

Self-reported perception of unilateral cochlear implantees on the contralateral use of hearing aid

Auto-percepção de usuários de implante coclear unilateral sobre o uso combinado de prótese auditiva contralateral

Auto-percepción de usuarios de implante coclear unilateral sobre el uso de audifono contralateral

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Abstract

Introduction: Several studies showed the importance of the combined use of the hearing aid (HA) with cochlear implant (CI), but not all CI users wear bimodal stimulation effectively. **Objective:** To identify the characteristics and reasons that explain the use of combined devices in adult CI users with HA in contralateral ear. **Methods:** A questionnaire was applied with 39 closed questions related to the experience with HA before and after CI surgery in bimodal users. The sample was divided according to the three-frequency pure tone average in the non-implanted ear. Group 1: below or equal 100 dBHL and Group 2: above 100 dBHL. **Results:** 49 adults were evaluated, with median auditory thresholds in group 1: 92 dB and group 2: 114 dB. After IC surgery, 78% (group 1) and 73% (group 2) continued to use HA for 10 hours daily or more. 41% (group 1) and 65% (group 2) required one to three adjustments per

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GFG. Data collection, literature review and study writing; ATMM. Project idealization, data analysis and revision, manuscript finalization; MVSGG. Project idealization, data analysis and revision, and manuscript translation; RKT. Clinical and logistic support. RFB. Scientific and logistic support.

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year in the HA, but 41% (group 1) and 31% (group 2) had not made any adjustments during the former year. Both groups responded that they feel benefits in bimodal stimulation for quiet, noisy situations, in reverberant places and in the perception of music. In the perception of sound localization, only 35% (group 1) and 12% (group 2) perceived that using bimodal helps in the identification of the direction of sound. **Conclusion:** The majority of patients prefer to use bimodal stimulation in daily basis, independently of residual hearing in the contralateral ear to CI.

Keywords: Deafness; Cochlear implants; Hearing aids; Adults; Surveys and Questionnaires

Resumo

Introdução: Vários estudos mostram a importância do uso combinado do aparelho de amplificação sonora individual (AASI) com implante coclear (IC), entretanto nem todos os usuários de IC usam a adaptação bimodal efetivamente. **Objetivos:** Identificar as características e os motivos que permeiam o uso combinado dos dispositivos em adultos usuários de IC com AASI na orelha contralateral. Método: Foi aplicado um questionário com 39 perguntas fechadas relacionadas à experiência com AASI antes e após a cirurgia do IC em usuários bimodais. A amostra foi dividida segundo as médias tritonais de limiares na orelha contralateral ao IC. Grupo 1: até 100 dBHL e Grupo 2: acima de 100 dBHL. **Resultados:** Foram avaliados 49 adultos, com mediana de limiares auditivos no grupo 1: 92 dB e no grupo 2: 114 dB. Após a cirurgia do IC, 78% do grupo 1 e 73% do grupo 2 continuaram a usar AASI por 10 horas diárias ou mais. 41% do grupo 1 e 65% do grupo 2 precisaram de um a três ajustes por ano no AASI, porém 41% do grupo 1 e 31% do grupo 2 não haviam realizado nenhuma regulagem no último ano. Ambos os grupos responderam que sentem benefícios na estimulação bimodal para situações silenciosas, ruidosas, em locais reverberantes e na percepção da música. Na percepção da localização sonora apenas 35% do grupo 1 e 12% do grupo 2 percebem que usar o bimodal ajuda na identificação da direção do som. **Conclusão:** A maioria dos pacientes prefere usar a estimulação bimodal em situações diárias, independentemente do resíduo auditivo do ouvido contralateral ao IC.

Palavras-chave: Surdez; Implantes cocleares; Auxiliares de audição; Adultos; Inquéritos e Questionários

Resumen

Introducción: Varios estudios demuestran la importancia del uso combinado del audífonos con el implante coclear (IC), aunque no todos los usuarios de IC usan la adaptación bimodal efectivamente. **Objetivos:** Identificar las características y los motivos por detrás del uso combinado de los dos dispositivos en adultos usuarios de IC y audífono en el oído contralateral. Método: Se aplico un cuestionario con 39 preguntas cerradas relacionadas a la experiencia con audífonos antes y después de la cirugía del IC en usuarios bimodales. La muestra se dividió en dos grupos según el umbral promedio tritonal en el oído contralateral al IC. Grupo 1: hasta 100 dBHL y Grupo 2: más de 100 dBHL. **Resultados:** Fueron evaluados 49 adultos, con mediana de umbrales auditivos en el grupo 1: 92dB y en el grupo 2: 114dB. Después de la cirugía del IC, 78% del grupo 1 y 73% del grupo 2 siguieron usando el audífono por 10 horas diarias o más. El 41% del grupo 1, y 65% del grupo 2 necesitaron entre un y tres ajustes anuales del audífono. Por otro lado, el 41% del grupo 1 y 31% del grupo 2, no habían hecho ningún ajuste durante el último año. Ambos grupos reportaron beneficios de la estimulación bimodal en situaciones silenciosas, ruidosas, en locales reverberantes y en la percepción de música. En la percepción de localización sonora, solo un 35% del grupo 1 y 12% del grupo 2 reportaron que la estimulación bimodal ayuda en la identificación de la dirección del sonido. **Conclusion:** La mayoría de los pacientes prefieren usar la estimulación bimodal en situaciones diarias, independientemente del resíduo auditivo del oído contralateral al IC.

Palabras clave: Sordera; Implantes cocleares; Audífonos; Adultos; Encuestas y Cuestionarios

Introduction

Bimodal adaptation is recommended for all adults and children who receive a unilateral cochlear implant (CI) and have contralateral residual hearing¹.

Several studies show the importance of combined use of hearing aids with CI (bimodal stimulation) compared to users of unilateral CI alone²⁻⁴.

The advantages of bimodal listening include better speech recognition in silence and noise and better sound localization. Tange et al.⁵ and Potts et al.⁶ revealed that bimodal performance was better than the cochlear implant or hearing aid alone in sound localization and speech perception. In this same study, a subjective questionnaire was applied after 6 weeks of hearing aid fitting and patients preferred bimodal use.

Some research suggests that patients with better hearing thresholds have better results in bimodal stimulation. According to Seeber et al.⁷ patients with residual hearing have better ability to locate sounds than patients with more severe hearing loss.

Other researchers suggest that patients with unilateral CI need to optimize hearing aid fitting after CI. In the study by Fitzpatrick et al.⁴, the majority of users indicated that they needed adjustments in hearing aid or CI volume. However, although the use of bimodal stimulation is recommended, patients' personal perception of this contribution may differ. In clinical practice we observed that some patients do not report or realize this contribution, and in others the opposite situation, patients in whom the contribution is little, but the patient has an effective use of the bimodal stimulation.

The analysis of the reasons that lead patients to use bimodal stimulation motivated this study.

Thus, this study aimed to identify the characteristics and reasons that underlie the combined use of the devices in adult users of CI with hearing aids in the contralateral ear.

Methods

This was a prospective cross-sectional study with exploratory character. The project was approved by the Ethics Committee under number 941.254.

Patients invited to participate and to answer a questionnaire were all users of unilateral CI and

hearing aids in the contralateral ear, with pre- or post-lingual deafness and duration of CI use over 6 months who attended the outpatient clinic from August to December 2015.

The questionnaire was based on the questionnaire developed by Fitzpatrick et al.⁴ and Fitzpatrick and Leblanc⁸, including additional relevant questions about the use of hearing aids, added by Neuman et al.⁹. The questionnaire consists of 39 questions with multiple choice answers related to the experience with hearing aids before and after receiving the CI, divided in three sections. The first section consists of questions about: (a) experience with hearing aids before cochlear implant surgery - questions 1 to 7; (b) experience with the CI - questions 8 to 10; and (c) the decision to use the hearing aid after cochlear implantation - questions 11 and 12. The second section (questions 13 to 31) is supposed to be answered only by individuals who continue to use the hearing aid after CI, addressing the following topics: (a) information about the hearing aid; (b) the pattern of use of hearing aids and CI; (c) perception of the benefits of the devices; (d) the adaptation of the hearing aid and the follow-up of the adjustments in the hearing aid after the implantation. The third section (questions 32 to 39) is supposed to be answered only by individuals who discontinued the use of hearing aids after CI (appendix 1).

Each question has multiple choice answers; the frequency of answers to each question was collected and described in the results (percentage).

Identification data, such as gender and age, as well as the pure tone average (500 Hz, 1 kHz and 2 kHz) of the contralateral ear to the CI of all patients were collected from the medical records. A value of 130 dB was set for absent thresholds. The mean results of the hearing thresholds were statistically analyzed using the nonparametric Mann-Whitney test.

The sample was divided based on the article by Neuman and Svirska¹⁰ which showed that hearing thresholds should be better than 95 dB up to 2000 Hz in the contralateral ear of cochlear implant patients for a better fitting of the hearing aid. Thus, the sample was divided into 2 groups, according to the tonal means to compare the responses according to the residual hearing in the contralateral ear:

- Group 1: pure tone average below 100 dB HL
- Group 2: pure tone average above 100 dB HL

Results

Forty-nine bimodal stimulation patients who answered the questionnaire were evaluated; 23 patients met the criteria of Group 1 with more residual hearing while 26 composed Group 2.

In Group 1, the average age was 44 years (minimum 19 and maximum 70 years), 10 females and 13 males, 48% of patients using cochlear implants over 2 years (n = 11) and 30% between 1

and 2 years (n = 7). In group 2, the mean age was 45 years (minimum 18 and maximum 83 years), with 19 females and 7 males, 50% of patients using cochlear implants over 2 years (n = 13) and 38% between 1 to 2 years (n = 10). The median audiometric thresholds in each group are shown in Table 1. Although these were profound hearing losses in both groups, the statistical analysis showed a significant difference in both the tritonal average and the average at each frequency.

Table 1. Median hearing thresholds (in dBHL) at each frequency and 3F pure tone average (PTA) in the CI contralateral ear.

	Group 1 (N = 23)	Group 2 (N = 26)	p*
	dBHL	dBHL	
PTA	95	113.5	< 0.0001
250 Hz	80	95	0.0001
500 Hz	85	110	< 0.0001
1000 Hz	95	112.5	< 0.0001
2000 Hz	95	120	< 0.0001
4000 Hz	105	130	0.0065
6000 Hz	130	130	0.0334
8000 Hz	130	130	0.2806

Legend: dBHL = decibel hearing level; n = number of subjects; * = significance from Mann Whitney test; 130 dB = absent response

The answers were analyzed quantitatively in each question; only questions 2 and 15, referring respectively to the location of the hearing aid fitting and the hearing aid brand were not analyzed

because they are not relevant to meet the objectives of this study. Some questions were grouped in the same table for better observation of the results before and after the cochlear implant.

Table 2. Hearing aid (HA) use data before CI (questions 1,3,4).

	Group 1 (n=23)	Group 2 (n=26)	Total (n=49)
Hearing aid use in both ears before CI	17 (74%)	23 (88%)	40 (82%)
HA fittings and follow up	16 (73%)	23 (88%)	39 (81%)
Time of use of AASI Less than 2 years	7 (30%)	9 (35%)	16 (33%)

Legend: n = number of subjects

Table 3. Time of hearing aid (HA) use before CI (question 5) and CI and hearing aid use together (question 17).

	Group 1 (n=23)	Group 2 (n=26)	Total (n=49)	Group 1 (n=23)	Group 2 (n=26)	Total (n=49)
	Time of hearing aid use before CI			Time of use of CI + HA		
>10 hours	18(78%)	21(81%)	39(80%)	18(78%)	19(73%)	37 (76%)
5-10hours	5(22%)	5(19%)	10(20%)	5(22%)	5(19%)	10 (20%)
<5 hours	0	0		0	2 (8%)	2 (4%)
Never	0	0		0	0	0

Legend: n= number of subjects

Table 4. Hearing aid contribution perceived by the user (question 6).

	Group 1 (n=23)	Group 2 (n=26)	Total (n=49)
Very usefull	8 (35%)	14 (54%)	22 (45%)
Somewhat usefull	11 (48%)	8 (31%)	19 (39%)
Rarely usefull	3 (13%)	4 (15%)	7 (14%)
Not usefull	1 (4%)	0 (0%)	1 (2%)

Legenda: n= número de sujeitos

Question 7 showed that most patients (52%) did not cope well with hearing loss before surgery, 60% (n = 13) in Group 1 and 46% (n = 12) in Group 2 felt that lack of hearing affected them negatively. However, question 9 showed that after cochlear implant surgery most were coping well all the time (47%) or most of the time (35%) in relation to deafness, with 43% (n = 10) in Group 1 and 50% (n = 13) in Group 2. And this improvement probably reflects that 80% of them reported hearing much better with CI when compared to the hearing aids, being 87% (n = 20) in Group 1 and 73% (n = 19) in Group 2 (question 10).

Questions 11 and 12, regarding the decision to use bimodal stimulation, showed that 81% of the sample (n = 38) had decided to use the hearing aid after surgery, and 55% (n = 27) said they were counseled by the audiologist about the bimodal stimulation, both before and after surgery.

Regarding the responses about the use of bimodal stimulation, question 13 showed that 39% (n = 19) of all patients realized that hearing on the

non-implanted side seemed slightly better after CI surgery; 70% (n = 16) of Group 1 and 73% (n = 19) of Group 2 of the patients were using the same hearing aid after implantation (question 14), and most devices had more than 2 to 4 years of use, in 39% (n = 9) of Group 1 and 54% (n = 14) of Group 2. Hearing aids had less than 2 years of use in 35% (n = 8) of Group 1 and 23% (n = 6) of Group 2 (question 16).

Regarding the use of hearing aids in bimodal stimulation, it is observed that most patients (47%) use the CI only condition a few times (TABLES 5,6), and most (49%) quickly adapted to the use of both devices (TABLE 7); but 36% of patients said they did not make any adjustments to the hearing aids during the last year (TABLE 8), as 55% (n = 26) of the patients do not modify the volume control in the hearing aids; 51% have only one program available, and if they have more than one program 45% do not usually change with the use of bimodal stimulation (questions 23 and 24).

Table 5. Is there any situation that you use only the cochlear implant? (question 18).

	Group 1 (n=23)	Group 2 (n=26)	Total (n=49)
Never	9 (39%)	6 (23%)	15 (31%)
Sometime	12 (52%)	11 (42%)	23 (47%)
Frequently	2 (9%)	7 (27%)	9 (18%)
Almost always	0 (0%)	2 (8%)	2 (4%)

Legend: n= number of subjects

Table 6. Is there any situation that you use only the hearing aid? (question number 19).

	Group 1 (n=22)	Group 2 (n=26)	Total (n=48)
Never	11 (50%)	14 (54%)	25 (52%)
Sometime	9 (41%)	9 (35%)	18 (38%)
Frequently	2 (9%)	2 (8%)	4 (9%)
Almost always	0 (0%)	1 (4%)	0 (0%)
Did not answer	1	0	1

Legend: n= number of subjects

Table 7. Beginning of use of the hearing aid and cochlear implant together and time of adaptation to the bimodal stimulation after the CI (questions 20 and 21).

	Group 1 (n=23)	Group 2 (n=26)	Total (n=49)	Group 1 (n=23)	Group 2 (n=26)	Total (n=49)
	Begin to use HA + CI			Adaptation to HA + CI		
Immediately	14 (61%)	12 (46%)	26(53%)	12(54%)	12 (50%)	24 (49%)
1 to 3 months	4 (17%)	9 (35%)	13(27%)	6(27%)	5 (21%)	11 (23%)
3 to 6 months	2 (9%)	3 (12%)	5 (10%)	2(9%)	3(12,5%)	5 (10%)
6 months	3 (13%)	2 (7%)	5 (10%)	1 (5%)	3(12,5%)	4 (8%)
Did not adapt	0	0	0	1 (5%)	1 (4%)	2 (4%)
Did not answer	0	0	0	1	2	3 (6%)

Legend: n= number of subjects; NR = Did not answer

Table 8. Number of appointments for hearing aid (question 22).

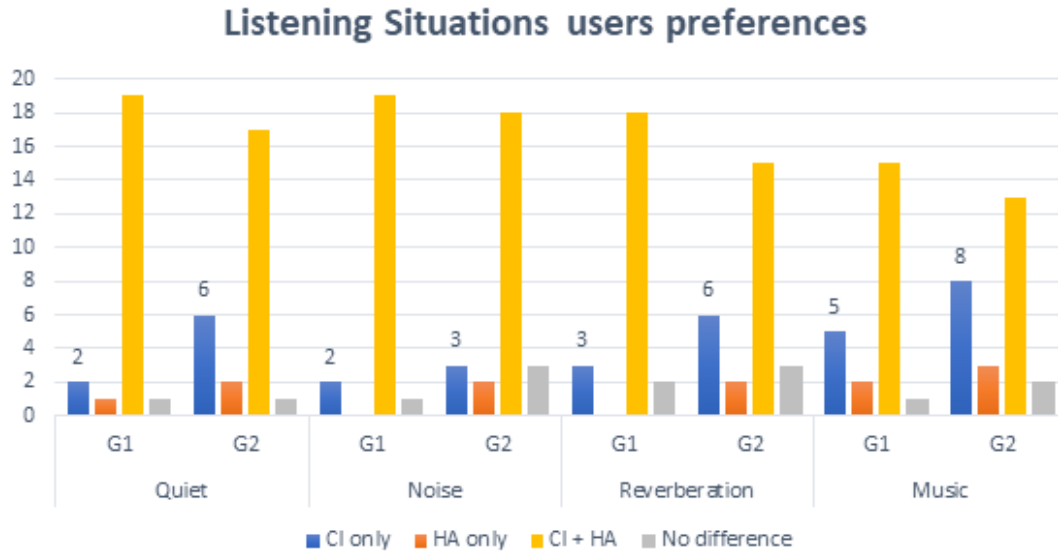
	Group 1 (n = 22)	Group 2 (n = 23)	Total (n = 45)
None	9 (41%)	7 (31%)	16 (36%)
1-3 times	9 (41%)	15 (65%)	24 (53%)
3-6 times	1 (5%)	1 (4%)	2 (4%)
More than 6 times	3 (13%)	0	3 (7%)
Did not answer	1	3	4

Legend: n= number of subjects

Figures 1 and 2 show the bimodal user preference in different listening situations separated by the two groups.

Questions 30 and 31 addressed the Stenger effect, that is, which side someone perceives sound using both devices. In Group 1: 55% (n = 12) of the

patients perceive closer to the CI and 36% (n = 8) perceive in the middle of the head. In Group 2, the same trend 62% (n = 16) of the patients perceive closer to the CI and 23% (n = 6) perceive in the middle of the head. When asked where the sound is perceived louder with the use of both devices,



Legend: CI = cochlear implant; HA: Hearing aid

Figure 1. Users preferences in different listening situations in both groups (questions from 25 to 28)

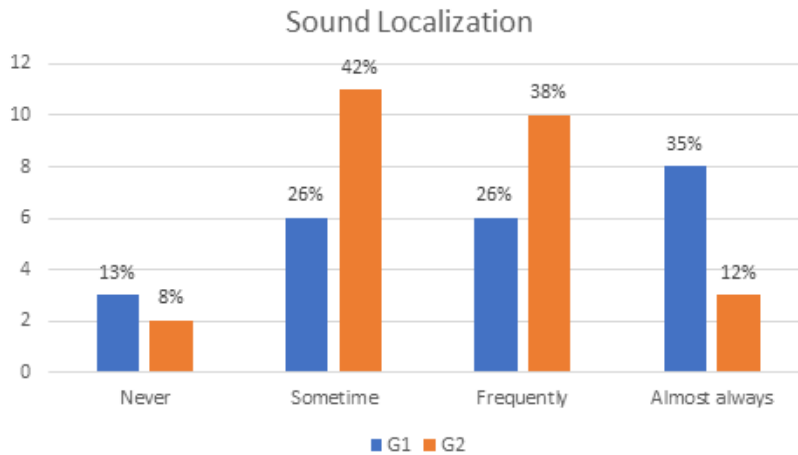


Figure 2. User perception regarding sound localization while using bimodal stimulation in both studied (question 29)

in Group 1: 78% (n = 18) of the patients perceive stronger in the CI's ear and 13% (n = 3) in both ears. In Group 2, 85% (n = 22) of the patients perceive stronger in the CI's ear and 12% (n = 3) in both ears. No one answered questions 32 to 39 because they were all users of bimodal stimulation at the study date.

Discussion

The objective of this study was to identify the characteristics and reasons that underlie the combined use of the devices in adult users of CI with hearing aid in the contralateral ear of the cochlear implant. However, the questionnaire answers provided us with important information for counseling before and after CI surgery, as well as discussions

to better evaluate and monitor the contralateral side of the CI.

In the evaluation process of cochlear implant candidates, the use of hearing aids in both ears is essential for completing the indication process and choosing the ear to implant, as well as maintaining stimulation of both auditory nerves while offering information from both ears to the central auditory nervous system. Patients who are unilaterally submitted to cochlear implant can and should maintain the use of hearing aids in the contralateral ear, but for this purpose, it is often necessary to analyze the audiological data and the balance of the two devices. For several reasons we see that the use of contralateral hearing aids is not unanimous, being described by around 12% of patients¹¹.

Table 1 shows that the average hearing thresholds of both groups configures a profound hearing loss, but statistically significant, residual hearing of the individual does not appear to be a major reason for the use of bimodal stimulation in this group of patients. Scherf and Arnold¹² found that bimodal benefits were not influenced by the amount of residual hearing or time spent using the devices together. In the studies by Yoon et al.¹³, mean thresholds were an important indicator for bimodal advantages in perception of speech, and the lack of benefits with bimodal stimulation can be attributed to poor hearing aid optimization.

Neuman et al.⁹ developed the questionnaire used in this study and applied it to 94 unilateral CI patients who continued to use the hearing aid in the contralateral ear for at least three months after surgery at the cochlear implant center in New York City. Of these 94 patients, 80 still used contralateral hearing aids and answered the questionnaire. When we compared the results with our study, the answers were very similar on several questions. For example, in our study we found that a large number of patients (from both groups) already used hearing aids bilaterally, before receiving CI, for more than 10 hours daily (Table 2); and after cochlear implant surgery, 78% of Group 1 and 73% of Group 2 continued to use more than 10 hours (Table 3). The authors found that 81% of patients used it for more than 10 hours a day after CI.⁹ Almost half of the sample said the appliances were very useful, or somehow useful, before the CI, although not accepting the hearing loss well (Table 4), showing that even with the small contribution of the preoperative hearing aids, the use of hearing

aids was constant, following the guidelines given when they were candidates for the CI. Eighty-one percent of the patients responded that the decision to use bimodal stimulation was made prior to CI surgery, and 55% said the audiologist influenced that decision.

After CI surgery, 39% of patients reported that contralateral hearing seemed a little better, but 27% did not notice any difference; in addition, 71% continued to use the same preoperative hearing aid, and on almost half (47%), hearing aids had 2 to 4 years of use. This shows the importance of a careful follow-up after CI, either monitoring hearing thresholds and complaints, or checking and validating the contralateral hearing aid programming.

The results showed that 53% of patients of both groups had started using hearing aids for more than 10 hours daily, immediately after receiving CI (Table 7). In fact, in the study by Neuman et al.⁹ they found that 85% started using hearing aids immediately after CI surgery. According to Fitzpatrick et al.⁴ who studied patients who answered a questionnaire about the frequency and situations of bimodal use, 63% of participants used hearing aids combined with CI for more than 50% of the time; in addition, the frequency of use of bimodal stimulation was not higher in individuals with better thresholds.

We found no clinical differences between the two groups regarding the beginning of the use of hearing aids and the time of adaptation with the bimodal stimulation. Only two patients, one in each group, were not using the combination of the two devices after surgery (Table 7).

What caught our attention was the need for adjustments in the hearing aids; 41% of Group 1 and 65% of Group 2 needed one to three adjustments per year, but 41% in Group 1 and 31% in Group 2 did not make any adjustments (Table 8). These data suggest that most patients with higher residual hearing do not make adjustments periodically and, consequently, do not monitor residual hearing on the contralateral side, and we know that the optimization in post-hearing aid is recommended by several researchers for a better acoustic and electrical combination of the devices^{2,10,14}. According to Huart and Sammeth¹⁵, the CI should be in a stable map and hearing aid adjustments should follow a protocol with a prescribing rule that prioritizes speech frequencies and a program that favors the amplification of bass sounds. Balancing the hear-

ing aids with the CI in clinical practice to adjust the sensation of loudness in the different hearing devices and to allow more effective use is also recommended. Magalhães et al.¹⁶ (submitted) showed that it is possible to make a protocol for balancing deep sensorineural hearing loss and to improve speech recognition tests in the bimodal condition.

Scherf and Arnold¹² conducted a survey with several rehabilitation centers in different countries to understand how the adjustments were made in the hearing aid and the CI and the recommendations made to the users. The majority of clinicians suggest adjustments in the hearing aid at the CI activation, but regarding the use, they suggest only for a few hours a day. Few of them recommend full time use of hearing aids, and rarely there are further adjustments to the hearing aid after the activation of the CI, which contribute to the rejection of the hearing aid use. Questions about the HA configurations showed that the majority (55%) do not modify the volume control or program change (45%) when using both devices, showing once again that the orientation in the HA adjustments do not apply in the daily lives of users, or there are not enough resources for changes in hearing aids to help speech perception in different environments. The communication between the hearing aid and the speech processor has been increasingly studied¹⁷ and the concern of the two devices acting together and helping the patient in difficult listening situations will be a major advance in bimodal stimulation.

In the questionnaire most patients perceive closer and stronger sound on the CI side, in both groups, perhaps this complaint is due to the lack of a correct balance between the hearing devices, stressing once again the importance of loudness sensation adjustments. Balancing the devices must take into account the patient's hearing thresholds and the maximum gain provided by the hearing aids, which often cannot be achieved, especially at the higher frequencies.

Despite the differences in devices, there are numerous benefits to bimodal hearing, including speech perception in noise, the head shadow effect, and sound localization^{3,4,19}. Luntz et al.¹⁸ showed that speech recognition results of CI combined with hearing aids were 75.6% compared to CI only results of 60.7%.

In our results, both groups of patients answered that they benefit from bimodal stimulation in quiet and noisy situations, reverberant places and music

perception (Figure 1). However, when analyzing the groups separately, it was observed that Group 1 had a higher number of users who presented preference for the use of CI and hearing aids in all situations compared to Group 2. In fact, in the study of Yoon et al.¹³, patients with pure tone average lower than 55 dB performed better in recognizing sentences in noise compared to those with a higher pure tone average.

Neuman et al.⁹ also found similar responses in which patients reported better listening in silence, noise, reverberation and music perception with the use of bimodal stimulation, and commented that the audiologist should not necessarily conclude that the hearing aid does not grant functional benefits for the patient based only on speech perception tests in the bimodal condition.

In the analysis of patients' responses, there is less benefit in relation to sound localization. Thirty five percent of patients with lower pure tone average report that using the hearing aid and CI together helps almost always to know the direction of sound, and only 12% of patients with higher average perceived this contribution (Figure 2). Seeber et al.⁷ also found that patients with better residual hearing had better sound localization ability than patients with more severe hearing loss.

In summary, hearing loss in both groups was profound, but when statistically analyzed, the difference is significant, and this difference reflected in the self-perception about bimodal hearing preference in different listening environments, such as silence, noise and reverberant places.

The success of the continuous use of hearing aids in the contralateral ear may not only be associated with residual hearing. According to Ching et al.², residual hearing is not a predictor of benefits in bimodal users. Thus, we noticed the importance of using subjective questionnaires together with bimodal stimulation assessment data to achieve a more realistic perception of contralateral hearing aid contribution, either to guide the adjustments and orientations of the devices use, or to further indication for sequential CI.

Conclusion

The evaluated implanted patients prefer to use CI and hearing aids in the contralateral ear in most daily situations, regardless of the ear residue in the contralateral ear.

Half of the patients immediately adapted to bimodal stimulation, but 41% of the patients with the largest residual hearing, and 31% of the group with the lowest residual hearing did not make any adjustments in the hearing aids. Most patients reported that the sound was closer and stronger on the cochlear implant side.

The initial survey showed that even without the balancing protocol of the two devices and the perception of higher loudness on the implanted side, more than half of the patients reported that they prefer to use bimodal stimulation in different listening environments, such as silence, noise, reverberant places, and in the perception of music. Nevertheless, sound localization ability is difficult to perceive in almost all situations for both groups.

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