E-ISSN: 2710-3854
P-ISSN: 2710-3846
Impact Factor (RJIF): 6.4
IJSA 2025; 6(2): 107-108

Journal's Website
Received: 13-07-2025
Accepted: 17-08-2025

Hannah Baby
Dr. Noushad's ENT Hospital and Research Centre, Kerala, India

Dr. Suman N
Ph.D., Audiologist, Vestibular Specialist, Department of Audiology, Shabdha Speech and Hearing Clinic, Bengaluru, India

Dr. Mohammad Noushad V
Chief ENT Surgeon & Implant Specialist, Department of ENT, Dr. Nosushad's ENT Hospital and Research Centre, Kerala, India

Correspondence
Hannah Baby
Dr. Noushad's ENT Hospital and Research Centre, Kerala, India

Electrical dynamic range (EDR) and its effect in pre-lingual children implanted during the critical period

Hannah Baby, Suman N and Mohammad Noushad V

DOI: https://dx.doi.org/10.22271/27103846.2025.v6.i2b.91

Abstract
The cochlear implantation surgery during the critical period of child's development has shown significant effect on the spoken language development. The Electrical Dynamic Range (EDR) is one of the key parameters to be considered during mapping. The purpose of this study was to investigate the longitudinal changes in the electrical dynamic range of cochlear implants and determine if age at implantation significantly influences this pattern over the first year of device use in pre-lingually deaf children. This prospective study included 27 unilaterally implanted children (CI 422 implant with CP802 processor) who were categorized into three groups based on implantation age: Group 1 (1–2 years; n=10), Group 2 (2–3 years; n=10), and Group 3 (3–4 years; n=7). The dynamic range (DR), calculated as the difference between behavioral threshold (T) and comfort (C) levels, was tracked from the time of switch-on through follow-up visits at 1, 3, 6, and 12 months. Analysis of the longitudinal data suggest that among children implanted before the age of four, the specific age at implantation does not significantly influence the long-term pattern of dynamic range changes.

Keywords: Electrical Dynamic Range (EDR), Cochlear implants, Critical period

Introduction

Hearing loss is one of the common sensory disorders which has high prevalence rate and negative impact on quality of life of individuals with hearing loss [1]. Cochlear implantation is a surgical procedure for individuals with hearing loss who has limited benefits with hearing aids [2-3]. The external device of a cochlear implant system also known as sound processor has to be programmed based on the needs of the users. This process is known as mapping. The mapping allows the recipient to listen to sounds to an optimum level from the CI electrode array [4, 5].

The mapping of sound processor includes setting the electrical dynamic range for that user. The dynamic range in cochlear implants refers to the span of perceived sound levels or, more specifically, the extent of electrical current amplitudes the implant delivers that a patient can hear. This Electrical Dynamic Range (EDR), defined as the difference between the most comfortable (C-level) and the softest audible (T-level) electrical stimulation, is considered a crucial element influencing an individual's auditory performance with their cochlear implant [6, 7].

The cochlear implant is one of the treatment methods used for children with hearing loss. The implantation and therapy done at early stages of them provides better outcomes. The critical period is important for spoken language development. This is due to the neural plasticity of the brain, prevention of cortical reorganization. The early implantation allows children to have consistent access to sounds. After the brain's main developmental window closes around age 7, the primary areas of the cortex that process sensory information are more likely to lose their strong connections to the higher-level brain regions surrounding them. This disconnection can lead to higher-order auditory processing areas being taken over by other senses, including vision and somatosensation [8].

Most children in India undergo cochlear implantation before the critical developmental period for hearing losses, but very few meet the minimum age criteria for the procedure. Hence this study aimed to understand if thereis any change in DR with respect to the age of implantation.

Subjects & Methods

The maps of 27 pre-lingual children were selected for the study who were grouped into three groups based on implantation age. Group 1 (n=10), the children who were implanted within the age of 1 to 2 years; Group 2 (n=10) 2 to 3 years and Group 3 (n=7) children who underwent surgery under the age range of 3 to 4 years. All of them were implanted unilaterally with CI 422 implant and using CP802 processor. The population mean method was used for mapping. This method gives an upper stimulation levels based on average values derived from analyzing thousands of existing patient maps. Each individual underwent Neural response Telemetry (NRT) at every visit. The Dynamic range (DR) was calculated using Threshold (T) and Comfort(C) levels. The DR was considered from the time of Switch On (SO), 1 month, 3 months, 6 months, and 1 year from the date of switch on for the study.

Results

The Linear Mixed Model was used to investigate how the dependent variable, a measure of dynamic range (DR), is affected by fixed effects (age at implant, time since implantation, and their interaction). The results showed coefficients for the 2 and 3-year age groups are small (-0.0909 and -0.3909) and have high p-values (0.974 and 0.898). The wide 95% confidence intervals (CI) for these coefficients both contain zero. This suggests no statistically significant difference in dynamic range, averaged across all time points, for patients implanted at age 2 or 3 years compared to those implanted at age 1 year. The coefficients for 1, 3, 6, and 12 months are also small and statistically non-significant, with high p-values (e.g., p=0.793 for 3 months) and CIs that include zero. This indicates no significant overall change in dynamic range over time compared to the switch on (baseline), when averaged across all age groups. A marginal (borderline) significant interaction was found for the children who were implanted at 2 years of age, at 6 months post implantation, with a coefficient of 6.3863 and a p-value of 0.05. The CI for this interaction (0.0015, 12.771) does not include zero. This suggests that among patients implanted at age 2, the change in dynamic range at 6 months post-implantation is significantly different from what would be predicted by the main effects alone. The positive coefficient suggests a potential increase in dynamic range for this specific subgroup.

Discussion

The results indicate no statistically significant differences in DR across age groups, the marginal interaction observed in children implanted at age 2 is intriguing. This subtle trend may suggest a developmental or neuroplastic advantage that warrants further exploration. It would be interesting to examine whether this increase in DR correlates with improved auditory or speech outcomes over time, and whether other variables such as auditory training intensity or residual hearing might mediate this effect. However, the previous study shows significant changes in psycho-electric parameters during the first 6 months of implant use. This may be due to the limited sample size, especially in Group 3, future studies with larger cohorts could help clarify these trends and potentially uncover age-related thresholds for optimal DR development. Additionally, incorporating behavioral measures or speech perception scores could enrich the interpretation of DR changes and their functional significance.

Conclusion

The age of implantation does not have an effect on the dynamic range in pre-lingual children when the implantation age is between 1 to 4 years. There is no strong evidence that age of implantation significantly influences the long-term pattern of dynamic range changes.

References

1. Wilson BS, Dorman MF, Woldorff MG, Tucci DL. Cochlear implants: A remarkable past and a brilliant future. Hear Res. 2008;242(1–2):3–21.
2. Brown KD, Balkany TJ. Benefits of bilateral cochlear implantation: a review. Curr Opin Otolaryngol Head Neck Surg. 2007;15(5):315–8.
3. Dazert S, Thomas JP, Loth A, Zahnert T, Stöver T. Cochlear implantation. Dtsch Arztebl Int. 2020;117(41):690–700.
4. Carlson ML. Cochlear implantation in adults. N Engl J Med. 2020;382(18):1677–87.
5. Allam A, Eldegwi A. Efficacy of using NRT thresholds in cochlear implants fitting in prelingual pediatric patients. J Otol. 2019;14(4):128–35.
6. Potts LG, Skinner MW, Gotter BD, Strube MJ, Brenner CA. Relation between neural response telemetry thresholds, T- and C-levels, and loudness judgments in 12 adult nucleus 24 cochlear implant recipients. Ear Hear. 2007;28(4):495–511.
7. Sharma A, Campbell J. A sensitive period for cochlear implantation in deaf children. J Matern Fetal Neonatal Med. 2011;24(Suppl 1):151–3.
8. Park B, Thak PK, Park E, Choi SJ, Lee J, Kwak S, Jung HH, Im GJ. Dynamic range and neural response threshold in cochlear implant mapping can be useful in predicting prognosis related to postoperative speech perception. J Audiol Otol. 2023;27(4):212–8.