REVIEW ARTICLE

ISOLATED SYSTOLIC HYPERTENSION IN YOUNG ADULTS – DIAGNOSTIC CONTROVERSIES AND CLINICAL SIGNIFICANCE: A REVIEW OF CURRENT DATA

Izolowane nadciśnienie skurczowe u młodych dorosłych – kontrowersje diagnostyczne i znaczenie kliniczne: przegląd aktualnych danych

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Abstract

In recent years, isolated systolic hypertension (ISH) has been increasingly reported in young adults, particularly lean men. This phenomenon, traditionally associated with advanced age and arterial stiffness, is now more frequently diagnosed in individuals under 50 years of age, raising numerous controversies regarding both its clinical interpretation and therapeutic management. In contrast to the older population, where ISH constitutes a significant cardiovascular risk factor, young individuals often present with so-called "pseudo-ISH" – a form of systolic hypertension resulting from physiological pulse-wave amplification, without accompanying pathological changes in the cardiovascular system. The aim of this review is to summarize the current state of knowledge on ISH in young adults, with particular emphasis on its pathophysiology, diagnostic tools (ambulatory blood pressure monitoring, home blood pressure monitoring, central blood pressure measurement, pulse wave velocity), prognostic significance, and therapeutic approach. Current controversies related to differentiating systolic–diastolic hypertension from its physiological variants are discussed, and the need for further research to unequivocally determine the risk and management strategies in this patient population is highlighted.

Streszczenie

W ostatnich latach coraz częściej obserwuje się występowanie izolowanego nadciśnienia skurczowego (ISH) wśród młodych dorosłych, szczególnie szczupłych mężczyzn. Zjawisko to, tradycyjnie kojarzone z podeszłym wiekiem i sztywnością tętnic, jest również częściej diagnozowane u osób poniżej 50. roku życia, co rodzi liczne kontrowersje dotyczące zarówno jego interpretacji klinicznej, jak i leczenia. W przeciwieństwie do starszej populacji, w której ISH stanowi istotny czynnik ryzyka sercowo-naczyniowego, osoby młode często prezentują tzw. „pseudo-ISH" – postać nadciśnienia skurczowego wynikającą z fizjologicznej amplifikacji fali tętna, bez towarzyszących patologicznych zmian w układzie sercowo-naczyniowym. Celem niniejszego przeglądu jest podsumowanie aktualnego stanu wiedzy na temat ISH u młodych dorosłych, ze szczególnym uwzględnieniem jego patofizjologii, narzędzi diagnostycznych (ambulatoryjnego monitorowania ciśnienia tętniczego, domowego monitorowania ciśnienia tętniczego, pomiaru ciśnienia centralnego, prędkości fali tętna), znaczenia rokowniczego oraz podejścia terapeutycznego. Omówiono również aktualne kontrowersje związane z różnicowaniem nadciśnienia skurczowego i rozkurczowego od jego wariantów fizjologicznych, a także wskazano na potrzebę dalszych badań, mających na celu jednoznaczne określenie ryzyka i strategii postępowania w tej populacji pacjentów.

Keywords: cardiovascular risk; young adults; central blood pressure; isolated systolic hypertension; pseudo-ISH

Słowa kluczowe: ryzyko sercowo-naczyniowe; młodzi dorośli; ciśnienie centralne; pseudo-ISH; izolowane nadciśnienie skurczowe

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Introduction

In recent years, an increasing prevalence of cardiovascular diseases and chronic kidney diseases has been observed among young and middle-aged adults. Although this population was previously considered to be at relatively low risk, current data suggest that adverse health trends are also affecting individuals under 40 years of age. One of the factors that may play a key role in this process is arterial hypertension, the rise of which is often associated with the obesity epidemic and unhealthy lifestyle patterns. Despite the growing scale of the problem, the management of hypertension in this age group remains controversial [1, 2].

Isolated systolic hypertension (ISH), an abnormality most commonly observed in older individuals in whom arterial stiffness and increased pulse pressure play a dominant role in its pathogenesis, presents particular diagnostic and therapeutic challenges [1, 3]. However, in recent years, an upward trend in the incidence of ISH has also been observed in young individuals, particularly men. This phenomenon generates many controversies, both in terms of diagnosis and therapy [2, 4]. In young adults, ISH may involve a different pathomechanism and is not always associated with increased cardiovascular risk [5, 6]. Despite a growing body of epidemiological evidence, the clinical significance of ISH at a younger age remains unclear. It is still debated whether it should be treated as an early marker of cardiovascular risk or rather as a physiological variant or "pseudo-hypertension" that does not require aggressive treatment. This review aims to outline the current state of knowledge on ISH in young and middle-aged adults – considering its prevalence, pathophysiological mechanisms, risk of complications, and therapeutic approaches [7, 8].

Definition and diagnostic criteria

Isolated systolic hypertension in young adults, defined as individuals between 18 and 40 years of age, is, according to the 2024 European Society of Hypertension (ESH) guidelines, characterized by systolic blood pressure (SBP) ≥140 mmHg with a concurrent diastolic blood pressure (DBP) <90 mmHg [8]. In this population, particularly among lean men, the phenomenon of pseudo-ISH (apparent arterial hypertension) is frequently observed. This refers to situations in which systolic blood pressure measured in an office setting is elevated, while central blood pressure remains within the normal range. This phenomenon results from an increase in arterial stiffness and pulse-wave amplification within the vascular system, which causes values measured peripherally to be higher than in the aorta. It occurs more frequently among younger, otherwise healthy individuals, and may therefore result in an erroneous diagnosis of arterial hypertension [9, 10].

In light of this, the latest 2024 ESH recommendations draw attention to the necessity of verifying blood pressure measurement results, especially in young individuals presenting with isolated SBP elevation. More accurate diagnostic assessment enables differentiation between true systolic–diastolic hypertension and pseudo-ISH, which is of crucial importance for therapeutic decisions [8].

Pathophysiology

Isolated systolic hypertension in young adults often results from hemodynamic mechanisms that differ from those observed in the older population. In younger patients, the main factor leading to ISH is pulse-wave amplification, a phenomenon in which systolic pressure measured in peripheral arteries (e.g., the brachial artery) is significantly higher than central aortic pressure. This amplification is a result of higher stiffness of peripheral arteries and variability in cardiac output, which are characteristic of younger individuals, particularly those leading an active lifestyle. Furthermore, younger individuals typically exhibit better vascular elasticity, which causes a greater discrepancy between systolic pressure in the brachial artery and central pressure, potentially leading to an erroneous diagnosis of systolic hypertension [11–13].

In such patients, despite elevated systolic blood pressure measured peripherally, central aortic pressure remains within normal limits. This phenomenon, referred to as pseudo-ISH, does not result from pathological changes in the vessel walls (e.g., loss of arterial elasticity), as is the case in older individuals. Instead, it arises from pulse-wave amplification. Pseudo-ISH thus reflects hemodynamic changes that do not indicate true pathological hypertension but rather an increased difference between central and peripheral pressure, which is a physiological phenomenon in many individuals [14, 15].

Diagnostic tools and differentiation

To improve the accuracy of ISH diagnosis in young patients, detailed blood pressure assessment using 24-hour ambulatory blood pressure monitoring (ABPM) is recommended. This method provides a more complete picture of blood pressure variability throughout the day, which is crucial for differentiating systolic–diastolic hypertension from white-coat hypertension, which may occur as a result of stress associated with examination in clinical settings. Additionally, home blood pressure monitoring (HBPM) is recommended, as it enables blood pressure evaluation in the patient's natural environment, eliminating the influence of stress-inducing factors associated with a visit to the doctor's office [10, 8].

In recent years, increasing importance in ISH diagnostics has been attributed to the measurement of central blood pressure, which is obtained using specialized tonomet-

ric or cuff-based devices, often supported by dedicated mathematical algorithms. Central blood pressure measurement allows for the assessment of pressure in the main arterial vessels, including the aorta, providing more precise data than traditional peripheral measurements. Another important tool in ISH diagnostics is the evaluation of arterial stiffness, which can be performed by measuring pulse-wave velocity (PWV). Arterial stiffness is an important indicator of cardiovascular risk and can help differentiate pseudo-ISH from true systolic–diastolic hypertension. Finally, echocardiography remains a key method for assessing cardiac load, enabling a detailed analysis of changes in cardiac function and potential damage related to chronic hypertension. Collectively, these diagnostic methods allow for a more precise assessment of the patient's hemodynamic condition and more reliable exclusion of the pseudo-ISH phenomenon [8, 16, 17].

Prognostic significance

Epidemiological data on isolated systolic hypertension in younger individuals remain inconclusive, and study results vary depending on the length of the observation period, sex, and age group. Several studies indicate that in young men, ISH is not associated with a significant increase in cardiovascular risk in the short-term perspective. Such findings suggest that, in this group of patients, despite elevated systolic blood pressure, diastolic pressure remains normal, which in the short term may not result in a significant increase in the risk of cardiovascular incidents compared with individuals with both systolic and diastolic hypertension [5, 6]. However, other studies indicate that in young women, ISH may be associated with a higher risk of developing cardiovascular disease than in individuals with high-normal blood pressure or isolated diastolic hypertension, although the risk remains lower than in combined systolic–diastolic hypertension [18].

A prospective study published in 2015 demonstrated that among younger adults with ISH, the risk of mortality from cardiovascular diseases, including ischemic heart disease, was higher compared with individuals with normal blood pressure. These findings suggest that although ISH may not lead to cardiovascular complications in the short term, it is associated with a greater risk of cardiac incidents in the long-term perspective [11]. Similar conclusions were reported in the MONICA/KORA cohort study (2021), which found that younger individuals who smoke regularly, are obese, have dyslipidemia, and exhibit elevated blood pressure, are at higher risk of developing ISH. The study highlights that factors such as cigarette smoking and obesity have a significant impact on the occurrence of ISH, particularly in men, and also contribute to an increase in cardiovascular risk in this patient group [3].

Therapeutic approach

In young adult patients with isolated systolic hypertension and SBP values of 140–159 mmHg, in whom no hypertension-related organ damage is found and no additional cardiovascular risk factors are present, a non-pharmacological approach is recommended in the first instance. This treatment should be applied for a period of 6 to 12 months, and its aim is to monitor the body's response to lifestyle changes, such as weight reduction, limitation of salt intake, and increased physical activity, before a decision is made to implement pharmacotherapy. In patients with SBP ≥160 mmHg, or in those with coexisting organ damage related to arterial hypertension and/or the presence of other cardiovascular risk factors, it is necessary to include pharmacotherapy to reduce the risk of cardiovascular complications [19].

Non-pharmacological interventions play a key role in the management of ISH, and their effectiveness is independent of baseline blood pressure values. The most effective methods include lifestyle modification, particularly weight reduction, limitation of salt intake, and regular physical activity. Study results indicate that a weight loss of 5 kg, as well as an increase in the level of physical activity in individuals under 45 years of age, leads to a reduction in SBP by an average of 5 mmHg. Even a modest decrease in body weight has a significant impact on improving blood pressure control, while regular physical activity, including aerobic exercise, effectively lowers SBP and reduces the risk of future cardiovascular events [4].

Controversies and challenges

Isolated systolic hypertension in young adults remains a subject of active debate in the medical community, especially in the context of its association with cardiovascular risk. On the one hand, some researchers suggest that ISH in young individuals, particularly tall, physically active men, may result from pulse-wave amplification in peripheral blood vessels. This mechanism leads to so-called "spurious" systolic hypertension, which is not associated with an actual increase in cardiovascular risk but may be misinterpreted as white-coat hypertension. In such cases, despite elevated systolic blood pressure values, there is no increased risk of cardiovascular events, although blood pressure monitoring outside the doctor's office is still indicated for a more accurate assessment of the patient's condition [14].

On the other hand, a growing body of evidence suggests that ISH in younger patients may indeed be associated with elevated cardiovascular risk, particularly when accompanied by elevated central blood pressure or the presence of organ damage related to hypertension. Cohort studies, including the MONICA/KORA study, have shown that young adults with ISH exhibit a higher risk of cardiovascular mortality compared with individuals with normal blood pressure [3]. These findings indicate the need for a more detailed assessment of patients with ISH to precisely distinguish individuals who require intensive monitoring and treatment from those who may be managed with clinical observation alone, without the need to introduce pharmacological therapy.

In the context of ISH therapy and diagnostics, some experts advocate distinguishing true ISH based on central blood pressure measurements, while treating other cases as physiological variants that do not require intervention [20]. However, ignoring ISH in the young adult population may lead to overlooking the early stages of arterial stiffness, which in the longer term can increase the risk of cardiovascular complications [21]. For this reason, there is an urgent need for further research to enable more precise determination of risk groups in this population and to establish optimal diagnostic and therapeutic strategies.

Conclusions

Isolated systolic hypertension in young adults constitutes a complex and not yet fully understood clinical issue. Unlike older individuals, where ISH is unequivocally associated with reduced vascular elasticity and increased cardiovascular risk, in younger patients, this phenomenon may have a different pathomechanism and, in many cases, may not reflect true cardiovascular risk. In the younger population, particularly among lean and physically active men, ISH is often associated with a phenomenon termed pseudo-ISH. For this reason, advanced diagnostic methods, such as ABPM, HBPM, central blood pressure measurement, and assessment of arterial stiffness (PWV), are of key importance, allowing for a more precise differentiation of true ISH from physiological variants. Although some studies indicate that ISH in young men is not associated with increased short-term cardiovascular risk, others suggest that in young women and individuals with additional risk factors (obesity, tobacco smoking, dyslipidemia), ISH may lead to complications in the longer term. These observations underscore the importance of an individualized approach to risk assessment and therapeutic decisions. Currently, there are no definitive guidelines regarding the management of ISH in young adults. Consequently, further well-designed cohort and randomized studies are needed to clarify the long-term clinical effects of ISH in this population and to optimize diagnostic criteria and therapeutic indications. In light of the available evidence, both overtreatment and trivialization of this phenomenon should be avoided.

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