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PREVALENCE OF RENAL DISORDERS AND OXIDATIVE STRESS IN TEXTILE PROCESSING AND DYEING INDUSTRY WORKERS

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ABSTRACT AND KEY WORDS

Background: India is one of the leading country in the sector of textiles and Extensive scientific and industrial development have resulted the adverse effects on human health. Exposure of organic solvent used in textile processing and dyeing industry may occur. Such workers may not know the risks of their exposure and they are not aware the relationship between an exposure of solvents and chemicals to kidney dysfunction. Therefore, there is, a need to assess kidney function in textile processing and dyeing industry workers. **Aim and Objectives:** To study the levels serum urea, creatinine, lipid peroxidation and nitric oxide in textile processing and dyeing industry workers and healthy controls. **Martial and Methods:** In this study, 95 subjects working in textile processing and dyeing industry more than 5 years and 95 healthy controls of both gender matching in age and sex were included. Blood urea, serum creatinine, lipid peroxidation and nitric oxide were assayed by autoanalyzer using diagnostic reagent kit. **Result:** The mean difference of serum urea, serum creatinine, serum Malondialdehyde(MDA) and nitric oxide(NO•) was significantly increased in the textile processing and dyeing industry workers ($P < 0.001$) as compared to that of controls ($P= 0.000$). **Conclusion:** Increased awareness and early diagnosis of the exposure to toxic substances in textile processing and dyeing industries are essential for performing prompt management, improving clinical outcomes.

KEYWORDS: Malondialdehyde(MDA), Reactive Oxygen Species (ROS), Nitric oxide(NO•).

INTRODUCTION

India is one of the leading country in the sector of textiles and garments and many of textile workers are exposed to organic solvents at different workplaces. Textile being the part of life for many purposes in the human society is now used in many colours.[1] Textile processing and dyeing industry were built up to colour and further textile processing, Dyes are mainly organic and inorganic chemical substances. And if these chemical and particles spread out in the environment, they may cause huge adverse impact on the environment as well as on health. Dyes may gain entrance into the system through inhalation, dermal contact and inadvertent ingestion. Systemic effect may occur beyond the site of contact when the dye is absorbed into the blood stream and distributed throughout the body. The liver and kidney in the body is often the target organ of chemical-induced tissue injury.[2]

Exposure of organic solvent used in textile processing and dyeing industry may occur despite the use of protective clothing, because solvents may penetrate certain types of gloves or cloth. Such workers may not know the risks of their exposure and they are not aware the relationship between an exposure of solvents and chemicals to kidney dysfunction and the development of high blood pressure or in the worst case situation, if untreated the development of end stage renal disease (ESRD). Therefore, there is, a need to develop a battery of biochemical markers for early detection of these effects.[3,4]

Free radicals are highly reactive species characterized by an unpaired electron in their outer orbital and involved in cellular damage. Free radical reactions, including lipid peroxidation, are considered to be important factors which creates oxidative stress leads to pathogenesis of a different disorders, which in turn damages biological

membrane. However, reactive oxygen species(ROS) have a vital role and is reported recently with a variety of zenobiotics.[3] The toxic effects of volatile organic solvents are caused by reactive oxygen species (ROS) are implicated in pathogenesis of several disease and important role in the regenerative process in kidney and liver. Development of oxidative stress because of free oxygen radical generation has been implicated in many diseases. The emphasis on awareness about the environmental concern for example air, water, noise and chemical pollution for the duration of the processing from textile material is essential in the present situations.[6,8]

The workers from textile processing and dyeing industry are exposed to various processing chemicals, dyes and different pollutant for long term which may causing hazardous effects on various organs like particularly lung, liver, kidney have become important issue and less data available which explain the effects of these chemicals on biochemical parameters. As renal damage and increased oxidative stress from solvent exposure may remain clinically silent for many years due to the large functional reserve capacity of the kidney, it is necessary to apply sensitive, reliable early biomarkers indicators to detect early effects and prevent further damage.[9] The aim of this study to detect the prevalence of renal impairment and oxidative stress among textile processing and dyeing industry workers exposed to organic solvents as nephrotoxic substance.

MATERIAL AND METHOD

The exposed group included ninety five workers and ninety five healthy controls of both gender matching in age and sex from a textile industry pollution free area and had never been directly exposed to these dyes were included in this study. All the workers were asked to answer a questionnaire that included question about age, smoking habit, health, working years as a textile worker. All Workers had least five years of working experience in this occupation.

The study was conducted in age group between 30 to 60 years. The analysis of biochemical parameters was done by using standard grade reagents and chemicals. The exclusion criteria were includes subjects having alcoholism, smoking and diseases like diabetes mellitus, respiratory diseases and cardiovascular disease. The subjects who are willing to participate with informed consent were included in the present study. All controls were free from infection and no medication during the last two weeks. The research sturdy protocol was approved by institutional ethical committee and informed consent were obtained in written form from each subject before they were included in the study.

Collection of Blood Samples

The blood samples were collected from both study subjects and controls under aseptic precautions using vacutainers. The blood samples was allowed to clot at room temperature for 20–30 minutes & serum was separated for analysis of biochemical parameters.

Measurement of blood urea and creatinine

The analysis of biochemical parameters was done by using standard grade reagents and chemicals. Serum Urea and Creatinine were assayed on autoanalyzer and diagnostic reagent kit had been used in this study.[10,11]

Measurement of Serum Lipid Peroxidation and Nitric Oxide

Lipid Peroxidation was measured as MDA in serum by the method of Kei Satoh.[12] The colour produced by the reaction of thiobarbituric acid with MDA was measured at 530 nm with the help of spectrophotometer and the results were expressed as nmol/ml. Nitric Oxide was assayed by Najwa K.Cortas and Nabil W. Wakid method[13], in which nitrate is reduced to nitrite by copper coated cadmium granules and purple colour complex produced was measured at 540 nm and result results were expressed as µmol/L.

Statistical Analysis

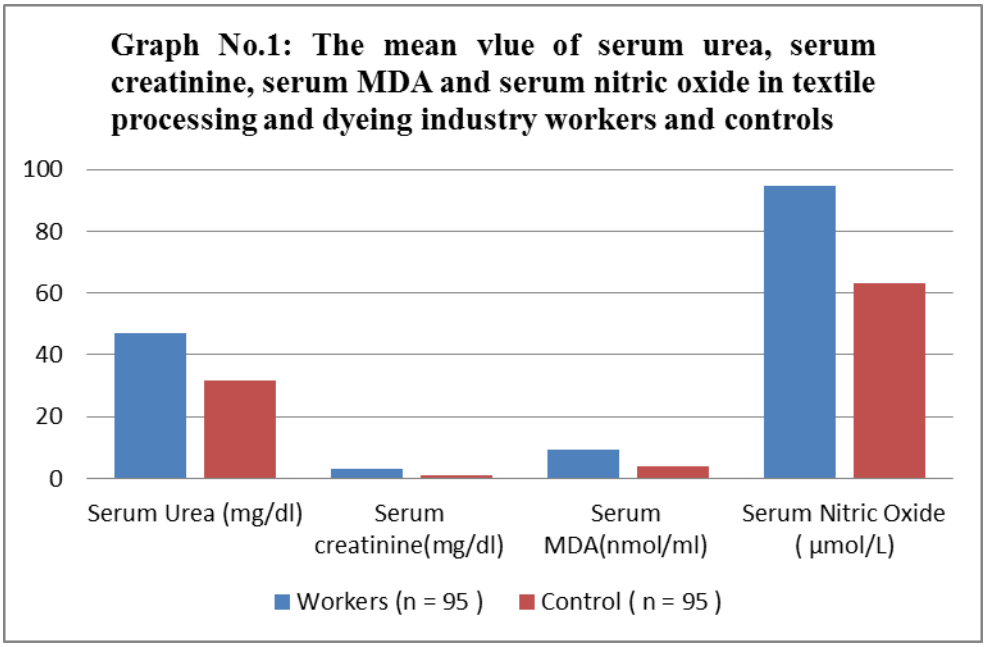
The SPSS software, version 22 was used to analyze the statistical analysis. The statistical analysis was done using the "z" test. All results were calculated as mean ± SD and a "p" value of <0.05 was considered statistically significant.

RESULTS

Table I: The mean value of serum urea, serum creatinine, serum MDA and serum nitric oxide in textile processing and dyeing industry workers and controls.

Name of Parameter	Workers (n = 95)		Control (n = 95)		Significance
	Mean ± S.D	Std. Error of mean	Mean ± S.D	Std. Error of mean	
Serum Urea mg/ dl	47.20 + 6.74 ***	0.60	31.72 ± 7.600.78	0.78	P = 0.000
Serum creatinine mg/ dl	2.97 ± 5.95 ***	0.61	0.82 ± 0.22	0.02	P = 0.001
Serum MDA nmol/ml	9.33 ± 0.84 ***	0.09	3.87 ± 1.36	0.14	P = 0.000
Serum Nitric Oxide µmol/L	94.63±12.48 ***	1.28	63.25 ±14.23	1.46	P = 0.000

The statistical method use to compare data was unpaired 't' test
*P > 0.05-------- Not Significant
**P < 0.05------- Significant
***P < 0.001--------Highly Significant



The mean of serum urea, serum cratinine, serum MDA and nitric oxide are as shown in table No1 and graph No. 1. Values are expressed as mean ± Std. deviation. The mean difference of serum urea, creatinine, serum MDA and nitric oxide was significantly increased in the textile processing and dyeing industry workers ($P < 0.001$) as compared to that of controls ($P= 0.000$). Mean of serum urea, creatinine, MDA and nitric oxide is high in the textile processing and dyeing industry workers than controls.

DISCUSSION

India is one of the leading country in the sector of textiles and Extensive scientific and industrial development have resulted in the destruction of the environment, as well as adverse effects on human health.[14,15] Dying is one of the critical procedures in textile industry in which the workers get exposed to a number of hazardous chemicals including acids, bases and caustics, bleaching agents, chromophores and organic solvents like formaldehyde and benzene. These chemicals gain entry into the system through inhalation or dermal contact. Systemic effects may occur beyond the site of contact if the dye is absorbed into the bloodstream and distributed throughout the body.[16]

Little information is available about possible toxic effect in workers from textile dyeing plants. In previous epidemiological studies performed to evaluate possible health risks in textile industry workers, diseases like Contact dermatitis, asthma, irritations of eyes and skin, chronic bronchitis, tuberculosis have been reported. Additionally some of the studies indicated an increased bladder cancer in some subjects working in dyeing and printing.[17]

The blood urea and creatinine are good indicator for impairment in renal functions. If kidney function fails, the blood urea and creatinine levels will be rise. Different mechanisms of action are probably responsible for the initial events leading to renal tubular cell damage. Unfortunately, for the majority of solvents used in textile and dyeing industry, the early critical effects are still speculative. The high serum levels of creatinine, uric acid and blood urea considered to be indicators for the damaging of the tubular epithelium. Nephrotoxicity caused by organic solvents is reversible once the exposure has increased.[18]

It is known however that elevated serum urea and creatinine level is associated with impaired renal function, especially glomerular function. Table No.I shows that there is highly significant difference seen in serum urea and creatinine as compared to controls ($P < 0.000$). The serious nature of solvent and dye toxicity might be underlining mechanisms involved in producing harmful effects. Solvent and dye toxicity is known to affect the redox status of the study subjects tissues through increased production of free radicals leading to create oxidative stress and it causes disturbance in the function of many body organs including kidney.[18,19]

Formaldehyde is a colorless and highly water-soluble aldehyde and it causes an increase in cytotoxic effects. Moreover, free oxygen radicals are increased in the tissues affected by formaldehyde, and this increase accelerates the processes (apoptosis or necrosis) that cause cell death. Formaldehyde exhibits antimicrobial activity, and it performs a fixative function in non-viable tissues. All these changes might be responsible for biochemical alteration in renal tissues, which might be cause for significantly elevated the concentration level of serum urea and creatinine, in textile dyeing and processing industry workers. In previous studies reported that systemic exposure of formaldehyde impaired glomerular pattern and thickened tubular and glomerular

basal membranes. Additionally, it was found that systemic application of formaldehyde caused congestion of the intratubular vessels, vacuolization and dilatation in distal tubules.[19]

Lipid peroxidation is the oxidative degradation of lipids. It is the process in which free radicals "steal" electrons from the lipids in cell membranes, resulting in cell damage. This process proceeds by a free radical chain reaction mechanism. Malondialdehyde (MDA) is a naturally occurring product of lipid peroxidation; it can also be generated during prostaglandin biosynthesis in cells. Increased levels of lipid peroxidation products, by measurement of MDA, have been associated with various conditions and pathological states of diseases.[20]

Table No. I shows that the mean difference of serum lipid peroxidation product (MDA) was significantly increased which was a resultant of associated to elevate the reactive oxygen species production in the textile processing and dyeing industry workers ($P < 0.001$) as compared to controls($P= 0.000$). The oxidative damage caused by free radicals is thought to be a basic mechanism underlying many pathological conditions, including hepatotoxicity by organic solvents. Oxidative stress develops when there is an imbalance between the pro-oxidant and antioxidant ratio, leading to the generation of Reactive Oxygen Species (ROS).[21] The present study revealed extensive increase in serum total lipid peroxidation product (MDA) as a consequence of long-term occupational exposure to organic solvents during textile and dyeing process. Few studies also reported that increased serum lipid peroxidation level by the action of ROS on lipids of cellular membranes. Biological membranes are particularly susceptible to the ROS effect, the peroxidaiton of unsaturated fatty acids in biological membranes leads to a decrease of membrane fluidity and disruption of membrane integrity and function, which is implicated serious pathological changes.[21,22]

Nitric oxide (NO•) is a known bronchodilator and a potent inhibitor of platelet adhesion and aggregation. Nitric oxide has significant effect on vascular smooth muscle tone and blood pressure.[23] In the present study we found significantly increased serum nitric oxide levels in workers. There is highly statistically significant difference in means of nitric oxide of Textile processing and dyeing industry workers as compared to that of controls ($P = 0.000$). Inhalation of cotton dust induce overproduction of nitric oxide in many ways viz. increased expression of iNOS, cytokines, activated macrophages etc. whose deleterious effect lead to inflammatory lung disorders.[114] Increased levels of nitric oxide cause loss of local vascular regulation, vasoconstriction and mechanical blockage of vessels, all cause a reduction in pulmonary vascular region.[24,26]

To conclude, overall scenario it is interesting to note that significant deviations were observed for various parameters serum urea, serum creatinine, lipid peroxidation and nitric oxide are associated with the increased risk of dysfunction of the kidney among the textile industry workers. Increased awareness and early diagnosis of the exposure to toxic substances in textile processing and dyeing industries are essential for performing prompt management, improving clinical outcomes. Thus occupational exposures to dyes, solvents, finishing and bleaching agents, and fiber dusts are harmful for the workers engaged in the textile industries. The textile processing and dyeing industry should improve their working pattern or they should use proper protection equipments for decreasing the magnitude of their exposure to the chemicals being used. Measurement of above biochemical investigations may be a valuable step in the hepatic and renal toxicity as well as oxidative stress assessment of textile processing and dyeing industry workers.

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