

Tinnitus: An unresolved challenge in the 21st Century

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Tinnitus remains one of the most complex and challenging symptoms in otolaryngology. Its high prevalence -affecting approximately 10 to 15% of the global population- and its impact on the quality of life of millions of individuals justify the growing scientific and clinical interest in this condition. However, despite significant research efforts, and well into the 21st century, its pathophysiology remains largely unknown, and current therapeutic strategies are still unsatisfactory for many patients.

We now know that the pathophysiological mechanisms of tinnitus are not limited to the ear but also involve functional alterations in both auditory and non-auditory brain networks¹. Changes in the spontaneous activity of the auditory pathway and in cortical plasticity across different brain regions, interactions with the limbic system, and alterations in alertness and autonomic networks are key elements for understanding the neurobiology of tinnitus. These changes could explain, at least in part, why tinnitus may persist even in the absence of evident cochlear damage. This view suggests that tinnitus most often originates from an alteration affecting the inner ear but becomes chronic due to changes in brain networks. Consequently, managing tinnitus requires an interdisciplinary approach, in which the perspective of the otolaryngologist must be complemented by insights from neurology, psychiatry, and other related disciplines.

In clinical practice, managing patients with tinnitus continues to be a challenge that demands empathy and active listening from the healthcare team. The heterogeneity of its causes, its subjective nature, and the frequent coexistence with hearing loss, hyperacusis, or neuropsychiatric disorders such as anxiety and depressive symptoms make the standardization of therapeutic protocols difficult. Sound therapies, auditory retraining, electrical or magnetic brain stimulation, and psychological

interventions based on mindfulness or cognitive-behavioral therapy show variable benefits.

Technological advances have also opened new opportunities. Artificial intelligence and machine learning allow the identification of physiological and behavioral patterns associated with tinnitus, improving diagnostic precision and enabling the prediction of therapeutic responses. Similarly, the development of hybrid auditory devices with multimodal stimulation -such as lingual electrical stimulation- opens new research pathways and raises hopes for more effective treatments in the near future². The integration of these tools into otolaryngological practice will require close collaboration among clinicians, engineers, and neuroscientists.

Tinnitus cannot be addressed in isolation, without considering its emotional dimension. The perception of a constant internal sound is modulated by affective state, attention, and physiological arousal. The link between tinnitus, anxiety, and sleep disorders reflects the involvement of brain networks related to emotion and alertness. Therefore, understanding the interaction between the auditory system and the brain circuits of alertness (locus coeruleus) and emotion (amygdala) is essential for developing therapies based on pathophysiological evidence³.

Finally, we must remember the crucial and active role that otolaryngology must play in the assessment and management of tinnitus. This includes performing a thorough differential diagnosis of otologic and neurotologic disorders, as well as providing leadership within the multidisciplinary clinical team. Equally important is promoting and supporting translational research. Only through such efforts can we advance toward a more complete understanding of tinnitus and eventually offer more effective and personalized treatments to our patients.

Tinnitus is not merely an auditory symp-

tom; it is a window into the complexity of the nervous system and its relationship with auditory perception and the emotional brain. Embracing this challenge is undoubtedly an opportunity to better understand this condition and, in doing so, help improve the quality of life of millions of people worldwide.

References

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