

Combination of Medical and Physical Therapy in Management of Posttraumatic Headaches and Sleep Disturbances in Patients with Post-Concussion Syndrome

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Abstract

Some of the main symptoms of mild traumatic brain injury in the long term are headaches and sleep disturbances. The purpose of our study was to investigate the influence of the combination medical and physical treatment using darsonvalization and magnetic therapy on headaches and sleep disturbances in patients with post-concussion syndrome.

Methods: We observed 67 patients with the consequences of mild traumatic brain injury. Patients were divided into two groups: the first group consisted of patients who received medical therapy. The second group included patients who received a similar medical therapy, adding physical therapy using the methods of magnetic therapy and darsonvalization. The treatment was controlled by Doppler ultrasound of the carotid arteries as well as by testing the patients according to MOS SF-36 quality of life questionnaire, which were carried out before and after the treatment.

Results: The analysis of the data obtained from the first group showed the increase of blood flow velocity by 5.2%. The data obtained from the second group showed the significant increase of blood flow velocity by 14.7%, as well as reducing the indices of vascular resistance (PI and RI) by 39.3%. In second group we saw the positive effect of physical therapy using darsonvalization and magnetic therapy. We observed a significant decrease in autonomic manifestations of the disease, which results in a reduction of headaches (75%), palpitations (57.2%), distal hyperhidrosis (64.7%), normal sleep (72.4%), improved emotional background mood (86.5%).

Conclusions: We suppose, that headache in patients with TBI can provoke increased sleep disturbances in turn this sleep disturbances later may lead to increased headache. Combination treatment with physical and medical therapy leads to subjective and objective improvement of the patients' health. Combination physical and medical therapy is recommended for more effective treatment of the consequences of traumatic brain injury.

Keywords: Traumatic brain injury; Consequences of mild traumatic brain injury; Headache; Sleep disturbances; Darsonvalization; Magnet therapy; Hemodynamics; Quality of life

Introduction

The most recent estimates indicate that each year 235,000 Americans are hospitalized for nonfatal traumatic brain injury (TBI). The northern Finland birth cohort found that 3.8% of the population had experienced at least 1 hospitalization due to TBI by 35 years of age. The Christchurch New Zealand birth cohort found that by 25 years of age 31.6% of the population had experienced at least 1 TBI, requiring medical attention (hospitalization, emergency department, or physician office). An estimated 43.3% of Americans have residual disability 1 year after hospitalization with TBI. The most recent estimate of the prevalence of US civilian residents living with disability following hospitalization with TBI is 3.2 million [1-5].

The largest group among patients with traumatic brain injuries consists of patients with mild traumatic brain injuries (70-80%) [6,7].

Post-concussion syndrome, also known as postconcussive syndrome or PCS, is a set of symptoms that may continue for weeks, months, or a year or more after a concussion – a minor form of traumatic brain injury (TBI). The rates of PCS vary, but most studies report that in individuals with a history of a single concussion can develop persistent symptoms associated with the injury [3]. A diagnosis may be made when symptoms resulting from concussion last for more than three months after the injury. Loss of consciousness is not required for a diagnosis of concussion or post-concussion syndrome [4]. PCS is the consequence of diffuse axonal injury. Of the post-concussion symptoms headaches and sleep disturbances are among the most common early features. Previous studies demonstrate a very high proportion of both symptoms and these require treatment to help combat the persistent disability [5,7,8].

There is insufficient data on mechanisms that "trigger" a headache and sleep disturbances a after minimal trauma [4]. It is generally accepted that headache during traumatic brain injury is largely provoked by neurodynamic shifts and the resulting disturbances of cerebral hemodynamics and cerebrospinal fluid dynamics [2,5,9]. The most common opinion about sleep disturbances in TBI is increased activity in the central nervous system, hyperarousal of the

hypothalamic-pituitary axis, and activation of proinflammatory cytokines, predispose individuals to developing sleep disturbances [3,4,9-12].

In recent years, scientific data on the pathogenesis of traumatic brain injury greatly increased thanks to the study of cerebrospinal fluid system from the point of anatomical and physiological characteristics and the sequence of shock waves influence on the intracranial structural elements [4]. From the anatomical and physiological point of view, intracranial pressure results from the interaction of three incompressible intracranial volumes: brain substance (80-85% of the total intracranial volume), cerebrospinal fluid (7-10%) and the volume of blood within the inextensible skull [13]. Consequently, the cerebrospinal fluid systems, in particular, cerebrospinal fluid production links, the outflow of cerebrospinal fluid and circulatory system as a whole, are closely connected. It is known that fluctuations in intracranial cerebrospinal fluid pressure are due to changes in the cerebrospinal fluid secretion, and the cerebrospinal fluid circulation mechanisms are closely connected with the pulse blood vessels filling of the brain and the venous outflow from the cranial cavity.

The pathogenesis of the mild TBI is based on temporary functional disturbances of the CNS, in particular, its vegetative centers that leads to dysfunction of the autonomic nervous system [11,12,14]. This disturbances can lead not only to headache and sleep disturbances, but also in turn, triggers dystonic cerebral disorders in cerebral venous and arterial beds [9]. Despite the prevalence of mild traumatic brain injury, there is no unified approach to medical therapy of this disorders. The treatment is often insufficient and it is not always pathogenically justified [1-3,11,12].

They still use conventional treatment in acute and remote periods of mild TBI. The versatility and complexity of the pathogenesis of hemodynamic and cerebrospinal fluid dynamic disorders in acute and remote periods of closed TBI, depending on its severity, concomitant neurological and somatic diseases, adaptive capabilities of the patient and on the period after the injury, complicates the choice of optimal treatment [15].

Considering the pathogenesis of this disorder development, it is very important to use a combination therapy with physical therapy methods, such as magnetic therapy and darsonvalization.

The purpose of the study was to investigate the influence of the combination medical and physical treatment using darsonvalization and magnetic therapy on headaches and sleep disorders in patients with consequences of mild traumatic brain injury and to assess the efficiency of treatment by determining the patients' quality of life and changers of hemodynamics in those patients.

Methods

We observed 67 patients with consequences of mild traumatic brain injury (defined as 3 months to 2 years after the injury), aged 25-45. We mainly investigated patients with consequences of concussion, as well as patients with mild contusions. At the time of study of these patients no organic brain damage was revealed during computed tomography.

We divided the patients into two groups: the first group (20 men and 10 women) consisted of patients who received only medical therapy that included vasoactive, nootropic drugs, non-steroidal anti-inflammatory drugs for 12-14 days. The second group consisted of patients (27 men and 10 women), who had a similar medical therapy,

and physical therapy, as well as magnetic therapy and darsonvalization for 12-14 days.

For magnetic therapy we used the "Polus 1" device. We applied a sinusoidal magnetic field in continuous mode with the induction of 35 mT; the exposure was carried out by two cylindrical inductors paravertebrally in the neck area for 15 minutes.

We used the "Korona" device for darsonvalization using a contact, brittle method. We first used the stable small mushroom-like electrode on the whole surface of the scalp, neck area, in the thermal dose for 1-2 minutes, then unstably, in low heat dose. The total time of the treatment was 5-8 minutes. The course of treatment was 10-12 procedures.

To evaluate the patients' hemodynamics we took into consideration the indicators of linear velocity of blood flow (LVBF)

To assess the major hemodynamic indicators of blood flow velocity and indicators of vascular reactivity in the carotid system (common, external and internal carotid arteries) before and after the treatment, all patients were examined with the USDG E SAOTE Megas GPX 2004 device, linear sensor 7.5-10 MHz. The study was conducted using the standard method. In order to evaluate hemodynamics and the vascular reactivity of the carotid system, we took into consideration the average primary linear velocity of blood flow (avLVBF), systolic linear velocity of blood flow (sLVBF), peripheral resistance index (RI), and the pulsativity index (PI) before and after the treatment.

To conduct neuropsychological research before and after the treatment, to separate anxiety as personality traits (constitutional anxiety) and clinical anxiety (state anxiety) we used the Spielberger-Hanin test; the total score of up to 30 was considered low anxiety level, 31-45 – moderate anxiety level, and 46 and above – high anxiety level.

Quality of life was estimated according to the MOS SF-36 questionnaire. The questionnaire consists of 36 items divided into eight scales: physical functioning, role functioning based on physical condition, pain intensity, general health, life activity, social functioning, role functioning (based on emotional state), and mental health [16].

The control group consisted of 30 healthy individuals without a TBI, matched by sex and age group with those examined.

The resulting digital data were processed by methods of variation statistics according to Student's t-test and R.Fisher's test. We calculated the correlation using Excel XP build 10.6612.6625-SP3 (Microsoft), Statistica 6.0 (Statsoft Inc) software packages.

Results

All the patients present the following problems: headaches (98.7%), hypersomnia (30.5%), insomnia (20.7%), sleep onset insomnia (7.2%), sleep maintenance insomnia (8.1%), parasomnia (15.3%), acting out dreams 5.2, nightmares (16.8%), sleep paralysis (3.1%), sleep walking (4.2%), nocturnal eating (5.9%), daily sleeping (63.8%). The patients also complained on: rapid fatigability (82.2%), attention and memory impairment (32.8%), dizziness (10.6%), acrimony (52.4%), anxiety (47.8%). The neurological examination showed the form of decrease of convergence (68.2%), slight asymmetry of tendinous reflexes (63.6%), paleness of skin cover (37.7%), red dermographism (78.3%), white dermographism (27.7%).

During the Doppler ultrasound in patients with consequences of mild TBI who received only medical treatment, the following changes were observed in the form of a small increase in blood flow velocity to 0.25 ± 0.05 before treatment and 0.27 ± 0.03 after treatment. Systolic LVBF before treatment was 0.73 ± 0.05 , and 0.76 ± 0.02 after treatment. The peripheral resistance index (RI), which reflects the state of blood flow resistance further away from the measurement point before treatment was 0.98 ± 0.02 , and 0.93 ± 0.05 after treatment. Pulsatility index (PI), showing the elastic properties of the arteries, before treatment was 1.70 ± 0.02 , and 1.65 ± 0.04 after treatment. The increase in the performance of pulsatility index (PI) and peripheral resistance index (RI) is indirect evidence of CSF hypertension. The data obtained are presented in Table 1.

	control group (n=20)	Before treatment	After treatment
	M ± m	M ± m	M ± m
Systolic LVBF (m/sec)	0.95 ± 0.02	$0.73 \pm 0.05^{***}$	0.76 ± 0.02
Average background LVBF (m/sec)	0.31 ± 0.07	0.25 ± 0.05	0.27 ± 0.03

Pulsatility index	0.84 ± 0.03	$1.70 \pm 0.02^{***}$	1.65 ± 0.04
Peripheral resistance index	0.75 ± 0.05	$0.98 \pm 0.02^{**}$	$0.93 \pm 0.05^{**}$

Table 1: Dynamics of major indicators of hemodynamics of internal carotid artery in patients with the consequences of mild traumatic brain injury after medical therapy (*- $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$).

During the Doppler ultrasound of the carotid system in patients with consequences of mild TBI who received combination medical and physical treatment, the following changes were observed in the form of a decrease in average linear velocity of blood flow to 0.29 ± 0.02 before treatment, and 0.42 ± 0.05 after treatment. Systolic LVBF before treatment was 0.72 ± 0.04 , and 0.86 ± 0.05 after treatment. The peripheral resistance index (RI) before treatment was 0.98 ± 0.05 , and 0.87 ± 0.03 after treatment. Pulsatility index (PI), showing the elastic properties of the arteries, before treatment was 1.72 ± 0.02 , and 1.15 ± 0.02 after treatment. The data obtained are presented in Table 2.

	control group (n=20)	Before treatment	After treatment
	M ± m	M ± m	M ± m
Systolic LVBF (m/sec)	0.95 ± 0.02	$0.72 \pm 0.04^{***}$	$0.86 \pm 0.05^{***}$
Average background LVBF (m/sec)	0.30 ± 0.03	0.29 ± 0.02	$0.42 \pm 0.05^{***}$
Pulsatility index	0.84 ± 0.03	$1.72 \pm 0.02^{***}$	$1.15 \pm 0.02^{***}$
Peripheral resistance index	0.75 ± 0.05	$0.98 \pm 0.05^{**}$	$0.87 \pm 0.03^{***}$

Table 2: Dynamics of major indicators of hemodynamics of internal carotid artery in patients with the consequences of mild traumatic brain injury after combination medical and physical therapy (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$).

The analysis of neuropsychological studies of the first group of patients who received only medical therapy, showed the following results: the quality of life on the scale of pain was 62.5 ± 1.4 points before symptomatic treatment, and 67.3 ± 1.5 points after the treatment. According to Spielberger-Hanin test, in most cases we recorded moderate state anxiety and mild trait anxiety in patients. The average value of state anxiety was 44.3 ± 0.5 points (in the control group – 20.7 ± 0.5 ; $p < 0.001$), and trait anxiety – 33.2 ± 1.2 points (in the control group – 21.5 points ± 0.7 ; $p < 0.001$). After treatment, the level of state anxiety was 35.6 ± 0.5 ($p < 0.05$), trait anxiety – 26.4 ± 0.5 ($p > 0.05$). The quality of life assessment showed a decrease according to the SF-36 questionnaire. On the scale of physical functioning, the quality of life averaged 72.2 ± 1.7 before treatment and 77.5 ± 1.5 after symptomatic therapy; the role functioning scale showed 71.4 ± 0.7 before treatment and 75.2 ± 0.5 after treatment. The influence of pain decreased daily activity to 71.5 ± 0.5 , and the value after treatment indicated 73.2 ± 0.5 ; general health was assessed at 68.7 ± 0.5 before treatment, and 72.3 ± 0.6 after symptomatic therapy. The quality of life on the scales of social functioning and emotional state was respectively 65.7 ± 0.7 and 69.5 ± 0.5 before treatment, and 71.3 ± 0.6 and 75.2 ± 0.2 points after treatment. The mental health of patients with mild traumatic brain injury was estimated by the patients at an average of

67.3 ± 1.8 before the symptomatic treatment, and 73.3 ± 0.8 after the treatment. The data obtained are presented in Table 3.

	control group (n=30)	Before treatment	After treatment
	M ± m	M ± m	M ± m
Trait anxiety	21.5 ± 0.7	33.2 ± 1.2	$26.4 \pm 0.5^{**}$
State anxiety	20.7 ± 0.05	44.3 ± 0.5	$35.6 \pm 0.5^{**}$
Pain intensity	90.2 ± 0.55	62.5 ± 1.4	$67.3 \pm 1.5^{**}$
Role functioning	90.5 ± 1.2	71.4 ± 0.7	$75.2 \pm 0.5^*$
Physical functioning	90.6 ± 1.5	72.2 ± 1.7	$77.5 \pm 1.5^{**}$
Life activity	93.5 ± 0.8	71.5 ± 0.5	73.2 ± 1.2
General health	92.3 ± 0.2	68.7 ± 0.5	$72.3 \pm 0.6^{**}$
Social functioning	92.4 ± 1.2	65.70 ± 0.7	$71.3 \pm 0.6^{**}$
Emotional functioning	94.5 ± 2.1	69.5 ± 0.5	$75.2 \pm 0.2^{**}$

Mental health	93.02 ± 0.9	67.3 ± 1.8	73.3 ± 0.8**
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Table 3: Indicators of quality of life in patients with mild traumatic brain injury before and after medical treatment (*p<0.05; **p<0.01;***p<0.001).

The second group of patients who received medical treatment and a course of physical therapy, showed the following data: the quality of life on the scale of pain intensity was 63.2 ± 0.03 before treatment and 83.6 ± 0.56 (p>0.001) after treatment. According to Spielberger-Hanin test, in most cases we also recorded moderate state anxiety and mild trait anxiety in patients. The average value of state anxiety was 43.3 ± 1.2 points (in control group — 20.7 ± 0.05; p<0.01), and the value of trait anxiety was 32.3 ± 1.3 points (in control group — 21.5 ± 0.7 points

(p<0.001)). After treatment, the level of state anxiety showed 30.30 ± 2.2 (p<0.001), and the trait anxiety equaled to 23.5 ± 1.5 (p<0.001).

On a scale of physical functioning the quality of life averaged 72.1 ± 0.5 before treatment and 82.7 ± 0.7 after treatment; role functioning — 73.1 ± 0.02 before treatment and 80.2 ± 0.5 after combination treatment. The influence of pain decreased daily activity to 64.5 ± 1.2 before treatment and 82.5 ± 1.7 after treatment; general health was estimated at 70.5 ± 0.4 points before treatment and 79.8 ± 1.5 after treatment. The quality of life on the scales of social functioning and emotional state was respectively 65.03 ± 1.3 and 67.5 ± 0.2 before treatment and 81.8 ± 1.25 and 87.2 ± 1.5 after treatment. The mental health was estimated by the patients as an average of 65.90 ± 0.3 points before treatment and 85.7 ± 1.3 after treatment. The data obtained are presented in Table 4.

	control group (n=30)	Before treatment	After treatment
	M ± m	M ± m	M ± m
Trait anxiety	21.5 ± 0.7	32.3 ± 1.3	23.5 ± 1.5***
State anxiety	20.7 ± 0.05	43.3 ± 1.2	30.30 ± 2.2***
Pain intensity	90.2 ± 0.55	63.2 ± 0.03	83.6 ± 0.56***
Role functioning	90.5 ± 1.2	73.1 ± 0.02	80.2 ± 0.5***
Physical functioning	90.6 ± 1.5	72.1 ± 0.5	82.7 ± 0.7***
Life activity	93.5 ± 0.8	64.5 ± 1.2	82.5 ± 1.7***
General health	92.3 ± 0.2	70.5 ± 0.4	79.8 ± 1.5***
Social functioning	92.4 ± 1.2	65.03 ± 1.3	81.8 ± 1.25***
Emotional functioning	94.5 ± 2.1	67.5 ± 0.2	87.2 ± 1.5***
Mental health	93.02 ± 0.9	65.90 ± 0.3	85.7 ± 1.3***

Table 4: Indicators of quality of life in patients with mild traumatic brain injury before and after the combination therapy, including medical and physical treatment (*-p<0.05; **p<0.01;***p<0.001).

Discussion

In our study, as also observed in national and international investigations, we have noticed, that headache in patients with TBI can provoke increased sleep disturbances in turn this sleep disturbances later may lead to increased headache [1,2,4,6].

The analysis of the data obtained from the patients who received only medical treatment showed that they tended to increase the hemodynamic velocity by 5.2%; these changes were not significant. In our study, as well as in studies of national and international scientists, we saw the positive effect of physical therapy using darsonvalization and magnetic therapy on patients with the consequences of traumatic brain injury [10,15,17,18]. In our patients, we observed a significant decrease in autonomic manifestations of the disease, which results in a reduction of headaches (75%), palpitations (57.2%), distal hyperhidrosis (64.7%), normal sleep (72.4%), improved emotional background mood (86.5%). It is easy to notice the positive effect on hemodynamics and cerebrospinal fluid dynamics, which shows in the form of a significant increase in blood flow velocity by 14.7%, as well as reducing the indices of vascular resistance (PI and RI) by 39.3%.

Thus, we came to the conclusion that the positive results obtained by the combined medical and physical therapy come from the magnetic therapy and darsonvalization on autonomic centers of the hypothalamic-pituitary system, causing increased blood flow velocity in the carotid arteries of the brain, and reduced cerebrospinal fluid hypertension syndrome by reducing venous stasis.

The most characteristic effect of local darsonvalization is the strengthening of microcirculation, which is caused by the expansion of arterioles and capillaries, removal of vascular spasms and changes in vascular permeability. At the same time the tone of the vein walls and the venous outflow increase, and the venous stasis decreases. Stimulation of the activity of the reticuloendothelial system cells provides for an anti-inflammatory and anti-edema effect [10,15,18].

Magnetic therapy has a sedative effect, improves sleep, reduces emotional tension. This effect is due to suppression processes in the central nervous system.

The most sensitive to the effects of the magnetic field are suprasedgmental vegetative regulatory centers – the hypothalamus, thalamus, midbrain reticular formation, and the brain stem [15,17].

Under the influence of the magnetic field with low-intensity induction, the cerebral vascular tone decreases, cerebral blood flow improves, nitrogen and carbohydrate-phosphorus metabolism activates, and the brain develops increased resistance to hypoxia.

The magnetic field causes a pressure drop in the system of deep subcutaneous veins and arteries. At the same time the tone of vascular walls increases, and there happens a change in elastic properties and bioelectrical impedance of blood vessel walls [1,10,15,18].

The resulting changes after the combination therapy that included medical and physical treatment, cause a significant improvement of both objective and subjective state of patients, which subsequently has a positive effect on the quality of life of patients. In our study, we observed a statistically significant increase in the quality of life on the scales of pain intensity, life activity, emotional and social functioning, and physical functioning.

Conclusions

In our opinion, headaches and sleep disturbances in patients with the consequences of mild traumatic brain injuries have similar pathogenesis. Headache and sleep in patients with TBI are the result of axonal damage of brain, also affecting the vegetative centers, especially the hypothalamic-pituitary axis.

We suppose, that headache in patients with TBI can provoke increased sleep disturbances in turn this sleep disturbances later may lead to increased headache. In many patients, the cerebral circulation is slowed for months or even years after injury and this can accompany prolonged postconcussion symptoms.

The use of physical therapy in patients with the consequences of traumatic brain injury leads to improvement of cerebral hemodynamics by increasing the linear velocity of blood flow in the carotid arteries, and reduction of cerebrospinal fluid hypertension by reducing venous stasis. Combination physical and medical therapy leads to subjective and objective improvement in patients. Combination physical and medical therapy is recommended for more effective treatment of the consequences of traumatic brain injury.

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