

# Comparative Mapping of Vocal Parameters in Auditory Neuropathy Spectrum Disorder with and Without Use of Speech Processor in Bilateral Cochlear Implantation - A Pilot Study

Mohammed Eliyas<sup>1\*</sup>, Sanjeev Mohanty<sup>2</sup>

<sup>1</sup>Senior Clinical Audiologist, The Institute of ENT Head & Neck Surgery, MGM Healthcare, Chennai, Tamilnadu, India.

<sup>2</sup>Senior Consultant & Department Head, The Institute of ENT Head & Neck Surgery, MGM Healthcare, Chennai, Tamilnadu, India

Corresponding Author Email: [elijasasp\[at\]gmail.com](mailto:elijasasp[at]gmail.com)

Phone number: 9486726417

**Abstract:** Cochlear implantation (CI) in auditory neuropathy spectrum disorder (ANSD) is considered as optimal treatment option who gets limited or no benefit from conventional devices which includes assistive listening devices as well. Prime characteristic feature in ANSD is poor speech discrimination and reduced speech intelligibility in presence of background noise. Effectiveness of analysis of deviant vocal parameters is important due to increase in auditory feedback and subsequent voice quality. This study is done in 11 - year - old female with ANSD, who had been implanted bilaterally with implant age of 1.5 years was participated. Vocal parameters including sustained and interrupted phonation, glides, and soft and loud phonation were recorded during 5 - hour intervals with the speech processor both on and off condition. Later, these samples were analyzed using PRAAT software. Acoustic Analysis revealed significant increment in the frequency dynamicity Fo in ON condition. Significant difference in the pattern of attenuation of higher formants is noted. Though assistive listening device and hearing aids play major role in late onset group, comparison of data with expanded version of study with large samples in assessing vocal parameters specific to post bilateral CI with respect to late onset group will helps surgeon and audiologist to arrive at a decision making of possible candidacy criteria followed by rehabilitation process. Future direction is to predict the minimum time period of off periods which has effect on auditory deprivation due to reduced usage of auditory feedback.

**Keywords:** Cochlear implantation, Auditory neuropathy spectrum disorder, vocal parameters, device usage, habilitation, auditory feedback.

## 1. Introduction

Auditory neuropathy spectrum disorder (ANSD) is a term derived by Starr et al, 1996 that describes a pattern of hearing loss in which altered function of auditory nerve with functional preservation of outer hair cells (OHC). The etiology of ANSD are multifactorial in origin such as genetic factor, pre - natal, ante - natal history, post - natal factors, environmental factor, etc. According to Almishaal et al. (2022), approximately 9.85% of 1, 025 children with sensorineural hearing loss were found to have ANSD.

In patients with auditory neuropathy (AN), the extent of hearing loss can range from mild to profound and may develop either prelingually or postlingually. Hearing impairment can be bilateral or unilateral. AN can occur independently or as part of various syndromes and may also be associated with inner - ear malformations. Risk factors such as hyperbilirubinemia, infections, prematurity, exposure to ototoxic drugs, cochlear nerve (CN) deficiencies, and congenital brain anomalies are strongly linked to AN (Rajput et al., 2019; Natale et al., 2020; Liddle et al., 2022).

CI can offer benefits for patients with ANSD (Sarankumar et al., 2018; Alzhrani et al., 2019). Research has shown that factors such as the age at implantation, the duration of cochlear use, and specific genetic lesion sites can influence CI outcomes (Daneshi et al., 2018; Shearer and Hansen,

2019). However, speech performance in CI recipients with ANSD has been inconsistent (Harrison et al., 2015; Chaudhry et al., 2020), which complicates the decision - making process for patients considering this treatment.

Here, in our study we aimed to profile segmental and suprasegmental aspects of vocal parameters in late identified ANSD post cochlear implantation (CI). The objective of the study is to To assess dynamicity of pitch by eliciting glide phonation. To assess change in Fo onset, and subsequent formants using sustained phonation /a/.

## 2. Materials and Methods

A simultaneous Bilateral Cochlear implantee aged 11 years, female with Implant Age of 1.5 years diagnosed as ANSD is participated in the study. All preliminary audiological evaluation such as Pure tone Audiometry (PTA), Immittance audiometry (IA), Oto acoustic emissions (OAE), auditory brainstem response (ABR).

Findings revealed profound hearing loss in PTA (Figure 1), No indication of middle ear pathology bilaterally in IA, Absent OHCs in both the ears & No clear peaks at 90dBnHL with repetition rate of 19.3 /sec in both the polarities. Cochlear microphonics were observed till 2 msec. Further tube press method was done to check the reduction of amplitude of the wave which was comparable. (Figure2)

After the diagnosis, bilateral hearing aid usage of 1 year was done in which the subject did not appreciate the benefit. Aided audiogram and speech scores revealed no benefit from the conventional hearing aids (Figure 3). Assistive device like mini mic was used as trial period for 1 month in which limited benefit was reported.

#### Imaging studies:

Preoperative imaging included high - resolution computed tomography (HRCT) of the temporal bone and non - contrast brain magnetic resonance imaging (MRI) to assess the inner ear structures, cochlear nerve, and central auditory pathway. Abnormalities on HRCT or MRI were interpreted based on established criteria. Cochlear nerve deficiency (CND) was defined as either hypoplasia (where the cochlear nerve appeared smaller in diameter than the facial nerve on oblique sagittal MRI in the internal auditory canal) or aplasia (where the cochlear nerve was absent on MRI).

Adhering to the CI protocol, simultaneous bilateral CI was done. Post recuperation period, switch ON was completed. After the intensive training by the auditory habilitationist, periodic check of measurable auditory percept (MAP) and aided thresholds were done. With implant age of 1.5 years, vocal parameters such as sustained & interrupted phonation, glide, soft & loud phonation is recorded in **on & off** periods of speech processor of 5 - hours timely. Recorded sample is analysed using PRAAT software.

### 3. Results and Discussion

Acoustic Analysis revealed significant increment in the frequency dynamicity  $F_0$  in ON condition. Significant difference in the pattern of attenuation of higher formants is noted.

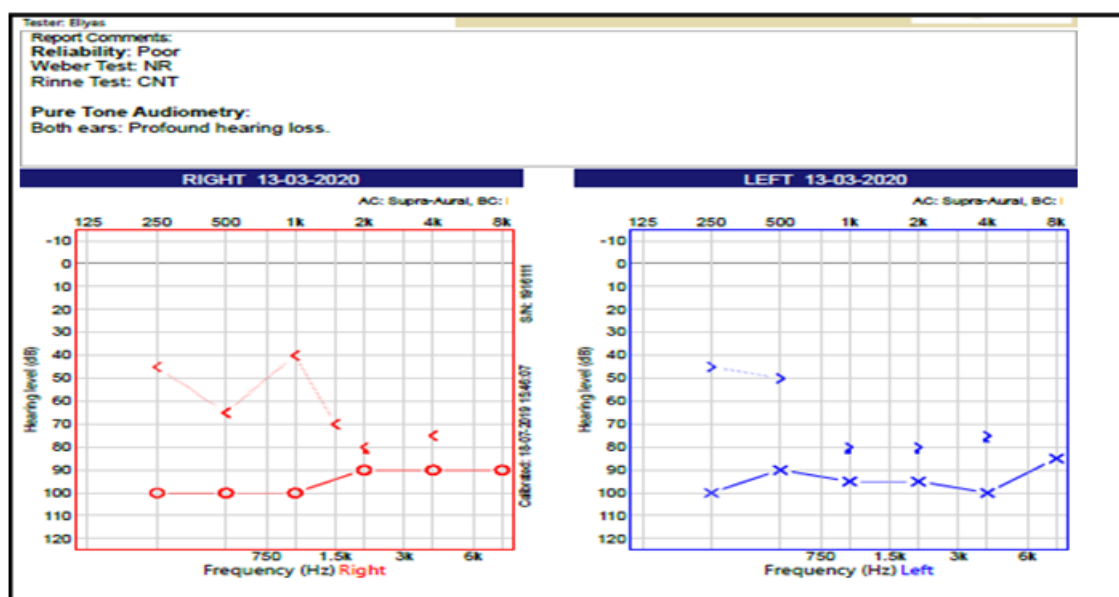


Figure 1: PTA results of the subject

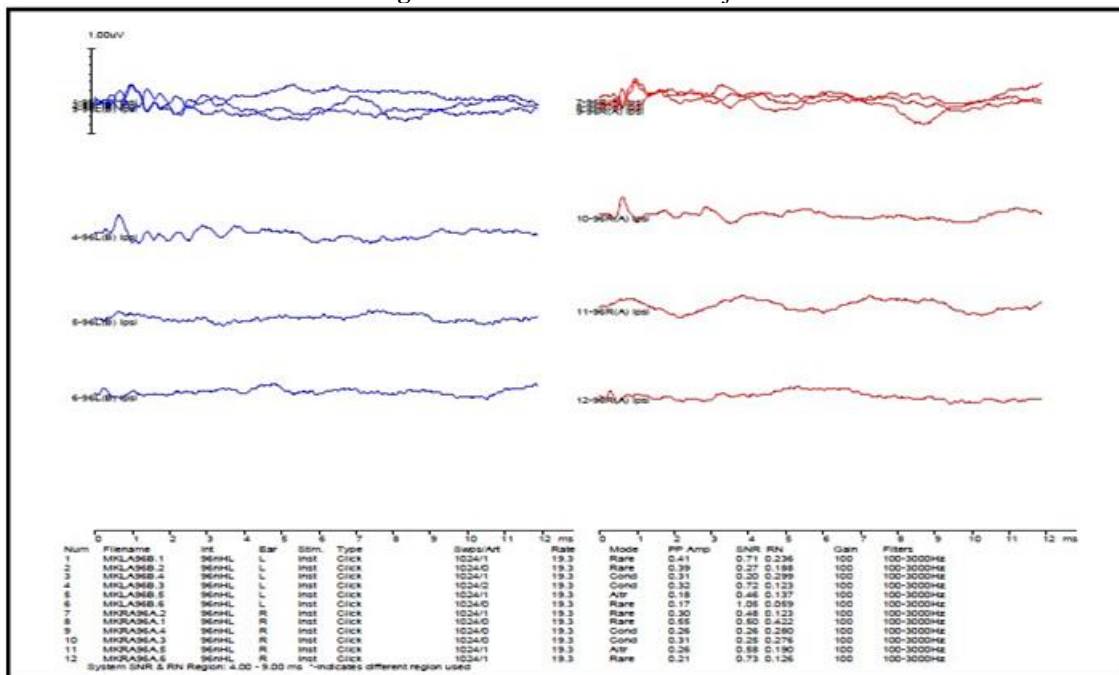


Figure 2: ABR result of the subject pre - operatively

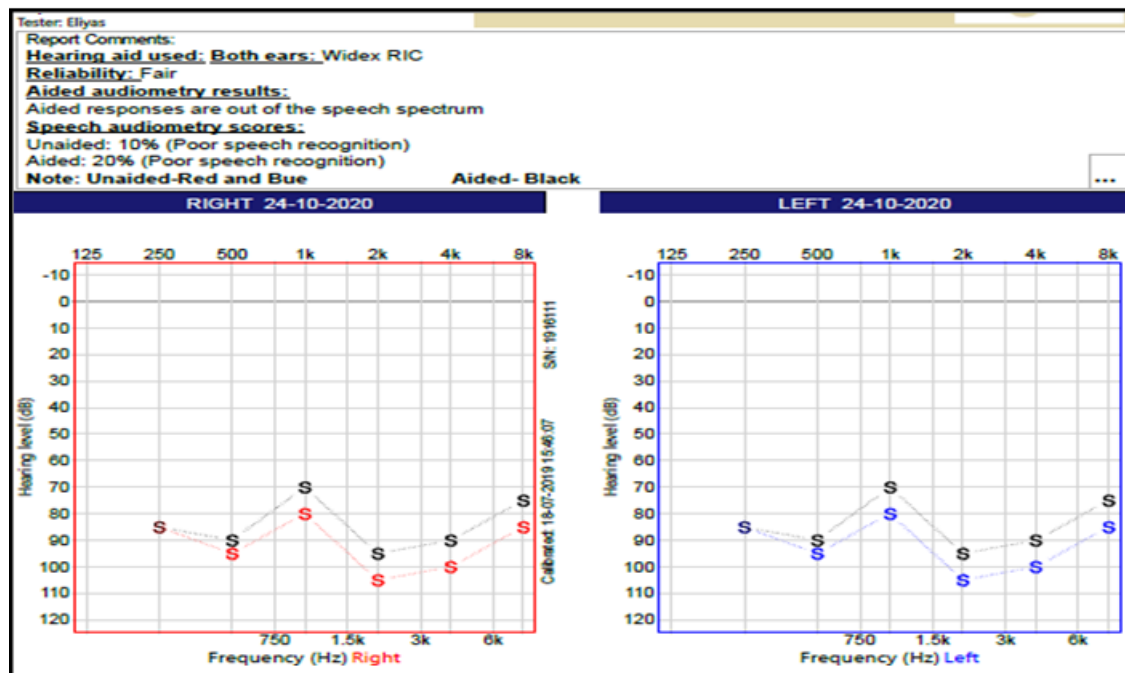


Figure 3: Aided thresholds of the subject with high power hearing aid.

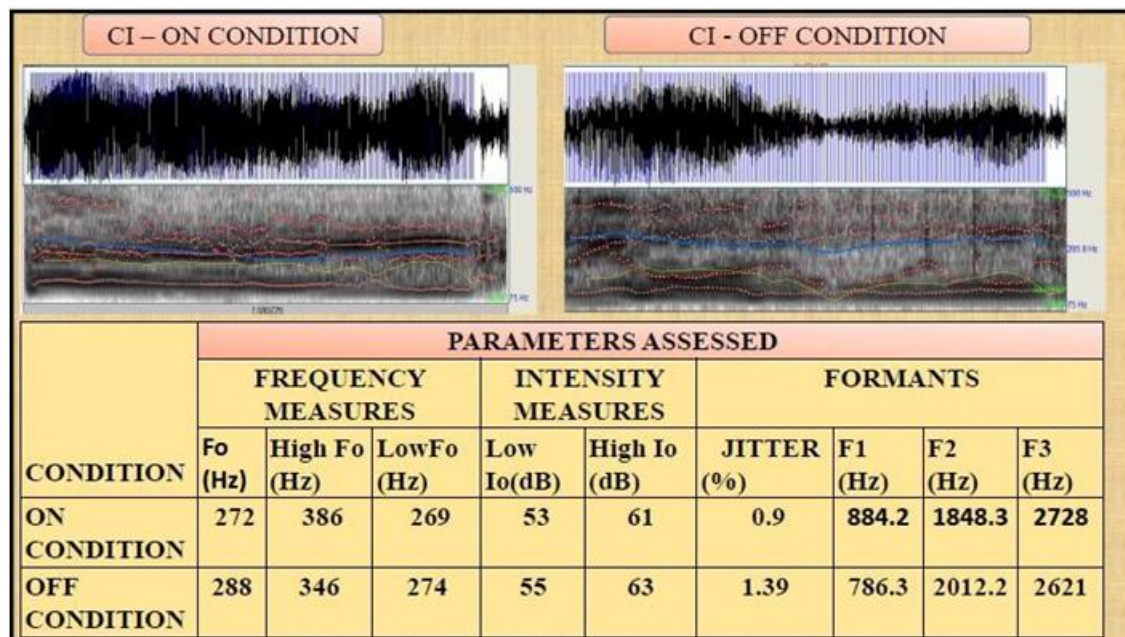


Figure 4: Vocal assessment of the subject using PRAAT software

Habitual Fo in ON condition seems to be low compared to OFF condition which encompass the involvement of auditory feedback. High Fo and Low Fo also showed similar variations across two conditions. With respect to intensity measures, not much difference of Io is observed. Formant frequencies were found to have a pattern corresponding to the two conditions analysed. In subject with late onset ANSD, usage of device consistently gives the optimal performance. Periodic check of MAP and habilitation follow up influences the outcome. Although a single case study, variables related to sample elicitation and analysis were taken into consideration.

#### 4. Conclusion

Though assistive listening device and hearing aids play

major role in late onset group, comparison of data with expanded version of study with large samples in assessing vocal parameters specific to post bilateral CI with respect to late onset group will helps surgeon and audiologist to arrive at a decision making of possible candidacy criteria followed by rehabilitation process. Future direction is to predict the minimum time period of off periods which has effect on Auditory deprivation due to reduced usage of auditory feedback.

#### References

- [1] Almishaal, A. A., Saleh, S., Alferaih, H., & Alhelo, O. (2022). Prevalence, risk factors, and audiological characteristics of auditory neuropathy. *International journal of audiology*, 61 (12), 1018–1026. <https://doi.org/10.1080/14992031.2022.2081111>

org/10.1080/14992027.2021.2014074

- [2] Starr A., Picton T. W., Sininger Y., Hood L. J., Berlin C. I. Auditory neuropathy. *Brain*.1996; 119: 741–753. doi: 10.1093/brain/119.3.741
- [3] Hood L. J. Auditory Neuropathy/Auditory Synaptopathy. *Otolaryngol. Clin. N. Am.*2021; 54: 1093–1100. doi: 10.1016/j. otc.2021.07.004
- [4] Prateek Lokwani, Prashanth Prabhu, Kavassery Venkateswaran Nisha, Profiles and predictors of onset based differences in vocal characteristics of adults with auditory neuropathy spectrum disorder (ANSND), *Journal of Otology*, <https://doi.org/10.1016/j.joto.2022.08.001>.
- [5] Zamani P, Bayat A, Saki N, Ataee E, Bagheripour H. Post - lingual deaf adult cochlear implant users' speech and voice characteristics: cochlear implant turned - on versus turned - off. *Acta Otolaryngol.*2021 Apr; 141 (4): 367 - 373. doi: 10.1080/00016489.2020.1866778.





**MGM - INSTITUTIONAL ETHICS COMMITTEE (IEC)**

**Chairperson**

Mr. Ravi Shankar Kannan

**Member secretary**

Dr. Sanjeev Mohanty

**Members**

Dr. Jagan Mohan Rajaram  
Dr. Navin Gnanasekaran  
Dr. Rajendiran Janardhanan  
Mr. Vikram Narayanan

Mr. Abishek Jenasenar  
Mr. B Goutam  
Ms. Jayabharathi  
Ms. Anitha rani

09.09.2024

To

Dr. Sanjeev Mohanty  
Senior Consultant & HOD,  
Dept of Otolaryngology, Head and Neck surgery,  
MGM Healthcare, Aminjikarai  
Chennai-600029

REF: Ethical committee submission - IEC - 02 / SEP / 03

Sub: " COMPARATIVE MAPPING OF VOCAL PARAMETERS IN AUDITORY NEUROPATHY SPECTRUM DISORDER WITH AND WITHOUT USE OF SPEECH PROCESSOR IN BILATERAL COCHLEAR IMPLANTATION – A PILOT STUDY " - reg

Thank you for submitting the above article write up for a possible publication in an indexed International journal. This proposal was reviewed by IEC, on 28/08/2024. The Institutional Ethics Committee approved the write up for journal submission as there was no evidence of plagiarism and the subjects (patients) in the study group were accessed from MRD.

Yours sincerely,

Dr. Ravi Shankar Kannan  
Chairman – MGM, IEC



Chair Person  
Institutional Ethics Committee

**MGM HEALTHCARE PVT LTD**

72, Nelson Manickam Road, Aminjikarai, Chennai - 600029 ☎ : +91 44 4524 2424 / 4527 2727  
• info@mgmhealthcare.in

CIN No. U74999TN2016PTC112606

mgmhealthcare.in

