Diagnostic and Prognostic Significance of Lung Function Tests in Chronic Obstructive Pulmonary Disease & Cardiovascular Diseases

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ABSTRACT

BACKGROUND

We wanted to assess the significance of diagnosis and prognosis of lung function tests in chronic obstructive pulmonary diseases (COPD) & cardiovascular diseases in this study.

METHODS

This study was conducted among 200 patients in the outpatient departments of General Medicine and Cardiology of King George Hospital/AMC. Data was collected with Spirometer machine (Digital), HELIOS-401, Recorders & Medicare Systems Pvt. Ltd, Haryana, Chandigarh-160002, India. The data were entered into MS Excel and analysed in SPSS v21.

RESULTS

Of the 200 patients enrolled in the study, 146 (73 %) were males and 54 (27 %) were females with an average age of 50.38 ± 9.86 yrs. In the study population, pulmonary function parameters were significantly different in COPD compared to control and a P-value of less than 0.05 was considered statistically significant. The difference in pulmonary function parameters between Controls, COPD, Post MI & Post MI & COPD groups was statistically significant. Whereas the pulmonary function parameters between the post-MI and controls were not statistically significantly different with a P-value of more than 0.05. In the study population, the pulmonary function parameters were significantly different between the Post MI and control, COPD and control, Post MI with COPD and control.

CONCLUSIONS

The diagnosis of COPD was done by the Lung function test which is considered the gold standard test. The lung function was improved in Post MI cases of more than one-month duration.

KEY WORDS

Lung Function Tests, COPD, Cardiovascular Diseases, Spirometry

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BACKGROUND

Pulmonary function tests are non-invasive tests that measure lung function in terms of lung volume, capacity, rate of flow, and gas exchange. Pulmonary function tests can be done in 2 methods – Spirometry and Plethysmography of which spirometry is the most commonly used method. The diagnosis of respiratory disorders is yielded doubly in primary care by the use of spirometry which is safe and accurate for early diagnosis and also simple and inexpensive. There is significant morbidity and mortality throughout the world in relation to ischemic heart diseases (IHD) and chronic obstructive pulmonary diseases (COPD).

Since clinical symptoms like dyspnoea and cough frequently overlap, the combination of these two conditions poses many difficulties in the diagnosis. There is sparse data addressing the combination of both diseases even though they have been extensively studied separately. COPD patients with IHD have a poor prognosis compared to those with either disease alone and hence it is important to identify and appropriately manage chronic obstructive airway disease in such patients. COPD is often undetected in cardiac patients as only one-third of them undergo spirometry, which is the gold standard for diagnosis of it, at least once with the remaining being underutilised.

“One-third of people die of cardiovascular disease as it is a common comorbidity and cause of death in people with chronic obstructive pulmonary disease (COPD)”.¹ To lessen the burden of COPD it is very important to reduce cardiovascular disease in this population.

“People with COPD have a higher risk of myocardial infarction (MI) than people without COPD according to various studies”.²⁻⁴ “Smoking is a major risk factor for the increased risk of MI in patients with COPD apart from several other cardiovascular risk factors including hypertension, inactivity, diabetes, old age and poor diet that are also prevalent in patients having COPD”.⁵⁻⁷ “There is an association found between reduced FEV₁ (forced expiratory volume1 s) and cardiovascular mortality in the general population according to several studies”.⁸ There is an increased risk of MI possibly being mediated through increased systemic inflammation or reduced FEV₁ in people with COPD which is thought to be an independent risk factor for MI.⁹ “Although the finding that patients with COPD have greater in-hospital and short-term mortality has not been found by all investigators, mortality is worse in patients with COPD in hospital and following discharge after an MI than in those without COPD according to some of them”.¹⁰⁻¹⁵

Objectives

1. To evaluate the lung function status by pulmonary function tests in patients having COPD.
2. To evaluate the lung function status by pulmonary function tests in patients of more than 1 month of Post MI.
3. To determine the diagnostic & prognostic significance of lung function tests in COPD and cardiovascular diseases.

METHODS

Written informed consent was taken from each individual in the local language for the study after permission from the Institutional Ethics Committee of Andhra Medical College / King George Hospital, Visakhapatnam. A sample size of 200 that included both chronic obstructive pulmonary diseases & cardiovascular disease cases was in the present comparative cross-sectional study. The sample was collected from patients attending the outpatient departments of General Medicine and Cardiology of King George Hospital/AMC. Data was collected with Spirometer machine (Digital), HELIOS-401, Recorders & Medicare Systems Pvt. Ltd, Haryana, Chandigarh-160002, India.

Control Cases	COPD Cases	Post MI Cass – 1 Month	COPD + 1 Month Post MI Cases	Total Cases
50	50	50	50	200
<i>The Types of Samples Collected Were Shown in the Following Table</i>				

Statistical Analysis

SPSS v21 was used for the analysis and its data were entered into MS Excel. Age and gender were represented in percentages. Unpaired student t-test was used to compare the pulmonary function parameters among the control and other groups. Analysis of variance (ANOVA) was used to evaluate the differences among the groups and a P-value of 0.05 was considered statistically significant.

Inclusion Criteria

1. Subjects who gave consent to the study
2. Both genders
3. Age between 30 and 60 years
4. Patients with myocardial infarction of more than 1 month of duration.
5. Patients with a history of chronic obstructive pulmonary disease
6. Patients suspected to be COVID, on test negative (RTPCR) were enrolled.

Exclusion Criteria

1. Patients who were not willing to participate.
2. Patients with a history of recent surgery of the head, chest, stomach, and eyes.
3. Patients with uncontrolled hypertension, unstable angina, or a recent myocardial infarction or stroke (< 1 month).
4. Patients with a history of the acute phase of communicable diseases.
5. Active haemoptysis, active tuberculosis and a history of syncope associated with forced exhalation.
6. Individuals with a history of pneumothorax.
7. Individuals with arrhythmias.
8. Patients with suspect COVID positive.

RESULTS

Sex			
		Frequency	Percentage
Gender	Female	54	27
	Male	146	73
Age	30-40	43	21.5
	41-50	64	32.0
	51-60	72	36.0
	61-70	21	10.5

Table 1. Demographic Characteristics

Lung Volumes/Parameters	Group	Mean $\pm$ SD	P-Value
FVC	Post MI	2.44 $\pm$ 0.49	0.388
	Control	2.56 $\pm$ 0.86	
FEV 1	Post MI	2.25 $\pm$ 0.42	0.678
	Control	2.30 $\pm$ 0.67	
FEV1/FVC	Post MI	92.52 $\pm$ 5.55	0.379
	Control	91.17 $\pm$ 9.31	
FEF 25-75	Post MI	3.07 $\pm$.76	0.430
	Control	3.22 $\pm$ 1.06	
PEFR	Post MI	4.92 $\pm$ 1.44	0.237
	Control	5.32 $\pm$ 1.82	
FIVC	Post MI	2.49 $\pm$ 1.03	0.150
	Control	2.67 $\pm$ 1.27	
SVC	Post MI	2.36 $\pm$ 0.54	0.165
	Control	2.53 $\pm$ 0.70	
ERV	Post MI	0.53 $\pm$ 0.66	0.321
	Control	0.68 $\pm$ 0.90	
IRV	Post MI	0.96 $\pm$ 0.75	0.218
	Control	1.18 $\pm$ 1.01	
MV	Post MI	23.20 $\pm$ 8.98	0.145
	Control	26.36 $\pm$ 12.30	
MVV	Post MI	41.84 $\pm$ 13.52	0.510
	Control	43.82 $\pm$ 16.27	
MRF	Post MI	30.21 $\pm$ 8.61	0.886
	Control	29.97 $\pm$ 8.10	
IT	Post MI	6.93 $\pm$ 0.80	0.427
	Control	7.07 $\pm$ 0.94	
ET	Post MI	6.70 $\pm$ 0.83	0.623
	Control	6.62 $\pm$ 0.82	

Table 2. Comparison between Post MI and Control

The functional parameters between the post-MI and control like FVC, FEV1, PEFR, FIVC and ET were not statistically significantly different with a P-value of more than 0.05 in the study population.

SBP	Group	Mean $\pm$ SD	P-Value
FVC	COPD	1.33 $\pm$ 0.57	0.000
	Control	2.56 $\pm$ 0.86	
FEV 1	COPD	1.01 $\pm$ 0.56	0.000
	Control	2.30 $\pm$ 0.67	
FEV1/FVC	COPD	78.55 $\pm$ 24.31	0.001
	Control	91.17 $\pm$ 9.31	
FEF 25-75	COPD	1.46 $\pm$ 1.17	0.000
	Control	3.22 $\pm$ 1.06	
PEFR	COPD	2.45 $\pm$ 1.63	0.000
	Control	5.32 $\pm$ 1.82	
FIVC	COPD	1.59 $\pm$ 0.90	0.000
	Control	2.67 $\pm$ 1.27	
SVC	COPD	1.75 $\pm$ 0.53	0.000
	Control	2.53 $\pm$ 0.70	
ERV	COPD	0.48 $\pm$ 0.61	0.182
	Control	0.68 $\pm$ 0.90	
IRV	COPD	0.68 $\pm$ 0.68	0.004
	Control	1.18 $\pm$ 1.01	
MV	COPD	17.50 $\pm$ 9.61	0.000
	Control	26.36 $\pm$ 12.30	
MVV	COPD	27.22 $\pm$ 15.61	0.000
	Control	43.82 $\pm$ 16.27	
MRF	COPD	28.26 $\pm$ 8.20	0.296
	Control	29.97 $\pm$ 8.10	
IT	COPD	5.73 $\pm$ 1.21	0.000
	Control	7.07 $\pm$ 0.94	
ET	COPD	6.92 $\pm$ 1.14	0.135
	Control	6.62 $\pm$ 0.83	

Table 3. Comparison between COPD and Control

Pulmonary function parameters were significantly different in COPD compared to control like FEF25-75, PEFR, SVC, FIVC, FVC, FEV1, FEV1/FVC, IRV, MV, MVV and IT were statistically significant with a P-value of less than 0.05

Lung Volumes	Group	Mean $\pm$ SD	P-Value
FVC	Post MI & COPD	1.46 $\pm$.48	0.000
	Control	2.56 $\pm$.86	
FEV 1	Post MI & COPD	1.11 $\pm$.51	0.000
	Control	2.30 $\pm$.67	
FEV1/FVC	Post MI & COPD	78.78 $\pm$.05	0.003
	Control	91.17 $\pm$.31	
FEF 25-75	Post MI & COPD	1.61 $\pm$.78	0.000
	Control	3.22 $\pm$.06	
PEFR	Post MI & COPD	2.56 $\pm$.45	0.000
	Control	5.32 $\pm$.82	
FIVC	Post MI & COPD	1.82 $\pm$.11	0.001
	Control	2.67 $\pm$.27	
SVC	Post MI & COPD	2.00 $\pm$.47	0.000
	Control	2.53 $\pm$.70	
ERV	Post MI & COPD	0.50 $\pm$.71	0.255
	Control	0.68 $\pm$.90	
IRV	Post MI & COPD	0.80 $\pm$.74	0.032
	Control	1.18 $\pm$.01	
MV	Post MI & COPD	22.36 $\pm$.49	0.083
	Control	26.36 $\pm$.30	
MVV	Post MI & COPD	35.54 $\pm$.56	0.004
	Control	43.82 $\pm$.27	
MRF	Post MI & COPD	29.89 $\pm$.34	0.960
	Control	29.97 $\pm$.10	
IT	Post MI & COPD	6.60 $\pm$.98	0.016
	Control	7.07 $\pm$.94	
ET	Post MI & COPD	6.85 $\pm$.84	0.174
	Control	6.62 $\pm$.83	

Table 4. Comparison between Post MI & COPD vs. Control

Pulmonary function parameters were significantly different in Post MI & COPD compared to control like FIVC, FEF25-75, PEFR, FEV1, FEV1/FVC, SVC, IRV, MVV, MRF and IT were statistically significant with a P-value less than 0.05

DISCUSSION

Of the total 200 patients enrolled for the study, 146 (73 %) were males and 54 (27 %) were females with an average age of 50.38 $\pm$ 9.86 yrs. (Table 1)

In the absence of any primitive lung disease, restrictive and/or obstructive lung impairment can be detected close to acute MI. The evaluation of lung function should be delayed until after one month of recovery in order to avoid diagnostic pitfalls. An increase in the pulmonary water, which may be very minimal with uncomplicated myocardial infarction and that, stays basically in the pulmonary interstitial space but becomes more severe progressively leading to alveolar flooding and marked impairment of pulmonary function is the basic pathophysiologic mechanism responsible for abnormalities of pulmonary function. With therapy, the above condition will be improved and there will be a gradual improvement in pulmonary function.^{16,17,18} In the present study, in post-MI more than one month, all the lung parameters were not statistically significant with a P-value of more than 0.05 (Table 2) which indicated the improvement of lung function which is one of the important factors for good prognosis with which, the therapy can also be modified.

In the previous similarly related studies done by 1. C A Hales, H Kazemi et al. and J Ibáñez Juvé, 2. M Fiol Sala, J M Raurich Puigdevall, J M Abadal Centellas, S García Moris et al. and 3. Mauro Contini, Edoardo Conte, Piergiuseppe Agostoni, the above statement was mentioned.

Spirometry is the standard respiratory function test used for the diagnosis of chronic obstructive pulmonary disease (COPD). "The criterion for diagnosis defined in guidelines is based on the FEV1/FVC ratio forced expiratory ratio (FER) and its severity is based on forced expiratory volume in one second (FEV1) from measurements obtained during maximal

forced expiratory manoeuvres."^{19,20} So, pulmonary function parameters like FVC, FEV1, FEV1/FVC, FEF25-75, PEF, FIVC, SVC, IRV, MV, MVV and IT measured with spirometry in this study were statistically significant (with a P-value less than 0.05) compared to the control group (Table 3). The cause for lesser values of lung parameters was airway obstruction. So, the previous two studies published in November 2014 Journal of Thoracic Disease 6 (11):1557-1569 DOI:10.3978/j.issn.2072-1439.2014.08.18 (Source PubMed) is also telling the same statement.

"Chronic respiratory diseases, such as chronic obstructive pulmonary disease (COPD) including emphysema, are among the leading causes of morbidity and mortality, claiming some 2.5 million lives worldwide in 2015. Moreover, chronic respiratory diseases increase cardiac overload and may result in cardiac impairment, thus increasing morbidity and further affecting the quality of life".²¹

"Recent studies reported on the association of impaired cardiac function and maladaptive deformation with respiratory parameters. Watz et al. showed decreased cardiac chamber sizes and impaired left ventricular diastolic filling patterns as well as global right-heart dysfunction in patients with known hyperinflation".²²

There is a greater risk of heart attack and stroke in people having a reduced lung capacity because they show evidence of inflammation.

Older adults with COPD have an increased risk of cardiovascular disease because inflammation is a risk factor for the hardening of the arteries or atherosclerosis.

"Establishing whether systemic inflammation leads to reduced lung function or whether lower lung function leads to inflammation is difficult, but this research suggests that the association between poor lung function and cardiovascular disease may be mediated by an inflammatory mechanism."^{23,24,25}

In the previous study, BMJ Specialty Journals. "Reduced Lung Capacity Linked To Cardiovascular Disease By Inflammation." Science Daily, 5 July 2007. www.sciencedaily.com/releases/2007/07/070702145409.htm is showing the same results as the present study (Table 4).

CONCLUSIONS

- The diagnosis of COPD is done by the Lung function test which is considered as the gold standard test for the diagnosis of the same.
- Lung function was improved in post-MI cases of more than one-month duration.
- Lung function was not improved if MI was associated with COPD.
- To know the status of the lung function in cases of MI associated with COPD, further studies may be needed with larger sample size.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

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