Biochemical parameters of liver function in artisans occupationally exposed to “vat dyes”

Abstract

Background: Vat dyes are the class of dyes used in textile dyeing in Abeokuta, South Western Nigeria. While some dyes (including vat dyes intermediates) have been associated with adverse effects on manufacturer’s health, there is paucity of data on effects of occupational exposure to vat dyes among end users, such as those involved in textile dyeing and finishing. Aims and Objectives: To investigate the possible effect of occupational exposure to vat dyes on the functions of the liver. Materials and Methods: Using convenience sampling technique, a cohort of dye workers (n=117) with a minimum of one year and a maximum of 60 years duration of exposure (mean =17.03 ± 1.19 years) were recruited in this study. Sixty traders, matched for age and sex and who had no previous exposure to vat dyes were selected as controls. A structured questionnaire was used to obtain information on demographic, occupational and environmental characteristics of the subjects. Plasma activities of alanine transaminase (ALT), aspartate transaminase (AST), alkaline phosphatase (ALP) and plasma concentrations of total protein, albumin and total bilirubin were measured using standard spectrophotometric methods. Statistical analyses: SPSS version 11.0 was used for statistical analyses. Tests of significance were carried out using Student’s t test, and correlation co-efficient. Results and Conclusion: The activity of ALP and the concentrations of total protein and albumin were significantly lower (P<0.05) in the exposed group. ALT and AST activities were significantly higher (P<0.05) in the exposed group. Occupational exposure to vat dyes may result in sub-clinical adverse effects on the liver, involving inhibition of its synthetic function.

Key words: Liver function tests, occupational exposure, sub-clinical effects, textile dyeing, vat dyes

INTRODUCTION

Textile dyeing is a prominent occupation among the people of Abeokuta, a town in Ogun state, South Western Nigeria. The end product of which is known as “adire” meaning tie and dye. It involves the use of vat dyes, a class of dyes containing chromophores such as anthraquinoids and indigoids. 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 bloodstream and distributed throughout the body. The liver, the largest gland in the body is often the target organ of chemical-induced tissue injury. Its susceptibility to chemical injury is a result of its unique position within the circulatory system and also because it is the primary organ for the biotransformation of chemicals within the body.[5] Shimizu et al.,[3] reported liver dysfunction among workers handling 5-nitro-o-toludine, a raw material for azo dyes. Hepatic malfunction in workers occupationally exposed to benzanthrone, an important dye intermediate used in the manufacture of vat dyes, has also been reported.[4] This study was designed to provide data on possible effects of occupational exposure to vat dyes on functions of the liver.

MATERIALS AND METHODS

One hundred and seventeen subjects that were occupationally exposed to vat dyes with minimum of one year and maximum of 60 years duration of exposure (mean = 17.03) in Itoku market, Abeokuta, were recruited for this study. They were sex and age matched with sixty control subjects who had no previous exposure to vat dyes. Pregnant mothers and those less than 18 years of age were excluded from this study. All the subjects gave their informed consent and approval for study was received from the Scientific and Ethical Review Committee of Olabisi Onabanjo University Teaching Hospital. A semi-structured questionnaire was used to obtain information on demographic,
occupational, and environmental characteristics of the subjects.

Blood was obtained from the ante-cubital vein using disposable syringes with steel needles and discharged into lithium heparin specimen tubes. Plasma was separated from cells by centrifuging blood at 700xg for 5 min.

Plasma was stored at -20°C until analyzed. Plasma total protein level was determined by the Biuret method. Plasma albumin was estimated by the method of Doumas et al., while total bilirubin was measured using the method of Jendsrassik and Grof. Plasma alkaline phosphatase activity was estimated by the method of Bessey et al., while Reitman and Frankel method was used to measure the activities of alanine transaminase and aspartate transaminase.

Statistical methods
Data collected was analyzed using Student's t-test and Pearson's correlation co-efficient as contained in the SPSS statistical package (version 11.0). Results were expressed as means ± (SEM). P values ≤ 0.05 were considered significant.

RESULTS
There was no significant difference between the mean age of the study and control groups. Also, the sex distributions of the study population and the control group were similar. The mean (SEM, range) duration of exposure to vat dyes was 17.03 (1.19, 1-60) years.

The means (SEM) plasma concentrations of the parameters of liver function: total protein, albumin, total bilirubin and activities of alkaline phosphatase, alanine transaminase and aspartate transaminase are as shown in Table 1. Comparison of means of the concentrations of these parameters in the exposed and in control showed that mean plasma levels of total protein, albumin and alkaline phosphatase were significantly lower in the exposed than control (P<0.05). Mean plasma activities of alanine transaminase and aspartate transaminase were significantly higher in the exposed than in control (P<0.05). No significant difference was found between the mean concentrations of plasma total bilirubin in the exposed and in the control. The means of plasma levels of all the parameters estimated apart from that of the alkaline phosphatase were observed to lie within the reference interval obtained in this environment.

There is a weak negative correlation between duration of exposure and the levels of total protein, albumin and total bilirubin, however this is not significant. There is no significant correlation between plasma levels of alkaline phosphatase, transaminases and duration of exposure [Table 2].

DISCUSSION
The liver performs multiple diverse functions essential to life, such as synthesis, excretion, and detoxification among others. In this study of occupational exposure to vat dyes, some of these specific functions were assessed by laboratory procedures to gain insight into the integrity of the liver relative to exposure. The trend normally observed in liver function impairment is decrease in plasma concentration of albumin, as a marker of reduced synthetic ability of the liver, increases in plasma activities of alanine transaminase (ALT) and aspartate transaminase (AST) as markers of hepatocellular damage and increase in plasma bilirubin concentration a marker of decreased excretory function. The fact that there are significant differences (consistent with the above trend) between some indices of liver function of the exposed group, compared with the unexposed may indicate some impairment of liver function.

The observation of lower mean plasma levels of total protein and albumin in the exposed than control is consistent with trend observed in liver diseases involving impaired synthetic function. This is because the liver is the primary site of the synthesis of plasma proteins, disturbances of protein synthesis therefore occur as a consequence of impaired hepatic function which will lead to a decrease in their plasma concentrations. The lower plasma albumin level of the exposed in this study therefore may indicate a reduction in the synthetic function of the liver relative to exposure. This finding is consistent with that of Pinnas et al., who observed inhibition of protein synthesis in subjects exposed to aldehydes which have similar carbonyl functional group with vat dyes. The mechanism of this decrease is unclear.

<table>
<thead>
<tr>
<th>Biochemical parameter</th>
<th>Exposed (n=117)</th>
<th>Control (n=60)</th>
<th>t</th>
<th>P</th>
<th>Statistical inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total protein (g/L)</td>
<td>76.0 ± 1.20</td>
<td>83.4 ± 1.10</td>
<td>4.93</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Albumin (g/L)</td>
<td>39.0 ± 1.20</td>
<td>41.7 ± 1.10</td>
<td>1.98</td>
<td>0.050</td>
<td>S</td>
</tr>
<tr>
<td>Total bilirubin (µmol/L)</td>
<td>7.01 ± 0.68</td>
<td>4.79 ± 0.16</td>
<td>1.76</td>
<td>0.081</td>
<td>NS</td>
</tr>
<tr>
<td>Alkaline phosphatase U/L</td>
<td>70.46 ± 2.49</td>
<td>92.17 ± 4.38</td>
<td>3.62</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Alanine transaminase U/L</td>
<td>7.84 ± 0.61</td>
<td>5.08 ± 0.32</td>
<td>3.36</td>
<td>0.001</td>
<td>S</td>
</tr>
<tr>
<td>Aspartate transaminase U/L</td>
<td>10.31 ± 0.51</td>
<td>8.19 ± 0.51</td>
<td>2.82</td>
<td>0.006</td>
<td>S</td>
</tr>
</tbody>
</table>

Values = mean ± SEM, P = probability, P value ≤ 0.05 represents significance, n = sample number, S = significant, NS = Not significant

Soyinka OO, et al.: Effects of vat dyes on liver...
Though a significant difference was observed between the mean plasma level of albumin in the exposed and the control, these mean levels fall within the reference range. This observed trend may be explained by the large functional capacity of the liver; significant decreases in plasma proteins will not become apparent except in severe or long standing hepatic disease. The relatively long half-life of these proteins is also a factor. Also, symptoms are not apparent until concentrations are quite low. It has also been observed that in some conditions of liver diseases e.g., cirrhosis, and chronic hepatitis, liver function test can remain normal. Pransky included chronic liver disease as one of the various disorders of occupational exposure. In such, there is no clinical evidence until after years of exposure. The effect of occupational exposure therefore on the synthetic function of the liver can be said to be at the sub-clinical level. It has been said that one of the limitations of these tests is that normal results of these variables are over valued as ruling out the possibility of present and future health effects related to exposure. Alkaline phosphatase (ALP) was found to be significantly lower in the exposed subject compared with the control in this study. This is not consistent with observation of plasma level of ALP in cholestatic liver diseases. ALP is a marker of intra- or extrahepatic cholestasis. Its synthesis increases and the enzyme is thus regurgitated into plasma in such conditions. This is also not consistent with the findings of Pinnas, who observed increase in plasma ALP with exposure to aldehydes which have carbonyl functional group just like vat dyes. The possible explanation for lower plasma activities of ALP is mild reduction in synthesis, which is sub-clinical.

The significantly higher level of activities of transaminases in the exposed group when compared with those of the control in this study was similar to what was observed by Singh et al. He reported significant elevation in serum aspartate transaminase and alanine transaminase in benzanthrone (BA) and 3-bromobenzanthrone (BBA) treated animals. The significant elevation was attributed to disturbance of membrane integrity by both BA and BBA. BA and BBA decrease endogenous glutathione and ascorbic acid levels with a concomitant increase in lipid peroxidative damage leading to leakage of the amino transaminases located within the cells. Both BA and BBA are dye intermediates used in the production of vat dyes and disperse dyes. The significant differences observed with ALT and AST in this study may suggest sub-clinical hepatocellular damage, which may have to do with disturbance of membrane integrity. Further studies should therefore focus on evaluation of the antioxidant status of those exposed to dyeing.

The lack of significant difference observed with plasma bilirubin and significantly lower value of ALP in the exposed than the control group confirms the absence of cholestasis at any level. The excretory function of the liver is therefore likely not compromised in occupational exposure to textile dyeing.

The study shows that occupational exposure to vat dyes may result in sub-clinical adverse effects on the liver, involving inhibition of its synthetic function.

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REFERENCES


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