OUTCOME MEASURES OF COCHLEAR IMPLANT RECIPIENTS VERSUS HEARING AID USERS IN SEVERE SENSORINEURAL HEARING LOSS AMONG EGYPTIAN CHILDREN.

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ABSTRACT:

Background: *Cochlear implantation is the standard treatment for the severe to profound bilateral sensorineural hearing loss. Candidacy criteria have expanded gradually due to technological developments and increasing experience. Main expansions include very young age, residual hearing, additional handicaps & special etiologies of deafness.*

Aim of the work: *To compare the outcomes of children with bilateral severe to profound SNHL with cochlear implant versus children with severe SNHL with hearing aids.*

Patient and Methods*: 60 children with age 5-15 years divided into 2 groups were included in the present study. Group I: 30 binaural HA users with bilateral severe sensorineural hearing loss. Group II: 30 CI users with bilateral severe to profound hearing loss. Test battery of outcome measures (Arabic versions) were done to evaluate and compare outcome of both groups including measures for: audibility, aided speech recognition test using PBKG lists, perception of everyday sounds by MAIS questionnaire and language assessment using PLS 4 test.*

Results: *Results showed that HA group scored better than CI group in aided speech recognition test by PBKG lists, MAIS questionnaire and PLS 4 test. CI group got better aided thresholds.*

Conclusion: *Children with severe hearing loss using hearing aids have the potential to receive sufficient auditory information from conventional hearing aids to acquire age-appropriate spoken communication.*

Key word*: Hearing aids, Cochlear Implant, Outcome*

INTRODUCTION:

Over the last two decades, the use of cochlear implants (CI) has grown widely especially with the spread of universal newborn hearing screening (UNHS) programs worldwide. Technology and performance improvement by CI recipients have resulted in expansion of CI candidacy criteria to involve patients with lesser degrees of hearing loss and higher speech discrimination scores [1&2].

Cochlear implant use has been resulted in better outcomes in speech perception, language, speech development and literacy compared to conventional hearing aid users. In spite of that, outcomes of CI in children differ greatly[3]. These benefits in individuals with severe-to-profound sensorineural hearing loss raised attention to the implantation of children with lesser degrees of hearing loss [4,5&6]. In spite of the evidence for improved benefits from CI compared to conventional hearing aids for children with

severe to profound sensorineural hearing loss, there is argument about implantation of children with more residual hearing[4&7]. Geers (2006) noted that the benchmark at which a cochlear implant can give better acoustic information than conventional hearing aids are still unclear[8]. For children with severe hearing loss range, conventional hearing aids can give satisfactory access to the speech information in the low and mid-frequencies but give no enough gain in the high-frequency range after about 3000 Hz[9].

There is difference in the last years in the determination of cochlear implant candidacy for audiologic borderline category of children. Most centers reported that examination of borderline candidates needs careful evaluation of many factors that extend beyond pure tone audiometry and speech discrimination scores, like social and academic performance.

Audiogram and speech recognition tests only are not sufficient to reveal the performance of CI recipients in everyday listening situations[10]. In the light of the expansion of candidacy criteria of cochlear implant, it is important to determine benchmarks for benefits in children with lesser degrees of hearing loss and to compare their outcomes with children with CI.

AIM OF THE WORK:

To compare the outcomes of children with bilateral severe to profound SNHL with cochlear implant versus children with severe SNHL with hearing aids.

PATIENTS AND METHODS:

Study Population: Sixty children, with age ranging from 5 to 15 years were included in our study. They were divided into 2 groups. **Group I** consisted of 30 children, 18 males (60%) and 12 females (40%) who underwent cochlear implantation at least two years before the study. **Group II** consisted of 30 children, 14 males (46.67%) and 16 females (53.33%) who underwent hearing aid fitting at least two years before the study.

Methods: All subjects were subjected to the following tests:

Full history taking**,** Psychometric evaluation (IQ testing), unaided pure tone audiometry and outcome measures.

Outcome measures

Every child was seated 1meter from the loudspeaker and at zero azimuth in a double walled sound treated room I.A.C. model 1602.

The following measures were done:

1. Aided audiometry with CI or hearing aids: Sound field testing using warble tone at 0.25, 0.5, 1, 2 & 4 KHz with age specific method (play or conventional audiometry)
2. Meaningful Auditory Integration Scale (MAIS) questionnaire, the Arabic version[11]: It evaluates the response of the child to sound in his/her everyday situations.
3. Arabic Speech perception test: Open-set Arabic Phonetically-Balanced Kindergarten (PBKG)[12].
4. Language evaluation using Modified Preschool language scale-4 (PLS-4), the Arabic version[13].

Ethical consideration:

All children' parents who were included in this study were asked for verbal consent before evaluation, after explanation of the aim and procedures of the testing. The protocol of the study was approved by Research Ethical Committee, Faculty of Medicine, Ain Shams University.

RESULTS:

I-Demographic data:

Table (1): Mean, Standard Deviation (SD) & and tests of significance for the age and gender in both hearing aid users and cochlear implant groups

		Group		Test of significance		
		HA (N= 30)	CI (N= 30)			
		Mean ± SD N (%)	Mean ± SD N (%)	Value	p-Value	Sig.
Age in years		9.87 ± 3.02	9.24 ± 2.83	***t*= 0.833***	0.408	NS
Gender	Male	14 (46.67%)	18 (60%)	X^2= 1.071**	0.301	NS
	Female	16 (53.33%)	12 (40%)			

*Student t-test of significance (t). **Chi-Square test of significance (X^2)

Table (2): Mean, Standard Deviation (SD) & test of significance for hearing data of both studied groups.

	Group		Test of significance		
	HA (N= 30)	CI (N= 30)			
	Mean ± SD N (%)	Mean ± SD N (%)	Value	p-Value	Sig.
Age at diagnosis (in years)	3.19 ± 1.55	1.51 ± 0.89	5.136*	<0.001	HS
Age of hearing aid fitting (in years)	3.62 ± 1.38	1.86 ± 0.85	5.928*	<0.001	HS
Hearing age (in years)**	6.26 ± 2.82	7.46 ± 2.62	-1.716 *	0.092	NS
Duration of rehabilitation (in years)	5.72 ± 2.86	5.92 ± 2.71	-0.269*	0.789	NS

*Student t-test of significance (t).**Hearing age in HA group: Period of hearing aid use since fitting.
Hearing age in CI group: period of hearing aid + CI use.

Table (3): Mean, standard deviation (SD), range and tests of significance hearing profile of both groups (non-implanted ear for the CI group)

		HA group	CI group	Test value	P-value	Sig.
		No. = 60 ears	No. = 30 ears			
High frequency thresholds average	Mean ± SD	87.57 ± 8.89	117.00 ± 4.80	-15.955*	0.000	HS
	Range	73 – 104	105 – 120			
Mid four thresholds average	Mean ± SD	77.43 ± 6.63	107.71 ± 7.95	-16.026*	0.000	HS
	Range	70 – 88	96.25 – 120			
Average speech discrimination	Mean ± SD Range	57.03 ± 13.89 % (24 – 74) %	1.20 ± 2.38 % (0 – 8) %	-6.85**	0.000	HS

*Student t-test of significance (t). **Mann-Whitney test

II-Outcome measures:

1. Audibility:

Table (4): Mean, Standard Deviation (SD) and test of significance of aided thresholds, average of mid four frequencies and high frequency average (2-4 kHz) (average of two ears in HA users group and aided cochlear threshold in CI group).

Average aided response		HA groups	CI group	Test value	P-value	Sig.
		No. = 60 ears	No. = 30 ears			
Average of aided mid four frequencies	Mean ± SD	41.27 ± 4.68	33.33 ± 5.66	5.915*	0.000	HS
	Range	36 – 52	22.5 – 43.75			
High frequency aided average (2-4 kHz)	Mean ± SD	48.23 ± 7.89	33.92 ± 6.39	7.724*	0.000	HS
	Range	38 – 68	22.5 – 45			

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant * Independent t-test

2. MAIS questionnaire:

Table (5): Mean, Standard Deviation (SD) and test of significance of Arabic version of Meaningful Auditory Integration Scale (MAIS) scores in both hearing aid users and cochlear implant recipients groups.

	Group		Student t-test		
	HA (N= 30)	CI (N= 30)			
	Mean ± SD	Mean ± SD	***t***	p-Value	Sig.
Total MAIS score	38.23 ± 1.36	36.67 ± 2.43	3.087	**0.003**	**HS**

*Student t-test of significance (t).

3. Speech recognition:

Table (6): Mean, Standard Deviation (SD) and test of significance of aided recognition test scores in both studied groups.

Aided test battery	Group		Student t-test		
	HA	CI			
	Mean ± SD	Mean ± SD	***t***	p-Value	Sig.
Open set speech discrimination by (PBKG) list	72.8 ± 11.19	65.2 ± 17.1	2.037*	**0.047**	**S**

*Student t-test of significance (t).

4. Language assessment:

Table (7): Mean, Standard Deviation (SD) and test of significance of Arabic version of preschool language scale (PLS-4) in both studied groups.

Language age in years		HA groups No. = 30	CI group No. = 30	Test value	P-value	Sig.
Receptive	Mean ± SD	6.47 ± 1.28	5.55 ± 1.05	3.025*	0.004	HS
	Median (IQR)	6.6 (5.9 – 8)	5.6 (5 – 6.11)			
	Range	3.11 – 8	3.11 – 8			
Expressive	Mean ± SD	5.95 ± 1.62	5.03 ± 1.50	2.300*	0.025	S
	Median (IQR)	6.2 (4.7 – 8)	5 (4 – 6.1)			
	Range	3.2 – 8	2.11 – 8			
Total	Mean ± SD	6.19 ± 1.41	5.28 ± 1.18	2.711*	0.009	HS
	Median (IQR)	6.35 (4.9 – 8)	5.2 (4.5 – 6.1)			
	Range	3.6 – 8	3.2 – 8			

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant
*: Independent t-test

DISCUSSION:

This study allowed us to illustrate auditory and language skills for a group of 5-15 years old children with severe degree of hearing loss with bilateral hearing aids and severe to profound degree of hearing impairments with unilateral CI who have spoken communication.

A-Aided performance:

In the present study, the aided threshold for both groups were good but wasn't the best, the mean average of mid four aided thresholds was 41.27 dBHL for hearing aid group and 33.33 dBHL for the CI group

There was difference between two groups in aided thresholds in 250 Hz, 2 kHz

and 4 kHz. Thresholds of Hearing aid group were better in 250 Hz, while cochlear implant group were better in 2 kHz and 4 kHz.

For hearing impaired children, many studies found that a considerable number of children have HA gain that deviate from target [16,17,18&19]. Furthermore, these deviations from target increase with higher degrees of hearing loss, especially at high frequencies such as 4–6 kHz [19]. Actually, for ultimate speech perception and language development, audibility of high frequency is crucial for children[20&21].

B- Meaningful auditory integration scale (MAIS) score:

There was statistically significant difference between the two groups in MAIS total score, which indicates that HA group children have better every day listening skills and better reliance on the hearing aid.

C- Speech recognition

In our study, speech perception scores of hearing aid group (mean aided PBKG score = 72.8%) were better than CI group (mean aided PBKG score = 65.2%). CI group scores are consistent with multiple studies were done in the same period in our center [22&23].

Abdelfattah et al., (2022) studied 40 children with CI, their chronological age was from 5 to 10 years, mean PBKG score was 63.70 % [23]. Nassar et al., (2022) studied group of 40 children with CI with age from 8 to 17 years old, they were subdivided into 2 groups, sub group (A) and subgroup (B), mean PBKG scores for subgroups (A) and (B) were 68.9% and 71.7% respectively[22].

On the other hand, Fitzprick et al., (2012) reported better score for CI group (80%) than HA group (72%), both groups aged 6–18 years. However, the difference was not significant[24].

Blamey et al., (2001) found that speech perception, production, and language scores were very similar between the two groups[25].

The key difference between these studies is age at implantation, Children who were implanted earlier showed speech recognition scores that were significantly higher than children who were implanted later [26]. Manrique and colleagues found that children implanted between 0 to 3 years of age performed better than children implanted between 4 to 6 years of age on open-set speech recognition scores[26].

D. Language development

In our study, although both groups were age matched, language development of the hearing aid group was significantly better than CI group in receptive, expressive and total scores. Also, significantly more children in the hearing aid group reached full language development (8 years).

Fitzpreck et al., (2012) also found that children with moderately severe or severe hearing loss performed significantly better than their peers with profound hearing loss and cochlear implants on receptive vocabulary and overall language ability [24].

Our study gives information about the abilities of hearing aid and CI using children. We suggest that hearing aid using children with severe hearing loss have the potential to receive sufficient auditory information from conventional hearing aids to acquire age-appropriate language and speech development.

Conflicts of interest:

No conflicts of interest.

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تقييم نتائج مزروعي قوقعة الأذن مقارنة بنتائج مستخدمي المعينات السمعية في الأطفال المصريين من ذوي ضعف السمع شديد الدرجة

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هدف البحث : تقييم ممنهج معتمد على اكتساب المهارات السمعية والتطور اللغوي للأطفال شديدي ضعف السمع اللذين يستخدمون معينات السمع بكلا الأذنين مقارنة بالأطفال زارعي القوقعة

المرضى والطرق:

٦٠ طفلا تم تقسيمهم إلى مجموعتين: المجموعة الأولى ٣٠ طفلا ذوى ضعف سمع حسي عصبي شديد الى عميق الدرجة وقد اجريت لهم عملية زراعة القعة لمدة سنتين عالأقل قبل بداية الدراسة مع تطابق العمر والجنس مع المجموعة الثانية والتى تضم ٣٠ ذوي ضعف سمع شديد الدرجة ويستخدمون معينات السمع التقليدية ،وقد تم تقييم اداء المجموعتين من حيث مستوى السمع بالقوقعة ومعينات السمع و الاستجابه للاصوت البيئية المحيطة ومستويات تفسير واستقبال الكلام و التطور اللغوي.

النتائج: تبين من خلال البحث ان مجموعة معينات السمع كانت نتائج اختباراتها افضل من مجموعة مزروعي القوقعة في كل الوجه ماعدا مستوى السمع باستخدام معينة السمع او القوقعة

النهاية: تبين من خلال البحث ان الاطفال من ذوي ضعف السمع الحسي العصبي شديد الدرجة يظهرون اداءا جيدا من خلال معينات السمع التقليدية وقد لايحتاجون الى زراعة القوقعة مثل اقرانهم من ذوي ضعف السمع الحسي العصبي شديد الى عميق الدرجة.