Assessment of Pulmonary Hypertension Exposure to Biomass Smoke in Female Patients

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ABSTRACT

Objective: Pulmonary hypertension is a common complication among patients with advanced stage chronic obstructive pulmonary disease (COPD). In communities using animal biomass fuels, biomass exposure causes COPD in females as much as it does in males, or even more. The aim of our study was to investigate the existence of pulmonary hypertension in biomass-exposed females.

Methods: Ninety non-smoking female patients who were previously exposed to biomass and underwent echocardiography examinations were retrospectively analyzed. Fifty-two of these patients who were diagnosed with COPD, according to GOLD criteria, were included in the study as the study group and 12 patients with no respiratory problem and normal respiratory function test were included as the control group. Systolic pulmonary arterial pressure (sPAB) of >35 mmHg was accepted as the presence of suspected pulmonary hypertension.

Results: High sPAB was detected in the study group, according to reference value (38.3±10.7). In the control group, sPAB was found to be 32.5±7.6 mmHg. However, no statistical significance in sPAB was found between the two groups.

Conclusion: In our study, the absolute value of sPAB was determined to be higher in the biomass-exposed COPD patients than in the normal controls. However, no statistical significance in echocardiography measurements was observed between the control and COPD patients. These results suggest that biomass exposure is related to pulmonary hypertension even without respiratory symptoms. As a result, cohort studies on the relationship between biomass exposure and pulmonary hypertension will help increase awareness of a very important public health problem and help decrease biomass exposure.

Keywords: Biomass, pulmonary hypertension, chronic obstructive pulmonary disease

INTRODUCTION

Exposure to animal biomass fuel is a major public health concern, particularly in developing countries. Approximately 3 million people worldwide use biomass and coal as sources of energy (1). Biomass exposure has been found to be associated with chronic obstructive pulmonary disease (COPD), acute respiratory infections, tuberculosis, lung cancer, and interstitial lung diseases (2). The association of biomass exposure with cardiovascular diseases and pulmonary hypertension (PH) has also been described (3, 4).

COPD is defined by the Global Initiative for Chronic Obstructive Lung Disease (GOLD) as an airway obstruction that is not completely reversible (5). The detection of PH in chronic lung diseases has been found to be associated with hypoxia, exercise intolerance, and poor prognosis (6).

We investigated systolic pulmonary arterial pressure (sPAP) measurements that were echocardiographically evaluated in female patients who were exposed to biomass fuel fumes in the Turkish countryside and in whom COPD developed, although they were nonsmokers, and we aimed to raise awareness about PH, which results in poor prognosis in COPD.

METHODS

A total of 140 patients who applied to the chest diseases polyclinic between the years 2014 and 2015 and whose echocardiography was taken and sPAP values were recorded were retrospectively evaluated. Our work was approved by the Ethics Committee of Batman State Hospital. The biomass exposures and smoking histories of the patients were obtained individually on telephone, and the patients were invited to the hospital to provide written informed consents. The physical examinations and pre-existing examinations of 90 female patients who accepted the invitation to the hospital and who were exposed to biomass were evaluated. Twenty-six patients with left heart failure, pulmonary embolism, sleep apnea, obesity (BMI>35), cancer, diabetes, bronchiectasis, or devastated lung were excluded from the study. Posteroanterior pulmonary graphs were obtained during the stable period, and pulmonary function tests with early and late reversibility were evaluated in all cases. Fifty-two patients who were diagnosed with COPD according to the GOLD criteria and who had no smoking history were included in the study. Twelve patients with no respiratory problems, no biomass exposure, and a normal pulmonary function test were included in the study as the

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control group. Echocardiographic findings, biomass exposure durations, pulmonary function test parameters, ages, and sexes of all patients were recorded.

Echocardiography: Echocardiographic measurements were obtained by the same cardiologist with a General Electric Vivid 4 echocardiograph. The measurements of cardiac cavities and ventricular diameters were obtained using M Mode 2D. Tricuspid insufficiency flow was assessed through continuous Doppler by enabling the Doppler curser to fall correspondingly on the insufficiency flow, and sPAP was calculated. The ejection fraction (EF) was calculated using the modified Simpson method. sPAP was calculated using the Bernoulli equation by adding the right atrium pressure to the 4th quadrant of the peak velocity of the tricuspid regurgitation flow obtained from the apical 4-chamber or from the right ventricular access pathways:

sPAP=[4×(tricuspid insufficiency current rate) 2]+right atrial pressure.

Right atrial pressure was assessed according to the diameter of the inferior vena cava from the subcostal view and the variability of the vein during inhalation (inspiratory collapse).

Respiratory Function Tests: Spirometric measurement tests were explained to all the patients by the same technician before the test. Daily calibration of the pneumotachograph was made. The measurements were obtained in the sitting position and using nose clips according to the recommendations of ERS. FVC, FEV_1, and FEV_1/FVC values of all patients were measured. The best value of the three tests was recorded as the result, and special attention was paid to ensure that the change among the values was less than 5%. ERS reference values were used as the expected value (7).

Following the recommendations of the Fourth World Pulmonary Hypertension Diagnosis and Treatment Symposium, the presence of sPAP greater than 35 mmHg was considered to indicate the presence of PH (8).

Statistical analysis

SPSS (Statistical Packages for the Social Sciences Inc.; Chicago, IL, USA) 15.0 for Windows was used for the statistical analysis. Descriptive statistics were reported as the number and percentage for categorical variables and as mean, standard deviation, and median for numerical variables. When numerical variables were normally distributed, independent two-group comparisons were made with Student's t-test, and when data were not normally distributed, the Mann–Whitney U-test was used. Relationships among the numerical values were examined by Spearman correlation analysis because the parametric test condition was not met. The intergroup ratios of the categorical variables were compared by chi-square analysis. Statistical significance level of alpha was accepted as $p<0.05$.

RESULTS

The mean age of the patients who had COPD and were exposed to biomass was 64.4±14.9 years (n=52) and that of the control group was 64.5±10.6 years (n=12). The duration of exposure to biomass was 29.5±6.5 years in the group of patients with COPD and 26.1±10.4 years in the control group.

The FVC%, FEV_1%, and FEV_1/FVC% averages of the patients with COPD were lower than those of the control group ($p=0.028$, $p<0.001$, and $p<0.001$, respectively). There was no statistically significant difference between the groups in terms of age, biomass exposure duration, EF, or sPAP (Table 1). In the group of patients with COPD, the absolute value of sPAP was found to be high (38.3±10.7 mmHg) according to the PH diagnosis criteria of the 4th World Pulmonary Hypertension Diagnosis and Treatment Symposium (8). In the control group, sPAP was 32.5±7.6 mmHg. However, no statistically significant difference was found between the two groups exposed to biomass (Table 1).

When the COPD and control groups that were exposed to biomass were evaluated together, sPAP was statistically significantly associated with age in a positive manner and with FVC% and FEV_1% in a negative manner ($p=0.009$, $p=0.035$,

Table 1. Patients' ages, duration of exposure to biomass, respiratory function values, and echocardiographic findings

	COPD cases		Control		
	M±SD	Median	M±SD	Median	p
Age (years)	64.4±14.9	66	64.5±10.6	68	0.986
Biomass exposure (years)	29.5±6.5	30	26.1±10.4	20	0.063
FVC (%)	67.5±22.1	71	78.0±11.0	80	0.028
FEV1%	64.0±26.3	62	86.8±14.3	84	<0.001
FEV1/FVC%	77.5±12.7	77	93.4±7.0	96	<0.001
Ejection fraction	63.0±3.0	65	63.0±2.4	64	0.430
sPAP	38.3±10.7	35	32.5±7.6	30	0.085

COPD: chronic obstructive pulmonary disease; M: mean; SD: standard deviation; FVC: forced vital capacity; FEV_1: forced expiratory volume in the 1st second; sPAP: systolic pulmonary artery pressure

Table 2. The relationship between sPAP and age, biomass exposure, and respiratory functions

	sPAP Rho	p
Age	0.341	0.009
Biomass exposure (year)	0.094	0.481
FVC %	–0.278	0.035
FEV_1%	–0.264	0.045
FEV_1 /FVC%	–0.094	0.481
EF	–0.052	0.697

FVC: forced vital capacity; FEV_1: forced expiratory volume in the 1st second; sPAP: systolic pulmonary artery pressure; EF: ejection fraction

Table 3. The relationship between sPAP and age, duration of biomass exposure, respiratory function tests, and EF in COPD and control groups

	sPAP COPD Rho	p	Control Rho	p
Age	0.314	0.032	0.650	0.030
Biomass exposure (years)	0.215	0.146	–0.115	0.737
FVC %	–0.222	0.033	–0.307	0.358
FEV_1%	–0.270	0.048	–0.304	0.363
FEV_1 /FVC%	–0.072	0.543	–0.332	0.319
EF	–0.148	0.322	0.195	0.565

COPD: chronic obstructive pulmonary disease; FVC: forced vital capacity; FEV_1: forced expiratory volume in the 1st second; sPAP: systolic pulmonary artery pressure; EF: ejection fraction

and p=0.045, respectively). Biomass exposure duration was not related to sPAP or EF (p=0.481 and p=0.697, respectively) (Table 2).

When COPD and control groups were evaluated separately, a statistically significant positive association was found between sPAP and age (p=0.032, p=0.030). Although a statistically significant negative correlation between sPAP and FVC% and FEV_1% in the COPD group (p=0.033 and p=0.048, respectively) was observed, no statistically significant relationship was observed in the control group. sPAP and EF were not significantly associated with the duration of biomass exposure in both groups (Table 3).

DISCUSSION

The incidence of COPD has risen worldwide from 10.7% to 11.7% over the past 20 years, and the number of people affected has increased from 227 million to 384 million (9). It is predicted that COPD will be responsible for 7.8% of deaths worldwide by 2030 (10).

The most important risk factor for COPD is cigarette smoking, and it is more common in males than females. Other known risk factors for COPD are various irritant gases and infections that one is exposed to occupationally or environmentally and hereditary factors. In Turkey, biomass fuel fumes, particularly from cooking and heating, increase the prevalence of COPD in women (11). More commonly in women than men, COPD has been reported to be associated with depression, anxiety, malnutrition, different anatomical distribution of emphysema, low dyspnea index, and poor quality of life (12). The differences between biomass exposure and smoking-associated COPD phenotypes are also unclear. For this reason, it is important to evaluate the phenotype of COPD in terms of various aspects in women who are exposed to biomass fuel fumes (13).

COPD causes functional and morphological changes as well as PH by increasing alveolar hypoxia vascular resistance in patients.

Several studies have demonstrated the association of COPD with biomass and PH. Özbay et al. (14) microscopically observed macrophage and eosinophil infiltrations, hyalinization, and increased collagen in the peribronchial, perivascular, and intima regions of female albino rats exposed to cow dung smoke for 3–6 and 9 months.

In the study conducted by Buturak et al. (15), carotid intima-media thickness (CIMT) and endothelium-independent vasodilatation (GTN) values of 47 healthy individuals who were exposed to cow dung smoke from birth were compared with the control group, and although no difference was detected between the two groups in terms of CIMT values, the GTN% values were found to be lower in those who were exposed to biomass fuel fumes. These results support the increased vascular resistance upon biomass exposure. In PH, the lungs are both the source and target organ of the vasoconstrictor mediators. The imbalance between the vasoconstrictor mediators in the tissue and circulation as a result of endothelial dysfunction is a characteristic feature in the development of PH (16).

In the study of Emiroğlu et al. (17), right ventricular pressure and pulmonary artery pressure were found to be higher in patients with biomass exposure than those who were not exposed, and natriuretic peptide levels were found to be associated with these parameters. These findings have been reported to support the role of biomass exposure in right ventricular dysfunction. In the study of Sertoğulları et al. (4), female patients who had moderate COPD and who were exposed to biomass fuel fumes were compared with male patients with COPD due to cigarette smoking, and the frequency of PH was reported to be more frequent statistically in women with biomass exposure, and no difference was detected in advanced stages. In our study, while PH (sPAP 38.3±10,7 mmHg) was detected in women with COPD and biomass exposure, sPAP was 32.5±7.6 mmHg in patients without pulmonary symptoms. Although sPAP

is observed at a lower rate in the second group, a statistically non-significant difference (p=0.085) is an indicator of an increase in pulmonary artery pressures even without respiratory findings.

While some studies have shown that there is a relationship between PH and spirometry values (18, 19), there are also studies indicating a weak or no relationship between FEV_1 and sPAP (20, 21). When COPD and the control group were evaluated together in our study, a negative correlation was found between sPAP and FEV_1 (p=0.045). PH is a common complication in advanced COPD (22). As FEV1 decreases in advanced COPD, sPAP increases, and our results support this. In our study, we believe that significantly high sPAP values found in women who do not smoke and in whom COPD developed due to biomass exposure, and although lower than the reference and not statistically different from the control group and the group with COPD, support the idea that biomass exposure alone might lead to changes in pulmonary artery pressure.

CONCLUSION

In reference to the 2009 guidelines, echocardiographic and indirect measurement of the pulmonary artery pressure might be a limiting factor in our study. Echocardiographically predicted sPAP and hemodynamically measured sPAP might not always be consistent (23). However, our study was planned retrospectively, and the Doppler echocardiography is still a valuable screening test for PH. It is required that comorbidities such as biomass-associated PH, which is a significant public health problem, should be clarified and the required measures should be taken through large cohort studies in which the echocardiographic diagnosis that was defined in the 2015 ESC/ERS Pulmonary Hypertension Guidelines (24) is evaluated together with peak tricuspid regurgitation rate, ventricular, pulmonary artery, vena cava inferior, and right atrium findings. The purpose of our study is to contribute to the awareness of PH that develops from biomass fuel fume exposure.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Batman State Hospital.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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