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Long-Term Results in Cochlear Implantation in Single-Sided Deafness in Children and Adult Populations

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Objectives: The aim of this study is to show the long-term effects of cochlear implant as a treatment in both children and adults with acquired single-sided deafness.
Study Design: Observational, descriptive, cross-sectional.
Setting: Tertiary referral center.
Patients: 21 children and 20 adults with SSD.
Intervention(s): Unilateral CI.
Methods: Speech detection thresholds and disyllabic words test (65 dB SPL) were performed in the modalities azimuth (S0), signal CI side (SCI), and signal on the normal hearing (SNH). The normal ear was masked with both white noise of +10 dB of the hearing threshold and plugging the same ear, whereas the speech testing was performed using the cochlear implant wireless system.
Results: All results were obtained up to 48 months after the activation of the sound processor. All study subjects showed improvements in speech test results in all conditions tested. Word recognition in noise in children improved from 42.76% at 6 months after activation of the sound processor to 76.38% at 48 months in the S0 condition, from 50 to 78.10% in the SCI condition, and from 38.48 to 66.48% in the SNH modality. Regarding adults, word recognition in noise went from 45.40% at 6 months of activation of the sound processor to 73.40% at 48 months in the S0 condition, from 52.60 to 76.20% in the SCI condition, and from 43.60 to 64.80% in the SCI condition ($p < 0.001$). The average duration of use of the speech processor daily was 11 hours in children and 9.4 hours in adults.
Conclusion: When comparing children's performance with adults', progressive improvement in speech discrimination compared with adults was observed.
Key Words: Cochlear implant—Single-sided deafness—Speech detection—Unilateral deafness.

Otol Neurotol **00:**00–00, 2025.

INTRODUCTION

Single-sided deafness (SSD) is defined as unilateral severe to profound hearing loss with normal hearing in the contralateral ear (1). People with only one functional ear experience difficulties in hearing and understanding in noisy environments, impaired sound localization, and increased stress and social isolation.

There are several studies that show that cochlear implantation can benefit people with single-sided deafness. The improvements observed are in speech recognition in the implanted ear and suppression of tinnitus if it is associated with hearing loss. In addition, greater balance control, improved localization, and improved speech recognition in noise when analyzed bilaterally (normal ear and implanted ear) (2–4).

The prevalence of SSD in children is increasing, likely due to the introduction of universal newborn hearing screening. Even then, the diagnosis of unilateral hearing loss in children may still be delayed (5,6).

The impact of SSD in children is now recognized as a cause of speech, and receptive and expressive language delay, affecting academic and social performance. Cochlear implantation (CI) in children with SSD should be considered as early as possible to maximize learning opportunities (7–9).

Studies show that cochlear implantation in adults with SSD improves several aspects of hearing achieving comparable speech perception outcomes to conventional

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This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
The authors disclose no conflicts of interest.

DOI: 10.1097/MAO.0000000000004527

candidates, as well as improves health-related quality of life (10,11).

The aim of this study is to show the long-term effects of cochlear implant (CI) as a treatment in children and adults with acquired single-sided deafness.

MATERIALS AND METHODS

This study was approved by the Ethics Committee of our Hospital (Code Etic Committee HUGCDN: 2021-228-1). Adults and parents were informed about the advantages and disadvantages of the treatment options for single-sided deafness (no treatment, bone conduction system, CROS system, or CI), and expectations were adjusted for the possible outcomes of cochlear implantation. All subjects trialed a bone-conduction device and the CROS system device before surgery, with no improvement in the hearing or localization tests. The investigators informed the adults and parents about the risks and benefits of participating in this study, obtaining informed consent before the start of the study

An oobservational, descriptive, cross-sectional study was conducted in two populations, adults and children (<12 yr) with acquired SSD. They underwent CI between January 2018 and December 2019. There was a minimum follow-up of up to 48 months after the activation of the sound processor of the cochlear implant.

We excluded implanted patients with ossification, cochlear malformation, or any other pathology that could prevent complete insertion of the electrode array, severe to profound hearing loss related to meningitis, and posterior fossa tumors or other retrocochlear pathologies or central hearing-loss. We also excluded subjects with middle ear pathologies precluding performance of CI (e.g., active middle ear infections, tympanic membrane perforation) or any additional disabilities that might preclude participation in the evaluations; we did not include subjects in whom parental consent was not obtained.

According to the protocol for the selection of cochlear implant candidates in our center, the following tests were performed on the children group: pure-tone audiometry (0.5–1–2 kHz), auditory evoked potentials in steady state (if it was considered necessary to confirm thresholds), and disyllabic speech test in quiet conditions at 65 dB SPL without lip reading in free-field tests. For lateralization test, five speakers were used in positions 0, 45, 90, 270, and 370 degrees. Genetic tests (Conexin 26, otoferlin) were also used. In adults: pure-tone audiometry (0.5–1–2 kHz), disyllabic speech test, and lateralization test were performed under the same conditions described for the children group. Imaging tests were performed in both groups: cerebral magnetic resonance imaging (MRI), and high-resolution computer tomography or cone-beam CT.

All the operations were performed by the same surgical team. The CI electrode arrays used in this study were the Cochlear Nucleus Profile with Slim Electrode Modiolar CI532 and Cochlear Nucleus with Contour Advanced Electrode CI512.

The ACE codification strategy was applied to program the speech processor by using the Software Custom Sound 3.1; the frequency assignation (FAP) by channel method was applied (12,13).

Hearing tests were performed at 6, 18, 24, 36, and 48 months of device usage.

All patients routinely used a standard protocol in our center ("Protocol for the assessment of hearing in Spanish Language") for adults and a version adapted to infant population (14).

The audiological test performed after cochlear implantation was a disyllabic speech test at dB-SPL condition without lip reading in free-field testing. The test (only disyllabic and disyllabic in noise) is presented in prerecorded digital format (14). Sound was presented in azimuth (sound presented from the center) (S0), signal CI side (SCI), and signal on the normal hearing (SNH); the normal-hearing ear was masked by an auditory threshold for white noise of +10 dB and a complete plugging and noise-canceling earphone. The ear with CI speech testing was performed using the Cochlear wireless Mini Microphone accessory.

A soundproof hearing booth with a separate booth for the operator, Audiotest 340 Interacoustics AS DK-5610 Assens audiometer, Denmark 2008 CE 0123, and with a set of Resolv Active Studio Monitor A5 45Hz-27 Khz Biamped 50 W speakers, was used to carry out all the tests.

In each visit, reports were obtained from parents regarding information on device use, attitude, and performance.

Data for the present study were stored in Microsoft Excel spreadsheets, and analyses were performed using the Statistical Package for Social Sciences (SPSS), version 25.0 (15). An exploratory and descriptive analysis was carried out. The categorical variables were expressed in percentages and absolute frequencies, whereas numerical variables were expressed as average, median, and standard deviation values. Percentages were compared by using the chi-square test, and average values were compared by using the Student *t* test for paired samples. Analysis of equality of distribution was performed using the analysis of variance (ANOVA) or Kruskal-Wallis test and Bonferroni test (multiple comparison test), depending on the characteristics of the data. Statistical significance was set at $p < 0.05$.

RESULTS

We studied 21 children (38.1% males, 61.9% female) and 20 adults (35.0% males, 65% female).

All subjects had acquired unilateral hearing loss. With respect to the causes of SSD in children, the etiologies were as follows: progressive hearing loss of unknown origin in 13 subjects (62%), a sudden hearing loss in 4 subjects (19. %), cholesteatoma in 2 subjects (9.5%), and cytomegalovirus (CMV) 2 subjects (9.5%). With respect to the causes of SSD in adults, the etiologies were as follows: progressive hearing loss of unknown origin in 10 subjects (50%), sudden hearing loss in 4 subjects (20%), Menière's disease in 2 subjects (10%), otoschlerosis in 3 subjects (15%), and acoustic trauma in 1 subject (5%). The whole sample's presurgical average PTA was 86 ± 12 dB in the implanted ear and 24 ± 4 dB in the normal-hearing ear.

The average age of implantation was 7.1 years (range, 6.0–12.0 yr) in children and 49.06 years in adults (range,

TABLE 1. *Characteristics of single-sided deafness in children*

Subject	Gender	Age at Implantation (yr)	Etiology	Laterality	Duration of Deprivation(mo)	Type of Cochlear Implant	Daily Hours of Use
1	Female	7.1	Unknown	Left	18	532	11
2	Female	6.0	Unknown	Left	6	532	13
3	Male	12.0	Cholesteatoma	Left	24	532	12
4	Female	6.2	Unknown	Left	12	532	10
5	Male	6.3	Sudden hearing loss	Right	12	532	10
6	Female	6.2	Unknown	Left	6	512	9
7	Female	6.7	Unknown	Left	9	532	10
8	Male	6.1	Unknown	Right	6	532	12
9	Male	6.2	Sudden hearing loss	Left	18	512	13
10	Male	8.1	CMV	Right	14	532	12
11	Female	7.1	Unknown	Right	8	532	12
12	Male	6.2	Unknown	Left	16	532	11
13	Female	10.2	Sudden hearing loss	Right	12	532	10
14	Female	6.7	Cholesteatoma	Right	11	532	11
15	Male	8.4	Unknown	Left	10	532	9
16	Male	7.2	Sudden hearing loss	Left	10	532	13
17	Female	6.4	Unknown	Right	12	532	9
18	Female	6.7	Unknown	Left	15	512	10
19	Female	6.0	Unknown	Right	14	532	12
20	Female	6.1	Sudden hearing loss	Left	6	532	11
21	Female	7.3	CMV	Right	14	532	10

34.8–59 yr). The right ear was the affected ear in 42.9% of children and in 35% of adults. The average duration of deprivation in the deafened ear in children was 12 months, and it was 9.7 months in adults, considered "the time of deprivation" from the time of first diagnosis of profound deafness or severe hearing loss. Cochlear Nucleus Profile with Slim Electrode Modiolar CI532 was used in all patients except in seven subjects who used Cochlear Nucleus with Contour Advanced Electrode CI512. The average duration of daily word processor use was 11 hours for children and 9.4 hours for adults; data were obtained by logging data directly from the speech processor (Tables 1 and 2).

In children, the average speech discrimination was 44.7% (SD, 4.122%) at 6 months postoperatively and 76.3% (SD, 2.801%) at 48 months; the average improvement was 31.6 percentage points ($p < 0.001$). For sounds presented to the implanted ear, the speech discrimination was 50.0% (SD, 3.688%) at 6 months postoperatively and 78.1% (SD, 2.0%) at 48 months; the average improvement in speech discrimination was 28.0 percentage points ($p < 0.001$).

For sounds presented to the contralateral ear, the speech discrimination was 38.4% (SD, 3.683%) at 6 months postoperatively and 66.4% (SD, 3.219%) at 48 months; the average improvement was 28 percentage points ($p < 0.001$; Table 3 and Fig. 1).

In adults, the average speech discrimination was 45.4% (SD, 2.981%) at 6 months postoperatively and 73.4% (SD, 3.733%) at 48 months; the average improvement was 28% ($p < 0.001$). For sounds presented to the implanted ear, the speech discrimination was 52.6% (SD, 2.683%) at 6 months postoperatively and 76.2% (SD,

TABLE 2. *Characteristics of single-sided deafness in adults*

Subject	Gender	Age at Implantation (yr)	Etiology	Laterality	Duration of Deprivation(mo)	Type of Cochlear Implant	Daily Hours of Use
1	Male	35.8	Sudden hearing loss	Right	10	532	10
2	Female	58.7	Otosclerosis	Left	6	532	7
3	Male	47.7	Sudden hearing loss	Left	11	532	9
4	Female	59.0	Unknown	Right	9	532	12
5	Male	57.4	Sudden hearing loss	Right	8	512	9
6	Male	38.4	Unknown	Left	6	512	10
7	Female	49.6	Unknown	Left	7	532	11
8	Female	47.5	Unknown	Right	7	532	11
9	Male	48.5	Menière's disease	Left	12	512	9
10	Female	49.9	Acoustic Trauma	Right	11	532	10
11	Female	56.4	Unknown	Left	10	532	10
12	Male	58.4	Menière's disease	Left	13	532	10
13	Female	59.0	Unknown	Right	11	532	8
14	Female	55.4	Unknown	Left	9	532	7
15	Female	44.8	Unknown	Left	11	532	9
16	Female	37.4	Sudden hearing loss	Left	13	532	10
17	Female	35.2	Unknown	Right	8	532	11
18	Male	34.8	Unknown	Left	12	512	9
19	Female	48.6	Otosclerosis	Left	13	532	8
20	Female	58.7	Otosclerosis	Left	7	532	8

TABLE 3. *Evolution of speech test results (azimuth (S0), signal CI side (SCI), and signal on the normal hearing (SNH) in children with single-sided deafness*

Direction of Sound Presented	Mean Speech Discrimination	Standard Deviation	Mean Improvement	*p* Value
Azimuth 6 mo	44.7	4.1	31.6	<0.001
Azimuth 48 mo	76.3	2.8		
Implanted ear 6 mo	50.0	3.6	28.0	
Implanted ear 48 mo	78.1	2.0		
Contralateral 6 mo	38.4	3.6	28.0	
Contralateral 48 mo	66.4	3.2		

An important improvement in the results is observed when comparing 6 and 48 months ($p < 0.001$).

3.548%) at 48 months; the average improvement in speech discrimination was 23.6% ($p < 0.001$). For sounds presented to the contralateral ear, the speech discrimination was 43.6% (SD, 3.409%) at 6 months postoperatively and 64.8% (SD, 4.420%; $p < 0.05$) at 48 months; the average improvement in speech discrimination was 21.2% ($p < 0.001$; Table 4 and Fig. 2).

A general linear model analysis of repeated measures was then performed for the abovementioned speech discrimination results in order to compare the main effects with a Bonferroni confidence interval adjustment. We obtain in the children's group the following results: 44.76% at 6 months, 47.24% at 18 months, 56% at 24 months, 68.57% at 36 months, and 76.38% at 48 months. For the adult group, we obtained 45.40% at 6 months, 52.20% at 18 months, 58% at 24 months, 65.60% at 36 months, and 73.40% at 48 months. Regarding the evolution of results (speech performance), a homogeneous increase is observed in the case of children, with gradual development throughout the study period. In the case of adults, there was a suggestion of an increase in results at month 36 onward; however, this did not reach statistical significance (Figs. 1 and 2).

In the complete sample, the relationship between the time of hearing deprivation and the performance in disyllables in the implanted ear, at 6 and 48 months, was analyzed, and it was observed that the shorter hearing preservation period, the better performance was obtained ($p < 0.001$).

DISCUSSION

Single-sided deafness has consequences beyond sound localization and spatial hearing; in the child, it affects language development, school performance, social relationships, and overall ability in cognitive tasks. Without intervention, children with SSD show developmental deficits in learning and memory, akin to those with bilateral cochlear implants (16).

When comparing the performance of children with that of adults, children unilaterally implanted with SSD exhibit a more proportional increase in speech discrimination and achieve comparable, if not slightly greater, maximum improvement.

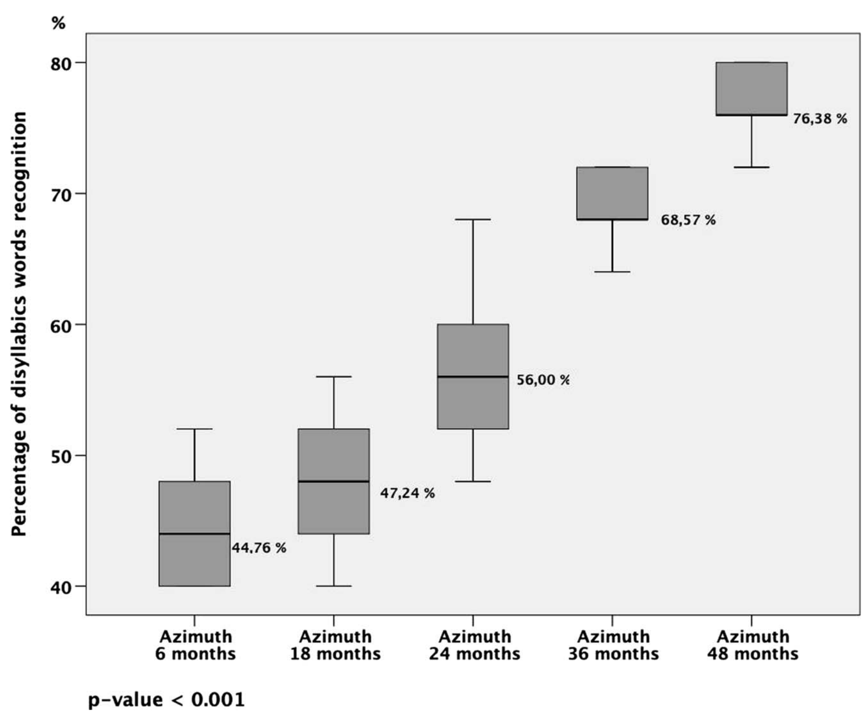

FIG. 1. Improvement in the results of speech tests (azimuth S0) in children from 6 to 48 months after implantation.

TABLE 4. *Evolution of speech test results (azimuth (S0), signal CI side (SCI), and signal on the normal hearing (SNH) in adults with single-sided deafness*

Direction of Sound Presented	Mean Speech Discrimination	Standard Deviation	Mean Improvement	*p* Value
Azimuth 6 mo	45.4	2.9	28.0	<0.001
Azimuth 48 mo	73.4	3.7		
Implanted ear 6 mo	52.6	2.6	23.6	
Implanted ear 48 mo	76.2	3.5		
Contralateral 6 mo	43.6	3.4	21.2	
Contralateral 48 mo	64.8	4.4		

An important improvement in the results is observed when comparing 6 and 48 months ($p < 0.001$).

In the study by Rahne and Plontke (11), as in our study, all patients (children and adults) with SSD benefited from cochlear implantation by significantly improving speech recognition. There are also recent neurophysiologic data showing that children undergoing unilateral CI for SSD can demonstrate reversal of cross-modal cortical reorganization after CI, even with prolonged periods of deafness before implantation (17).

Pediatric subjects with SSD benefit substantially from cochlear implantation. Objective speech outcome measures are improved in both quiet and noise (18). In our study, verbal recognition only of the implanted ear has been evaluated with the aim of seeing the evolution and extent of improvement in long-term follow-up. Shin et al. (19) in their systematic review conclude that cochlear implantation improves speech and language skills in CMV-infected patients, but the results are mixed compared with non-CMV-infected children; this is possibly the same reason why our study obtained better results because our cohort includes only a small percentage of CMV-infected subjects.

The effect of age of onset of hearing loss and age of implantation is another critical, unresolved piece of the puzzle to understanding the performance outcomes of hearing implants in children. Benchetrit et al. (20), in a systematic review and meta-analysis, reported that children with congenital SSD obtained lower results on patient-reported hearing performance questionnaires compared with children with acquired SSD. However, in a case series presented in the study by Deep et al. (21), the authors reported improvements in speech perception in both patients with congenital SSD and those with acquired SSD. In our series, the shorter the deprivation time in both children and adults, the better the results are achieved in a shorter period of time.

There has been some concern regarding device nonuse in children undergoing unilateral CI for SSD. Thomas et al. (22) showed that 4 of 21 subjects (19%) were limited or nonusers, and this was despite the fact that they found significant improvements in all aspects of binaural hearing regardless of whether they were implanted more or less than 6 years of age in a congenitally deafened population.

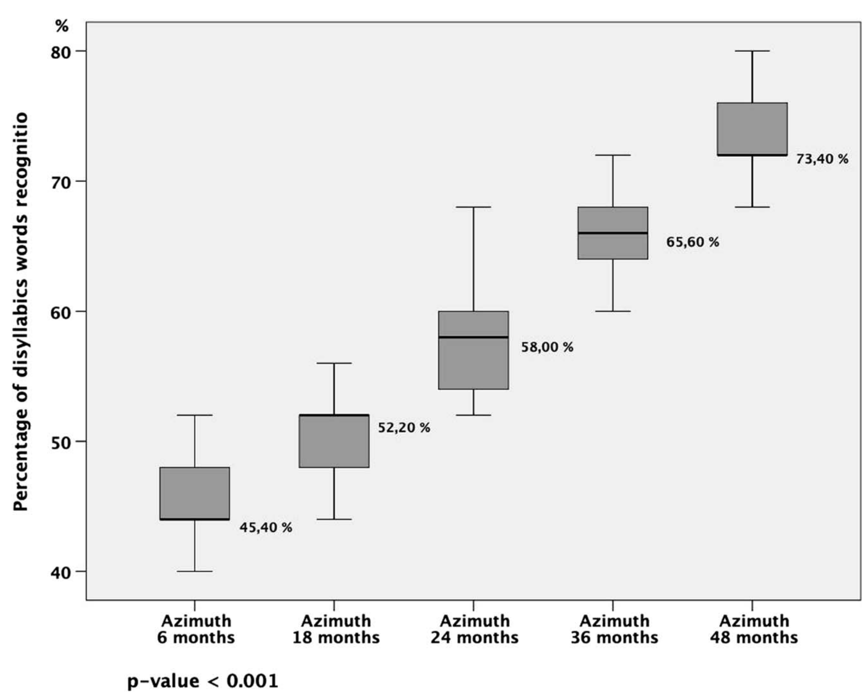

FIG. 2. Improvement in the results of speech tests (azimuth S0) in adults from 6 to 48 months after implantation.

Additionally, 60% of the subjects with post-implantation follow-up of more than 3 years were limited or nonusers. However, in our study, compliance was excellent up to 4 years.

Indeed, the literature is variable with regard to compliance. In the study by Ehrmann-Mueller et al. (23), all implanted children are full-time users regardless of age or duration of deafness before implantation. Gordon et al. (21,24) studied a group of 57 children and found that outcomes and subsequently compliance were better in younger children than adolescents. Our study population had no adolescents and that could explain the better compliance. Although children with permanent bilateral hearing loss rely on their CI and therefore have good compliance, children with SSD have a normal hearing ear that is adequate for certain listening environments and may not perceive a deficit. In the current study, we found that approximately 70% of patients are regular users (>7 h/d) of their CI and that older patients used their device more, similar to previous studies. That being said, it should not be immediately assumed that patients with limited device use are dissatisfied with their CI. There may be satisfaction with the result of the CI, but the subjects may mainly use it during school hours. This highlights the “situational deficit” presented by SSD and the fact that patients with SSD can still gain significant satisfaction and utility from their CI despite not wearing it during all waking hours.

In our study, as in other studies, the adults CI users with SSD and bilateral SNHL have comparable duration of device usage at longer follow-up periods (25).

CONCLUSION

Our study has shown that hearing performance improves over a period of 4 years in both children and adults who had cochlear implantation for acquired single-sided deafness

REFERENCES

1. Vila PM, Lieu JE. Asymmetric and unilateral hearing loss in children. *Cell Tissue Res* 2015;361:271–8.
2. Firszt JB, Holden LK, Reeder RM, et al. Auditory abilities after cochlear implantation in adults with unilateral deafness: A pilot study. *Otol Neurotol* 2012;33:1339–46.
3. Ramos Á, Polo R, Masgoret E, et al. Cochlear implantation in patients with sudden unilateral sensorineural hearing loss and associated tinnitus. *Acta Otorrinolaringol Esp* 2012;63:15–20.
4. Arndt S, Aschendorff A, Laszig R, et al. Comparison of pseudobinaural hearing to real binaural hearing rehabilitation after cochlear implantation in patients with unilateral deafness and tinnitus. *Otol Neurotol* 2011;32:39–47.
5. Rohlfs AK, Friedhoff J, Bohnert A, et al. Unilateral hearing loss in children: A retrospective study and a review of the current literature. *Eur J Pediatr* 2017;176:475–86.
6. van Wieringen A, Boudewyns A, Sangen A, Wouters J, Desloovere C. Unilateral congenital hearing loss in children: Challenges and potentials. *Hear Res* 2019;372:29–41.
7. Hunter JB, Yancey KL, Lee KH. Pediatric single-sided deafness. *Otolaryngol Clin N Am* 2022;55:1139–49.
8. Ramos Macías Á, Borkoski-Barreiro SA, Falcón González JC, de Miguel Martínez I, Ramos de Miguel Á. Single-sided deafness and cochlear implantation in congenital and acquired hearing loss in children. *Clin Otolaryngol* 2019;44:138–43.
9. Huttunen K, Erixon E, Löfkvist U, Mäki-Torkko E. The impact of permanent earlyonset unilateral hearing impairment in children—A systematic review. *Int J Pediatr Otorhinolaryngol* 2019;120:173–83.
10. Deep NL, Spitzer ER, Shapiro WH, et al. Cochlear implantation in adults with single-sided deafness: Outcomes and device use. *Otol Neurotol* 2021;42:414–23.
11. Rahne T, Plontke SK. Functional result after cochlear implantation in children and adults with single-sided deafness. *Otol Neurotol* 2016;37:e332–40.
12. Falcón-González JC, Borkoski-Barreiro S, Limiñana-Cañal JM, Ramos-Macías A. Recognition of music and melody in patients with cochlear implants, using a new programming approach for frequency assignment. *Acta Otolrrinlaringol Esp* 2014;65:289–96.
13. Falcón González JC, Borkoski Barreiro S, Ramos De Miguel A, Ramos Macías A. Improvement of speech perception in noise and quiet using a customised frequency-allocation programming (FAP) method. *Acta Otorhinolaryngol Ital* 2019;39:178–85.
14. Huarte A, Molina M, Manrique M, Olleta I. Protocolo para la valoración de la audición y el lenguaje, en lengua española, en un programa de implantes cocleares. *Acta Otorrinolaringol Esp* 1996;47(suppl 1):1–14.
15. IBM Corp. Released 2017. *IBM SPSS Statistics for Windows, Version 25.0*. Armonk, NY: IBM Corp.
16. McSweeny C, Cushing SL, Campos JL, Papsin BC, Gordon KA. Functional consequences of poor binaural hearing in development: Evidence from children with unilateral hearing loss and children receiving bilateral cochlear implants. *Trends Hear* 2021;25:23312165211051215.
17. Sharma A, Glick H, Campbell J, et al. Cortical plasticity and reorganization in pediatric single-sided deafness pre- and postcochlear implantation: a case study. *Otol Neurotol* 2016;37:e26–34.
18. Zeitler DM, Sladen DP, MD DJ, et al. Cochlear implantation for single-sided deafness in children and adolescents. *Int J Pediatr Otorhinolaryngol* 2019;118:128–33.
19. Shin JJ, Keamy DG Jr., Steinberg EA. Medical and surgical interventions for hearing loss associated with congenital cytomegalovirus: A systematic review. *Otolaryngol Head Neck Surg* 2011;144:662–75.
20. Benchetrit L, Ronner EA, Anne S, Cohen MS. Cochlear implantation in children with single-sided deafness: A systematic review and meta-analysis. *JAMA Otolaryngol Head Neck Surg* 2021;147:58–69.
21. Deep NL, Gordon SA, Shapiro WH, et al. Cochlear implantation in children with single-sided deafness. *Laryngoscope* 2021;131:E271–7.
22. Thomas JP, Neumann K, Dazert S, Voelter C. Cochlear implantation in children with congenital single-sided deafness. *Otol Neurotol* 2017;38:496–503.
23. Ehrmann-Mueller D, Kurz A, Kuehn H, et al. Usefulness of cochlear implantation in children with single sided deafness. *Int J Pediatr Otorhinolaryngol* 2020;130:109808.
24. Gordon KA, Alemu R, Papsin BC, Negandhi J, Cushing SL. Effects of age at implantation on outcomes of cochlear implantation in children with short durations of single-sided deafness. *Otol Neurotol* 2023;44:233–40.
25. Garcia A, Haleem A, Chari DA, et al. Influence of listening environment on usage patterns in cochlear implant patients with single-sided deafness. *Cochlear Implants Int* 2023;24:335–41.