

Research Article

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Six Minute Walk Test as a Criteria for Evaluation of Functional Status and Disability by One Time Single Measurement of Distance Walked in Six Minutes for Breathless Patients

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Abstract

6 Minute Walk Test is increasingly used in clinical practice, as an objective measurement of functional status in patients with moderate to severe impairment. It is one of the simple tests of low complexity that measures the distance a patient can walk in 6 minutes. The 6MWT is useful to assess response to medical interventions, prognosis and as single measurement of functional status in cardio respiratory disability.

Objective: There are few studies done in India that prompted us to do this study with the objective to evaluate functional status and disability by one-time measurement of 6-minute walk distance in patients with complains of breathlessness.

Methods: 121 Patients with complains of breathlessness were registered for the study between June 2010 to July 2011. Test procedures, purpose of the study were explained to participants. The materials used, patient's preparation and layout was done using ATS-2002 guidelines. The participants were asked to walk at their self-selected pace, attempting to cover as much distance as possible in 6 minutes. The total distance walked in 6 minutes was recorded.

Result: 121 patients were evaluated. Mean age, height and weight was 56.75 years, 161.80cm and 64.93 kg respectively. 101 patients completed the test, mean 6MWD was 390.08 meters (males 410.45, females 356.13m). 6MWD was significantly decreased in cardio-pulmonary diseases.

Conclusion: In our study we demonstrated that 6MWT can be safely performed even in patients with advanced cardiopulmonary conditions. It is a useful marker for the severity, progression and prognosis.

Keywords: 6MWT; 6MWD; Incremental Scuttle Walk Test; Cycle-Ergometry, Cardiac Stress Test; CPET; PFT

Introduction

Walk testing was first advocated by "Balke" in 1963 to assess physical fitness. K. H. Cooper used 12MWT in healthy air force personnel to demonstrate a strong correlation between maximal oxygen consumption and maximal exercise testing. McGavin used walk test to assess disability in COPD patients. 6MWT was introduced as functional exercise test by Lipkin in 1986 which correlated with those of 12MWT and cycle ergometry or treadmill. Although PFT continues to play a major role in management and research (FEV1 and FVC is used to assess severity of breathlessness). The effectiveness and reliability

of the 6MWT became the most widely accepted protocol to assess functional disability. Walking is a measure of functional status of daily activities. 6MWT is practical, simple, requires the ability to walk. The distance a patient walks on a flat surface in 6 minutes is used as a one-time measurement of functional status, or improvement during rehabilitation. The test is self-paced, reflects the exercise level needed for daily tasks [1], can be done by a technician. In 2002 ATS [1] outlined guidelines for 6MWT which reviewed the physiological response to exercise. Guidelines were used to limit controllable factors for variability (use of practice test, oxygen and medications prior to or during

testing). Technician does not walk with the patient to avoid influencing the patient's pace. Measurement of SPO₂ is optional, the test is usually terminated if the SPO₂ falls below 85% [2], however it can be continued depending on experience of the physician. In patients on long term oxygen therapy the 6MWT can be performed with portable oxygen. The 6MWT should be performed by a technician certified in cardio-pulmonary resuscitation at the basic life support level although advanced cardiac life support certification is desirable. Test is terminated when there are signs of severe distress, confusion, dizziness, diaphoresis, severe dyspnoea, fatigue. The patients were allowed to stop if mild distress occurred, however they were asked to resume walking. The patients were observed for 10-15 minutes after the test, patients who started to walk but did not complete the test were included in the study.

Indications

- Response to medical interventions in patients with moderate to severe cardio-pulmonary diseases.
- One-time measurement of functional status as a criterion for pulmonary affection and disability.
- Pre and post pulmonary surgery evaluation.
- Cardio pulmonary predictors of morbidity and mortality.

Materials and methods

Inclusion Criteria

Stable patient's between 13-85 years of age with complaints of breathlessness.

Exclusion Criteria

Myocardial Infarction in the preceding month, unstable angina, resting heart rate >120/min, systolic BP >180 mm Hg, diastolic BP >100 mm Hg, syncope, arthritis, skeletal or neuromuscular diseases. Stable angina is not an absolute contraindication (after taking anti angina drugs).

Test Procedure

The test was performed on a flat surface corridor of 15-meter length (recommendation is 15-30 meters) marked with small cones at the starting and end points and at every 3m distance, the time and laps were recorded on a worksheet. Patients were asked to wear comfortable clothes, take light meals, to sit for 10 minutes at the starting point for check on contraindication, informed written consent was taken and details of test procedure and risk associated were explained. Medical history with clinical examination was undertaken along with BMI, BP, Borg scores for dyspnoea and fatigue with resting heart, respiratory rate and SPO₂ were recorded after 10 minute's rest, and after completion of the test. Spirometry was performed and data collected as per ATS guidelines. The patients were asked to walk while attempting to cover as much distance as possible in 6 minutes.

Measurement

The total distance walked in meters in 6 minutes with number of rest and stops during the test were also recorded.

Statistical Analysis

Statistical analysis was performed with statistical software SPSS (Statistical Package for Social Sciences). The distribution of continuous variables was used for normality. The data were presented as mean+SD, except where otherwise specified. Rates and proportions were analyzed by Fisher's exact test and χ^2 test of general association where appropriate. The data were checked for normality using Kolmogorov Smirnov Z-test for individual variables of all groups. Pearson product correlation was used to assess for relationships among appropriate variables, two sample student- t test with assumption of unequal variance measured during 6MWT alone (age, sex, height, weight, body mass index), distance ambulated, resting and exercise heart rate, blood pressure, respiratory rate, oxygen saturation were evaluated for their association with 6MWD by first univariate analysis with the spearman's correlation test and then adjusted to multivariate analysis using stepwise multiple linear regression. To determine entry and removal of candidate variables from the model P-values of 0.05 and 0.01 were used respectively. Kaplan-Meier method was used to compare patients by categories of 6MWD (<149- severe, 150-249 moderate, 250-349 mild, >350 normal). 6MWD measured in our study was compared with predicted 6MWD derived from the studies of Enright PL & Sherrill DL [3] for healthy adults.

Optimal reference equations

From healthy population based samples using 6MWD methods are not yet available, several authors [1-16], determined factors affecting 6MWD in healthy adults and proposes the reference equation or normative data for 6MWT outcome (Table 1). When 6MWD is reduced a thorough search for the cause of the impairment should be made i.e. PFT, Cardiac function, ankle-arm index, muscle-strength, nutritional status, orthopaedic and cognitive function.

Interpreting the results

Once 6MWD for a given patient is available we have calculated the predicted distance using equation from published studies of healthy people of same age group much like spirometry.

Result

Patient's characteristics

Table 1 shows the physiological characteristics of the patients and their relation with 6MWD. We evaluated 121 patients between 13-85 years of age, 32 smokers. 108 had respiratory disease, 12 had cardiac disease, most of the patients completed the test. Mean age, height and weight were 56.75±15.054 years, 161.80±8.352cm, 64.93±14.633kg respectively. Mean FEV₁%, FVC%, and FEV₁/FVC% were 63.49±18.837, 63.7±16.230, and 99.72% respectively.

Table 1: Demographic Characteristics of the Patients: mean values.

Variables	All (n=121)	Male (n=75)	Female (n=46)	P
Age(years)	56.75±15.054	58.36±16.460	54.13±12.143	<0.005
Height(cm.)	161.80±8.352	166.23±5.675	154.59±6.872	<0.001
Weight (kg.)	64.93±14.633	64.44±13.850	65.74±15.952	<0.005
B.M.I.(kg/m ²)	25. ±.042098	24.0123±4.021	26.0342±4.0341	N.S.
6MWD(m)	390.08±143.211	410.45±146.000	356.13±133.164	0.001
FEV1%	63.49±18.837	61.31±18.919	67.00±18.365	
FVC%	63.71±16.230	63.12±15.615	64.65±17.307	
FEV1/FVC%	99.7248±17.49029	96.9069±18.88277	104.2579±14.1720	

As per pulmonary function test

41(33.58%) patients had obstructive airways disease of which 20 (18.2%) had mild, 16 (13.2%) moderate and 5 (4.1%) had severe obstruction. 43 (35.53%) had restrictive disease of which 27 (22.3%) had mild, 13 (10.7%) moderate, and 3 (2.5%) had severe restriction.15 (12.40%) had combined obstructive and restrictive disorder of which 3 (2.5%) had mild, 7 (5.8%) moderate and 5 (4.1%) had severe disorder;22 (18.18%) had normal spirometry. Mean 6MWD was 390.08+143.211m (range 264.769-533.29). 51 patients walked >400m, 24 between 300-400m, 19 between 200-300m, 11 between 100-200m, and 2 patients walked <100 m.

a) In males: Total patients were 75, mean age, height and weight were 58.36+16.460years, 166.23+5.675cm, 64.44kg+13.850 respectively. Mean FEV1%, FVC% and FEV1/FVC% were 61.31+18.919, 63.12+15.615, 96.90%+18.88277. 6MWD was 410.45+146.000m (264.45-556.45).

b) In females: Total patients were 46, mean age, height and weight were, 54.13+12.143yrs, 154.59+6.872cm, 65.74+15.952kg. Mean FEV1%, FVC% and FEV1/FVC% were 67.00+18.365, 64.65+17.30, 104.2579+14.01720 respectively. 6MWD was 356.13+133.164m (222.966-489.294) 6MWD was lower in females. Disease wise 6MWD (Table 2 & Figure 1) was 290.8+121.997m (89-411) in COPD, 207+112.834m (100-430) in IPAH, 330.72+120.906 m (151-525) in ILD, 385.45+141.408 m (198-55)in CHE,473.00+106.828m (250-655) in BA, 418+114.698 m (146-655) in Bronchiectasis. 101 (83.40%) patients completed 6MWT of which 31(30%) had to stop during walking for few seconds but resumed walking, 20 (16.50%) patients could not complete the test, and the test had to be terminated the various reasons were breathlessness, giddiness, fatigue, tiredness, chest heaviness, drop in saturation.

Table 2: Disease wise distribution of patients and 6MWD.

Diagnosis	Mean	N	Std. Deviation
B.A.	473.00	36	106.828
BRE	418.33	9	114.695
C.H.D.	385.42	12	141.408
C.K.D.	410.00	2	56.569

C.O.P.D.	290.81	21	121.997
EOSINOPHILIA	540.00	1	.
HEALTHY	540.00	1	.
I.L.D.	330.72	18	120.906
METASTESIS Ca	312.00	1	.
OHS	533.00	1	.
OLD TBP	288.00	2	144.250
P.H.T.	207.14	7	112.834
Pneumonectomy	432.00	1	.
R.A.D.S.	600.00	1	.
S.L.E.	300.00	1	.
SARCOIDOSIS	543.00	5	87.293
SCLERODERMA	514.00	1	.
Total	390.08	120	143.211

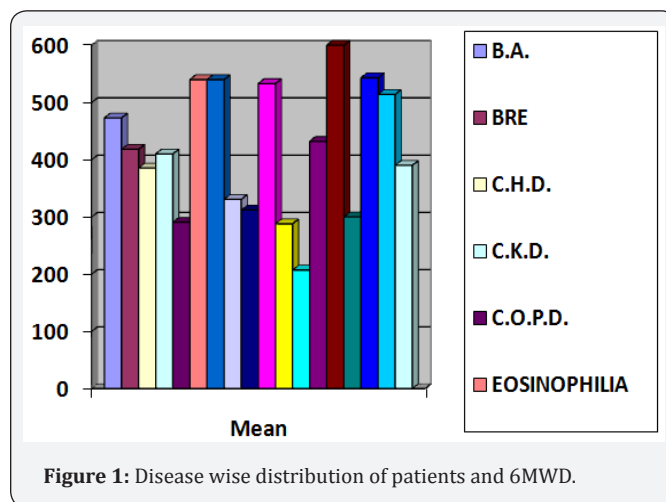


Figure 1: Disease wise distribution of patients and 6MWD.

As per reference [6] 55 (46%) patients achieved lower limit of normal (LLN), 15 (12.50%) achieved target walk distance. Disease wise COPD 4(19%), ILD 8 (44.44%), PHT 2 (28.37%), CHD 8 (90%), Sarcoidosis 4 (80%), Bronchiectasis 4 (44.44%) and B.A. 22 (60%) patients achieved LLN.1 patient achieved target walk distance in COPD, ILD 3 (16.66%), Sarcoidosis 2 (40%), PHT 1(14.30%), Bronchial Asthma 9 (24.32%) and others 1(14.30%) could achieved target walk distance.

Correlation between 6MWD and various physiological and pulmonary parameters

Table 3: Correlations between 6MWD and various physiological and pulmonary parameters.

		Six Min Walk
AGE	Pearson Correlation - r	-.387(**)
	Sig. (2-tailed) p	.000
	N	120
SEX	Pearson Correlation - r	-.184(*)
	Sig. (2-tailed) p	.044
	N	120
HEIGHT	Pearson Correlation - r	.285(**)
	Sig. (2-tailed) p	.002
	N	120
WEIGHT	Pearson Correlation - r	.219(*)
	Sig. (2-tailed) p	.016
	N	120
B.M.I.	Pearson Correlation - r	.061
	Sig. (2-tailed) p	.505
	N	120
borgescale	Pearson Correlation - r	-.659(**)
	Sig. (2-tailed) p	.000
	N	117
mmrc_pre	Pearson Correlation - r	-.455(**)
	Sig. (2-tailed) p	.000
	N	94
SMOKER	Pearson Correlation - r	-.211(*)
	Sig. (2-tailed) p	.030
	N	107
FEV1	Pearson Correlation - r	.404(**)
	Sig. (2-tailed) p	.000
	N	119
FVC	Pearson Correlation - r	.484(**)
	Sig. (2-tailed) p	.000
	N	119

RatFEV1FVC	Pearson Correlation - r	-.030
	Sig. (2-tailed) p	.748
	N	119
mmrcpost	Pearson Correlation - r	-.613(**)
	Sig. (2-tailed) p	.000
	N	108
borgescalepost	Pearson Correlation - r	-.687(**)
	Sig. (2-tailed) p	.000
	N	117
spo2_pre	Pearson Correlation - r	.382(**)
	Sig. (2-tailed) p	.000
	N	120
Spo2_post	Pearson Correlation - r	.439(**)
	Sig. (2-tailed) p	.000
	N	120
rr_pre	Pearson Correlation - r	-.455(**)
	Sig. (2-tailed) p	.000
	N	120
rrpost	Pearson Correlation - r	-.418(**)
	Sig. (2-tailed) p	.000
	N	120

(Tabb 3) Male tend to be significantly taller and BMI less than female. Significant positive correlation found between 6MWD and height ($p < 0.002$, $r = 0.285$) and weight ($p < 0.016$, $r = 0.219$), but no correlation was found between 6MWD and B.M.I. Significant negative correlation found between age ($p = 0.000$, $r = 0.387$), Borg score of dyspnoea, fatigue ($p = 0.000$, $r = 0.659$), and MMRC score of dyspnea ($p = 0.000$, $r = 0.455$), (correlation was more significant post-test for Borg and MMRC Score ($p = 0.000$, $r = 0.687$ and $p = 0.000$, $r = 0.613$) and smoking ($p < 0.030$, $r = 0.211$). Significant positive correlation found between spirometry values FEV1% and FVC% ($p = 0.000$, $r = 0.404$, $P = 0.000$, $r = 0.484$ respectively) and SPO2 pre and post-test ($p = 0.000$, $r = 0.382$, $p = 0.000$, $r = 0.439$ respectively).

Discussion

Table 4: Mean 6MWD (in meters) by various authors for all subjects (men and women) and comparison with our study.

Study	All Subjects	Men	Women	Significant Difference
Enright & Sherrill et al [3]		576(391-728)	494(310-664)	yes
Gibbons WJ, et al [9]	698±96	687±89	583±53	yes
Chetta		638±44	593±57	yes
CamarniB & Eastwood P [12]	659±62	685±49	628±59	yes
Hermion, Poh, PeterR. Eastwood et al Singapore	560±105	586±126	538±82	no
Li et al		680±65	642±58	yes
Almeri et al		429±47	386±45	yes

Bennsard et al		711±81	551±75	yes
Icoama et al		622±80	551±71	yes
Troster et al [7]	631±93			
Devshyam, et al [15] (Indian)	480±62.33	524±	425±	yes
Sivaranjani S, et al [16] (Indian)	445±55.64	482±89	408±39.86	yes
Our study (Indian)	390.08±143.211	410.45±146	356.13±164	yes

The ability to walk for a distance is an easy way to measure exercise capacity in patients with cardiac-pulmonary diseases. 6MWT is found to be an effective way of assessing exercise tolerance. We evaluated 121 adults, mean 6MWD was 390.80+143.211m, males cover more distance than females. We compared 6MWD with several studies done world over in healthy adults 1-16 (Table 4). A reference equation published by Enright & Sherril [3] found that age, gender height, and weight were independent factor associated with 6MWD. They administered 6MWT to 117 healthy man and 173 healthy women aged 40 to 80 years, the median distance walked was 576 m for man and 494 m for women. We selected this reference [3] equation for computation of 6MWD in our study: For Men: 6MWD= (7.57x height in cm)-(5.02x age in yrs.)-(1.76xwt.)-309, alternative using B.M.I 1140m-(5.61X B.M.I.)-(6.94x age). For women: 6MWD= (2.11x height in cm) - (2.29 x wt. in kg) - (1.76x age in yrs.)+667, alternative using B.M.I.: 1017m-(6.24x B.M.I.)-(5.85x age in years) when using either equations we subtracted 153 m for men and 139 m for women as lower limit of normal (LLN). In our study mean 6MWD was 390+143.211m. The mean 6MWD values described in various studies 1-16, was 613+93m and 659+62m in western and Caucasian healthy subjects respectively, compared to above studies our results were 62% (lower by 38% than western studies). There are two studies done in Indian healthy adults: Devshyam, et al [15] (281 healthy subjects mean 6MWD was 480+62.33m), and Sivaranjani SS, et al [16] (60 healthy subjects mean 6MWD was 445+55.64m) compared to these two studies our mean 6MWD were 82% and 87% lower by 18% and 13% respectively. Al Ameri [17] studied 129 Saudi Arab subjects, mean 6MWD was 341+70 m, compared to our study it was significantly lower, marked difference in above study may be due to selection of the patients,

(COPD (37%), PHT (1%), ILD (62%)). In our study we selected all types of patients, when calculated for COPD, ILD, PHT, 6MWD was 283m which is lower by 18%. In our study mean 6MWD value in male and female patients were 410.45+146.000 and 356.13+133.164m respectively. Compared to study done by Paul Enright & D Sherril [3] (6MWD in healthy adult males and females, mean 6MWD were 576m and 494m respectively), our mean 6MWD values were 71.17% (29% lower) in males and 72% (28% lower) in females respectively. In comparisons to study done by: (1) Devshyam, et al. [15] (mean 6MWD were 524 and 425m in males and females), our study showed significant lower value of 6MWD [410m (78.84%) and 356m (76%), lower by 22% and 24%]. (2) S. Sivaranjani S, et al [16] (6MWD were 482+45.89 and 408+29.86m in males and females respectively), our study showed lower values of 6MWD [410 m (85.41%) and 356 m (87.24%) lower by 15% and 13% respectively]. In our studied population the 6MWD has a significant correlation with various physiological and pulmonary parameters (Table 4). Positive correlation found with height (p<0.002, r=0.285,) and weight (p<0.016, r=0.219). Significant negative correlation found with gender (p<0.044, r=0.184 males covered more distance than females, normal reference values are lower in females than males) and age (p=0.000, r=0.659). 6MWD was positively correlated with FEV1 (p=0.000, r=0.404), FVC% (p=0.000, r=0.484) and oxygen saturation pre and post (p=0.000, r=0.382, p=0.000, r=0.439 respectively). 6MWD decreases with decrease in FEV1, FVC and SPO2, and inversely correlated with Borg score of dyspnea (p=0.000, r=0.659) and MMRC Scale (p=0.000, r=0.455) of dyspnea, as the age, Borg and MMRC scale of dyspnea increases 6MWD decreases, also smoking (p<0.300, r=0.211) decreases the 6MWD.

Disease Specific Discussion (Table 5)

Table 5: Correlation between 6 MWD severity and disease severity.

Total		6min Walk Distance				Total
		1.00 Normal (>=350)	2.00 Mild (250-349)	3.00 moderate (150-249)	4.00 Severe (<= 149)	1.00 Normal (>=350)
B.A.	Count	32	4	0	0	36
	% within diagnosis	88.90%	11.10%	0.00%	0.00%	100.00%
BRE	Count	7	1	0	1	9
	% within diagnosis	77.80%	11.10%	0.00%	11.10%	100.00%
C.H.D.	Count	7	2	3	0	12

	% within diagnosis	58.30%	16.70%	25.00%	0.00%	100.00%
C.K.D.	Count	2	0	0	0	2
	% within diagnosis	100.00%	0.00%	0.00%	0.00%	100.00%
C.O.P.D.	Count	7	6	4	4	21
	% within diagnosis	33.30%	28.60%	19.00%	19.00%	100.00%
EOSINOPHILIA	Count	1	0	0	0	1
	% within diagnosis	100.00%	0.00%	0.00%	0.00%	100.00%
HEALTHY	Count	1	0	0	0	1
	% within diagnosis	100.00%	0.00%	0.00%	0.00%	100.00%
I.L.D.	Count	8	4	6	0	18
	% within diagnosis	44.40%	22.20%	33.30%	0.00%	100.00%
METASTETIC Ca	Count	0	1	0	0	1
	% within diagnosis	0.00%	100.00%	0.00%	0.00%	100.00%
OHS	Count	1	0	0	0	1
	% within diagnosis	100.00%	0.00%	0.00%	0.00%	100.00%
OLD TBP	Count	1	0	1	0	2
	% within diagnosis	50.00%	0.00%	50.00%	0.00%	100.00%
P.H.T.	Count	1	0	4	2	7
	% within diagnosis	14.30%	0.00%	57.10%	28.60%	100.00%
PNEUMONECTOMY	Count	1	0	0	0	1

COPD: The FEV1 is often used to grade the severity of disease; however patients with COPD have systemic manifestations that are not reflected by the FEV1%. Several factors have been identified that predict poor survival in COPD these includes low FEV1, active smoking, hypoxemia, poor nutrition, presence of cor-pulmonale, resting tachycardia, lower exercise capacity, severe dyspnea, poor health related quality of life, anemia, frequent exacerbations, co-morbid illness, and low DLCO. Patients with FEV1 <35% predicted have about 10% mortality per year, if patient reports that they are unable to walk 100 meters without stopping because of breathlessness, the 5-year survival is only 30%. A multidimensional prognostic index [17] that takes into account several indicators of COPD prognosis are the BODE Index. Inclusion of 6MWD along with FEV1, dyspnea rating and BMI into a 10-point index was better at predicting mortality in COPD than FEV1 alone. B.R. Celli, Cote C.G., JM Martin et al. [18] evaluated 207 patients and found that above four factors predicted the risk of death in this cohort: in which a higher score indicates a higher risk of death. The hazard ratio (HR) for death from any cause increased by 1.34 per point increase in BODE INDEX (95% confidence interval 1.26 to 1.42, p<0.001) and HR for respiratory cause was 1.62 (95% confidence interval-1.48 to 1.77, p<0.001). "0" point is given for 6MWD >350 m, 1point for 250-349 m, 2 points for 150-249 m, and 3 points for <149 m. This demonstrate the independent role that exercise capacity measured by 6MWT has in predicting mortality in COPD. In our study we had 21 patients of COPD 18 male (all were smokers), 3 female (non-smokers), mean 6MWD was 290.81meters (range 89 to 401 meters), 9 patients could not complete 6MWT due to dyspnea, fall in saturation, only one patient could achieved

Target 6MWD (100%), as per ref 6 equation 3 patients could not achieve lower limit of normal distance walk, 4 patients walked <149 meters only (3 points), 4 patients walked between 150-249 meters (2 points), 6 patients walked between 250-349 meters (1 point) and 7 patients walked > 350 meters (0 point). As per BODE INDEX: 2 patients had score of "10", 2 patients had score of "9", 1 patient had score of "8", 5 patients had score of "7", 2 patients had score of "5", 9 patients had score of "2-4". A BODE score > 7 is associated with 30% 2 years' mortality, where as a score of 5-6 is associated with 15% 2 years' mortality, if BODE score is<5 the 2 years' mortality is less than 10%. In our study 10 patients had BODE score of >7, 2 patients had score of 5, and 9 patients had score<5 that can predict 2 yrs. mortality, which is higher in 12 patients in our study. In another study done by Szekely LA, et al [19] they evaluated 47 subjects preoperatively for LVRS a 6MWD <200 meters had a specificity of 84% for prediction of 6 months mortality after LVRS for emphysema. Patients with unacceptable risk for this procedure were identified by the 6MWT and a resting PCO2>45 mmHg. In our study 6 patients walked < 200 meters which is significant. In a study done by Casanova C, Cote C, JM Martin, et al. [20] for 576 COPD patients with wide range of airflow obstruction seen at 4 centers in two countries reported on the value of 6MWD and Spo2 during 6MWT, 6MWD was a good independent predictor of all cause and respiratory mortality particularly for the group with FEV1<50% of predicted and fall in Spo2>4% or to < 90%. In our study 11 patients had FEV1 <50% with 10 patient's 6MWD <350m with fall in saturation >4% during exercise test (Spo2<90%). In a mixed group of patients with advanced lung disease undergoing evaluation for lung transplantation a study

done by Kadikar A, [21] many of had severe COPD, 6MWD was <300 meters had a 80% mortality rate. In our study we have 9 patients who had severe COPD 5 walked < 300m another 5 patients who had combined obstructive and restrictive disorder walked <300 meters, in all these patients 6MWD predicts higher mortality.

Idiopathic Pulmonary Arterial Hypertension: In patients with Idiopathic pulmonary hypertension 6MWD was significantly but modestly related with New York Heart association functional class, baseline cardiac output, pulmonary vascular resistance, but not mean pulmonary artery pressure. A study done by Shoichi Miyamoto, John Satohet, et al [22] in 43 patients with pulmonary hypertension together with echocardiography, right heart catheterization and measurement of plasma epinephrine and norepinephrine. Symptom related cardiopulmonary exercise performed in a sub sample of patients (n=27) distance walked in 6 minutes was significantly shorter in patients than in age and sex matched subjects (297+188 versus 655+91m, p<0.001). The distance walked had strong significant correlation with CPET parameters. Among the various parameters only 6MWD <332 meters independently related to mortality by multivariate analysis. Patients had a lower survival than those walking further. In our study we had 7 patients of pulmonary hypertension out of which 5 patients walked <250 meters and 2 walked < 140 meters, indicating higher mortality. In another study done by Paciocco G, et al [23] 6 MWD <300 meters and reduction of saturation >10% at the end of 6MWT was associated with increased mortality with an HR of 2.4 and 2.9 respectively. In our study 7 patients of pulmonary hypertension 5 patients walked < 300m with 2 patients desaturates >10% at the end of the test which is quite significant.

Idiopathic Pulmonary Fibrosis: The importance of measuring oxygen desaturation during 6MWT was highlighted in a study of patients with IPF by Flaherty KB, et al [24] which showed that a decrease in SPO₂ during exercise had prognostic value though ATS does not recommends measurement of SPO₂ during test, 6MWD was a weak predictor of mortality which was no longer significant when patients were split into presence or absence of SPO₂< 88% during exercise. Patients with an SPO₂< 88% during their 6MWT had a median survival time of 3.2 years, compared to 6.8 years in those with lesser degree of oxygen desaturation. Even in those with a milder degree of desaturation, a 10-point increase in desaturation area gave HR for mortality of 1.33 (95% confident interval, 1.08 to 1.63 p=0.007). For patients with baseline 6MWT SPO₂< 88% the best predictor of mortality was serial decrease in diffusion capacity of carbon mono-oxide [25]. In those with lesser degrees of 6MWT desaturation at baseline serial decrease in FVC and increase in desaturation significantly predicted mortality. In our study 12 patients' desaturates > 4% (range 4 to 9%) (base line spo₂ <88%). This finding highlights the importance of measurement of spo₂ during 6MWT to assess prognosis, an approach specifically not recommended by ATS. In our study 3 patients could not

complete the 6MWT due to severe dyspnea, tachypnea, and drop in saturation >4%, 15 patients completed 6MWT, 8 stopped due to dyspnea and drop in SPO₂ >4% for 15-30 seconds but continue walking after rest. In another study by Vibha N Lama et al [26] prognostic value of desaturation during 6MWT in IPF patients, exercise induced hypoxia is an index of the severity of ILD. Desaturation during 6MWT predict mortality for patients with UIP (n=83) and NSIP (n=27), desaturation is defined fall in saturation < 88% or less during 6MWT. Patients desaturated had higher mortality than those who did not have.

Chronic heart failure: 12 patients (9 males, 3 female) mean 6MWD is 385.42+408 m, 2 patients could not complete the test due to drop in saturation >4%, 5 patients could not achieve lower limit of normal walk distance. 2 patients achieved Target walk distance. In patients with CHF strong correlation between 6MWD and exercise ergometry and VO₂ max were observed by several researchers and moderate to strong association with NYHA functional classification. Results of other studies in the same population have shown that distance walked in 6MWT (<300m) can identify those with increased likelihood of death or hospitalization within a time frame ranging from 3 months to 1 year. In our study 5 patients walked < 300 m out of which only one could achieve lower limit of normal 6minute walk distance. In a study done by Lipkin DP, et al [27] 26 patients with mean age of 58 years (range 36-58) with stable CHF NYHA class II & III and 10 normal subjects of similar age there was significant difference in walking distance between normal, CHF patients with class II & III (683, 558, and 402m) respectively, the distance walked varies with oxygen consumption. In a study done by Shah MR, et al [28] in patients with congestive heart failure (CHF) those with a 6MWD below a median of 218 m had a 4-6-fold higher mortality risk for every 100 m decrease in 6MWD, the HR for death, hospitalization and the composition of the two end points was 0.58, 0.85 and 0.75 respectively. In another CHF study done by Passantino A, et al [29] 6MWD and short term change in 6MWD in response to change to therapy were significant independent predictor of survival. Prognostic value of 6MWT in stable CHF patients a study by Sakir Arslam et al [30] with two groups of patients, death risk was higher in patients with a distance of <300m (p=0.05) with LVEF<0.30(p=0.02). Studies of Left Ventricular Dysfunction (SOLVD) was the first large investigation (898 patients) by Bittener, et al [31] to show a strong correlation between distance walked during 6MWT and death (decrease in distance walked increases the mortality). In our study 5 patients walked <300m. with drop in saturation showed increased mortality.

Bronchiectasis: Total 9 patients (5male, 4female) 2patients could not complete the test due to drop in saturation, tachypnea, and dyspnea, 4 patients could not achieve lower limit of normal distance, 8 patients could not achieve Target walk distance, 4 patients had > 4% drop in saturation. In a study by Lee A³¹ 6MWD severity of disease and HRQOL had a stronger association compared to physiological measures of disease severity.

Sarcoidosis: 5 patients with mean 6MWD-543.0 +87.293m all patients walked > 400m and achieved lower limit of normal walk distance, only one patient achieved Target walk distance, all had > 4% drop in saturation during 6MWT but all completed 6MWT, 3 patients became tachypnic with respiratory rate>24/mt. In a study done by Bittener, et al [31] for 26 Saudi patients with pulmonary sarcoidosis all completed 6MWT female covered shorter distance than males, lowered Spo2 at end of test than others, mean 6MWD for entire cohort was 364m, females < than males [343m (223-389) vs 416m (352-500m), with significant lower Spo2 at end of 6MWT than male [90.5% (61-99%) vs 96% (75-98%). In our study there was no such difference seen in distance walked in 6 minutes but all patients had drop in saturation >4% which is significant [33-36].

Bronchial Asthma: 37 patients (18 male, 19 female), 1had severe, 7 moderate, 14 mild, 15 patients had normal disease, all had completed 6MWT, 8 male and 4 female became tachypnic with 8 had >4% drop in saturation, 33 patients walked >350 m, 4 walked between 150-249m, 10 patients could not achieved lower limit of normal (LLN) as per reference equation, all had long standing Bronchial Asthma. In a study done by AL Ameri [35] for respiratory disease patients 6MWD was significantly correlated with FEV1 patients.

Other patients: (1Carcinoma lung, 2RADS, 1Tuberculosis, 2CKD, 1Pneumonectomy all patients completed the test except 1T.B. patient), 5 walked >350m, 1 between 250-349 m, 1<249m (150-249).

Conclusion

In our study we demonstrated that 6MWT can be safely performed. Its validity reliability, and reproducibility were studied in several populations world over [1-16]. As per our knowledge this is one of the study done in Indian population, with no untoward events or complications that required emergency management, was highly tolerable in different age groups, gender and in patients with advanced cardiac-respiratory conditions, only few patients could not complete the test. 6MWD is a useful marker for the severity and progression of the disease. The co-relation of 6MWT and PFT, in patients with respiratory diseases makes this test easy and simple tool for assessing the disease status. 6MWD was lower in females and had significant positive correlation with height, FEV1, FVC, SPO2, and negative correlation with age, Borg and MMRC scale of dyspnea and smoking.

Contributors

All the authors designed the study, review the case, revised and checked it. PKV wrote the manuscript, prepared tables and images, reference collection, and obtained informed consent from the patient. PSB and GBG helped smooth conduction of the test, helped in writing manuscript. SVR consultant Respiratory Physician reviewed draft, supervised whole procedure suggested improvements. JRS, HOD helped in conducting, selection of place,

reviewed draft, RSM helped in preparation of draft, suggested reviews and references.

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