RETROSPECTIVE CHROMOSOME ABERRATION ANALYSIS OF FORMER URANIUM MINERS

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Introduction

Despite of the large occupational population worldwide of underground uranium miners rather few studies have been published on the cytogenetic status or injuries of the exposed persons (Brandom et al 1978, Köteles et al 1988). In this paper we present our data collected in the period of 1981-1985 on 165 persons exposed by different radon concentrations expressed in working level month (WLM) units from 100 up to 600. Following the decommissioning of the uranium mine in Hungary in 1997 cytogenetic status of 131 persons were within a follow-up-study of their health conditions initiated by the Hungarian Academy of Science. The persons have terminated their underground activities 5 to 20 years before testing. The comparison of the two datasets suggest a long-term persistence of cytogenetic alterations above the population average values in large percentages of persons investigated.

Materials and methods

Whole blood samples were taken in heparinized tubes and cultured for 48 hours in the presence of bromodeoxyuridine. The chromosome sets were scored following FPG staining from duplicate slides. Only cells within the first cell cycle were evaluated at least 100 metaphases from each person. The persons investigated were categorized into 6 groups according to their cumulative exposures from 100 up to 600 WLM. The number of persons and the number of cells scored in each group are listed on Table 1.

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Table 1. **Number of uranium miners tested and the number of lymphocytes scored in the various exposure groups.**

Exposure category	No of persons	No of cells scored	No of persons and cells years after underground work					
			3-7 yrs		8-12 yrs		18-25 yrs	
			person	cell	person	cell	person	cell
I	27	2554	4	559	22	4080	4	632
II	32	2720	2	300	38	6189	27	3746
III	32	2814			12	1968	10	1720
IV	25	1866			6	1080		
V	21	1880			4	800	4	520
VI	28	2173			4	800	4	520
Total	165	14007	6	859	86	14917	49	7138

Results and Discussion

Data obtained between 1981-1985.

The frequency of chromosome aberrations in peripheral lymphocytes of exposed persons in function of their exposures in WLM are shown on Table 2. It is seen that the aberration frequencies are higher than the values in unexposed population in all exposure groups and for all types of aberrations scored. Among the various exposure groups no considerable dependencies on WLM categories were found in respect of the total number and chromatid type aberrations (deletions). The frequency of chromosome-type aberrations (dicentrics) suggests an increasing tendency as the cumulative exposure gets higher, especially in the IV and V categories the frequencies reach a plateau, then either they level at this value or decrease. This phenomenon was observed by other authors, too (Brandom et al 1978). The persons tested have been worked for years in underground mines. In the meantime the working conditions have been improved considerably, therefore, their exposures were decreasing. Therefore an analysis was also performed, when the dicentric aberration frequencies were related not to the cumulative exposure, but to the average yearly exposure. It was evident that the frequency of dicentrics was increasing considerably.

Data obtained between 1998 and 2002.

The dataset on the frequency values obtained 5 to 20 years after finishing the underground work is seen on Table 3. It was observable that the dicentric aberrations decreased while the deletions were found almost unchanged during this period. The frequency of the total aberrations was decreased, too.

Large fraction of persons carrying aberrations as well as the long-term persistence of aberrations suggest that certain clastogenic factors might maintain the cytogenetic alterations similarly to the clean-up-workers in Chernobyl (Emerit et al 1994, Emerit 1998). It has to be mentioned, however, that long-acting chromosome aberrations were demonstrated earlier in A-bomb survivors (Awa 1983), Japanese fishermen exposed to fallout radiation (Ishihara and Kumatori 1983), therapeutically irradiated ankylosing spondylitis patients (Buckton 1983). Further investigations are planned to analyse a few response-modifier factors like the tumor necrosis alfa (TNFα) as well as the total antioxidant status of former miners.

Table 2. **Frequency of chromosomal aberrations in the lymphocytes of active uranium miners in various exposure categories.**

Exposure category	No of scored cells	Frequency of aberrant cells	Dicentrics	Acentrics	Deletions	Total aberrations
WLM		$x10^{-2}$	$x10^{-3}$	$x10^{-2}$	$x10^{-2}$	$x10^{-2}$
I	2554	4,07	4,9	3,73	1,58	5,88
II	2720	5,40	5,5	3,97	1,51	6,14
III	2814	5,84	5,6	4,21	1,98	6,79
IV	1866	6,22	8,1	4,45	2,20	7,56
V	1880	5,02	8,4	3,27	1,58	5,76
VI	2173	6,26	8,5	4,12	1,47	6,54
Control			0,5-1	1-3		1-3

Table 3. **Changes of the cytogenetic parameters years after finishing underground work in former uranium miners.**

Exposure category	**Time**	**Dicentrics**	**Acentrics**	**Deletions**	**Total**
		aberrations			
	Year	**10^{-3}**	**10^{-2}**	**10^{-2}**	**10^{-2}**
I.	in active years	4,9	3,73	1,58	5,88
	after 3-7 years	5,4	1,25	2,15	3,94
	after 8-12 years	4,2	1,57	1,79	3,77
	after 18-25 years	1,6	1,90	1,27	3,36
II.	in active years	5,5	3,97	1,51	6,14
	after 8-12 years	4,7	1,53	1,66	3,62
	after 18-25 years	4,0	1,10	1,74	3,20
III.	in active years	5,6	4,21	1,98	6,79
	after 8-12 years	3,0	1,93	2,03	4,27
	after 14-23 years	2,9	1,16	1,45	6,91
IV.	in active years	8,1	4,45	2,20	6,22
	after 8-12 years	1,9	1,39	1,94	3,52
V.	in active years	8,4	3,27	1,58	5,76
	after 8-12 years	2,0	1,00	0,50	1,75
	after 17-23 years	1,35	7,70	2,50	4,62
VI.	in active years	8,5	4,12	1,47	6,54
	after 8-12 years	2,5	6,30	1,13	2,25

In summary, the frequency of chromosome aberrations of uranium miners was found increased in function of their exposure to radon. The comparison of the miner's categories 20 years ago and in the recent years demonstrated the long-term existence of aberrations for many years after completion of underground mining activities.

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