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VÎRZOB CLAUDIA - RALUCA

THE MANAGEMENT OF THE CARE PROCESS FOR PATIENTS WITH DEAFNESS

ABSTRACT OF THE DOCTORAL THESIS

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GENERAL PART

1. Anatomy of the ear

The history of otology, spanning from ancient civilizations to the modern age, has been a fascinating journey of scientific discovery and medical advancement. The study of ear diseases and hearing impairments began with the development of rudimentary treatments using plant extracts and oils. The Middle Ages saw a decline in otology, but the Renaissance era saw renewed interest in the subject. The 17th, 18th and 19th centuries saw significant progress in otology, with the invention of the microscope, otoscope, and antibiotics. The 20th century saw revolutionary changes in otology and ENT medicine, with the development of audiology, electronic hearing aids, and cochlear implants [1,2]. Advancements in medical imaging technologies, such as MRI and CT scans, have improved diagnosis and treatment outcomes, reducing patient discomfort and recovery time [3].

The ear is a complex organ responsible for hearing and maintaining balance. It is divided into three main parts: the outer ear, middle ear, and inner ear. The outer ear consists of the pinna, which collects sound waves and funnels them into the ear canal. The middle ear, located behind the eardrum, mainly consists of three tiny bones called ossicles: malleus, incus, and stapes. These bones transmit sound vibrations from the eardrum to the inner ear. The middle ear is connected to the back of the throat through the Eustachian tube, which helps equalize air pressure and prevents fluid buildup. The inner ear, situated deep within the temporal bone, is a complex structure comprising the cochlea, vestibule, and semicircular canals. The cochlea is responsible for hearing and converting sound vibrations into electrical signals that are sent to the brain. Adjacent to the cochlea are the vestibule and semicircular canals, which play a vital role in maintaining balance and spatial orientation. The ear also includes other critical structures, such as the tympanic membrane, and the auditory nerve [4].

The external ear is crucial in the hearing process and acts as the first barrier for sound waves to enter the auditory system. It consists of three main components: the auricle, the external auditory canal, and the eardrum. The auricle has a complex and unique shape that aids in capturing and directing sound waves toward the ear canal. Its structure is composed of elastic cartilage covered by a thin layer of skin, consisting from structural elements such as a helix, antihelix, tragus, antitragus, concha, and lobule. The external auditory canal is a tube-like structure that extends from the auricle to the tympanic membrane. It is approximately 2.5 cm long in adults and slightly S-shaped, with a lateral third made of elastic cartilage and the medial two-thirds consisting of bone covered by skin. Cerumen is produced in the external auditory canal, protecting the ear from foreign particles and infections. The tympanic membrane separates the external ear from the middle ear and is composed of three layers: the outer layer, continuous with the skin of the ear canal; the middle fibrous layer providing structural support; and the inner mucosal layer, continuous with the lining of the middle ear cavity. The eardrum's primary function is to convert sound waves into mechanical vibrations, which are then transmitted to the ossicles, initiating sound amplification [5-7].

The middle ear is the following vital component of the auditory system, transmitting and amplifying sound vibrations from the outer ear to the inner ear. It consists of two main components: the tympanic cavity and the ossicles (malleus, incus, and stapes). The tympanic cavity is an air-filled space connected to the nasopharynx via the Eustachian tube, which maintains middle ear pressure and ventilation. It opens during activities like yawning, swallowing, or sneezing, allowing air to enter or exit the middle ear. Children's shorter and straighter tubes are more likely to have middle ear infections. The epitympanic recess, located above the tympanic cavity, contains the malleus and incus. The ossicles, the smallest bones in the human body, form a bridge between the eardrum and the inner ear's oval window. The malleus transfers vibrations to the incus, which then transmits them to the stapes. The chain-like arrangement of the ossicles efficiently transmits vibrations to the fluid in the cochlea, amplifying the force of sound waves. The Tensor Tympani and Stapedius muscles in the middle ear protect the ear from vibrating and reducing sound reaches the inner ear. The handle of the malleus is where the Tensor Tympani attaches after emerging from the auditory tube, while the facial nerve innervates the Stapedius muscle [4,5]

The inner ear is responsible both for detecting sound and maintaining balance. It is located deep within the temporal bone of the skull and consists of the membranous labyrinth and the bony labyrinth. The inner ear comprises various structures that work together to convert mechanical vibrations into electrical signals that can be processed by the brain. The membranous labyrinth, consisting of the cochlea, vestibule, and three semi-circular canals, is the main part of the inner ear. The vestibule is the centerpiece of the bony labyrinth, communicating with the cochlea and posteriorly with the semi-circular canals. The vestibule contains the saccule and utricle, two components of the membranous labyrinth, which are responsible for detecting linear acceleration and head positioning with respect to gravity. The anterior, lateral, and posterior semi-circular canals are present, along with the utricle and saccule, and house hair cells similar to those found in the semicircular canals. The vestibular apparatus, also known as the organs of balance, consists of the semicircular ducts, saccule, and utricle and are housed within the membranous labyrinth [4,6].

The cochlea, the auditory portion of the inner ear, is responsible for converting sound vibrations into electrical signals that can be interpreted by the brain. Its spiral-shaped structure is divided into three fluid-filled compartments: the scala vestibuli, the scala media (cochlear duct), and the scala tympani. The Organ of Corti, the key structure within the cochlea, houses sensory cells responsible for hearing. It rests on the basilar membrane, which separates the scala media from the scala tympani. The inner hair cells are responsible for converting sound vibrations into neural signals, which are transmitted through the auditory nerve to the brain. The outer hair cells amplify and fine-tune the vibrations within the cochlea, enhancing the sensitivity and selectivity of hearing. The membranous and bony labyrinths receive different arterial supplies, with the basilar membrane playing a crucial role in frequency tuning. High-frequency sounds are detected near the base, while low-frequency sounds are detected near the apex [4,7].

Understanding the anatomy of the ear is essential for diagnosing and treating various ear-related conditions, including hearing loss, balance disorders, and other auditory issues. The ear's complexity and interconnectedness make it a fascinating subject of study, continually enriching our understanding of this vital sensory organ. As medical knowledge and technology advance, effective care and support for those experiencing hearing and balance challenges will become more accessible.

Auditory processing involves the innervating structures that offer the sense of hearing to a person. The auditory pathway involves several auditory structures, including the auditory nerve (cranial nerve VIII), cochlear nuclei, superior olivary complex, lateral lemniscus, inferior colliculus, medial geniculate nucleus of the thalamus, and the auditory cortex in the temporal lobe. The primary auditory cortex connects to the conscious perception system and is called the lemniscal pathway. Additionally, auditory information, such as attention, emotional response, and auditory reflexes, is processed unconsciously through the non-lemniscal pathway [8].

First order neurons' cell bodies are located within the spiral ganglion, which receive information from hair cells in the Organ of Corti. The cochlear nerve is primarily made up of their central axons, and the vestibular nerve connects with the cochlear nerve as it leaves the internal acoustic meatus. The auditory nerve fibers synapse in the cochlear nuclei, which are responsible for processing and relaying auditory information to higher auditory centers in the brain. The superior olivary complex is another brainstem structure that plays a significant role in sound localization, allowing for the comparison of sound timing and intensity between the two ears. Fibers carrying auditory information converge in the inferior colliculus after ascending through the lateral lemniscus from the cochlear nuclei and the superior olivary nuclei. The MGN on the opposite side of the thalamus communicates back and forth with the auditory cortex and refines the information received tonotopically, allowing for continued processing of specific frequency information [9].

The auditory cortex, located in the superior temporal gyrus, is the final destination for auditory processing. Neurons in the primary auditory cortex are tonotopically organized, processing low-frequency sounds in the more anterior regions and high-frequency sounds in the more posterior regions. This tonotopic organization allows for the precise representation and discrimination of different frequencies, essential for understanding speech and identifying different sound sources [10].

2. Etiology and epidemiology of deafness

Deafness is a significant sensory impairment affecting millions of people worldwide. The etiology of deafness is complex, with various causative factors contributing to its development. Factors include genetics, infectious diseases, toxic medications, trauma, ageing, occupational hazards, socioeconomic status, autoimmune diseases, and drug and substance abuse. The prevalence of hearing loss varies across populations, age groups, and geographical regions. The World Health Organization estimates that over 5% of the world's population, approximately 466 million people, are affected by disabling hearing loss. Age-related hearing loss, also known as presbycusis, is the most common form in older adults, affecting nearly one-third of people aged 65 to 74 years and almost half of those over 75 years. Early identification and intervention are crucial to minimize the impact of hearing loss on language development and cognitive abilities in children [11-13].

Hearing loss can be categorized into age-related (adults and elders) or pediatric types, with genetic factors playing a prominent role in its etiology. Hereditary deafness can be categorized into two main types: syndromic and non-syndromic. Genetic syndromes linked to hearing loss include Usher syndrome, Waardenburg syndrome, and Pendred syndrome. Non-syndromic deafness accounts for the majority of genetic hearing loss cases, with mutations in genes affecting inner ear development and function [12,13].

Hearing loss can be classified into different degrees based on the severity of impairment, measured in decibels (dB). The WHO has established the following degrees of hearing loss: mild (26-40 dB), moderate (41-60 dB), moderately severe (60-80 dB), severe (80-90 dB), and profound (91 dB and above) [14].

Conductive hearing loss occurs when sound waves are unable to pass through the outer or middle ear, often caused by conditions such as ear infections (otitis), earwax blockage, foreign bodies, or abnormalities in the ear structure. Otitis media refers to inflammation and infection of the middle ear, which can result in ear pain, hearing loss, fever, and drainage of fluid or pus from the ear. Prompt treatment with antibiotics is essential to prevent complications like eardrum perforation or the spread of infection to the inner ear [15]. Sensorineural hearing loss results from damage to the inner ear (cochlea) or the auditory nerve. It is the most common type of permanent hearing loss and can be caused by aging, exposure to loud noises, head injuries and infections, certain medications, or genetic factors. Symptoms of sensorineural hearing loss can vary depending on the degree of impairment and the frequencies affected [16]. Mixed hearing loss is a combination of conductive and sensorineural hearing loss, occurring when there is damage to both the outer or middle ear and the inner ear or auditory nerve. Treatment for mixed hearing loss depends on the severity and underlying causes of both components [17].

Hearing loss and deafness are complex issues that can have significant impacts on individuals' lives. The etiology of deafness, age of onset, and early intervention are crucial factors in determining the outcomes and prognosis of individuals affected by it. Exposure to excessive noise, tinnitus, and vestibular symptoms can also contribute to hearing loss. Proper hearing protection and awareness of noise-induced hearing loss risk are essential for preventing or minimizing the impact of these factors. Audiological evaluation is the first step in determining the degree and type of hearing loss. Different audiometric patterns can indicate specific etiologies and help predict the likely course of hearing impairment. Various audiological measures, such as speech audiometry and immittance testing, can aid in hearing loss prognostication [18].

Socioeconomic factors, such as access to healthcare, education, and rehabilitation services, can influence the prognosis of hearing loss. Early diagnosis and intervention, coupled with appropriate rehabilitation measures, can significantly improve outcomes for individuals with hearing impairment. Psychological factors, such as coping mechanisms and mental health, also play a role in determining an individual's overall well-being and quality of life. Access to quality education is vital for the overall development of deaf individuals, with inclusive environments with appropriate accommodations and support enhancing academic achievements and fostering social integration. However, some advocates argue for specialized schools where sign language and Deaf culture are central to the curriculum [19-23].

Individuals with hearing loss often face lower employment rates and reduced economic participation compared to their hearing counterparts. Efforts to promote workplace diversity and inclusion, along with reasonable accommodations for deaf employees, can improve employment prospects and economic outcomes for the Deaf community. Legal protections and advocacy efforts have played a crucial role in improving the outcomes and prognosis of deaf individuals. The Americans with Disabilities Act (ADA) in the United States mandated equal access and accommodations for people with disabilities, including those with hearing loss. Advancements in technology, such as video relay services and text messaging, have also significantly impacted the outcomes and prognosis of deafness [24].

3. Therapeutic approaches and the role of healthcare staff in deafness

Therapeutic approaches for the deaf and hard of hearing population can be categorized into three main areas: medical interventions, assistive technologies, and communication strategies. Assistive technologies are devices or tools designed to aid individuals with hearing loss in various listening situations, such as mild to moderate hearing loss. They can significantly improve communication and overall functioning, and are typically relevant for people with mild to moderate hearing loss. Advancements in hearing aid design and fitting have made them more effective in managing hearing loss.

Assistive Listening Devices (ALDs) are technologies designed to enhance sound perception in specific situations, such as watching television, attending lectures, or conversing in noisy environments. ALDs work in conjunction with hearing aids or cochlear implants, offering supplementary benefits. Advancements in mobile technology have led to the development of numerous apps and smartphone-based solutions for individuals with hearing loss, offering features like sound amplification, captioning, and speech-to-text functionalities [25].

Medical interventions aim to address the underlying cause of hearing loss or restore hearing function. Cochlear implants are a viable option for individuals with severe to profound sensorineural hearing loss who receive little or no benefit from hearing aids. They directly stimulate the auditory nerve, bypassing damaged hair cells in the inner ear. Research has shown that cochlear implants significantly improve speech perception and language development in children, leading to enhanced educational outcomes [26]. Bone-Anchored Hearing Aids (BAHA) are another type of medical intervention suitable for individuals with conductive or mixed hearing loss. BAHA works by transmitting sound vibrations directly to the inner ear through bone conduction, bypassing the damaged outer or middle ear and can be either surgical or non-surgical. Research has shown that BAHA can improve hearing thresholds and speech recognition in patients with single-sided deafness [27].

Lastly, communication strategies play a crucial role in enhancing communication effectiveness for individuals with hearing loss. These strategies involve teaching individuals how to navigate challenging listening environments, fostering effective communication with others, and advocating for their communication needs. Auditory training is a form of therapy that aims to improve the individual's ability to perceive and interpret speech sounds. Speech reading, also known as lip reading, is a valuable technique for individuals with hearing loss, especially in situations where sound is unclear or unavailable [28].

For individuals who are culturally Deaf or prefer visual communication, sign language is a vital component of their therapeutic approach. American Sign Language and other sign languages provide a complete and rich form of communication, promoting linguistic and cultural identity. The provision of sign language interpreters and captioning services in educational, workplace, and public settings is essential to ensure effective communication access for the Deaf and hard of hearing community [29]. Early intervention is crucial for optimizing communication and language development in deaf individuals, and children who receive appropriate support, such as sign language or auditory-verbal therapy, can achieve language milestones similar to their hearing peers.

Access to appropriate healthcare is crucial for managing deafness and addressing related health issues. Healthcare staff must be equipped with knowledge, skills, and sensitivity to accommodate the communication and accessibility needs of patients with deafness. Deafness is a condition characterized by partial or complete loss of hearing ability, affecting communication, language development, and social interactions. Healthcare staff must employ various communication strategies to ensure accurate information exchange and patient understanding. Cultural competence refers to the ability of healthcare professionals to understand and accommodate the cultural and linguistic diversity of their patients. Healthcare facilities should foster inclusivity by hiring staff members who are part of the deaf community or have experience working with deaf patients. This will help patients feel more comfortable expressing their needs and concerns, leading to improved patient satisfaction and outcomes [30].

Modern healthcare relies heavily on technology for diagnosis, treatment, and patient communication. Ensuring accessibility is crucial for patients with deafness to fully benefit from these advancements. Healthcare institutions should invest in assistive devices, real-time captioning for videos and multimedia presentations, and electronic health record systems that include information about patients' communication preferences and accommodations required [31].

Patients with deafness often face mental health challenges stemming from communication barriers, social isolation, and experiences of discrimination. Healthcare staff should be attuned to these unique mental health needs and offer appropriate support and counseling services. Training in mental health awareness and deaf sensitivity can empower healthcare professionals to identify signs of distress and provide necessary interventions. Healthcare staff plays a vital role in advocating for the rights and needs of patients with deafness, ensuring that healthcare policies and facilities comply with disability rights laws and regulations. Staff members should actively collaborate with patients to identify potential barriers and implement solutions to enhance accessibility and inclusivity [32].

Collaboration among various healthcare professionals, including audiologists, speech therapists, psychologists, and social workers, is essential for providing holistic care to patients with deafness. Healthcare staff should actively engage in these collaborations, share information, and maintain open lines of communication to optimize patient outcomes. As such, the role of healthcare staff in the care process of patients with deafness is multifaceted and vital. By employing effective communication strategies, embracing cultural competence, promoting accessibility, addressing mental health needs, and advocating for patient rights, healthcare staff can make a profound impact on the lives of individuals with deafness.

SPECIAL PART

4. The general purpose and objectives of the thesis

Access to thorough audiological services, efficient communication methods, inclusive support systems, and working directly with the deaf population is crucial for improving the lives of individuals with hearing impairment. Deafness presents unique challenges for Romanian patients, affecting their auditory experience and other aspects of their lives. Hearing loss is a significant public health issue in Romania, affecting millions of people. The prevalence of hearing loss has increased due to factors such as an aging population, noise pollution, inadequate healthcare access, and limited awareness about hearing health. Around 1.1 million people in Romania have moderate to severe hearing impairment, and nearly 5% of the population experiences some degree of hearing loss [33]. As Romania's population continues to age, the prevalence of hearing impairment is expected to escalate further due to age-related hearing loss, known as presbycusis.

The healthcare infrastructure in Romania faces challenges in addressing hearing health adequately. Many rural areas lack access to specialized audiology services, leading to underdiagnosed and untreated cases. Hearing aids and assistive devices can be expensive, making them inaccessible to a significant portion of the population. Limited health insurance coverage for hearing-related treatments further exacerbates the problem. Additionally, lack of awareness about hearing health and available support can lead to delayed intervention and treatment, exacerbating the impact of hearing impairment on an individual's quality of life.

This thesis aimed to investigate hearing loss in a developing European country, focusing on both pediatric and adult patients. A literature review revealed few studies on hearing loss in Romanian patients. The research aimed to fill knowledge gaps and offer valuable insights into hearing healthcare in Romania. As such, one way this could be done was by exploring the impact of bilateral cochlear implantation on patients' overall quality of life, considering factors such as social integration, communication skills, and psychological well-being. The management of care for patients with bilateral hearing loss and cochlear implants in Romania involves an integrated approach involving medical and educational specialists. The primary goal is to ensure proper evaluation, correct implantation, and effective vocal and auditory rehabilitation to maximize benefits and improve the quality of life. The impact of cochlear implantation on patients' daily functioning and psychosocial well-being is also assessed.

The initial evaluation involves a detailed audiological consultation by a specialized audiologist to determine if the patient is a candidate for bilateral cochlear implantation and assess any potential medical conditions. A team effort between audiologists, specialized ENT surgeons, and medical assistants is essential for a safe and efficient procedure. Vocal and auditory rehabilitation after implantation is crucial, as patients need to learn to interpret sounds and develop communication skills. Speech and hearing therapy specialists work with patients to develop these skills. Emotional and psychological support is also essential, as adjusting to life with bilateral cochlear implants can be challenging.

Evaluating patients' quality of life after implantation is crucial, as studies have shown significant improvements in their quality of life. Patients gain more efficient communication skills, engage in more social and professional activities, and experience increased self-esteem and reduced social isolation, contributing to overall well-being.

The second part of the study addressed otosclerosis in Romanian patients, focusing on its prevalence, risk factors, challenges in diagnosis and management. It aims to encourage further research in areas where knowledge is limited, potentially leading to better treatment options and better outcomes for patients with hearing loss in Romania. Early detection and accurate diagnosis are crucial in managing otosclerosis effectively. Treatment options include hearing aids, surgical intervention like stapectomy and stapedotomy, and audiological rehabilitation to help patients adapt to their improved hearing abilities. The impact of otosclerosis extends beyond the physical aspect, affecting a patient's emotional and psychological well-being. Psychological support and counseling are integral components of the care process, addressing emotional aspects of hearing loss to improve quality of life and overall mental health. Raising awareness about otosclerosis and its management is essential in Romania to encourage early detection and timely treatment. Educational campaigns can dispel myths and misconceptions about hearing loss, while public health initiatives emphasize the need for regular hearing screenings.

Continuous follow-up and long-term care are essential for patients with otosclerosis. Regular check-ups and assessments enable healthcare professionals to monitor progress and make necessary adjustments to treatment plans. Providing ongoing support and resources ensures patients maintain their hearing health and quality of life in the long run.

Ultimately, these studies aimed to contribute to evidence-based guidelines, inform healthcare policies, and enhance the overall well-being and quality of care for individuals with hearing impairments in Romania.

5. Efficacy of bilateral cochlear implantation in pediatric and adult patients with profound sensorineural hearing loss

Hearing loss is a widespread and under-addressed global health concern, causing social isolation, melancholy, loss of autonomy, and cognitive impairment. It hinders people's integration into the workforce, reducing economic stability and healthcare resources. Recent breakthroughs in cochlear implantation have improved the quality of life for children with severe to profound hearing loss. Individual results can vary, with age and length of implant use impacting speech comprehension, language development, and communication abilities. Research shows that children receiving a second cochlear implant have better speech and auditory processing of sounds. The duration of bilateral cochlear implant usage is crucial for effectiveness, adaption, and advancement of audiological results. In the US, bilateral cochlear implantation is considered cost-effective, but pediatric sequential, adult bilateral, geriatric, and long-term deaf implantations are less so [34,35]. The WHO acknowledges the situation and urges member nations to gather high-quality, population-based data on ENT conditions and hearing loss to build evidence-based plans and policies. The investigation and reporting of the pediatric and adult patients who received bilateral cochlear transplants in Western Romania was therefore important.

Regarding **materials and methods**, this part of the thesis focused on patients who received bilateral cochlear implant surgeries at the Timisoara Municipal Emergency Clinical Hospital ENT Clinic, Cochlear Implant Department, over a five-year period (2016-2020) and employed a retrospective design in accordance with the STROBE standards [36].

The study involved bilateral cochlear implantation for patients with significant sensorineural hearing loss. The clinic provided voice and auditory rehabilitation services for the first month, followed by four appointments for follow-up and patient evaluation. Auditory training and communication therapy sessions were conducted to improve patients' awareness and ability to overcome communication difficulties. Speech perception, speech output, and reading achievement were evaluated using various tests, including the Word Intelligibility by Picture Identification test (WIPI) and the Phonetically Balanced Kindergarten Word List (PBK). Factors such as the subject's country of origin, gender, age, implantation age, implantation period, development of otitis following cochlear implantation, speech perception and speech production scores, reading achievement scores, and a WHO mental domain quality of life assessment were considered.

Data were gathered from the hospital's database, which contains all hospitalized patients' digital and physical records. Patients who met the requirements for cochlear implantation had to have a bilateral profound sensorineural hearing loss of 85 dB or more, with little to no gain with hearing aids in terms of speech recognition, or need to replace an external processor due to advanced physical wear. Both closed-set and open-set speech perception tests were used to get baseline data on speech perception.

The patient cohort was divided into four groups for data analysis. Patients in Group 1 received their first cochlear implants, while in Group 2 had non-congenital severe sensorineural hearing loss, and in Group 3 received a second cochlear implant. The study used JASPv16.3 and Microsoft Excel 365 for statistical analysis, with the significance level set at $p < 0.05$.

Results: the study examined patients with congenital bilateral sensorineural hearing loss receiving their first implant (CBSHL1, n = 20), non-congenital severe acquired bilateral sensorineural hearing loss (NSASHL, n = 12), patients with congenital bilateral sensorineural hearing loss (CBSHL2, n = 4), and patients with previously implanted patients who were hospitalized for the change of implant. The majority of patients in all categories, including 65.0% of CBSHL1 patients, 75.0% of CBSHL2 patients, 75.0% of NSASHL patients, and 61.0% of CP patients, all lived in metropolitan regions. The mean age of patients across study groups differed significantly, with the CBSHL1 group having more male patients (65.0% and 50.0%), while the NSASHL and CP groups had more female patients (66.7% and 58.5%, respectively). The mean implantation age varied significantly between groups, with the CBSHL1 group having an average age of 1.95 years, the CBSHL2 group having an average age of 37.33 years, the NSASHL group having an average age of 2.25 years, and the CP group having an average implantation age of 4.73 years. The implantation period varied significantly between the study groups, with a higher percentage of children with congenital bilateral sensorineural hearing loss experiencing otitis after receiving their first cochlear implant.

A Mann-Whitney test was performed to assess differences in age, implantation age, and implantation period between patients based on gender, environment, primary procedure, and the presence or absence of associated diseases. The findings suggest that the patient's age at implantation and the length of the implantation period can significantly impact the primary procedure and the presence or absence of associated diseases. A one-way analysis of variance (ANOVA) was used to examine potential differences between age, implantation age, and implantation duration in four different subgroups.

The study also aimed to determine if congenital bilateral severe-to-profound sensorineural hearing loss (CBSHL) during the initial or follow-up implantation could be considered a risk factor for developing otitis. The odds ratio parameter, 95% confidence interval, and a chi-square test were used to determine statistical significance. The results showed that CBSHL was a significant risk factor for the development of otitis.

Regarding quality of life analysis, three tests were used to evaluate listener comprehension of speech: the Phonetically Balanced Kindergarten Word List, the Word Intelligibility by Picture Identification test, and the Hearing in Noise Test. The mean WIPI accuracy scores for CBSHL2 and NSASHL groups were 13.5 ± 9.2% and 20.2 ± 12.7%, respectively. There was no significant difference between the two groups in the mean percentages of correct responses. The mean WIPI scores significantly increased at 12 months following rehabilitation, while the mean HINT scores also increased. The mean reading performance scores also increased significantly at 12 months following rehabilitation.

The non-parametric Wilcoxon signed-rank test was employed to evaluate the variations in the mental domain of the WHOQOL-BREF survey before and after cochlear implantation. The findings demonstrated a statistically significant increase in patients' quality of life following cochlear implantation, with the mean quality of life score rising from 2.0 before the surgery to 4.2 after cochlear implantation. The statistical analysis showed an overall pattern of rising quality of life following cochlear implantation.

This study, the first investigation into bilateral cochlear implants in Romania, a developing European country, provided valuable insights into the benefits and improvements in both the quality of life for adults and children. The four groups of patients with various degrees of sensorineural hearing loss had significant differences in age, implantation age, and implantation period. However, there were no discernible differences in reading achievement or speech perception or production between the study groups according to pre-cochlear implant investigations. The current study also demonstrates significant gains in reading proficiency for adult patients following cochlear implant rehabilitation in speech perception, speech production, and reading.

Congenital sensorineural hearing loss is more common in male patients, but some recent studies found no statistically significant differences between the sexes. In this study, there were more female patients than male patients, with 53.25% of subjects being female and 46.75% being male. The majority of patients with profound congenital sensorineural hearing loss had cochlear implant surgery between the ages of 1 and 3 years. The results showed highly significant differences ($p< 0.001$) across all examined variables.

Several studies suggest that cochlear implantation in infants younger than 12 months may produce better results than implantation in children older than this, with observable gains in language learning, sound localization, speech and language development, speech intelligibility, reading comprehension, and auditory perception. Speech recognition and speech production in cochlear implant users has been found to be significantly correlated with frequency discrimination skills, which are essential for learning to hear and speak [37,38].

The age at which implantation takes place is a key factor in determining the procedure's success rate because the brain's plasticity varies as people age. Children who receive cochlear implants between the ages of 1 and 3 show enhanced language acquisition and comprehension, which is evidence that early implantation gives significant benefits. For pre-lingual patients, early cochlear implantation is crucial for maximizing the results of language and speech rehabilitation. However, there are no set time limits for this intervention in post-lingual patients [39,40].

A paper published by Rijke and his peers in 2021 concluded that some limitations still persist in children with cochlear implants, looking especially disadvantaged in areas like information access, communication, social interaction, and academic involvement. Access to cochlear implants at 12 months of age decreased the size of anticipated delays one year later, narrowing the expected gap between hearing age and chronological age [41].

According to Teagle et al., who studied a 25-year period of pediatric cochlear implants in 2019, an increase in the usage of implant surgeries through the years, possibly due to technological advances and increased awareness [42]. The interdisciplinary medical team, speech therapist, family, and communication techniques are additional crucial elements in the management of cochlear implant patients. Nursing for these patients requires specialized care and sensitivity, as nurses must understand the implant's function and maintenance to ensure optimal performance. Regular monitoring of implant status and assisting caregivers with troubleshooting are essential. Clear communication is crucial and special attention should be given during postoperative recovery to prevent infections and complications. Nurses also play a vital role in educating families about cochlear implant care and rehabilitation, promoting a nurturing environment that fosters the child's speech and language development.

Despite significant advancements in vocal rehabilitation after cochlear implantation in youngsters, differences from classmates who are not hearing-impaired still exist. Access to information, communication, social involvement, other people's empathy, and academic engagement are all areas that face difficulties. It is important to remember that family dynamics play a significant role in a child with a cochlear implant's ability to grow audio-verbally [43,44].

Craddock et al. found a progressive increase in scores for adults who used lip reading alone, hearing aids, or cochlear implants. Also, a contralateral routing of signal device could be connected to regular cochlear implants, with promising results. Complications may include minor issues like otitis or more serious issues like electrode failure, mastoiditis, or facial paralysis. Children with cochlear implants have a higher risk of infection during the first few months, with age being a significant confounder. The overall complication rate is 14.9% minor and 5% major issues, with implant dysfunction accounting for 42.8% of all issues [45]. De Sousa and her team found that the social domain was the best-assessed domain in the cochlear implant quality of life assessment, while the psychological domain was the best-assessed domain. Factors like gender, length of time, and auditory modality did not impact outcomes [46].

6. Otosclerosis under the magnifying glass

Otosclerosis is a disorder affecting the stapes bone within the otic capsule, with no known etiology. It is caused by inadequate remodeling of newly synthesized trabecular bone and is characterized by osseous extracellular matrix sclerosis and disrupted osteons. The condition is most common in Europe, with 15-20 cases per 100,000 persons each year. The onset of symptoms usually occurs by the early third decade of life, with factors such as hormonal effects of puberty, pregnancy, and menopause affecting the development of the illness. The Caucasian population is predisposed to otosclerosis, while Black, Indian, and oriental people rarely exhibit it. The prevalence is also low among populations of South America and Japan [47,48].

The energy of sound at the tympanic membrane level in the inner ear is diminished, causing hearing loss, particularly at low frequencies. The most common clinical sign of otosclerosis is conductive hearing loss, which may occasionally be sensorineural or mixed. Hearing loss may also be sensorineural or mixed, and some individuals may also claim to have tinnitus. Stapes surgery is one of the treatment options, along with implantable hearing aids like middle ear or bone conduction implants. Cochlear implants may be an alternate treatment for more serious conditions. Different pharmacological therapies for otosclerosis are not often recognized as standard therapy options, and their efficacy is still debatable [49].

Regarding **materials and methods**, a retrospective analysis of 70 patients diagnosed with otosclerosis at the Emergency City Hospital in Timişoara, Romania, was conducted between January 2021 and December 2022. The study involved a patient observation sheet and a database of demographics, biological studies, and medical history. The inclusion criteria included unilateral or bilateral mixed hearing loss, type A tympanogram, absent Stapedius reflex, a surgery procedure (stapedotomy or stapedectomy), and fitting of a titanium prosthesis at the same surgical time. Exclusion criteria included acute otic infections at the time of hospitalization and incomplete investigations like lack of audiogram. Three patients were excluded due to factors such as age, surgery type, refusal of surgery, and incomplete investigations.

Biopsies were harvested and processed according to international protocol. Hematoxylin-Eosin (HE) staining and Giemsa histochemical staining were used to complete the HP diagnosis. Immunohistochemistry reactions were used to phenotype inflammatory cells and characterize the blood vessel network. NovocastraTM was used for the materials used in immunohistochemistry. The inclusion period for all antibodies was 30 minutes.

Statistical analyses were performed using Microsoft Excel, calculating median, minimum, and maximum range values, frequencies, and percentages for ordinal variables. Patients signed informed consent forms after the study received approval from the hospital ethics committee. The authors followed all applicable rules, regulations, and ethics and safety protocols throughout the study.

Results: A study involving 69 patients with otosclerosis was conducted, with a majority aged between 40 and 49 (39%), followed by those aged between 50 and 59 (19%) and 30-39 (12%). The majority of the patients were female, with 77% of them from urban areas and 23% from rural areas. Out of the 70 patients, 56 had bilateral otosclerosis, while 54% had tinnitus upon admission. Additional symptoms included auricular fullness and otalgia.

The length of symptoms was known for 50% of the patients, with 33% reporting symptoms lasting between one and five years, 14% between six and ten years, and only 3% lasting longer than 20 years. Thirty percent of the patients had co-morbid conditions, including high blood pressure, tumors, benign and malignant conditions, autoimmune thyroiditis, type 2 diabetes, and hypercholesterolemia. Coagulationopathies, septal deviation, chronic hypertrophic rhinitis, type C hepatitis, herniated disc, chronic venous insufficiency, ovarian cyst, chronic uveitis, and sinus tachycardia were present in one patient each.

Of the 70 patients, 67 underwent stapedotomy, with a 27-year-old woman having her hypoacusis treated with stapedectomy and two other female patients being candidates for posterior stapedectomy. A reject of the titanium prosthesis was discovered in a 43-year-old woman and had to be removed three days after implantation. Among the 61 patients with right ear hypoacusis, 31 had conductive hearing loss, 27 had mixed hearing loss, and three had sensorineural hearing loss. The audiogram of the right ear was normal in nine instances. In the case of the 27-year-old female patient, significant family history events were documented, and the findings revealed an otosclerosis transmission through the maternal line.

The HP analysis showed that on HE- and Masson's trichrome-stained slides, there was always evidence of the formation of an osteoid, which was lined by osteoblasts and osteoprogenitor cells and surrounded by connective tissue. Additionally, there were areas of calcified osseous matrix, which showed osteocytes disposed in lacunae between osseous lamella arranged in incompletely shaped osteons. The Giemsa staining revealed the presence of mast cells around small blood vessels .

Most of the mature T-lymphocytes in the inflammatory infiltrate were CD3-positive and immunohistochemically positive. Only a small percentage of the T-cells were CD4-positive. Only a few cells were CD8 positive. B-cells, which were very few in quantity, were CD20-positive lymphocytes. A reasonably extensive vascular network made up of hyperemic capillary structures and marked immunohistochemically with anti-CD31 and anti-CD34 antibodies was found in the surrounding connective support.

Otosclerosis is a condition characterized by the fixation and rigidity of the ossicular chain, leading to hearing loss in patients. The most common cause of hearing loss in this study was conductive (44% for the right ear and 47% for the left ear), with mixed hearing loss also significant (39% for the right ear and 37% for the left ear). In 80% of cases, otosclerosis is diagnosed as a bilateral condition. The study found that 60% of otosclerosis patients have family members who also have the ailment, but only one female patient described a condition that was also experienced by other family members. Other authors believed that 40% of otosclerosis cases could be attributed to various causes, including autosomal dominant inheritance or rare cases transmitted through alternative modes of inheritance [50].

Otosclerosis is a fairly uncommon diagnosis in those under the age of 30 and in people over the age of 60. It exhibits protection brought on by sexual hormones, much like those seen in various malignancies. Women are affected twice as frequently as men, with 77% of the cases in this study, with a female to male ratio of 3.34:1. This also applies to pregnant women [51].

High blood pressure, tumor conditions, and autoimmune thyroiditis were the most frequently found co-morbid conditions in the study's participants. No research has yet been published in the English literature to show whether there is a connection between otosclerosis and autoimmune thyroiditis or various types of tumors. Future research should focus on these correlations to determine whether there is a link between these pathologies and an etiological pathway that could be disrupted by preventive therapies [52-54].

A 45-year-old female patient from the current study also had osteosclerosis, a condition that some authors have linked to Paget's disease of the bone. However, further research is needed to determine whether these two diseases are related [55].

Bisphosphonates have been shown to prevent bone remodeling by influencing osteoclast activity, which may be the basis for certain writers' recommendations of bisphosphonates as the best possible treatments for osteosclerosis. Additionally, surgical procedures such as posterior stapedectomy, stapedectomy, or stapedotomy followed by the implantation of an ossicular chain prosthesis continue to be the "gold standard" therapy for otosclerosis [56].

The stapes footplate contains osteoblasts, osteoclasts, vascular proliferation, fibroblasts, and macrophages, according to HP investigations of otosclerosis. Three HP patterns are possible in the bone throughout the dynamic of otosclerotic disease: spongiotic bone, sclerotic bone with dense mineralized bone, and mixed bone. In the current study, the HP examinations of the pericochlear region, oval window, and stapes base indicated the presence of osteoclasts and osteoblasts, surrounded osseous trabeculae with foci of enhanced cellularity and areas of bone resorption and deposition [57-60].

The genetic makeup of patients plays a huge role in hearing loss conditions, especially in otosclerosis. A genome-wide association study in 2022, which included Romanian patients, replicated five out of seven candidate genes reported in previous studies [61]. Computer tomography images can prove useful in certain situations, but this radiological investigation cannot rule out otosclerosis [48].

CONCLUSIONS

Understanding the anatomy of the ear is crucial in diagnosing and managing various hearing-related health issues and plays a significant role in audiology, otolaryngology, and ear-related medical interventions. Hearing loss is a complex issue affecting millions of individuals worldwide, influenced by genetic, environmental, and lifestyle factors. Early identification, prevention, and intervention are crucial for addressing hearing loss and improving overall health. Public health initiatives, improved access to hearing healthcare services, and ongoing research are vital in mitigating the burden of hearing loss and promoting better outcomes for individuals of all ages.

Sensorineural hearing loss is a prevalent form of permanent hearing impairment caused by damage to hair cells in the cochlea or auditory nerve pathways. Symptoms can range from mild to profound, and may include difficulty understanding speech, hearing muffled sounds, and experiencing tinnitus. Various management options, such as hearing aids, cochlear implants, assistive listening devices, communication strategies, and counseling, can help individuals with sensorineural hearing loss improve their communication and quality of life.

Prognostic factors play a crucial role for providing personalized and effective management strategies to individuals with hearing impairment. Early diagnosis, appropriate intervention, and access to communication support are critical for optimizing outcomes for individuals with hearing loss. Moreover, societal attitudes and inclusivity efforts significantly impact the quality of life and opportunities available to deaf individuals.

Medical interventions like cochlear implants and bone-anchored hearing aids have been transformative in restoring hearing function for some individuals. Assistive technologies, such as hearing aids, ALDs, and mobile apps, play a crucial role in improving communication and accessibility. Communication strategies, such as auditory training, speech reading, and sign language use, complement these interventions, enhancing communication effectiveness and overall quality of life.

Non-medical factors, such as educational opportunities, workplace accommodations, and legal protections, are equally crucial in promoting positive outcomes for the Deaf community. Continued research, increased awareness, and collaborative efforts between medical professionals, educators, policymakers, and the Deaf community are essential to further enhance the outcomes and prognosis of hearing loss and ensure a more inclusive and accessible world.

In Romania, hearing loss is a pressing public health issue affecting millions of individuals. The rising prevalence of hearing impairment, noise pollution, limited healthcare access, and low awareness create challenges for those affected by this condition. However, efforts are underway to improve hearing healthcare through public awareness campaigns, subsidized hearing devices, and initiatives to strengthen the audiology workforce. By addressing these challenges and investing in hearing health, Romania can work towards a future where all citizens can access the support they need to maintain a high quality of life, regardless of their hearing abilities. Two areas that are likely to shape the landscape are the efficacy of bilateral cochlear implantation and advancements in managing otosclerosis.

The management of care for patients with bilateral cochlear implants in Romania requires an interdisciplinary approach, involving healthcare and education specialists. Proper evaluation, precise surgical implantation, and adequate vocal and auditory rehabilitation are crucial for achieving optimal outcomes. The quality of life for patients after implantation is an essential measure of the intervention's success, and the improvements observed in communication and social integration can have a significant impact on their overall well-being.

Post-implantation, a significant percentage of patients showed enhanced open-set speech comprehension. Patients with progressive hearing loss, spoken verbally throughout infancy, and using a hearing aid in the implanted ears showed significantly improved speech perception results. Cochlear implantation is a therapy option that adults and children with severe bilateral sensorineural hearing loss should consider, but customized treatment options should be used. More government financing is required for everyone to have access to cochlear implants.

Technologically, bilateral cochlear implantation offers the potential for improved binaural hearing, allowing patients to localize sounds more accurately, enhance speech understanding in noisy environments, and experience a more natural auditory perception. Future cochlear implant systems may focus on enhancing synchronization and connectivity between the implants, leading to better sound integration and reduced processing delays. Advancements in neural interface technology can lead to more precise and selective stimulation of auditory nerve fibers, resulting in enhanced sound discrimination and better speech comprehension in complex listening situations.

Bilateral cochlear implantation in children holds immense potential for language development and educational outcomes. Research in this area may focus on optimizing age-appropriate interventions and refining auditory training programs to maximize the benefits of early implantation.

Otosclerosis management plays a crucial role in improving hearing outcomes and overall quality of life for Romanian patients. Early detection, accurate diagnosis, and appropriate treatment options are vital in addressing the impact of otosclerosis on hearing abilities. Audiological rehabilitation and psychosocial support help patients adapt to their improved hearing and cope with emotional challenges associated with hearing loss. Educational campaigns and increased awareness can benefit more individuals from early intervention, leading to better long-term outcomes.

The current work emphasized osteosclerosis epidemiological data and described HP features on morphologically stained slides using HE and Masson's trichrome. Giemsa staining and IHC responses also aided in characterizing inflammatory infiltration, T-cells and mast cells around newly developed trabeculae, and the characteristics of small blood vessels. A greater understanding of the biology of otosclerosis may provide a cure for this ailment, which is currently incurable and significantly impacts patients' quality of life. Current treatments for otosclerosis include hearing aids and surgical interventions such as stapedectomy or stapedotomy. Future perspectives on managing otosclerosis include improving surgical techniques and exploring innovative therapies.

Advancements in surgical instrumentation and imaging technology may pave the way for more minimally invasive approaches to treat otosclerosis, reducing surgical risks, shortening recovery times, and improving patient outcomes. The development of biocompatible implants or prostheses that can replace affected ossicles more effectively while minimizing the risk of complications, gene therapies targeting genetic factors responsible for abnormal bone growth, and novel pharmacological approaches that could inhibit bone remodeling or promote bone absorption in affected areas.

The future management of hearing loss is likely to embrace personalized treatment plans based on individual patient characteristics, disease progression, and preferences. Advances in genomics and precision medicine could play a significant role in tailoring interventions to specific patient needs. As technology and research progress, healthcare professionals will be better equipped to meet the unique needs of each patient and pave the way for a more inclusive and accessible society.