

Transcranial physiotherapy in the correction of reproductive system disorders in adolescent girls with obesity

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Abstract: The study was undertaken to evaluate and optimize various modes of transcranial physiotherapy for reproductive system disorders in puberty girls with obesity. Combined use of transcranial magnetic therapy (TMT) and transcranial electrostimulation (TES) was substantiated by a study of the hormonal status, carbohydrate metabolism, anthropometric and clinical data, ultrasonography and electroencephalography. The application of AMO-ATOS-E apparatus for this purpose could normalize a menstrual cycle in 86,3% of the obese girls, by reducing body weight by an average of $9,26 \pm 4,28$ kg for 3 months. This method was shown to ensure effective prevention of polycystic ovary syndrome. Analysis of electroencephalography indicates a baseline impairment of brain bioelectrogenesis in adolescent girls with reproductive system disorders and their correction with TMT and TES therapy.

Keywords: Obesity, Adolescents, Reproductive System, Transcranial Physiotherapy

1. Introduction

It has been proved that the reproductive system disorders including ovarian dysfunction, early miscarriages in the pregnancy, polycystic ovary syndrome in women of young age may be concerned with the obesity [1]. The occurrence of such pathology in the system of reproductive dysfunctions ranges from 30 to 35% and to 70% of the patients with endometrial hyperplasia. The incidence of early miscarriages in the pregnancy increases to 40-50% [2,3]. Moreover it is known that the risk of development of malignant ovarian and breast tumors and tumors in other endocrine organs increases in more than 2 times [4,5].

There is a strict range of medicinal preparations for the treatment of obesity among them neurotropics such as sibutramine, lorcaserin, phentermine [6,7]. However, these preparations are not administered to children and adolescents. From the pathogenetic point of view the influence of physical factors on the centers of CNS regulation aimed at the correction of hormonal and autonomic nervous system disorders which accompany the development of obesity

during the puberty period is considered to be safe [8].

The presently developed factors include transcranial magnetic therapy (TMT) treatment and transcranial electrostimulation (TES) or mesodiencephalic modulation [9]. TMT in a dynamic variant is characterized by expressed autonomic nervous regulation correcting, hypotensive and sedative effect [10]. The application of combined techniques is considered to be promising including the combination of transcranial magnetic therapy and TES [11].

The research goal is to evaluate the efficacy of different variants of transcranial methods in the correction of reproductive status in puberty girls with obesity.

2. Methods

The research has included 80 puberty girls aged between 12 and 16 years (mean age $14,1 \pm 1,8$ y.o.) with obesity. The control group included practically healthy 20 puberty girls without obesity. The observation has been composed of the

anaemnesis, the evaluation of physical state, the body mass index (BMI), the waist-to-hip ratio to determine the type of obesity (abdominal, gluteofemoral), checking of arterial blood pressure. The Tanner scale has been used to determine sex characteristics. Particular attention has been paid to the terms and the sequence of the development of secondary sex characteristics. Standard glucose tolerance oral test has been performed. The immunoreactive insulin (IRI) level has been determined with measurement of index HOMA (homeostatis model assessment). Index over 2,5 indicated the presence of insulin resistance. The evaluation study of the reproductive system included the inspections by gynecologists, ultrasound investigation of genital organs, determination of the hormonal profile (luteinizing hormone (LH), follicle-stimulating hormone (FSH), estradiol, progesterone, testosterone, prolactin) on the 5th day of menstrual cycle by the methods of the enzyme-linked immunosorbent assay and radioimmunoassay (RIA).

All the patients have undergone electroencephalography (EEG) with revealing the character of α -rhythm registration and dysrhythmia in the frontal, temporal, parietal and occipital lobes of the brain. The spectral power and its type have been estimated.

Application of transcranial physical methods (transcranial magnetic stimulation (TMS) treatment and transcranial electrostimulation (TES) and their combined use) has been carried out by the apparatus "AMO-ATOS-E" ("Trima", Saratov, Registration code RF №FSR 2009/04781).

The effectiveness of the physical method is increased when the frequency parameters become similar to the frequency of the body systems functioning (1-1,5 Hz – normal heart rate, 8-10 Hz – normal α -rhythm of electroencephalography), the frequency of magnetic field scanning 1-12Hz. Transcranial magnetic therapy (TMT) procedures have been performed by the special device taken from the apparatus "AMO-ATOS-E" when the patient is sitting or lying with the induction on the surface of radiator 20-45 mT (according to the age). Magnetic field has been directed from the temporal lobe to the occipital lobe synchronously on the both hemispheres for 7-12 minutes (bitemporal method).

Cranial electrotherapy stimulation (CES) has been performed by frontal-mastoid technique with potential of 15-20V and with the average current to 25 mA. The frequency of pulse burst ranges from 50 to 77 Hz.

For the realization of the research objective determined all the children have been randomized into 4 groups equal to the age, BMI and duration of obesity. In Group 1 (n=20) patients have received TMT. Patients (n=18) undergoing cranial electrotherapy stimulation (TES) have been included in Group 2. Patients (n=22) undergoing combined TMT and TES treatment have been included in Group 3. Patients in Group 4 (n=20) have undergone placebo therapy with the imitation effect.

The number of procedures in all the groups varies from 12-14. The control study has been carried out in a month and

three-month period after the completion of the treatment. In all groups in combination with the main therapy/placebo procedures hypocaloric diet and physical exercises (walking for 5-6 km) have been used.

Data gathered were checked for completeness and accuracy. The data analysis was carried out using "XLStatistics" (version 2.0 software (R.Carr, Australia).

3. Results

The objective study has revealed that the girls in all groups have suffered abdominal obesity with the average BMI - $32,7 \pm 2,9 \text{ kg/m}^2$, SDS BMI - $4,52 \pm 0,68$. No significant difference between groups have been noted. The presence of striae on the skin of abdomen and hips of white and pink color has been determined in 80% of patients. Hypertension in 40% of patients, hirsutism in 25% of patients have been determined. The majority of patients (95%) has shown waist circumference (WC) over 80 cm by the average index $91,5 \pm 7,2 \text{ cm}$. It has been marked the early beginning of the puberty process (at the age $10,8 \pm 0,8$ years). Menstrual cycle disorders have been revealed in 70% of the patients. 60% of them developed menstrual cycle disorders by the type of opsomenorrhoea and secondary amenorrhoea. The proportion of patients with algomenorrhoea and oligomenorrhoea has been respectively measured 20% and 20%.

The oral glucose tolerance test in 100% cases has revealed normal blood glucose level. Fasting and stimulated hyperinsulinaemia ($>20 \text{ mcU/ml}$ and $>80 \text{ mcU/ml}$, respectively) and insulin resistance (HOMA) have been respectively marked in 50% and 77,5% of patients.

The findings of the ultrasound imaging of sex organs have been characterized by the presence of infiltration of stroma, small cystic inclusions and absence of dominant follicle in 42 (52,5%) patients.

While studying the hormonal status it has been measured the decreased follicle-stimulating hormone (FSH) content, the increased level of luteinizing hormone (LH), index of LH/ FSH, testosterone, estradiol, immunoreactive insulin (IRI). It may be referred to the activation of the neuroendocrine system.

The 14 (70%) patients in Group 1 undergone one-month treatment have determined the improvement in self-esteem; the 15 (75%) patients have matched the increased working capacity and overall state; the 14 (70%) patients have experienced the sleep normalization and overall emotional state. Headaches have been arrested in 50% of patients and arterial blood pressure has been decreased to the normal range in 16 (80%) patients. The decrease of body weight has been determined in 10 (50%) patients in a three-month treatment. The average indices of weight loss have been ranged to $6,35 \pm 2,36 \text{ kg}$ comparing to the initial data. The menstrual function has been normalized in every third patient. In 50% of cases the cycles have become ovulatory. The decrease of the testosterone level on 12,5% (Table 1) has been revealed.

Table 1. Hormone levels in adolescent girls with obesity ($M \pm SD$)

Hormones	Group 1 (n=20)		Group 2 (n=18)		Group 3 (n=22)		Group 4 (n=20)	
	Before treatment	TMT treatment	Before treatment	TES treatment	Before treatment	TMT+TES treatment	Before treatment	Placebo procedures
FSH, U/l	4,9 \pm 1,6	5,0 \pm 0,8	4,8 \pm 1,9	5,3 \pm 1,1*	4,9 \pm 1,1	5,8 \pm 0,7*	5,3 \pm 1,6	5,6 \pm 2,1
LH, U/l	5,9 \pm 3,5	5,0 \pm 1,1*	6,0 \pm 3,1	5,3 \pm 0,9*	5,5 \pm 2,4	4,2 \pm 0,6*	5,4 \pm 2,8	5,3 \pm 3,9
LH/FSH	1,3 \pm 0,9	1,2 \pm 0,5	1,6 \pm 0,9	1,4 \pm 0,6*	1,4 \pm 1,1	1,0 \pm 0,4*	1,1 \pm 0,9	1,1 \pm 1,0
Estradiol, pmol/l	966,7 \pm 92,6	900,3 \pm 86,3	946,7 \pm 92,6	903,9 \pm 60,3	998,7 \pm 92,6	726,2 \pm 61,2*	939,7 \pm 92,6	966,7 \pm 95,9
Testosterone, nmol/l	2,4 \pm 1,8	2,1 \pm 1,1	2,4 \pm 1,8	2,0 \pm 0,9*	2,8 \pm 2,0	1,9 \pm 0,4*	2,6 \pm 2,1	2,5 \pm 1,8
IRI, mcU/ml	28,9 \pm 10,2	26,9 \pm 5,2	27,1 \pm 9,2	25,3 \pm 3,9*	26,6 \pm 7,2	24,6 \pm 2,1*	26,8 \pm 8,2	26,1 \pm 9,6

*significant difference ($p < 0,01$)

The 12 (66,6%) patients in Group 2 undergone treatment have determined the improvement in self-esteem; the 11 (61,1%) patients have matched the increased working capacity. Headaches have been arrested in 11 (61,1%) patients and in 2 (11,1%) patients the headaches intensity has been decreased. Arterial blood pressure has been decreased to the normal range in 2 (11,1%) patients. The decrease of body weight has been determined in 11 (61,1%) adolescent girls in a three-month treatment. The average indices of weight loss have been ranged to 4,06 \pm 2,25 kg comparing to the initial data. The improved data on carbohydrate metabolism have been matched in 11 (61,1%) patients that has been resulted in the normalization of insulin sensitivity and the levels of fasting and stimulated plasma insulin level. The decrease of the testosterone level on 16,6% (to 2,0 \pm 0,9 nmol/l) has been revealed. The correlation of LH/FSH has been found out to be decreased (1,4 \pm 0,9). The menstrual function has been normalized in 13 (72,2%) patients. The level of estradiol in Groups 1 and 2 has not been significantly changed.

The patients of Group 3 have shown the most favorable results by means of the combined action of both factors in a month period. The 19 (86,4%) patients undergone treatment have determined the improvement in self-esteem; the 20 (90,9%) patients have matched the increased working capacity. Headaches have been arrested in 19 (86,4%) patients and in 3 (13,6%) patients the headaches intensity has been decreased. In a three-month period 20 (90,9%) adolescent girls have experienced the decrease of body weight ranged to 9,26 \pm 4,28 kg comparing to the initial data. The decrease of BMI and WC has been proved in 19 (86,4%) patients. The improved data on carbohydrate metabolism have been matched in 20 patients resulted in the normalization of sensitivity to insulin. The normalization of testosterone level (1,9 \pm 0,8 nmol/l), the decrease of LH/FSH (to 1,0 \pm 0,8 nmol/l) and the normalization of estradiol have been confirmed. The menstrual function has been normalized in 86,3% of patients. The ultrasound findings have not revealed previously checked pathology.

The 20% of patients in Group 4 undergone placebo therapy have experienced clinical improvement. The improvement in self-esteem, the increased working capacity and the decrease of body weight ranged to 3,04 \pm 1,07 kg comparing to the initial data have been determined in 4 (20%) girls. Laboratory studies have not revealed any significant

changes.

Therefore the use of various transcranial methods has positive results for the puberty girls with obesity and disorders of the reproductive system.

Before treatment in all groups high frequency of electroencephalography (EEG) findings - 55,4% of disorganized and "flat" types have proved the dysfunction of brainstem structure, disorders in autonomic nervous regulation and prevalence of processes of agitation.

In one-month period elevation of EEG total power has been matched in the patients of Group 3 explained by spectral power of α -rhythm to the normal parameters - from 84,5 \pm 16,2 to 132,0 \pm 24,6 mcV²/Hz. The positive dynamics has been studied in the differentiation of α -rhythm. Its frequency increase has been ranged to 15-20% in Group 1 and to 22,7-36,4% in Group 3. Dysrhythmia has decreased in these groups to 20% and 22,7% respectively. At the same time the average α -rhythm frequency increased from 9,3 \pm 1,4 to 10,2 \pm 1,2Hz in Group 1 and from 9,1 \pm 1,6 to 10,4 \pm 1,4Hz Group 3. It may be concluded that transcranial magnetic therapy with 10Hz frequency organizes the main EEG rhythm, influencing the brain structures.

4. Discussion

It is worth pointing out that obesity affects the formation and the state of reproductive system in women, the regulation of which is performed by the autonomic nervous system. A great number of research works has proved the efficacy of transcranial methods of physiotherapy particularly transcranial magnetic therapy on the autonomic nervous system [12,13]. TMS may be considered as a variant of magnetic therapy characterized by the synchronization of body systems functioning, including hypothalamus-hypophysis-adrenal glands axis [9,14].

Otherwise the susceptibility of nervous and endocrine systems to the external physical factors of general character (e.g. balneotherapy, hypoxi-therapy, etc.) has been determined increasing the susceptibility to insulin [4,15]. Transcranial methods are concerned with such external factors being applied to the central nervous system. The removal of insulin resistance consequently results in the decrease of evaluated level of testosterone, LH and IRI with the increased production of FSH – factors, leading to the formation of polycystic ovary syndrome in girls and

infertility in the future.

Visceral obesity may be also caused by bulimia explained by the disturbances in neurotransmitters' control for the digestive function as the hypothalamus is responsible for hunger. It should be proposed that both factors of transcranial physical activity are interrelated: transcranial magnetic stimulation (TMT) with frequency to 10Hz organizes the main EEG rhythm influencing the brain structures thus improving bioelectrogenesis and restoring the balance of neurotransmitters; TES effects the centers of hunger by means of endogenous opiates (endorphin, serotonin) [11].

5. Conclusion

The use of various transcranial methods of physiotherapeutic activity has improved the indices of clinical and hormonal status in adolescent girls with obesity.

The most promising technique has been reported the combined transcranial method. Its efficacy has been assessed by the positive results in 86,4% of patients.

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