

# Two Types of Hemodynamic Rearrangements in Hypertensive Patients during Treatment with Millimeter Electromagnetic Waves

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Two types of hemodynamic rearrangements, due to a decrease in the stroke index and a decrease in the total peripheral vascular resistance, are revealed. As a result of treatment these rearrangements allow the systolic and diastolic arterial pressure to be corrected and enable the severity of clinical symptoms to be reduced along with the doses of administered drugs.

**Key Words:** *essential hypertension; hyperkinetic type of circulation; systemic hemodynamics*

Low-intensity millimeter electromagnetic radiation (MEMR) has a powerful effect upon biological systems [2,3,10,11]. In 1988 we were the first to demonstrate a high therapeutic efficacy of MEMR in the treatment of patients with essential hypertension (HT) [6]. Our later findings provided evidence that the parameters of the systemic hemodynamics reliably change in patients with HT during MEMR treatment [7,9]. Studies of the mechanism of this therapeutic effect carried out on volunteers have also demonstrated that the effect is realized via the neuroreflex mechanism, which enabled us to classify this method among the physioreflexotherapeutic methods [5,8]. This has also been corroborated by other experimental findings [1,3]. The present study was probes more deeply into the mechanisms of the therapeutic effect of MEMR in patients with HT.

## MATERIALS AND METHODS

Exposure to MEMR (10 procedures in one treatment session) was performed using a Yav'-5.6 de-

vice (frequency 53,534 MHz, frequency modulation  $\pm 50$  Hz, power flux density 10 MW/cm<sup>2</sup>, duration 20 min; the patient lies on his side). The C<sub>2</sub>-C<sub>4</sub> region of spinous processes along the dorsal midline was irradiated. Fifty-three patients with the hyperkinetic type of circulation and with stage I-II HT were examined. Stage I and II HT was diagnosed in accordance with World Health Organization criteria. The effect of MEMR was assessed according to changes in the systolic (SAP) and diastolic (DAP) arterial pressure and in the parameters of systemic hemodynamics, and according to the reduction of the pathological clinical symptoms in the patient ( $fi_{clin}$ ) and the decrease in the amount of drugs administered ( $fi_{drug}$ ), using multifactor analysis which was described in detail previously [4]. The parameters of the systemic hemodynamics were determined by the method of tetrapolar thoracic rheography after Cubicek with modifications proposed by Sherkovina [12], using an RM-600 Nihon Kohden polygraph (Japan). The minute volume blood flow rate (MVFR, liters/min), the total peripheral vascular resistance (TPVR, dyn/sec/cm<sup>5</sup>), the cardiac index (CI, liters/min/m<sup>2</sup>), the stroke index (SI, ml/m<sup>2</sup>), the

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**TABLE 1.** Indexes of Systemic Hemodynamics in Hypertensive Patients with the Hyperkinetic Type of Circulation before and after Treatment with MEMR

Group of patients	MVFR, liters/min	CI, liters/min/m <sup>2</sup>	SI, ml/m <sup>2</sup>	CC, arb. units	TPVR, dyn/sec/cm <sup>5</sup>	HR, beats/min	SAP, mm Hg	DAP, mm Hg
Group 1 (n=29)								
A	11.9	5.7	71.6	6.5	858.6	79.4	155.0	95.7
B	8.0	3.9	52.3	4.2	1106.9	76.7	133.6	84.3
C	3.9±0.5***	1.8±0.3***	19.3±2.7***	2.4±0.3***	248.3±55.3***	2.8±2.3	21.4±3.0***	11.4±2.2***
Group 2 (n=24)								
A	8.6	4.4	60.6	4.7	1136.7	73.1	154.8	95.0
B	11.0	5.6	77.8	5.5	793.3	71.9	129.8	84.0
C	2.4±0.5***	1.2±0.3***	17.2±3.0***	0.7±0.4*	343.3±43.9***	1.3±1.6	25.0±3.2***	11.0±1.9***

Note. A: arithmetic means before exposure; B: the same after exposure; C:  $M \pm m$ . Here and in Tables 2–4 one, two, and three asterisks denote the reliability of differences at  $p < 0.05$ ,  $p < 0.01$ , and  $p < 0.0001$ , respectively;  $n$ : the number of patients in the group.

**TABLE 2.** Baseline Indexes of Systemic Hemodynamics in Groups 1 and 2 of Hypertensive Patients with the Hyperkinetic Type of Circulation

Group of patients	MVFR, liters/min	CI, liters/min/m <sup>2</sup>	SI, ml/m <sup>2</sup>	CC, arb. units	TPVR, dyn/sec/cm <sup>5</sup>	HR, beats/min
Group 1 (n=29)	10.8–13.0	5.2–6.2	65.3–77.9	5.9–7.1	783.5–933.7	74.5–84.3
Group 2 (n=24)	8.0–9.2	4.0–4.8	54.7–66.5	4.3–5.1	1019.3–1254.1	68.4–77.8
$M \pm m$	3.3±0.7***	1.3±0.3***	11.0±4.5**	1.8±0.4***	278.0±68.8***	6.3±3.5*

Note. Confidence intervals (95%) for the indexes of systemic hemodynamics before exposure to MEMR are presented.

cardiac capacity (CC, arb. units), and the heart rate (HR, beats/min) were recorded. The results were statistically processed by the differential method of variational statistics using Student's  $t$  test and Pearson's nonparametric method using the  $\chi^2$  test.

## RESULTS

Our findings showed that exposure to MEMR reduced the SAP in 93% and DAP in 76% of examinees with the hyperkinetic type of circulation. The reduction of arterial pressure was found to be due to hemodynamic rearrangements of two types. In type I the drop of the arterial pressure (SAP and DAP, respectively, dropped 13.8% and 11.9%

on average) was due to a decrease in MVFR, CI, SI, and CC by 32.8, 31.6, 27, and 36.9%, respectively (Tables 1 and 2). The HR in this case did not change reliably, but tended to decrease. The TPVR rose 28.9%. In type II hemodynamic rearrangement ( $n=24$ , group 2) after treatment the SAP and DAP dropped 16.1 and 11.6% on average, which was primarily due to a decrease in the TPVR (by 30.2%, on average). In this case a slight, evidently compensatory, increase in the MVFR, CI, SI, and CC (by 27.9, 27.3, 28.4, and 14.9%, respectively) was observed (Table 1). The HR in this group remained virtually unchanged. Changes in the SI and TPVR in patients of groups 1 and 2 are presented in Table 3.

A comparison of the two groups revealed that the mean age in group 1 was  $44.7 \pm 2.7$  and in group 2,  $48.1 \pm 1.8$  years (Table 4); the ratio between male and female patients in group 1 was 1:1, while in group 2 males predominated. In group 1 the number of patients with a history of the disease lasting less than 5 years was 5 times lower than in group 2 ( $p < 0.05$ ). Meanwhile, the incidence of stage I of the disease was higher in group 1 than in group 2, although the difference was statistically unreliable. The time course of the abatement of the clinical pathological symptoms and of the amount of drugs administered was ap-

**TABLE 3.** Changes of SI and TPVR in Groups 1 and 2 of Hypertensive Patients after MEMR Treatment Sessions

Index	Group of patients	
	1	2
Reduction of SI	28/29	3/24***
Reduction of TPVR	5/29	23/24**

Note. Here and in Table 4 the numerator shows the number of patients exhibiting a reduction of the index studied, and the denominator shows the total number of patients in the group.

TABLE 4. Clinical Indexes in Hypertensive Patients with the Hyperkinetic Type of Circulation

Group of patients	$f_{i_{clin}}$ (>50%)	$f_{i_{drug}}$ (>50%)	Duration of disease <5 years	Stage of disease	Sex	Age
Group 1	6/28	15/19	2/26	7/28-I	14/29-f 21/28-II	44.7±2.7 15/29-m
Group 2	6/24	18/24	11/24*	4/24-I	7/24-f 20/24-II	48.1±1.8 17/24-m

TABLE 5. Drugs Taken by Hypertensive Patients with the Hyperkinetic Type of Circulation before Treatment with MEMR

Group of patients	$\alpha_2$ -Adreno- mimetics	Diuretics	$\beta$ -Adreno- blockers	Spasmo- lytics	Calcium antagonists	Anxiolytics	Sedatives
Group 1	10/19	8/19	2/19	7/19	2/19	8/19	5/19
Group 2	7/20	4/20	2/20	9/20	4/20	3/20	3/20

Note. The numerator shows the number of patients taking a given preparation; the denominator shows the total number of patients in the group.

proximately similar in groups 1 and 2. On the other hand, there were differences between the two groups with respect to the type and dose of drugs administered. For instance, the number of patients taking diuretics and anxiolytics was approximately two and three times, respectively, higher in group 1 (Table 5).

Analysis of the initial indexes of systemic hemodynamics in the two groups of patients showed reliable differences between the groups with respect to MVFR, CI, SI, CC, TPVR, and HR (Table 2), which, evidently, predetermined two types of hemodynamic rearrangements in patients during treatment. In group 1 MVFR, CI, SI, CC, and HR were higher and TPVR lower than in group 2.

Thus, two mechanisms of the therapeutic effect of MEMR were revealed in patients with the hyperkinetic type of circulation: due to a decrease in the SI (type I) and due to a decrease in the TPVR (type II). It may be assumed that this effect does not result from some specific impact of MEMR on patients with HT; the identified types of hemodynamic rearrangements are to be observed when the arterial pressure in hypertensive patients with the hyperkinetic type of circulation normalizes under the influence of any kind of therapy, which may be due to the presence of two different mechanisms of formation of the hyperkinetic type of the circulation. On the basis of the baseline indexes of the systemic hemodynamics obtained in the present study, the nature of the therapeutic effect in hypertensive patients with the hyperkinetic

type of circulation may be predicted with a high probability, which is an important consideration in antihypertensive treatment.

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