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From surgery to communication: The role of the speech-language therapist in supporting children with cochlear implants

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Abstract:
This article addresses the pivotal role of the speech-language therapist in the care of individuals with hearing impairment who have received cochlear implants, positioning the speech-language therapist as a central factor in the success of this auditory technology. The article outlines the various stages of the speech-language therapist 's intervention, beginning with preoperative assessment, followed by device programming and monitoring of auditory responses, and culminating in auditory and language rehabilitation aimed at restoring the child's communication skills. The article also emphasizes the importance of working within a multidisciplinary team and the critical role of the family in supporting the rehabilitation process. Drawing on field experience, the author concludes that the effective success of cochlear implantation can only be achieved through regular speech-language follow-up, which ensures the development of auditory and linguistic abilities and facilitates the child's integration into their social and linguistic environment.

Keywords: speech-language therapist, hearing-impaired individuals, cochlear implant.

Introduction

Hearing is a fundamental pillar in the development of human communication, serving as the primary gateway for acquiring spoken language and building communicative and social competencies, particularly during early childhood. Any impairment in auditory capacity can have varying effects on linguistic and cognitive development, with severity depending on the degree, onset, and nature of the hearing loss, making hearing impairment one of the most impactful disabilities on learning and social interaction.

Hearing impairment represents a heterogeneous population, requiring multifaceted interventions tailored to the individual characteristics of each case. While some individuals benefit from conventional hearing aids, these devices remain limited in effectiveness for those with severe or profound deafness, necessitating the exploration of more advanced technological alternatives. In this context, cochlear implantation has marked a significant breakthrough in audiology, representing one of the most effective solutions for enabling individuals with sensorineural hearing loss to regain auditory perception and engage meaningfully in their linguistic and social environment.

However, the functional success of cochlear implantation is not solely dependent on surgical or technological factors; it heavily relies on the quality of subsequent rehabilitative support, with speech-language pathology intervention being central to the development of auditory, linguistic, and communicative skills. Despite significant advancements in cochlear implant technologies, the literature indicates that outcomes remain highly variable among individuals, highlighting the critical role of educational and rehabilitative factors in determining functional results.

A review of previous studies reveals that much of the research has focused on medical and surgical aspects or the auditory efficacy of the device, whereas investigations addressing the practical and methodological role of the speech-language pathologist across the various stages of cochlear implantation—particularly from an educational and communicative perspective—remain relatively limited, especially within Arabic-speaking contexts. This underscores a scientific gap concerning the documentation of field-based speech-language practices and their role in supporting linguistic and educational integration for children with cochlear implants.

Against this backdrop, the present article aims to highlight the role of the speech-language pathologist in supporting children with cochlear implants, from the preoperative stage to the development of functional communication and language integration, emphasizing their pivotal role within a multidisciplinary team. The article draws on over a decade of field experience in speech-language pathology, seeking to provide an applied analytical perspective that demonstrates the contribution of SLP intervention to the success of cochlear implantation and the enhancement of its educational and communicative outcomes.

1. Definition of the Cochlear Implant

A cochlear implant (CI) is a device that enables hearing and enhances verbal communication abilities in individuals with severe, profound, or total sensorineural hearing loss who have not benefited from conventional hearing aids after an adequate period of rehabilitation. The device consists of a multi-electrode system that transmits auditory information to the inner ear. While it does not restore normal hearing, it improves the individual's ability to perceive environmental sounds.

Cochlear implants function by converting environmental sounds into electrical signals capable of stimulating the cochlear nerve, thereby producing auditory sensations (Chouard, 2010).

2. Components of the Cochlear Implant

The cochlear implant consists of external and internal components:

2.1. External components include:

- **Microphone:** Captures sounds from the environment.
- **Speech processor:** Positioned on the ear, it encodes and processes sounds.
- **Cables:** Transmit the processed signals.
- **Transmitting coil (antenna):** Positioned on the scalp and connected to the skull.
- **Battery:** Rechargeable, providing power to the device; sizes vary depending on the model.

The microphone captures environmental sounds and sends them to the speech processor, which encodes them into electrical pulses. These pulses travel via the cables to the antenna on the skull, allowing transcutaneous transmission to the internal device.

2.2. Internal components include:

- **Electronic stimulator:** Implanted under the skin.
- **Electrode array:** Surgically inserted into the cochlea.

The electronic stimulator transmits the processed signals to the electrodes inside the cochlea. The electrode array conveys these signals to the auditory nerve fibers, which then transmit them to the auditory cortex for processing (Gipp, 2023, p.3).

2.3. Functioning of the cochlear implant:

- The microphone captures sounds and converts them into electrical signals.

- These signals are sent to the transmitter, which relays them to the implanted receiver under the skin.

- The receiver generates electrical impulses for the electrodes in the cochlea.

- Upon stimulation of the auditory nerve, the impulses are transmitted to the brain, where they are perceived as sound.

The entire process, from sound acquisition to cortical interpretation, occurs rapidly, allowing the individual to perceive sounds in real time continuously.

3. Candidates for Cochlear Implantation

Cochlear implantation is considered the only effective solution for correcting perceptual deafness, typically when hearing loss exceeds 80 dB and cochlear function is severely compromised. Suitable candidates include:

- **Severe hearing loss:** Individuals who, despite using powerful conventional hearing aids, can hear some sounds but cannot comprehend them.

- **Profound hearing loss:** Cochlear implants can stimulate auditory perception even if the organ of Corti is entirely damaged.
- **Total deafness:** Individuals with total deafness cannot perceive environmental sounds even with the most powerful hearing aids; cochlear implantation is the only viable solution (Al-Zriqat, 2008).

4. Criteria for Cochlear Implantation

Several criteria must be met for cochlear implant candidacy:

- Absence of medical or surgical obstacles, or congenital malformations that would prevent surgery.
- Demonstrated inadequate benefit from conventional hearing aids after sufficient and correct use, typically for at least six months.
- Presence of bilateral sensorineural hearing loss with severity of 80 dB or higher (severe, profound, or total).
- Integrity of the auditory nerve confirmed through specialized testing (as the goal is to replace the cochlea, not the nerve).
- Psychological and physical readiness of the candidate.
- Age, which plays a critical role in the success of implantation (Sandi & Al-Ashri, 2016, p.33).

5. Stages of Cochlear Implantation

5.1. Preoperative Stage

Before deciding on cochlear implantation, several examinations and assessments must be conducted to determine the child's suitability for the procedure and its subsequent outcomes. These evaluations include:

- **Medical Examination:** Assessment of the ear and vestibular system, thyroid function, and a general health check (including vision, neurological, and cardiac evaluations).
- **Auditory Evoked Response Testing:** Conducted by an audiologist or audiometric technician, this assessment helps determine the degree of hearing loss. It typically includes both pure-tone audiometry and speech audiometry.
- **Electrical Testing:** A brief procedure performed within a few minutes using local anesthesia on the ear or mild sedation, allowing correct placement of the electrode.
- **Radiological Assessment:** Commonly employed techniques include computed tomography (CT) scans and magnetic resonance imaging (MRI), which are particularly useful for examining the bony structures and other internal components of the ear. These imaging techniques identify anatomical malformations, provide surgical guidance, and approximate surgical sites. For children, these tests are conducted under general anesthesia, whereas adults may not require sedation.
- **Psychological Assessment:** This is crucial for informing the patient and family about all procedural steps. The presence of a foreign device in the ear may cause psychological stress for the child and family. Psychological evaluation enables clinicians to assess the patient's readiness to accommodate the new device (Deriaz, 2009, p.20).
- **Speech-Language Pathology Assessment:** The speech-language pathologist conducts a pre-implant evaluation through a clinical interview with the patient and caregivers to collect information on the child's history of hearing loss, developmental progression, and communication needs. This assessment also includes:
  - Evaluation of spoken language and voice analysis.
  - Analysis of communication methods and strategies.
  - Identification of strengths and weaknesses that may facilitate or hinder pre-implant adaptation.
  - Careful observation of the child's behavior during the interview.

The outcome of this initial stage allows the multidisciplinary team to develop a preliminary understanding of the child's need for cochlear implantation. The final decision is made after the child undergoes a preparatory program, yielding clear and definitive results (Nabawy, 2010, p.44)

5.2. Surgical Stage and Recovery

Once medical and anatomical evaluations confirm the absence of surgical obstacles or congenital malformations, the child is prepared for surgery. Cochlear implantation is performed under general anesthesia and typically lasts about three hours for a single ear, as the number and positioning of implanted electrodes are crucial for achieving optimal auditory outcomes.

Surgical techniques for cochlear implantation are largely consistent regardless of the specific device chosen. Although minor variations may exist between surgeons—mainly concerning the size and shape of the incision—the fundamental surgical principles remain the same. Hair behind the ear is shaved, a skin incision is made, and the surgeon elevates the skin flap to expose the mastoid bone. A small mastoidectomy is performed, with the facial nerve serving as a landmark to access the cochlea.

The postoperative recovery period is particularly critical during the first few weeks. The medical team provides intensive support, including guidance on wound care and psychological support to address the fear and anxiety experienced by the patient and family regarding surgical outcomes. Regular postoperative monitoring is essential to prevent complications such as infection, and any issues must be promptly reported to the operating surgeon.

5.3 Rehabilitation Stage

Rehabilitation sessions typically begin approximately six weeks after surgery, once the surgical site has healed and the implanted electrodes are active. Rehabilitation strategies are individualized based on the patient's needs, and the device is programmed to ensure optimal settings for auditory stimulation. Patients then participate in structured programs designed specifically for cochlear implant users (Hussein, 2014, pp. 86–87).

5.3.1 Cochlear Implant Programming

Instead of the natural ear, the speech processor converts sound into electrical pulses that are captured by the electrodes in the cochlea and transmitted to the brain via the auditory nerve. Programming, or mapping, begins by verifying the proper function of all electrodes. The goal is to determine:

- The **threshold level (T-level):** the lowest electrical stimulation perceived as sound.
- The **comfort level (C-level):** the highest stimulation that remains comfortable for the patient.

Each electrode is programmed individually, creating a **MAP**, which represents the patient-specific electrical dynamic range stored in the processor. Key MAP settings include:

- **Coding strategies:** Methods for analyzing acoustic signals and converting them into electrical stimulation.
- **T- and C-levels:** Define the threshold and comfort levels for each electrode.
- **Pre-processing algorithms:** Options to optimize speech perception in various environments, such as quiet or noisy settings (Pawelczyk, 2014).

Programming usually begins four to six weeks post-surgery, once the incision has fully healed. Mapping is adjusted gradually based on the patient's behavioral responses. Programming in young children is particularly challenging; therefore, a collaborative approach involving the surgeon, audiologist, and speech-language pathologist is recommended to ensure trust and comfort between the child, family, and clinical team.

Device programming is an ongoing process that continues throughout speech-language rehabilitation. The speech-language pathologist provides detailed feedback on auditory behavior to the audiologist, allowing incremental adjustments as needed. Initial follow-ups are conducted monthly, then every two to three months, followed by six, nine months, and one year. Once the patient achieves a satisfactory level of auditory understanding, annual monitoring is generally sufficient, with programming adjustments aligned with the patient's ongoing rehabilitation progress.

5.3.2 Speech-Language Rehabilitation

Speech-language rehabilitation for children with cochlear implants is a critical step, as the success of the implant largely depends on the quality and continuity of therapy. Rehabilitation begins immediately after device activation and programming, following a structured, multi-stage approach.

A. Auditory Detection and Awareness

This preliminary stage aims to help the child detect and attend to sounds in their environment. Responses may vary, manifesting as facial expressions, eye blinking, or physical movements. Activities in this stage may include: ringing a bell, using an alarm, tapping a spoon in a cup, or knocking on a door.

B. Sound Localization

At this stage, the child is trained to associate sounds with their direction and source, relying solely on auditory input. Common stimuli include door knocks, bells, drums, and musical instruments. If the child struggles to localize sounds, the clinician provides guidance by producing the sound and encouraging the child to orient toward it.

C. Auditory Discrimination

The child is trained to distinguish between:

- Low and high-pitched sounds.
- Sharp (high-frequency) and dull (low-frequency) sounds.
- Long and short sounds.
- Familiar environmental sounds, such as cats, doors, birds, dogs, and cars.
- Human voices, distinguishing between men, women, boys, and girls.
- Different musical instruments.

D. Language and Auditory Recognition

The clinician fosters simultaneous development of cognitive and auditory skills through repetition and imitation. Environmental sounds and animal noises (onomatopoeias) are first named visually (e.g., via lip reading) and later without visual cues. The child is trained to recognize sounds by identifying them.

E. Auditory Comprehension and Meaning

This stage focuses on the child's ability to understand spoken language and connect sounds to words and sentences. Picture-based stories are used, with repeated explanation by the clinician, followed by the child's description. Text comprehension progresses from short to longer passages to prevent cognitive overload.

F. Auditory Closure and Listening in Noise

Auditory closure exercises train the child to complete sentences with missing words (e.g., "The car moves by ______?"). Listening in noisy environments helps the child identify and distinguish sounds in daily life. Noise may be introduced in the therapy setting through radios, open windows, or conversations, with the child required to respond accurately.

G. Understanding Spoken Language

At this stage, the child develops the ability to comprehend speech, narrate, participate in dialogues, and use the telephone.

Additional speech-language therapy exercises include:

- **Respiratory Exercises:** Training the respiratory muscles to control airflow for vocalization. Inhalation occurs through the nose with closed mouth and fixed shoulders, and exhalation is performed vocally through the mouth.
- **Orofacial Exercises:** Focused on movements of the mouth, tongue, and facial muscles.
- **Blowing and Suction Exercises:** Regulate expiratory airflow.
- **Relaxation Exercises:** Reduce tension, restore energy, correct breathing patterns, and serve as a self-regulation technique for anxiety.
- **Postural and Balance Training:** Aims to improve overall body balance, chest and shoulder extension, spinal elongation, and strengthen tendons, legs, and thighs. These exercises can also help alleviate voice disorders.
- **Voice Training:**

- Whispering and Voicing Exercises: The child produces whispered sounds, followed by their voiced counterparts, maintaining continuous airflow. Examples include: /f/ →

/v/, /dʒ/ → /ʃ/, /s/ → /z/. Proper posture and muscle engagement are carefully monitored during these exercises.

- Vibration Awareness Exercises: Children are trained to feel vibrations in different areas of the vocal apparatus, e.g., /z/ for upper teeth and lower lip, /n/ for the nasal cavity. This helps them locate the point of airflow and voicing (laryngeal and supralaryngeal areas).

- Sustained Vowel Exercises: Children produce vowels (/i/, /u/, /a/) at low intensity, gradually increasing to maximum intensity and then decreasing, promoting dynamic vocal control.

Speech-language rehabilitation sessions demand significant effort and time from the clinician, the family, and the child, and progress is gradual and continuous.

Conclusion

In conclusion, this article has sought to highlight the author's professional experience as a former speech-language pathologist in working with children with cochlear implants, emphasizing the pivotal role of the speech-language specialist in ensuring the success of cochlear implantation. Based on this experience, the following recommendations are proposed:

- Emphasize the importance of auditory training for cochlear implant recipients, particularly during early childhood.
- Organize training programs for speech-language specialists to familiarize them with the auditory and speech skills that should be developed in children with cochlear implants.
- Conduct guidance and training sessions for the families of children with cochlear implants to support effective home-based care, given the critical role of the family in the success of auditory and language rehabilitation.
- Promote community awareness through educational campaigns and media initiatives, highlighting the significance of immediate post-implant training and rehabilitation as an essential step in language acquisition.

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