GENETICS

Experimental Study of Reproduction in C57Bl/6 and Random-Bred Mice Exposed to Nonionizing High-Frequency Radiation

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Experimental study of changes in the reproductive function in 10 generations descending from C57Bl/6 and random-bred mice exposed to nonionizing radiation showed a trend to deviation of this function from the normal: the number of newborns in the litter of generations 3-5 was below the normal, which starting from generations 5-6 it gradually increased, approaching the normal.

Key Words: *very high frequency radiation; C57Bl/6 mice; random-bred mice; reproduction; adult age*

The main results of our many-year studies of the effects of low-intensity (nonthermal) electromagnetic radiation (EMR) on the main vital processes in mammals were previously reported [2,3,5]. These studies include evaluation of common biophysical effects and possible extrapolation of the results obtained on experimental animals into clinical practice (very high frequency (VHF) therapy and magnetotherapy). Possible side effects should be detected [4], most characteristic of exposure of biological objects to VHF EMR (30-300 GHz), when power below 10 mW/cm^2 (used in VHF therapy) is applied to the skin surface. For example, exposure to VHF EMR leads to abnormalities in mitotic and meiotic divisions (distortion of spermatogenesis processes) [2].

We studied the effect of VHF EMR on changes in the reproductive norms in the progeny of 10 generations of C57Bl/6 and random-bred mice.

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MATERIALS AND METHODS

A series of long-term experiments was carried out: C57Bl/6 and random-bred mice (parental generation) were exposed to VHF EMR at f=37 GHz and power <0.1 mW/cm^2. The duration of a single exposure was 15 min, number of sessions n=32, total duration of exposure t_{Σ}^{max}=8 h. We used and validated these protocols and parameters of exposure previously [2,3,5].

The progeny of these mice was planned to be studied over 10 generations in order to solve the following problems: detecting disorders in the reproductive function (if any); examination of parental generation and the progeny for detecting changes in gestation terms, newborn weight, onset of reproductive age; detecting developmental abnormalities initiated by exposure to VHF EMR; analysis of changes in the number of newborns in the litter in the chain of generations (number of newborns/litter as the main criterion).

Pairs (male×female) were formed from young adult C57Bl/6 and random-bred (alb) mice, 2 pairs

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per experimental series: B-II (C57Bl/6), B-II' (alb), and 2 pairs of both strains in the control. Hence, the parental generation consisted of 8 experimental and 4 control mice. These animals were irradiated from 31.03 till 6.05.2000. Repeated stage of the experiment was carried from 10.05 to 15.05.2000 with a similar number and composition of families in groups C-1 (C57Bl/6) and C-I' (alb).

The data on the number of newborns in the litter were fixed for 4 litters in each of 10 generations. Experiment was over in 2003.

The number of animals in the litter is a species-specific value: 2-4 for C57Bl/6, 6-10 for random-bred mice. This parameter depends on male and female age, stress, temperature, volume and composition of the fodder. Hence, in order to rule out possible effects of these factors, the animals used in experiments, similarly as the controls, were kept under the same conditions.

The number of newborn mice in the first litter of adult animals is as a rule 1.5-2 times less than in subsequent litters and is virtually constant for each animal until the beginning of fading of the reproductive function. As we selected the number of animals in the litter as a precise criterion, we counted the newborn mice in 4 litters running.

TABLE 1. Number of Animals in the Litters, Series B-II (C57Bl/6) and B-II' (alb)

Generation	B-II (C57Bl/6)								B-II' (alb)							
	litter				litter				litter				litter			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
P	2	1	2	3	1	2	4	2	5	4	8	2	4	6	8	5
F1	1	2	3	3	2	1	4	3	6	6	8	8	5	4	8	8
F2	2	1	2	3	1	1	2	3	4	6	4	5	3	6	6	6
F3	1	2	2	—	2	2	—	—	5	8	7	7	4	7	6	8
F4	1	2	1	—	1	1	—	—	3	3	5	5	2	6	6	6
F5	1	2	2	—	2	1	1	2	6	7	7	8	5	7	7	7
F6	2	3	4	4	2	2	4	4	4	6	8	8	5	6	8	8
F7	2	1	4	4	1	2	3	3	5	6	7	9	6	6	8	8
F8	1	2	4	4	2	2	3	3	6	6	8	10	5	6	8	9
F9	3	4	4	4	1	2	1	4	3	7	7	7	6	8	8	10
F10	2	3	4	4	2	2	3	4	5	8	9	9	6	8	9	10

TABLE 2. Number of Animals in the Litters, Series C-I (C57Bl/6) and C-I' (alb)

Generation	C-I (C57Bl/6)								C-I' (alb)							
	litter				litter				litter				litter			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
P	1	2	3	2	2	1	2	3	4	2	7	6	4	6	3	8
F1	1	2	2	2	1	2	3	3	4	5	6	6	4	6	7	7
F2	2	2	1	—	1	2	2	1	2	4	5	5	3	3	4	5
F3	—	—	—	—	1	2	—	—	2	3	4	4	3	2	4	4
F4					1 male	1 male	—	—	5	6	7	7	5	6	7	8
F5									4	6	7	7	4	6	6	9
F6									4	6	6	8	5	7	9	9
F7									3	7	7	10	4	8	8	10
F8									6	7	9	9	6	8	10	10
F9									4	8	8	10	6	8	8	8
F10									5	8	9	9	5	7	9	8

RESULTS

Progeny with the male/female ratio sufficient for the formation of new pairs descended from all mice of parental generation (Tables 1-3).

Obvious deviations were observed in generations 3-5 of C57Bl/6 mice: no generations 3 and 4 descended from some families (mice ceased to give progeny, Tables 1-3, Fig. 1). The number of newborns in the litter was below the normal; series C-I could not be continued because of the absence of progeny in the 3rd generation in one family and impossibility of creating a new pair, because litters 1 and 2 of the 4th generation consisted of just one male each.

No "drop out" of this kind was observed in random-bred mice in generations 3-5, but the shifts in the number of newborns in the progeny in comparison with the control were also significant.

Later, starting from generations 5 and 6, the number of newborns in the progeny gradually increased and approached the classical picture, when the number of newborns in the 1st litter was 1.5-2 times lower than in subsequent litters and was con-

TABLE 3. Number of Animals in the Litters (Control Groups)

Generation	C57Bl/6				alb			
	litter				litter			
	1	2	3	4	1	2	3	4
P	1	2	2	4	5	8	8	8
F1	2	3	3	4	4	7	8	9
F2	2	2	4	3	6	8	8	8
F3	1	3	3	3	5	9	9	10
F4	2	2	4	4	5	6	7	7
F5	1	1	3	4	4	6	7	7
F6	2	4	4	4	6	6	8	8
F7	2	2	4	4	5	8	10	10
F8	2	3	3	4	6	8	8	8
F9	3	4	4	4	6	7	9	9
F10	2	2	3	3	4	9	9	9

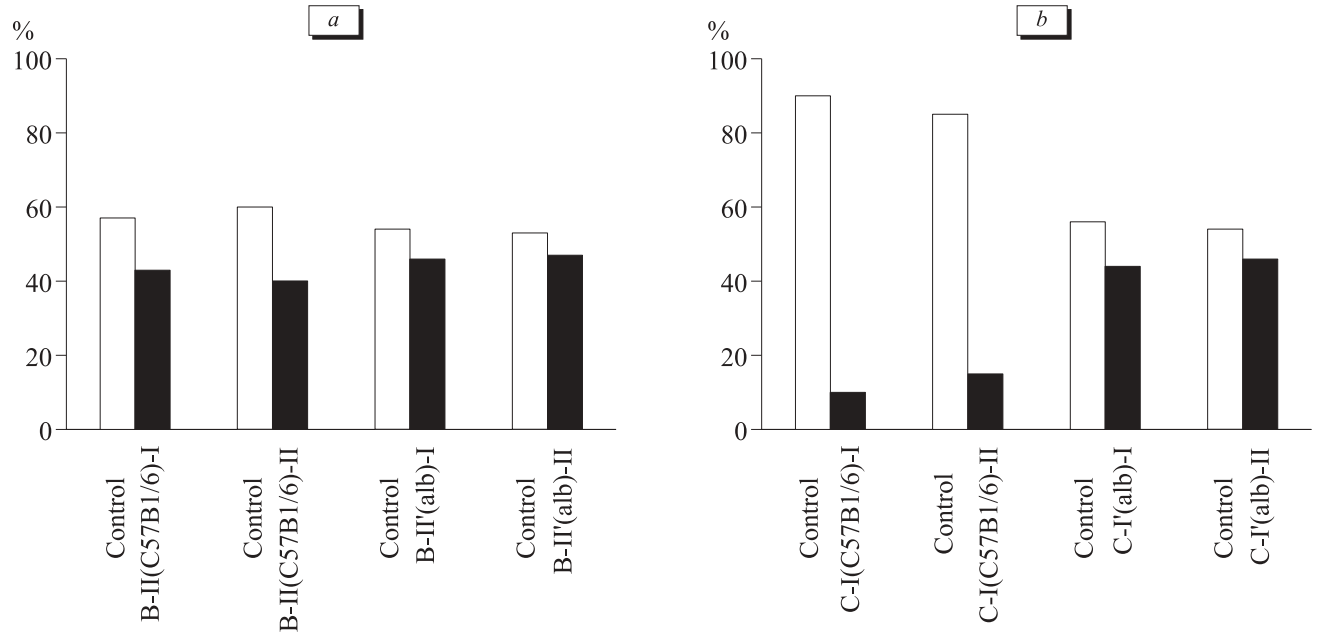

Fig. 1. Birth rates in animals of different groups. *a*) series B-II (C57Bl/6), B-II' (alb); *b*) series C-I (C57Bl/6), C-I' (alb).

stant for the female starting from litters 3-4. No deviations in gestation periods were detected: 21-24 days (21-24 days in the control); according to a previous report [1] 20-26 days, mean period 22 days. Newborn body weight was 1-2 g, which corresponded to normal [1]. Reproductive age was attained at the age of 30-35 days, this also being normal [1].

The results confirmed our hypothesis about changes emerging in the reproductive function of descendants from animals exposed to low-intensity VHF EMR [2]: changed number of animals in the litter, gradually leveling in subsequent generations. Presumably, this effect is a result of disturbed spermatogenesis because of exposure of parent to VHF EMR [2].

Hence, VHF therapy can be prescribed to patients of reproductive age only in urgent cases, but not as a health-improving measure.

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