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HEMODYNAMIC CHANGES IN INDIVIDUALS WORKING UNDER MICROWAVE IRRADIATION

BY

P. N. FOFANOV, ET AL

- USSR -

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HEMODYNAMIC CHANGES IN INDIVIDUALS WORKING UNDER MICROWAVE IRRADIATION

- USSR -

[Article by P.N. Fofanov (Scientific Research Laboratory No 2, and Chair of Therapy for Advanced Training of Physicians, Military-Medical Academy imeni S.M. Kirov, Leningrad); Moscow, Kardiologiya, Russian, Vol 9, No 4, 1969, pp 124-126]

Some changes in the human circulatory system after prolonged exposure to microwaves have been described in a number of works (A.A. Orlova; E.A. Drogichina; N.V. Uspenskaya; T.P. Asanova; N.M. Konchalovskaya, and K.V. Klotova, and others). There are only isolated reports of changes in the most important indices of human hemodynamics under the influence of microwave irradiation (L.V. Zakharov; Ye.V. Gembitskiy).

We made a clinical survey and study of the main hemodynamic indices of 30 men ranging in age from 25 to 40 years and working with exposure to ultra-high frequency electromagnetic irradiation in the centimeter range (with a PPM [expansion unknown] at the working stations of 10 to 170 microwatts per square centimeter per working day, and up to 500 microwatts per square centimeter or more, six or seven times a month). Eight of the men had been on the job for under five years, ten over five years, and 12 over ten years. All of the subjects were admitted to the clinic for 14-20 days, and on the second or third day tachyoscillograms and polysphygmograms were recorded (once) under metabolic conditions, as well as electrocardiograms.

Mechanocardiograms were recorded on the mechanocardiograph of the Krasnogvardeyets plant (model N-063), and the electrocardiograms on EKPS-2 machines with 12 leads. The obtained data were processed by the method of variation statistics according to the laws of small samplings. The following data (Table 1) were obtained from processing the arterial pressure indices.

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Table 1

Mean indices of arterial pressure (in millimeters) of 30 patients

(a) Статистический показатель	Mп	My	Nw	Mx	пд (b)	гду (c)
M	76	87,4	102	116	26	14
±σ	5,6	5,6	7,3	7,3	5,7	4,7
±m	1	1	1,3	1,3	1,03	0,85

Legend:

a) statistical index
b) pulse pressure
c) GDU [expansion unknown-- hemodynamic pressure ...?]

Table 1 shows that the mean indices of arterial pressure are within the range of normal fluctuations. However, in ten cases, the lateral systolic pressure and in eight the maximum arterial pressure were closer to the lower border of normal and in eight cases there was an elevation of mean hemodynamic pressure to 93-97 mm [millimeters].

The results of investigation of the rate of distribution of the pulse wave in arteries of the elastic (V_e) and muscular (V_m) type, the ratio between them (V_m/V_e) and magnitude of peripheral resistance are given in Table 2.

Table 2

Mean indices characterizing vascular tonus in 30 patients

(a) Статистический показатель	(b) Скорость распространения пульсовой волны (в см/сек)			Общее периферическое сопротивление (в усл. ед.) (c)		
	(d) $C_э$	(e) $C_м$	(f) $C_м/C_э$	(g) фактическое	(h) должное	(i) рабочее
M	583	750	1,29	48	39,7	46,3
±σ	76,4	85,4	0,14	10,9	7	10,5
±m	13,9	15,5	0,025	2	1,3	1,9

Legend:

a) statistical index
b) velocity of pulse wave (in centimeters per second)
c) total peripheral resistance (in arbitrary units)
d) V_e
e) V_m
f) V_m/V_e
g) actual
h) rated
i) working

The indices of velocity of distribution of the pulse wave in elastic and muscular vessels, with the exception of a few cases, did not

exceed normal range. However we observed changes in the V_m/V_e ratio in the direction of an increase; thus, in 11 cases it reached 1.4-1.6 (versus the normal of 1.1-1.3 according to V.P. Nikitin and K.A. Morozov). We were struck by the increase in actual peripheral resistance in a significant number of subjects, and in 70% of the cases it was above the rated value. However, aside from isolated observations, the actual peripheral resistance corresponded satisfactorily to the working values.

A study of energetics of cardiac activity yielded the data submitted in Table 3.

Table 3
Indices of Energetics of cardiac contractions in 30 subjects

(a) Статистический показатель	(b) Частота сердечных сокращений	(c) Объем сердца: (d) систолический (в мл)	(e) минутный (в л)	(f) Объемная скорость выброса (в мл)	(g) Мощность (в вт)	(h) Расход энергии (в вт)
M	60	57	3,4	205	1,8	8,74
$\pm\sigma$	8,03	10,4	0,7	38,6	0,32	1,2
$\pm m$	1,4	1,9	0,1	7	0,06	0,2

Legend:
a) statistical index
b) cardiac contraction race
c) heart volume
d) systolic (mm)
e) minute (liters)
f) volumetric output (milliliters)
g) power (watts)
h) energy expenditure (watts)

Although the mean heart rate was 60, almost half the subjects (47%) presented bradycardia of up to 44-56 beats per minute. In approximately 63% of the cases the systolic heart volume showed a tendency toward decrease, which is also indicated by its mean value. The mean minute volume (see Table 3) was within normal range. Nevertheless in eight out of 30 cases the minute volume was under 3 liters, while the mean dynamic pressure remained within normal range (80-85 mm).

The mean indices of output and power of the left ventricle (205 milliliters and 1.8 watts respectively) were also somewhat lower than the mean values obtained by M.N. Syvorotkin on healthy young people. There was no appreciable change in energy expenditure for displacement of one liter of minute volume of circulation.

Electrocardiographic examination revealed sinus bradycardia and bradyarrhythmia in 13 people. Slow conduction was noted in six cases, and this somewhat more often along the right branch of the bundle of

His (in 4 cases) in the form of partial block. In over 33% of the subjects we observed the $T_{V_1} > T_{V_6}$ syndrome indicative of deviation of the vector of electromotive force of the heart due to some overload of the left ventricle as well as of positional correlations. In the V_4 lead the T wave was greater than half the R wave in seven cases, although there was no appreciable change in its voltage. A U wave was recorded in 25% of the subjects in the V_3 lead. The position of the heart was predominantly vertical and semivertical. After a physical load (Master's test) the EKG failed to reveal any changes other than faster rhythm.

To summarize the foregoing, it must be noted that an in-depth investigation of the circulatory system of individuals exposed to ultra-high frequency irradiation for a long period of time reveals that there is a tendency toward bradycardia and moderate decrease in stroke and minute volume of the heart, without any appreciable change in mean hemodynamic pressure.

Corresponding to the decrease in stroke and minute volume there was some decrease in volumetric output rate and power of the left ventricle.

There was some compensatory constriction of the precapillary bed in response to the mild decrease in cardiac output. The arteriolar reaction was adequate (actual peripheral resistance corresponded to the working resistance). In addition in a number of cases the major ar-arterial vessels presented increased tonus. Evidently these compensatory adaptive mechanisms provided maintenance of a normal level of mean dynamic pressure.

The electrocardiographic changes were indicative of stronger vago-tonic influences on the heart. Some of the subjects showed signs of overload of the left ventricle and changes that could be indicative, to some extent, of fluctuations of potassium-sodium balance in the myocardium.

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