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COMPARISON OF FUNCTIONAL CAPACITY VALUES MEASURED BY SIX MINUTES WALK TEST (6MWT) IN CHRONIC OBSTRUCTIVE LUNG PATIENTS ACCOMPANIED

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Abstract

Introduction: Chronic Obstructive Pulmonary Disease is still the leading cause of mortality in the world. Increased pulmonary pressure and hypoxemia in COPD cause impaired left ventricular diastolic function. Impaired respiration accompanied by cardiovascular disorders can cause a decrease in activity ability. Functional capacities that describe the ability of activities can be assessed by the 6 minute walk test. The purpose of this study was to assess the comparison of functional capacity values in COPD patients with or without diastolic disorders.
Method: This study is a cross-sectional analytic study involving 88 subjects who met the inclusion criteria. Patients were grouped according to the severity of COPD and the presence of diastolic dysfunction assessed by echocardiography. Cardiac training was performed in all test groups. Data analysis uses bivariate analysis to determine comparisons on categorical variables followed by multivariate analysis to determine comparisons between test groups.
Results: Of a total of 88 patients, there were 28 patients (31%) with mild COPD without diastolic dysfunction, there were 16 patients (18%) with mild COPD accompanied by diastolic dysfunction, 15 patients (17%) with severe COPD without diastolic dysfunction, 29 patients (32%) with severe COPD accompanied by diastolic dysfunction. Significant differences in functional capacity ($p = 0.00$) were found between each test group.
Conclusion: There is a significant difference in functional capacity values between COPD groups with different severity and with or without diastolic dysfunction.

Introduction

Cardiovascular disease is the main comorbid in COPD and is probably the most frequent and most important disease together with COPD. The Lung Health study shows that most deaths in mild COPD sufferers are a result of cardiovascular complications, and a large epidemiological study recently revealed an increase in cardiovascular mortality, especially in patients under 65 years of age with COPD.1

In COPD patients who experience cardiovascular complications in the form of right heart failure, pulmonary hypertension, worsening cardiac ischemia and heart rhythm disorders that are not treated adequately will eventually lead to heart failure. COPD accompanied by heart failure causes a vicious cycle in these two diseases, where both conditions will worsen one another. The estimated prevalence of heart failure with COPD is higher than the general adult population with an odds ratio of 2.57.2

Patients with heart failure who are classified as preserve ejection fraction (pEF) are more likely to have a history of COPD compared to heart failure patients with ejection fraction reduction. The paradigm found in patients with pEF heart failure is preceded by pro-inflammatory status that is triggered by various comorbidities, such as COPD, DM, HT and obesity.3

Patients with a diagnosis of heart failure, for whatever reason, show impaired functional capacity. The pathophysiological changes in one of the cardiovascular, respiratory and neomuscular systems affect functional capacity and adversely affect patients with heart failure.4 Cardiovascular integrity, respiratory system and skeletal

muscle are the main determinants of functional capacity. If one or more systems have problems, the functional capacity will be affected.

The difference in functional capacity in COPD patients can indicate a disturbance in the respiratory system, but can also be influenced by complications that occur, especially those involving the cardiovascular system. This research can help us to do the best further management and can decrease the morbidity and mortality.

Methods

This study is a cross-sectional analytic study which perfomed at Haji Adam Malik General Hospital Medan with permisson from Research Ethics Commitee of Faculty of Medicine, Universitas Sumatera Utara-RSHAM. Subjects were recruited from December 2018 to Desember 2019. The study involved 88 patients. The inclution criteria were patient who were Male and female patients aged> 30 years who have been diagnosed with chronic obstructive pulmonary disease from the outpatient polyclinic of the Department of Pulmonology and Respiratory Medicine, FK USU/H. Adam Malik Hospital Medan by Spirometri test and willing to participate in research by signing informed consent. While exclution criteria were patients with pulmonary abnormalities other than COPD that have been previously diagnosed, patients who have been diagnosed by other heart abnormalities (coronary artery disease, valve disorders and congenital heart disease), COPD with acute sxacerbations and patients with lower limb motor disorders.

Data collection was carried out starting from clinical data consisting of disease history, initial physical examination, ECG, spirometry results and echocardiography. The severity of COPD is determined by the GOLD criteria based on the results of spirometry. The degree of air flow resistance is classified as GOLD 1 (FEV1 ≥ 80% prediction), GOLD 2 (50% ≤ FEV1 <80% prediction), GOLD 3 (30% ≤ FEV1 <50% prediction) and GOLD 4 (FEV1 <30% prediction) coupled with a FEV1/FVC value (Forced Expiratory Volume in 1 Second / vital capacity) < 0.70. Diastolic dysfunction is determined by echocardiographic parameters with> 2 positive at this value (E / e '> 14, e' septal <7 or e 'lateral <10, TR velocity > 2.8 m/s, LA volume index> 34 ml / m2).

Study Procedure

Patients were grouped into 2 groups based on the severity of COPD. i.e. mild group (GOLD I-II) and severe group (GOLD III-IV). Then each group is divided into 2 based on the presence or absence of diastolic dysfunction. There are 4 groups at the end, group A (mild COPD without diastolic dysfunction), group B (mild COPD with diastolic dysfunction), group C (severe COPD with diastolic dysfunction) and group D (severe COPD with diastolic dysfunction). All of participant followed Six Minutes Walk Test. The mileage that achieved by participants is then converted to functional capacity values (METs). METs values then divided into 3 level, low (METs < 3), moderate (METs 3-6), high (METs > 6).

Statistical Analysis

Categorical variables are represented by the number or frequency (n) and percentage (%). Numerical variables are represented by mean values (mean) with standard deviations for normally distributed data and Median Values for non-normally distributed data. Numerical variable normality test on all research subjects used the Kolmogorov-Smirnov test with n> 50. The Pearson Chi Square test is used for the comparative test of unpaired categorical variables between groups on the independent and dependent variables. If Chi Square test requirements are not met, then the Fisher test is used.

Post hoc analysis was performed on unpaired numerical variables using the unpaired T-test. If it is known that the data has an abnormal distribution, the Mann Whitney test was used. The basis for decision making in the categorical analytical test was taken by comparing the Asymp values. Significancy in the Chi Square test output on the critical value of 0.05 (with a type I error rate = 5%). If the Asymp Significance Value is found <0.05 then there is a relationship between the two research variables.

Results

The total number of subjects in this study were 88 people. The middle age of the study subjects was 59.5 years with the youngest age 24 years and the oldest age 82 years. With 76 people (86.4%) are men. The mean weight

of the study subjects was 61 ± 11.4. There are 11 people (12.5%) also suffer from hypertension. The mean duration of COPD suffered was 3.3 years with the maximum duration of 11 years. While smoking is the main risk factor obtained by 45 people (51.1%) are smokers> 20 years and the number of cigarettes consumed is at most 1-2 packs per day in 45 people (51.1%). In the spirometry examination, the mean value of FEV1 was 50.1 with the lowest value of 11. The spirometry value was a reference for grouping patients into 2 groups, namely mild COPD group with FEV1 value> 50% and severe COPD group with FEV1 <50%. Diastolic dysfunction was found in 44 people (50%).

Table 1. Baseline Characteristics

Variable	n = 88
Age (years)	59.5 (24-82)
Sex (n, %)	
Male	76 (86.4%)
Female	12 (13.6%)
Weight (kg)	61 ± 11.4
Height (cm)	160 (145-172)
Body Mass Index	23.44 ± 3.45
HTn (n, %)	
Yes	11 (12.5%)
No	77 (87.5%)
PPOK duration (years)	3.3 (1-11)
Smoking duration (n, %)	
<20 vrs	43 (48.9%)
>20 vrs	45 (51.1%)
Cigarretes (n, %)	
<1 pac/day	34 (38.6%)
1-2 pac/day	45 (51.1%)
>3 pacs/day	9 (10.2%)
FEV1	50.5 (11-83)
PVC	60.5 (13-95)
FEV1/PVC	74.5 (24-99)
Diastolic dysfunction (n,%)	44 (50%)
Mileage (meters)	271.5 (70-670)
Functional capacity (METs)	4.4 (1.01-11.59)

The results of a heart training test using the 6 minutes walk test method and found the mean distance traveled is 271.5 meters with a range of 70-670 meters. Then the mileage is converted with the components of age and weight so that the median value of METs 4.4 is found. Of 88 subjects found that age in group A was younger than other groups and found a significant age difference in all groups. Also found significant differences in gender and weight. No significant difference was found in height.

Table 2. Baseline Characteristics of each group

	Group A	Group B	Group C	Group D	
			N		p-value
Age (years)	39.5 (24-59)	66.5 (42-77)	65 (58-79)	66.5 (39-82)	0.00
Sex					0.038
Male	20 (71.4%)	14 (87.5%)	14 (93.3%)	28 (96.6%)	
Female	8 (28.8%)	2 (12.5%)	1 (6.7%)	1 (3.4%)	
Weight (kg)	61.0 ± 8.2	65.4 ± 9.6	55.0 ± 13.3	64 ± 12.7	0.052
Height (cm)	162 (148-172)	162 (156-168)	157 (145-170)	162 (149-172)	0.056
BMI	23.13 ± 2.93	24.6 ± 2.97	21.3 ± 3.29	24.2 ± 3.82	0.024
HTn	0 (0%)	2 (12.5%)	4 (26%)	5 (17%)	0.027
COPD duration (yrs)	1.6 (1-5)	3.6 (1-6)	4.6 (1-8)	4.0 (1-11)	0.00
Smoking duration					0.00
<20 yrs	24 (85.7%)	14 (87.5%)	2 (13.3%)	3 (10.3%	
>20 yrs	4 (14.3%)	2 (12.5%)	13 (86.7%)	25 (89.7%)	
Cigarretes					0.00
<1 pac/day	19 (67.9%)	13 (81.3%)	0 (0.0%)	2 (6.9%)	
1-2 pac/day	9 (32.1%)	3 (18.7%)	11 (73.3%)	22 (75.9%)	
>2 pac/day	0 (0.0%)	0 (0.0%)	4 (26.7%)	5 (7.2%)	
FEV1	76.4 (55-83)	66.8 (52-81)	29.4 (11-45)	29.2 (11-49)	0.00
PVC	79.5 (47-95)	68.5 (42-92)	37.8 (17-66)	39.7 (13-72)	0.00
FEV1/PVC	85.14 (64-99)	78.13 (26-95)	63.4 (46-83)	57.07 (24-92)	0.00
Mileage (meter)	458 (210-640)	285 (160-670)	168 (85-520)	206 (70-348)	0.00
Functional capacity (METs)	8.3 (4.09-11.59)	4.7 (2.3-11.44)	2.9 (1.01-8.47)	3.2 (1.03-5.72)	0.00

From table 2 we can see in the component of the results of the 6 minutes walk test that is the distance and METs found significant differences between groups. With the lowest distance found in group C with a middle value of 165 meters and the highest distance in group A with a middle value of 485 meters. The calculation value of METs also significantly differed between groups with the highest mean of 8.3 in group A and the lowest value of 2.9 in group C.

Analysis was performed on categorical functional capacity variables (low, medium and high) based on METs values according to Piepoli (2010) to the severity of COPD with and without diastolic dysfunction (Table 3). from the table found significant differences ($p < 0.05$) between the four groups.

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Table 3. Analysis I (Categoric vs Categoric)

Group	Low METs	Moderate METs	High METs	p-value
A	0 (0.0%)	8 (17.6%)	20 (74.1%)	<0.05
B	0 (0.0%)	10 (21.7%)	6 (22.2%)	
C	7 (46.7%)	7 (15.2%)	1 (3.7%)	
D	8 (53.3%)	21 (45.7%)	0 (0.0%)	
	15 (100%)	46 (100%)	27 (100%)	

Then an analysis of numerical functional capacity variables on the severity of COPD and diastolic dysfunction was used to determine differences between groups. And found the results of significant differences in the value of functional capacity between each group of samples except between groups C and D (p = 1.0)

Table 4. Analysis II (Categoric vs Numeric)

	Functional Capacity (METs)			
	A	B	C	D
A	-	0,016 (0.243-3.77)	0,0 (3.13-6.74)	0,0 (3.13-6.15)
B	0,017 (-3.78-(-0.24))	-	0,01(0.86-4.95)	0,01 (0.89-4.40)
C	0,0 (-6.74 - (-3.13))	0,01 (-4.95- (-0.86))	-	1 (-2.02-1.55)
D	0,0 (-6.15 - (-3.13))	0,01 (-4.41- (-0.892))	1 (-1.55-2.02)	-

Significant differences between groups based on the p value in the table above are based on the results of the METs in each group and to find out the difference in METs between each group can be seen in table 5.

Table 5. Functional capacity difference

	Functional capacity difference (METs)			
	A	B	C	D
A	-	2.01341	4.89741	4.66380
B	-2.01341	-	2.88400	2.65039
C	-4.89741	-2.88400		-0.23361
D	-4.66380	-2.65039	0.23361	

From the analysis with chi square tests found significant differences in functional capacity between groups. This was then clarified by the Anova test on numerical functional capacity values with the results of significant differences between groups except between groups with the severity of severe COPD with and the presence or absence of diastolic dysfunction. The biggest difference in METs between groups A and C was 4.66. While between 2 groups of severe COPD with or without diastolic dysfunction only found 0.2.

Discussion

Demographic data in this study showed that the majority of subjects were male with a frequency of 76 people (86% of the sample) and the majority of the age range was in the 5th to 7th decades with a median value of 59.5 years. The age of the study subjects was approximately the same as the age of the subjects in the study by Inal Ince et al, where the mean age of the study subjects was 62.8 years. In theory, the age prevalence of COPD patients in Indonesia is also in the same age range. 5

In this study also found that the number of male samples is much greater than women with a ratio of 6.3: 1. This demographic comparison is similar to the study conducted by Chaudari et al (2018) with a male and female subject ratio of 4.55:1.6 Male sex and age are risk factors for COPD events. This is related to long-term cigarette consumption as the main cause of COPD. Thus the results of this study are also in line with research that states old age, smoking habits and exposure to cigarette smoke exposure or air pollution for longer affect the severity of COPD.7

In other demographic data, no significant differences were found in anthropometric status (body weight and height). This illustrates the distribution of subjects based on homogeneous anthropometry in each group. Thus weight and height considerations have the same opportunities for cardiovascular events (diastolic dysfunction) and can be ignored.

On the results of the examination of the heart training 6 minutes walk test, it was found that the distance traveled in each group was significantly different. Where in groups C and D, the distance traveled by subjects was lower than groups A and B. From the Inal-Ince (2005) study it was mentioned that the distance traveled by severe COPD patients was shorter than in populations without COPD.5 These results can be caused by the limitations of COPD due to respiratory problems, so the heavier the degree of COPD experienced, the more limited the function of the lung. The results of this study also show that 6MWT can be used as an evaluation tool from limitations due to respiratory system disorders.

After calculating the METs and classification based on Piepoli (2010), significant differences were obtained between all study groups.8 The study continued with post-hoc statistical analysis, which showed the highest group A METs values compared to the other groups and found significant METs differences between groups except in groups C and D. Group A had higher METs values than group B who have diastolic disorders. State that left ventricular diastolic dysfunction independently can reduce functional capacity.9 One mechanism by which diastolic function parameters can affect functional capacity is related to its role in producing maximum cardiac output. When exercising, maintenance of adequate left ventricular filling to ensure normal cardiac output includes the ability to achieve a filling rate greater than the ejection level during the systolic phase. In tachycardic conditions triggered by activity, abnormalities during relaxation and left ventricular filling cause low filling and are not proportional to adequate cardiac output during activity even if the left ventricular systolic function is normal. Increased left atrial pressure is also needed until it reaches a pressure gradient large enough, to provide adequate ventricular filling during activity in the relaxation regulation of the disrupted left ventricle.9

While there were no differences between groups C and D in line with the research of Inal Ince (2005) which stated that there was no difference in functional capacity in the moderate to severe COPD group. So the difference in diastolic function does not affect the low functional capacity values found in the two groups.5

In a comparative analysis between the METs value and COPD severity, a significant comparison was found between each group with a value of $p = 0.00$. where more severe COPD severity results in lower functional capacity values compared to mild COPD patients. This can be related to the possibility of abnormalities in the cardiovascular system thereby reducing the value of functional capacity significantly. This is in line with Safitri's study (2019) which states that there is a significant relationship between the severity of COPD and changes in heart structure assessed from echocardiography.10 Also in line with research from Arif (2019) which concluded that there is a significant relationship between the severity of chronic obstructive pulmonary disease with markers of changes in the structure and function of the heart in ECG assessment in Adam Malik hospital.11

Conclusion

There is a significant difference between the functional capacity values assessed by the 6 minutes walk test and the severity of COPD with or without diastolic dysfunction.

Conflict of Interest

The authors declare that there is no conflict of interest

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