BIOLOGIJA. 2014. Vol. 60. No. 1. P. 47–57

Fatigue influence on dynamics of cardiovascular functional parameters during head-up tilt table test in women non-athletes cohort

Aušrinė Packevičiūtė*,

Eurelija Venskaitytė,

Kristina Poderienė,

Jonas Poderys

Lithuanian Sports University,
Sporto str. 6,
LT-44221 Kaunas,
Lithuania

Cardiovascular response to the head-up tilt table test in the period when the vasovagal reaction emerges can reveal important information useful for diagnostic and preventive purposes. The aim of this study was to evaluate the influence of fatigue on the dynamics of functional cardiovascular parameters during the head-up tilt table test in non-athlete women cohort.

A group of healthy non-athlete women attending health promotion training took part in the study (n = 20). In order to investigate the effect of post-workload parametric dynamics the subjects performed a 30-minute running sessions at a moderate intensity (aerobic exercising). Electrocardiography (ECG), arterial blood pressure (ABP) measurements were employed for the assessment of cardiovascular changes during an orthostatic test (head-up tilt table test) before and after the training session.

The study results revealed significant differences in cardiovascular parameters analysed in this study: heart rate (HR), ST-segment depression, systolic, diastolic and pulse ABP before and after the workload ($p < 0.05$). In response to orthostasis an increase of the arterial blood flow intensity was indicated, while in response to clinostasis the decrease of arterial blood flow was observed. After the training session a post-workload hypotension was observed, and in response to orthostasis an increase of peripheral vascular tone was lowered. The results of the study confirmed that baroreflex regulation and autoregulation are sensitive to orthostatic body changes and could reveal the peculiarities of the cardiovascular functioning.

Key words: head-up tilt table test, cardiovascular system, fatigue

INTRODUCTION

Cardiovascular variables exhibit distinct dynamical patterns in response to external perturbations (e.g. exercise tests or workouts) as well as in internal pathological states (e. g. chronic fatigue syndrome, cardiac arrhythmia) (Mailey et al., 2010; Nemati et al., 2012). The nervous system is an underlying control mechanism which captures all dynamical changes and adapts arterial blood

* Corresponding author. E-mail: ausrine.packeviciute@lsu.lt

pressure (ABP) accordingly. But if the control system is malfunctioning, the conspicuous fluctuations of ABP can occur (Barón-Esquivias and Martínez-Rubio, 2003; Hain, 2011).

Circulatory changes provide a possibility to indicate a disorganized baroreflex response to a stimulus during an orthostatic test, if the malfunctioning of the cardiovascular system is caused by the control system or an impaired cardiac or peripheral vascular function (Baron-Esquivias and Martínez-Rubio, 2003). Orthostatic hypotension induced syncope helps to identify autonomic nervous system disorders, cerebrovascular diseases, inadequate exercise-induced changes in the circulating blood volume, cardiac arrhythmias and structural heart diseases or syncope induced by heart and lung failure, etc. Dilation of the blood vessels (vasodilation), and / or a slow heart rate (HR) (bradycardia) may lead to reflex syncope, though each of these factors may have a different influence on the formation of systemic and cerebral circulatory insufficiency (hypoperfusion).

During the head-up tilt table test a typical reaction pattern in young and healthy persons is a rapid and complete initial reflex phase of adaptation to the upright position with a stabilization of ABP and HR (normal baroreflex function) that lasts until a rapid onset of the vasovagal reaction. A different pattern is typical of an abnormal reaction, characterized by absence and various changes in hemodynamic, caused by the absence (Grubb and Kosinski, 1997). Persons characterised as intolerant to orthostatic tests develop more alterations during magnetic resonance imaging (MRI) which are so called periventricular white matter lesions, but the origin of these lesions is unrevealed (Kruit et al., 2013).

Recently not only conventional exercise tests have been applied in order to evaluate the functional state of athletes as well as non-athletes. Much attention is paid to orthostatic tests and the impact of the tests on cardiovascular control mechanisms as well as the significance of the interactions of the control mechanisms with other body systems. Optimal health improvement and exercising programs are still a matter of debate, especially when setting exercise intensity, because the absence of a precise evaluation of the body provides an excessive risk to choose inadequate physical activity or even lead to the state of overtraining. Often the evaluation of the same person's physical condition before and after the load does not reflect the real situation.

This article focuses on the evaluation of the response of functional state indicators, particularly cardiovascular functional parameters to the head-up tilt table test (TTT) in healthy non-athlete women attending health improvement trainings. It was shown that the interaction of the central and peripheral indices changes significantly in the state of fatigue. The obtained results revealed that the orthostatic test can be used as a simple test procedure in which the influence of regulatory system activation mechanisms and their interaction features in the functional state of cardiovascular system are evaluated.

The results suggest that baroreflex regulation and autoregulation are sensitive to orthostatic effects: transition to the vertical position has a stronger effect on the cardiovascular system than transition to the supine position. Coronary insufficiency as a factor limiting the application of strenuous exercise can be evaluated by employing the orthostatic test. The orthostatic test is also appropriate for investigations designed for healthy subjects attending health improvement trainings when a selection of the optimal physical load is required.

The purpose of this study was to evaluate the influence of fatigue on the dynamics of functional cardiovascular parameters during the head-up tilt table test in non-athlete women attending health improvement trainings.

MATERIALS AND METHODS

A group of healthy non-athlete women (n = 20) attending health promotion training was involved in this study (Table). The study protocol was approved by the Ethics Committee of Biomedical Research of Lithuanian University

Table. Anthropometric characteristics of subjects

Number of subjects	Age (years)	Height, cm (interval)	Weight, kg (interval)
20	33 ± 7	169–181	56–71

of Health Sciences. All subjects signed an approved consent form prior the participation in the study.

The following methods were used in the study: electrocardiography (ECG), arterial blood pressure (ABP) assessment and the orthostatic test (TTT).

Electrocardiography. During the tilt-table test the computerized ECG analysis system "Kaunas-Load" developed by the Institute of Cardiology of Kaunas University of Medicine was applied for the 12-lead ECG recording and analysis. ECG parameters of each cardiac cycle were analysed: the heart rate (HR) and ST-segment depression. The ECG analysis system processed the average values of cardiovascular functional parameters and their changes in all 12-lead within a 10-second interval of registration every 15 seconds.

Arterial blood pressure (ABP) measurement. ABP was measured on the left upper arm by Korotkoff method. The measurements were performed in the supine position at rest before the orthostatic test (each minute), during elevation to the upright position as well as the onset of the position change, and then each minute during orthostasis. Analogically, the parameters were assessed while shifting back to the horizontal position. The following ABP indices were analysed: systolic ABP, diastolic ABP and pulse ABP.

Physical workload. To investigate the dynamics of cardiovascular parameters in the post-workload condition, the subjects were asked to perform a 30-minute running session at a moderate intensity (aerobic exercise).

The orthostatic head-up tilt table test. The orthostatic tilt table test (TTT) was used in order to reach the effect of orthostasis in the study. The test was also used to evaluate the cardiovascular function. The test included a passive position change from the horizontal to vertical and then back to horizontal position. The study was performed using the orthostatic table "*Veronese*" (Italy).

The test begins by measuring blood pressure placing the cuff on the upper arm and placing ECG electrodes according to the standard guidelines. Later on, the subject is asked to lie down on the orthostatic table. The subject is fastened to the table with special belts over the shoulders, hips and knees. This is necessary to ensure the safety of the subject during the test when changing the body position from horizontal to vertical. It also helps to reduce the tension of the muscles. During the test subject is asked not to make any moves, not to speak or sleep.

Protocol. The protocol scheme is provided in Fig. 1. The testing of the subjects was performed two times: before and after the physical load.

Statistics. SPSS 19.0 statistical analysis software and Microsoft Excel were used to analyse and evaluate the research data. In all cases the arithmetic mean ($\overline{x}$), the standard deviation (s) and the standard error of the mean (s_x) were calculated. The dependent t-test for paired samples was applied to evaluate the statistically significant difference of the analysed parameters. The difference between the compared values was statistically significant with the standard error less than 5%, i. e. $p < 0.05$.

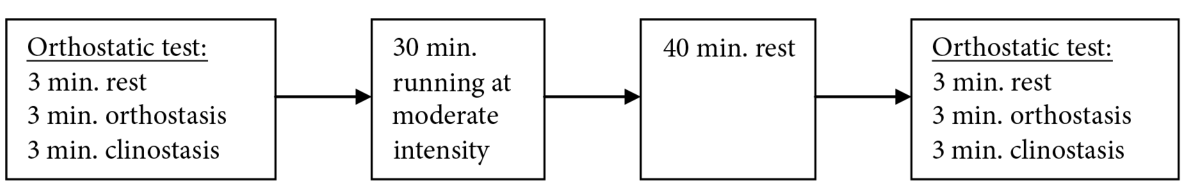

Fig. 1. Protocol scheme

The assessment of inter-parametric relationship of cardiovascular parameters and the changes was based on the model of the functional state evaluation which provides a possibility of the integrated analysis of the parameters of the three major functional systems of the body: regulatory (CNS), performing (the musculoskeletal system) and supplying (the cardiorespiratory system). The purpose of this model is to refer the registered indices to a corresponding functional system or fractal level and thus to perform an integrated analysis. A detailed description of the model has been presented in many publications (Vainoras, 2002).

RESULTS

The influence of fatigue on the dynamics of cardiovascular parameters during the orthostatic test was evaluated. The analysis of HR in the fatigue condition during the orthostatic test showed that prior to the workload HR increased by 11 ABPm – from 62.8 ± 2.8 ABPm in the horizontal position, to 73.8 ± 3.0 ABPm in the vertical position (Fig. 2).

The main change of HR was gradual after half minute and in the vertical position it has reached the plateau phase and remained essentially unchanged until the next shift. Comparing HR resting values and the values obtained during orthostasis a significant difference ($p < 0.05$) was found. Going back to the lying position the average HR decreased by 12 ABPm and almost reached the initial resting level.

Meanwhile HR during the orthostatic test after the physical load revealed lower values than those found in the pre-workout test. In the transition from the horizontal position to orthostatic, HR increased by 20 ABPm – from 83.3 ± 4.2 to 104 ± 3.1 ABPm. After the transition to the standing position, it continued to rise until the end of the second minute of orthostasis when it reached the peak – 116.6 ± 3.5 ABPm and only then got stabilized. Switching from orthostasis to the horizontal position after exercise an abrupt decline in HR was observed and the difference was statistically significant ($p < 0.05$).

The summary of the results revealed statistically significant differences in HR before and after the workload ($p < 0.05$).

The analysis of ST-segment depression change during the orthostatic test revealed that before and after the physical load in the steady supine position myocardial ischemic events alternated within the normal range – 0.07 to

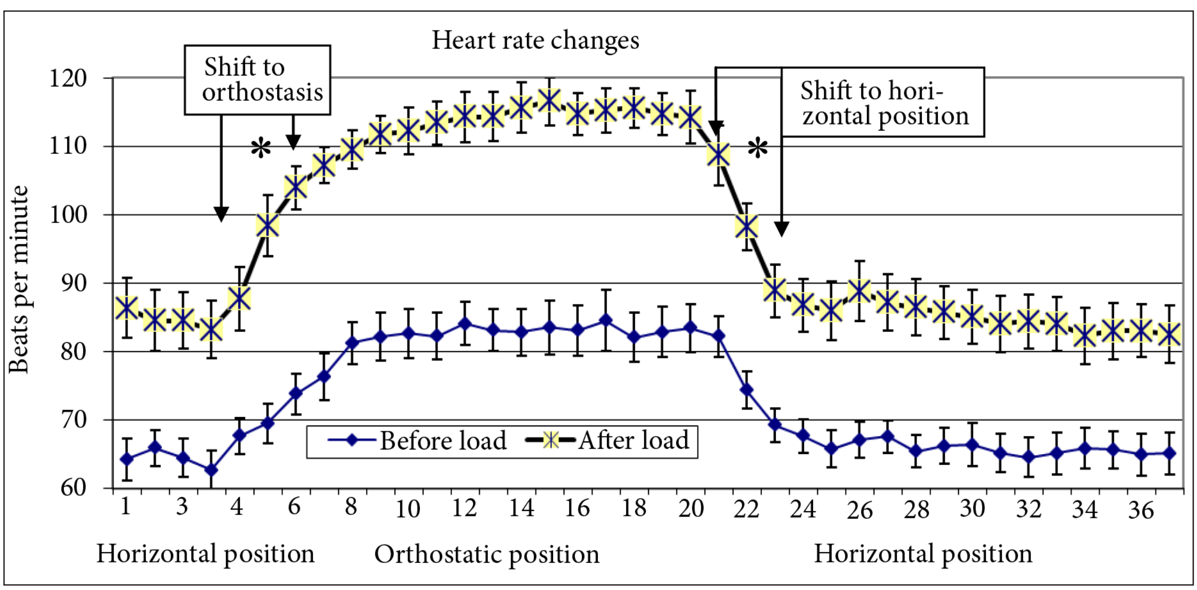

Fig. 2. HR dynamics in every ECG registration during orthostatic test before and after workload (*p < 0.05)

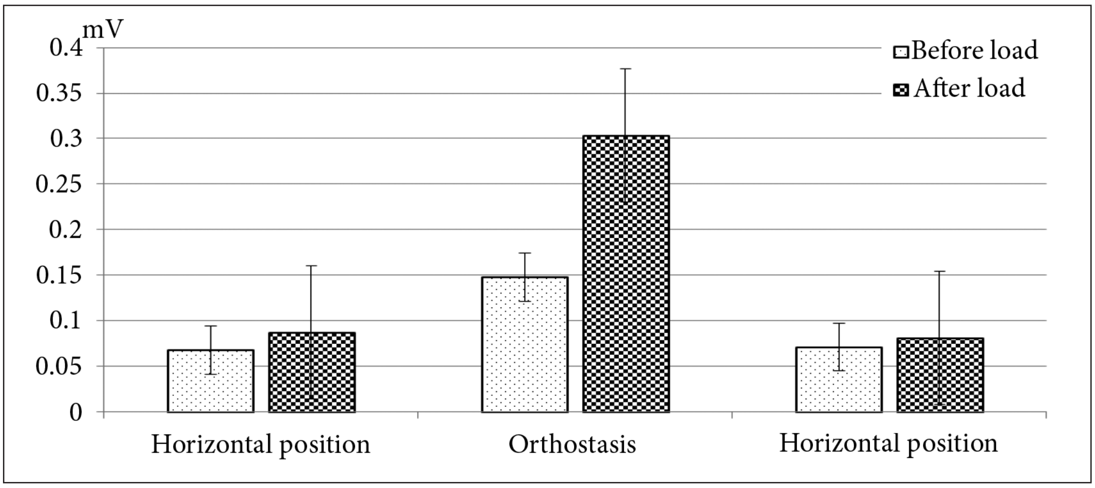

Fig. 3. ST-segment depression dynamics during orthostatic test before and after workload

0.09 Mv (Fig. 3). When shifting to orthostasis after the physical load the ST-segment value increased to 0.3 mV, resulting in the statistically significant difference between the steady state and orthostasis ($p < 0.05$). The changes show that the metabolic processes in the heart are inadequate regarding to the applied physical load. Upon return to the lying position, the ST-segment alternation returned to the normal range, and the comparison of values obtained during orthostasis and clinostasis also revealed statistically significant differences ($p < 0.05$). The ST-segment depression values before the test and during clinostasis differed insignificantly, because the ST-segment value reached during clinostasis is close to its initial state.

The systolic ABP dynamics before the workload decreased evenly – in average a decrease

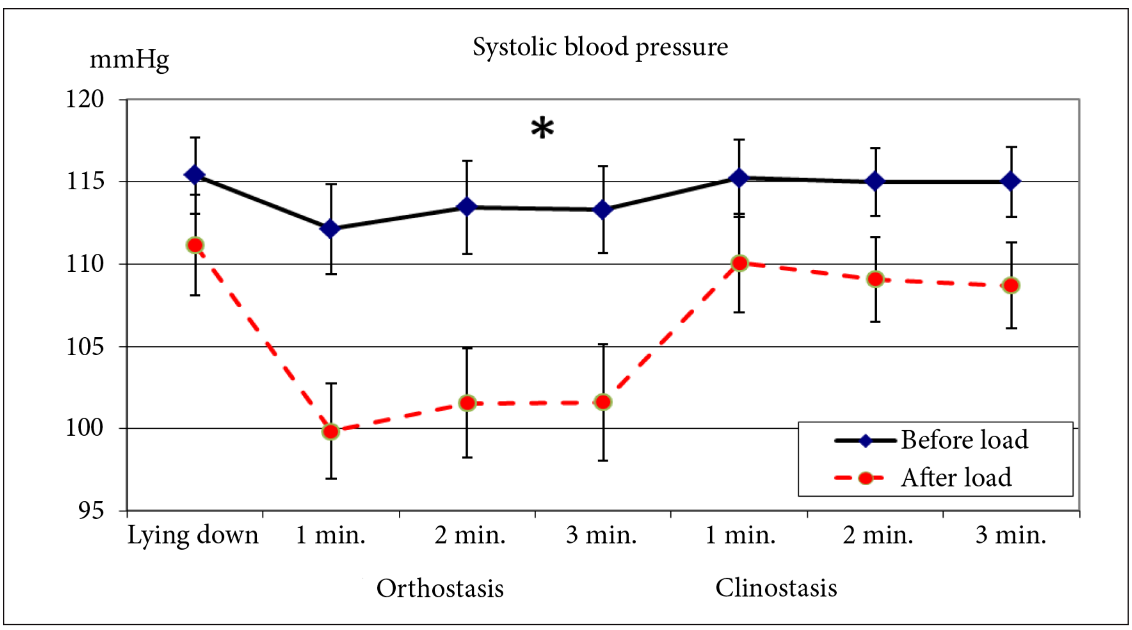

Fig. 4. Systolic blood pressure dynamics during orthostatic test before and after workload

* Statistically significant difference between the systolic blood pressure before and after workload, $p < 0.05$

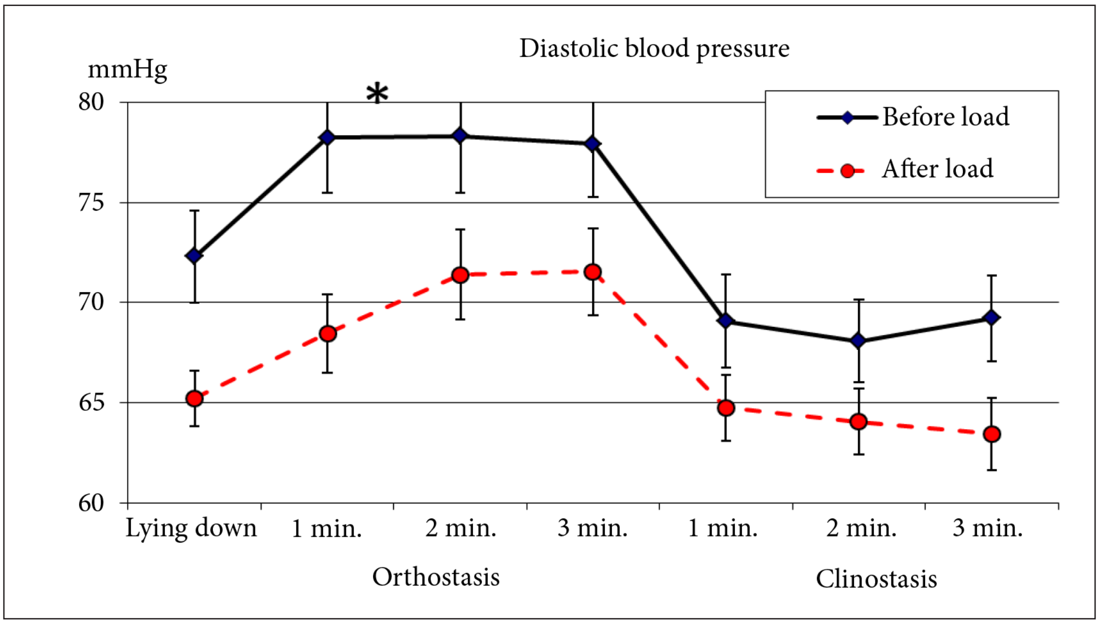

Fig. 5. Diastolic ABP dynamics during orthostatic test before and after workload

* Statistically significant differences between diastolic ABP before and after workload, $p < 0.05$

of 3 mmHg ranging from 115.4 ± 8.3 mmHg to 112.2 ± 9.9 mmHg was observed during the head-up tilt table test while changing the position from horizontal to vertical, but quickly returned to its original level and did not change until the end of the test (Fig. 4). The orthostatic test after the physical load was followed by significant changes in ABP regulation (Fig. 4). In response to the changing conditions – the shift to orthostasis – the statistically significant decrease of systolic ABP from 111.2 ± 2.3 mmHg to 99.8 ± 2.7 mmHg was observed during orthostasis ($p < 0.05$). The comparison of systolic ABP data before and after workload also showed that significant differences were noted during orthostasis ($p < 0.05$).

During the test two participants experienced obvious symptoms of orthostatic hypotension (dizziness, nausea), therefore they could not stay in orthostasis and were returned to the horizontal position.

Reverse dynamics was observed in the dynamics of diastolic ABP (Fig. 5). Diastolic ABP during the head-up tilt table test before moving on to the standing position increased from 72.31 ± 3.8 mmHg to 78.23 ± 5.4 mmHg and remained at this level during all orthostasis.

Meanwhile the mean values of post-training diastolic ABP altered much slower. After exercise, diastolic ABP reached a plateau only in the second minute of orthostasis. The change was similar to the dynamics observed before the physical load – it increased from 65.23 ± 1.1 mmHg to 71.38 ± 1.5 mmHg. Statistically significant changes were observed during the study state and the first minute of orthostasis also differed significantly before and after the physical load ($p < 0.05$).

Pulse ABP at rest differed insignificantly (43 and 44 mmHg, respectively) before and after the physical load. In response to orthostasis, pulse ABP dropped to 34 mmHg before the load and to 36 mmHg after the physical load. Analysing the dynamics of pulse ABP during orthostasis, the results revealed a difference between the results before and after exercise, but the statistically significant difference was reached only in the third minute of orthostasis ($p < 0.05$). Even though before the workload pulse ABP after the first minute of orthostasis started to increase slightly, after the physical

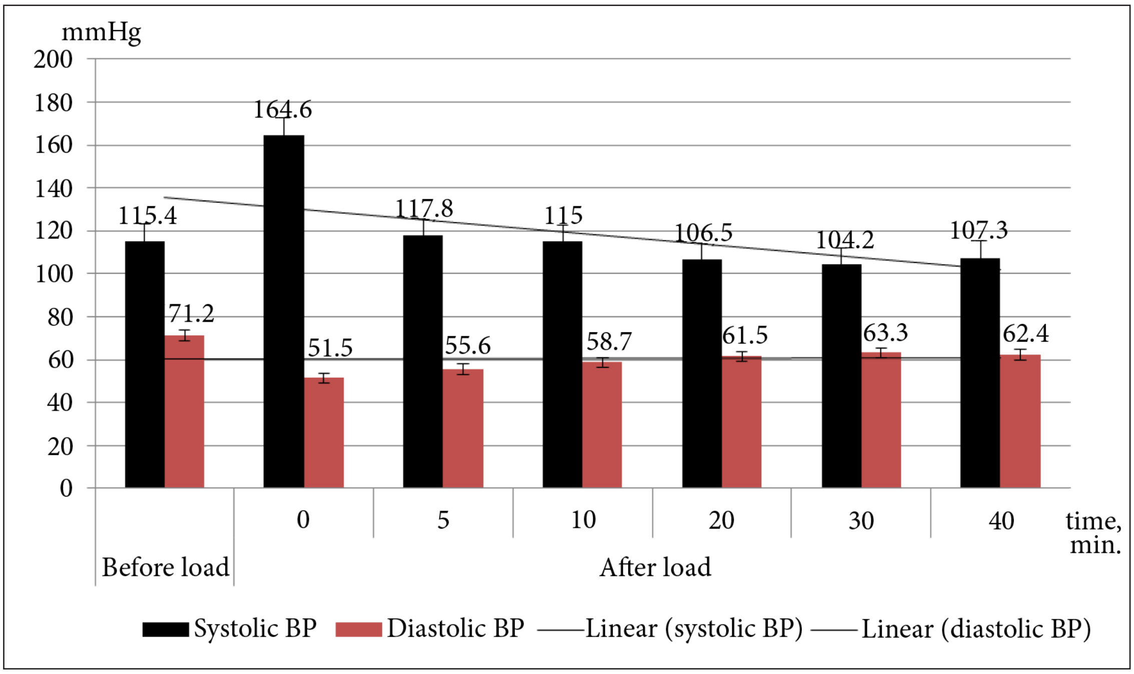

Fig. 6. ABP dynamics after workload

load during orthostasis the mean pulse ABP remained almost unchanged – 36 mmHg.

The measurement of the women's ABP after the physical load and the recovery period revealed the following results: if before the load systolic and diastolic ABP was within the physiological range of normal ABP, then after the workload a significant decrease in diastolic ABP was observed (Fig. 6).

The largest decrease in diastolic ABP was recorded during the first five minutes after exercise – diastolic ABP decreased from 71.2 ± 2.0 mmHg to 51.5 ± 2.8 mmHg, while systolic ABP increased from 115.4 ± 2.3 mmHg to 164.6 ± 3.0 mmHg. This increase was observed only in the first few minutes, later on it started to decrease. After the load at the end of the rest period systolic ABP reached lower values compared with the same data before the load – 107.3 ± 2.2 mmHg.

The observed feature of diastolic ABP was different during the resting period compared with systolic ABP – it was characterized by stable, gradually increasing variations of the observed parameter. Within 40 minutes of rest, diastolic ABP increased from 51.5 ± 2.8 mmHg to 62.4 ± 1.6 mmHg.

DISCUSSION

Orthostatic intolerance indicates the hypersensitive autonomic system that overreacts to various stresses, proposing an impaired baroreflex response or malfunctioning of the target organs, the cardiac or peripheral vasculature. The mechanism responsible for switching from haemodynamic compensation to vasovagal physiology still has to be investigated and described in more details (Barón-Esquivias and Martínez-Rubio, 2003).

A number of methods have been discussed in scientific literature in order to determine parameters and protocols or methods for an early prediction of TTT outcome. Some recent studies have analysed the obstacles met in the analysis of the early prediction results (Gimeno-Blanes et al., 2011). However, the predictive capacity of functional cardiovascular parameters and the changes of these parameters induced by the passive TTT (without inductor agents) in the fatigue condition of healthy non-athletes have not been examined conclusively. The modulation of the regulatory mechanism during orthostatic stress and its consequences (Ichinose and Nishiyasu, 2012) are not fully understood. Therefore, in this study the authors aimed to evaluate the influence of fatigue on the dynamics of functional cardiovascular parameters during TTT in non-athlete women attending health improvement trainings.

The trend of cardiovascular response to TTT in the period when the vasovagal reaction emerges can reveal significant data for preventive or diagnostic purposes (Brignole et al., 2000). As for HR, the findings of the testing are considered normal if the transition to the upward position induces an increase of the parameter within the limits of the normal range. Also the morphological factor plays a significant role in the dynamics of HR: the bigger the ventricular end-diastolic diameter, the lower the maximum HR (Silva et al., 2007). The study results suggest that the baroreflex regulation and autoregulation are sensitive to the stress of orthostatic origin. Increased vagal modulation and peripheral vasodilatation are regulated by the autonomous nervous system. During the shift from orthostasis to clinostasis, after the physical load was applied, an abrupt and significant decline in HR ($p < 0.05$) was observed. In the period of the body recovery the inverse dynamics of the parameter was observed compared to the signal alteration during orthostasis.

The test results coincide with the findings of Gimeno-Blanes et al. (2011) who carried out tests with 28 subjects and analysed the influence of TTT on HR and ABP parameters. They found out that during the TTT period cardiac variability decreased significantly in the patients with negative TTT (negative TTT means that the patient did not show abnormal signs which cause the changes in HR or ABP) and the average RR intervals (the time elapsing between two consecutive R waves in the ECG) declined in all the subjects. In the latter case, comparing HR resting values and the values obtained during orthostasis, the significant difference ($p < 0.05$) was found. Such dynamics, according to Gimeno-Blanes et al. (2011), is the result of an increased sympathetic tone, causing the response to orthostatic stress. Although the nature of the changes is the same during the second TTT after applied physical workload a more pronounced bifurcation during shifts from one position to another and elevated HR values indicated body fatigue. Functional cardiovascular indices showed increased activeness of body functions after the exercise had been carried out. The dynamics of the parameters and the fact that most cardiovascular functional parameters recover faster after post-exercise testing show that the cardiovascular function during post-exercise testing improves, but that does not mean that the athlete is not fatigued. This is the evidence of the increased adaptation to the physiological processes.

If myocardium is insufficiently supplied with blood and the lack of oxygen occurs, the metabolic balance changes and causes changes in electric myocyte potentials which are evident in the recorded ECG (ST-segment depression). Thus, the functional assessment of ischemic events during exercise is also reasonable and shows the functionality of the heart (Ežerskis, 2010).

A limited possibility to investigate ST-segment and T wave changes caused by left ventricular hypertrophy (LVH) is challenging in terms of the possibility to distinguish between ischaemic and LVH related ST-segment depression alternations (LVH is common in persons with an increased working capacity and a functional state of the body) (Pollehn et al., 2002). Still ST-segment depression has been widely investigated and it is beneficial in terms of monitoring metabolic processes of myocardium. Our findings revealed pronounced changes of ST-segment depression during the orthostatic test. Before and after the load in the resting supine position ST-segment depression alternated within the normal range. The increased imbalance of metabolic processes of the myocardium and the applied physical load are evident in the ST-segment depression dynamics during the shifting to orthostasis which shows the statistically significant difference between a steady state and orthostasis ($p < 0.05$). Upon return to the lying position, ST-segment alternation returns to the normal range, and the comparison of the values obtained during orthostasis and clinostasis also revealed statistically significant differences ($p < 0.05$). ST-segment values before the test and during clinostasis differed insignificantly, because ST-segment depression reached during clinostasis was close to its initial state, as it was before orthostasis. Also a fast recovery of the parameter to the initial state exhibits the subject's increased working capacity and an optimized functional state of the body.

The syncopal vasovagal phase can be easily determined at the time of an abrupt fall in diastolic ABP suggesting a sympathetic withdrawal. This is accompanied by a decrease in systolic and pulse ABP. The decrease in the HR coincides with or follows shortly after the decrease of ABP (Barón-Esquivias and Martínez-Rubio, 2003).

Peripheral vasoconstriction and elevated HR are decisive cardiovascular adjustments to orthostatic stress and determine a part of the reflex response generated via carotid sinus, aortic baroreceptors (ABR) and cardiopulmonary stretch receptors. Kamiya et al. (2005) suggested that one or more control systems governing the muscle nerve sympathetic activity (MSNA) are modulated prior to the inhibition of MSNA during the development of orthostatic syncope. Therefore, modulation of ABR function under orthostatic stress, possibly, one of the mechanisms maintaining ABP and limiting orthostatic hypotension, and impairment of ABR control over sympathetic vasomotor activity leads to a severe hypotension associated with orthostatic syncope (Ichinose and Nishiyasu, 2012). A positive TTT leads to a trend toward significantly larger systolic-diastolic differences (Gimeno-Blanes et al., 2011) since systemic blood flow regulatory mechanisms are oriented to maintain the pressure gradient which is essential for insuring the adequate blood flow in active muscles.

After the orthostatic test was applied in post-exercise conditions, significant changes occurred in the ABP dynamics. In response to the changing conditions – shifting from the supine to the upright position – a statistically significant decrease of systolic ABP was present during orthostasis ($p < 0.05$). Similarly, the comparison of systolic ABP before and after the workload also showed that the significant difference was noted during orthostasis ($p < 0.05$). Bradycardia observed in the state of presyncope turns out to be more closely related to the withdrawal of sympathetic system activity than to the induced parasympathetic cardiac activity (Jardine et al., 1998).

In the acute phase of recovery after the physical workload the changes were more pronounced in the peripheral vascular reactions: diastolic ABP varied more than systolic ABP. The degree of fatigue and the changes in the functional state of the subjects were reflected in the changes of the initial ABP values (diastolic ABP). Statistically significant changes of diastolic ABP obtained during the steady state and the first minute of orthostasis also differed significantly before and after the physical load ($p < 0.05$). Similarly to the findings of Brignole et al. (2000), the results showed that autonomic regulation is sensitive to orthostatic stress: although in the latter case the transition from the supine to the upright position has a stronger effect on the cardiovascular system than the transition to the horizontal position.

Other ABP parameters, such as pulse ABP, have changed as a consequence of diastolic pressure variations. The local circulatory system was effectively controlled when the hydrodynamic vascular resistance was changing, thus pulse ABP is a significant indicator. The increased baroreceptor excitation leads to vasodilatation, consequently – a reduced peripheral vascular resistance (Poškaitis et al., 2007). The analysis of pulse ABP dynamics during the orthostatic test before and after the physical load revealed that the test vessel is in good condition and able to respond to physical stress and its induced cardiovascular effects.

The results of observing the dynamics of pulse ABP during orthostasis revealed the difference between the results before and after exercising, but the statistically significant difference was reached only in the third minute of orthostasis ($p < 0.05$). Based on the test results, which coincide with the findings of other investigators (Qi Fu, 2012), it was established that a moderate fall in the cardiac output with the following vasodilatation was evident in the majority of presyncopal subjects. Goldstein et al. (2003) proposed that circulating adrenaline alone without any changes in the sympathetic activity may also contribute to vasodilation during syncope by sending impulses to vasodilatating β2-adrenergic receptors in the blood vessels of skeletal muscles.

The analysis of the results confirmed that the interaction of central and peripheral indices changes significantly in a fatigue condition when TTT is applied. Coronary insufficiency is a factor limiting application of strenuous exercise therefore it can be evaluated employing orthostatic stress. Thus, the orthostatic test is a simple test procedure in which regulatory mechanisms of reorganization of functional body systems and their interaction allow a more pronounced evaluation of the cardiovascular functional state.

CONCLUSIONS

ECG recording during the head-up tilt table test allows to assess the functional fitness of cardiovascular system and the changes induced by increasing fatigue.

The higher degrees of changes in the central and peripheral cardiovascular parameters were revealed while the orthostatic test performed in the state of fatigue, and in individuals with a lower functional fitness functional ischemic myocardial events emerged.

The post-exercise hypotension was noted after the aerobic exercise training session, and the increase of peripheral vascular tone in response to orthostasis was decelerated.

Received 15 January 2014
Accepted 22 March 2014

References

1. Barón-Esquivias G, Martínez-Rubio A. Tilt table test: state of the art. Ind Pac Electrophysiol J 2003; 3(4): 239–52.
2. Brignole M, Menozzi C, Del Rosso A, Costa S, Gaggioli G, Bottoni N, Bartoli P, Sutton R. New classification of haemodynamics of vasovagal syncope: beyond the VASIS classification. Europace 2000; 2: 66–76.
3. Ežerskis M. Dynamics of cardiovascular functional indices of elite Greco-Roman wrestlers during annual training cycle. Doctoral thesis. Lithuanian Academy of Physical Education. 2010; p. 49.
4. Gimeno-Blanes JL, Rojo-Álvarez, Caamaño AJ, Flores-Yepes JA, García-Alberola A. On the feasibility of tilt test outcome early prediction using ECG and pressure parameters. EURASIP J Advanc Signal Process 2011; 33: 1–7.
5. Goldstein DS, Holmes C, Frank SM, Naqibuddin M, Dendi R, Snader S, Calkins H. Sympathoadrenal imbalance before neurocardiogenic syncope. Am J Cardiol 2003; 91: 53–58.
6. Grubb ABP, Kosinski D. Neurocardiogenic syncope and related syndromes of orthostatic intolerance. Cardiol Rev 1997; 5:182–189.
7. Hain TC. Neurophysiology of vestibular rehabilitation. NeuroRehabilitation 2011; 29(2): 127–141.
8. Ichinose M, Nishiyasu T. Arterial baroreflex control of muscle sympathetic nerve activity under orthostatic stress in humans. Front Physiol 2012; 3(314): 1–10.
9. Jardine DL, Ikram H, Frampton CM, Frethey R, Bennett SI, Crozier IG. Autonomic control of vasovagal syncope. Am J Physiol 1998; 274(6 Pt 2): 2110–2115.
10. Kamiya A, Hayano J, Kawada T, Michikami D, Yamamoto K, Ariumi H, Shimizu S, Uemura K, Miyamoto T, Aiba T, Sunagawa K, Sugimachi M. Low-frequency oscillation of sympathetic nerve activity decreases during development of tilt-induced syncope pre-

ceding sympathetic withdrawal and bradycardia. Am J Physiol Heart Circ Physiol 2005; 289: 1758–1769.

11. Kruit MC et al. Syncope and orthostatic intolerance increase risk of brain lesions in migraines and controls. Neurology 2013; 80: 1958–1965.
12. Mailey EL, White SM, Wójcicki TR, Szabo AN, Kramer AF, McAuley E. Construct validation of a non-exercise measure of cardiorespiratory fitness in older adults. BMC Public Health 2010; 10: 59.
13. Nemati S, Lehman LW, Adams RP, Malhotra A. Discovering shared cardiovascular dynamics within a patient cohort. Conf Proc IEEE Eng Med Biol Soc 2012; 6526–9.
14. Fu Q, Verheyden B, Wieling W, Levine BD. Cardiac output and sympathetic vasoconstrictor responses during upright tilt to presyncope in healthy humans. J Physiol 2012; 590(8): 1839–1848.
15. Pollehn T, Brady WJ, Perron AD, Morris F. The electrocardiographic differential diagnosis of ST segment depression. Emerg Med J 2002; 19: 29–135.
16. Poškaitis V, Miseckaitė B, Venskaitytė E, Poderys J, Vainoras A. Characteristics of changes in oxygen saturation in muscular tissue and ischemic episodes in cardiac muscle during the bicycle ergometry. Medicina (Kaunas) 2007; 43(5): 385–389.
17. Radke A et al. Evidence for a vestibulo-cardiac reflex in man. The Lancet 1992; 356: 736–7.
18. Silva RT, Martinelli Filho M, de Oliveira JC, de Lima CE, Martins DG, Guirao CI, Nishióka SA, Costa R, Sosa EA, Ramires JA. Ventricular remodelling in right ventricular apical pacing. Arq Bras Cardiol 2007; 88(2): 152–8.
19. Suetani H, Horita T, Mizutani S. Noise-induced order in type-I intermittency. Proceedings of SPIE 2004; 5471: 445–456.
20. Vainoras A. Functional model of human organism reaction to load – evaluation of sportsman training effect. Educ, Physic Train, Sport 2002; 88–93.

Aušrinė Packevičiūtė, Eurelija Venskaitytė, Kristina Poderienė, Jonas Poderys

NUOVARGIO POVEIKIS NESPORTUOJANČIŲ MOTERŲ ŠIRDIES IR KRAUJAGYSLIŲ SISTEMOS FUNKCINĖS BŪKLĖS RODIKLIŲ KAITAI ORTOSTATINIO TESTO METU

Santrauka

Širdies ir kraujagyslių sistemos (ŠKS) atsako ypatumai, kai ortostatinio testo metu pasireiškia klajojančio nervo reakcija, gali suteikti reikšmingų duomenų ŠKS sutrikimų prevencijai ar diagnostikai. Šio tyrimo tikslas – įvertinti nuovargio poveikį moterų ŠKS funkcinės būklės rodiklių kaitai ortostatinio testo metu.

Tyrime dalyvavo sveikos merginos (n = 20), reguliariai lankančios sveikatos stiprinimo fiziniais pratimais užsiėmimus. Pratybų metu visos tiriamosios atliko 30 min. trukmės vidutinio intensyvumo aerobinį krūvį (bėgimą ristele). Prieš pratybas ir po jų buvo vertinta ŠKS reakcija į ortostatinį testą: buvo registruojama 12 standartinių derivacijų elektrokardiograma (EKG) ir matuojamas arterinio kraujo spaudimas (AKS).

Tyrimo rezultatai atskleidė reikšmingus ŠKS funkcinės būklės rodiklius: širdies susitraukimo dažnį, ST-segmento depresiją, sistolinio, diastolinio ir pulsinio AKS pokyčius po fizinio krūvio ($p < 0,05$). Arterinis kraujo spaudimas padidėdavo ortostatinio poveikio metu ir mažėdavo ŠKS reaguojant į klinostatinį poveikį. Po aerobinio krūvio buvo nustatyta hipotenzija, reaguodamas į ortostazę sumažėjo periferinis kraujagyslių tonusas. Tyrimo rezultatai patvirtino, kad ŠKS reguliaciniai mechanizmai yra jautrūs ortostatiniams poveikiams, o tai leidžia vertinti reikšmingas ŠKS funkcijos ypatybes.

Raktažodžiai: ortostatinis testas, širdies ir kraujagyslių sistema, nuovargis