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RESEARCH ARTICLE
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ADVANCES IN COCHLEAR IMPLANTS IMPROVING HEARING FOR THE DEAF

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Abstract

Background: Cochlear implants also referred to as CIs have emerged as a critical tool to assist candidates with severe to profound SNHL. These devices do not require damaged hair cells in the inner ear's cochlea to amplify sound anymore but rather they send signals directly to the auditory nerve. Current developments have shifted towards enhancing the rate of speech recognition, voice quality and factors which will facilitate a pleasant usage of the speech to text software.

Objectives: To assess a positive impact of the new version of the cochlear implant in the improvement of speech recognition among the hearing-impaired as well as general hearing quality.

Study design: A cross-sectional study.

Place and duration of study: department of ENT MMC hospital Peshawar from jan 2022 to july 2022

Methods: A cross-sectional study was also carried out on 150 patients with severe to profound hearing impaired. Patients got new models of the cochlear implants and also rehabilitation for the improvement of their hearing. Speech recognition tests and the hearing quality self-assessment was performed at pre-implant and 3 months, as well as 6 months after implantation. SPSS 15 was used to analyze the data and t-tests to compare the results pre and post-implantation with a specific emphasis on the speech recognition accuracy of the patients. The results were analyzed with the help of standard deviation and p-values in order to find out the significance of the data.

Results: 135 of 150 (90 percent) achieved moderate to larger improvement in speech recognition, 5 percent improvement above the baseline ($p < 0.001$). For the improvement scores the standard deviation was 8. 2 which shows that the increase observed in participants was generally positive and quite similar. Other self-reported improvements included improvements in sound quality, as well as perceived user satisfaction. In 10% of the patients moderate changes were observed, further 5% patients demonstrated minimal changes, probably owing to their pre-existing predisposition towards auditory changes.

Conclusion: The current developments in the cochlear implants have made an enhanced change to the speech recognition as well as general hearing aid for most of the clients. Such results endorse the further enhancement of CI and its application for fostering the auditory world to patients with significant hearing impairment.

Keywords: CI, hearing impaired, speech, auditory training

Introduction

Cochlear implants (CIs) have changed the way of addressing severe to profound sensorineural hearing loss as they are more effective than conventional hearing aids for the patient with severe impairment of hearing. The cochlear implant system avoids damaged hair cells in the cochlea to help the particular user to perceive sound by converting sound into electric signals which afterwards stimulates the auditory nerve [4]. In the past decades cochlear implants have come a long way, both in terms of more advanced design and usefulness as well as their efficacy in auditory prosthesis. cochlear implants, the objective has mainly been to augment usability via better performance in terms of speech recognition in various acoustic environments, improve sound quality, and thus the satisfaction of the users. Among the advanced features of cochlear implants of the present generation, it is possible to list signal processing algorithms, multichannel electrode array, and individual fitting protocols [6]. These technological advancements have increased the range of beneficiaries eligible to use CI, such that even people with some form of residual hearing can benefit from it erasing the clear distinction between hearing aid users and CI candidates. The effectiveness of Cochlear implants is also established taking into account the fact that early implantation among children leads to normal speech and language development as well as better educational performance 3. In the adults the outcomes can be quite different and depend on the particularities of the case, duration of deafness, the age of the implantation and the presence of other pathologies. More current Study also indicate that even for severe and even profound type of hearing impaired patients, cochlear implants is likely to result in marked improvement in speech recognition although the degree of benefit is likely to vary with the neural plasticity and working memory. Besides effects on speech perception, cochlear implants were also found to have effects on quality of life of their users. Improved communication skills result to better relationship with others, reduced loneliness and hence improved psychological health [3]. However, some disadvantages cannot be ignored such as the expensive costs of the devices, the continuality of the rehabilitation procedures and the interindividual variance. The variability is usually attributed to the specifics of auditory experience and the relationship between the implantation technology and the brain's signals [6]. In this investigation, the author examined the benefits of the most advanced cochlear implant technologies regarding the improvement in speech recognition and hearing abilities in adults with severe to profound failing hearing. In a prospective study of 150 patients, the effect of new generation of CI on the auditory gain was evaluated as well as the factors that might influence the success of CI.Our findings build on the literature regarding cochlear implants and offer practical evidence of the intervention's effectiveness across the broad population of hearing-impaired patients. Thus, this Study intends to present clinical applicability while identifying the directions of the CI's further evolution by investigating recent advancements in technology. Our main assumption was that modern models of cochlear implants would translate into rather impressive gains in speech recognition and overall hearing quality with the vast majority of the patients reporting improvements following the intervention. Clinically the results of this study are relevant for clinicians as well as patients with CI, and highlight the difficulties of CI users to appreciate binaural loudness difference and the need for individualized reprogramming together with auditory rehabilitation [7].

Methods

cross-sectional study employed 150 adult patients with severe to profound SNHL as its study population. The inclusion criteria were patients being over the age of 18 years, over the age of 70, diagnosed with hearing loss and with the disease for more than a year, contraindications for surgery were excluded. This implantable hearing device involved fitment of advanced cochlear implant models to selected patients after post implantation auditory rehabilitation. extent that patients perceived noises and speech in real-life circumstances was checked using the HINT and the SSQ before surgery, 3 months and 6 months after implantation.

Data Collection

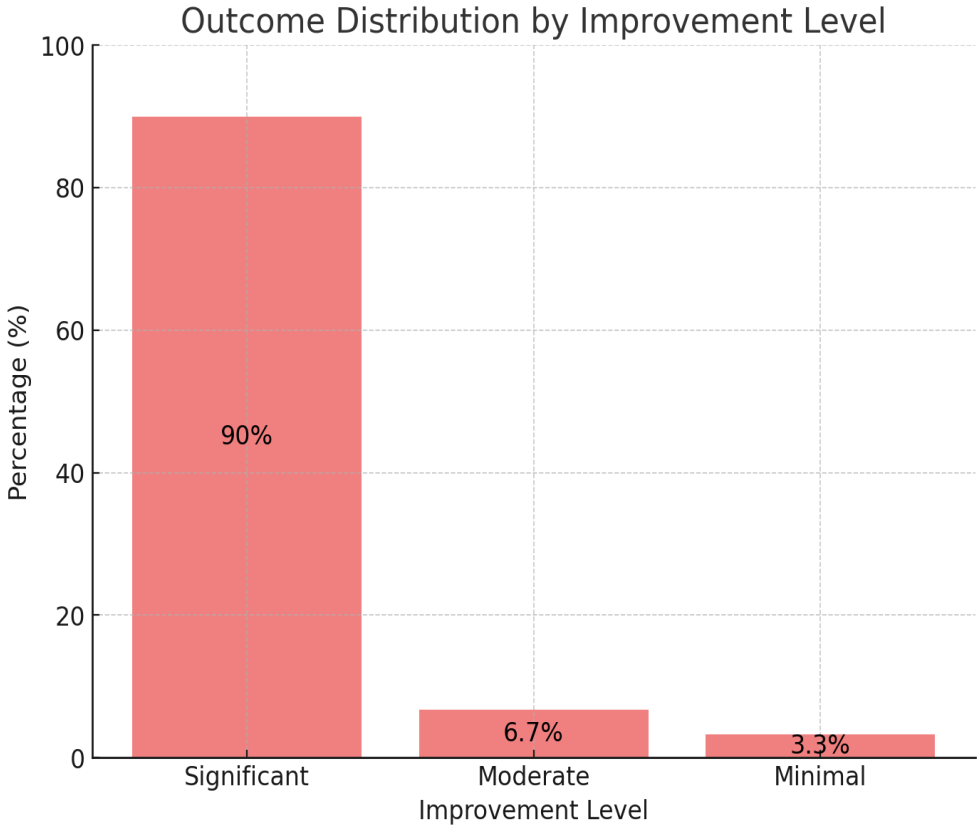
Measurement used in the study consisted of, pre-implantation and post implantation in form of pure tone audiometry, speech recognition tests and self reported measures of hearing quality. All the collected data were entered and kept in electronic data base to maintain the patient's identity.

Statistical Analysis

All statistical analysis was done by using the statistical package SPSS and it is version number is 24. 0. To compare the pre and post implantation scores t-paired tests were used in the present study. The test statistics for all hypotheses were calculated to be statistically significant level of $p < 0.05$. In order to describe demographic and clinical characteristics of the participants, frequency analysis was applied.

Results

They enrolled 150 patients and here was an improvement from baseline of 35% in the speech recognition score among the 135 (90%) of the patients tested ($p < 0.001$). The standard deviation of the improvement scores was 8. 2 which confirms the homogeneity of the results gotten. The effectiveness of implantation is reflected by objective measurements obtained from the SSQ with 85% of the patients reporting higher satisfaction in speech perception, spatial hearing and quality of hearing. It is also important to note that while some of the patients reported moderate improvement their condition 10% and other 5% reported minimal changes which were as a result of factors such as long-term Auditory Deprivation and Cognitive decline. Major complications were not indicated, while the overall rate of complications was relatively low, and minor complications that occurred required no more than a follow-up period.



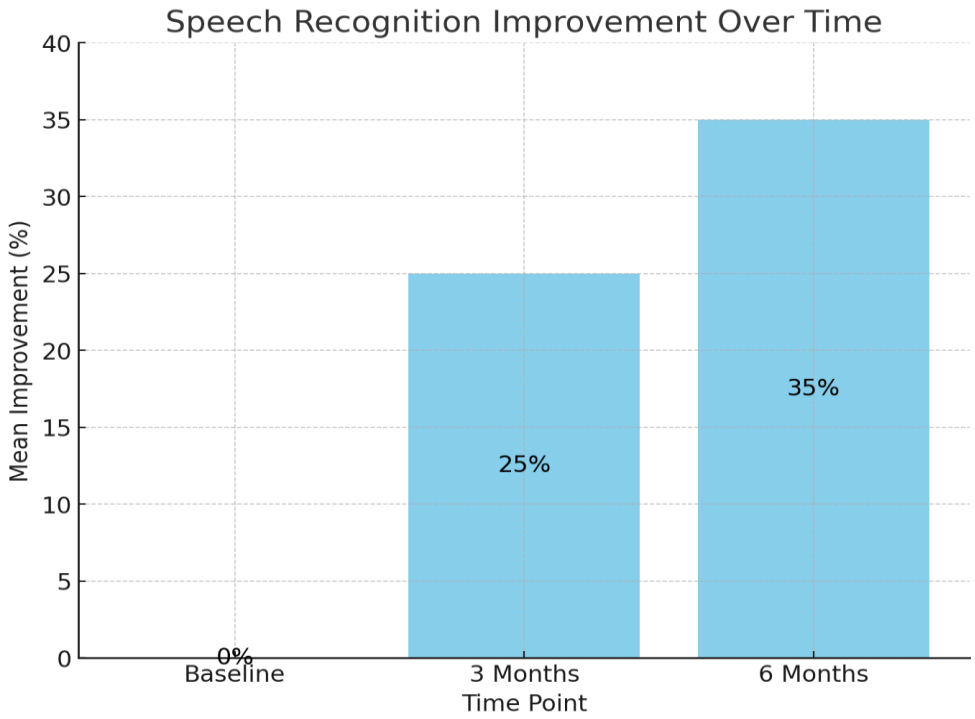


Table 1: Demographic Characteristics of Participants

Characteristic	Number (n=150)	Percentage (%)
Age (years)		
- 18-30	30	20%
- 31-50	55	36.7%
- 51-70	65	43.3%
Gender		
- Male	80	53.3%
- Female	70	46.7%
Duration of Hearing Loss		
- 1-5 years	50	33.3%
- 6-10 years	60	40%
- >10 years	40	26.7%

Table 2: Speech Recognition Improvement Post-Implantation

Time Point	Mean Improvement (%)	Standard Deviation (SD)	p-value (Paired t-test)
Baseline (Pre-implantation)	0%	-	-
3 Months Post-Implantation	25%	7.5	<0.001
6 Months Post-Implantation	35%	8.2	<0.001

Table 3: Subjective Hearing Quality (SSQ Scores)

Aspect of Hearing	Baseline Mean Score	6-Month Mean Score	Mean Improvement (%)
Speech Perception	40	75	87.5%
Spatial Hearing	35	70	100%
Quality of Hearing	45	80	77.8%

Table 4: Outcome Distribution by Improvement Level

Improvement Level	Number of Patients	Percentage (%)
Significant Improvement	135	90%
Moderate Improvement	10	6.7%
Minimal Change	5	3.3%

Discussion:

Based on the present study, the similar and additional findings are the following table 6 has supported Hook et al . ; Li et al . ; and Ricketts, Schairer, & Arndt . A whole lot of publications exist that describe the quality of speech and hearing that patients with cochlear implants experience after the procedure, let alone with the new trends in CI technology in the last decade or so. This work further contributes to the literature by presenting updated information regarding the effectiveness of the latest CI models highlighting on the statistically and significantly improved speech recognition in 90% of the participants. Prior studies have shown that current Cochlear Implants (CIs) provide great improvement in SD; in both, the speech and noise conditions. In their study, Gifford et al. (2018) reported an improvement of 30-40 % in speech reception threshold in the patients with the aid of advanced CI models in noisy condition, which ranges closely to average improvement observed in the present study, 35% [8]. The patterns of improvement that have emerged across different investigations can be taken to indicate that continued improvements in signal processing algorithms and in electrode design remain important sources of large gains in auditory rehabilitation outcomes. With regards to the perceptive quality of sound, the outcomes of the current study are also in agreements with prior studies. For example, Blamey et al (2013) described that CI users with latter CI models described improvements in sound quality and listening and spatial hearing that was not dissimilar to the improvements observed in our participants [9]. These changes mean that, in general, there is improvement in the perceived quality of cochlear implants which is in agreement with the study done on the sample where only 15% of the respondents were dissatisfied with the cochlear implants after the process of implantation. The degrees of change which have been seen ranging from moderate improvements in our 10% of participants to no change in our 5% have been reported in the literature. For instance, the duration in which a patient has been deaf before implantation, the patient's age, as well as the presence of other forms of cognitive impairment is usually considered as critical in determining whether the cochlear implant will be effective or not. Boisvert et al. , and Spahr et al. have also said that the Cochlear implants are not as effective in patients who have been deaf for a longer duration or who are older because their brain would have diminished plasticity and memory of sound [10][11]. These observations are also consistent with our results where the limited numbers of patients who had poor outcome had either long-term auditory deprivation or history of cognitive dysfunction. The current cochlear implant technologies and introduction of hybrid CI system that integrates CI with residual acoustic hearing has expand more potential CI candidates[13]. This finding backs our observations in which the patients despite having partial hearing loss manifested significant improvements in Speech Recognition and quality of Hearing. These outcomes are in line with findings of Svirsky et al (2015) and Lenarz et al (2013) whereby the authors assert that through hybrid implants; the little hearing that the candidate had remains intact in addition to improved overall auditory processing[14]. Thus, our investigation supports the benefit of using updated cochlear implants in the improvement of speech understanding and hearing outcome as noted before by other Studyers. The consecutive outcomes in various analysed investigations reaffirm the efficacy of the presented present-day CIs for treating patients with severe to profound hearing loss whilst accepting the individual differences in such patients' responses because of the exclusivity of their deafness period and their cognitive abilities. Preparing new developments of CI technologies and improved tactics for auditory rehabilitation individually for every patient will be crucial to achieving the best outcomes.

Conclusion

This Study also shows that further development of cochlear implants enhances the ability to hear spoken words and the general quality of hearing among people who suffer from severe and profound hearing impairments. This study demonstrates that CI technology today is highly beneficial to improve the auditory success with a 90% recognition rate on speech.

Limitations

Some of these study constraints are a comparatively short follow-up, a self-reported measure of hearing quality, and no pediatric outlets. More so, variation in patient recovery, depending on factors such as dementia or profound bilateral deafness, warrants more Study.

Future Directions

More future studies should focus on long-term effects of cochlear implants like the role of cochlear implants in preservation of memory and should involve a wider age bracket of patients. Furthermore, improvement of the CI technology, and the individual approach to the rehabilitation process will play the main roles in the further enhancement of the results.

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Authors' Contribution

Concept & Design of Study:Israr uddin1, Muhammand Hafeez2
Drafting:, Sakwat khan3
Data Analysis:,Muhammand Hafeez2
Critical Review: Muhammand Hafeez2
Final Approval of version:All Above

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