“Six minute walk distance: Correlation with spirometric & clinical parameters in chronic obstructive pulmonary disease”

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ABSTRACT

Background: Six minute walk test (6MWT) is used as an indicator of the functional capacity in patients with cardiopulmonary diseases. This study was designed to assess the correlation of six minute walk distance (6MWD) with spirometric parameters and various clinical parameters in COPD patients.

Method: A cross sectional study was carried out in 65 COPD patients reporting to the OPD or admitted in the wards. Their severity was assessed by dyspnoea (MMRC grade), GOLD criteria and additionally other spirometric indices like peak expiratory flow rate (PEFR), forced expiratory flow (FEF25-75%) and was correlated with 6MWD.

Results: The 6MWD negatively correlated to breathlessness (MMRC grade) (P<0.05). There was statistically significant association between 6MWD to all spirometry parameters like forced expiratory volume in one second (FEV1 % predicted), forced vital capacity (FVC % predicted), PEFR % predicted, FEV1/FVC, FEF25-75% % predicted, FEV1(L), FVC(L), PEFR(L), FEF25-75%(L/s) (p<0.05). The different GOLD stages were found to have positive correlation to 6MWD (P<0.05). The 6MWD correlated positively to weight, BMI (P<0.05), but not to the height and age. Despite advance GOLD staging (III, IV) seven patients managed to walk more than 300 meters.

Conclusion: 6MWT is simple and safe test. In our study overall 6MWD had linear relationship with FEV1, FVC, FEV1/FVC, PEFR, grading of dyspnea and GOLD stages. In conclusion, in COPD patients 6MWT is a useful test to assess severity of disease.

Key words: Chronic obstructive pulmonary disease, Six Minutes Walk Test, Spirometry

INTRODUCTION:

Chronic obstructive pulmonary disease (COPD) is a growing worldwide public health problem. COPD is a major cause of mortality and morbidity globally. Millions of people suffer from this disease for years and die prematurely by its complications(1). COPD causes 2.7 lac deaths every year in India, hitherto it is under diagnosed. It is now recognized in 4-10 per cent of adult male population of India and several other Asian countries. In Asian countries COPD prevalence is estimated 6.3 per cent with a range from 3.5 to 6.7%.
In a large, multi-centric study from India, the population prevalence of COPD was 4.1 per cent, with a male to female ratio of 1.56:1. Almost all forms of smoking products are significantly associated with COPD. In non-smokers, especially women, an exposure to biomass fuels is an important factor (2).

According to GOLD international COPD guidelines (3), spirometry is the gold standard for accurate and repeatable measurement of lung function. Spirometry is however only one way of interpreting COPD disease severity. Other measures, such as the MMRC dyspnoea scale for measuring breathlessness, exacerbation frequency, body mass index, quality of life assessment, and exercise capacity all help to build a more complete picture.

Quantitative assessment of symptoms like dyspnoea, measurement of PEFR and exercise test like 6-minute walk test (6-MWT), which are cheaper modes of diagnosis, can be considered to substitute the spirometry at places where it is not available. Recently, guidelines developed under the WHO-Govt. of India committee group also suggest that if spirometry is not available then both staging of the disease and follow up of patient can be done on the basis of severity of symptoms, PEFR and 6 MWT (4). Therefore this study aims to find out correlation of Six Minutes Walk Test with Spirometric and Clinical parameters in COPD patients.

**MATERIAL AND METHODS**

A cross sectional study was carried out in COPD patients at Mahatma Gandhi Medical College & Hospital Sitapura, Jaipur. A total of 65 patients were included in the study, reporting to the OPD or admitted in the wards. The purpose of the study was explained to the patients and written consent was obtained thereof. Institutional ethical clearance was obtained for the study.

The diagnosis and staging were made on the basis of spirometric criteria.

All these cases were subjected to:

- Interrogation regarding symptomatology, smoking habits and risk factors of COPD patient as per pre designed Proforma.
- Physical examination both general and systemic was done with specific emphasis on respiratory system.
- All routine investigations CBC, ESR, Chest X ray, spirometry, sputum examination were done for diagnosis of COPD or to exclude the diagnosis of other diseases.

1. **Inclusion criteria:**
   - a. Diagnosis of COPD (GOLD criteria)
   - b. Age ≥ 40.

2. **Exclusion criteria:**
   - a. Asthma and respiratory failure
   - b. Domiciliary oxygen therapy and non invasive ventilation.
   - c. Diseases (eg, lung cancer, pulmonary tuberculosis, unstable angina, CHF, any other disease limiting patient’s movement.)
   - d. Acute exacerbation of COPD.
   - e. Patients with active neurological, rheumatological or peripheral vascular diseases.
   - f. Patients with elevated systolic blood pressure more than 180 mm Hg.

**Six minute walk test**

At the time of test, the patient’s heart rate, blood pressure and oxygen saturation were measured. The 6MWT was performed according to the ATS guidelines (5). Subjects were asked to walk at their own pace, along a 30 m long and straight hospital hallway marked at intervals of one
RESULTS

Table No. 1: Distribution of number and percentage of patients according to age & gender

<table>
<thead>
<tr>
<th>Age group (In yrs)</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-49</td>
<td>10 (15.38)</td>
<td>4 (6.15)</td>
<td>14 (21.53)</td>
</tr>
<tr>
<td>50-59</td>
<td>10 (15.38)</td>
<td>7 (10.76)</td>
<td>17 (26.15)</td>
</tr>
<tr>
<td>60-69</td>
<td>21 (32.30)</td>
<td>3 (4.61)</td>
<td>24 (36.92)</td>
</tr>
<tr>
<td>70-79</td>
<td>4 (6.15)</td>
<td>2 (3.07)</td>
<td>6 (9.23)</td>
</tr>
<tr>
<td>≥80</td>
<td>3 (4.61)</td>
<td>1 (1.53)</td>
<td>4 (6.15)</td>
</tr>
<tr>
<td>Total</td>
<td>48 (73.84)</td>
<td>17 (26.15)</td>
<td>65 (100)</td>
</tr>
</tbody>
</table>

Perusal of table 1 shows that out of 65 COPD patients, 48 (73.84%) were males and 17 (26.15%) were females.

Pulmonary Function Test

Patients with definite respiratory diagnosis underwent a pulmonary function test, using standard protocol. Spirometric indices including FEV$_1$, FVC, FEV$_1$/FVC and peak expiratory flow rate, FEF$_{25.75}$ were tested using computerized spirometer (ndd Medizintechnik AG). Reproducibility was ensured by doing at least three measurements for each lung function.

Statistical Analysis

Statistical analysis was performed using SPSS software. The data were reported as mean ± standard deviation (SD). The absolute (6MWD) in meters was used. The correlation between 6MWD and the patient’s demographic features and pulmonary function test measurements, were evaluated using Pearson's coefficient. One way analysis of variance was used to study the relationship between the 6MWD results and the severity of COPD stages based on the measured FEV$_1$. The criteria for statistical significance was set to be $P <0.05$. 

RESULTS

Table No. 1: Distribution of number and percentage of patients according to age & gender
Table No. 2: Distribution of number and percentage of patients according to GOLD stages & subgroups of 6 MWD (meters)

<table>
<thead>
<tr>
<th>6MWD (Meters)</th>
<th>I (%)</th>
<th>II (%)</th>
<th>III (%)</th>
<th>IV (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-200</td>
<td>0</td>
<td>1(5.55)</td>
<td>1(3.57)</td>
<td>1(6.66)</td>
<td>3(4.61)</td>
</tr>
<tr>
<td>201-300</td>
<td>0</td>
<td>4(22.22)</td>
<td>10(35.71)</td>
<td>7(46.66)</td>
<td>21(32.30)</td>
</tr>
<tr>
<td>301-400</td>
<td>1(25)</td>
<td>6(33.33)</td>
<td>13(46.42)</td>
<td>6(40)</td>
<td>26(40)</td>
</tr>
<tr>
<td>≥401</td>
<td>3(75)</td>
<td>7(38.88)</td>
<td>4(14.28)</td>
<td>1(6.66)</td>
<td>15(23.07)</td>
</tr>
<tr>
<td>Total (%)</td>
<td>4(100)</td>
<td>18(100)</td>
<td>28(100)</td>
<td>15(100)</td>
<td>65(100)</td>
</tr>
</tbody>
</table>

In stage I and II, 5 patients could walk less than 300 meters while in stage III and IV, 7 patients walked more than 300 meters. It signifies that we can’t apply 6MWD universally for the grading, therefore interpretation should be individualized. Moreover 7 patients in stage III, IV with good walking capacity (>300 meters) were likely to have better quality of life and prognosis.

Table No 3: Correlation between 6MWD and Patient’s parameters

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Mean±SD</th>
<th>R(correlation coefficient)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age(Years)</td>
<td>40-86</td>
<td>58.83±10.83</td>
<td>0.21</td>
<td>&gt;0.5</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>35-81</td>
<td>54.31±12.97</td>
<td>0.32</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Height (Meters)</td>
<td>1.39-1.75</td>
<td>1.6±0.07</td>
<td>-0.06</td>
<td>&gt;0.5</td>
</tr>
<tr>
<td>BMI (Kg/M²)</td>
<td>12.55-32.89</td>
<td>21.20±5.15</td>
<td>0.33</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Breathlessness</td>
<td>1-4</td>
<td>3.05±0.84</td>
<td>-0.42</td>
<td>&lt;0.5</td>
</tr>
</tbody>
</table>

The mean 6MWD was 334.46 ± 69.69 meters (range 180-470 m) and correlated positively to weight, BMI and negatively correlated to breathlessness (MMRC grade) (P<0.05). (Table no 3).
Table no 4 : Correlation between 6MWD and Spirometry parameters

<table>
<thead>
<tr>
<th>Range</th>
<th>Mean±SD</th>
<th>R(correlation coefficient)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV1 (% predicted)</td>
<td>12 – 98</td>
<td>44.94 ± 19.31</td>
<td>0.56</td>
</tr>
<tr>
<td>FVC (% predicted)</td>
<td>18 – 108</td>
<td>60.35 ± 21.94</td>
<td>0.42</td>
</tr>
<tr>
<td>PEFR (% predicted)</td>
<td>10 – 66</td>
<td>35.72 ± 13.87</td>
<td>0.74</td>
</tr>
<tr>
<td>FEV1/FVC</td>
<td>0.31 - 0.69</td>
<td>0.55 ± 0.9</td>
<td>0.46</td>
</tr>
<tr>
<td>FEF(25%-75%) (% predicted)</td>
<td>5 – 64</td>
<td>24.80 ± 12.61</td>
<td>0.46</td>
</tr>
<tr>
<td>FEV1(L)</td>
<td>0.13 - 2.3</td>
<td>1.12 ± 0.44</td>
<td>0.43</td>
</tr>
<tr>
<td>FVC(L)</td>
<td>0.28 - 3.5</td>
<td>2.03 ± 0.71</td>
<td>0.33</td>
</tr>
<tr>
<td>PEF(L/s)</td>
<td>0.43 - 5.29</td>
<td>2.67 ± 1.05</td>
<td>0.52</td>
</tr>
<tr>
<td>FEF(25%-75%) (L/s)</td>
<td>0.07 - 1.53</td>
<td>0.64 ± 0.33</td>
<td>0.31</td>
</tr>
</tbody>
</table>

The mean 6MWD was 334.46 ± 69.69 meters (range 180-470 m) and correlated positively to all spirometry parameters FEV1 % predicted, FVC % predicted, PEFR % predicted, FEV1/FVC, FEF(25%-75%) % predicted, FEV1(L), FVC(L), PEF(L), FEF(25%-75%) (L/s) (p <0.05). (Table No 4)

Table no 5 : Comparison between six minute walk distance (6MWD) and the severity of COPD

<table>
<thead>
<tr>
<th>GOLD Stages</th>
<th>FEV1 (%predicted)</th>
<th>Number</th>
<th>(Mean±SD)6MWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (MILD)</td>
<td>&gt;80</td>
<td>4</td>
<td>427.5±43.49 meters</td>
</tr>
<tr>
<td>II (MODERATE)</td>
<td>50-80</td>
<td>18</td>
<td>366.11±73.01 meters</td>
</tr>
<tr>
<td>III (SEVERE)</td>
<td>30-50</td>
<td>28</td>
<td>319.64±61.19 meters</td>
</tr>
<tr>
<td>IV (VERY SEVERE)</td>
<td>&lt;30</td>
<td>15</td>
<td>299.33±50.77 meters</td>
</tr>
</tbody>
</table>

F-Ratio=6.734 P<0.05

The different GOLD stages has positive correlation to 6MWD (P<0.05). (Table no 5)
DISCUSSION

Chronic Obstructive Pulmonary Disease (COPD): The chronic airflow limitations characteristic of COPD is caused by a mixture of small airway disease (obstructive bronchiolitis) and parenchymal destruction (emphysema). COPD also causes numerous significant extrapulmonary manifestations. These include reduced physical activity, cardiovascular diseases, weight loss, depression and anemia, and they have an enormous impact on the severity, morbidity and mortality of COPD (6-9).

6 Minute Walk Test (6MWT): 6MWT evaluates the integrated responses of all including the respiratory system, cardiovascular systems, blood, neuromusculoskeletal system, and muscle metabolism.

COPD is associated with loss of muscle mass and muscle weakness and finally results in the degression of the exercise tolerance (10). Exercise tolerance is determinant of patient’s quality of life and predicts the prognosis. The 6MWT is easy to administer, economic, better tolerated, and more reflective of activities of daily life. It may be widely used to evaluate the exercise tolerance in patients with heart or lung disease (11).

6MWT is best used to determine the response the treatment in heart or lung disease (12-23). The 6MWT has also been used as a one-time measure of functional status of patients, as well as a predictor of morbidity and mortality of patients of COPD and heart failure (24-27).

Correlation of Dyspnea (MMRC grade) and 6MWD: Present study demonstrate that higher the grade of dyspnoea (MMRC grade), lower the distance.(P<0.05) (Table No.3).

dyspnoea as a sense of increased effort to breathe, heaviness, air hunger or gasping. However, the terms used to describe dyspnea vary both by individual and by culture. In clinical practice, the MMRC grade remains the commonest scale used because of its simplicity, ease of administration and established validation as a useful marker in COPD. It predicts the likelihood of survival of patients with COPD (28).

Correlation of Spirometry indices and 6MWD:
The standard spirometry manoeuvre is a maximal forced exhalation (greatest effort possible) after a maximum deep inspiration (completely full lungs). Several indices can be derived from this blow.

- **Forced Vital Capacity (FVC) and forced Expiratory Volume in One Second (FEV₁)** – Present study demonstrate positive correlation between 6MWD and FVC as well as FEV₁ (Table No.4). This results were similar to other studies Hatem FS Al Ameri (29), Naghshin R et al (30), Mehta A et al (31).

- **FEV₁/FVC** – Present study demonstrate positive correlation between 6MWD and FEV₁/FVC (Table No.4), also demonstrated same result by Chulmsky et al (32).

- **Forced expiratory flow at 25% to 75% vital capacity (FEF₂₅-₇₅%)**: FEF₂₅-₇₅% has a wide range of normality, is less reproducible than FEV₁, and is difficult to interpret if the VC (or FVC) is reduced or increased." Although present study demonstrate positive correlation between 6MWD and FEF₂₅-₇₅% (Table No.4).

- **Peaked Expiratory Flow Rate (PEFR)**: Present study demonstrate positive correlation between 6MWD and PEFR(Table No.4), similar to data published by Knox et al (33), Naghshin R et
Our study showed correlation between severity of COPD and 6MWD test (P<0.05 ) were similar to those of Naghshin R et al(30) (Table No.5).

In stage I and II, 5 patients could walk less than 300 meters while in stage III and IV, 7 patients walked more than 300 meters. It signifies that we can’t apply 6MWD universally for the grading, therefore interpretation should be individualized. Moreover 7 patients in stage III, IV with good walking capacity (>300 meters) were likely to have better quality of life and prognosis (Table no -2).

**Correlation of Age, Height, Weight, Body Mass Index (BMI) and 6MWD** : Present study demonstrates statistically significant positive correlation between 6MWD and the patient’s weight and BMI. In healthy individual walking distance directly correlated to age and height (34), however this correlation is not proved in our study (Table no. 3) due to different rate of progression of disease in different individuals due to varied reasons.

The correlation of 6MWT and pulmonary function test, in patients with respiratory diseases, makes this test easy and a simple tool for assessing the disease status. We feel that this test is underutilized by clinicians. Test may be easily carried out in hospital settings with adequate space but may be difficult to be carried out in office practise due to time and space constrains.

PFT is the gold standard for the diagnosis of COPD at present (3). However, PFT is difficult to perform for some patients, especially for those patients with seriously impaired pulmonary function and severe dyspnoea. It is also a costly method with restricted availability. Long-term monitoring of pulmonary function by PFT is also difficult. There is a good correlation between the 6MWT and spirometric parameters in COPD patients. The 6MWT is also a simple, convenient, and effective exercise test which could be widely applied (35-37). Equipment needed to implement the 6MWT, such as finger pulse oximeter, sphygmomanometer, stopwatch, etc are all simple medical instruments. After a simple training, even non-medical people such as a family member could carry out the 6MWT, although caution is always needed. Therefore, the 6MWT may be used to assess the response of treatment and progress in COPD patients.

There were some limitations in our study. Females far outnumbered male patients. Possible reason for this may be less prevalence and lack of seeking medical care due to socioeconomic reasons by females. The test was not repeated to assess test reproducibility.

**CONCLUSION**

6MWT is simple and safe test. In our study overall 6MWD had linear relationship with FEV\(_1\), FVC, FEV1/FVC, PEFR, grading of dyspnoea and GOLD stages. In conclusion, in COPD patients 6MWT is useful test to assess severity of disease.

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