VOLUME - 11, ISSUE - 09, SEPTEMBER - 2022 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Audiology

IMPEDANCE CHANGES IN COCHLEAR IMPLANT CHILDREN OVER A PERIOD OF TIME

Pradeep V R — Ph.D. Scholar (Part of Ph.D. work), Dr. M. V. Shetty College of Speech & Hearing, Mangalore University

Dr. T A. Subba Rao — Dr. M. V. Shetty College of Speech & Hearing, Mangalore University

KEYWORDS :

INTRODUCTION

Subjective measurements play an essential role in finding the functions of the electrodes in pediatric cochlear implantees. Impedance measurements are carried out during the time of the surgery and at the time of switching the speech processor. These impedance measurements can give us detailed information about what is happening in the inner ear liquids and tissues around the electrode. Also, this will tell us the position of the electrode in the cochlea. The communication between the internal implant and external speech processor signal is checked via custom sound software.

In Neural Response Telemetry (NRT), the electrode impedance measures the resistance encountered by electricity passing through the wires, electrodes, and tissues. It is calculated as the ratio of applied effective voltage to a circuit and the amount of absorbed electrical intensity. Neural Response Telemetry (NRT) also gives us precise information about the impedance of the electrode, electrode position, electrical problems like short circuits and open circuits, and the electrode's failure during and after surgery. The unit of the impedance is 'ohm.'

Objective information about the cochlear implant is crucial to assess the technical conditions of the implant over time. It plays a significant role in children with a cochlear implant and helps the clinician control the implant. The program, the sound processor, is based on the subjective responses obtained from the patient by electrical stimulation of the electrodes. This subjectivity is significant if patients do not cooperate or are too young children or adults with communication difficulties. Objective measurements are essential in estimating the maximum comfort and detection level in such cases.

Aim of the study

The current study aimed to measure the changes in impedance values of cochlear implant children in four different conditions: during the surgery, switch on (thirty days), at six months, and twelve months.

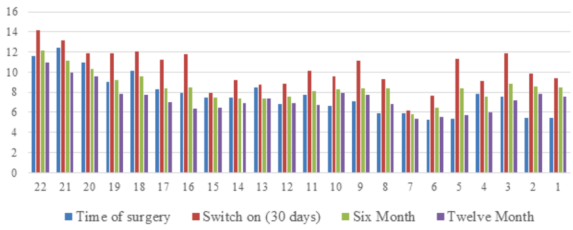
MATERIALS AND METHODS

In the current study, 25 children diagnosed with bilateral profound hearing loss have been operated on with CI24RE(ST) Cochlear Nucleus, aged between 18 to 60 months. For all 22 electrodes, impedance was recorded using Custom Sound EP during surgery and Custom Sound Software during mapping (Switch on, six months & twelve months). Both procedures were carried out using CP802 Speech Processor.

RESULTS

The outcomes of the current study have been explained very clearly in the below graph. The four different conditions in all 22 electrodes have been pictorially explained in a single graph. The first line of the graph indicates the time of Surgery (Inter op) and the second line indicates the time of switch on, the third line indicates the impedance value after six months, and the last line in the graph indicates the impedance value after 12 months as shown in Chart 1. The impedance values are significantly lower in the first condition (during surgery) than in the other three conditions. This is mainly because of excessive fluid leakage in the inner ear while cochleostomy and the time to insert the electrodes.

Chart 1. Impedance values of all four conditions in all 22 electrodes



The remaining three conditions follow the same patterns of all 22 electrodes. During the time of switch (first 30 days after surgery), the impedance values are very high, but later, over time, it is reduced. This is happening mainly because the external object, an electrode, has been accepted by the cochlea. This is mainly happening because the layer of fibrosis tissues forms over the electrodes, and the inflammatory changes are accepted in it. So, impedance values decrease over time. Table 1 shows the impedance values of all 22 electrodes in all four conditions.

Table 1 Average Impedance values of all 22 electrodes in all four conditions

Electrodes	Time of surgery	Switch on 30 days	Six months	Twelve months
22	11.6	14.22	12.14	10.93
21	12.42	13.15	11.15	9.97
20	10.92	11.84	10.34	9.55
19	9.06	11.9	9.23	7.85
18	10.17	12.09	9.61	7.74
17	8.32	11.25	8.35	6.99
16	7.94	11.78	8.45	6.32
15	7.48	7.88	7.46	6.44
14	7.44	9.23	7.41	6.94
13	8.49	8.76	7.34	7.41
12	6.8	8.87	7.6	6.9
11	7.7	10.15	8.1	6.75
10	6.62	9.56	8.3	7.88
9	7.13	11.17	8.38	7.7
8	5.9	9.34	8.34	6.86
7	5.91	6.19	5.77	5.36
6	5.29	7.62	6.5	5.5
5	5.34	11.35	8.34	5.7
4	7.81	9.1	7.56	5.98
3	7.59	11.9	8.89	7.18
2	5.46	9.85	8.6	7.87
1	5.47	9.39	8.5	7.59

Table 2 explains the average mean difference between all the conditions. The second column shows average impedance values differences between the time of surgery & time of switch

on (30 days). The third column shows average impedance values differences between the initial switch on and 60 days off time. The last column shows average impedance values differences between six months and posts twelve months of cochlear implant surgery with successful usage. After the precise analysis, the statistical values show a clear significant difference in all the conditions. The statistical outcomes also support the current study.

Table 2 Average Impedance values differences of all 22 electrodes

Electrodes	Time of surgery - Switch on (30 days)	Switch on (30 Days) – Six Months	Six Months – Twelve Months
22	2.62	-2.08	-1.21
21	0.73	-2	-1.18
20	0.92	-1.5	-0.79
19	2.84	-2.67	-1.38
18	1.92	-2.48	-1.87
17	2.93	-2.9	-1.36
16	3.84	-3.33	-2.13
15	0.4	-0.42	-1.02
14	1.79	-1.82	-0.47
13	0.27	-1.42	0.07
12	2.07	-1.27	-0.7
11	2.45	-2.05	-1.35
10	2.94	-1.26	-0.42
9	4.04	-2.79	-0.68
8	3.44	-1	-1.48
7	0.28	-0.42	-0.41
6	2.33	-1.12	-1
5	6.01	-3.01	-2.64
4	1.29	-1.54	-1.58
3	4.31	-3.01	-1.71
2	4.39	-1.25	-0.73
1	3.92	-0.89	-0.91

CONCLUSION

Enormous studies and many changes have been happening in the past two decades in the Cochlear Implant field. Globally most of the studies are carried out in unilateral Cochlear Implant children. The current study also used only a few unilateral implanters data. A longitudinal study should be carried out to find the changes in impedance values over time. In the future, the number of children should be increased, and the time span of using cochlear implants should also be tracked to find the differences. The current study also supports all previous studies which were carried out all around the world.

REFERENCES

1) Busby P.A., Plant K.L., Whitford L.A. (2002) Electrode impedance in adults and children using the Nucleus 24 cochlear implant system. Cochlear Implants International. 3:87–103
2) Henkin Y., Kaplan-Neeman R., Muchnik C., Kronenberg J., Hildesheimer M. (2003) Changes in electrical stimulation levels and electrode impedance values in children using the Nucleus 24 M cochlear implant. Int. J. Pediatr. Otorhinolaryngol. 67: 873–880
3) Ishai R, Herrmann B.S., Nadol J.B., Quesnel A.M., (2017) The pattern and degree of capsular fibrous sheaths surrounding cochlear electrode arrays. Hearing research. 348:44–53
4) Newbold C, Richardson R, Huang C. Q., Milojevic D, Cowan R, Shepherd R. (2004) An in vitro model for investigating impedance changes with cell growth and electrical stimulation: implications for cochlear implants. Journal of neural engineering. 1 (4): 218
5) Xi X., Han D., Huang D., Yang W., Hong M. (2003) A longitudinal study of electrode impedance in nucleus 24M cochlear implant users. Lin Chuang Er Bi Yan Hou Ke Za Zhi. 17:593–595
6) Zadrozniak M., Szyma ski M., Siwiec H., Broda T. (2011) Impedance changes in cochlear implant users. Otolaryngol. 65:214–217