Correlation of forced expiratory volume in first second with 6-minute walk work in COPD patients

Anil Kumar K[1], Prasanna Purna K[2*], Surekha T[3], Mohan[4], Prathyusha[5]

[1]Assiciate Professor, [2]Professor, [3]Consultant, [4,5]2nd Year PG Resident, [1,2,4,5]Dept. of Respiratory Medicine, [3]Dept. of Gynecology, [1,2,4,5]Narayana Medical College, Andhra Pradesh, [3]Mydhili Hospital, Andhra Pradesh, India

***Corresponding Author: Prasanna Purna K**
Email: prasannakuruganti@gmail.com

Abstract
Background: 6 minute walk test (6MWT) is a simple routine exercise test. This test provides information about functional capacity of COPD patients. Though 6 minute walk distance (6MWD) is most commonly used outcome measure, it is influenced by various physical factors like body weight. So, we tried to assess the correlation between 6 minute walk work (6MWW) and forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC).
Methodology: A cross sectional study done at a tertiary care hospital in Nellore. Institutional ethical committee approved the study. All patients with COPD attending Respiratory medicine OPD were recruited. Detailed history was taken and physical examination was done after taking informed consent. Patients underwent chest x-ray, Arterial blood gas analysis, Electrocardiogram, Transthoracic 2-D Echo, Spirometry and 6 MWT. Data was analysed using MS Excel 2007.
Results: Total of 154 subjects were included.122 were males and 32 were females. 49(31.81%) walked a distance of ≥ 350 meters, 91(59.09%) walked ≥ 250 to 349 meters, and 14(9.09%) walked < 250meters. 32(20.77%) had 6mww > 22000kg.m, 32(20.77%) had ≤15000kg.m, 90(58.44%) had 15001-22000kg.m. 6MWW correlated better with FEV1 and FVC.
Conclusions: 6MWW is a better outcome measure of 6MWT and can be used to assess functional capacity of COPD patients and monitoring where spirometry cannot be done.

Keywords: Six minute walk work, Six minute walk distance, Forced expiratory volume in 1 second, Forced vital capacity, Chronic obstructive pulmonary disease.

Introduction
6 minute walk test (6MWT) is a simple, cheap, reliable, easily acceptable and submaximal exercise test. It gives information regarding functional capacity, response to therapy and prognosis in Chronic obstructive pulmonary disease (COPD) [1,2]. Patients with COPD have significant differences in performing 6MWT [3]. 6MWT is more reproducible than forced expiratory volume in 1 second (FEV1). The facility of spirometry is not available in many rural areas of India because of lack of infrastructure where 6MWT can be done easily. 6MWT can be a useful replacement of spirometry for assessing severity of COPD [4].

Most commonly used outcome parameter is the total distance walked during the test (6 MWD) [2,5]. But patient body weight has significant effect on distance walked. So it is important to consider patient body weight also while assessing functional status of the COPD patients [6].

Our study aim was to assess the relation between 6MWW (the product of distance x body weight) and spirometry parameters.

Materials and Methods
This was a cross sectional observational study done at a tertiary care hospital in Nellore. Study was approved by ethics committee of Narayana medical college, Nellore. COPD patients attending respiratory medicine OPD were recruited. Total 160 patients were recruited from January 2017 to December 2017. Detailed clinical history was noted and physical examination was done after taking informed consent. All patients underwent chest x-ray, Arterial blood gases analysis, Electrocardiogram, Transthoracic 2-D Echo were done. Using spirometer (Micro Quark, Cosmed, Rome, Italy) post bronchodilator FEV1/FVC, FEV1, FVC, FEV1 % predicted, FVC % predicted, FEF25-75% were obtained. Severity was defined according to the COPD GOLD guidelines.

6 minute walk test was done according to ATS guidelines. A 100 meter straight corridor in out patient department was marked by a colored tape at each end. Patients were encouraged to walk from one end to other end along the markings to cover as much distance as possible in the allotted 6 minutes. Pulse rate, blood pressure and oxygen saturation (SaO2) were noted before performing the test. Patient's dyspnea was graded using modified medical council (MMRC) dyspnea scale. Patients were encouraged verbally by our technician. Patients were allowed to stop and take rest if they felt any discomfort while walking. At the end of 6 minutes, dyspnea, oxygen saturation, pulse rate and blood pressure were again recorded. Total distance was calculated according to number of laps and was rounded off to the nearest number. By multiplying total distance walked in 6 minutes with patient body weight, we got 6 MWW.

Patients with acute exacerbation within last 6 weeks, those on domiciliary oxygen therapy, patients with other respiratory and cardiovascular systems diseases, musculoskeletal or claudication pain found difficulty in performing spirometry and or 6MWT. So, they were excluded from the study

Data was analyzed using MS excel 2007(Microsoft, USA).

Results

Out of 160 patients recruited, 6 patients were excluded as they could not complete 6 minute walk test. We could analyze only 154 patients' data. Of 154, 122 were males and 32 were females. 52 had HTN, 32 had DM and 64 had more than one comorbidity. 6 patients had no comorbid illness. 69(44.80%) had normal BMI, 38(24.67%) had BMI more than 24.9 and 47(30.51%) had under weight. 60(38.96%) had moderate obstruction, 82(53.24%) had severe obstruction and 12(7.79%) had very severe obstruction. 78(50.64%) had > 20 pack years of smoking, 32(20.77%) had ≤ 20 pack years of smoking and 44 (28.57%) were never smokers. No patient had hypoxemia at the time of study. Pao2 of 42 (27.27%) was ≥ 80 mm of Hg, 76(49.35%) subjects was between 70-79 mm of Hg and 36 (23.37%) had 60 -69 mm of Hg. 138 (89.61%) had Paco2 < 45 mm of Hg and 16(10.38%) had ≥ 45 mm of Hg. 49 (31.81%) walked a distance of ≥ 350 meters, 91(59.09%) walked ≥ 250 to 349 meters, and 14(9.09%) walked < 250meters. 32(20.77%) had 6mww > 22000kg.m, 32 (20.77%) had ≤15000kg.m, 90 (58.44%) had 15001-22000kg.m. 6MWW was correlating more positively with FEV1 and FVC and showing more linear relation than 6MWD. Fig. 1-4 represents correlation between walk test parameters and spirometry parameters.

Discussion

In the present day scenario spirometry is considered the gold standard for the diagnosis of COPD. But, it is not feasible for long term monitoring of pulmonary function by spirometry [7]. Moreover patients with seriously impaired pulmonary function and extreme dyspnea find it difficult to perform. Also not all peripheral hospitals are specially equipped with spirometry. So, 6 MWT can be used extensively to evaluate functional capacity in COPD patients and it has withstood the test of time [2].

To understand hypoxia of the patients in quiet state and post exercise, dyspnea (MMRC scale) and SPO2 were assessed before and after performing the 6MWT. Hypoxia induced by exercise was detected. Simple medical equipment like finger pulse oximeter, sphygmomanometer etc., needed to perform the 6MWT. Therefore, the 6MWT can be used to roughly monitor changes of pulmonary function in COPD patients [7].

The main outcome used in this field test is the total distance covered in the allotted 6-min period [5]. COPD patients can be stratified for clinical trials and interventions using 6MWD to modifying exacerbations, hospitalizations and death [8]. Determinants of 6MWD are complex. They depend on psychological and physical factors which include both pulmonary and non-pulmonary factors [3]. Since the 6MWT is a self-paced test, the results are influenced by external factors such as energy expenditure, operator encouragement and subject motivation. The inconsistencies resulting from gait speed (height), body weight and gender are sources of error to calculate exercise tolerance by 6MWD alone [9].

Our study shows advantage of 6MWW over 6MWD for assessing functional status of COPD patients as it is correlating strongly with spirometry. Since work is closely related to the energy requirements for task participation, it should yield an improved outcome index for the 6MW when compared to the distance. Changes in weight can significantly affect the energy requirement, and thus the amount of work accomplished [2]. Calculation of 6MWORK also may assist in accounting for differences in walk distance resulting from changes in body weight alone [2].

A better association was found between 6MWW and peak achieved during CPET than the 6-MWD alone [5]. 6 minute walk work correlated well with severity of the COPD [6]. COPD is common in elderly people. Few of study patients are of < 50 years of age. It represents increase in prevalence and early occurrence of COPD due to various causes. Age has no correlation with 6MWD (r = -0.1180), but has weak negative correlation with 6MWW (r = -0.3069). This was supported by Dogra et al., [9] where there was no relation between age and 6MWD and 6MWW. This indicates lack of effect of age alone on 6MWT. Because physical and functional status does not depend on age.

Height positively correlated with 6MWW(r=0.5195) but no correlation found with 6MWD(r = 0.1791). In contrast, in a study by Dogra et al., [9] 6MWD showed some positive relation and no relation between 6MWW and height. There was strong positive correlation between weight and 6MWW (r = 0.6418). Weak negative relation was observed between 6MWD and weight. This is because weight is a component of 6MWW calculation. 6MWD (r = -0.5252) showed strong negative correlation with BMI whereas 6MWW (r = 0.4353) had weak positive relation. This shows how 6MWD and 6MWW influenced by height and weight of COPD patients and also substantiates the superiority of 6MWW to 6MWD for assessing functional status.

FEV1 correlated more positively with 6MWW (r=0.6172) than with 6MWD (r=0.4531) and correlation between FEV1 and 6MWW is more linear as shown in figure 1 and 2. As subject body weight was also considered in calculating 6MWW, it correlated better with FEV1. This represents the strong relation between spirometry and 6 MWT and also demonstrates advantage of 6MWW over 6MWD. FVC also correlated with 6MWW(r=0.6010) and with 6MWD (r=0.5071). This is similar to findings of Carter R et al,[2] Dogra et al.,[9] and Agrawal et al.,[10] Based on these, we may use 6 MWT as an alternative to spirometry to assess pulmonary function of COPD patients.

In a study by Teixeira et al., [11] there was a strong correlation between DLCO and 6MWD and 6MWW rather than with spirometry. As DLCO testing is costlier, not routinely available and intention of our study is different we did not look into this. We did not find any significant relation between 6MWD and 6MWW with pre-test oxygen saturation, PaO2, PaCO2 and smoking in pack years.

As equipment needed for 6MWT are simple, it can be done even at a remote health center and even a non-medical person can perform this test with a simple training. 6MWwork is an improved outcome of 6MWT to monitor functional capacity of COPD patients [9].

Limitations

Correlation between 6MW test parameters and spirometry parameters lacks statistical significance.

Table 1: Baseline characteristics of study group (n=154)

Parameter	Mean	STD	Range
Age (years)	63.51	10.07	34 - 85
Height (cm)	163.01	8.69	146 - 183
Weight (kg)	58.22	14.78	27 - 112
BMI (kg/m^2)	21.9	5.58	12.49-42.15
Smoking (Pack years)	17.12	11.84	0-40
FEV1(L/sec)	1.19	0.44	0.54-2.56
FVC (L/sec)	2.02	0.67	0.83-4.16
SpO2 (%)	95.4	1.32	93-99
PaO2 (mm Hg)	75.3	6.62	62-96
PaCO2 (mm Hg)	39.76	3.24	28-47
6MWD (meters)	324.12	56.01	178-460
6MWW (kg.meters)	18525.34	4353.07	9240-28858

BMI-Body mass index, **FEV1**-Forced expiratory volume in 1 second, **FVC**-Forced vital capacity, **SpO2**- Arterial oxygen saturation, **PaO2**- Arterial partial pressure of oxygen, **PaCO2**- Arterial partial pressure of Carbon dioxide, **6MWD**-6 minute walk distance, **6MWW**-6 minute walk work.

Table 2: Correlation coefficients of 6 MWD and 6MWW with other parameters

Parameter	6MWD	6MWW
Age	-0.118	-0.3069
Height	0.1791	0.5195
Weight	-0.4201	0.6418
BMI	-0.5252	0.4353
FEV1	0.4531	0.6172
FVC	0.5071	0.601
PaO2	0.3688	0.3208
PaCO2	-0.1261	0.0773
SpO2	0.1634	0.191
pack years	0.0309	0.1508

BMI-Body mass index, **FEV1**-Forced expiratory volume in 1 second, **FVC**-Forced vital capacity, **SpO2-** Arterial oxygen saturation, **PaO2**- Arterial partial pressure of oxygen, **PaCO2**- Arterial partial pressure of Carbon dioxide, **6MWD**-6 minute walk distance, **6MWW**-6 minute walk work. P value not statistically significant. P value < 0.005 considered statistically significant.

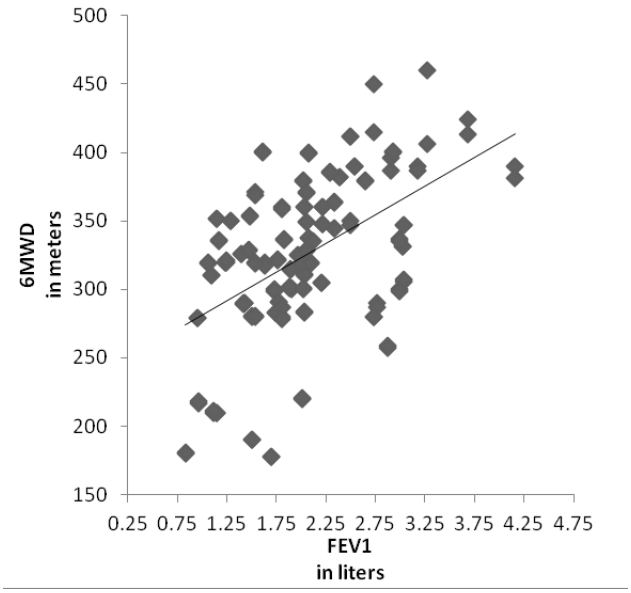

Fig. 1: Correlation between 6MWD and FEV1

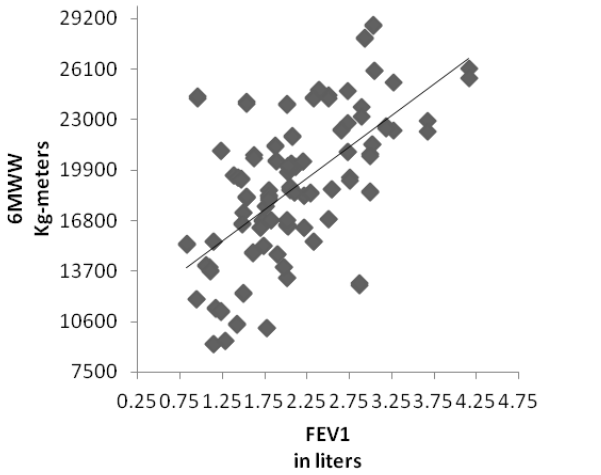

Fig. 2: Correlation between 6MWW and FEV1

Conclusion

Even though spirometry is the standard for diagnosing COPD; it may not be useful for frequent monitoring of pulmonary function of all COPD patients. Particularly in a developing country like India due to requirement of equipment, trained staff and cost. 6 MWT is an alternative and can assess functional status of COPD patients with ease. It does not require much equipment and simple training is sufficient to do the test even for patient attendants. As 6MWW positively correlated better than 6MWD with FEV1, it can be used to assess functional status of COPD patients.

Conflicts of Interest: None.

Acknowledgements: Nil

References

1. American Thoracic Society. Guidelines for the six-minute walk test. *Am J Respir Crit Care Med* 2002;166 (1):111-7.
2. Carter R, Holiday DB, Nwasuruba C, Stocks J, Grothues C, Tiep B et al. 6-minute walk work for assessment of functional capacity in patients with COPD. *Chest* 2003;123:1408-15.
3. Spruit MA, Watkins ML, Edwards LD, Vestbo J, Calverley PMA, Celli VR, et al. Determinants of poor 6-min walking distance in patients with COPD: The ECLIPSE cohort. *Respir Med* 2010;104(6):849-57.
4. Kundu A, Maji A, Sarkar S, Saha K, Jash D, Maikap M, et al. Correlation of six minute walk test with spirometric indices in chronic obstructive pulmonary disease patients: A tertiary care hospital experience. *J Assoc Chest Physicians* 2015;3:9-13.
5. Poersch K, Berton DC, Canterle DB, Castilho J, Lopes AL, Martins J et al. Six-minute walk distance and work relationship with incremental treadmill cardiopulmonary exercise test in COPD. *Clin Respir J* 2013;7 (2):145-52.
6. Kodavala AK, Dash S. Correlation between Forced Expiratory Volume in First Second (FEV1) And 6 Minute Walk Distance In Moderate, Severe and Very Severe Chronic Obstructive Pulmonary Disease. IOSR *J Dent Med Sci (IOSR-JDMS)* 2013;5(2):72-6.
7. Chen H, Liang BM, Tang YJ, Xu ZB, Wang K, Yi Q et al. Relationship between 6-minute walk test and pulmonary function test in stable chronic obstructive pulmonary disease with different severities. *Chin Med J (Engl)* 2012;125(17):3053–8.
8. Celli B, Tetzlaff K, Criner G, Polkey MI, Sciurba F, Casaburi R et al. COPD Biomarker Qualification Consortium; Insights from the COPD Biomarker Qualification Consortium. The 6-Minute-Walk Distance Test as a chronic obstructive pulmonary disease stratification tool. *Am J Respir Crit Care Med* 2016;194:1483–93.
9. Dogra A, Gupta U, Sarkar M, Padam A, Chauhan A, Thakur S. Six-minute walk work in patients with chronic obstructive pulmonary disease. *Int J Res Med Sci* 2014;2(4):1283-8.
10. Agrawal MB, Awad NT. Correlation between Six Minute Walk Test and Spirometry in Chronic Pulmonary Disease. *J Clin Diagn Res* 2015;9(8):OC01-4.
11. Teixeira PJ, Costa CC, Berton DC, Versa G, Bertoletti O and Canterle DB. Six-minute walk work is not correlated to the degree of airflow obstruction in patients with Chronic Obstructive Pulmonary Disease (COPD). *Rev Portuguesa de Pneumol* 2006;12(3):241-54.

How to cite this article: Anil Kumar K, Purna PK, Surekha T, Mohan, Prathyusha. Correlation of forced expiratory volume in first second with 6-minute walk work in COPD patients. *Indian J Immunol Respir Med* 2019;4(2):82-5.