A Study on Evaluation of Nutritional Status in Patients with Chronic Obstructive Pulmonary Disease

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ABSTRACT

BACKGROUND

Currently, chronic obstructive pulmonary disease is the fourth leading cause of death in the world. Nutritional depletion is a common finding in patients with COPD (Chronic Obstructive Pulmonary Disease). Even stable COPD patients have high proportion of under nutrition. Malnutrition is an important factor that leads to low quality of life in COPD patients and could cause exacerbation of the disease. Hence malnutrition needs to be assessed and considered in management of COPD.

METHODS

A cross sectional study was conducted over a period of 2 years to determine the association of COPD with malnutrition. 50 male COPD patients between 40 to 60 years of age fulfilling the inclusion criteria were selected, and the analysis was restricted to this age group, so as to ensure the uniformity of analysis. They were staged based on PFT and evaluated by anthropometric measures and biochemical parameters. Statistical analysis was done and $p < 0.05$ was considered statistically significant.

RESULTS

In this study the average age of the population was 52.52 ± 5.64 years. 50 male COPD patients were categorized into mild ($n = 10$), moderate ($n = 27$), severe ($n = 10$) and very severe ($n = 3$) groups with spirometry based on GOLD criteria. Anthropometric measures (BMI, TSF, MAMA, MAFA) and biochemical parameters (serum albumin and pre-albumin) were evaluated. The difference in severity of airway obstruction, body weight, BMI, pre-albumin and serum albumin among the various age groups was not significant statistically. There was a significant difference ($p < 0.05$) in BMI, MAMA, MAFA, pre-albumin and serum albumin values in severe and very severe airway obstruction patients when compared to those with mild and moderate airway obstruction. The present study showed a statistically significant and strong correlation of BMI (i.e. $r = 0.75$ and $p < 0.05$), MAMA ($r = 0.81$ and $p < 0.05$), MAFA ($r = 0.72$ and $p < 0.05$), serum pre-albumin ($r = -0.315$ and $p = 0.006$), and albumin ($r = 0.74$) when compared with severity of airway obstruction.

CONCLUSION

A significant number of patients with Chronic Obstructive Pulmonary Disease was malnourished. Measures of protein stores (serum albumin and pre-albumin) and the anthropometric measures of nutrition [BMI, body muscle mass and fat stores] were inversely related with severity of airway obstruction.

KEY WORDS

COPD, BMI, PFT, TSF, MAMA, MAFA, Serum Albumin, Pre-Albumin

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BACKGROUND

"Chronic obstructive pulmonary disease (COPD) is the fourth leading cause of death in the world.¹" Globally the COPD burden is predicted to increase in coming decades because of aging of the population and continuous exposure to COPD risk factors.² "Major cause of chronic morbidity and mortality throughout the world is COPD."³ "Nutritional depletion is a common finding in patients with COPD. Stable COPD patients also had high proportion of under nutrition."⁴

Malnutrition is the most important factor that leads to low quality of life in COPD patients and contributed to the exacerbation of disease.⁵ Most of the patients with severe COPD are lean, and in a malnourished or under nourished state referred to as pulmonary cachexia syndrome, characterized by loss of fat free body mass causing wasting of muscles. It is estimated to occur in 25 to 40 % of COPD patients and is associated with a decline in functional status, carry an unfavourable prognosis.⁶⁻⁸ The wasting of muscles in COPD patients not only leads to decreased skeletal muscle function leading to reduced exercise capacity, is also a major determinant of mortality in COPD, independent of airflow obstruction. Nutritional supplement therapy has been incorporated in the management of COPD since a long time and has shown promising results.⁹ The exact cause for malnutrition remains unclear in COPD patients, as multiple factors like tissue hypoxia, disuse atrophy, changes in metabolism and calorie intake, oxidative stress, aging, inflammation and medications (glucocorticoids) contribute to a progressive reduction in lean body mass. To assess the severity of malnutrition, biochemical parameters that reflect the visceral protein levels in the body are also used.

Objectives

1. To determine the association of Chronic Obstructive Pulmonary Disease and malnutrition.
2. To determine the association between severity of airflow obstruction and malnutrition.
3. To evaluate as to whether the biochemical markers of protein stores (serum albumin and prealbumin) correlate with the severity of airflow obstruction.

METHODS

This was a simple, cross-sectional study conducted in the department of Pulmonary Medicine, for a period of 2 years at MNR Medical College and Hospital, Sangareddy. The subjects who consented for the study were taken and was approved by the Institutional Ethical Review Board. 50 patients who fulfilled the inclusion & exclusion criteria were selected.

Inclusion Criteria

Male COPD patients between age group of 40 to 60 years.

Exclusion Criteria

- Patients with exacerbation of symptoms less than 2 months prior to study.

- Patients with comorbidities like diabetes mellitus, cor pulmonale, bronchial asthma, tuberculosis and HIV.
- Critically ill patients and those patients who were not able to perform spirometry.
- Patients on oral corticosteroids.
- Patients with other related diseases which will affect the nutritional status e.g. liver cirrhosis, bronchiectasis and cystic fibrosis etc.
- Non-smokers.

Method of Data Collection

Patients were defined as having COPD supported by GOLD (Global Initiative for Obstructive Lung Disease) criteria. To make sure the uniformity of research, the study was restricted to patients between the age group of 40 – 60 years. BMI was calculated and **TSF (Triceps Skinfold Thickness)** thickness of the non-dominant arm was measured by employing a vernier calipers.¹⁰ Mid arm circumference was measured with a standard measuring tape. Nutritional Indices were calculated using the below standard formulae⁴

$$\text{Mid Arm Muscle Circumference} = \text{MAC} - (3.14 \times \text{TSF}) \text{ (cm)}.$$

$$\text{Mid Arm Muscle Area (MAMA)} = (\text{MAMC})^2 / 4 \times 3.14 \\ \text{(MAMA)} \text{ (cm}^2\text{)}$$

$$\text{Mid Arm FAT Area (MAFA)} = [\text{MAC}^2 / (4 \times 3.14)] - \text{MAMA} \\ \text{(MAFA)} \text{ (cm}^2\text{)}$$

$$\text{FAT / Muscle Index} = \text{MAFA} / \text{MAMA}$$

Laboratory Investigations

Serum pre-albumin was measured by using standard immunoturbidimetric method. This provides reference value of 16 – 40 mg / dL. Serum albumin sample was measured using spectrophotometric method. This gives reference value of 3.5 - 5.5 gm / dL or 35 – 55 gm / litre. For every patient, detailed medical record was taken and clinical examination was done. On the study day, weight and height of the patients were recorded.

Statistical Analysis

The information was processed and analysed using SPSS software version 25.0 for windows and Microsoft excel. All data were analysed using descriptive analysis. For the comparison of variables with in the two independent groups, unpaired t-test was used. The difference among more than two groups were evaluated by one-way ANOVA (Analysis of variance). The relation between anthropometric indices and FEV₁ was evaluated by Pearson's correlation. P < 0.05 was considered statistically significant.

RESULTS

We included 50 patients who were examined and evaluated. The difference within the severity of airway obstruction, weight, pre-albumin and albumin among the distinct age groups was not significant statistically. There was a

statistically significant difference within the mean weight of patients in severe and very severe groups compared with mild and moderate groups.

Parameter	Mean	Standard Deviation
Age	52.52 yrs.	5.64
Weight (wt.)	56.30 Kg	9.82
Height (ht.)	1.64 mts.	0.07
Mid Arm Circumference	23.41 cms	3.74
Triceps Skin Fold	1.32 cms	0.28
Body Mass Index	20.76 Kg / m ²	3.09
Mid Arm Muscle Circumference (MAMC)	19.25 cm	3.01
Mid Arm Muscle Area (MAMA)	30.23 cm ²	8.93
Mid Arm Fat Area	14.52 cm ²	4.93
Fat / Muscle Ratio	0.47	0.07
Pre-Albumin	25.52 mg / dL	7.09
Albumin	3.67 gm / dL	0.30
FEV ₁	64.13 %	18.33

Table 1. Study Population Characteristics

Most of them (68 %) were within the age between 50 and 60 yrs.

Severity of Airway Obstruction	FEV ₁ (% Predicted)	Number	Percentage (%)
Mild	>= 80	10	20 %
Moderate	50 - 79	27	54 %
Severe	30 - 50	10	20 %
Very Severe	< 30	3	6 %

Table 2. COPD Severity (Based on FEV₁).

Severity of Airway Obstruction	Mean BMI (Kg / m ²)	Standard Deviation	One Way ANOVA
Mild (n = 10)	23.80	1.63	p < 0.0001 Significant
Moderate (n = 27)	21.35	2.28	
Severe (n = 10)	17.45	2.00	
Very Severe (n = 3)	16.34	1.23	

Table 3. Relation between BMI and Severity of Airway Obstruction

Severity of Airway Obstruction	Avg. MAMA (cm ²)	Standard Deviation	One Way ANOVA
Mild (n = 10)	38.57	6.17	p < 0.0001 Significant
Moderate (n = 27)	32.11	6.47	
Severe (n = 10)	21.05	5.14	
Very Severe (n = 3)	16.10	2.22	

Table 4. Relation between Severity of Airway Obstruction and MAMA.

Severity of Airway Obstruction	Avg. Serum Pre-Albumin (mg / dL)	Standard Deviation	One Way ANOVA
Mild (n = 10)	32.51	2.08	p < 0.0001 Significant
Moderate (n = 27)	27.33	5.10	
Severe (n = 10)	16.74	3.15	
Very Severe (n = 3)	15.30	0.72	

Table 5. Relation between Airway Obstruction and Serum Prealbumin

There was a significant difference in BMI, MAMA, MAFA, pre-albumin and serum albumin values in patients with severe and very severe airway obstruction groups as compared to patients with mild and moderate airway obstruction groups.

Of the 13 (26 %) patients with severe and very severe airflow obstruction, 10 of them were within the bottom quartile of BMI, 9 patients were in the lower quartile of Midarm Muscle Area (MAMA) and 10 patients were within the bottom quartile of MAFA. Out of 50 total patients, 14 (28 %) were found to have a BMI less than 18.5 Kg / m². 9 (18 %) patients have albumin level of less than 3.5 gm / dL.

DISCUSSION

Chronic obstructive pulmonary disease is the major public health concern and is often associated with significant nutritional abnormalities. Malnutrition can be harmful in patients with COPD which is due to reduced respiratory

muscle mass and strength; decreased cell immunity, poor wound healing and decreased ventilatory response to hypoxia.¹¹ Results of the study showed that most of the measured parameters in COPD patients decreased as the disease severity increased. These reductions were much in stage 3 and 4 of the disease. These findings confirm previous studies conducted on nutritional status in COPD patients and have shown that with increase in the severity of disease, the patients face a decline in BMI, muscle and fat mass and albumin levels. In this study, the average age of the population was 52.52 + 5.64 years (Table 1). The patients in the present study were between 40 - 60 yrs. of age. This was done for the reason that FEV₁ was found to steadily decrease as the age advances. To ensure the uniformity of analysis in the study, patients were selected within the narrower age group.

No significant difference was found in the severity of airway obstruction (FEV₁) and the biochemical parameters (serum albumin and pre-albumin) between the distinct age groups. As the pre-albumin values were found to vary between males and females; females have a lower value of pre-albumin, the patients in this study includes only males. Soler JJ et al⁴ study includes 177 (99.4 %) male and 1 (0.6 %) female patients. In the study by Mathew JT et al,¹² included 25 patients, and all were male.

Forced Expiratory Volume in the First Second (FEV₁)

The mean FEV₁ of patients in this study was 64.13 + 18.33 (percentage predicted) (Table 1). The population was divided into mild (n = 10), moderate (n = 27), severe (n = 10) and very severe (n = 3) airway obstruction based on GOLD criteria³ (Table 2). FEV₁ did not differ significantly among the various age groups. Soler JJ et al,⁴ study established that malnutrition in stable COPD patients is the most common problem that increases as the severity of disease progresses. In the study by Chaudhary SC et al,¹³ there was no statistically significant difference between the age and airway obstruction (FEV₁) of the disease.

Anthropometric Measures

Anthropometric assessment is used as it is an inexpensive and simple alternative for evaluation of the body composition.

Weight

The average weight of the present study population was 56.3 + 9.82 Kg. Body weight among different age groups of the patients was not significant statistically (p = 0.053). But there was a statistically significant difference in the body weight of patients among the different groups of severity of disease (p < 0.05). A significant and moderate positive correlation was found between the body weight of patients and severity of disease (r = 0.67 and p < 0.05). "These findings are similar to the study done by Soler JJ et al⁴."

Height

The average height of the present study population was 1.64 + 0.07 mts (Table 1).

Body Mass Index

The average BMI of the study population was 20.76 ± 3.09 Kg / m² (Table 1). According to WHO classification, BMI less than 18.5 Kg / m² is considered as underweight in general population.¹⁴ This study demonstrated a correlation between severity of airway obstruction and lower BMI. 14 (28 %) patients have BMI of less than 18.5 Kg / m². There was a significant difference in the mean BMI value between severe, very severe airway obstruction and the above two (mild and moderate) groups. This study also established a significant, strong and positive correlation between BMI and the severity of airway obstruction (FEV₁) (i.e. $r = 0.75$ and $p < 0.0001$). Out of 50 patients, 13 (26 %) were in the lower quartile (< 25th percentile) of the study population. In the study by Sami et al,¹⁵ BMI had positive and significant correlation with FEV₁ ($r = 0.27$ and $p = 0.020$). These findings are similar to the study done by Gupta B et al.¹⁶

Mid Arm Circumference (MAC)

In this study the mean midarm circumference was 23.4 ± 3.74 cm. Anthropometric studies done by Matthews AL et al¹⁷ showed that a midarm circumference < 23 cm signifies under-nutrition.

Triceps Skinfold Thickness

The mean TSF thickness in this study population was 1.32 ± 0.28 cm. Though there are no particular standards, population studies (done by Robert JM et al¹⁸) have found a value of 0.9 – 2.1 cm. As TSF is highly affected by subcutaneous oedema and so may be reported higher than the real value, there is a lack of association between TSF thickness and disease severity. In the study conducted by Soler JJ et al⁴, TSF thickness was at or within the bottom quartile for 58 (32.6 %) patients.

Mid Arm Muscle Area (MAMA)

In this study the average MAMA of patients was 30.23 ± 8.93 cm² (Table 1). 12 (24 %) patients who were in the lower quartile (< 25th percentile) of the distribution were found to have severe depletion in the muscle mass. A statistically significant difference was found in MAMA of patients with severe and very severe airflow obstruction when compared to those who have mild and moderate airway obstruction. But there was no significant difference between severe and very severe groups (Table 4). This study also showed a statistically significant and strong positive correlation between decrease in muscle mass and increase in severity of airflow obstruction ($r = 0.81$ and $p < 0.0001$). In the study by Soler JJ et al,⁴ also showed a significant correlation between midarm muscle area (MAMA) and FEV₁ ($r = 0.30$ and $p < 0.001$). He established that muscle store was the compartment most often affected. This suggested that malnutrition induces to muscle wasting rather than deficiency in the other body stores. In the study by Marquis et al,¹⁹ found that muscle mass is an even better predictor of mortality than body weight.

Mid Arm Fat Area (MAFA)

In this study the average MAFA of the population was 14.52 ± 4.93 cm² (Table 1). 12 (24 %) patients were in the bottom

quartile (< 25th percentile) of the distribution and were found to have severe fat depletion. A significant difference was established in MAFA of the patients with severe and very severe airway obstruction when compared to those with mild and moderate airway obstruction. This study also showed a statistically significant and moderate positive correlation between decrease in MAFA and increase in severity of airway obstruction (correlation coefficient is 0.72) ($r = 0.72$ and $p < 0.0001$). The severity of muscle mass depletion correlated more strongly with the severity of airway obstruction when compared to the severity of fat depletion. These findings are similar with study done by Soler JJ et al.⁴

Measures of Visceral Protein Stores

In this study measures of visceral protein stores such as serum albumin and pre-albumin were used.

Serum Pre-Albumin

The average pre-albumin value in the study population was 25.52 ± 7.09 mg / dL. An inverse correlation was found between the pre-albumin levels and the severity of airflow obstruction (with correlation coefficient is 0.81). A statistical significant difference was established in the mean pre-albumin values between severe and very severe groups and with mild and moderate groups of disease ($p < 0.0001$). A strong, positive and significant correlation was found between severity of airway obstruction and decreased pre-albumin levels. Study by Toppo A et al,²⁰ demonstrated significant difference between severity of the disease and serum pre-albumin levels ($p < 0.05$). There was a significant and strong negative correlation between the COPD grading and serum pre-albumin ($r = -0.315$ and $p = 0.006$).

Serum Albumin

The mean albumin value of the patients in the study was 3.67 ± 0.30 gm / dL. This study found a significant and inverse correlation between the severity of airway obstruction and albumin levels ($r = 0.74$). A statistical significant difference was established in the mean albumin values between severe and very severe and with mild and moderate airway obstruction ($p < 0.001$). 9 (18 %) out of 50 patients have a serum albumin of less than 3.5 gm / dL. In Soler JJ et al⁴ study, 17 (9.6 %) patients have a serum albumin level less than 3.5 gm / dL. In Chaudhary SC et al¹³ study, A significant decrease in mean serum albumin levels with increasing severity of the disease was observed ($p < 0.001$). In the study by L Yazdanpanah et al,²¹ the mean albumin levels were significantly decreased with increase in the severity of disease ($p = 0.000$).

CONCLUSIONS

A significant number of patients with Chronic Obstructive Pulmonary Disease were malnourished. Measures of protein stores [serum albumin and pre-albumin] and the anthropometric measures of nutrition (BMI, body muscle mass and fat stores) were inversely related with severity of airway obstruction.

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

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