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Frequencies of Sister Chromatid Exchanges in Lymphocytes of Factory Workers Exposed to Multiple Mutagenic Agents

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Modern man lives in a hazardous environment being continually exposed to a large variety of natural and synthetic pollutants. These toxic agents may either cause mutation of germ cells resulting in accumulation of heritable abnormal genes or may lead to mutation of somatic cells leading to formation of tumors. Nearly 85% of all cancers have an environmental component (Vainio 1980). It is therefore imperative and important to identify any potential genetic toxicity because of these substances and to assess their biological impact on man. In India, workers are still working under primitive conditions without protective measures. Illiteracy, lack of awareness of the workers, and apathy on the part of the management are contributory factors. It is not one but a multitude of agents or mutagens whether physical or chemical that the industrial worker is exposed to (Sugimura 1981). Chromosomal damage constitutes a set of efficient and reliable criteria to measure genetic toxicity (Hsu 1982). Sister chromatid exchange is a sensitive and convenient test giving objective results (Perry and Wolff 1974).This formed the basis of the present study in which an attempt was made to study SCE frequency in factory workers employed in an electrical plant exposed to a variety of industrial pollutants such as iron dust, metallic fumes, carbon black and heat stress.

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MATERIALS AND METHODS

The factory workers were divided into 3 groups of 8 workers each. The short term exposure group (GROUP A) were exposed to the factory environment for less than 5 years and the long term exposure group (GROUP B) for up to 20 years. Control individuals (GROUP C) were chosen from the factory staff and office workers in the same socio–economic status, not directly exposed to the factory environment. Each worker was interviewed for comprehensive personal and family history. Then the workers were subjected to a general physical examination.

Two ml of peripheral venous blood were collected in a heparanized disposable syringe under strict aseptic precautions. One half ml of this blood was cultured in minimum essential medium supplemented with 10% fetal bovine serum, .1% phytohemagglutinin (M) and 0.25% penicillin. Three ug/ml of bromodeoxyuridine (BrdU) were added to the cultures. The final medium was filtered through a sterile Millipore filter. The culture vials were wrapped in black paper and incubated at 37^0 C for 72 hours. After 69 hours colchicine (0.1 ug/ml) was added to the culture vials and the vials were re-incubated for 3 hours. Cultures were then harvested and the slides prepared according Perry and Wolff 1974. Slides thus obtained were stained with 0.5 ug/ml Hoechst dye 33258 (Sigma Aldrich, USA) in distilled water for 15 minutes. The slides were covered with cover slips and exposed to sunlight for 3 hours. Subsequently they were washed with distilled water and stained with 10% giemsa for 7 minutes. A minimum of 25 good metaphases were scored per worker. The mean and standard deviation were calculated and the data analyzed statistically using student 't' tests. (Fatima 1995)

RESULTS AND DISCUSSION

Table 1 shows sister chromatid exchange (SCE) frequencies of the 3 groups with inter group comparisons. The group of workers with the longest duration of exposure (Group B) had a higher frequency of SCE (7.34) as compared to Group A (3.29) and the control group (1.27). A statistically significant difference in the SCE frequency was also observed when Group A was compared to Group B. The results have clearly presented evidence that there is a dose-dependent induction of SCE, i.e., the more years of polluted factory environment that the workers encounter, the greater the genetic damage. The present study chose workers exposed to many pollutants, on the premise that to isolate one particular agent is very difficult.

The mutagenic effect on workers is due to the cumulative effect of these agents. It is also believed that the human environment is too complex to be simplified for experimental purpose. There is a uniform, agreement that SCE is a simple and sensitive test for routine chemical mutagenicity testing (Anwar1994 & Kukura1994.) The study of Bauchinger & Schmid (1990) revealed elevated SCE frequency in workers employed in an electrical plant. Elevated SCE frequencies can be produced directly or in directly in response to environmentally induced DNA damage. Mutagens undergo a long and complicated process between the first contact with human body and detectable chromosomal damage (Vogel 1978). Thus, SCE frequencies if determined in factory workers, may indicate the beginning of a mutational event which may be detected by periodic health monitoring of the workers. Our results suggest that exposure of workers to multiple industrial pollutants may result in genetic damage which can be stopped if detected at an early stage and further alteration of the genetic milieu prevented by using appropriate protective measures.

Table 1. Sister chromatid exchange frequencies of factory workers with inter group comparisons

Groups	Exposure (yrs.)	SCE Frequencies	Level of Significance
A	3.06	3.30 ± 1.08	
B	2.10	7.34 ± 0.50	
C	CONTROLS	1.28 ± 1.12	
C with A			>.01 Significant
C with B			<.001 Highly Significant
A with B			<.001 Highly Significant

P>.05 Not Significant
.01<P<.05 Significant
P<.001 Highly Significant

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