https://doi.org/10.52388/1857-064X.2021.1.04

COMBINATION OF SOMATOSENSORY STIMULATION AND DIET WITH A REDUCED GLYCEMIC INDEX IN THE PREVENTION AND CORRECTION OF OBESITY

Baciu Anatolie[1,4], Listopadova Liudmila[3,4], Fedas Vasile[1,2]

[1]-Institute of Physiology and Sanocreatology; [2]-N. Testemitanu State University of Medicine and Pharmacy; [3]-Moldova State University; [4]-Transnistria State University

Rezumat

Pentru a preveni și a corecta acumulare a excesului de masă grasă, în special a țesutului adipos visceral, a fost utilizată o combinație de stimulare somatosenzorială sub formă de masaj reflex cu utilizarea unei diete cu un indice glicemic redus. Au fost relevate modificări ale parametrilor antropometrici, ale profilului lipidic, precum și creșterea coeficientului aterogen în funcție de indicele de masă corporală. Organizarea și implementarea unui program preventiv și de îmbunătățire a sănătății bazat pe o combinație de stimulare somatosenzorială și o dietă cu un indice glicemic redus permite corectarea profilului lipidic, reducând severitatea acumulării de masă grasă visceral.

Cuvinte cheie: stimulare somatosenzorială; indice glicemic redus; țesutului adipos visceral; profilul lipidic.
Depus la redacţie: 20 iulie 2021.

---

*Adresa pentru corespondenţă:*Baciu Anatolie, Institutul de Fiziologie şi Sanocreatologie, str. Academiei, 1, MD-2028, Chișinău; anatolikbacio@gmail.com, tel. mobil.: +37368185223

Introduction

Various forms of human behavior are mainly aimed at ensuring their safety, satisfaction from achieving the set goal, preventing threats and pathologies induced by stress. Compliance with these conditions leads to an emotional sensation of pleasure. Food consumption with a high glycemic, fat and protein index is also associated with the generation of positive emotions, due to the activation of the mesolimbic and mesocortical reward systems. However, the use of such food in combination with insufficient physical activity (sedentary behavior), as well as genetic predisposition, underlie the genesis of metabolic disorders leading to the development of obesity, type 2 diabetes mellitus and metabolic syndrome. Whereas the use of various somatosensory reflex stimulations ensures the action of mechanisms for regulating energy and plastic balance, metabolic homeostasis and anti-inflammatory mechanisms. The complex of somatosensory afferent signals coming from the skin, adipose and muscle tissues, as well as from the organs of the digestive and reproductive systems make a significant contribution to the regulation of eating behavior, the balance of energy and plastic metabolism [4, 5].

The production of physiologically active factors (tumor suppressor candidate 5, TUSC5, and synuclein-γ), depending on the degree of manifestation of obesity, exhibits unusually high co-expression in fat cells (adipocytes) and sensory neurons. It is obvious that sensory afferentation is closely interrelated with carbohydrate and lipid metabolism, and the endocrine function of adipose tissue [14, 19, 20]. Thus, in the mechanism of the pathogenesis of diabetic neuropathy, there is a clear link between diabetes mellitus, insulin resistance and peripheral nervous system dysfunction [20]. Sensory signaling from adipose tissue transmits metabolic information from the periphery to the higher nerve centers that regulate energy and plastic metabolism. Nerve sensory projections, ascending from adipose tissue, reach the formations of the brain stem, the nuclei of the hypothalamus, in particular, the neurosecretory cells of the paraventricular nucleus and the preoptic region of the hypothalamus [2]. These projections, presumably, form a feedback loop between the sensory elements of adipose tissue and the centers of neuroendocrine regulation of maintaining homeostasis. Sensory ascending pathways provide the transmission of detailed, strictly differentiated information about lipid metabolism and the structural and functional status of adipose tissue as the main reserve of the energy substrate. Bidirectional connections between the periphery and the center underlie the fine coordination of changes, in general, in body weight and, in particular, the ratio of adipose, muscle tissue, bone density, and the amount of intercellular fluid [7]. For example, the effect of leptin circulating in the bloodstream is associated with sensory activation of brain centers, which is induced by adipose tissue. Somatosensory stimulation changes the sensitivity of tissues and nerve centers to insulin associated with an effect on the endocrine function of the pancreas [23, 25]. In obese people without signs of diabetes, as well as in laboratory animals with obesity caused by a diet with a

high glycemic and fat index, disorders of motor and sensory nervous reactions are directly associated not with fasting blood glucose levels, but with hyperinsulinemia and decreased insulin sensitivity [6, 12, 13].

Importantly, unlike muscle and adipose tissue, nerve cells do not require insulin to absorb glucose. However, insulin receptors are present in the peripheral nervous system, and insulin signaling stimulates neurite growth and sensory neuron regeneration [22, 24]. Modifications of the diets used, the status of energy and plastic metabolism, manifested in the form of changes in the lipid profile and lipid peroxidation, significantly affect the physiology of the peripheral nervous system. The antistress effect of somatosensory stimulation is associated with the activation of the neurosecretory activity of the hypothalamus, in particular, the production of oxytocin and the enhancement of its effect on target cells. Oxytocin is released in response to the activation of sensory neurons not only during childbirth and breastfeeding [21], but also upon contact of the infant's skin with the mother's skin [12], during physical, positive, warm interaction between people [10], as well as during communication people with animals (pets) [6, 13, 17]. An increase in oxytocin neurosecretion and characteristic changes in the psychoemotional state are found during certain types of massage [25], stimulation of the nipple during sucking by newborns [11] and when taking hedonic food [18]. Eating hedonic food has the potential to induce pleasure.

The aim of the investigation is to test the effectiveness of the combination of reflex massage with a diet with a reduced glycemic index in the program for the prevention and correction of overweight and obesity.

Material and methods

The subjects of the study were female individuals (n = 20) with overweight, as well as signs of obesity of varying degrees, undergoing a course of reflexotherapy based on somatosensory stimulation in the form of massage and pressopuncture (acupressure). Pressopuncture (acupressure), in contrast to acupuncture, is a non-invasive method of mechanical reflexogenic action on biologically active points (BAP). Somatosensory stimulation was performed once a day for a period of 21 days, anthropometry, determination of body weight and calculation of body mass index (BMI) were performed daily. The Waist to Hip Ratio (WHR) and BMI values were assessed in accordance with the recommendations of the experts from the World Health Organization (WHO). Individuals were divided into groups depending on body mass index: 1st group (control, n = 5) – BMI = 24.8 ± 2.9; 2nd group (n = 5) – BMI = 33.2 ± 3.6; 3rd group (n = 5) – BMI = 36.4 ± 4.1; 4th group (n = 5) – BMI = 42.3 ± 4.6. In addition, the entire contingent of the surveyed women was divided into two groups depending on the applied method of somatosensory stimulation in the form of reflex massage: 1st group (n = 10) – segmental reflex massage; 2nd group (n = 10) – acupressure reflex massage. For acupressure reflex massage in accordance with the recommendations of traditional Chinese medicine, bioactive points were selected: stomach meridian: ST25 (Tianshu), ST21 (Liangmen), ST36 (Zusanli); spleen meridian: SP6 (Sanyinjiao), SP15 (Daheng); large intestine meridian: LI11 (Quchi); Zhigou point: SJ6 or TE6 on both sides (bilaterally), as well as points in the abdominal region: Ren12 or CV12 (Zhongwan); Ren6 or CV6 (Qihai). After the standard procedure of disinfection of the skin surface, mechanical manual somatosensory stimulation was performed in the area of localization of the corresponding points, using rhythmic pressure with moderate force and rotational

movements for 2-3 minutes. The session lasted 25 minutes. For segmental reflex massage, the meridian of the stomach, large intestine (Yangming), the meridian of the gallbladder (Dai) and the Ren channel in the abdominal cavity were selected. The glycemic index of the consumed diet was reduced by excluding confectionery, liver, sweet curds and yoghurts from the diet, replacing it with fresh fruits and vegetables. The concentrations of triglycerides (Tg) and total cholesterol (TC) in plasma were determined by the enzymatic method on an automatic analyzer (Analyzer A15, BioSystem S.A., Spain). The concentration of high density lipoproteins (HDL) was strictly dosed in the supernatant after precipitation of low density lipoproteins (LDL) and very low density lipoproteins (VLDL) with divalent cations. The concentrations of LDL and VLDL were calculated using the Friedewald formula: LDL = CX - (Tg / 5) - HDL (mg / dL). VLDL = TG / 5 (mg / dL). Alternatively, we can use the unit of measurement: mmol / L. The coefficient of atherogenicity (CA) was also established by calculation: CA = (TC - HDL) / HDL. Dyslipidemia was determined at Tg > 1.8 (mmol / L) and / or Tg > 6.2 (mmol / L), HDL <1.0 (mmol / L). Blood samples were taken in the morning on an empty stomach. The statistical significance of the results obtained was assessed using the Student's t-criterion test. The minimum statistically significant difference was considered at a significance level below 0.05 ($P < 0.05$).

Results and discussion

Analysis of the results obtained indicates that both segmental and point reflex massage (acupressure) are effective, namely, in combination with a diet with a reduced glycemic and fat index and/or with exercise. The effects of combining somatosensory stimulation with diet and exercise are reflected in significant reductions in body weight, in particular body mass index, waist-to-hip ratio (Fig. 1), and percentage of adipose tissue compared to subjects non-undergone reflexology course. However, the decrease in the proportion of adipose tissue is more pronounced in the abdominal region than in the hips. The beneficial effect of somatosensory stimulation on body weight, body mass index, waist-hip ratio, on the proportion of adipose tissue increases as the duration of the course increases, for example, starting from a 4-, 6- and 8-week course and ending with a 12-week course.

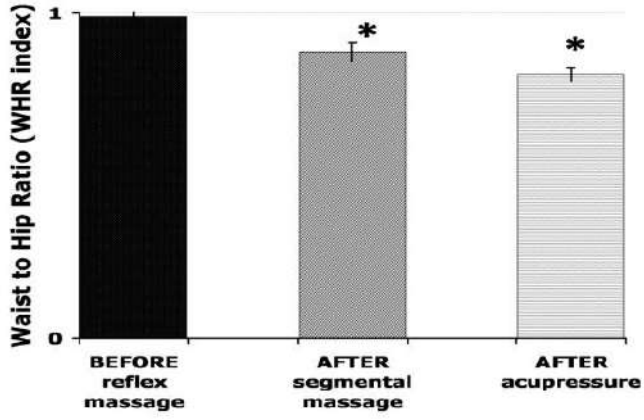

Figure 1. Anthropometric indicator (waist to hip ratio, WHR index) in representatives of groups that have undergone a course of reflex massage: segmental and acupressure in combination with a diet with a reduced glycemic index.

It is significant that the lipid profile in the examined subjects is modified in a clear dependence on the body mass index, while statistically significantly different from the results obtained in the control group. In a number of groups with an increased body mass index, hypertriglyceridemia and hypercholesterolemia are found, characterized by an increase in total cholesterol (TC) and a decrease in the concentration of high density lipoproteins (HDL) against the background of an increase in the concentration of low density lipoproteins (LDL) and very low density lipoprotein (VLDL) fraction (Fig. 2).

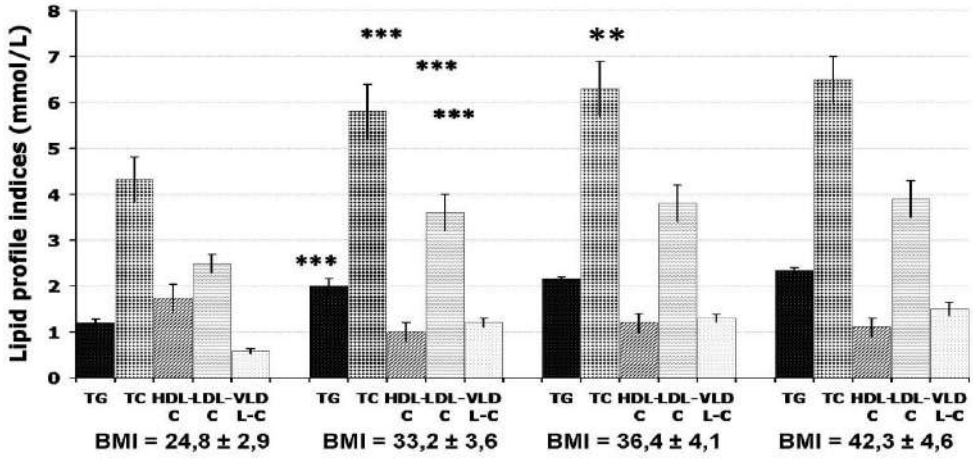

Figure 2. Modification of the lipid profile in the examined subjects depending on their body mass index (BMI).

These data demonstrate that the examined individuals with an increased body mass index show mixed dyslipidemia. This manifestation of dyslipidemia is accompanied by a high degree of atherogenic risk, reflected by an increased coefficient of atherogenicity (Fig. 3). Carrying out a course of somatosensory stimulation and diets made it possible to reduce their manifestations.

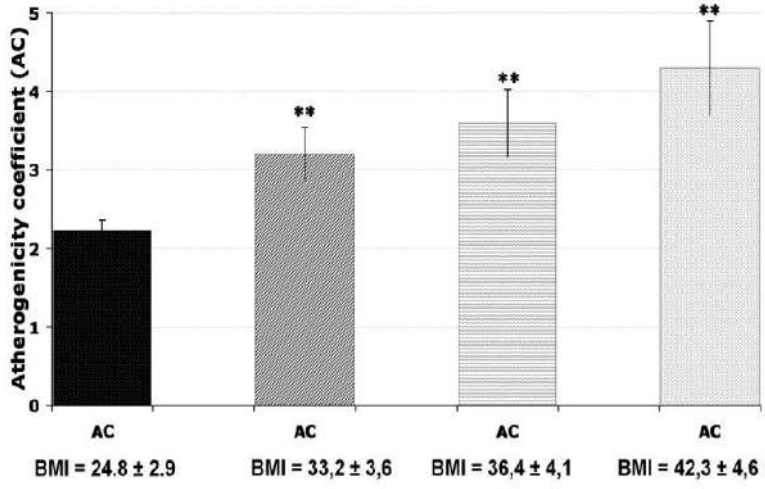

Figure 3. Increase in the degree of atherogenic risk in overweight individuals.

The obtained results demonstrate a statistically significant increase in the atherogenic coefficient in individuals with a body mass index of more than 33 kg/m^2. An essential elevation in the risk of metabolic disorders and cardiovascular disease associated with the manifestation of overweight has been shown even in children [3]. In turn, overweight and metabolic syndrome show a close linear relationship with an increase in LDL cholesterol (LDLc) [8]. It is important that physical activity is an evolutionarily determined means of preventing metabolic syndrome and its atherogenic impact. However, physical exercise is more effective in combination with reflexology and oral administration of chromium picolinate [1].

Conclusion

The combination of somatosensory stimulation with diet and corresponding exercises lead to essential reduction in body weight, in particular body mass index, waist-to-hip ratio, and percentage of adipose tissue compared to subjects non-undergone reflexology course.

In subjects with an increased body mass index, hypertriglyceridemia and hypercholesterolemia are developing in association with an increase in total cholesterol and a decrease in the concentration of high density lipoproteins against the background of an increase in the concentration of low density lipoproteins and very low density lipoprotein fraction.

An increase in the atherogenic coefficient is revealed in individuals with a body mass index of more than 33 kg/m^2. The application of somatosensory stimulation in the form of massage in combination with a decrease in the glycemic index of the diet used can reduce the increase in the atherogenic coefficient in overweight people.

The organization and implementation of a Preventive and Health-improving Program based on a combination of somatosensory stimulation and a diet with a reduced glycemic index makes it possible to correct the lipid profile, to reduce the severity of the accumulation of visceral fat mass.

References

1. *Arslan F., Güven Ş.D., Özcan A., Vatansev H. and Taşgin Ö.* The effect of exercise, reflexology and chrome on metabolic syndrome. International Journal of Medical Research & Health Sciences. 2018, vol. 7(8), p. 77-85.

2. *Bartness T.J., Shrestha Y.B., Vaughan C.H., et al.* Sensory and sympathetic nervous system control of white adipose tissue lipolysis. Mol Cell Endocrinol. 2010, vol. 318, p. 34-43.

3. *D'Adamo E., Guardamagna O., Chiarelli F., et. al.* Atherogenic dyslipidemia and cardiovascular risk factors in obese children. Int J Endocrinol. 2015, vol. 2015, Article ID 912047, p. 1-9.

4. *Dockray G.J.* Enteroendocrine cell signalling via the vagus nerve. Curr Opin Pharmacol. 2013, vol. 13, p. 954-958.

5. *Handlin L., Jonas W., Petersson M., et al.* Effects of sucking and skin-to-skin contact on maternal ACTH and cortisol levels during the second day postpartum-influence of epidural analgesia and oxytocin in the perinatal period. Breastfeed. Med. 2009, vol. 4, p. 207-220.

6. *Harris R.B.* Sympathetic denervation of one white fat depot changes norepinephrine content and turnover in intact white and brown fat depots. Obesity (Silver Spring). 2012, vol. 20, p. 1355-1364.

7. *Herman R.M., Brower J.B., Stoddard D.G., et al.* Prevalence of somatic small fiber neuropathy in obesity. Int J Obes (Lond). 2007, vol. 31, p. 226-235.

8. *Laclaustra M., Lopez-Garcia E., Civeira F., et. al.* LDL cholesterol rises with BMI only in lean individuals: Cross-sectional U.S. and Spanish Representative Data. Diabetes Care. 2018, vol, 41(10), p. 2195-2201.

9. *Light K.C., Grewen K.M., Amico J.A.* More frequent partner hugs and higher oxytocin levels are linked to lower blood pressure and heart rate in premenopausal women. Biol. Psychol. 2005, vol. 69, p. 5-21.

10. *Lupoli B., Johansson B., Uvnäs-Moberg K., et al.* Effect of suckling on the release of oxytocin, prolactin, cortisol, gastrin, cholecystokinin, somatostatin and insulin in dairy cows and their calves. J. Dairy Res. 2001, vol. 68, p. 175-187.

11. *Matthiesen A.S., Ransjo-Arvidson A.B., Nissen E., et al.* Postpartum maternal oxytocin release by newborns: effects of infant hand massage and sucking. Birth. 2001, vol. 28, p. 13-19.

12. *Miller S.C., Kennedy C., Devoe D., et al.* An Examination of changes in oxytocin levels in men and women before and after interaction with a bonded dog. Anthrozoös. 2009, vol. 22, p. 31-42.

13. *Millership S., Ninkina N., Guschina I.A., et al.* Increased lipolysis and altered lipid homeostasis protect gamma-synuclein-null mutant mice from diet-induced obesity. Proc Natl Acad Sci USA. 2012; 109: 20943–20948 Erratum in: Proc Natl Acad Sci USA. 2013, vol. 110, p. 52-69.

14. *Miscio G., Guastamacchia G., Brunani A., et al.* Obesity and peripheral neuropathy risk: a dangerous liaison. J Peripher Nerv Syst. 2005, vol. 10, p. 354-358.

15. *Obrosova I.G., Ilnytska O., Lyzogubov V.V., et al.* High-fat diet induced neuropathy of pre-diabetes and obesity: effects of "healthy" diet and aldose reductase inhibition. Diabetes. 2007, vol. 56, p. 2598-2608.

16. *Odendaal J.S., Meintjes R.A.* Neurophysiological correlates of affiliative behaviour between humans and dogs. Vet. J. 2003, vol. 165, p. 296-301.

17. *Ohlsson B., Forsling M.L., Rehfeld J.F., Sjolund K.* Cholecystokinin stimulation leads to increased oxytocin secretion in women. Eur. J. Surg. 2002, vol. 168, p. 114-118.

18. *Oort P.J., Knotts T.A., Grino M., et al.* Gamma-synuclein is an adipocyte-neuron gene coordinately expressed with leptin and increased in human obesity. J Nutr. 2008, vol. 138, p. 841-848.

19. *Oort P.J., Warden C.H., Baumann T.K., Knotts T.A., Adams S.H.* Characterization of Tusc5, an adipocyte gene co-expressed in peripheral neurons. Mol Cell Endocrinol. 2007, vol. 276, p. 24-35.

20. *Stock S., Uvnäs-Moberg K.* Increased plasma levels of oxytocin in response to afferent electrical stimulation of the sciatic and vagal nerves and in response to touch and pinch in anaesthetized rats. Acta Physiol. Scand. 1988, vol. 132, p. 29-34.

21. *Sugimoto K., Murakawa Y., Sima A.A.* Expression and localization of insulin receptor in rat dorsal root ganglion and spinal cord. J Peripher Nerv Syst. 2002, vol. 7, p. 44-53.

22. *Suri A., Szallasi A.* The emerging role of TRPV1 in diabetes and obesity. Trends Pharmacol Sci. 2008, vol. 29, p. 29-36.

23. *Toth C., Brussee V., Martinez J.A., et al.* Rescue and regeneration of injured peripheral nerve axons by intrathecal insulin. Neuroscience. 2006, vol. 139, p. 429-449.

24. *Tsui H., Paltser G., Chan Y., Dorfman R., Dosch H.M.* "Sensing" the link between type 1 and type 2 diabetes. Diabetes Metab Res Rev. 2011, vol. 27, p. 913-918.

25. *Uvnäs-Moberg K.* Massage, relaxation and well-being: a possible role for oxytocin as an integrative principle, in touch and massage in early child development, ed. Field T. (Calverton, NY: Johnson & Johnson Pediatric Institute;). 2004.