



## Aurioral Rehabilitation in Consanguineous Cochlear Implanted Patients: Related Experience

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### Abstract

**Introduction:** Hearing loss causes comprehension difficulties, worsens speech perception and discrimination, and decreases the deaf quality of life.

**Objective:** To describe the results of variations in impedance measurements (IM) and the advances of hearing categories in cochlear implant (IC) patients.

**Method:** Qualitative, descriptive, and longitudinal study. Three consanguineous patients implanted and treated in speech therapy with aurioral approach. Telemetry of five-step neural responses was recorded, followed by impedance measurements, sound location tests, simplified Glendonald hearing detection procedure (GASP) tests, Ling sound tests, and recognition of vowels and words. All subjective measures classified the state of hearing categories that ranged 1 (no sound recognition and no oral communication) to 5 (sound localization and oral communication established). The follow-up period was 12 months.

**Results:** There was an overall increase in impedance measurements in all implanted ears. Training in sound localization, auditory memory, auditory closure, background figure, and temporal ordering skills promoted better speech performance. It was noticed that hearing abilities development was adequate because of restored social hearing and communication.

**Conclusion:** The variation of Impedance Measures was continuous and progressive and was concomitant and proportional to the performance improvement of hearing categories, ranging from condition 1 to 5 which improved oral communication in these cases.

## Keywords

Cochlear Implantation, Deafness, Equipment and Supplies, Hearing Loss, Measurement Equipment

## Introduction

Profound hearing loss leads to comprehension difficulties, worsening speech perception and discrimination, and decrease the patient's quality of life [1,2].

Hearing loss could be repaired with the cochlear implant (CI), an electronic device surgically implanted in the inner ear that stimulates the auditory nerve. The Neural response telemetry (NRT) is the first measurement to verify the integrity of the implanted system and the electrical response of the auditory nerve stimulation [3].

To reach success on rehabilitation it's important to consider the age, aetiology, method of rehabilitation, auditory sensorial deprivation, motivation, and familiar involvement [4,5]. Rehabilitation with aurioral emphasis increases spontaneous speech within the first five months after CI activation [6]. Studies pointed out the importance of individualized and direct rehabilitation programs and the development of verbal skills procedures [6-8].

Due to the scarce reports about hearing abilities and rehabilitation progress in implanted deaf people [8].

## Objective

This study aimed to describe the results in impedance measurements' changing and the advances of hearing categories in cochlear implant (IC) users.

## Method

This project was approved by the Ethical Committee by number 31533814.0.0000.0065 and all subjects or their guardians signed Free and Informed Consent Form. Two females and one male, age ranging from 13 to 20 years with severe to profound bilateral sensorineural hearing loss and consanguinity evidence were included in this analysis. They use the same brand of devices and it will be present the variations in impedance measurements and the progress in auditory categories over a period of one year with aurioral

rehabilitation. The NRT was recorded on an intraoperative act and it was performed four new adjustments named mapping on both ears. The first mapping, performed 40 days after the surgical implantation, provided a low electrical level to identify the dynamic area for each electrode and reached the minimum and maximum stimulation levels.

Three new programs were created with progressive increases of minimum and maximum levels to ensure acoustic comfort that was adjusted on speech therapy. It was performed the mapping 2, 3, 4, and 5 respectively after three, six, nine, and twelve months after activation to establish new programs that increased dynamic area offered loud stimulus and verified the impedance and telemetry measurements of the auditory nerve. In the same period, the revaluation of the auditory categories was performed to compare with the first one and show the progress in aurioral rehabilitation. It was used the following standard test: a) sound localization test; b) simplified test of the *Glendonald Auditory Screening proceeding* (GASP); c) the sounds of Ling; d) recognition of vowels and words test [9].

The speech therapy, based on the aurioral approach focused on sound detection, auditory discrimination, auditory recognition, and auditory comprehension. The revaluation of auditory categories was performed at therapeutic discharge.

## Results

**Table-1** shows the values of the IM of electrodes 3, 7, 11, and 15 of the three patients. It is possible to verify telemetry measurements at surgical and discharge moments in the three rehabilitated cases. At surgery, it ranged from 1.9 to 12.4 ms in the right ear and from 1.4 to 9.6 ms in the left. At discharge, these values ranged from 3.7 to 13.5 ms in the right ear and 3.7 to 12.3 ms in the left, which means an increase of the impedance in the system.

**Table-1: The impedance measurements on 3, 5, 11 and 15 electrodes in the both ears at the surgery and therapeutic discharge of the three patients**

	Electrode (E)	Impedance Measure (MI): Surgery		Impedance Measure (MI): Discharge	
		Rigth Ear	Left Ear	Rigth Ear	Left Ear
<b>Patient-1</b>	<b>E3</b>	3.5 ms	2.9 ms	6.9 ms	4.8 ms
	<b>E7</b>	2.4 ms	2.7 ms	9.3 ms	11.5 ms
	<b>E11</b>	2.4 ms	2.7 ms	9.6 ms	9.9 ms
	<b>E15</b>	3.2 ms	1.4 ms	8.5 ms	8.2 ms
<b>Patient-2</b>	<b>E3</b>	12.4 ms	6.7 ms	13.5 ms	4.5 ms
	<b>E7</b>	7.9 ms	5.1 ms	11.7 ms	3.7 ms
	<b>E11</b>	6.1 ms	7.6 ms	9.6 ms	6.6 ms
	<b>E15</b>	10.3 ms	9.6 ms	7.7 ms	8.2 ms
<b>Patient-3</b>	<b>E3</b>	2.1 ms	2.1 ms	4.0 ms	4.8 ms
	<b>E7</b>	2.1 ms	2.1 ms	3.7 ms	4.8 ms
	<b>E11</b>	2.1 ms	2.4 ms	10.7 ms	10.9 ms
	<b>E15</b>	1.9 ms	1.9 ms	10.9 ms	12.3 ms

**Table-2** shows the mean values of the impedance measurements captured in the implanted's devices of each patient at the surgery and discharge. Thus, respectively, we noticed that for patient 1 it ranged from 2.6 to 7.7 ms in the right ear and 3.1 to 8.6 ms in the left, for patient 2 it ranged from 8.9 to 11.2 ms in the right ear and 6.8 to 5.3 ms in the left and for patient 3 it ranged from 2.0 to 6.8ms in the right ear and 2, 4 to 7.5 ms on the left. It's possible to verify that these measures increased.

### Discussion

It was noticed an increase in the auditory category

that changed from 1 to 4 or 5. Some variations of the impedance's values could be explained due to the absence of the pattern in the behaviour of the connective tissue on the auditory pathway [10]. Other studies related that changes in electrical stimuli threshold occur randomly without corresponding to a predetermined parameter [3,11,12].

The increase in impedances was agreed with a study suggested that the values of these impedances revealed the load distribution in the intracochlear electrode varies for neural fibbers excitation depending on the cochlear and neural topology [13].

**Table-2: Mean values of all electrodes of both ears of the three patients at surgery and therapeutic discharge**

	Patient-1		Patient-2		Patient-3	
	Surgery	Discharge	Surgery	Discharge	Surgery	Discharge
<b>Right Ear</b>	2.6 ms	7.7 ms	8.9 ms	11.2 ms	2.0 ms	6.8 ms
<b>Left Ear</b>	3.1 ms	8.6 ms	6.8 ms	5.3 ms	2.4 ms	7.5 ms

The involvement of the patients and early auditory intervention and diagnosis contributed to success [14,15]. Face on a long period of sensory deprivation It was observed progress on auditory abilities, restauration the social hearing, and social communication. The training of sound localization, auditory memory, auditory closure, background figure, and temporal ordering was effective [6,16].

These related cases were agreeing a study [17] which indicated that in the period of six months to one year of telemetry remained unchanged in the implantation process and showed a good correlation with the position of the CI in the inner ear.

The therapeutic progress in a short period of intervention provided an encouraging experience for patients, parents, and clinicians because improved the communication capacity of patients and optimizes the communication benefits provided by CI [3,13,16].

## Conclusion

The variation of Impedance Measures was continuous and progressive and was concomitant and proportional to the performance improvement of hearing categories, ranging from condition 1 to 5 which improved oral communication in these cases.

## Author Contribution

Conception and design of the study, collection, analysis or interpretation of data: Carlos Kazuo Taguchi, Raissa Valença de Souza Santos, Lívia Caroline Menezes Almeida, Larissa Karoline Santos, Lúcia Maysa Muniz da Silva, Mateus Ferreira da Silva Santos.

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## Conflict of Interest

All authors have read and approved the final version of the manuscript. The authors have no conflicts of interest to declare.

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