

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Functional Features Of Microcirculatory Processes In Obese Women Against A Background Of Long Daily Wearing Of Corrective Clothing.

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ABSTRACT

The development of obesity inevitably affects the aesthetic characteristics of the female figure. With this, many women do not want to put up and often resort to correcting the situation to wearing corrective clothing. At the same time, this event requires additional safety assessment with regard to the effect on the process of hemocirculation in vessels of the smallest caliber. In the work, the effect of the daily wearing of the author's version of corrective clothing for six months on microcirculatory parameters in 43 women with obesity of 1 degree in the gynoid type was assessed. Control is represented by 37 clinically healthy women of the second adulthood. In the work performed instrumental, laboratory and statistical methods of conducting the research are applied. As a result of the semi-annual wearing of corrective clothing, observed women maintained normal microcirculation on the lower extremities. This became possible as a result of maintaining normal linear systolic blood flow velocity, linear mean flow velocity, mean volumetric flow velocity and systolic blood flow velocity. In the plasma of observed obese women for 6 months wearing corrective clothing, the physiological balance between metabolites of arachidonic acid-thromboxane B₂ and 6-keto-prostaglandin F1 α was maintained. This was accompanied in the surveyed women by maintaining a high plasma content of total metabolites of nitric oxide at a level close to the control one. The women wearing corrective clothing worn regularly showed a high content of erythrocyte-discocytes in the blood and optimal amounts of reversibly and irreversibly altered forms of red blood cells. At the same time, the normal activity of erythrocyte aggregation, estimated by the amounts of the erythrocyte sum in the aggregates, the number of these aggregates and the level of the red cells not aggregated in erythrocytes, was preserved in the observation group after 6 months. The results obtained suggest that the wearing of second-generation corrective clothing by women with obesity does not affect the normal level of microcirculation and rheological properties of erythrocytes. In this regard, wearing women with obesity corrective clothing is completely safe with respect to metabolism in tissues.

Keywords: women, second mature age, obesity, erythrocytes, microcirculatory bed, aggregation, surface properties of the membrane, corrective clothing.

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INTRODUCTION

Modern women of adulthood often have obesity [1]. The basis of its development, as a rule, is the presence of simultaneously excessive food, low physical activity and genetic predisposition [2,3]. Their combination leads to the development of obesity in women of working age in all regions of the planet [4,5].

It is noticed that pronounced obesity almost always leads to a deterioration of the general functional state of the organism [6]. This is due to the extremely negative influence of pronounced obesity on the functioning of most internal organs [7]. The growth of anabolic processes in adipose tissue is accompanied by dysfunctions of vital organs, which forms hypoxia in them [8], often disrupting anabolic processes in them and weakening their vitality [9]. This creates the basis for the development of various pathologies in the internal organs [10,11] and promotes the appearance of a persistent vasospasm [12,13].

However, the initial manifestations of obesity often cause women great psychological discomfort and a desire to improve the situation [7]. To this end, they often use various dietary restrictions, regular exercise and medication aimed at reducing the mass of adipose tissue in the body [14]. However, not all women are acceptable for such types of effects on the body [15]. In many cases, it may be acceptable to have more appropriate and less time-consuming and applied efforts to wear corrective clothing [16]. Its daily use can make problematic parts of the body of women visually smaller by several dimensions [17]. This can provide women with obese obesity a sufficient degree of psychological comfort, increase their level of satisfaction with their figure and instill a sense of self-confidence. [18] At the same time, among women there is an unsupported opinion about the possibility of negative influence of corrective clothing on blood circulation in the zone of its wearing and on the body as a whole [19]. In this point of view, the information obtained earlier in the clinic [20,21] and in the experiment [22,23] on the possibility of a positive effect of various non-medicamentous effects on the processes of microcirculation [24] is questioned. At the same time, in this situation, it was entirely justified to conduct additional studies on the nature of the effect of daily wearing of corrective clothing on microcirculation. In this connection, the goal is to assess the state of the characteristics of microcirculation in women of the second adulthood with obesity of the 1st degree, who daily carried the author's version of corrective clothing for six months.

MATERIALS AND METHODS OF RESEARCH

The work was done on women living in Central Russia (Moscow and Moscow region). In the study, 33 healthy women of the second adulthood (mean age 42.1 ± 2.2 years) were taken, which comprised a control group. Also, 45 women of the same age (mean age 43.2 ± 1.8 years) with obesity of the 1st degree in the gynoid type, who made up the observation group, were examined. The diagnosis of obesity and its degree was made in accordance with the current criteria. The accompanying chronic diseases (chronic bronchitis, chronic tonsillitis, chronic cholecystitis) in some women from the observation group were in all cases permanently in a state of persistent long-term remission. The study was approved by the local ethics committee of the Russian State Social University on May 14, 2015 (protocol №5). All the women surveyed gave written, voluntary, informed consent to participate in the study.

For the evaluation of microhemodynamics in the lower limbs, a non-invasive transcutaneous ultrasound dopplerography was used, equipped with the Minimax-Doppler-K diagnostic system manufactured by Minimax (Russia). The condition of microcirculation was determined on the nail rolls of the first toes, using an ultrasonic sensor of 25 MHz. The following parameters were taken into account in the study: linear systolic blood flow velocity (Vas), linear mean flow velocity (Vam), volume systolic blood flow velocity (Qas), mean space velocity of blood flow (Qam).

The activity of the processes of lipid peroxidation (LPO) in the blood plasma was determined, which was recorded by the content of thiobarbituric acid-active products in it with the help of the Agat-Med (Russia) and acyl hydroperoxides (AHP) level [25]. In all cases, the antioxidant activity of the blood was recorded [26].

In the blood plasma of the examinees, the content of the metabolite of thromboxane A_2 -thromboxane B_2 and the metabolite of prostacyclin-6-keto-prostaglandin $F_{1\alpha}$ was determined by enzyme immunoassay with the help of Enzo Life science kits (USA). Also in the plasma, the total content of nitrogen oxide metabolites was determined [27].

After washing and resuspension in erythrocytes, the levels of cholesterol were quantitatively evaluated by the enzymatic colorimetry method using the "Vital Diagnosticum" (Russia) kit and the total phospholipids in terms of the amount of phosphorus they contain [28].

The severity of the processes of intra-erythrocyte LPO was elucidated in washed and resuspended erythrocytes by the concentration of malonic dialdehyde (MDA) in the reduction reaction of thiobarbituric acid and the number of AHP [25].

The state of microrheological properties of erythrocytes was judged by their cytoarchitectonics and aggregation. The number of normal and altered forms of erythrocytes in the blood was determined with the help of light phase-contrast microscopy [29]. The ability of erythrocytes to spontaneously aggregate was established with the help of light microscopy by counting in the Gorjaev chamber the number of erythrocyte aggregates, the number of reaggregated and non-aggregated erythrocytes [29].

All women of the observation group for 6 hours a day for 6 months each carried the corrective clothing developed by the author, designed to correct the figure and reduce its visual perception. The female figure corrective figure used in the work consisted of interconnected front and back panels made of fabric, forming, when connecting the trousers, in which the leg openings and the waist opening were edged with an elastic band. In the front middle seam of the applied product, there was a connecting element consisting of a vertical row of hooks and several vertical rows of loops in response to them. The panels consisted entirely of elastic fabric. In the perineal region, an opening was made on each panel [30].

Women of the observation group were examined and examined at the end and after 3 months and 6 months of daily wearing corrective clothing. The inspection team was inspected and examined once.

The results obtained in the work were processed by Student's criterion (t).

RESULTS OF THE STUDY

Daily wearing of corrective clothing provided women with greater slenderness of their figures, reducing their visual perception by 2-3 sizes. This provided women with great psychological satisfaction, gave them a sense of self-confidence and was not accompanied by any negative feelings during wearing the corrective clothes applied.

Estimation of the initial rates of microcirculation in women with obesity of 1 degree showed its compliance with the control values. So in this group of women on the lower extremities, the optimal speed of blood flow was noted: linear velocity in systole from both sides, average linear velocity on both sides, average volume velocity on the right and left at normal level of mean space velocity in systole on the right and on the left.

In the examined, who had obesity of 1 degree, the normal level of LPO processes was noted in the outcome (Table 1). The amount of AHP and thiobarbituric acid products in their plasma did not differ from the control (1.75 ± 0.036 D₂₃₃/1 ml and 3.19 ± 0.049 $\mu\text{mol/l}$, respectively). This was provided by their high activity of antioxidant protection of plasma ($32.0 \pm 0.44\%$).

In the blood of the examined women with beginning obesity, a strict balance of arachidonic acid metabolites was noted in the outcome: the level of thromboxane B₂ and 6-keto-prostaglandin F_{1 α} in their plasma was comparable with the control (Table 1). This was accompanied in them in the outcome by a high content of plasma in the amount of total metabolites of nitric oxide, not differing from the reference values.

In the erythrocyte membranes of women in the observation group, the normal cholesterol content (0.95 ± 0.009 $\mu\text{mol}/10^{12}$ erythrocytes and total phospholipids (0.73 ± 0.008 $\mu\text{mol}/10^{12}$ erythrocytes) was noted. In the control, similar parameters were comparable: cholesterol 0.94 ± 0.010 $\mu\text{mol}/10^{12}$ erythrocytes and total phospholipids 0.72 ± 0.008 $\mu\text{mol}/10^{12}$ erythrocytes). This was accompanied by a low activity of LPO in erythrocytes (AHP 3.18 ± 0.007 D₂₃₃/10¹² erythrocytes, MDA 1.44 ± 0.009 nmol/10¹² erythrocytes), comparable with the level in the control group (AHP 3.15 ± 0.009 D₂₃₃/10¹² erythrocytes, MDA 1.44 ± 0.011 nmol/10¹² erythrocytes).

In the examined women who had obesity of the 1st degree when taking under supervision, a high level in the blood of erythrocytes-discocytes, not differing from the control, was noted (Table 1). The number of reversibly and irreversibly altered forms of red blood cells in their blood was small and also corresponded to control. At the same time in obese women, taken in the study, a low aggregation activity of erythrocytes was found. This was indicated by a low level of total involvement of red blood cells in aggregates, a small number of these aggregates and a large number of free erythrocytes, the level of which was comparable with the level of the control group.

Daily wearing of author's corrective clothing provided a rapid visual decrease in the size of the hips and an invariance of the optimum of the microcirculation parameters on the lower limbs. By the end of the observation on the legs of women wearing corrective clothes on a daily basis, the Vas, Vam, Qam and Qas values were recorded on the right and left.

As a result of the daily wearing of corrective clothing, the observed levels of lipid peroxidation in plasma were observed in observed women with initial signs of obesity. After 3 months of observation, the amount of AHP and thiobarbituric acid products in their plasma was 1.72 ± 0.046 D₂₃₃/1ml and 3.25 ± 0.040 $\mu\text{mol/l}$ (in the control 1.74 ± 0.032 D₂₃₃/1ml and 3.22 ± 0.037 $\mu\text{mol/l}$, respectively). By 6 months of applying corrective clothing, the content of AHP in the blood of women wearing it has also remained without dynamics. This turned out to be possible as a result of the stability of the antioxidant activity of the plasma, which remained at the level corresponding to the control.

In the plasma of women with obesity, who carried corrective clothing on a daily basis, a balance of arachidonic acid metabolites was noted. By 6 months of observation, the levels of thromboxane B₂ and 6-keto-prostaglandin F_{1 α} remained at a level close to the control values (Table 1). This was followed in 6 months after the maintenance of the content in their plasma of a high content of total metabolites of nitric oxide.

As a result of 3 months of wearing corrective clothing in the erythrocyte membranes of women with obesity of 1 degree, the optimal cholesterol level was 0.96 ± 0.005 $\mu\text{mol}/10^{12}$ erythrocytes and total phospholipids 0.72 ± 0.009 $\mu\text{mol}/10^{12}$ erythrocytes. Continuation of its wearing did not affect the lipid composition of red blood cells.

After 3 months of daily wearing corrective clothing, the normal normal in erythrocytes of women with obesity LPO did not change. After 6 months of constant use of corrective clothing, the content of LPO products in their erythrocytes also remained without dynamics (AHP 3.16 ± 0.010 D₂₃₃/10¹² erythrocytes and MDA to 1.42 ± 0.010 nmol/10¹² erythrocytes, respectively), corresponding to the control level.

Daily wearing of corrective clothing was accompanied by the stability of the percentage of discocytes in women's blood (Table 1). So, after 3 months of their application, the level in their blood of discoid red blood cells was $84.9 \pm 0.24\%$, not changing by 6 months to $85.5 \pm 0.19\%$. The number of reversibly and irreversibly altered forms of erythrocytes in the observation group as a result of wearing corrective clothing was stable, accounting for half a year of observations of $11.3 \pm 0.06\%$ and $3.2 \pm 0.06\%$, respectively.

Due to 6 months of daily use in women with obesity corrective clothing, stable compliance with the level of control of the amount of erythrocytes in aggregates, the number of these aggregates and the amount of freely lying red blood cells was noted.

DISCUSSION

Unfortunately, not every woman owns a slim figure today. At the same time, it is now possible to adjust the figure in women not only through dietary influences and physical training [10]. Now the production of corrective linen is adjusted, in which a woman can quickly become visually smaller by several sizes already during the day. It allows the female body to acquire more perfect forms and elasticity. The special value of corrective linen is associated with its ability to adjust the shape and volume of the hips in women with a gynoid obesity type [31]. In addition, the use of corrective clothing has an anti-cellulite effect and improves skin tone [32]. At the same time, there are still some fears that prolonged wearing of corrective clothing can negatively affect blood circulation parameters in women's tissues. To refute this erroneous view, the present study was conducted.

The performed estimation of microcirculation indices allows to consider that at obesity of 1 degree its optimum in the lower extremities is preserved. This is indicated by the normal level in this category of women Vas, Vam, Qam and Qas. This indicates that there is no shunting type of blood flow in the examined women and a sufficient degree of perfusion of their tissues. During the application of the author's version of corrective clothing, the preservation of microcirculation processes at the optimum level was noted. The stability of the condition of these indicators indicates the absence of the influence of corrective clothing on the vascular bed, which is confirmed by the preservation of the optimum of peripheral resistance and elasticity of the walls of microvessels, the sufficiency of perfusion of soft tissues at the time of systolic ejection and the influx of necessary blood into the tissue of women wearing corrective clothing [33,34]. Preservation of normal speed indicators against the background of the use of corrective clothing allows us to speak about maintaining the norm of microcirculatory channel parameters [35,36]. The revealed rate of blood flow velocity in the right and left lower extremities shows the indifference of corrective clothing with respect to vascular reactions and blood flow.

As a result of this study, it became clear that the daily wearing of corrective clothing can lead in women with obesity 1 degree to preserve the optimum of microcirculatory processes also due to the unchanged normal rheological properties of the most numerous group of blood cells - erythrocytes [37]. Of particular importance in this process is the maintenance of a high level of antioxidant protection of plasma, which inhibits the activity of LPO in the blood and inside the erythrocytes themselves [38]. A stably low amount of lipid peroxidation products in plasma and in erythrocyte membranes ensures the optimum of their condition from the outside and from the inside, which ensures the norm of their structure and function [39]. The stability of the lipid balance in the erythrocyte membranes is of great importance for maintaining a long optimum of erythrocyte parameters during the wearing of corrective clothing. This is an important mechanism for maintaining the normal functional characteristics of these blood cells, their normal selective permeability and the viscosity of the membrane. These phenomena stabilize the state of membrane-bound proteins, preserving their normal secondary and tertiary structure. The emerging situation contributes to the persistent preservation of the optimal state of the membranes of the bulk of the red blood cells present in the blood, minimizing the appearance of their reversibly and irreversibly altered forms.

Revealed during the wearing of corrective clothing in women with obesity phenomena of low aggregation of red blood cells can be regarded as the result of indifference of this clothing in relation to microrheological processes [42,43]. The low level in the blood of the observed women of the number of all altered red blood cells provides a reduction in the number of red blood cells on the background of wearing corrective clothing. The low expression of erythrocyte aggregation in these women during the entire period of wearing corrective clothing can also be largely explained by the weak effect on them of catecholamines, the level of which in blood under physiological conditions remains low [12]. This process is always accompanied by a decrease in the number of erythrocytes of α_2 receptors. This leads to the activation of adenylate cyclase, and as a consequence, to the growth of the level of cyclic adenosine monophosphate in them. In addition, the stably low aggregation of erythrocytes in women, also accompanied by corrective clothing, may also be related to the low level of free Ca^{2+} content in them [44].

At the heart of the optimum micro-rheological indicators, the daily wear of the corrective clothing of women is also based on the stability of the optimum synthesis of biologically active substances that can affect the aggregation of erythrocytes. This was confirmed by the optimal level of proaggregants detected in the blood of women. This was due to the invariably low activity of formation of thromboxane A_2 , which was judged by the low concentration in their blood of its inactive form - thromboxane B_2 . Also during the wearing of corrective clothing, observed women maintained a high level of his physiological antagonist - prostacyclin, which ensured the maintenance of a balance of metabolites of arachidonic acid in their blood. This condition was physiologically beneficial in women wearing corrective clothing, the stability of active production in the walls of blood vessels NO. This is probably due to the high activity of endothelial NO synthase in them. The absence of microrheological abnormalities in erythrocytes in these conditions also supports the optimum of microcirculation and trophic processes, including in the walls of blood vessels, thereby supporting the production of the necessary amount of disaggregants in them.

As a result of the study, it can be argued that for 6 months of applying corrective clothing in women with obesity beginning to ensure the full maintenance of the normal level of microcirculatory parameters. In this regard, we can assume that this type of exposure to the body is completely safe and very effective in

terms of visual correction of manifestations of obesity. In this regard, given the availability, ease of use and the lack of drug or physiotherapy load on the body, corrective clothing can be widely recommended to women with obesity, who can not otherwise adjust the manifestations of this condition.

CONCLUSION

The development of obesity in women is always accompanied by a deterioration in the visual qualities of the figure. This causes them the need to correct the situation, including by wearing corrective clothing. Its long-term use with a tight fit of the body causes fears in the development of microcirculation disorders in tissues when it is applied. The work assesses the impact of a 6-month daily wear of the author's version of corrective clothing on women with obesity of 1 degree. It was found that its use effectively reduced the visual dimensions of the body, keeping the processes of lipid peroxidation in plasma and red blood cells stably low. This was accompanied in these women by the stability of the normal level of microcirculation parameters. It was based on the preservation of the optimum of peripheral resistance and the invariability of high elasticity of microvessel walls. They provided functional sufficiency of perfusion of soft tissues at the time of systolic ejection. The women wearing corrective clothing worn regularly showed a stable optimum of surface membrane properties and aggregation of their erythrocytes, which persisted throughout the observation at the control level. It was proved that the use of corrective clothing does not have a negative effect on the functional parameters of the vascular wall and the rheological properties of red blood cells. This keeps in the normal course for these women microcirculation processes in the thigh and lower extremities and provides them with the necessary level of metabolism, which is the key to maintaining their well-being. The obtained results allow to consider the author's version of corrective clothing as a full-fledged component of correction of the figure of women, not dangerous to the health of their internal organs and preferred for mass application.

Table 1. Dynamics of the characteristics of the surveyed women with obesity against the background of wearing corrective clothing

Options	Women with obesity while wearing corrective clothing, n=45, M±m			Control, n=33, M±m
	initial state	3 months	6 months	
Vas right leg, cm/s	1.56±0.024	1.57±0,020	1.58±0.027	1.56±0.019
Vam right leg, cm/s	0.26±0.019	0.24±0,023	0.26±0.021	0.25±0.014
Qas right leg, ml/min	0.53±0.028	0,52±0,022	0.53±0,021	0.52±0.023
Qam right leg, ml/min	0.24±0.006	0.25±0.007	0.25±0,009	0.25±0.010
Vas left leg, cm/s	1.56±0.012	1.58±0.017	1.58±0.15	1.57±0.026
Vam left leg, cm/s	0.25±0.009	0.26±0.009	0.27±0.013	0.26±0.007
Qas left leg, ml/min	0.53±0.022	0.51±0.022	0.52±0.020	0.53±0.020
Qam left leg, ml/min	0.24±0.019	0.25±0.015	0.25±0.012	0.26±0.014
Acylhydroperoxides of plasma, D ₂₃₃ /l ml	1.75±0.036	1.72±0.046	1.76±0.041	1.74±0.032
Thiobarbituric acid-products of plasma, μmol/l	3.19±0.049	3.25±0.040	3.21±0.038	3.22±0.037
Antioxidant activity of plasma, %	32.0±0.44	31.9±0.35	32.4±0.40	32.3±0.44
thromboxan B ₂ , pg / ml	170.1±0.62	168.8±0.69	169.0±0.53	169.2±0.66

6-keto-prostaglandin F _{1α} , pg / ml	95.1±0.39	95.3±0.42	95.4±0.46	95.2±0.40
nitric oxide's metabolites, umol/l	35.9±0.22	36.1±0.30	36.3±0.29	36.2±0.27
cholesterol of erythrocytes, mkmol/10 ¹² erythrocytes	0.95±0.009	0.96±0.005	0.94±0.012	0.94±0.010
common phospholipids of erythrocytes, mkmol/10 ¹² erythrocytes	0.73±0.008	0.72±0.009	0.72±0.011	0.72±0.008
acylhydroperoxides of erythrocytes, D ₂₃₃ /10 ¹² erythrocytes	3.18±0.007	3.19±0.012	3.16±0.010	3.15±0.009
malonic dialdehyde of erythrocytes, nmol/10 ¹² erythrocytes	1.44±0.009	1.41±0.008	1.42±0.010	1.44±0.011
erythrocytes-discocytes, %	85.4±0.22	84.9±0.24	85.5±0.19	85.6±0.18
reversibly modified erythrocytes,%	11.2±0.10	11.6±0.12	11.3±0.06	11.0±0.08
irreversibly modified erythrocytes,%	3.4±0.09	3.5±0.12	3.2±0.06	3.4±0.07
sum of all the erythrocytes in an aggregate	33.0±0.12	32.8±0.12	32.7±0.13	32.7±0.11
quantity of aggregates	6.1±0.05	6.0±0.10	6.1±0.12	6.2±0.10
quantity of free erythrocytes	288.5±0.36	289.1±0.29	288.0±0.31	287.4±0.30

Note: there was no significant difference between the observation group and the control group throughout the study.

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