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THE RELATIONSHIP BETWEEN CHRONIC KIDNEY DISEASE AND SENSORINEURAL HEARING LOSS: CLINICAL AND PATHOPHYSIOLOGICAL ASPECTS

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Abstract.
Hearing loss is one of the most common causes of disability worldwide and has a significant impact on the quality of life of patients. Chronic kidney disease (CKD) is also among the most common chronic diseases and is associated with systemic complications. In recent years, more attention has been paid to the relationship between kidney function and hearing function.
Keywords: chronic kidney disease, sensorineural hearing loss, audiometry, nephropathy, hearing

Hearing impairment represents a major medical and social issue that significantly affects communication, cognitive performance, and overall quality of life. It contributes to social isolation, decreased productivity, and increased risk of depression and cognitive decline. According to international health organizations, the global prevalence of hearing loss continues to rise, driven by both demographic aging and the increasing burden of chronic diseases.

Chronic kidney disease (CKD) is one of the most prevalent non-communicable diseases worldwide. Its prevalence in the general population is estimated at approximately 10–13%, and it is characterized by a progressive decline in renal function, often leading to end-stage renal disease and requiring renal replacement therapy. CKD is associated with a wide range of systemic complications affecting multiple organs and systems.

In recent decades, increasing attention has been directed toward the relationship between renal function and the auditory system. Although the kidneys and the structures of the inner ear perform different physiological roles, they share several important morphological, embryological, and functional characteristics. This similarity provides a biological basis for the observed association between CKD and hearing impairment.

Of particular clinical relevance is the observation that sensorineural hearing loss (SNHL) is frequently identified in patients with CKD, with a prevalence that exceeds that in the general population. Hearing loss currently affects approximately 1.6 billion people worldwide and is recognized as the third leading cause of disability. Similarly, CKD is associated with unfavorable clinical outcomes and substantial healthcare expenditures, highlighting the importance of understanding potential interconnections between these conditions.

From an embryological perspective, the auditory system and the kidneys share a common developmental origin. Genetic abnormalities that lead to hereditary forms of hearing loss may also be associated with renal pathologies. At the cellular level, both organs rely on the function of cilia located on the apical surface of cells. Furthermore, renal tubular cells and sensory epithelial cells of the cochlea utilize similar ion transport mechanisms to regulate the

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composition of luminal fluids. Both tissues also share a common basement membrane structure composed of type IV collagen, which plays a critical role in maintaining structural integrity. These shared characteristics support the hypothesis of a pathophysiological link between CKD and hearing impairment, making this association clinically and scientifically significant.

Objective of the Study

The aim of this study is to summarize current evidence regarding the relationship between chronic kidney disease and sensorineural hearing loss and to determine the clinical significance of this association.

Materials and Methods

This work was conducted as an analytical review of scientific literature. Relevant publications were identified through systematic searches in major international databases, including PubMed, Scopus, and Web of Science. Studies were selected based on predefined inclusion criteria. These included: the presence of patients diagnosed with chronic kidney disease; objective assessment of auditory function; a study population of at least 500 participants; publication in peer-reviewed scientific journals.

Exclusion criteria were as follows: absence of statistical data analysis; small sample sizes; duplicate or overlapping publications. Renal function in the analyzed studies was typically evaluated using the glomerular filtration rate (GFR) and CKD staging systems. Sensorineural hearing loss was confirmed using standardized audiological assessments. The most commonly reported audiometric abnormality in patients with chronic renal failure was high-frequency hearing loss. In particular, a characteristic dip at 6 kHz was frequently observed. Despite these changes, speech discrimination ability was generally preserved in most patients.

Auditory function was primarily assessed using pure-tone audiometry, with special emphasis on high-frequency thresholds, as these are most sensitive to early cochlear damage.

Results

The analysis of the selected studies demonstrated a significantly higher prevalence of sensorineural hearing loss among patients with chronic kidney disease compared to the general population. In most studies, the prevalence ranged from 30% to 60%, while in advanced stages of CKD, it reached up to 70%. A clear and consistent association was identified between the severity of renal dysfunction and the degree of hearing impairment. As kidney function declines, the likelihood and severity of hearing loss increase correspondingly. Chronic kidney disease and hearing impairment are both highly prevalent conditions, each contributing substantially to morbidity. Importantly, they frequently coexist, suggesting a potential shared pathophysiological basis. The kidneys and auditory organs share a common morphogenetic origin and rely on similar biological structures, such as cilia, which play a crucial role in maintaining normal cellular function. Additionally, both systems utilize specialized transport mechanisms for ion and fluid regulation. These similarities may explain their parallel vulnerability to pathological processes.

Genetic factors also play a significant role. Certain genetic mutations that lead to CKD may simultaneously affect auditory function, resulting in combined renal and hearing impairments. Conversely, genetic conditions initially presenting with hearing loss may also involve renal abnormalities. A strong, graded, and independent relationship has been identified between kidney function and the risk of hearing loss. The highest risk is observed in patients undergoing hemodialysis, likely due to a combination of metabolic disturbances and treatment-related factors. However, increased risk is also present in kidney transplant recipients and in

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individuals with early stages of CKD, indicating that even mild renal dysfunction may impact auditory health.

Clinical observations suggest that patients with congenital or acquired auditory dysfunction should be evaluated for potential renal abnormalities. Similarly, individuals with CKD should undergo routine assessment of hearing function to allow early detection and intervention.

The findings also highlight the need for further research, including basic science studies, clinical trials, and healthcare system analyses, to better understand the mechanisms underlying this association and to develop effective prevention and management strategies.

Discussion

The observed relationship between chronic kidney disease and sensorineural hearing loss can be explained by several pathophysiological mechanisms. Shared embryological origin and structural similarities between the kidneys and the inner ear suggest that both organs may be affected by similar genetic and developmental abnormalities. At the cellular level, dysfunction of cilia and ion transport systems can impair both renal and cochlear function. Disturbances in electrolyte balance, which are common in CKD, may directly affect the ionic composition of the endolymph in the cochlea, leading to impaired auditory transduction. Another important factor is the role of the basement membrane, particularly type IV collagen. Alterations in this structure may compromise the integrity of both renal glomeruli and cochlear tissues, contributing to disease development in both systems. In addition to intrinsic mechanisms, external factors related to CKD management may also contribute to hearing loss. These include the use of ototoxic medications and the effects of hemodialysis, which may lead to rapid changes in fluid and electrolyte balance, potentially affecting cochlear function. Despite these insights, the exact mechanisms underlying the association between CKD and hearing loss remain incompletely understood. Further studies are needed to clarify causal relationships and to identify potential therapeutic targets.

Conclusion

In conclusion, there is a significant relationship between kidney function and the auditory system at both developmental and physiological levels. Epidemiological data support the existence of a graded and independent association between chronic kidney disease and the risk of sensorineural hearing loss. In addition to shared biological mechanisms, hearing impairment in CKD patients may also be influenced by treatment-related factors, including medications and hemodialysis. Although this relationship is not always clinically apparent, it has important implications for both research and clinical practice. Early identification of hearing impairment in patients with CKD, as well as evaluation of renal function in individuals with unexplained hearing loss, may improve patient outcomes and quality of life. Further research is necessary to deepen understanding of this association and to develop effective strategies for prevention, diagnosis, and management.

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