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# Sister Chromatid Exchange Analysis among Underground Water Wells Workers in Saudi Arabia

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**Abstract:** In the absence of permanent rivers or bodies of water half of the Saudi Arabia domestic water consumption is provided through desalination. The other half is derived from groundwater. Groundwater from the Disi aquifer is already used for drinking water in parts of Jordan and, more extensively, in Saudi Arabia, where it is known as the Saq aquifer. Some of the geological analyses of the host sandstone aquifer rocks show 228Ra and 226Ra. The usefulness of sister chromatid exchanges (SCEs) as a bioindicator for ionizing radiation effect was tested in underground water well workers at Saudi Arabia in this industry producing technologically enhanced naturally occurring radioactive material (TENORM). The induction of SCEs was studied to assess the potential genotoxic effects of occupational exposure to radiation. *Blood* samples were obtained from 10 persons working in underground water well. The age range of the workers was 25-40 years and their duration of service ranged from 3-7 years. For comparison blood samples were also collected from 10 subjects (controls) who belonged to same age and socioeconomic status. Subjects in the both groups were nonsmokers and non alcoholics. The SCE analysis was performed. The occupationally exposed workers showed higher SCE frequencies than the non-exposed group. This study demonstrated that occupational exposure to radiation leads to a significant induction of cytogenetic damage in peripheral lymphocytes of workers engaged in underground water well.

**Key words:** Cytogenetics · Sister Chromatid Exchanges and Biological indicators of exposure

## INTRODUCTION

Most of Saudi Arabia can be considered a typically arid region where the annual average amount of rainfall varies between 50 and 100 mm. In the absence of permanent rivers or bodies of water half of the Saudi Arabia domestic water consumption is provided through desalination. The other half is derived from groundwater. Groundwater from the Disi aquifer is already used for drinking water in parts of Jordan and, more extensively, in Saudi Arabia, where it is known as the Saq aquifer. The Saq aquifer is a Cambro-Ordovician Sandstone Formation that extends over 1200 km in Saudi Arabia and northwards in Jordan. This aquifer has been pumped heavily since the early 1970s especially in the areas of Tabuk, Hail and Al Qasim [1, 2].

Some of the geological analyses of the host sandstone aquifer rocks show high levels of naturally occurring radium isotopes have been measured in groundwater from the Rum Group of the Disi sandstone aquifer in Jordan. The combined 228Ra and 226Ra activities are up to 2000% higher than international drinking water standards [3].

Workers in underground water well are occupationally exposed at low-level dose of ionizing radiation especially who are responsible on filter change in Water Company. This industry producing technologically enhanced naturally occurring radioactive material (TENORM).There is little available information about the effect of this low level exposure. Ionizing radiation is a well known classical mutagen capable of inducing various kinds of stable and unstable chromosomal alterations.

Sister chromatid exchanges (SCEs) reflect the reciprocal interchange of DNA replication products at apparently homologous loci, which involves DNA breakage and reunion [4]. The analysis of SCE has been considered to be highly sensitive for measuring the mutagenic and carcinogenic potential of many environmental agents [5]. On the other hand; different

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investigations have shown that in vivo and in vitro ionizing radiation exposure is capable of inducing SCEs in cells [6-9]. With regard to the application of the SCE assay for the biomonitoring of human populations exposed to ionizing radiation, there is some data indicating no increases in the SCE level [10-13]. Even if it was observed that radiation is a poor inducer of SCEs, but the stimulation of SCEs by in vitro irradiation varies from no increase to levels as high as 2-3-fold the basal level [14-19]. While, other authors have shown significant increases in the frequency of SCE in cultured lymphocytes from persons occupationally, accidentally or therapeutically exposed to ionizing radiation [20-22].

To add new data on the applicability of the SCE assay in the biomonitoring of human populations exposed to ionizing radiation and following our previous investigations on the potential genotoxic effects of occupational exposure to radiation in underground water well workers in Saudi Arabia [23], we analyzed SCE frequency in peripheral blood lymphocytes of the workers.

## MATERIALS AND METHODS

**Investigated Subjects:** In the present study blood samples were collected from 10 underground water well workers. The age group of workers ranged from 25-40 years and their duration of service ranged from 3-7 years. A control group was assembled from the administrative staff of the same company. It consisted of 10 individuals who are 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 nonalcoholic. All investigated subjects, exposed and controls, answered a personal questionnaire from which a profile of each group was obtained. Informed consent documents were obtained after an explanation of the study had been given.

**Blood Samples and Culture Conditions:** Intravenous blood samples were drawn into heparin tubes. 0.5 ml of whole blood was added to 4.5 ml RPMI 1640 medium supplemented with 15% fetal calf serum, 2 mM glutamine, 2% phytohemagglutinin, 100 units/ml penicillin, 100 µg/ml streptomycin and 10 pg/ml of 5 bromodeoxyuridine (BrdU). The cells were grown in darkness and harvested after 72 h. The SCE analysis was performed according to the standard protocol [24].

**Analysis of Sister Chromatid Exchanges:** A total of 100 well-spread, second-division metaphases were examined to determine the SCE frequency per sample.

**Statistical Analysis:** Significant differences between the exposed and control group were tested by using independent samples t test.

## RESULTS

The results of the frequencies of SCEs in the peripheral blood lymphocytes of each individual in the group of occupationally exposed workers and for the control group are illustrated in Table 1 The frequency of SCEs lymphocytes of occupationally exposed workers higher than that in the controls, although the difference is statistically significant at level 0.01. Table 2 shows the statistical comparison of the frequency of SCEs in two groups.

## DISCUSSION

In the recent years several evidences have shown that due to prolonged exposure even low level radiations accumulate in the body result in mutations and neoplasms. The present results give evidence about the level of exposure in Underground Water Company in center region in Saudi Arabia. The mean values of the SCEs frequencies in occupationally exposed and control workers at Water Company are shown in the Fig. 1. We found without any doubts significant increased frequency of SCEs in the exposed workers.

Our results confirm earlier reports of who recorded significant increases in the frequency of SCEs in workers in a similar industries producing technologically enhanced naturally occurring radioactive material (TENORM).Though we did not notice a clear trend of increased the frequency of SCEs as a function of age or years of employment [20-22]. Nevertheless, our data are in contrast to the results reported which did not obtained significant SCE increases in different populations occupationally or accidentally exposed to ionizing radiation [10, 11, 12, 13]. Our data are in agreement with previous study carried out by us in the same workers where the doses of occupationally exposed ionizing radiation are effective producing chromosomal aberrations [23]. This idea is supported by the study of Perry, *et al* in which ionizing radiation were able to affect SCE

Table 1: The SCEs in the peripheral blood lymphocytes in the control and the occupationally exposed workers.

| Group | Age (years) | Years of employment | SCE | X ± SE |
|---|---|---|---|---|
| Exposed workers | 27 | 3 | 7-19 | 12.00 ± 1.00 |
| | 40 | 5 | 8-20 | 14.00 ± 1.08 |
| | 36 | 6 | 7-19 | 12.00 ± 1.00 |
| | 37 | 5 | 6-21 | 13.50 ± 1.19 |
| | 28 | 3 | 5-19 | 12.00 ± 1.15 |
| | 30 | 4 | 7-20 | 13.50 ± 1.12 |
| | 33 | 4 | 5-19 | 12.00 ± 1.15 |
| | 38 | 6 | 7-18 | 12.50 ± 1.04 |
| | 36 | 7 | 6-17 | 12.50 ± 1.04 |
| | 27 | 3 | 7-19 | 13.00 ± 1.08 |
| Total | | | | 12.63 ± 0.35 |
| Controls | 32 | 4 | 2-9 | 5.50 ± 0.87 |
| | 29 | 3 | 1-6 | 3.50± 0.76 |
| | 40 | 7 | 3-8 | 5.50± 0.76 |
| | 34 | 4 | 3-7 | 5.00± 0.71 |
| | 35 | 3 | 2-5 | 3.50±0.65 |
| | 28 | 5 | 3-7 | 4.67±0.67 |
| | 35 | 3 | 4-5 | 4.50±0.50 |
| | 39 | 7 | 2-9 | 5.50±0.87 |
| | 33 | 6 | 4-8 | 6.00±0.71 |
| | 37 | 5 | 2-9 | 5.50±0.87 |
| Total | | | | 5.03±0.27 |

Table 2: *t*-test between the frequencies of SCEs in the control and the occupationally exposed workers.

| P | *t* value | SD | Mean of SCE | Mean age (years) | Number of individuals n | Group |
|---|---|---|---|---|---|---|
| 0.000** | 13.741 | 2.03 | 12.64 | 33.20 | 10 | Exposed workers |
| 0.000** | | 3.99 | 5.03 | 34.20 | 10 | Controls |

** Significant at level 0.01.

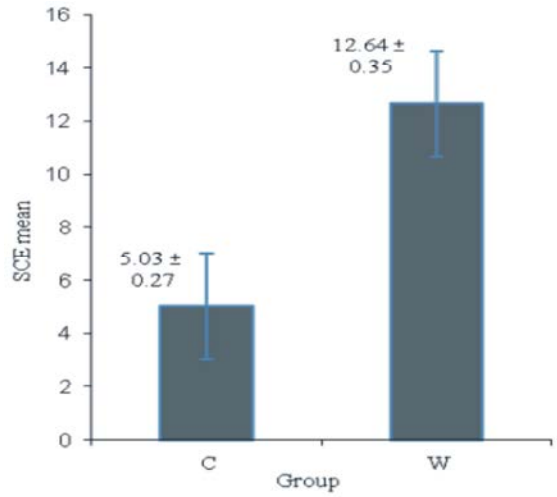


Fig 1: The mean frequencies of SCEs in occupationally exposed and control workers at Water Company.

frequencies and chromosomal aberrations. In addition to this, it has been reported that a combination of SCE frequency and chromosomal aberrations could be used in assessment of the mutagenic effects of ionizing radiation [14].

## CONCLUSIONS

In conclusion, the results of this study indicate that prolonged occupational exposure to radiation can be detected using the SCE frequencies. The hazard estimation in occupationally exposed workers at low doses and dose rate is difficult and involves a certain degree of interpretation. The need for better information, which can be used in originating recommendations for the radiobiological protection of underground water workers.

**Declaration of Interests:** The author reports no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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