Assessment of Nutritional Status in Chronic Obstructive Pulmonary Disease Patients

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Abstract

Background: Chronic obstructive pulmonary disease (COPD) is considered a major public health problem in the world. Weight loss, muscle and fat mass depletion are common nutritional problems in COPD patients and are determinant factors in pulmonary function, health status, disability and mortality. In the present study, we assessed nutritional status in COPD patients.

Methods: This cross-sectional study was performed in the Rasul-e-Akram Hospital, Tehran, Iran on 63 COPD patients with mean age (SD) of 67.6 (9.4) years. All subjects were diagnosed by a pulmonary specialist and based on a spirometry test. They were divided into three groups (2, 3, 4 stages of disease). Anthropometric and biochemical indices, body composition analyses by bioelectric impedance, spirometry test and determination of disease severity were performed for all subjects. All analyses were performed using the SPSS 14. All data presented as means (± sd).

Results: Reduction of body mass index (BMI), Mid-Arm Muscle Circumference (MAMC) and Fat-Free Mass (FFM) were observed alongside an increase in disease severity but it was not significant. Significant reduction of Fat Mass (FM) ($P= 0.007$), Fat Mass Index (FMI) ($P= 0.03$) and biochemical indices like Albumin ($P= 0.000$) and Total Protein ($P= 0.04$) were associated with an increase in disease stages.

Conclusion: It is suggested that in addition to BMI, other nutritional status indices like MAMC, FFM and FM should be used for early diagnosis of malnutrition before weight loss occurs.

Keywords: *Chronic obstructive pulmonary disease, Mid-arm muscle circumference, Fat-free mass, Fat mass index, Bioelectric impedance*

Introduction

Chronic obstructive pulmonary disease (COPD) is a major public health concern and characterized by progressive airflow limitation that is not completely reversible (1-5). The increasing prevalence of disease morbidity and mortality is a significant and alarming public health problem in the world and will be the third cause of death and the fifth cause of disability by 2020 worldwide (5). COPD is a very costly disease and poses a major economic burden on individuals and society (2). Smoking is the most important cause of COPD (3). The use of biomass fuel, such as wood for cooking and heating, increases the risk of COPD by three to four times, and may be an important contributor to COPD prevalence, especially in developing countries and rural areas (4, 6). Air pollution, occupational smoke or dust and genetic factors are other causes of COPD (7).

COPD is often associated with significant nutritional abnormalities, the so-called systemic effects of COPD. The alterations like weight loss, depletion of fat free mass and to a lesser extent loss of fat mass are common in COPD patients. Weight loss can be seen in 15-50% of patients with mild to severe COPD (8, 9). Low body weight, body mass index and depletion of fat free mass are independent risk factors for mortality in COPD patients (10). Muscle wasting that is reflected by reduction of fat free mass is observed in 20-40% of the patients (11). Assessment of body composition has shown that loss

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of muscle mass can be the main cause of weight loss in these patients (12, 13). Muscle wasting may also occur in normal weight stable subjects. These abnormalities are associated with peripheral muscle weakness, decrease in muscle mass, impaired functional and exercise capacity, increase in the length of hospital stay, make the symptoms of the disease and the quality of life worse (14). The causes of weight loss, depletion of fat free mass and fat mass are unclear; although increased metabolic rate and decreased caloric intake(10), tissue hypoxia (9), systemic inflammation like cytokines, interleukins and tumor necrosis factor (TNF)-α (11, 15), oxidative stress(9), drugs(16) and sedentary life (9,17), are likely to be relevant pathogenic factors.

The high prevalence of weight loss, muscle and fat mass wasting in COPD patients suggests that effective nutritional screening must be implemented to detect and treat nutritional problems, to minimize COPD-related medical care costs, to improve the patients' health and to ameliorate their quality of life.

The aim of this study, which has been performed for the first time in Iran, was to assess nutritional status in COPD patients, therefore anthropometric and biochemical indices, analysis of body composition were assessed for all COPD patients who participated in this study.

Materials and Methods

This cross-sectional study was performed in the Rasul-e-Akram Hospital in Tehran on 63 COPD patients with mean age (SD) of 67.6 (9.4) yr. All subjects had COPD which was diagnosed by a pulmonary specialist and on the basis of a spirometry test, then according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines, COPD severity for all subjects was determined and they were divided into three groups (2, 3, 4 stages of disease). At the time of the study all COPD patients were no more exacerbated and were in stable condition. Exclusion criteria were liver, heart or kidney failure, cancer, endocrine abnormalities and fever, presence of other pulmonary disease in addition to COPD.

Spirometry and determination of COPD severity

The spirometry test is a simple and is the most common of the Pulmonary Function Tests, and it measures lung function using a device called a spirometer. All subjects underwent the test with a nurse who was specially trained to perform spirometry. Patients were instructed not to use bronchodilator on the day of pulmonary function assessment. All patients were studied in a sitting position. Data from the highest amount of flow-volume curve Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 Second (FEV_1) were used for calculations. FEV_1 was expressed as FEV_1% predicted, based on gender, height and age, using the reference of the American Thoracic Society, and then severity of disease in accordance to GOLD guidelines was determined as follows:
Stage1: $FEV_1/FVC < \%70$ and $FEV_1 \geq \%80$,
Stage2: $FEV_1/FVC < \%70$ and $50\% \leq FEV_1 < 80\%$,
Stage3: $FEV_1/FVC < \%70$ and $30\% \leq FEV_1 < 50\%$,
Stage4: $FEV_1/FVC < \%70$ and $FEV_1 < 30\%$.

Nutritional assessment

Nutritional status was assessed by anthropometric indices, bioelectric impedance analysis and biochemical indices.

Anthropometric indices

Body weight was assessed with a beam scale to the nearest 0.1 kg with subjects standing barefoot and in light clothing. Height was measured by a clinical stadimeter in bare or stocking feet. BMI, defined as weight (kg) divided by the square of height (meters), was calculated. The Triceps Skin Fold (TSF) was measured by means of a caliper. Mid arm circumference (MAC) was measured midway between olecranon and acromion, then MAMC that indicates body muscle mass was calculated as follows: MAMC= MAC-($\pi \times$ TSF).

Bioelectrical Impedance Analysis (BIA)

Bioelectric impedance is a safe, noninvasive and rapid method for analyzing body composition. we analyzed body composition by FM, FFM and Total Body Water (TBW) by bioelectric impedance (BODY STAT, Quad Scan 4000, USA) with 4 electrodes, 4 frequency (5, 50, 100, 200) and was

taken with the subjects lying relaxed on a bed. Electrodes were connected to the hands (wrist and middle fingers) and feet (ankle and above the knuckle of the toe). For accurate results, the patients were recommended not to consume anything since 4 h before the test and to avoid drinking tea and coffee in the previous 24 h. FFM and FM were standardized for height, and they are as follows: FFM/height^2 (kg/m^2), FM/height^2 (kg/m^2).

Biochemical indices

Blood samples were analyzed for albumin, total protein and cholesterol. Albumin and total protein were measured colorimetrically and cholesterol was measured enzymatically.

Normal ranges of our biochemistry laboratory are as follows: Albumin: 3.5-5.3g/l, total protein: 6.4-8.3g/l and normal amount of cholesterol is less than 200mg/dl.

Statistical analysis

Non-parametric test (Kolmogrove-Simirnov) was used for assessing normal distribution of data. To assess the significant differences in normally distributed variables among GOLD stages (three subgroups), One-Way Anova test was used and if the difference was significant, we used Scheffe test for slighter assessment. Kruskal-Wallis test was used for the variable age, which was not distributed normally. All analyses were performed using the SPSS 14. All data presented as means (±sd) and A P-value less than 0.05 was considered to be statistically significant.

Results

Sixty three COPD patients included 52 men (82.5%) and 11 women (17.5%), with a mean age (SD) of 67.6(9.4) yr in disease stages 2 to 4, participated in the study. The subjects, based on the severity of the disease (GOLD stage) were divided into three groups.

28.6% of the COPD patients were classified in stage 2, 50.8% in stage 3 and 20.6% in stage 4. There was no significant difference in variable age among groups. All the male COPD patients and one female were smokers. The rest of the

participating female COPD patients had a mean 20 yr history of bread baking by using biomass fuels in rural places and their husbands were smokers. In addition to these, one female patient had a history of carpet weaving. In addition, COPD patients used inhaler corticosteroid.

Results of measured anthropometric indices of subjects according to GOLD stages are shown in Table 1.

Mean value of BMI, MAC, MAMC diminished as the severity of disease increased; the reduction in stage 4 was very severe. Slight increase in the mean TSF was observed among GOLD stages. The results of anthropometric measurements did not significantly differ among disease stages.

Results of BIA measurements are shown by disease severity according to GOLD stage in Table 2. BIA was another assessment, which was performed in this study. Lower mean values of FM, FMI, FFM and its index were associated with increasing severity of disease. BIA data showed that means of FM and FMI significantly diminished with progression of disease stages (P= 0.007). Patients in stage 4 in comparison with stage 2 and patients in stage 3 compared with those in stage 2 showed a significantly lower mean FM (P= 0.04, P= 0.01). Mean values of FMI reduced significantly with the increase in the severity of disease. FFM and its index values showed no significant difference among groups.

Table 3 shows the mean values of visceral proteins and total cholesterol measurements according to GOLD stages.

Plasma levels of albumin and total protein were significantly lowered with the increase in the severity of disease (P= 0.000, P= 0.04). Patients in stages 4 and 3 showed significantly lower mean value of albumin than patients in stage 2 (P= 0.000, P= 0.01), patients in stage 4 showed lower mean value of albumin in comparison with those in stage 3 (P= 0.03).

Significant reduction of total protein was observed as stage 4 is compared with stage 2 (P= 0.04).

Non-significant reduction of total cholesterol was observed among disease stages with the increase in the severity of disease.

Table 1: Results of measured anthropometric indices of subjects by GOLD stage

Variables	Stage of Disease			P Value
	2	**3**	**4**	
BMI (kg/m^2)	25.9 ±5.3	24.2±4.1	22.3±3.03	NS
MAC (cm)	25.5 ±4.8	24.2±3.3	23.1±4.5	NS
MAMC (cm^2)	19.7±2.9	19.3±2.2	17.6±3.1	NS
TSF (mm)	16.5±9.1	16.7±10.1	16.9±9.4	NS

NS means not significant

Table 2: Results of BIA measurements by GOLD stage

Variables	Stage of Disease			P Value
	2	**3**	**4**	
FM (kg)	23.5 ±7.3	19.1±5.3	16.9±4.6	0.007
FMI (kg/m^2)	8.8 ± 3.03	7.09±2.46	6.7±2.29	0.03
FFM (kg)	46.6±11.4	44.1±7.2	40.3±9.2	NS
FFMI (kg/m^2)	17.3±3.4	16.06±2.06	15.8±2.8	NS
TBW (L)	40.3±11.7	36.3±4.8	36.1±6.2	NS

P Value<0.05 is significant
NS means not significant

Table 3: Results of biochemical indices by GOLD stage

Variables	Stage of Disease			P Value
	2	**3**	**4**	
Albumin (mg/dl)	4.43±0.52	4.06±0.4	3.6±0.33	0.000
Total Protein (mg/dl)	6.7 ± 0.61	6.5±0.66	6.2±0.58	0.04
Total cholesterol (mg/dl)	188±62.1	187.9±41.9	171.07±30.9	NS

P Value<0.05 is significant
NS means not significant

Discussion

Results of the study showed that all measured parameters (anthropometric, biochemical indices and body composition analysis) in the COPD patients decreased as the disease became more severe. These reductions were much severe in stage 4 than in any other stage.

These findings confirm previous studies performed on nutritional status in COPD patients and have shown that with the increase in the severity of disease, the patients face a loss in weight, muscle and fat mass and albumin.

Mean anthropometric values of our COPD patients decreased with the increase in the severity of disease, but they were not statistically different among groups.

Clinical findings have shown that involuntary weight loss and low BMI are related to increased risk of COPD exacerbation, frequent hospitalization, the need to mechanical ventilation and mortality independent of the degree of airflow obstruction (16, 18, 19).

Factors possibly contributing to the weight loss include imbalance between energy intake and expenditure (10), drug therapy (16), inactivity (9, 17), systemic inflammation (11, 15) and hypoxia (9).

Malnutrition is usually defined as the reduction of body weight. However, the use of body weight

as the sole criterion of malnutrition may lead to an underestimation of nutritional depletion, and offers no qualitative information on body composition, which is also altered in these patients and does not discriminate fat from muscular mass. Evaluation of body composition can detect where the loss is occurring and to determine about the pathogenesis of weight loss (13, 20, 21). Assessment of body composition in addition to body weight is very important because normal-weight or overweight patients also show muscle depletion. This is important since obesity is highly prevalent in developed countries and may cover muscle wasting (13).

MAMC is a rapid indirect and quite simple to perform method for measuring body composition, muscle mass and protein stores (13). Decrease in MAMC mean values, which was observed among stages of disease, and diminished FFM and its index mean values, which were obtained from bioelectric impedance, showed presence of muscle wasting in our subjects; and the muscle wasting increased with the progression of the disease. So we confirmed that the loss of muscular mass in our subjects is related to the increase in the severity of disease.

Soler et al. reported that the prevalence of low body mass index and mid arm muscle area increased significantly as bronchial obstruction increased (14).

The mechanisms leading to muscle wasting in patients with COPD are still uncertain. Accelerated muscle proteolysis is considered the primary cause of the loss of lean body mass, not only in COPD, but also in many other chronic diseases (22). Inactivity, hormonal dysfunction, increased levels of cytokines play important roles in muscle wasting (14, 23).

Skin fold thickness measurement is a means of assessing the amount of body fat in individuals (24). We did not find any difference in TSF among three stages of the disease. The results of bioelectric impedance analysis showed that our COPD patients had significantly lower FM in kg and FMI in advanced stages of disease. Loss of the fat mass may represent an imbalance due

to inadequate dietary intake-examples: early satiety, dyspnea and fatigue; or an increased energy requirement, due to increased ventilation work (20, 25). Significant decrease of fat mass in our study, which was observed among disease stages, may be related to the above-mentioned factors. Our subjects suffered from anorexia, early satiety and many of them consumed less food than they required because they lived alone and did not have the patience and the ability to prepare food.

In this study, COPD patients showed a decrease in mean values of albumin, total protein and total cholesterol as the severity of the disease increased. Several studies have also reported reduced albumin levels in COPD patients (14, 26).

The lower mean of albumin and total protein may be due to malnutrition or inflammation (26-28). Specific markers of inflammation were not analyzed in the subjects; therefore it is hard to say whether bad nutritional status or inflammation has led to lower values.

Decreased levels of total cholesterol may be more significant than absolute values. Concentration correlates with the decrease in albumin, transthyretin, iron, zinc and vitamins A and E and protein-energy malnutrition (28).

The worldwide growth in the number of smokers, rising prevalence of COPD in the world as a major public health problem with heavy economic burden on society and high nutritional abnormalities in COPD patients, and their adverse effects on COPD patients have made it necessary to provide more evaluations of nutritional status to reduce their rate of incidence and to mitigate their impacts and to provide a basis for treating them.

In conclusion, the study findings pointed to the need to consider body composition instead of the use of BMI as the sole criterion of malnutrition, because our patients do show frequent alterations in body composition, affecting the muscle store, the fat and visceral protein stores as the disease became more severe. Analysis of body composition can detect where the loss is occurring and determine the pathogenesis of weight loss.

Acknowledgements

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