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Original Research Article

Correlation of spirometry and six minute walk test in patients with chronic obstructive pulmonary disease from Sundargarh, Odisha, India

Yara Dinakar[1], Pradeep Panchadi Kiran[1], Akshaya K. Mohanty[2], Praveen Kishore Sahu[3], Anita Mohanty[1]*

[1]Department of Pulmonary Medicine, Ispat General Hospital, Rourkela, Odisha, India
[2]Infectious Disease Biology Unit, Institute of Life Sciences, Bhubaneswar, Odisha, India
[3]Department of Molecular and Immunology, Ispat General Hospital, Rourkela, Odisha, India

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***Correspondence:**
Dr. Anita mohanty,
E-mail: dranitamohanty@gmail.com

ABSTRACT

Background: Six-Minute Walk Test (6MWT) is a simple, objective, reproducible test which correlated well with different spirometric indices, and thus able to predict severity of Chronic Obstructive Pulmonary Disease (COPD) and can replace spirometry in resource poor set-up. Here, author evaluated the correlation of 6 minute walk distance (6MWD) with spirometric indices in COPD patients and the potential of 6MWT as an alternative to the assessment of severity of COPD.
Methods: This cross-sectional observational study included a total of 80 COPD patients, diagnosed by GOLD criteria (Post bronchodilator FEV1/ FVC ratio <0.7). Modified Medical Research Council (mMRC) grading was used (age, weight, height, body mass index- BMI and breathlessness) and all the patients underwent spirometric measurement of FEV1, FVC and FEV1/ FVC ratio and tests were repeated after bronchodilation using 200-400 µg of salbutamol. 6MWT was performed following American Thoracic Society (ATS) protocol of 6MWT and distance was measured in meters.
Results: Author found significant negative correlation of 6MWT with age (r=-0.384, p=0.00) and mMRC grading of dyspnea (r=-0.559, p=0.00) and significant positive correlation with height (r=0.267, p=0.019) and weight (r=0.293, p=0.008). Significant positive correlation of 6MWD was noted with post bronchodilator FEV1(r=0.608, p=0.00), FEV1% (r=0.429, p=0.00), FVC (r=0.514 p=0.00), FVC% (r=0.313 p=0.005), FEV1/FVC % (r=0.336, p=0.001). Positive correlation was also observed between 6MWT and BMI but statistically insignificant (r=0.177, p=0.116). There was significant negative correlation between 6MWT and GOLD staging (r=-0.536, p=0.00).
Conclusions: This finding concludes that 6MWT can be used for the assessment of severity of disease in COPD patients in places where spirometry is not available.

Keywords: Chronic obstructive pulmonary disease, Global initiative for chronic obstructive lung disease, Six-minute walk test, Spirometry

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a common, preventable and treatable disease characterized by persistent respiratory symptoms and airflow limitation due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases.[1] GOLD advocated spirometric measurement of

post bronchodilator forced expiratory volume in first second (FEV1) for assessing the severity of COPD and there by staging the disease and treatment.[1] Spirometric test is costly and is not available in many resource poor countries like India. Recent guidelines developed by WHO and Govt. of India committee group suggest that in the absence of spirometry, staging of the disease and follow-up can be performed on the basis of severity of symptoms, Peak Expiratory Flow Rate (PEFR) and Six Minute Walk Test (6MWT).[2]

Measuring the 6MWT has been used to evaluate the functional capacity of patients with COPD. The relationship between the walking distance in a certain period of time and the functional capacity of patients with COPD has been investigated in several studies. Moreover, the result of the 6MWT in patients suffering from COPD has been found to be more reproducible than the measurement of FEV1.[3-6] Therefore, this study aims to assess the correlation of 6 minute walk distance with spirometric indices in COPD patients and its correlation with clinical parameters i.e. age, weight, height, body mass index (BMI), breathlessness as per Modified Medical Research Council (mMRC) and to find out whether 6MWT can be used as an alternative in the assessment of severity of COPD.

METHODS

The present study was a cross-sectional observational type, which enrolled 80 patients diagnosed with COPD and attending outpatient's department of Pulmonary Medicine, Ispat General Hospital, Rourkela, Sundergarh, Odisha between August 2015 to January 2017.

Inclusion criteria

- Stable, mild to severe COPD patients aged between 40-80 years with baseline SpO2 ≥90%, with no acute exacerbation for the past 6 weeks.

Exclusion criteria

- Patients with history or clinical evidence of pulmonary disease other than COPD. COPD patients with resting heart rate >120 beats per minute, systolic blood pressure of >180 mmHg and/ or diastolic blood pressure >100 mmHg, pulmonary hypertension, obstructive sleep apnoea, central sleep apnoea, cardiovascular disease, renal disease leading to hypoxemia, unstable angina or myocardial infarction during previous 1 month, patients with co-morbid illness like neuromuscular, musculoskeletal, peripheral vascular diseases, cardiovascular diseases which limit their capacity to perform 6MWT and patients who deny informed consent.

A proforma of detailed clinical history, risk factors, physical examination, investigations were prepared. Clinical history was taken from patients. Complete physical examination and the investigations were done e.g. haemoglobin, total leukocyte count, differential leucocyte count, total platelet count, serum urea, creatinine, electrolyte profile, bilirubin, Alanine Aminotransferase (ALT), Aspartate Transaminase (AST), blood sugar, lipid profile. Plain chest radiograph, electrocardiogram, echocardiography were also performed. Patients satisfying inclusion criteria and not excluded by exclusion criteria were enrolled for the study. Patients' age, sex, height, weight, BMI and dyspnea by mMRC grading were noted. Spirometry was performed in these patients before and after giving short acting bronchodilator (200-400 µg of salbutamol) and spirometric parameters like Pre FVC, Pre FEV1, Pre FEV1/FVC ratio, post FVC, post FEV1, post FEV1/FVC ratio were noted and they were categorized as per GOLD (Global initiative for chronic obstructive lung disease) guidelines. 6MWT was performed in a 30m long and ventilated indoor corridor according to American Thoracic Society (ATS) guidelines.[7] All the patients underwent the 6MWT within 15 minutes of spirometry. Each patient was rested for at least 10 min prior to the 6MWT.

At the onset of the 6MWT, the patient's heart rate, blood pressure, and oxygen saturation were measured. Patients were given proper instructions about the procedure. Encouraging phrases such as "keep up the good work", "well done", and "good" were used during the test. All the subjects were allowed to stop if indications of chest pain, dyspnea, or diaphoresis were observed during the test and subsequently allowed to continue walking when they felt better. However, the resting time was included in the 6-minute time period. The test was discontinued if patients experienced any chest pain, severe dyspnea, spasm of lower extremity muscles, or if the patient wanted to quit. At the end of the test, blood pressure, heart rate, oxygen saturation by pulse oximeter, and the distance walked for 6 minutes were recorded in meters. The patients were observed for at least 15 minutes after the test to assess any possible untoward effects.

Predicted six-minute walk distance (6MWD) were calculated as per Indian reference equation[8]

Indian male= 561.022- [2.507 x age (years)] + [1.505 x weight (kg)] - [0.055 x height (cm)]

Indian females= 30.325- [0.809 x age (years)] - [2.074 x weight (kg)] + [(4.235xheight (cm)]

Statistical analysis

Descriptive and inferential statistical analyses were carried out and statistically described in terms of mean, Standard Deviation (SD), range, frequencies (number of cases) and percentages using Microsoft Excel and IBM SPSS V 20.0 software. Paired sample t-test was also used to test the level of significance.

Correlation was evaluated by Pearson's coefficient and the p value <0.05 was taken as statistically significant.

RESULTS

In this study, out of the 80 cases, males 64(80%) were more than females 16 (20%). The study population age ranged between 40 years-78 years with the mean age being 64.09±9.86 years, weight ranged between 30 kg-79 kg (mean 56.51±12.24 kg), height ranged between 1.45 meters- 1.79 meters (mean 1.61±0.74). The BMI of the population ranged between 12 kg/m^2-29 kg/m^2 (mean 21.62±4.20 kg/m^2). The patients were in mMRC grade 1 and 2. Out of 80 patients, 61 patients were mMRC grade 1(76.3%) and 19 were mMRC grade 2(23.8%). Spirometric parameters of the patients in study group are shown in Table 1. The pre FEV1 in liters ranged from 0.37 to 2.10 with a mean of 1.13 and SD of 0.47, compared to post FEV1 in liters (0.39 to 2.35, with a mean of 1.27 and SD 0.51). The Pre FEV1% ranged from 24 to 95% with a mean of 56.9 SD of 20.38 compared to post FEV1% which was from25 to 99 with mean of 63 and SD of 21.55. The patients showed pre FVC (0.71 to 3.61 with a mean of 2 and SD of 0.68) when compared to the post FVC(0.73 to 3.67 with mean of 2.22 and SD of 0.77) and pre FVC% (32 to 115%, mean of 72.71 and SD 21.66) compared to post FVC% (33 to 132%, mean of 80.77 and SD of 23.70). The Pre FEV1/FVC% ratios varied from 36.60 to 69.50 with a mean of 55.43 and SD of 8.31, whereas the post FEV1/FVC% varied from 36.49 to 69.50 with mean of 56.33 and SD of 8.47 (Table 1).

Table 1: Descriptive Statistics for pre and post bronchodilator spirometric parameters.

Spirometric parameters	Minimum	Maximum	Mean	SD
Pre FEV1 in liters	0.37	2.10	1.1355	0.47337
Post FEV1 in liters	0.39	2.35	1.2709	0.51915
Pre FEV1%	24.00	95.00	56.90	20.38528
Post FEV1%	25.00	99.00	63.5108	21.55086
Pre FVC in liters	0.71	3.61	2.0070	0.68862
Post FVC in liters	0.73	3.67	2.2280	0.77250
Pre FVC%	32.00	115.00	72.7125	21.66149
Post FVC%	33.00	132.00	80.7751	23.70375
Pre FEV1/FVC%	36.60	69.50	55.4301	8.31284
Post FEV1/FVC%	36.49	69.50	56.3341	8.47480

Table 2. Correlation of GOLD staging with Post bronchodilator.

GOLD staging	Post bronchodilator FEV1%	Number	(Mean± SD) 6MWD
Gold 1	≥80	25(31.3%)	513.12±52.220
Gold 2	50 to < 80	29(36.3%)	437.07±60.754
Gold 3	30 to < 50	24(30.0%)	429.54±63.307
Gold 4	< 30	2(2.5%)	332.50±0.707

The Severity of COPD as per GOLD stage distribution of patients studied and mean±SD of 6MWD are shown in Table 2. Among 80 patients, 25 (31.3%) were in GOLD stage 1, the mean 6MWD is 513.12 with SD of 52.22. In this study 29 (36.3%) patients were in GOLD 2 with a mean 6MWD of 437.07 and SD of 60.75. 24 patients were in GOLD stage 3 had a mean 6MWD of 429 and SD of 63.30. Among them 2 patients were in GOLD stage 4 with a mean 6MWD of 332.5 with SD of 0.70. The correlation of 6MWD with different clinical and spirometric parameters is shown in Table 3. There is significant negative correlation between 6MWD with mMRC (r -0.559 and p 0.00) and age (r-0.384and p 0.00). There is significant positive correlation seen between 6MWD with weight (r 0.293 and p 0.008) and height (r 0.261 and p 0.019). Positive correlation seen between 6MWD and BMI but is not significant (r 0.177 and p 0.116).

In this study author got significant positive correlation of 6MWD with pre FEV1 (r 0.614 and p 0.00), post FEV1 (r 0.608and p 0.00, figure1), pre FEV1% (r 0.44 and p 0.00), post FEV1% (r 0.429 and p 0.00), Pre FVC (r 0.55 and p 0.00), post FVC (r 0.514 p 0.00, figure 2), pre FVC% (r 0.348 and p 0.002), post FVC% (r 0.313 and P 0.005), pre FEV1/FVC% (r 0.373 and p 0.001) and post FEV1/ FVC% (r 0.366 and p 0.001, figure 3). There is significant negative correlation seen between 6MWD and GOLD stage (r 0.536 and p 0.00, figure 4).

DISCUSSION

Spirometric measurement of post bronchodilator forced expiratory volume in 1 second (FEV1) is essential for establishing the diagnosis, assessment of severity (staging), to predict the outcome, and to plan treatment in

COPD. Spirometric test is often expensive and unavailable in resource limited settings of developing countries. Measurement of the walking distance is used to assess functional capacity of patients with COPD. 6MWT is a simple, objective and reproducible test. A reasonable portion of the recent literature shows definite correlation between 6MWT with different spirometric indices.

Table 3: Correlation of 6MWD with clinical and spirometric parameters.

	Pearson's correlation(r)	p value
Age	-0.384**	0.000
Weight	0.293 **	0.008
Height	0.261*	0.019
BMI	0.177	0.116
mMRC	-0.559	0.000
Pre FEV1 in liters	0.614**	0.000
Post FEV1 in liter	0.608 **	0.000
Pre FEV1%	0.440**	0.000
Post FEV1%	0.429**	0.000
Pre FVC in liters	0.557**	0.000
Post FVC in liters	0.514**	0.000
Pre FVC%	0.348**	0.002
Post FVC%	0.313**	0.005
Pre FEV1/FVC%	0.373**	0.001
Post FEV1/FVC%	0.366**	0.001
GOLD stage	-0.536	0.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

The present study enrolled 80 cases, with males 64(80%) more than females 16(20%). A probable cause for this, could be the much higher prevalence of chronic and active smoking in males and /or much prolonged exposure to smoking.[9-12] There was a significant negative correlation between 6MWD and age (r=0.384, p=0.000 (<0.001)) observed here, which is similar to earlier findings with positive correlation between 6MWD and age though statistically insignificant (r+0.025, p 0.872). In contrast, findings by Khandelwal et al, showed positive correlation between 6MWD although statistically insignificant (r+0.21 p>0.5).[13,14] The negative influence of advanced age on the 6MWD might be explained by the gradual reduction in muscle mass, muscle strength and maximal oxygen uptake that typically occurs with ageing.[9] In this study significant positive correlation is present between 6MWD and weight (r+0.293, p0.008(<0.01)). Similar significant positive correlations were observed in other studies.[10,14] This observations highlighted a significant positive correlation between 6MWT and height of patients (r +0.261, p 0.09 (<0.05);which is in accordance with earlier observations (10) with (r +0.42, p<0.01), at the same time contradictory to a set of findings by Khandelwal et al, (r -0.06, p>0.05).[14] The height of the subject affects stride length. This can potentially influence the distance covered since it is a major predictor of gait speed.[15-18]

In this study there was no significant positive correlation between 6MWD and BMI (r +0.177, p 0.166 (>0.05)), which is in line with earlier observations(13)with (r+0.049, p 0.747(>0.05)) but unlike studies(14) that showed significantly positive correlation(r+0.33, p <0.05) as well as another study by Kundu A et al, with (r -0.156, p>0.05), a negative correlation between 6MWT and BMI yet not statistically significant (r -0.156 p 0.168 (>0.05).[12] This supports the theory that variable effect of BMI on 6MWD in COPD patients. Author found a significant negative correlation between 6MWD and mMRC grading (r -0.559, p 0.000 (<0.001)) which is similar to earlier observation, indicating that with increase in mMRC grading, 6MWD indices may reduce.[14]

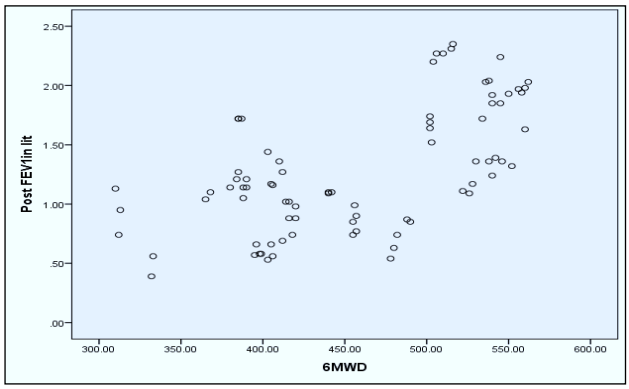

Figure 1: Scatter diagram showing correlation of 6MWD with Post FEV1.

In present study there was a significant positive correlation between 6MWD and FEV1 (r +0.608, p 0.000 (< 0.001)) as depicted in the scatter diagram (Figure 1) which is in concurrence with earlier investigations(10,11, 14) where r +0.35 (p<0.05), r +0.67, (p<0.001); r 0.43, (p<0.05) respectively. At the same time, a similar study showed positive correlation between 6MWD and FEV1 but does not show any statistical significance(r +0.280 p> 0.05).[13] Author found significant positive correlation observed between 6MWT and FVC (r +0.514, p 0.000 (<0.001)) which is similar to previous studies.[11,14] Previous studies showed positive correlation between 6MWT and FEV1 but does not show any statistical significance (r +0.289, p 0.062) whereas another observation showed negative correlation but statistically insignificant.[10,13] In present study there is significant positive correlation between 6MWD and post bronchodilator FEV1/ FVC % (r+0.366, p 0.001 (<0.01)) as shown in figure 3. Similar results were found in study done by Khandelwal et al, (r 0.46, p <0.05) and Naghshin et al, (r +0.56, p <0.001).[11,14]

In this study there is significant positive correlation between 6MWT and post bronchodilator FEV1 % (r +0.429, p 0.000 (<0.001)). Similar results were found in study done by Khandelwal et al, (r +0.56, <0.05) and Naghshin et al, (r +0.67, p <0.001).[11,14] In present study there is significant positive correlation between 6MWD

and post bronchodilator FVC % (r +0.313, p 0.005 (<0.01)). Similar results were found in study done by Khandelwal MK et al, (r +0.42, p<0.05) and Naghshin R et al, (p<0.001).[11,14]

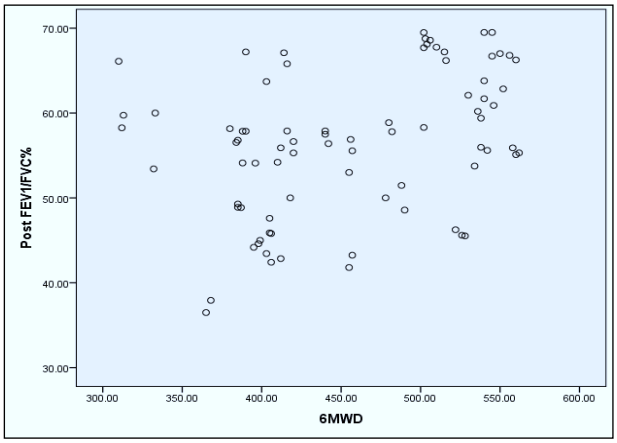

Figure 2: Scatter diagram showing correlation of 6MWD with post FVC.

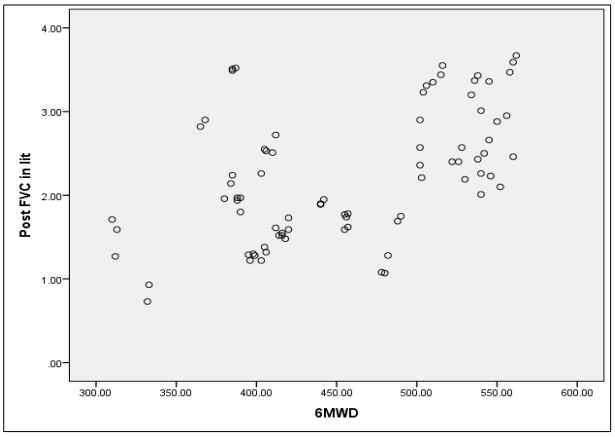

Figure 3: Scatter diagram showing correlation of 6MWD with post FEV1/ FVC% of predicted.

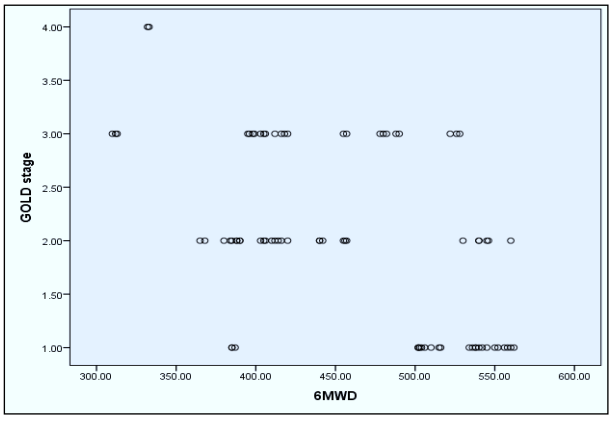

Figure 4: scatter Diagram showing correlation of 6MWD with GOLD stage.

In present study there was a negative correlation between 6MWD and GOLD stage with coefficient of correlation (r) - 0.536 with p value 00.000 (<0.001) which is highly significant (Figure 4). This indicates with increase in GOLD stage severity of COPD, 6MWD will decrease. But author didn't get any published study to compare the correlation of severity of COPD with 6MWD. The male patients far outnumbered female patients - a possible reason for this may be less prevalence and lack of awareness and seeking medical care due to several socio-economic issues experienced in females. Patients with resting oxygen saturation < 90% were not included in this study, which might also have excluded the patients with very severe COPD.

CONCLUSION

In summary, the six min walk test is a simple, safe and cost-effective method to assess the functional capacity of patients with COPD. The study showed significant positive correlation of 6MWT with height, weight and BMI and significant negative correlation present with age and mMRC grading of dyspnea in COPD patients. There is a significant positive correlation of 6MWT with post bronchodilator FEV1, FEV1%, FVC, FVC%, FEV1/FVC ratio in COPD patients and significant negative correlation present between 6MWD with GOLD stage of COPD patients. This concludes that, 6MWTcan be used for the assessment of severity of disease in COPD patients in places where spirometry is not available especially, in limited resource settings and places with poor access to healthcare facilities. Hence, 6MWT can be an apt alternative to spirometry in places where spirometer is not available.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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