Assessment of humoral immunity in workers occupationally exposed to low levels of ionizing radiation

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Abstract: The aim of this study was investigating the effect of low levels of ionizing radiation on immunoglobulin, complement levels in radiology workers occupationally exposed to ionizing radiation. **Materials and Methods:** The present study was conducted in the Department of immunology, college of medicine, Tabriz University of medical sciences, Iran. during the year of 2006-2007. Blood samples were taken from 45 radiology staff and from 35 subjects who had never been exposed to radiation. Samples were analyzed for immunoglobulin, complement levels. **Results:** Serum total IgA, IgM, c3, c4 levels were as significantly lower in the radiology workers exposed to ionizing radiation compared to the controls ($p<0.05$). A significant difference was observed in IgA, IgM levels and age in radiology workers ($p<0.05$). A statistical significant difference between IgA, IgM and c3 and working period was found in this study. **Conclusion:** The present study suggests that exposure to low levels of ionizing radiation causes decreased IgA, IgM, c3, c4 levels in radiology workers. Further studies are needed for determining the appropriateness of periodic check-ups of immune functions for detecting early changes in the immune system. [Mehrangiz. Rajaii Oskouii, Soheila. Refahi, Masoud. Pourissa, Yaser Tabarraei**. Assessment of humoral immunity in workers occupationally exposed to low levels of ionizing radiation**. *Life Sci J* 2013;10(5s):58-62] (ISSN:1097-8135). http://www.lifesciencesite.com. *10*

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Introduction

It is well established that ionizing radiation has negative biologic effects on living organisms depending on dose of radiation and duration of exposure (1). The single largest contributor of man-made radiation is the medical profession. The effects of ionizing radiation on a given population are generally divided into two categories, acute and chronic. The acute effects are considered to be those which happen in the immediate post irradiation periods, i.e. from the time of radiation exposure up to 6 months to a year post exposure. Acute effects are generally the result of long radiation exposure delivered to the whole body, or at least a major port of it, in average short time, on the other hand the chronic effects of radiation results from relatively low exposure levels delivered over long periods of time. Therefore long – time effects of low doses seems to be the main risk factor and that might results from occupational exposure (2). There are some difficulties in radiation studies in attempting to investigate effects due to radiation, particularly at the very low exposure levels. Thus, any association of a particular biologic effect with an exposure to ionizing radiation must have with it a degree of uncertainty. Another problem that we encounter in the study of low – level radiation effects is the latent period, for example effects of low dose irradiation on genetic abnormalities, immune system functions and immune system cells (T & B cells) (2, 3). Individuals working in radiology-related occupation are among persons exposed to long-term levels of ionizing radiation that have been shown to have immunocompromising effects due to occupation (4). Health consequences of the Chernobyl accident with regard to ionizing radiation have been well studied in subjects living in Russia and neighboring countries. There are limited numbers of studies investigating the effect of long - term, low dose ionizing radiation exposure on the immune status of radiology workers. Therefore, the objective of our study was investigating the effect of low levels of ionizing radiation on immunoglobulin, complement levels in radiology workers occupationally exposed to ionizing radiation.

Material and Methods

The investigation was carried out in 80 subjects divided in two groups: the first (study group) consisted of 45 radiology staff (27 males, 18 females aged 25-60 years, range, 40.6 ± 9.45 years), and the second (control group) consisted of 35 subjects (17 males, 18 females aged 28-60 years, range 42.22± 8.1 years) who had never been exposed to radiation. This study was conducted within the Department of immunology of faculty of medicine, Tabriz

University of medical sciences, Iran, between March 2006 and March 2007. Details of occupational and medical history were obtained from a questionnaire form completed by each subject. Subjects who had gross anemia, known history of diabetes mellitus, cardiopulmonary disease, acute or chronic infection, autoimmune disease, malignancy, and current or previous tobacco were excluded from the study. Length of working period in radiology staff varied from 3 to 30 years (average length 15.17±7.2 years) with daily at least 25 (average 37.44±10.48) exposures. With respect to sex and working period the following subgroups were then selected-the subgroup of women-18 subjects aged from 25 to 41 years (mean=32.94±4.91 years) and one of men-27 subjects aged from 31-60 years (mean=45.7± 8.24 years), the subgroup of radiology staff that had > 10 years working period- 33 subjects and subgroup of 12 subjects working period <10 years.

Blood samples were collected from the antecubital vein (before breakfast, between 7:00 and 9:00 h) of radiology staff and persons qualified for the control group with the purpose of obtaining immunology markers. Serum of blood samples was obtained by centrifuging at 5000 rpm for 10 min. Assessment of immunoglobulins (IgG, IgM, IgA, C_3, and C_4) carried out using SRID (Single Radial Immunodiffusion) technique with the ready for use plate of Germany Behringer Company product. In this procedure preformed mixture of gel and antihuman globulin (C_3, C_4 and heavy chain of immunoglobulins) were distributed into the plates with 12 wells. We put on 5 µl of serum samples in wells of plates with Hamilton syringe then after 72 h measured the diameters of formed immune complex circle around the wells. There is a direct relationship between serum concentrations of immunoglobulins and diameters of formed immune complex circles.

This study had been approved by the local bioethics commission and all persons were informed about the aims and scope of the study and gave their informed consent prior to their inclusion in the investigation. All statistics were performed in SPSS version 11.5 software. The obtained results were compared on the following manner: (A) between total group of radiology staff (45 persons) and control group (35 persons); (B) between the subgroup of females (18 workers) and males (27 workers) in study group and subgroup of females (18 subjects) and one of males (17 subjects) in control group; (C) between the subgroup of workers for >10 years (33 Subjects) and the subgroup of persons working <10 years (12 subjects).

Parameters among control and study groups and testing effect of gender were compared using Mann-Whitney U test. Student t test was used for comparing parameters between subjects occupationally exposed to ionizing irradiation for < or > 10 years. Pearson correlation test was performed for analyzing correlation among parameters. A level of p<0.05 was considered significant.

Results

The demographic characteristics of groups were illustrated in Table 1. Distribution of C3, C4, and total Ig levels for study and control groups are presented in Table 2. Levels of mean serum total IgA, IgM, C_3, and C_4 were significantly lower in study group than in control group using Mann- Whitney U test. The C_3, C_4, and total Ig levels of men and females subgroups are showed in Table 3. When levels of antibodies were compared with regard to gender of subjects, levels of mean serum IgA, IgM, and C_3 of females were significantly higher than males for study group, whereas level of antibody IgM, male: 2.45 ± 0.65 vs. female: 1.98 ± 0.53 was significantly lower for females than males subjects for control group.

In the study group, there was significant correlation between age and IgA and IgM levels, respectively (r; -0.348, -0.547, p; 0.019, p; 0.000), whereas in control group, there was significant correlation between age and IgM level (r; 0.354, p; 0.037).

Levels of total Ig and C_3 and C_4 with regard to working period were demonstrated in Table4. When comparison was made between subjects in the study group with regard to working period, levels of immunoglobulin IgA, IgM, and C_3 were significantly lower for subgroups of radiology staff >10 years working period than <10 years working period. In study group, we found a positive statistically significant correlation between IgA, IgM, and C3 and working period, respectively (r; 0.535, 0.663, 0.398) respectively.

Conclusion

The effects of low level exposure to ionizing radiation are of concern to a large number of people, including workers occupationally exposed to radiation. Medical radiation workers are employees of hospitals, clinics and private offices where radiation is used in the process of delivering health care to human (5). It is very important to estimated doses from individuals occupationally exposed to ionizing radiation in order to carry out radioprotection procedures and restrict the hazards to human health (6), but the extent of the health hazards is difficult to assess. Therefore, the development of procedures that can be used to precisely identify health hazards in exposed populations is important to establish effective programmes for disease prevention (7).

Table 1. Demographic characteristics of groups

	Study group (n=45)	Control group (n=35)
Age (years)	40.6 ± 9.45	42.22 ± 8.1
Gender (M/F)	27/18	17/18
>10-year working period	33	-
<10-year working period	12	-

Table2. C_3, C_4, and total Ig levels among groups

Group	IgA (g/L)	IgM (g/L)	IgG (g/L)	C_3 (g/L)	C_4 (g/L)
Study group	2.15 ± 0.81	1.70 ± 0.80	12.73 ± 15.28	0.98 ± 0.30	0.29 ± 0.11
Control group	2.63 ± 0.45	2.20 ± 0.63	12.03 ± 2.81	1.20 ± 0.10	0.32 ± 0.06
P (Mann-Whitney U test)	0.001	0.001	0.009	0.000	0.009

Table 3. C_3, C_4, and total Ig levels of men and females subgroups

	Study group		P (Mann-Whitney U test)	Control group		P (Mann-Whitney U test)
	Male	Female		Male	Female	
IgA (g/L)	1.8 ± 0.73	2.66 ± 0.65	0.001	2.49 ± 0.50	2.77 ± 0.38	0.134
IgM (g/L)	1.34 ± 0.61	2.24 ± 0.76	0.000	2.45 ± 0.65	1.98 ± 0.53	0.016
IgG (g/L)	12.84±19.79	12.58 ± 2.44	0.000	11.62 ± 2.29	12.41± 3.24	0.108
C_3 (g/L)	0.92 ± 0.32	1.06 ± 0.25	0.005	1.21 ± 0.10	1.19 ± 0.09	0.555
C_4 (g/L)	0.27 ± 0.12	0.30 ± 0.10	0.1	0.31 ± 0.06	0.34 ± 0.06	0.246

Table4. Levels of total Ig and C_3 and C_4 with regard to working period

	>10 year working period	<10 year working period	P(Student t test)
IgA (g/L)	1.88 ± 0.70	2.86 ± 0.67	0.000
IgM (g/L)	1.38 ± 0.57	2.58 ± 0.69	0.000
IgG (g/L)	12.47 ± 17.86	13.45 ± 2.34	0.853
C_3 (g/L)	0.90 ± 0.32	1.18 ± 0.11	0.007
C_4 (g/L)	0.27 ± 0.11	0.34 ± 0.11	0.075

The immune systems of the atomic-bomb (A-bomb) survivors were damaged proportionately to irradiation levels at the time of the bombing over 60 years ago. Although the survivor's immune system repaired and regenerated as the hematopoietic system has recovered, significant residual injury persists, as manifested by abnormalities in lymphoid cell composition and function (8). There are limited studies in the literature investigating effects of ionizing radiation exposure on humoral immunity. Lakovlev et al found that natural and specific immunoglobulin production were decreased (9). The results of present study illustrated that mean serum c3, c4, IgA and IgM levels of radiology workers were significantly lower than those of control group subjects. Similar study in Turkey showed that levels of serum total IgG, IgA, IgM, c3 and c4 were determined as significantly lower in workers exposed to ionizing radiation compared with controls. Thus it can be postulated that risk of infections by extracellular agents increase in subjects exposed to long-term low dose of ionizing radiation (10). Another study by Serhatlioglu et al showed that total immunoglobulins (IgA, IgG, IgM), c3, c4 levels were lower in radiology workers exposed to long-term ionizing radiation (11). In study group our results is in consistent with above reports except IgG level that were significantly higher in radiology workers when compared with control group. In this study, the number of female subjects was lower than for males; perhaps, by making subject ratio equal, differences of IgG would be lower or higher. Levels of immunoglobulins may vary by gender and race (12-15). Generally, human subjects throughout the world show differences, though small, in serum immunoglobulin levels, this is due, presumably, to environmental, nutritional, health, and ethnic variations (16, 17).

Data analysis showed a significant difference between the male and female subjects. In study group results for c4 level was similar in both sexes, but for IgG levels, it has been observed that, in males, the IgG level significantly is higher than in females.

Kardar et al in their study measured local reference ranges of immunoglobulins in Iranian healthy adult blood donor volunteers. They showed the means of IgM in females were higher than for males (18). Other investigations showed that results for IgA and IgG levels are similar in both sexes, but IgM levels in females is higher than male subjects (19, 20) and some studies found a relationship between number of X chromosomes and IgM concentration(21). Also it was reported that immune response is regulated by sex hormones (22, 23). However, this hypothesis was not proved by other studies (24, 25)

In control group a variation on IgM level was significantly observed, being lower in female than in males. This data is not connected with above works.

When we considered working period of radiology workers, our results is consistent with observations from Ahmet et al in the IgG and c4 levels (10).

There is no established threshold for initiation of biologic changes as a consequence of exposure to low level of irradiation. Since the radiology workers are vulnerable to side effects of radiation being exposed in addition to avoiding radiation as much as possible, we think that periodic checks of immune response levels in them could be of importance for early detection of immune deficiencies. Additionally, we recommended that X-ray workers should regularly use appropriate personal protective equipments at their work site. These measures may assist in the process of reducing the radiation dose received by individuals to prevent the hazards of X-ray radiations.

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