Implications of stress on the development of arterial hypertension: new approaches to therapy and prophylactics

Implicaciones del estrés en el desarrollo de la hipertensión arterial: nuevos enfoques terapéuticos y profilácticos

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Abstract

Arterial hypertension (AH) remains one of the most common and socially significant pathologies of the cardiovascular system, being a key risk factor for the development of myocardial infarction, stroke, chronic heart failure and other complications. In recent years, the role of psychoemotional stress in the pathogenesis of AH has received increasing attention. Chronic stress caused by social, occupational or personal factors contributes to prolonged activation of the sympathetic nervous system, which leads to increased blood pressure, impaired regulation of vascular tone and endothelial dysfunction. The article details the mechanisms by which stress affects the cardiovascular system. Modern approaches to therapy and prevention of AH include not only traditional methods of drug treatment, but also innovative strategies aimed at reducing stress load. The article presents data on the effectiveness of cognitive behavioural therapy (CBT), which helps patients to change negative thinking patterns and reduce anxiety. Relaxation techniques, mindfulness practices, yoga and meditation are also discussed, which help to reduce sympathetic activity and improve psycho-emotional well-being. The results emphasise the need for an individualised approach to the treatment of patients with AH, taking into account not only physiological but also psychological aspects of the disease. Complex therapy combining drug treatment, psychotherapy and lifestyle modification can significantly increase the effectiveness of blood pressure control and reduce the risk of cardiovascular complications.

Keywords: arterial hypertension, stress, sympathetic nervous system, cognitive behavioural therapy, oxidative stress.

Resumen

La hipertensión arterial (HA) sigue siendo una de las patologías más comunes y socialmente significativas del sistema cardiovascular, siendo un factor de riesgo clave para el desarrollo de infarto de miocardio, accidente cerebrovascular, insuficiencia cardíaca crónica y otras complicaciones. En los últimos años, se ha prestado una atención creciente al papel del estrés psicoemocional en la patogénesis de la HA. El estrés crónico, provocado por factores sociales, laborales o personales, contribuye a una activación prolongada del sistema nervioso simpático, lo que conlleva un aumento de la presión arterial, una alteración en la regulación del tono vascular y disfunción endotelial. El artículo detalla los mecanismos mediante los cuales el estrés afecta al sistema cardiovascular. Los enfoques modernos para la terapia y la prevención de la HA incluyen no solo métodos tradicionales de tratamiento farmacológico, sino también estrategias innovadoras dirigidas a reducir la carga de estrés. Se presentan datos sobre la eficacia de la terapia cognitivo-conductual (TCC), que ayuda a los pacientes a cambiar patrones de pensamiento negativos y reducir la ansiedad. También se discuten técnicas de relajación, prácticas de mindfulness, yoga y meditación, que contribuyen a reducir la actividad simpática y a mejorar el bienestar psicoemocional. Los resultados enfatizan la necesidad de un enfoque individualizado en el tratamiento de los pacientes con HA, teniendo en cuenta no solo los aspectos fisiológicos, sino también los psicológicos de la enfermedad. Una terapia integral que combine tratamiento farmacológico, psicoterapia y modificación del estilo de vida puede aumentar significativamente la eficacia del control de la presión arterial y reducir el riesgo de complicaciones cardiovasculares.

Palabras clave: hipertensión arterial, estrés, sistema nervioso simpático, terapia cognitivo-conductual, estrés oxidativo.

Introduction

One of the most important factors contributing to the development and progression of AH is psychoemotional stress. In the conditions of modern society characterised by high pace of life, information overload and social instability, stress becomes an integral part of everyday life. Chronic stress leads to prolonged activation of the sympathetic nervous system, which is accompanied by increased levels of catecholamines, cortisol and other hormones that have a negative effect on the cardiovascular system[1,2]. This contributes to the development of vasoconstriction, increased heart rate, impaired regulation of blood pressure and damage to vascular endothelium. In addition, stress conditions are often accompanied by an unhealthy lifestyle, including poor diet, low physical activity, smoking and alcohol abuse, which further aggravates the course of AH[3,4].

In recent years, more and more studies have been devoted to the study of the relationship between stress and arterial hypertension, as well as the search for new methods of therapy aimed at reducing stress load. Traditional approaches to the treatment of AH, including the use of antihypertensive drugs, are often insufficiently effective in patients with high levels of stress. This highlights the need to implement comprehensive strategies that combine medication with psychotherapeutic methods, such as cognitive behavioural therapy (CBT), mindfulness practices, relaxation techniques and other non-medication approaches[4-7].

The purpose of this article is to analyse current data on the influence of stress on the development and progression of arterial hypertension, as well as to review new approaches to therapy and prevention of this disease. The paper considers the mechanisms by which stress affects the cardiovascular system, discusses modern methods of stress reduction and their effectiveness in blood pressure management. Special attention is paid to the role of lifestyle adaptation and individualised approach to the treatment of patients with AH.

The relevance of the topic is due to the need to develop comprehensive strategies aimed not only at controlling blood pressure, but also at improving the quality of life of patients, reducing the risk of cardiovascular complications and increasing the effectiveness of long-term treatment. The introduction of new approaches to therapy and prevention of AH, taking into account the influence of stress, may become an important step in the fight against this widespread and dangerous disease.

Materials and methods

Modern theoretical concepts and research methods were used to write an article on the influence of stress on the development of arterial hypertension (AH) and new approaches to therapy and prevention. The biopsychosocial model considers health and disease as a result of the interaction of biological, psychological and social factors. In the context of AH and stress, emphasis is placed on biological factors (sympathetic nervous system activation, increased cortisol levels, endothelial dysfunction), psychological factors (anxiety, depression, coping strategies) and social factors (social isolation, occupational stress, economic difficulties).

Based on Hans Sellier's stress theory, stress causes three stages of the body's response: anxiety, resistance, and exhaustion. Chronic stress can lead to the exhaustion stage, which contributes to the development of AH and other diseases.

Psychoneuroendocrinology studies the interaction between the nervous, endocrine and immune systems under the influence of stress. In the context of AH:

Activation of the hypothalamic-pituitary-adrenal axis (HPA-axis) and cortisol release.

We also reviewed current research on the impact of stress on AH, analysed data on new approaches to therapy and prevention, including non-drug methods and the prevalence of AH in populations exposed to high levels of stress (e.g. people with high levels of occupational stress or social isolation).

Overall, theoretical concepts, research methods, and practical approaches were combined to write this article, creating a comprehensive understanding of the problem and suggesting new strategies for the therapy and prevention of stress-related AH.

Results

Current research confirms that psychoemotional stress plays a significant role in the development and progression of cardiovascular diseases, including arterial hypertension (AH)[3]. Table 1 presents modern data on the mechanisms of psychoemotional stress influence on the cardiovascular system, including sympathetic nervous system activation, endothelial dysfunction and impaired blood pressure regulation.

Table 1. Current data on the mechanisms of psychoemotional stress effect on the cardiovascular system, including sympathetic nervous system activation, endothelial dysfunction and impaired blood pressure regulation

Mechanism	Description	Consequences
Activation of the sympathetic nervous system (SNS)		
Catecholamine release	Stress stimulates the release of adrenaline and noradrenaline.	Increase in HR and cardiac output, increase in blood pressure.
Vasoconstriction (vasoconstriction)	Noradrenaline causes peripheral vasoconstriction.	Increase in peripheral vascular resistance, increase in blood pressure.
Chronic hypersympathicotonia	Prolonged activation of the SNS leads to a sustained increase in sympathetic nervous system activity.	Development of sustained hypertension, damage to target organs (heart, kidneys, vessels).
Endothelial dysfunction		
Oxidative stress	Stress increases the formation of free radicals, which reduces the bioavailability of nitric oxide (NO).	Disorder of vasodilatation, increase in vascular resistance, ravatherosclerosis.
Inflammation	Activation of proinflammatory cytokines (interleukin-6, tumour necrosis factor alpha) under the influence of stress.	Endothelial inflammation, vascular damage, increased risk of atherosclerosis.
Disturbance of the balance of vasoactive substances	Decreased production of vasodilators (NO, prostacyclin) and increased production of vasoconstrictors (endothelin-1, angiotensin II).	Prevalence of vasoconstriction, increase in blood pressure.
Disruptiof blood pressure regulation		
Hyperactivation of the renin-angiotensin-aldosterone system (RAAS)	Stress stimulates the production of renin, resulting in increased levels of angiotensin II and aldosterone. Sodium and water retention, increased circulating blood volume, increased blood pressure.	Sodium and water retention, increased circulating blood volume, increased blood pressure
Disorder of baroreflex function	Baroreflex dysfunction Stress reduces the sensitivity of baroreceptors that regulate blood pressure.	Inadequate regulation of blood pressure, tendency to increase it.
Additional mechanisms		
Increased cortisol levels	Chronic stress activates the hypothalamic-pituitary-adrenal axis (HPA-axis), resulting in increased cortisol levels.	Sodium retention, increased blood volume, increased peripheral vascular resistance.
Behavioural change	Stress contributes to unhealthy lifestyles: smoking, alcohol abuse, low physical activity, unhealthy diet.	Aggravation of risk factors for AH and cardiovascular disease.

Psychoemotional stress activates the sympathetic nervous system through central mechanisms associated with the hypothalamus and brainstem, resulting in the release of adrenaline and noradrenaline from the adrenal glands and sympathetic nerve endings. Adrenaline increases heart rate and cardiac output, while noradrenaline causes peripheral vasoconstriction, which increases total peripheral resistance[4]. As a result, blood pressure increases. Chronic activation of the sympathetic nervous system leads to a sustained increase in blood pressure, which contributes to the development of hypertension and cardiovascular damage.

Endothelium, the inner layer of blood vessels, plays a key role in the regulation of vascular tone. Under the influence of stress, endothelial function is impaired, which is manifested by a decrease in the production of nitric oxide, an important substance responsible for vascular relaxation. At the same time, the production of substances that cause vasoconstriction, such as endothelin-1, increases, resulting in an imbalance between vascular dilation and constriction, which contributes to an increase in blood pressure[5]. In addition, stress causes inflammation and oxidative stress, which damage the endothelium and aggravate its dysfunction.

Stress affects the mechanisms that regulate blood pressure, including the renin-angiotensin-aldosterone system. Activation of this system by stress leads to increased production of angiotensin II, which causes vasoconstriction and retention of sodium and water in the body. This increases the volume of circulating blood and increases blood pressure. In addition, stress reduces the sensitivity of baroreceptors - special receptors that regulate blood pressure in response to changes in blood pressure, which leads to impaired adaptation of the cardiovascular system to changes and contributes to the development of hypertension [6].

Chronic stress also affects the production of cortisol, a hormone that promotes sodium and water retention in the body, increasing blood volume and blood pressure. In addition, stress is often accompanied by unhealthy behaviours such as smoking, alcohol abuse, low physical activity and poor diet. These factors further increase the risk of arterial hypertension and cardiovascular disease.

Thus, psychoemotional stress has a complex effect on the cardiovascular system, including activation of the sympathetic nervous system, endothelial dysfunction and impaired regulation of blood pressure. These mechanisms are interrelated and contribute to the development and progression of arterial hypertension.

Chronic stress activates inflammatory processes and increases the formation of free radicals, which damage blood vessels and contribute to the development of hypertension[7]. Chronic hypertension leads to left ventricular hypertrophy, which increases the heart's oxygen demand. Simultaneously, atherosclerosis caused by endothelial dysfunction and inflammation narrows coronary arteries, reducing blood supply to the heart. The combination of increased stress on the heart and reduced blood flow creates conditions for myocardial ischaemia, which can lead to heart attack.

Sustained hypertension damages the walls of brain vessels, making them more vulnerable to rupture (haemorrhagic stroke) or blockage (ischaemic stroke). Atherosclerosis caused by chronic stress also increases the risk of blood clots that can block blood flow in the cerebral arteries[8].

Chronic hypertension damages the renal vessels and tubules, resulting in decreased kidney function. The said condition is known as hypertensive nephropathy. The impaired kidney function, in turn, exacerbates hypertension, creating a vicious cycle. This can eventually lead to chronic renal failure.

Prolonged hypertension causes hypertrophy of the left ventricle, which over time leads to a decrease in its contractility [9]. This condition is known as hypertensive heart failure. Heart failure is accompanied by blood stasis in the lungs and other organs, which significantly impairs the quality of life and increases the risk of mortality.

Chronic stress promotes the formation of atherosclerotic plaques in blood vessels through inflammation, oxidative stress and endothelial dysfunction, which increases the risk of myocardial infarction and stroke[10]. Constant activation of SNS and high blood pressure increase the load on the heart, which leads to its hypertrophy and, ultimately, to heart failure.

Stress-induced chronic hypertension damages not only the heart but also other target organs such as kidneys, brain and blood vessels[11]. This situation increases the risk of multi-organ failure. Chronic stress contributes to the development of metabolic syndrome including obesity, insulin resistance and dyslipidaemia. These conditions exacerbate the course of hypertension and increase the risk of cardiovascular complications[12].

Chronic stress plays a key role in the formation of sustained hypertension and the development of its complications such as myocardial infarction, stroke and renal failure. The mechanisms of this process include sympathetic nervous system activation, endothelial dysfunction, impaired blood pressure regulation, inflammation and oxidative stress[13]. Taking into account the impact of stress on the cardiovascular system allows us to develop more effective strategies for the prevention and treatment of hypertension and its complications.

Discussion

Modern approaches to therapy and prevention of arterial hypertension (AH) include not only traditional medication methods, but also innovative strategies aimed at reducing stress load, improving psycho-emotional state and lifestyle adaptation. Such approaches are particularly relevant for patients in whom stress plays a key role in the development and progression of hypertension[14].

Cognitive-behavioural therapy is a psychotherapeutic technique aimed at changing negative patterns of thinking and behaviour that contribute to stress and high blood pressure. CPT helps patients to identify and change the thoughts that cause anxiety and stress[15]. Therapy includes teaching stress management techniques such as setting realistic goals, problem solving, and developing positive thinking.

Studies show that CBT reduces anxiety and depression, which has a positive effect on blood pressure control.

Patients who have undergone CBT experience a 5-10 mmHg decrease in systolic and diastolic blood pressure.

Relaxation techniques are aimed at reducing the activity of the sympathetic nervous system and improving the psycho-emotional state. Slow and deep inhalations and exhalations help to reduce stress levels and blood pressure. Alternately tensing and relaxing the muscles of the body helps to reduce overall tension. Self-hypnosis and concentration on the sensations of warmth and heaviness in the body help to achieve a state of deep relaxation[16].

Regular use of relaxation techniques reduces cortisol and catecholamine levels, resulting in lower blood pressure. These techniques are particularly effective when combined with other approaches such as CBT or mindfulness practices.

Meditation is a practice of mindful presence in the present moment that helps to reduce stress and improve emotional well-being. Concentrating on breathing, bodily sensations or ambient sounds can help reduce anxiety. A combination of exercise, breathing techniques and meditation helps to reduce stress and improve overall well-being.

Mindful eating helps reduce the risk of overeating and improve metabolic health. Meditation reduces stress levels, improves endothelial function and helps to reduce blood pressure[17].

Lifestyle modification is the basis of prevention and treatment of AH. Current approaches include not only traditional recommendations but also new strategies. Regular aerobic exercise (walking, running, swimming) reduces blood pressure and improves cardiovascular health. At least 150 minutes of moderate physical activity per week is recommended.

The DASH (Dietary Approaches to Stop Hypertension) diet includes increasing your intake of fruit, vegetables, whole-grain foods and reducing your intake of salt, saturated fat and sugar. Moderate alcohol consumption and smoking cessation also play an important role. Normalising sleep patterns and treating sleep disorders (such as sleep apnoea) can help reduce stress levels and blood pressure. Participating in support groups and socialising with loved ones can help reduce stress levels and improve emotional well-being.

A combination of several methods aimed at reducing stress, improving psycho-emotional state and adapting lifestyle is most effective[18].

New approaches to therapy and prevention of AH, including cognitive-behavioural therapy, relaxation techniques, and meditation can effectively reduce stress levels and control blood pressure. Such methods are especially important for patients in whom stress is a key factor in the development of hypertension. Complex application of these approaches can significantly improve the quality of life of patients and reduce the risk of cardiovascular complications.

Prospects for the use of pharmacological agents aimed at reducing stress load and improving the psychoemotional state of patients with arterial hypertension (AH) represent an actively developing area of research[19]. Modern medicine seeks to develop drugs that not only reduce blood pressure, but also affect the psycho-emotional factors that contribute to the development of hypertension.

Activation of SNS plays a key role in the development of stress-induced hypertension. Modern drugs are aimed at modulating SNS activity. Beta-blockers have traditionally been used to lower blood pressure, but newer generations of beta-blockers (e.g. nebivolol) also have vasodilatory properties and improve endothelial function. Such drugs can reduce anxiety and stress, which makes them promising for patients with psychoemotional disorders[20].

Drugs such as moxonidine and rilmenidine act on imidazoline receptors in the brain, reducing SNS activity. They not only lower blood pressure, but also reduce stress and anxiety levels.

Drugs that affect the renin-angiotensin-aldosterone system (RAAS) play an important role in blood pressure regulation and stress response. ACE inhibitors and angiotensin II receptor blockers (BRAs) reduce angiotensin II levels, which cause vasoconstriction and increase blood pressure. Some studies show that ACE inhibitors and BPAs can improve psycho-emotional well-being by reducing stress and anxiety levels [21].

Endothelial dysfunction is one of the key mechanisms for the development of stress-related AH. In addition to lowering cholesterol levels, statins improve endothelial function and reduce inflammation. Such effects may be beneficial for patients with stress-induced hypertension.

Phosphodiesterase-5 inhibitors (e.g. sildenafil) improve nitric oxide production, which helps relax blood vessels and lower blood pressure. They can also improve psycho-emotional well-being by reducing stress levels.

Cortisol is a stress hormone that contributes to high blood pressure. Drugs such as mifepristone block the effects of cortisol, which may be helpful in patients with chronic stress. Drugs such as metyrapone reduce cortisol production, which may help control blood pressure in patients with high levels of stress.

Some drugs traditionally used in psychiatry may be useful in patients with stress-induced hypertension. Selective serotonin reuptake inhibitors (SSRIs) such as sertraline or escitalopram reduce anxiety and depression, which may help lower blood pressure. Drugs such as buspirone reduce anxiety without significant sedation, making them promising for patients with hypertension.

Oxidative stress and inflammation play an important role in the development of stress-related AH. Drugs such as coenzyme Q10 or vitamin C reduce oxidative stress, which may improve endothelial function and lower blood pressure. Some studies suggest that low doses of anti-inflammatory drugs (such as aspirin) may be beneficial for patients with stress-induced hypertension.

Gene therapy research is aimed at correcting genes associated with blood pressure regulation and stress response. Techniques such as transcranial magnetic stimulation (TMS) can be used to reduce sympathetic nervous system activity and improve psycho-emotional well-being. Development of individualised treatment regimens based on the genetic, biochemical and psychological characteristics of the patient[22].

Prospects for the use of pharmacological drugs aimed at reducing stress load and improving the psycho-emotional state of patients with AH include both traditional and innovative approaches. Such drugs may not only reduce blood pressure but also improve patients' quality of life by reducing the risk of cardiovascular complications. Further research in this area will help to develop more effective and safer treatments for stress-related hypertension.

Conclusions

Arterial hypertension (AH) is a multifactorial disease in the development of which psychoemotional stress plays a significant role. Chronic stress activates the sympathetic nervous system, causes endothelial dysfunction and impairs blood pressure regulation, which contributes to the formation of sustained hypertension and increases the risk of cardiovascular complications such as myocardial infarction, stroke and renal failure.

Modern approaches to the treatment and prevention of AH include not only traditional medication methods, but also innovative strategies aimed at reducing stress load and improving the psycho-emotional state of patients. These include cognitive behavioural therapy, mindfulness practices, relaxation techniques and lifestyle adaptations. Such techniques have proven effective in reducing blood pressure and improving patients' quality of life.

Special attention is paid to an integrated approach that combines drug treatment, psychotherapy and risk factor modification. This approach allows not only to achieve the target level of blood pressure, but also to reduce the risk of cardiovascular complications, improve the general state of health and improve the quality of life of patients.

Prospects for further research are associated with the development of new pharmacological agents aimed at reducing stress load and improving endothelial function, as well as with the introduction of personalised treatment programmes that take into account the individual characteristics of patients.

Overall, understanding the role of stress in the development of AH and the implementation of comprehensive approaches to treatment and prevention offer new opportunities for effective disease control and reducing the burden of cardiovascular complications. This emphasises the importance of interdisciplinary collaboration between cardiologists, psychotherapists and other specialists to achieve the best results in the treatment of patients with arterial hypertension.

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