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Analysis of Chromosomal Aberrations in the Peripheral Lymphocytes of Workers Exposed to Diagnostic X-rays

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KEY WORDS X-rays; occupational exposure; X-ray technicians; chromosomal aberrations.

ABSTRACT The incidence of chromosomal aberrations were evaluated in the lymphocytes of peripheral blood of 70 persons working in different hospitals at Hyderabad and occupationally exposed to X-rays. The age range of the workers was 25-54 years and their duration of service ranged from 3-25 years. For comparison blood samples were also collected from 50 subjects (controls) who belonged to same age and socioeconomic status and not exposed to any chemical agents. Subjects in the both groups were nonsmokers and nonalcoholics. The radiographers showed a significant increase of chromosomal aberrations (8.18%) when compared to controls (0.44%). Further the incidence of chromosomal aberrations increased significantly with duration of exposure when compared to controls.

INTRODUCTION

X-rays are widely used in medicine not only for diagnosis but also for treatment of diseases. They also have application in industry and in research. If handled properly in therapy and diagnosis they are boon to man but their indiscriminate or improper use may lead to health hazards to patients, physicians, and radiographers who are occupationally exposed to X-rays.

It is well known that radiation induces alterations in the genetic material in experimental animals and humans. Xiao et al. (1999) reported aberrations in 3,4,8 and 9 chromosomes of Chinese hamster cells exposed to X-rays. Adverse effects of X-rays on female fertility and germinal cells were recorded by Martinez et al. (1998) in adult rats. Durante et al. (1996) reported radiation induced genetic instability in the human mammary epithelial cells. Leukemia and chromosomal aberrations also were observed by Mac Donald et al. (2001) in the mice exposed to X-rays.

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Cytotoxic effects of X-rays in occupationally exposed workers were also recorded in several earlier studies. Jha and Sharma (1991) reported high frequency of chromosomal aberrations such as dicentrics and acentrics in the peripheral blood lymphocytes of personnel handling diagnostic X-ray machines. A four-fold increase in the incidence of chromosomal aberrations were recorded in the peripheral lymphocytes of workers occupationally exposed to X-rays and nuclear medicine areas (Hagelstrom et al. 1995). Thierens et al. (2000) reported a high frequency of centromere positive and centromere negative micronuclei in the peripheral lymphocytes of hospital workers who were occupationally exposed to X-rays and gamma rays. High incidence of dicentrics, rings and acentric fragments were observed in the peripheral blood lymphocytes of medical staff who were occupationally exposed to X-rays (Kasuba et al. 1998).

Despite all these studies there is a paucity of information on the genetic damage in radiographers who are occupationally exposed to X-rays. Hence the present study was carried out to evaluate the cytogenetic effect of X-rays in the peripheral lymphocytes of radiographers.

MATERIALS AND METHODS

In the present study blood samples were collected from 70 radiographers working in different hospitals at Hyderabad. The age group of workers ranged from 25-54 years. They worked for 8 hours per day. A control group belonging to same age and socioeconomic status and not exposed to any known physical or chemical agent was also studied. Subjects in both the groups were nonsmokers and nonalcoholics. The radiographers were divided into 3 groups based on duration of exposure.

Intravenous blood was collected from the subjects asceptically using heparin. The whole blood was then added to RPMI 1640 medium

supplemented with 25% human AB serum, 0.5% phytohemagglutinin, 0.25% dicristicin and 0.25% gentamycin. All the cultures were incubated at 37ºC for 72 hours. 0.1 µg/ml of colchicine was added 2 hours before harvesting the cultures, then the cultures were harvested and slides were prepared according to standard method of Moorhead et al. (1960). For each sample 150 metaphases were screened for chromosomal aberrations such as gaps, breaks, fragments, dicentrics and polyploids. Since gaps are not stable aberrations they were excluded from the total number of aberrations. The significance of total chromosomal aberrations was analysed using chi-square ('χ^2') test.

RESULTS

The incidence of chromosomal aberrations such as gaps, breaks, fragments and dicentrics in the exposed workers and matched controls was presented in Table 1.

There was a significant increase in the frequency of total chromosomal aberrations in the exposed group (8.18%) when compared to the controls (0.44%). The chromosomal aberrations like gaps, breaks, fragments, dicentrics which were recorded in the present study were both of chromatid and isochromatid type. Gaps and polyploids were not included in total number of aberrations. The frequency of chromatid type aberrations such as breaks (2.69%), fragments (1.47%), exchanges (0.26%) increased significantly when compared to breaks (0.28%), fragments (0.11%) and exchanges (0.00%) recorded in the controls. Isochromatid aberrations also increased significantly when compared to data from control subjects. Dicentrics and polyploids were not recorded in the controls whereas in the exposed group their frequency was 0.59% and 0.27%, respectively.

DISCUSSION

X-rays which belong to low level ionisizing radiations are most extensively used for therapy and nondestructive testing of internal organs of body. In the recent years several evidences have shown that due to prolonged exposure even low level radiations accumulate in the body and result in mutations and neoplasms.

Genotoxic effects of X-rays were reported in various human tissues by several authors. Kadhim et al. (1998) reported post irradiation chromosomal instability in human fibroblasts. Human lymphocytes when exposed to 1.5 Gy X - rays invitro showed significant increase in the frequency of chromosomal aberrations when compared to normal cells (Mosesso et al. 2001). A linear dose response DNA double strand breaks were recorded in the human sperms irradiated with 12.5, 25, 50 and 100 cGY X-rays (Singh and Stephens 1998). Durante et al. (1996) reported chromosomal instability in H 184 B5 F5-1 M/10 cell lines of human mammary epithelial cells irradiated with X-rays.

In the present study there was a significant increase of chromosomal aberrations in the peripheral lymphocytes of exposed group when compared to controls. Our results are in agreement which Wang et al. (2002) who reported a high risk of cancer in medical X-ray workers that increased with their duration of service. Maluf et al. (2002) recorded increased frequency of micronuclei and dicentric bridges in the lymphocytes of workers exposed to X–rays. Yadav and Seth (2000) also studied a significant increase in the chromosomal aberrations and sister chromatid exchanges in the workers exposed to X-rays.

Our results also confirm earlier reports of Boei et al. (2001) who recorded high incidence of chromosomal aberrations in human lymphocytes irradiated with 1 Mar fast neutrons (These are low level ionizing radiations like X-rays). Cheriyan et al. (1999) observed a high incidence of chromosomal aberrations in human population from southwest coast of India who were exposed to low level natural radiations. High incidence of leukemias and genetic abnormalities were observed by Schubauer et al. (2001) in the workers and patients exposed to therapeutic radiation.

The present study revealed high incidence of chromosomal aberrations in the workers exposed to X-rays. Thus it is obligatory on the part of hospital management to take appropriate steps to minimise exposure to X-rays at the workplace. Otherwise undue exposure might result in genetic damage in the X-ray technicians.

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Table 1: Frequency of chromosomal aberrations in workers exposed to diagnostic X-rays

Group & duration of exposure	*Number of samples*	*Number of metaphases screened in years*	*Chromatid type aberrations*				*Iso - chromatid aberrations*				*Total number of aberrations*	*Number of polypoid cells*
			Gaps	*Breaks*	*Acentric Fragments*	*Exchanges*	*Gaps*	*Breaks*	*Acentric Fragments*	*Dicentrics*		
Control Group	50	7500	54 (0.72)	21 (0.28)	8 (0.1)	0	4 (0.05)	2 (0.02)	2 (0.02)	0	33 (0.44)	
Exposed Group												
3-10	28	4200	70 (1.66)	80 (1.92)	43 (1.02)	6 (0.14)	52 (1.23)	45 (1.07)	5 (0.11)	32 (0.76)	131* (3.0)	4 (0.09)
11-17	24	3600	101 (2.80)	110 (3.05)	50 (1.38)	10 (0.27)	60 (1.66)	72 (2.0)	9 (0.5)	64 (1.77)	251* (6.97)	10 (0.27)
18-25	18	2700	100 (3.70)	92 (3.40)	62 (2.29)	12 (0.44)	58 (2.14)	73 (2.70)	22 (0.81)	71 (2.66)	332* (12.29)	15 (0.59)
Total	70	10500	271 (2.58)	283 (2.69)	155 (1.47)	28 (0.26)	170 (1.61)	190 (1.80)	36 (0.34)	167 (1.59)	859* (8.18)	29 (0.27)

*P< 0.05
150 metaphases were screened for each sample.
Values in parentheses are percentages.
Gaps and polyploids are not included in total number of aberrations.

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