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INFLUENCE ON PHYSICAL PERFORMANCE AND ITS METABOLIC, HORMONAL AND HEMODYNAMICS ACCOMPANIMENTS OF REHABILITATION AT SPA TRUSKAVETS'

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Abstracts

Background. State of physical performance is one of the attributes of quality of life and the criterion of the effectiveness of treatment and rehabilitation. Prominent among the methods of rehabilitation takes balneotherapy. Data on the effect of rehabilitation in Truskavets' spa resort on the physical performance of different groups of patients ambiguous. In a previous study we found a number of positive and negative actotropic factors. The aim of this study is to assess the influence of balneotherapy at resort Truskavets on physical performance and clarify some its mechanisms. **Materials and methods.** The object of observation were 29 women (average age 45 years with a range of 29-61 years) suffering from chronic cholecystitis in remission who arrived at spa Truskavets' (Ukraine) for rehabilitation. Physical performance evaluated by veloergometry. State of central hemodynamics investigated by echocardiography. Plasma levels of hormones determined by ELISA, electrolytes by methods reflometry and spectrophotometry. **Results.** Ascertained increase physical performance in 48% of women, the lack of significant change in 24% and decrease in 28%. Found that changes in physical performance are accompanied concordance changes in aldosteronemia, sodium level in erythrocytes, calciumemia, enddiastolic volume of left ventricule, blood pressure and general peripheral vascular resistance while opposing changes in phosphatemia, magniumemia, activity of Na,K-ATPase of red blood cells and body mass. **Conclusion.** Multivariate effects of balneotherapy on physical performance due multivariate effects on electrolytes exchange and central hemodynamics.

Key words: physical performance, hemodynamics, exchange of electrolytes, balneotherapy, Truskavets'.

INTRODUCTION

State of physical performance is one of the attributes of quality of life and the criterion of the effectiveness of treatment and rehabilitation [1,13]. Prominent among the methods of rehabilitation takes balneotherapy [12]. Data on the effect of rehabilitation in Truskavets' spa resort on the physical performance of different groups of patients ambiguous [14,15]. Ambiguous changing parameters as electrolyte [5] as well as autonomous nervous system [10], which may be involved in the mechanism actotropic effect. In a previous study we found a number of positive and negative actotropic factors [17]. The aim of this study is to assess the influence of balneotherapy at resort Truskavets on physical performance and clarify some its mechanisms.

MATERIALS AND METHODS

The object of observation were 29 women (average age 45 years with a range of 29-61 years) patients with chronic cholecystitis in remission who passed rehabilitation course at the spa Truskavets'. Three-week rehabilitation treatment include: drinking bioactive water Naftussya to 3,5 ml/kg for 1 hour before meals three times a day; application of ozokerite to the lumbar region, t^0 45^0C, lasting 20-30 minutes, every other day, 8 procedures; font mineral, concentration Cl-SO_4-Na-Mg-salt of 20-30 g/l, t^0 36-37^0C, duration 8-10 minutes, every other day; diet; therapeutic exercise.

At admission and after rehabilitation physical performance was assessed by a two-stage (load 0,5 and 1,5 W/kg) veloergometry (usable veloergometer "Tunturi", Finland [16]). This was calculated as classic parameters [2.3] and proposed IL Popovych IL [14,15] index tachicardic-hypertensive reaction (ITCHTR) to load 1,5 W/kg.

In order to clarify the role in changes of physical performance of hormonal, metabolic and hemodynamic factors measured in dynamic content in plasma hormones: cortisol, aldosterone, testosterone, progesterone, estradiol, thyroxine, triiodothyronine, prolactin, TSH, LH, FSH (ELISA [7], analyzer "Tecan", Oesterreich) and electrolytes: phosphate, chloride, calcium, magnesium, sodium, potassium, and the last two also in erythrocytes (methods reflometry and spectrophotometry [6], sets "Reflotron", Deutschland; "Pointe-180", USA; "SF-46", Russia). Determined as activity Na,K-, Ca- and Mg-ATPase shades of red blood cells [11]. State central hemodynamics was investigated by echocardiography (echocamera „Toshiba-140", Japan).

Digital material is processed on a PC by methods variational, correlation and canonical analysis using the software package "Statistica 5.5".

RESULTS AND DISCUSSION

The first stage of analysis observed contingent was divided retrospectively into three groups, based on actotropic effect of balneotherapy, ie changes in ITCHTR, taken as a criterion of physical performance (norm: 62–92 μW/kg•beat•mmHg).

Table 1. Multivariate of actotropic effects of balneotherapy and related changes in body mass

Actotropic effects		ITCHTR, μW/kg•beat•mmHg			VO_2max, мл/хв*кг			Fitness quantity, points		
		Before	After	Δ	Before	After	Δ	Before	After	Δ
Deterioration (n=8)	X m	84,6 7,8	76,0 6,9	-8,6 1,3#	38,5 3,4	35,3 3,1	-3,2 0,9#	3,25 0,45	2,75 0,49	-0,50 0,19#
Unchanged (7)	X m	71,1 4,2	71,6 3,8	+0,5 0,5	32,4 1,8	32,2 1,8	-0,2 0,6	2,71 0,18	2,71 0,18	0 0
Improvements (14)	X m	77,8 3,6	8,72 0,41	+9,4 1,7#	36,7 2,0	37,4 2,4	+0,7 1,1	3,14 0,27	3,28 0,26	+0,14 0,14

Continued Table. 1.

Actotropic effects		Body mass, kg			Body mass, % of adequate			Body mass index, kg/m^2		
		Before	After	Δ	Before	After	Δ	Before	After	Δ
Deterioration (n=8)	X m	77,0 7,7	79,8 7,6	-0,25 0,31	115 11	115 11	-0,4 0,5	29,2 2,9	29,1 2,8	-0,1 0,1
Unchanged (7)	X m	72,9 4,9	73,4 4,6	+0,5 7 0,53	113 8	114 8	+0, 9 0,8	28,4 2,0	28,6 1,9	+0,2 0,2
Improvements (14)	X m	76,9 4,2	75,9 4,2	-1,00 0,46#	112 5	110 5	-1,4 0,6#	28,4 1,3	28,0 1,3	-0,4 0,2#

Notes. Brought average values (X) and their error (m) before and after balneotherapy. Significant effects are calculated as a direct difference (Δ) individual values and marked #.

Found (table. 1), as a result of the rehabilitation at 48% women ITCHTR increased on average by 12% by reducing the hypertensive response from 149±4 mm Hg to 137±3 mm Hg without changes in tavhicardic response (130±3 beats/min and 130±4 beats/min at the beginning and end, respectively). At 24% women ITCHTR unchanged, however, at 28% stated reduction ITCHTR by 10% by increasing tachycardia from 125±4 beats/min to 136±2 beats/min in the absence of changes in response systolic blood pressure (135±5 mm Hg and 137±6 mm Hg at the beginning and end, respectively). However, please note that the reduction ITCHTR went only to the middle zone rules.

A similar measure (by 8%) decreased in these entities and classic setting maximum oxygen consumption (VO_2max) as well as qualitative-quantitative assessment of physical condition by Ástrand scale. Compliance settings pronounced in cases with neutral actotropic effects. But in people with increased ITCHTR these parameters increased insignificant. PWC_{150} in the first cases decreases from 2,52±0,38 W/kg to 1,82±0,14 W/kg, remained stable in the second cases (1,62±0,11 W/kg and 1,60±0,10 W/kg, respectively), while at third cases increases from 2,08±0,13 W/kg to 2,31±0,16 W/kg.

Increasing ITCHTR combined with a significant decrease in body weight parameters, whereas at other two actotropic effects these parameters are not changed regularly. Yet the correlation between changes in body mass and ITCHTR detected significant (r=-0,38 at critical to the sample size |r| 0,37).

Screening correlation between changes due to rehabilitation ITCHTR and registered hormonal and metabolic parameters showed only 6 significant or at least noteworthy. The dynamics of the three of them correlated with dynamics ITCHTR positive: sodium level in red blood cells (r=0,42), aldosteronemia (r=0,39) and calciumemia (r=0,22), while the other

three negative: phosphatemia (r=-0,35), magnesiumemia (r=-0,25) and the activity of Na,K-ATPase (r=-0,20). Therefore, further analysis confine the dynamics of these parameters as possible factors or satellite multivariate actotropic effects of balneotherapy.

As shown in table. 2, ITCHTR increase is associated with increased plasma calcium by 4,5%, of aldosterone by 11% and sodium content in red blood cells (and hence in myocytes) by 23%. Instead reduction ITCHTR accompanied by a decrease these settings by 5%, 10% and 20% respectively. Neutral actotropic effect corresponds to the stability of these parameters.

Table 2. Related concordant changes in parameters exchange of electrolytes for different actotropic effects of balneotherapy

Actotropic effects		Sodium of erythrocytes, 17,6±0,8 mM/l		Calcium of plasma, 2,53±0,04 mM/l		Aldosterone of plasma, 85±7 ng/l	
		Before	After	Before	After	Before	After
Deterioration (n=8)	X m	29,0 2,0*	23,4 1,9*#	2,40 0,11	2,28 0,12*	99 6	89 3
Unchanged (7)	X m	24,6 0,6*	22,5 1,6*	2,06 0,12*	2,07 0,07*	80 3	80 2
Improvements (14)	X m	23,7 1,2*	29,2 2,1*#	2,26 0,08*	2,36 0,08	82 2	91 3#

Notes. After setting brought rules averages [by: 9,10] and their errors. Significant differences from normal values marked*, significant changes in values marked#.

On the other hand (table. 3) positive actotropic effect associated with decreased levels plasma phosphate by 20%, magnesium by 8% and activity of Na,K-ATPase of erythrocyte membranes (and hence the cell membranes of myocytes) by 11%. For negative actotropic effect changes in these parameters are insignificant, but with the opposite trend (+7%, +3% and +9% respectively), which is dominated this by neutral actotropic effect.

Table 3. Related discordant changes in parameters exchange of electrolytes for different actotropic effects of balneotherapy

Actotropic effects		Phosphate, 0,97±0,06 mM/l		Magnesium, 0,95±0,04 mM/л		Na,K-ATPase, 0,76±0,04 M/l•h	
		Before	After	Before	After	Before	After
Deterioration (n=8)	X m	0,90 0,07	0,96 0,07	0,74 0,02*	0,76 0,02*	0,85 0,12	0,93 0,11
Unchanged (7)	X m	0,83 0,10	0,87 0,05	0,78 0,02*	0,75 0,02*	0,98 0,09*	1,04 0,07*
Improvements (14)	X m	1,03 0,06	0,83 0,06*#	0,80 0,02*	0,74 0,02*#	1,06 0,08*	0,94 0,08

The canonical correlation analysis shows that the relationship between changes (d) in ITCHTR, on the one hand, and these six parameters exchange of electrolytes, on the other hand, is significant (Fig. 1).

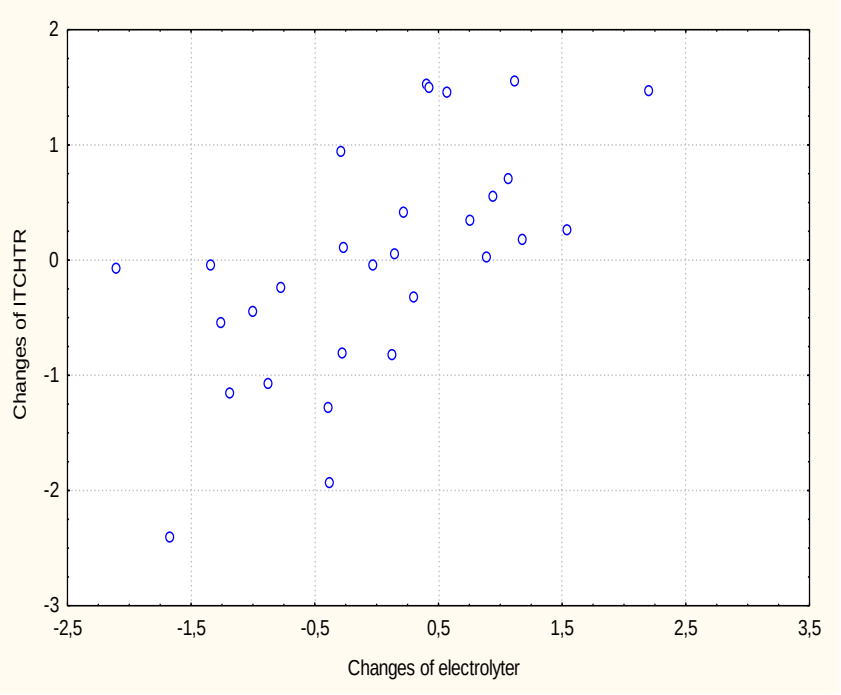

Fig. 1. The canonical correlation between changes in parameters exchange of electrolytes (X-line) and ITCHTR (Y-line)

Multiple regression equation is as follows:

$dITCHTR=1,06 + 0,3 \cdot dNa_e + 0,11 \cdot dAld + 4,6 \cdot dCa – 9,3 \cdot dP – 6,2 \cdot dMg – 3,0 \cdot dNa,K\text{-}ATPase$
$R=0,624; R^2=0,389; F_{(6,2)}=2,34; Chi^2=11,9; p=0,06; SD=\pm 8,0$ µW/kg•beat•mmHg

Consequently, changes due to rehabilitation of these six options of electrolytes exchanges determine physical performance by 39%.

Changes in the parameters of central hemodynamics (in rest) appeared to be associated with changes ITCHTR very weak. In noteworthy only enddiastolic volume (EDV) of the left ventricle (r=0,28), general peripheral vascular resistance (R) (r=0,21), diastolic (Pd) (r=0,20) and systolic (Ps) (r=-0,13) blood pressure as well as shok volume (SV) of the left ventricle (r=-0,18). Despite weak pairwise correlation, canonical correlation between changes in ITCHTR and constellations of hemodynamic parameters detected significant (Fig. 2).

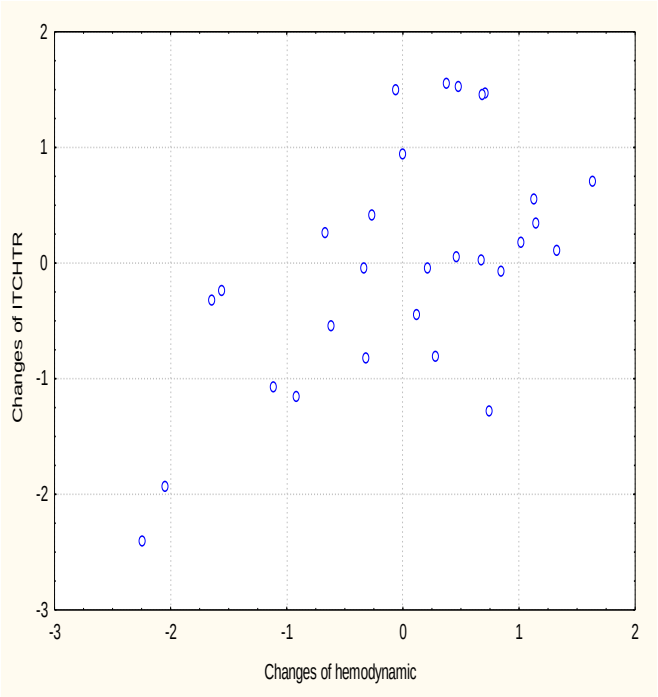

Fig. 2. The canonical correlation between changes in parameters of hemodynamics (X-line) and ITCHTR (Y-line)

Multiple regression equation is as follows:

dITCHTR=1,02 + 0,13•dEDV - 0,27•dR + 0,65•dPd - 0,34•dPs - 0,28•dSV
R=0,598; R^2=0,360; $F_{(5,2)}$=2,56; Chi^2=10,8; p=0,056; SD=±8,0 µW/kg•beat•mmHg

Regarding specific quantities note that when take place the neutral actotropic effect any change is not detected, while improving physical performance is accompanied by a tendency to increase only enddiastolic volume (from 122±4 ml to 127±5ml), general peripheral resistance of vessels (from 16,9±1,7 kPa•sec/m^3 to 17,9±1,6 kPa•sec/m^3) and diastolic pressure (from 79±2 mm Hg to 83±2 mm Hg) and reduction in systolic pressure (from 126±3 mm Hg to 122±3 mm Hg) as well as SV (from 74±4 ml to 70±4 ml).

The opposite trend associated with a decrease in physical performance. For EDV this is 137±4 ml and 127±5 ml, GPRV 17,6±1,6 kPa•sec/m^3 and 16,9±1,5 kPa•sec/m^3, diastolic blood pressure 78±2 mm Hg and 75±2 mm Hg, systolic blood pressure 117±3 mm Hg and 118±3 mm Hg, SV 67±7 ml and 63±7 ml.

However, the cumulative changes in these parameters of central hemodynamics in rest determine the changes in parameters of tachicardic-hypertensive reaction to dosed physical loud by 36%.

If we combine the 6 parameters of electrolytes and 5 hemodynamic parameters, the determination of the degree of a change of physical efficiency increases to 58%: R=0,763; R^2=0,582; $F_{(11,2)}$=2,15; p=0,07; m=±7,6.

Regarding the changes in registered hormonal parameters may be noted merely tends to increase levels of triiodothyronine (from 1,39±0,27 nM/l to 1,74±0,27 nM/l) and FSH (from 5,1±0,5 IU/l to 6,2±0,4 IU/l) for positive actotropic effect, whereas when take place other actotropic effects any regular changes were not found. Levels of TSH, LH, prolactin, estradiol, cortisol and testosterone not changed by any variant of actotropic effect of balneotherapy. This applies also changes, or rather their absence, other parameters of electrolytes exchange and hemodynamics.

Thus, we confirmed previous researchers discovered multivariate influence balneotherapy at spa Truskavets' on the physical performance of gastroenterology patients and healthy children, residents of contaminated territories [14,15]. This we confirmed earlier found correlations physical performance changes with changes in calciumemia, magnesiumemia and systolic blood pressure, and first discovered connections with dynamic in phosphatemia, sodiumhistia, activity of Na,K-ATPase, general peripheral vascular resistance, enddiastolic volume of the left ventricle and aldosteronemia. The role of aldosterone and the activity of Na,K-ATPase in changes in physical performance caused by bioactive water Naftussya indirectly evidenced by experiments on rats [15] on the positive correlation changes in length swim to exhaustion with urine sodium concentration (r=0,50) and negative correlation with dynamics of diuresis (r=-0,45).

Regarding actotropic factors in the composition of bioactive water Naftussya we believe the most likely phenols [8], capable of altering the activity of the autonomic nervous system [10].

ACCORDANCE TO ETHICS STANDARDS

This study was approved by the local ethical committee of Truskavets' Scientists Assotiation. Tests in patients are conducted in accordance with positions of Helsinki Declaration 1975, revised and complemented in 2002, and directive of National Committee on ethics of scientific researches. During realization of tests from all participants the informed consent is got and used all measures for providing of anonymity of participants. For all authors any conflict of interests is absent.

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