10,21] Hence, the walking cannot predict the patient's stair climbing performance.

Simple tools emphasizing the clinical method are the need of hour. Mini Wright peak expiratory flow meter which was used for FEV_1 measurement is simple, economic and available in respiratory clinical set up. The FEV_1 and MRC are found to be independent predictor of Vertical height climbed. Hence the result can be used to estimate stair climbing performance in COPD patients and to plan the pulmonary rehabilitation program. It can be used to evaluate exercise tolerance before and after pulmonary rehabilitation program. Further study can be done in large sample size and different geographical areas. Age and height can also be evaluated for independent predictors and can be used in the prediction equation with MRC score and FEV_1. Standard spirometric measurement of FEV_1 can be used in formulating the prediction equation.

CONCLUSION

From this study, it is concluded that the baseline medical research council dyspnoea score and forced expiratory volume in 1 second correlate with vertical height climbed and are independent predictors of vertical height climb by chronic obstructive pulmonary disease patients. The vertical height climb can be predicted as by the equation- Vertical height (m) = 12.94 + 5.58(FEV_1) – 3.35(MRC). This can be used for planning pulmonary rehabilitation exercise program to improve exercise capacity and increase physical activity in COPD patients.

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