ORIGINAL ARTICLE

Relationship of Reduced Lung Function in Male Chronic Heart Failure Patients

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ABSTRACT

Background: Chronic heart failure (CHF) is a major cause of morbidity and mortality throughout the world affecting multiple organ systems of the body including lungs.

Objective: To observe and compare FVC, FEV_1 and FEV_1/FVC%in CHF patients of different functional classification with healthy individual.

Methods: This Cross Sectional study was conducted in the Department of Physiology of Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbag, Dhaka, during 2016. For this, 60 stable male CHFpatients were randomly selected, these study subjects based on staging of the disease (Stage C) and New York Heart Association (NYHA) functional classification were further divided into two groups, 30 patients of NYHA Class-Iand 30 patients of NYHA class–II. Age, sex and BMI matched, 30 were apparently healthy subjects were taken as control. All the participants were aged 35-65 years.FVC, FEV_1 and FEV_1/FVC%of all subjects were measured by a portable Digital Spirometer. For statistical analysis, One way ANOVA and Independent sample't' test was performed by using SPSS for windows version-16& $p \leq 0.05$ was accepted as level of significance.

Results: The mean percentage of predicted values of FVC and FEV_1 were significantly lower (except FEV_1/FVC%) in chronic heart failure patients in comparison to the healthy control. All the study variables were significantly lower in patients of NYHA class–II as compared to patients of NYHA class–I. In addition, 73.33%NYHA class–Ipatientsand 63.33% NYHA class–II patients had restrictive feature.

Conclusion: This study concluded thatsomeventilatory variables decrease in CHF patients andto observe extend of lung damage by comparing NYHA class - I and II patients found mild and severe restriction respectively.

Key words: Lung function parameters, Chronic heart failure, NYHA functional classification

Introduction

Heart failure (HF) is a chronic epidemic global health burden with increasing incidence and prevalence alsomajor cause of morbidity, mortality and decreased life expectancy.[1] In the USA, in every year 1.5 to 2% of the total population has been diagnosed as incidental cases of heart failure.[2,3]There is no study about exact prevalence of heart failure in Bangladesh but the accountability of South Asian countries prevalence has been estimated 5.2% & Bangladesh include in South Asian countries.[4]Data shows, male aged 45 to 65 years or more detected as HF and 3 years survival rate about50% in every year per thousand populations.[5,6]A survey report in Bangladesh found among 17% cardiovascular diseases, 80% death occur due to HF.[7,8]

Heart failure (HF) is a complex clinical syndrome that arises secondary to abnormalities of cardiac structure and/or function (inherited or acquired) that impair the ability of the left ventricle to fill or eject

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Date of submission: 12.08.2020, Date of acceptance: 05.10.2020

blood. [9]Chronic heart failure (CHF) is characterized by the symptoms that appear slowly over a period of times and become worst gradually.[1,2]The diagnosis of CHF was made as per the criteria set by American Heart Association (AHA), 2013: Stable HF symptoms (>3 months), Duration of HF symptoms (>1 year) andEjection Fraction (≥35% to ≤50%) measured by Echocardiogram.[1,10]

Functionally symptoms of patients were graded according to New York Heart Association (NYHA) classification: NYHA class I, without any symptoms attributable to heart disease, NYHA classes II, III and IV, those patients who have mild, moderate and severe symptoms.[11]According to American Heart Association (AHA) staging system, the development of heart failure has been categorized into 4 stages of the disease, Stage A: high risk for developing HF; Stage B: asymptomatic LV dysfunction; Stage C: structural heart disease with past or current symptoms of HF; Stage D: refractory heart failure requiring specialized interventions.[1,9]As per guidelines most common causes of heart failure are coronary artery disease, respiratory diseases, diabetes, hypertension, dyslipidemia, valve disease, atrial fibrillation.[11]

Cardiac and respiratory systems are hemodynamically and mechanically co related due to heart and lungs both reside in a closed thoracic cavity. Several previous investigations found abnormal lung function in CHF related to pulmonary edema, increased bronchial conductance and obstruction.[12-16]Some other studies found that mild to moderate changes in lung function in CHF are mainly restrictive and some extent obstructive changes because of respiratory muscle weakness, pulmonary hypertension, reduction in lung diffusing capacity, changes in lung fluid balance and chronic neurohumoral changes.[10,17,18]

Different studies investigated and found that reduced lung function as measured by FVC, FEV_1 and FEV_1/FVC%was associated with an increased risk of cardiovascular morbidity and mortality.[19,20,21]Another study observed that FVC is a predictor of respiratory muscle strength.[22] Framingham heart study, suggested that low FVC is the predictor of severity of heart failure.[23]Previous study found thatrisks for HF had significant association with low value of FEV_1 and FVC among older persons with reduced and preserved ejection fraction without clinical lung disease.[19] Another researcher found that 20% population have reduced FEV_1 with low grade systemic inflammation that developed atherosclerosis which was responsible for cardiovascular morbidity and mortality independent of age, gender, height and cigarette smoking.[24]

So, this study has been designed to observe FVC, FEV_1 and FEV_1/FVC% in Bangladeshi male chronic heart failure patients.

Methods

This cross sectional study was carried out in the Department of Physiology, BSMMU, Dhaka from March 2015 to February 2016. Study protocol was approved by InstitutionalReview Board (IRB), BSMMU.For this, 90male subjects were randomly selected, 60 were stable diagnosed aged 35-65 years CHFpatients by the cardiologist were selected as study group from the Cardiology department of BSMMU.According to American Heart Association (AHA) guidelines, 2013 based on staging of the disease (Stage C) and New York Heart Association (NYHA) functional classification, study subjects were further divided into two groups, patients of NYHA Class- Iand patients of NYHA class –II with 30 patients in each group. Age and BMI matched 30 apparently healthy males were taken as control group for comparison from different area of Dhaka city by personal contact.

All the subjects with history of acute or chronic lung & chest wall diseases e.g. pneumonia, COPD, pneumothorax, malignancy etc, angina, acute myocardial infarction, valvular surgery, alcohol users, smokers and for study group with NYHA class- III and IV patients were excluded from the study.

After selection, objectives and the study procedure were explained in details to the subjects and the accompanying relatives and encouraged for voluntary participation. If they agree to participate at their free will, informed written consent was obtained in a prescribed form. During the study period the patients were treated with standard optimized medications for heart failure and they were clinically stable as determined by clinicians.

A detail personal, medical, family, socioeconomic, occupational, dietary and drug history was taken. After thorough physical examinations all the information were recorded in a preformed standard questionnaire. For the assessment of lung function, all the subjects were measured for FVC, $FEV_1$and FEV_1/FVC% by a PONY FX portable Digital Spirometer. Data were expressed as mean ± SE (Standard Error) of percentage of predicted value and also in percentage of frequency. Data analysis was done by One-way ANOVA and Independent sample't' test by using SPSSfor windows version 16. P value ≤0.05 was accepted as statistical significant.

Results

General characteristics (Age and BMI) both the control and CHF patients were comparable as their differences were statistically non significant but Pulse rate and Blood pressure were statistically highly significant(Table I).

In this study, the mean percentages of predicted values of FVC and FEV_1 were significantly lower in study group than those of control. Again, the mean percentage of predicted value of FEV_1/FVC% was significantly higher in study group in comparison to that of control (Table II).

Among the NYHA class–ICHF patients, 73.33% patients had restrictive, 10.00% small airway obstruction and 16.67% patients showed features of mixed type of lung dysfunction.Again,NYHA class–IICHF patients, 63.33% patients had restrictive, 13.33% small airway obstruction and 23.33% patients showed features of mixed type of lung dysfunction (Table III).

Among the NYHA class–ICHF patients, 60% were presented with mild restriction, 23.33% with moderate restriction and 16.66% with moderately severe restriction. Again, NYHA class–IICHF patients, 50% with severe restriction, 20% with very severe restriction, 16.66% with moderately severerestriction and 13.33% with moderate restriction (Table IV).

Table I: General characteristics of the subjects in different groups (n=90)

Parameters	Group A (n=30)	Group B_1 (n=30)	Group B_2 (n=30)	P value
Age (years)	50.03±1.26	51.70±1.62	50.33±1.24	0.801^{ns}
BMI (Kg/m^2)	22.38±0.26	22.21±0.25	21.51±0.25	0.951^{ns}
Pulse rate (beats/min)	76.57±0.98	91.90±1.05	95.97±0.76	0.000^{***}
SBP (mmHg)	121.0±1.80	128.0±1.06	129.0±1.08	0.000^{***}
DBP (mmHg)	75.67±0.92	81.67±1.05	83.50±1.20	0.000^{***}

BMI= Body Mass Index, SBP= Systolic Blood Pressure, DBP= Diastolic Blood Pressure

Data were expressed as mean ± SE (Standard Error).

Statistical analysis were done by Independent sample't' testand One way ANOVA

Group A **:** Apparently healthy subjects (Control group)

Group B_1**:** Diagnosed patients with CHF of NYHA Class- I (Study)

Group B_2**:** Diagnosed patients with CHF of NYHA Class -II (Study)

*** : Significant (p≤0.001)

ns**:** non significant (p>0.05)

n**:** number of subjects

Table II: Percentages of predicted values of FVC, FEV_1 and FEV_1/FVC% in different groups (n=90)

Parameters	Group A (n=30)	Group B_1 (n=30)	Group B_2 (n=30)	P value
FVC (L)	97.13±1.32	73.07±0.79	54.83±1.92	0.000^{***}
FEV_1(L)	93.90±1.33	75.50±1.41	49.10±1.32	0.000^{***}
FEV_1/FVC%	94.17±1.71	106.30±1.65	99.00±0.73	0.000^{***}

Forced Vital Capacity (FVC), Forced Expiratory Volume in 1st second (FEV_1), Forced Expiratory Ratio (FEV_1/FVC %)

Data were expressed as mean ± SE (Standard Error)

Statistical analysis were done by Independent sample't' testand One way ANOVA

Group A**:** Apparently healthy subjects (Control group)

Group B_1**:** Diagnosed patients with CHF of NYHA Class- I (Study)

Group B_2**:** Diagnosed patients with CHF of NYHA Class -II (Study)

*** : Significant (p≤0.001)

Table III: Frequency distributionof pulmonary disorders in CHF patientsin different study groups (n=60)

Type of pulmonary disorder	Group B_1	Group B_2
Restrictive disorder (RD)	22 (73.33%)	19 (63.33%)
Large airway obstruction (LAO)	0 (0%)	0 (0%)
Small airway obstruction (SAO)	3 (10.00%)	4 (13.33%)
Combination of RD and SAO	5 (16.67%)	7 (23.33%)
Total	30 (100%)	30 (100%)

Table IV: Frequency percentage of CHF patients by the type of restrictive disorders in different study groups (n= 60)

Type of restrictive abnormality	Group B^1	Group B^2
Mild	18 (60%)	0 (0%)
Moderate	7 (23.33%)	4 (13.33%)
Moderately severe	5 (16.66%)	5 (16.66%)
Severe	0 (0%)	15 (50%)
Very severe	0 (0%)	6 (20%)
	30 (100%)	30 (100%)

Group B_1**:** Diagnosed NYHA Class- I CHF patients (Study)

Group B_2**:** Diagnosed NYHA Class- II CHF patients (Study)

n**:** number of subjects

Discussion

In this study, the value of lung function variables in healthy control group were within normal limit and almost similar to that of different investigators from other countries.In this study, mean percentage of predicted values of FVC and FEV_1 in CHF patients were significantly lower than the control. Evidence from similar findings were also observed by various investigators.[13,14]Some researchers of other countries reported FEV_1/FVC% was found significantly higher in CHF patients than healthy control.[12]Also, reported by other researcher FEV_1/FVC% was found lower value and the differences among the different groups were statistically non significant.[17,26]

This result suggests the pattern of pulmonary disorder was found mainly restrictive also obstructive and both restrictive and obstructive of these CHF patients. Several researchers of different countries have reported, similar types of findings in this group of patients, but the frequency distribution was not similar to the present study.[16] Among the CHF patientsof NYHA class-I were presented with predominantly mild restriction also moderate and moderately severe restriction, respectively. Again, CHF patients of NYHA class-II were presented with mainly severe restriction also moderate, moderately severe and very severe restriction, respectively. These findings are similar with those of some other investigators.[14,16]

There are different postulated mechanisms suggested regarding these changes with lung abnormalities to chronic heart failure.Several investigators have suggested that energy deficit is a relevant contributor to the development of cardiac and skeletal myopathy.[13] In heart failure most of functions of muscle bioenergetics are altered such as oxygen availability, substrate oxidation, ATP production by the mitochondria and transfer to contractile apparatus.[13,29]

Also, it has been suggested that CHF is associated with increased venous capacitance with elevated pulmonary capillary pressure which adversely affects FVC and FEV_1.[27]Researcher proposed that alterations of respiratory mechanics and gas exchange capacity are strictly related in CHF. This lung diffusion abnormality might be related to interstitial edema, alveolar-capillary membrane hydrostatic injury and altered alveolar fluid.[25,28]It has been supported by the evidence of high frequency distribution of restrictive pulmonary disorder due to reduced respiratory muscle perfusion, low cardiac output and respiratory muscle weakness which results in decrement of forcefully ventilatory variables.[17,18]

The physiological mechanism behind this phenomenon is still undefined but all of these above mentioned factors may cause overall lung dysfunction also changes in ventilatory variables in stable chronic heart failure patients of this study.

Conclusion

Fromthe results of thestudy, it isconcluded that lung functions may be reduced and restrictive disorders are more prevalent in chronic heart failure patients.

Conflict of interest: None.

Reference

1. Yancy CW, Jessup M, Bozkurt B, Butler J, Casey DE, Drazner MH, Fonarow GC, Geraci SA, Horwich T, Januzzi JL, Johnson MR, Kasper EK, Levy WC, Wilkoff BL. ACCF/AHA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Circulation. 2013; 128: 240-327.
2. Rahman MT, Majumder A, Rahman A, Chowdhury AW. Clinical Presentation of Heart Failure Patients Admitted in National Institute of Cardiovascular Diseases, Dhaka. Journal of Medicine. 2014; 15(1): 18-22.
3. Lee HM, Truong ST, Wong ND. Evidence of Lung Function for Stratification of Cardiovascular Disease Risk. Korean circulation journal. 2011; 41(4):171-4.
4. Gill PS, Davis R, Davies M, Freemantle N, Lip GY. Rationale and study design of a cross sectional study documentingthe prevalence of Heart Failure amongst the minority ethniccommunities in the UK: the E-ECHOES Study (Ethnic -Echocardiographic Heart of England Screening Study). BMC Cardiovascular Disorders. 2009; 9(1):47.
5. Díez-Villanueva P, Alfonso F. Heart failure in the elderly. Journal of geriatric cardiology: JGC. 2016; 13(2):115.
6. Heidenreich PA, Albert NM, Allen LA, Bluemke DA, Butler J, Fonarow GC, Ikonomidis JS, Khavjou O, Konstam MA, Maddox TM, Nichol G. Forecasting the impact of heart failure in the United States: a policy statement from the American Heart Association. Circulation: Heart Failure. 2013; 6(3): 606-19.
7. Bangladesh Bureau of Statistics. Available at: http://www.bbs.gov.bd/. Accessed January, 2009.
8. World Health Organization. Cardiovascular diseases. Available at: http://www.who.int/. Accessed February, 2009.
9. Hunt SA, Abraham WT, Chin MH, Feldman AM, Francis GS, Ganiats TG, Jessup M, Kosntram MA, Mancini DM, Michl K, Oates JA. ACC/AHA 2005 guideline update for the diagnosis and management of chronic heart failure in the adult: a report of the ACC/AHA Task Force on Practice Guidelines. Circulation. 2005; 112(12):154-235.
10. Olson TP, Beck KC, Johnson BD. Pulmonary Function Changes Associated with Cardiomegaly in Chronic Heart Failure. J Card Fail. 2007; 13(2): 100-7.
11. McMurray JJ, Adamopoulos S, Anker SD, Auricchio A, Böhm M, Dickstein K, Falk V, Filippatos G, Fonseca C, Gomez-Sanchez MA, Jaarsma T. Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2012 of the European Society of Cardiology; ESC Committee for Practice Guidelines. ESC guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: The Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC. Eur J Heart Fail. 2012; 14(8):803-69.
12. Ceridon ML, Morris NR, Hulsebus ML, Olson TP, Lalande S, Johnson BD. Influence of Bronchial Blood Flow and Conductance on Pulmonary Function in Stable Systolic Heart Failure. Respiratory Physiology & Neurobiology. 2011; 177(3): 256-64.
13. Apostolo A, Giusti G, Gargiulo P, Bussotti M, Agostoni P. Lungs in Heart Failure. Pulmonary Medicine. 2012. doi:10.1155/2012/952741.
14. Habedank D, Meyer FJ, Hetzer R, Anker SD, Ewert R. Relation of respiratory muscle strength, cachexia and survival in severe chronic heart failure. Journal of cachexia, sarcopenia and muscle. 2013; 4(4): 277-85.
15. Gehlbach BK, Geppert E. The Pulmonary Manifestations of Left Heart Failure. CHEST. 2004; 125(2): 669-82.
16. Johnson BD, Beck KC, Olson LJ, O'Malley KA, Allison TG, Squires RW, Gau GT. Pulmonary Function in Patients with Reduced Left Ventricular Function. CHEST. 2001; 120(6): 1869-76.

17. Daganou M, Dimopoulou I, Alivizatos PA, Tzelepis GE. Pulmonary function and respiratory muscle strength in chronic heart failure: comparison between ischaemic and idiopathic dilated cardiomyopathy. Heart. 1999; 81(6): 618-20.

18. Evans SA, Watson L, Hawkins M, Cowley AJ, Johnston ID, Kinnear WJ. Respiratory muscle strength in chronic heart failure. Thorax. 1995; 50(6): 625-8.

19. Georgiopoulou VV, Kalogeropoulos AP, Psaty BM, Rodondi N, Bauer DC, Butler AB, Koster A, Smith AL, Harris TB, Newman AB, Kritchevsky SB. Lung function and risk for heart failure among older adults: the Health ABC Study. The American journal of medicine. 2011; 124(4):334-41.

20. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, Crapo R, Enright P, Van Der Grinten CPM, Gustafsson P, Jensen R. Standardisation of spirometry. EurRespir J. 2005; 26(2): 319-38.

21. Van der Palen J, Rea TD, Manolio TA, Lumley T, Newman AB, Tracy RP, Enright PL, Psaty BM. Respiratory muscle strength and the risk of incident cardiovascular events. Thorax. 2004; 59(12):1063-7.

22. Kannel WB, Hubert H, Lew EA. Vital capacity as a predictor of cardiovascular disease: the Framingham study. Am Heart J. 1983; 105(2): 311-5.

23. LIoyd-Jones DM, Larson MG, Leip EP, Beiser A, D'Agostino RB, Kannel WB, Murabito JM, Vasan RS, Benjamin EJ, Levy D. Lifetime Risk for Developing Congestive Heart Failure: The Framingham Heart Study. Circulation. 2002; 106(24): 3068-72.

24. Sin DD, Wu L, Man SP. The Relationship Between Reduced Lung Function and Cardiovascular Mortality: A Population-Based Study and a Systematic Review of the Literature. CHEST. 2005; 127(6): 1952-9.

25. Mancini DM, Henson D, LaManca J, Levine S. Respiratory muscle function and dyspnoea in patients with chronic congestive heart failure. Circulation. 1992; 86(3): 909-18.

26. Engstrom G, Hedblad B, Janzon L. Reduced lung function predicts increased fatality in future cardiac events. A population–based study. Journal of Internal Medicine. 2006; 260(6): 560-7.

27. Nanas S, Nanas J, Papazachou O, Kassiotis C, Papamichalopoulos A, Milic-Emili J, Roussos C. Resting Lung Function and Hemodynamic Parameters as Predictors of Exercise Capacity in Patients With Chronic Heart Failure. CHEST. 2003; 123(5): 1386-93.

28. Wright RS, Levine MS, Bellamy PE, Simmons MS, Batra P, Stevenson LW, Walden JA, Laks H, Tashkin DP. Ventilatory and diffusion abnormalities in potential heart transplant recipients. Chest. 1990; 98(4):816-20.

29. Chua TP, Coats AJ. The lungs in chronic heart failure. Eur Heart J.1995; 16(7): 882-7.