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LEVELS OF FUNCTIONAL-VEGETATIVE HOMEOSTASIS AS THE CRITERIA FOR THE EFFECTIVENESS OF MAGNETOTHERAPY

(FINAL INFORMATION)

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Background. *Disorders of the autonomic nervous system (VNS) are caused by 25 to 80% of functional disorders of reserves and mechanisms of adaptation to the changing environment, physical and psychosomatic efforts. The attention is drawn to the complete absence of information on the influence of MT on the indicators of vegetative homeostasis, the violation of which is conditioned by the development of any functional pathology.*

Objectives. *The purpose of the study is to investigate the vegetative rehabilitation trend of magnetotherapy (MT) at various initial conditions of functional-vegetative disorders.*

Materials and methods. *Functional-vegetative diagnostics (FVD) method was chosen as a method of control of functional and vegetative efficiency of magnetotherapy (MT) by Makats. This method has been admitted to be used in medical practice by the Academic Council of the Ministry of Health of Ukraine and the joint session of the Republican Problem Commissions (RPC) of Pediatrics, Obstetrics and Gynecology, Quantum Medicine, Hematology and Transfusiology, New Medical Technology and New Diagnostic Tools (Minutes No. 1, 08-01 dated September 11, 1994). The diagnostic complex "BIOTEST-12M" serves as the technical tool for the FVD. The latter does not use traditional external power sources and the RPC "New medical technology and new methods of diagnostics, prevention and rehabilitation" by the Ministry of Health of Ukraine (Minutes No. 5 dated December 25, 1991) has been approved for practical use. The analysis of the results was carried out on the basis of computer programs "Search" (development of the European center of postgraduate education of the UNAP). A survey of 38 children of different age and sex was conducted in the physiotherapy department of the Vinnytsia Regional Children Clinical Hospital in 2016-2017. The children were divided into 7 groups according to the levels of functional vegetative homeostasis: 1 - with significant parasympathetic activity (PA-sig); 2 - with expressed parasympathetic activity (PA-exp); 3 - with the zone of admissible functional vegetative norm (ZAN); 4 - with expressed sympathetic activity (SA-exp); 5 - with a significant sympathetic activity (SA-sig). They were also divided into 2 groups according to gender: a female group (FG) - 13 children and a male one (MG) - 25 children. FVD was twice held in the first half of the day (10^{00}-12^{00}) before and after the MT session. The bioelectric activity of 12 symmetrical pairs of functionally active skin zones (24 FAZs) was studied, 2016 tests were performed. The attention was paid to the direction of dispersion of the integral vegetative homeostasis levels. The following areas of influence were chosen for MT: parasternal, epigastric and anterior abdominal wall, interscapular, lumbar-sacral and the region of pelvic (femoral), knee and ankle joints.*

Results. *The problem of the influence of physiotherapeutic factors on the indicators of integral functional vegetative homeostasis has been raised for the first time. The results of our studies have shown that MT has a different effect on the vegetative activity and systemic and functional dependence in the observation groups and that depends on the coefficient of functional vegetative homeo-stasis. That is, in a group with a significant parasympathicotonia (group 1), MT has a positive effect; in the group with the expressed parasympathicotonia (group 2) it has a relatively positive effect; in groups with functional compensation of parasympathicotonia (group 3), with the autonomic balance of the VNS (group 4) and in the group with functional compensation of sympathicotonia (group 5) MT has a relatively neutral effect; in a group with severe sympathicotonia (group 6) it has negative effect and in a group with significant parasympathicotonia (group 7) it has negative effect as well. According to the results of our research, the absence of gender-age characteristics of the influence of MT on the dispersion of vegetative levels has been revealed. For low-frequency magnetotherapy in all groups of observation is characteristic sympathetic vegetative orientation. Therefore, it can only be used to patients with significant and severe parasympathicotonia. The rehabilitation expediency requires the maintenance of functional vegetative homeostasis at the level of "FcP-VB-FcS" in conjunction with functional-vegetative diagnostics using the method of V.G. Makats. The method of functional-vegetative diagnosis is easy to use, gives repeated comparable results and can be applied in stationary and out-patient conditions.*

Conclusions. *Magnetotherapy can be recommended for use only to patients with significant and expressed parasympathicotonia.*

Keywords: *magnetotherapy, functional-vegetative diagnostics, vegetative homeostasis, vegetative level, vegetative coefficient.*

Introduction. Disorders of the autonomic nervous system (VNS) are caused by 25 to 80% of functional disorders of reserves and mechanisms of adaptation to the changing environment,

physical and psychosomatic efforts [1,2]. By performing the integrative role at the central level, the VNS ensures the regulation of vegetative homeostasis, systemic disorders of which determine the pathogenetic basis of functional and somatic diseases [1,3,4]. Their fundamental evaluation goes beyond certain parameters of vegetative regulation, requires a systematic approach and the study of a holistic organism as a multilevel inter-dependent system [5,6]. A significant support for the problem of vegetative pathogenesis is the normalization of vegetative indices in the rehabilitation period. In this case, special attention should be paid to the use of traditional FAZ (functionally active skin zones) [7-9].

Nowadays, according to WHO recommendations, "Electro acupuncture diagnostics and reflexotherapy" should become the basis for rehabilitation medicine (WHO International Council, Yerevan, 19.09.03). Its General Assembly (2014) herewith officially advises the States (WHO participants) to include these areas into national health programs and draws the attention to the development of biophysical methods for controlling the rehabilitation effectiveness of physiotherapeutic and preformed factors [5,10,11]. Therefore, much attention should be paid to the recently discovered "Functional-vegetative system of a human" (FVS) [12], which has proved the biophysical reality of traditional "acupuncture channels" as well as their direct relation to the vegetative homeostasis and, in addition, requires its place in the classical physiological system [13,14].

Low-frequency magneto therapy (MT) is widely used in modern physiotherapeutic practice using the magnetic component of low-frequency electromagnetic fields [15-17]. MT has an impressively wide range of indications (anti-inflammatory, anti-edematous, trophic, hypocoagulant, vasoactive, anaesthetic, stimulating reparative processes and immuno-modelling) [18-20]. The official list of absolute and relative official contraindications is, concurrently, also impressive. The attention is drawn to the complete absence of information on the influence of MT on the indicators of vegetative homeostasis, the violation of which is conditioned by the development of any functional pathology.

The purpose of the study is to investigate the autonomic rehabilitation of magnetotherapy (MT) at different initial states of functional vegetative disorders.

Materials and methods of the research. The scientific research work, conducted by us is a fragment of the program "Two-stage system of rehabilitation of vegetative disorders in children living in the zone of ecological (radiation) control of Ukraine" (is being carried out according to the assignment of the Cabinet of Ministers of Ukraine No. 12010/87). "Functional-vegetative diagnostics" (FVD) by the method of V.G. Makats has been chosen as a method of control of functional and vegetative efficiency of MT [12-14]. This method has been admitted to be used in medical practice by the Academic Council of the Ministry of Health of Ukraine and the joint session of the Republican Problem Commissions (RPC) of Pediatrics, Obstetrics and Gynecology, Quantum Medicine, Hematology and Transfusiology, New Medical Technology and New Diagnostic Tools (Minutes No. 1, 08-01 dated September 11, 1994).

The diagnostic complex "BIOTEST-12M" serves as the technical tool of the FVD. The latter does not use traditional external power sources and the RPC "New medical technology and new methods of diagnostics, prevention and rehabilitation" by the Ministry of Health of Ukraine (Minutes No. 5 dated December 25, 1991) has been approved for practical use. The probability of the obtained data was estimated by means of parametric and nonparametric statistics. The analysis of the results was carried out on the basis of computer programs "Search" (developed by the European Center for Postgraduate Education of the UNAP).

Functional autonomic systems ("acupuncture channels") are based on the international "acupuncture nomenclature" (IAN) suggested by the WHO (Table 1). The following zones (levels) of functional-vegetative homeostasis are scientifically based on the coefficients of functional-vegetative homeostasis (k-V) [3]: PA-sig (k-V to 0.75 - a zone of significant parasympathetic activity); PA-exp (k 0,76-0,86 - zone of expressed parasympathetic activity); FcP (k-V 0,87-0,94 - functional compensation zone of the parasympathicotonia); VB (k-V 0,95-1,05 - zone of vegetative balance); FcS (k-V 1,06-1,14 - zone of functional compensation of sympathicotonia); SA-exp (k-V 1,14-1,26 - zone of clear sympathetic activity); SA-sig. (k-V≥1,26 - zone of significant sympathetic activity). The planned research works were being conducted under the guidance of a high-level expert of the National Academy of Sciences of Ukraine, Doctor of Medical Sciences, Professor V.G. Makats.

Table 1.

Traditional Channel	MAH	Traditional Channel	MAH
Lungs	LU	Bladder	BL
Large Intestine	LI	Kidneys	KI
Stomach	ST	Pericardium	PC
Spleen, Pancreas	SP	Triple heater	TE
Heart	HT	Gallbladder	GB
Small intestine	SI	Liver	LR

A survey of 38 children of different age and sex was conducted in the physiotherapy department of the Vinnytsia Regional Children Clinical Hospital in 2016-2017. The children were divided into 7 groups according to the levels of functional vegetative homeostasis: 1 - with significant parasympathetic activity (PA-sig); 2 - with expressed parasympathetic activity (PA-exp); 3 - with the zone of admissible functional vegetative norm (ZAN); 4 - with expressed sympathetic activity (SA-exp); 5 - with a significant sympathetic activity (SA-sig). They were also divided into 2 groups according to gender: a female group (FG) - 13 children and a male one (MG) - 25 children. FVD was twice held in the first half of the day (10:00-12:00) before and after the MT session. The bioelectric activity of the 12 symmetrical pairs of functionally active skin zones (24 FAZs) was studied, 2016 tests were carried out. The attention was paid to the direction of dispersion of the integral vegetative homeostasis levels. The following areas of influence were chosen for MT: parasternal, epigastric and anterior abdominal wall, intrascapular, lumbar-sacral and the region of pelvic (femoral), knee and ankle joints.

Results. The data on the effect of magnetic radiation on the vegetative status of animals and humans can be found in the literature. The effect of weak (up to 3.5 mT) and low-frequency (up to 100 Hz) impulse magnetic field on the state of the vegetative nervous system of animals has been studied by analyzing the variability of the heart rate. The effect of the magnetic field was estimated by a specially designed complex for recording cardiac signals of animals. Several specially selected regimes of impulse magnetic fields were studied. It was shown that the impulse magnetic field possesses a high biological activity at all regimes used, and the indices of the vegetative nervous system after the exposure to the impulse magnetic field approach the values typical for normotonic animals. This makes it possible to use magnetic fields at these regimes in magneto therapy [21].

The study of the effect of transcranial magneto therapy of 63 people with 1st degree AG at the age of 38-50 years old showed that after the course of therapy, the number of patients with

hyper-sympathicotonia decreased from 24 (69%) to 14 (40%) and the number of patients with normal and asympathicotonic vegetative regulation of 39% and 21% respectively [22].

There is also evidence that the effect of the electromagnetic field of the ultrahighfrequency range results in the optimization of the autonomic balance of the body in patients with autonomic nervous system disorders. The electromagnetic field (EMF) has sympatholytic, parasympatolytic and tonic action on a person [23].

We still believe that the data obtained from these studies can not fully characterize the effect of the magnetic and wave effect on the body due to the selected methods of diagnosing vegetative state. In the first two cases rhythmocardiography was used for these purposes. Diagnostic tables were used in the third case. These research methods of the VNS map the functional state of individual VNS subsystems and separate mechanisms of vegetative regulation. The method of functional-vegetative diagnostics by V.G. Makats gives more complete, stable, comparable in time periods results.

The study of the influence of MT on the vegetative activity and the systemic and functional dependence in the initial significant parasympathicotonia (group 1), it was found that, regardless of the topography of the effect, MT positively affects the vegetative homeostasis translating its vegetative coefficients to a higher level of functional activity into the functional compensation zone of parasympathicotonia (FcP), as evidenced by an increase of the functional-vegetative homeostasis coefficient (k-V) from 0.66 to 0.88 (Fig. 1, Table 2).

The study of the influence of MT on vegetative activity and systemic-functional dependence in the initial expressed parasympathicotonia (group 2) revealed that, regardless of the topography of the effect, MT affects the vegetative homeostasis relatively positively, translating its vegetative coefficients to higher levels of functional activity, as shown by an increase of the coefficient of functional vegetative homeostasis (kV) from 0.85 to 0.9 (Fig. 2, Table 2).

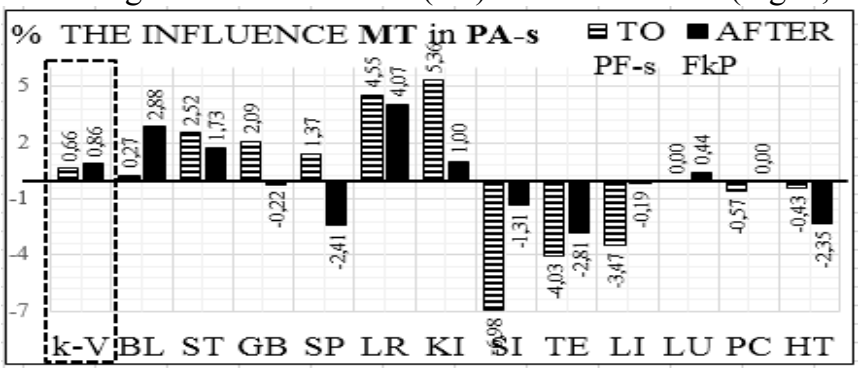

Fig. 1. Influence of MT at PA-sig.

What is more, there is a dispersion of levels of vegetative balance (LVB) under the influence of MT, which is accompanied by the transition of 28.57% of children to the FcP zone and 14.28% in the zone of VB and FcS (Table 3).

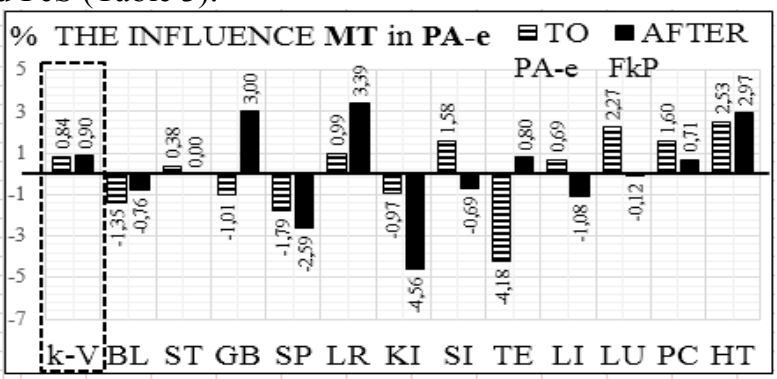

Fig. 2. Influence of MT at PA-exp.

The system correlation of "acupuncture channels LU-PC-HT, SI-TE-LI, ST-GB-KI-LR) is in a state of interrelated dynamic functional compensation (Fig. 2).

Table 2. Effect of MT on systemic-functional dependence

MT	k-V	LU	PC	HT	SI	TE	LI	SP	LR	KI	BL	GB	ST
Initial significant parasympathicotonia (group 1)													
1*	**0,66**	8,7	7	7	3,8	2,8	3,8	12	12	13	11,1	8,4	9,8
2*	**0,88**	8,7	7,7	5,1	8,2	2,6	5,1	8,2	12	12	14.1	7,2	10,2
Initial expressed parasympathicotonia (group 2)													
1	**0,85**	11,2	9,4	10,2	12,6	2,7	8,3	8,8	8,6	6,7	9,4	5,3	7,8
2	**0,90**	8,0	8,4	10,5	8,8	6,3	4,2	8,0	11,3	6,3	9,2	10,5	8,4
Initial functional compensation of parasympathicotonia (group 3)													
1	**0,90**	7,4	9,7	9,5	11,4	5,9	6,7	8,6	9,0	8,0	9,9	7,6	5,9
2	**1,25**	6,8	6,5	6,8	13,5	9,5	7,2	9,0	7,2	9,0	11,3	7,9	7,2
Initial autonomic balance of the VNS (group 4)													
1	**1,06**	11,0	9,3	8,2	11,4	3,0	7,6	11,0	4,0	4,9	18,3	5,3	5,5
2	**0,86**	6,7	8,3	8,8	10,2	5,4	10,0	14,0	8,0	7,9	10,6	4,8	5,4
Initial functional compensation of sympathicotonia (group 5)													
1	**1,07**	7,5	7,2	8,7	13,7	5,0	8,0	8,7	7,5	8,6	10,1	7,2	7,7
2	**0,86**	7,5	9,2	9,6	11,7	4,7	4,9	10,0	8,2	9,6	9,2	7,0	8,8
Initial significant and expressed sympathicotonia (groups 6,7)													
1	**1,26**	8,8	6,3	5,7	9,1	10,0	11,0	7,1	8,5	8,0	8,8	6,0	11,1
2	**2,28**	4,6	6,8	3,0	6,1	10,6	11,0	9,5	2,7	3,8	31,6	3,8	6,1

1 * - here and further. Before the exposure of magnetic radiation

2 * - here and further. After the exposure of magnetic radiation

Table 3. The influence of MT on the dispersion of levels of the vegetative balance (LVB) in %

MT	PA-sig	PA-exp	FCP	VB	FcS	SA-exp	SA-sig
Initial significant parasympathicotonia (group 1)							
1	100						
2	33,33	33,33	33,33				
Initial expressed parasympathicotonia (group 2)							
1		100					
2	14,28	28,57	28,57	14,28	14,28		
Initial functional compensation of parasympathicotonia (group 3)							
1			100				
2			37,50	25,00		25,00	12,50
Initial autonomic balance of the VNS (group 4)							
1				100			
2	20,00		20,00	30,00	20,00	10,00	
Initial functional compensation of sympathicotonia (group 5)							
1					100		
2		12,50	12,50	50,00	12,50		12,50
Initial significant and expressed sympathicotonia (groups 6,7)							

1						100	
2					25,00	50,00	25,00

The study of the influence of MT on vegetative activity and systemic an functional dependence taking into account the initial functional compensation of parasympathicotonia (group 3), the initial autonomic balance of the VNS (group 4) and the initial functional compensation of sympathicotonia (group 5) showed that the effect of the magnetotherapy is relatively neutral concerning functional vegetative homeostasis, which in approximately 70% of cases fluctuates within the functional compensation of sympathetic and parasympathetic activities (Table 3). The value of vegetative coefficients (kV) indicates the tendency to "maintain stability" and the systemic ratio of acupuncture channels LU-PC-HT, SI-TE-LI, ST-GB-KI-LR, in its turn, is staying in a state of interdependent dynamically- functional compensation (Table 2).

The study of the influence of MT on vegetative activity and systemic and functional dependence in the initial expressed and significant sympathicotonia (groups 6-7) revealed that MT, regardless of the topography of the effect, negatively affects the vegetative homeostasis increasing its level of significant neo-rewards (rice 3, Table 2), which is accompanied by a significant increase in the value of kV from 1.26 to 2.28. In the case of MT only 25% passes to the poor level of functional activity in the zone of functional compensation sympathicotonia (FcS) (Table 3). The systemic ratio of acupuncture channels LU-PC-HT, SI-TE-LI, ST-GB-KI-LR), in this case, is in a state of interdependent dynamic functional compensation (Fig. 3).

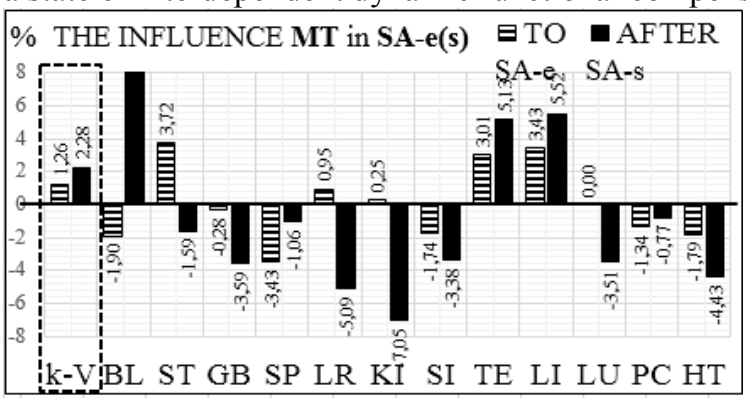

Fig. 3. Influence of MT at initial SA-exp (sig).

Investigating the gender and age characteristics of the influence of MT on the dispersion of the vegetative levels, the same type of dispersion of vegetative levels in the female and male observation groups was revealed (Table 5).

The performed analysis shows that there is no gender and age specificity of the influence of MT on the variance of vegetative levels. Under all conditions, this factor positively affects only the initial levels of the benefits of parasympathetic activity. Its usage in other vegetative disorders causes the development of a higher sympathetic orientation. The conclusion is due to the directed dispersion of vegetative levels at various states of initial vegetative disorders (Table 4).

Table 4. The effect of magneto therapy (MT) on vegetative dispersion at various stages of initial vegetative disorders in female and male groups

№	Female group (in %)	Male group (in %)

	PA-sig	PA-exp	FcP	VB	FcS	SA-exp	SA-sig	PA-sig	PA-exp	FcP	VB	FcS	SA-exp	SA-sig
Initial significant parasympathicotonia														
1	100							100						
2			100						50		50			
Initial expressed parasympathicotonia (group 2)														
1		100							100					
2			100					20	20	20	20	20		
Initial functional compensation of parasympathicotonia														
1			100							100				
2						100				42,8	42,8			14,3
Initial autonomic balance of the VNS (group 4)														
1				100							100			
2			50	25	25			40			60			
Initial functional compensation of sympathicotonia (group 5)														
1					100							100		
2				66,6	16,6		16,6		50	50				
Initial significant and expressed sympathicotonia														
1						100							100	
2					10	60	30					25	50	25

Discussions. In connection with the fact that the organism is a multi-level hierarchical system the effect of magnetic fields manifests itself at different levels of the organization and depends on many external and internal factors. The reactions of the organism to the action of magnetic fields are characterized by the diversity, instability and phase flow, during which a change in their direction to the opposite is often observed. This is determined by the differences in the individual sensitivity of the organism, its systems, their initial state as well as by the nonspecific character of the action of magnetic fields. The effect of magnetic fields in many cases is normalizing or corrective. First of all, the central parasympatolytic effect during the action of low-frequency magneto therapy in all groups of observations, which has been revealed by us, should be noted. That happens possibly due to the improvement of the parameters of peripheral hemodynamics and sanogenesis processes. This effect, along with the sedative effect of low-frequency magneto therapy, is realized through affecting the subcortical centers and the pituitary-hypothalamic system. It should also be noted that low-frequency magneto therapy is capable of exerting an activating influence on the processes of sanogenesis which contributes to the restoration of the disturbed self-regulation of many functional systems and the organism as a whole. It forms effective protective reactions as well as compensatory and adaptive processes and, moreover, it expands the range of homeostatic response of the organism in conditions of disturbed mechanisms of self-regulation. The obtained data do not coincide with the data demonstrated in the literature, where the corrective effect of the magneto therapeutic influence on the parasympathetic and sympathetic units of the vegetative NS or has a pronounced sympatholytic activity is described. This is primarily due to the age characteristics of the child's organism and its vegetative status. The second important aspect is the method of functional and vegetative diagnosis according to V.G. Makats, chosen by us to determine the vegetative status of children, as more universal and complete one.

Conclusions.

1. The problem of the influence of physiotherapeutic factors on the indicators of integral functional vegetative homeostasis has been raised for the first time.

2. The results of our studies have shown that MT has a different effect on the vegetative activity and systemic and functional dependence in the observation groups and that depends on the coefficient of functional vegetative homeostasis. That is, in a group with a significant parasympathicotonia (group 1), MT has a positive effect; in the group with the expressed parasympathicotonia (group 2) it has a relatively positive effect; in groups with functional compensation of parasympathicotonia (group 3), with the autonomic balance of the VNS (group 4) and in the group with functional compensation of sympathicotonia (group 5) MT has a relatively neutral effect; in a group with severe sympathicotonia (group 6) it has negative effect and in a group with significant parasympathicotonia (group 7) it has negative effect as well.

3. According to the results of our research, the absence of gender-age characteristics of the influence of MT on the dispersion of vegetative levels has been revealed.

4. For low-frequency magnetotherapy in all groups of observation is characteristic sympathetic vegetative orientation. Therefore, it can only be used to patients with significant and severe parasympathicotonia.

5. The rehabilitation expediency requires the maintenance of functional vegetative homeostasis at the level of "FcP-VB-FcS" in conjunction with functional-vegetative diagnostics using the method of V.G. Makats. The method of functional-vegetative diagnosis is easy to use, gives repeated comparable results and can be applied in stationary and out-patient conditions.

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