Original Research Article

Study of superoxide dismutase, vitamin-c and malondialdehyde in smokers with chronic obstructive pulmonary disease patients

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Abstract

Background: High morbidity and mortality are associated with chronic obstructive pulmonary disease (COPD). COPD is generally correlated with a history of consuming tobacco. The tissue damage seen in COPD is due to free radicals in the smoke. Several studies have shown a significant correlation between oxidative stress and COPD. Antioxidant reductions also contribute to oxidative stress, as antioxidants not only protect against the direct harmful effects of oxidants but also modify inflammatory events which play an important role in COPD pathogenesis.**Methods:** The total number of subjects studied was 100, consisting of 50 safe controls and 50 cases of COPD. Out of 50 cases of COPD, 25 were patients with chronic bronchitis and 25 were patients with emphysema. Malondialdehyde (MDA) levels of oxidants were measured, and superoxide dismutase (SOD) and vitamin C levels of antioxidants were measured. Cases and controls were tested for superoxide dismutase, vitamin C, and malondialdehyde levels.**Results:** Serum superoxide dimutase and vitamin C levels were significantly reduced and serum MDA was significantly increased as compared to controls in COPD cases. Compared to chronic bronchitis patients, the abnormality was more significantly seen in emphysema patients.**Conclusion:** The present study suggests that the increased MDA levels in COPD patients are due to increased lipid peroxidation mediated by toxic free radicals and decreased levels of serum superoxide dismutase and vitamin C as a result of increased oxidative stress. Further studies, to evaluate the molecular mechanisms by which antioxidants modulate their protective role and also to identify new antioxidant molecules which may well prove to be better preventive factors or additional protective factors, should be done.

Keywords: Oxidative stress, Antioxidants, COPD, Superoxide dismutase, Vitamin C, Malondialdehyde.

Introduction

The fourth leading cause of death globally is a chronic obstructive pulmonary disease (COPD). In countries where smoking is extremely common, the prevalence of COPD is higher. COPD is a frequent respiratory disease affecting millions of individuals in India. There is a growing propensity to misuse tobacco in India, and COPD is becoming a major public health concern [1]. The most significant COPD risk factor is cigarette smoking. It is estimated that 80% of patients with COPD have substantial exposure to cigarette smoke. In the production of COPD, the remaining 20% have a combination of exposure to ambient

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cigarette smoke, occupational dust, and chemicals, indoor air pollution from biomass fuel used for cooking in poorly ventilated houses, outdoor air pollution, airway infection, family and inherited variables [2]. American Thoracic Society defines "Chronic obstructive pulmonary disease as a condition of illness marked by the occurrence of chronic bronchitis or emphysema airflow obstruction; airflow obstruction is normally progressive, may be followed by hyper-reactivity of the airway, and may be partly reversible" [2]. Chronic bronchitis is a clinical condition characterized by prolonged bronchial mucus secretion and manifests in at least 2 consecutive years of everyday productive cough for 3 months or more. Emphysema is a pathological diagnosis that signifies an irregular permanent expansion of air spaces distal to the terminal bronchiole without apparent fibrosis, with the destruction of their walls [2]. A relationship is also expected between passive smoking and the development of chronic obstruction of airflow. An existing hypothesis in the pathogenesis of COPD is that the increased oxidant pressure may not be sufficiently counterbalanced by the lung antioxidant systems, resulting in oxidative stress, both directly as a result of smoking and indirectly by the release of reactive oxygen species from airspace leukocytes. An excess of oxidants can then lead to increased expression of the pro-inflammatory gene and oxidative tissue injury resulting in COPD [3].

Superoxide dismutase (SOD) is an effective protection against antioxidants in all oxygen-exposed cells [4]. SOD is generally expressed in human lungs in areas containing type I collagen fibers, bronchial epithelium, and alveolar macrophages, mainly located in an extracellular matrix. They serve as bulk scavengers of the radicals of superoxide **[**4].

In respiratory epithelial lining fluid, vitamin C is a significant antioxidant that forms the first line of protection against smoking exposure. Vitamin C is a water-soluble free radical scavenger that can directly scavenge O_2 and OH radicals and helps neutralize the physiological oxidant burden provided by exogenous and endogenous sources [5].

Malondialdehyde (MDA) a lipid peroxidation product is an indication of oxidative stress that is inversely associated with pulmonary function [6]. Depletion or deficiency of antioxidants could lead to oxidative stress. Not only do antioxidants protect against the direct harmful effects of oxidants, but they also modify inflammatory events that play a significant role in COPD pathogenesis **[**7].

In the current study, serum superoxide dismutase, vitamin C, and malondialdehyde were tested in controls, and smokers with cases of chronic obstructive pulmonary disease.

Method

An analysis of serum superoxide dismutase, vitamin C, and malondialdehyde has been performed in smokers with chronic obstructive pulmonary disease. Consent has been sought from controls (non-smokers) and cases of the chronic obstructive pulmonary disease (smokers). The ethical and research committee accepted this report.

Inclusion criteria:

i) Cases: Smokers were classified in cases of chronic obstructive pulmonary disease diagnosed clinically and radiologically. In total, 50 COPD patients were classified into 25 emphysema cases and 25 chronic bronchitis cases.

ii) Controls: It included 50 average, healthy individuals with no history of smoking or chronic lung disease.

Exclusion criteria: Patients with other FEV1-reduced pulmonary disorders, a history of heart failure or other surgical operation, diabetes mellitus, hypertension, liver disease, kidney disease. Superoxide dismutase was analyzed by the Marklund and Marklund method in controls and patients [8], serum vitamin C was analyzed by the AYE KYAW simple colorimetric method [9], and serum malondialdehyde by the TBA method.

Results

Table 1: Comparison of Serum Superoxide Dismutase, Vitamin C and Malondialdehyde in Controls and COPD Cases

Groups		SOD (U/ml)	VITAMIN-C (mg/dl)	MDA (nmol/ml)
Controls	**MEAN ± S.D**	9.16 ± 1.68	1.2 ± 0.18	2.68 ± 0.54
Cases	**MEAN ± S.D**	4.38 ± 1.18	0.53 ± 0.11	5.42 ± 0.78
Controls Vs Cases	**p-value**	<0.001	<0.001	<0.001

Table 2: Comparison of Serum Superoxide Dismutase, Vitamin -C and MDA in Controls and Chronic Bronchitis Cases

Groups		SOD(U/ml)	Vitamin-C(mg/dl)	MDA(nmol/ml)
Controls	MEAN ± S.D	9.16 ± 1.68	1.2 ± 0.18	2.68 ± 0.54
Chronic bronchitis	MEAN ± S.D	5.25 ±0.21	0.64 ± 0.08	4.89 ± 0.51
Controls vs Chronic bronchitis	p-value	<0.001	<0.001	<0.001

Table 3: Comparison of Serum Superoxide Dismutase, Vitamin C and MDA in Controls and Emphysema Cases

Groups		SOD (U/ml)	Vitamin-C(mg/dl)	MDA(nmol/ml)
Controls	MEAN ± S.D	9.16 ± 1.68	1.2 ± 0.18	2.68 ± 0.54
Emphysema	MEAN ± S.D	3.51 ± 0.89	0.42 ± 0.07	5.95 ± 0.52
Controls vs Emphysema	p-value	<0.001	<0.001	<0.001

Table 4: Comparison of Serum Superoxide Dismutase, Vitamin C and MDA in Chronic Bronchitis and Emphysema Cases

		SOD (U/ml)	Vitamin-C(mg/dl)	MDA(nmol/ml)
Chronic Bronchitis	MEAN ± S.D	5.25 ± 0.21	0.64 ± 0.08	4.89 ± 0.51
Emphysema	MEAN ± S.D	3.51 ± 0.89	0.42 ± 0.07	5.95 ± 0.52
p-value	p-value	<0.001	<0.001	<0.001

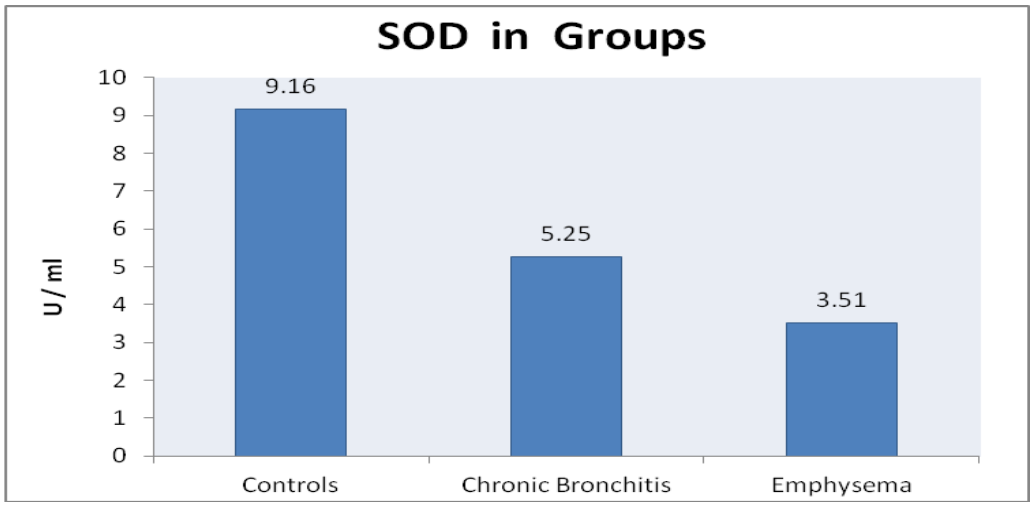

Fig 1:Bar Diagram Showing MDA in Three Groups

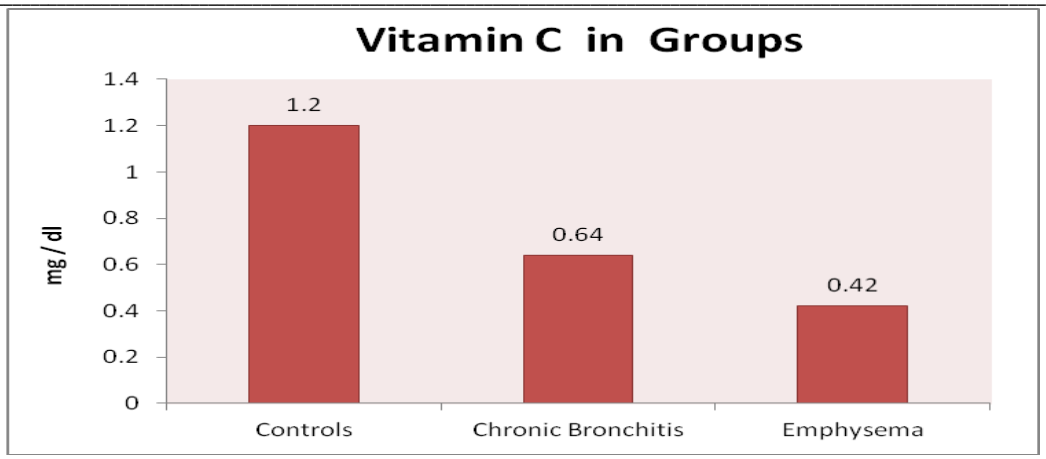

Fig 2: Bar Diagram Showing Vitamin C in Three Groups

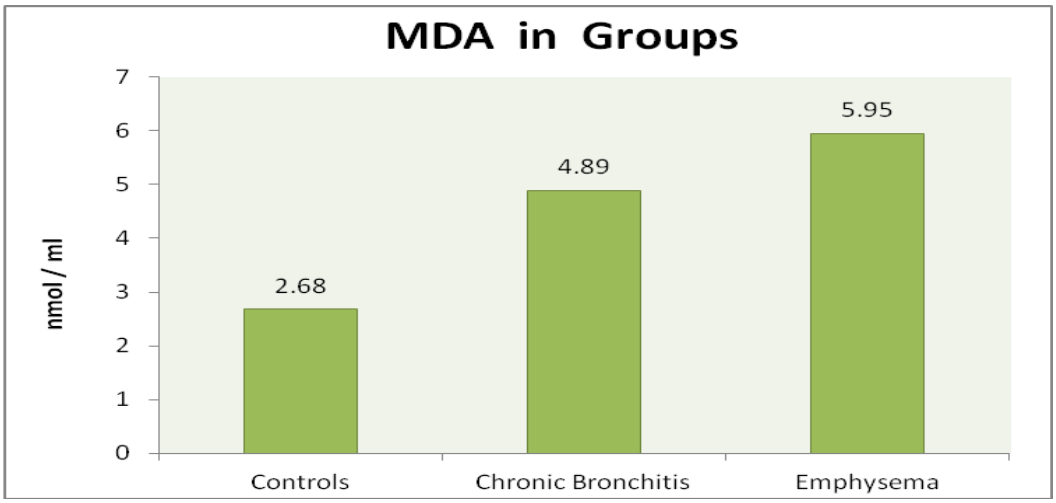

Figure 3:Bar Diagram Showing MDA in Three Groups

Discussion

The fourth leading cause of death globally is a chronic obstructive pulmonary disease. In countries where smoking is extremely common, the prevalence of COPD is higher. There is a growing propensity to misuse tobacco in India, and COPD is becoming a major public health concern [10]. In the pathogenesis of COPD, oxidative stress plays a significant role, induced by an imbalance between the output of oxidants and the existence of antioxidants. [11]. The main objective of this study is to test serum SOD, vitamin C and MDA alterations in controls and patients with chronic obstructive pulmonary disease. The current research involved 100 participants, of which 50 were patients with chronic obstructive pulmonary disease and 50 were generally healthy subjects. Out of 50 patients with COPD, 25 were patients with chronic bronchitis and 25 were patients with emphysema.Superoxide dismutase is an antioxidant enzyme that functions in the body as a superoxide radical scavenger. When there is oxidative stress, the amount of SOD is reduced. This plays an important role in different diseases' pathogenesis [5].In

the controls, the mean SOD value is 9.16 ± 1.68 U/ml in cases and 4.38 ± 1.18 U/ml in cases. Patients with COPD have substantially reduced levels of SOD as compared to controls (p-value < 0.001). This is in accordance with studies of Raghunath R Rai et al. [5], Gamze Kirkil et al. [18]. In chronic bronchitis patients, the mean value of SOD is 5.25 ± 0.21 U/ml and in emphysema patients, 3.51 ± 0.89 U/ml. Compared with chronic bronchitis patients, SOD is substantially reduced (p-value < 0.001) in emphysema patients. This is in accordance with the study of Papaioannou et al. [14].Alterations in antioxidant enzymes such as SOD suggest that COPD patients have a redox imbalance. Increased development of free radicals in COPD patients, leading to increased consumption of antioxidant enzymes, is the mechanism involved in decreased serum SOD operation.Vitamin C is a water-soluble free radical scavenger that can directly scavenge $O2^-$ and OH^- radicals and helps neutralize the physiological oxidant burden provided by exogenous and endogenous sources [5]. The mean value of serum vitamin C in controls is 1.2 ± 0.18 mg/dl and in COPD cases, 0.53 ± 0.11 mg/dl. COPD patients have substantially reduced vitamin C levels (p-value < 0.001) as compared to controls. This is in accordance with studies of Raghunath R. Rai et al. [5], L.A. Sargeant et al. [12], and Mukadder Cali Koglu et al. [13]. In chronic bronchitis patients, the mean value of serum vitamin C is 0.64 ± 0.08 mg/dl, and in emphysema patients, 0.42 ± 0.07 mg/dl. Compared to chronic bronchitis patients, vitamin C is substantially reduced (p-value < 0.001) in emphysema patients. This is in accordance with the study of Papaioannou AI et al. [14].As an essential free radical scavenger, vitamin C works. The process involved in decreasing the amount of vitamin C in COPD is due to the rapid free radical oxidation of ascorbic acid. If the oxidant burden is increased, the negative relationship between vitamin C and MDA may be due to vitamin C depletion [13]. As an antioxidant, vitamin C works. It stops other compounds from being oxidized in the process by donating their electrons. A free radical, i.e., ascorbyl radical, is the species formed after the loss of one electron. Ascorbyl radical is relatively stable with a half-life of 10^{-5} seconds compared to other free radicals and is fairly non-reactive, illustrating the antioxidant nature of vitamin C and its choice. Reduction of a reactive free radical is often called free radical scavenging or quenching with the formation of a less reactive compound [15].MDA is a result of lipid peroxidation that is produced by reactive oxygen species during the oxidative phase of PUFA. The sensitive marker for lipid peroxidation is MDA. Patients with COPD are exposed to elevated oxidative stress and increased MDA levels. The mean serum MDA value in controls is 2.68 ± 0.54 nmol/ml, and in COPD cases, 5.42 ± 0.78 nmol/ml. COPD patients have substantially increased MDA levels (p-value < 0.001) as compared to controls. This is in accordance with the study of M.K. Daga et al. [16], Birgul Isik et al.[17] and Gamze Kirkil et al. [18].

In chronic bronchitis, the mean value of serum MDA is 4.89 ± 0.51 nmol/ml and 5.95 ± 0.52 nmol/ml in emphysema patients. Compared to chronic bronchitis patients, the MDA level is substantially elevated (p value < 0.001) in emphysema patients. This is in accordance with the study of J. Gea et al. [19]. Oxidative stress has been implicated in chronic obstructive pulmonary disease caused by the pathogenesis of tobacco smoke. Via lipid peroxidation of cell membranes, reactive oxygen species present in tobacco smoke can cause damage to human alveolar epithelial cells. Increased MDA levels in COPD patients are attributable to increased development of reactive oxygen species and hence more lipoxidation products [16]. Compared with chronic bronchitis patients, an elevated level of MDA in emphysema patients suggests more oxidative stress. This may be attributed to more extreme lung function deficiency, lower body mass index, poor quality of life, and more serious systemic dysfunction in patients with emphysema [14,20].

Conclusion

The current research indicates that, relative to controls, there is elevated oxidative stress in patients with COPD and that, compared to chronic bronchitis patients, it is higher in emphysema patients. In emphysema patients, antioxidants are especially reduced as compared to chronic bronchitis patients. This study shows that cigarette smoke triggers oxidative stress in smokers, resulting in chronic pulmonary obstructive disorder. Therefore, public knowledge of smoking cessation and advice on a diet rich in antioxidants or antioxidant supplementation may prevent further oxidative damage in patients with COPD.

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