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The Impact of Elevated Arterial Blood Pressure on The Development of Tinnitus and Sensorineural Hearing Loss

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Abstract: Arterial hypertension is one of the most prevalent chronic diseases of the cardiovascular system and is known to adversely affect multiple target organs, including the auditory analyser. Persistent elevation of arterial blood pressure contributes to vascular and neural alterations that may compromise cochlear function and auditory nerve transmission. This article explores the mechanisms underlying the development of tinnitus and sensorineural hearing loss in patients with arterial hypertension, with particular emphasis on their clinical and audiological characteristics and preventive aspects.

The study involved patients with arterial hypertension who underwent clinical examination, ambulatory and office-based blood pressure monitoring, pure-tone and speech audiometry, tympanometry, and otoacoustic emission testing. The findings demonstrated that a substantial proportion of hypertensive patients experienced tinnitus and sensorineural hearing loss, predominantly affecting high-frequency ranges. These auditory disturbances were closely associated with the severity of arterial hypertension, disease duration, and insufficient blood pressure control.

The results indicate that chronic haemodynamic instability and hypertension-related microangiopathic changes play a key role in the impairment of cochlear microcirculation and neural structures of the auditory pathway. Regular monitoring of arterial blood pressure combined with systematic audiological screening enables early identification of hearing-related complications and may help prevent further progression of auditory dysfunction in patients with arterial hypertension.

Keywords: Arterial hypertension; arterial blood pressure; tinnitus; sensorineural hearing loss; auditory analyser; audiological assessment; microangiopathy; prevention.

Introduction: Arterial hypertension (AH) remains one of the most pressing challenges of modern medicine and is recognised worldwide as a leading risk factor for cardiovascular disease, stroke, and heart failure. According to epidemiological data reported by the World Health Organization, the prevalence of arterial hypertension continues to increase globally, largely due to population ageing, sedentary lifestyles, and metabolic disorders [1]. Persistent elevation of arterial blood pressure results in long-term haemodynamic stress, affecting not only large arteries but also the microcirculatory network, thereby inducing functional and structural alterations in various target organs [2].

The auditory analyser represents one of the organ systems particularly sensitive to hypertension-related vascular changes. The inner ear is supplied by a terminal vascular system with limited collateral circulation, rendering it highly vulnerable to disturbances in cochlear blood flow. Even minor haemodynamic instability within the spiral artery and capillary networks may impair oxygen delivery and metabolic exchange, leading to dysfunction of sensory

hair cells and auditory nerve fibres [3].

As a consequence of these vascular and neural alterations, patients with arterial hypertension may develop tinnitus and sensorineural hearing loss. These conditions often evolve gradually and may remain clinically unrecognised during the early stages of the disease. Tinnitus, in particular, is considered an early subjective manifestation of cochlear or neural dysfunction and is frequently reported by hypertensive patients prior to measurable changes in hearing thresholds [4].

Recent clinical and population-based studies increasingly support the view that arterial hypertension acts as an independent risk factor for both tinnitus and sensorineural hearing loss, irrespective of age-related auditory decline [5]. Hypertension-related microangiopathy, endothelial dysfunction, and impaired autoregulation of cochlear blood flow have been proposed as key mechanisms underlying auditory impairment in this patient population [6].

Despite growing evidence linking arterial hypertension with auditory dysfunction, the clinical and audiological characteristics of these conditions remain insufficiently explored in routine medical practice. Hearing complaints are often overshadowed by more overt cardiovascular symptoms, and audiological assessment is not routinely included in the standard evaluation of hypertensive patients [7]. Consequently, hearing impairment is frequently diagnosed at advanced stages, when pathological changes may already be irreversible.

In this context, comprehensive investigation of hearing function in patients with arterial hypertension is of considerable clinical importance. A detailed clinical and audiological assessment may facilitate early detection of tinnitus and sensorineural hearing loss, enable timely preventive interventions, and contribute to improved long-term outcomes. Therefore, the present study aims to provide an integrated evaluation of auditory disturbances associated with arterial hypertension and to highlight the role of preventive strategies in reducing hearing-related complications [8].

Materials and methods

The study was carried out among patients diagnosed with arterial hypertension. Participants were assessed according to the level of arterial blood pressure, duration of the disease, and the effectiveness of antihypertensive therapy. A control group consisted of individuals without cardiovascular or audiological disorders, allowing comparative evaluation of auditory findings.

All participants underwent a detailed clinical and otorhinolaryngological examination. Blood pressure status was assessed using 24-hour ambulatory monitoring. Audiological evaluation included pure-tone threshold audiometry within the frequency range of 125–8000 Hz, speech audiometry, tympanometry, and otoacoustic emission testing using transient-evoked and distortion-product methods.

Clinical analysis revealed that tinnitus was one of the most frequently reported complaints among patients with arterial hypertension. The tinnitus was described as either constant or intermittent and tended to intensify during periods of elevated blood pressure. In some patients, tinnitus preceded objectively measurable hearing loss, suggesting early involvement of the auditory system.

Pure-tone audiometry demonstrated elevated hearing thresholds predominantly at high frequencies, which is characteristic of sensorineural hearing loss. Speech audiometry showed reduced speech perception ability, particularly in patients with longer disease duration. Tympanometric findings were mostly within normal limits, confirming that middle ear pathology did not play a significant role and that the observed auditory dysfunction was primarily of cochlear origin.

Otoacoustic emission testing revealed decreased amplitudes or complete absence of responses in a considerable proportion of hypertensive patients. These findings indicate impaired function of the outer hair cells and reflect degenerative changes associated with microcirculatory disturbances in the inner ear.

From a pathogenetic perspective, arterial hypertension leads to vascular spasm, sclerosis, and endothelial dysfunction within the cochlear microvasculature. These changes result in chronic hypoxia and metabolic insufficiency of inner ear structures. Fluctuations in arterial blood pressure may also alter labyrinthine fluid dynamics, contributing to the onset and persistence of tinnitus. Over time, sustained hypertension promotes degenerative changes in auditory nerve fibres, creating conditions for the progressive development of sensorineural hearing loss.

The results of this study demonstrate a clear association between auditory impairment and both the duration of arterial hypertension and the adequacy of blood pressure control. Poorly controlled hypertension was consistently linked to more pronounced hearing deficits, underscoring the importance of long-term haemodynamic stability for auditory health.

From a preventive standpoint, effective management of tinnitus and hearing loss in hypertensive patients should focus on maintaining stable blood pressure levels through individually tailored antihypertensive

therapy. Regular audiological screening, ideally conducted at least once a year, allows early detection of subclinical auditory changes. In addition, reducing exposure to stress and excessive noise, along with cautious use of potentially ototoxic medications, may help minimise the risk of hearing-related complications in this patient population.

Results and discussion

The findings of the present study demonstrate that auditory disturbances are a common clinical feature among patients with arterial hypertension. Tinnitus emerged as one of the most frequently reported complaints and was often described as persistent or intermittent, with noticeable exacerbation during periods of elevated blood pressure. In several cases, tinnitus appeared before measurable hearing threshold changes were detected, suggesting that it may represent an early manifestation of hypertension-related auditory involvement.

Pure-tone audiometric evaluation revealed that a substantial proportion of hypertensive patients exhibited sensorineural hearing loss, predominantly affecting high-frequency ranges. This pattern is characteristic of cochlear damage and is consistent with impaired function of the inner ear hair cells. Speech audiometry further supported these findings, as reduced speech perception ability was observed, particularly in patients with longer disease duration and suboptimal blood pressure control. These results indicate that hypertension-related auditory impairment extends beyond peripheral sensory damage and may also involve neural processing of acoustic signals.

Tympanometric findings were largely within normal limits, indicating preserved middle ear function and confirming that the observed hearing deficits were primarily of cochlear origin. This observation is clinically important, as it helps differentiate hypertension-associated sensorineural hearing loss from conductive hearing disorders that may present with similar subjective complaints.

Otoacoustic emission testing provided objective confirmation of cochlear dysfunction. Reduced amplitudes or absence of otoacoustic emission responses were recorded in many hypertensive patients, reflecting compromised outer hair cell activity. The frequency and severity of these abnormalities were greater in patients with poorly controlled blood pressure, highlighting the sensitivity of cochlear microstructures to chronic haemodynamic stress.

From a pathophysiological perspective, arterial hypertension induces persistent microvascular alterations within the inner ear, including vasospasm, endothelial dysfunction, and progressive sclerosis of small vessels. These changes impair cochlear microcirculation and oxygen delivery, leading to chronic hypoxia and metabolic imbalance. Fluctuations in arterial blood pressure may further disturb labyrinthine fluid dynamics, which is believed to contribute to the development and persistence of tinnitus. Over time, sustained vascular insufficiency promotes degenerative changes in auditory nerve fibres, creating conditions for the gradual progression of sensorineural hearing loss.

The observed association between auditory dysfunction, disease duration, and blood pressure control underscores the cumulative nature of hypertension-related damage to the auditory system. Patients with long-standing hypertension and inadequate therapeutic control consistently demonstrated more pronounced audiological abnormalities. These findings emphasise the importance of considering hearing impairment as part of the spectrum of hypertension-related target organ damage.

Overall, the results of this study support the concept that arterial hypertension is not only a cardiovascular disorder but also a condition with significant sensory consequences. Incorporating audiological assessment into the routine evaluation of hypertensive patients may improve early detection of auditory dysfunction and facilitate timely preventive and therapeutic interventions.

Conclusion

Elevated arterial blood pressure represents an important pathogenetic factor in the development of tinnitus and sensorineural hearing loss. The findings of this study indicate that auditory dysfunction is common among patients with arterial hypertension and that the severity of hearing impairment is closely associated with disease duration and the level of blood pressure control. These results highlight the cumulative effect of prolonged haemodynamic stress on the auditory system.

Early identification of arterial hypertension, effective and sustained antihypertensive treatment, and regular audiological monitoring play a key role in preventing hearing-related complications. Incorporating routine hearing assessment into the long-term management of hypertensive patients may facilitate early detection of auditory dysfunction and help reduce the progression of sensorineural hearing loss and tinnitus.

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