Electroacoustic Stimulation with Cochlear Implants for Deafness Treatment

João Paulo Peral Valente¹, Luciane Calonga ², Alexandre Caixeta Guimarães¹, Walter Adriano Bianchini¹, Jorge Rizzato Paschoal¹ and Guilherme Machado de Carvalho*¹

¹Department of ENT, Campinas University, South America
²Department of Audiologist, Cochlear Implant Specialist, South America

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*Corresponding author: Guilherme Machado de Carvalho, Head & Neck Surgery Department, UNICAMP, PO Box 6111, Postal Code: 13081-970, São Paulo, Brazil, South America.

Abstract

Background: Cochlear implant is an electronic hearing aid surgically inserted into the inner ear that, unlike a conventional hearing aid, picks up sound waves and transforms it into an electrical impulse that directly stimulates the cochlear nerve.

Objective: This study aims to describe the profile and outcomes of patients submitted to hybrid cochlear implant in the in a tertiary hospital in the last three years.

Methods: It was conducted a clinical study including 8 patients implanted with the brand MED-EL FLEX EAS in a tertiary hospital in the last three years.

Results: It was observed an improvement in all tonal thresholds after the activation of the cochlear implant.

Conclusion: The hybrid cochlear implant was successful procedure, with an improvement of tonal thresholds after the activation of cochlear implants.

Keywords: Cochlear implants; Hearing aids; Hearing preservation; Electroacoustic stimulation; Deafness; Bilateral deafness

Introduction

Cochlear implant is an electronic hearing aid surgically inserted into the inner ear that, unlike a conventional hearing aid, picks up sound waves and transforms it into an electrical impulse that directly stimulates the cochlear nerve. The development of multichannel cochlear implants, new speech processing strategies and more modern processors enabled gradually better results. In 1995, most of the implanted patients already reached results above 80% correct sentences in speech perception tests [1,2]. With the improvement of the cochlear implant performance, studies began to be developed to carry out cochlear implant in patients with residual hearing, which were not good fit with hearing aids.

New types of electrodes and changes in surgical technique have been developed in order to preserve the auditory trace these patients and promote rehabilitation by means of electrical stimulation combined with the acoustic stimulation (soft surgery) [3-7]. The electro-acoustic stimulation (EAS) of hearing aims to combine the amplification of residual hearing of the patient by conventional hearing aids, with electrical stimulation of the cochlea performed by the cochlear implant [8]. This is the principle of hybrid cochlear implants. This study aims to describe the profile and outcomes of patients submitted to hybrid cochlear implant in a tertiary hospital in the last three years.

Methods

It was conducted a clinical study including 8 patients implanted with the brand MED-EL FLEX EAS in a tertiary hospital in the last three years. Were admitted to the study all patients in the last three years whose implant was done with full insertion of the electrode bundle and consented to participate in the study through the Term of Consent. All patients used the internal component SONATA TM model and have been adapted by Maestro System TM software. Patients who had postoperative electro stimulation used speech processor DUET 2 Tim. The group had purely electrical stimulation postoperative differed only in the speech processor, having been used in such cases the OPUS 2 Tim. Patients with incomplete data, which did not meet the inclusion criteria or who would not be subject to such assessment were excluded from this Protocol.
Audiological evaluation

Audiological tests were performed including impedanciometry, speech and pure tone audiometry. The tests were performed using an audiometer AC30-SD25, calibrated according to ISO 389 standards / 64. The OAEs distortion products were performed at frequencies 700 to 8000 Hz with stimulus at 65-55 dB SPL, with a frequency ratio of 1.22. OEA was considered present when the signal/noise ratio was greater than 6 dB, and with reproducibility greater than or equal to 70%. The tests from the ABR and CM were performed with insert earphones. Stimulus of 100 dB HL was used for the ABR covered with frequencies between 250 and 8000 Hz, with duration of 100 microseconds, and condensed and rarefied polarities. The abnormality of ABR was defined as absence of wave formation or severe changes in morphology of the same with up to 100 dB HL stimulus.

The CM was evaluated in tests from the ABR, with the feature of inverting the polarity (condensed and rarefied). When CM was positive with stimuli of 100 dB HL electrophysiological threshold, in decreasing order was researched. For ABR, which were repeated at least two times, the device AT-235 (Interacoustics) was used. Hearing loss impairment was classified through audiometry stratification in mild, moderate, severe / severe or profound hearing loss [9].

Speech perception tests: During preoperative evaluation, all subjects underwent to a speech perception test on the same day of their surgery. The speech perception test is based on several studies in English language, adapted and developed for Portuguese language by Bevilacqua et al. [10]. Patients performed the tests with hearing aids, in a quiet and peaceful place (best aided condition). Postoperatively, all subjects repeated the speech perception test at least one year experience with cochlear implant. The tests were performed using the cochlear implant (CI). The same audiologist performed all tests (pre-and postoperative).

Subjective evaluations: When the patients did their postoperative speech tests it were asked to rate the quality of their experience with CI compared to last year on a Likert scale ranging from 0 to 10, similar to the visual analog scale. A score of 0 indicates that user intervention regretted not recommend to others, and felt he / she had been better in the past, with their hearing aids. A score of 10 indicates that the user was completely satisfied with the work and highly recommended.

Statistical analysis

The data were analyzed using descriptive analysis, with production of means, medians, standard deviation tabs. Chi-Square was used to compare the groups of our sample. Because of the small size of some of the variables analyzed Fisher’s Exact test was also used to check the correlation between the groups. The confidence Interval was of 95%, and p-value <0.05 was considered significant.

Ethical considerations

The institutional review board approved this study and all subjects gave written informed consent. The survey was conducted considering ethical, and was approved by the Ethics Committee under protocol number 24802914.8.0000.5404.

Results

The hybrid cochlear implants were performed in 8 patients in these periods. The evaluated aspects are described in (Table 1). In (Figure 1) can be seen the average of pure tone thresholds in the preoperative, postoperative and after activation of the cochlear implant (CI).

Table 1: Evaluated aspects of subject’s clinical data.

<table>
<thead>
<tr>
<th>Subject’s Clinical Data</th>
<th>n=8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>42</td>
</tr>
<tr>
<td>Median</td>
<td>42</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>19.12</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>3 (37.5%)</td>
</tr>
<tr>
<td>Male</td>
<td>5 (62.5%)</td>
</tr>
<tr>
<td>Surgery side (CI)</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>Left</td>
<td>6 (75%)</td>
</tr>
<tr>
<td>Presence of tinnitus</td>
<td></td>
</tr>
<tr>
<td>Preop</td>
<td>7 (87.5%)</td>
</tr>
<tr>
<td>Postop</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>Preop Speech Therapy</td>
<td>1</td>
</tr>
<tr>
<td>Use of Hearing Aid preop</td>
<td>8 (100%)</td>
</tr>
<tr>
<td>Time of use of Hearing Aids preop (average)</td>
<td>10 (years)</td>
</tr>
<tr>
<td>Time of deafness (average)</td>
<td>15, 5 years</td>
</tr>
</tbody>
</table>

Discussion

The EAS of hearing aims to combine the amplification of residual hearing of the patient by conventional hearing aids, with electrical stimulation of the cochlea performed by the cochlear implant. It is an excellent option for people with residual hearing in low frequencies (preserved below 1 kHz) but not at high frequencies and with insufficient benefit with hearing aids [8]. Typically, these individuals are able to detect all the vowels, but probably few or no consonants. The low frequencies also provide additional information for speech perception, speech production and perception of environment sounds. This preservation of residual hearing of low frequency despite the insertion of an
The soft surgery was a successful procedure considering the improvement and preservation of tonal thresholds after the activation of cochlear implants, with no complications regarding the studied patients.

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**References**