



# Evaluation of Results of Speech Therapy by the APCEI Score in a Population of Patients with Cochlear Implants in Yaounde and Douala

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## Summary:

**Introduction:** Deafness is the most common neurosensory deficit in the world. The impact on language acquisition is a major concern in children. In Cameroon, 14 children with profound bilateral prelingual sensorineural hearing loss were rehabilitated with cochlear implants in the ENT departments of the Yaounde and Douala General hospitals. We proposed to evaluate the speech and language performance of these children with implants using the APCEI score.

**Methodology:** We conducted a cross-sectional descriptive and prospective study over an 18-month period, from January 2019 to June 30, 2021. The study sites were two speech therapy centers in Yaounde and Douala. All children managed with implants in the ENT departments of the Yaounde and Douala General hospitals, followed up in speech therapy were selected for the study.

**Results:** 14 children were selected. In the end, we noted a great variability in the evolution of the profile of each child compared to the others for the same delay but always a progression of the score from one time frame to the other for each patient. There was a significant improvement in the APCEI score of the patients over time and the mean score increased from  $22083.14 \pm 7735$  in month 1 to  $4029.93 \pm 9981$  at the end of the study ( $P < 0.0001$ ). All in all, there was an increase in the overall APCEI score, which indicates an increasing prosthetic gain.

**Conclusion:** The APCEI score is a simple and reliable tool for assessing speech and language performance in cochlear implant children. Early age of implantation, attendance at speech therapy sessions, and duration of cochlear implant wear are factors that positively influence prosthetic gain and language acquisition.

## Introduction

Deafness is the most common neurosensory deficit in the world. The impact on language acquisition is a major concern in children. Indeed, the occurrence of severe or profound bilateral deafness in a child in the prelingual period compromises language acquisition. To rehabilitate this severe or profound prelingual deafness, the solution lies in the installation of a cochlear implant, which allows the restoration of hearing function. The gain for the child will be objectively evaluated by the acquisition of language after implantation. This acquisition of language is possible through speech therapy sessions. In Cameroon, 14 children with bilateral prelingual profound neurosensory hearing loss were rehabilitated with cochlear implants in the ENT departments of the Yaounde and Douala General hospitals. The APCEI profile is a simple tool for assessing speech performance post cochlear implantation [1]. It is a rapid method of rating the performance of a child with an implant or prosthesis at a given time and a system for storing the child's performance through audiological and speech therapy data already present in the medical record. As such, this profile should be able to be applied retrospectively to older assessments ("rAPCEI" for "retrospective APCEI"). The APCEI profile makes it possible to summarise the overall performance of a child wearing a hearing aid

(implant or prosthesis) in the form of a 5-digit number. We set out to assess the speech and language performance of these implanted children using the APCEI score. We also carried out subjective evaluations on: the implementation or not of the audiophonic loop, the consistency of the children at the sessions, the difficulties encountered during the sessions, the linguistic performances, the school attendance and the psychological evaluations of the implanted children.

## Methodology

We conducted a descriptive and prospective cross-sectional study over an 18-month period, from January 2019 to June 30, 2021. The study sites were two speech therapy practices in Yaounde and Douala. All children implanted in the ENT departments of the Yaounde and Douala General hospitals, followed up in speech therapy were selected for the study. Parental consent was required beforehand. An evaluation of the APCEI profile was done at one month, three months, six months, twelve months and eighteen months according to the follow-up of each patient. The APCEI profile allowed us to summarise the overall performance of a child wearing a hearing aid (implant or prosthesis) as a 5-digit number. Five areas are addressed (Table 1):

**Table 1:** The APCEI profile used in the study.

APCEI Profile	0	1	2	3	4	5
ACCEPTANCE to wear the device	Refusal	Objection Wearing under constraint for some hours	Wearing with no constraint, periodic, not all day long	Acceptance and passive wearing can do without. Batteries?	Wearing requested asks for batteries, puts antenna back on Active start	Needs, demands it, Wear it all day long
PERCEPTION Quantitative then qualitative threshold: sound discrimination	Vibration Cophosis	At over 80 dB Reacts to very loud sounds	At 80-60 dB Loud voice Some sounds	At 60-40 dB Normal voice Many sounds	At 40-20 dB Low voice Many sounds	At 40-20 dB Perceives more than 80% Logatoms or related words
COMPREHENSION Discrimination of words, meaning of the message	None	Has an auditory awareness	Identifies speech/noise Identifies some familiar sounds, knows their name	Understands simple sentences, Understands more than 80% of closed lists	Identifies phrases, understands more than 80% of open lists talks on phone with relatives	Understands the meaning of language with ease, uses the telephone with ease
ORAL EXPRESSION Use of voice, syntax	Mute	Produces meaningless sounds with no intention to communicate	Single words or phrases, regular use of voice, intention to communicate	Association of several words, Simple sentences, poor syntax	Good syntax, oralizes, lacks spontaneity and fluency	Speaks with ease and fluency; conversations
INTELLIGIBILITY Articulation	Mute	Unintelligible	Some intelligible words	Understood by the professionals and parents (to be decoded)	Understood by non-professionals	Excellent articulation and fluency

→ A = Acceptance of the device and/or implant

→ P = Hearing perception with the aid

→ C = Comprehension of the perceived oral message (without lip reading)

→ E = Oral expression, use of voice (syntax)

→ I = Child's intelligibility (quality).

Each of these areas was rated between 0 and 5: 0 corresponding to no performance and 5 corresponding to the maximum performance required, i.e. excellent performance allowing school attendance in good conditions with minimal assistance. Other subjective assessments were made regarding the implementation or

not of the audio-phonatory loop, the consistency of the children at the sessions, the challenged faced during the sessions, the linguistic performance, school attendance and the psychological assessments of the implanted children. The collected data was entered into a data entry mask of the CS. Pro version 7.3, and then exported to IBM SPSS version 23.0, in which the statistical analyses were carried out.

### Results

Our sample consisted of 14 patients.

#### Assessment of the APCEI profile

The APCEI profile was scored for each of the items: acceptance (A), perception (P), comprehension (C), expression (E) and intelli-

gibility (I) and the score was calculated as the sum of all the values obtained for each item. Each child was assessed at different time frames during their speech therapy. Table 2 shows the scores for each item and their sum to obtain the score at different time frames for each child. In the end, we note a great variability in the evolution of the profile of some patients in relation to others for the same period of time, but always a progression of the score from one period to another for each patient (Figures 1 & 2). There was a significant improvement in the APCEI score of the patients over time and the mean score increased from  $22083.14 \pm 7735$  in month 1 to  $4029.93 \pm 9981$  at the end of the study ( $P < 0.0001$ ). Global representation of the sums of the APCEI scores of the 14 patients at different evaluation dates; overall, there is an increase in the global APCEI score, which indicates an increasing prosthetic gain.

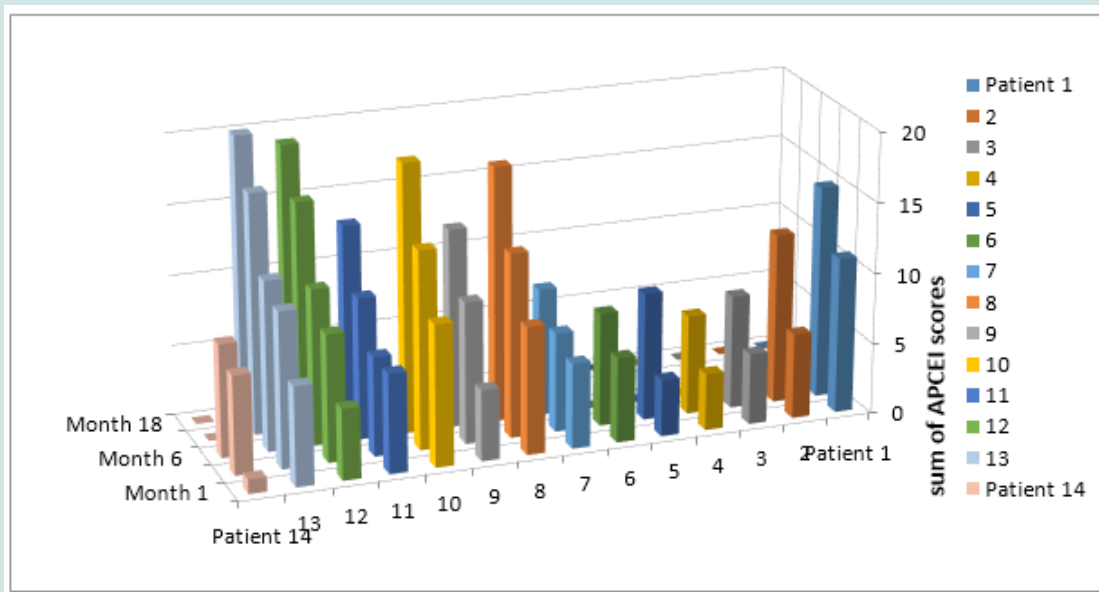


Figure 1: Evolution over time of the APCEI scores of the 14 patients.

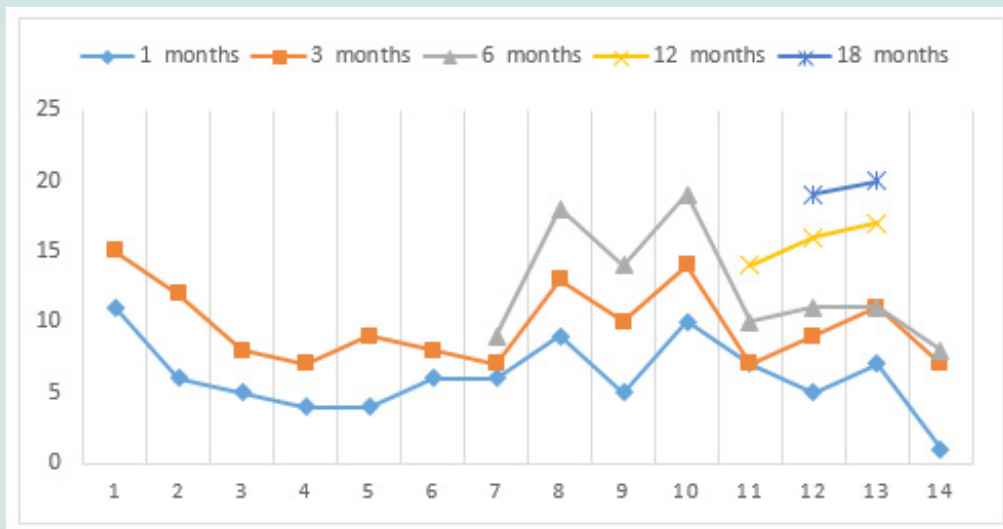


Figure 2: Time trend curves of APCEI scores of the 14 patients.

**Table 2:** Distribution of APACEI scores for the 14 children and sum of the score for each assessment.

	1 Month A.P.C.E.I	S*	2 Months A.P.C.E.I	S*	6 Months A.P.C.E.I	S*	12 Months A.P.C.E.I	S*	18 Months A.P.C.E.I	S*
Patient 1	32222	11	33333	15	/////	//	/////	//	/////	//
Patient 2	21111	6	33222	12	/////	//	////	//	/////	//
Patient 3	21011	5	32111	8	/////	//	////	//	/////	//
Patient 4	21100	4	31111	7	////	//	/////	//	/////	//
Patient 5	11011	4	32121	9	////	//	/////	//	/////	//
Patient 6	31011	6	32111	8	/////	//	/////	//	/////	//
Patient 7	21111	6	22111	7	33111	9	/////	//	/////	//
Patient 8	22122	9	33223	13	54333	18	/////	//	/////	//
Patient 9	21011	5	42211	10	53321	14	/////	//	/////	//
Patient 10	32122	10	43223	14	54334	19	/////	//	/////	//
Patient 11	22111	7	22111	7	33211	10	44222	14	/////	//
Patient 12	11111	5	22122	9	32222	11	43333	16	44344	19
Patient 13	32110	7	33221	11	33222	12	43334	17	54344	20
Patient 14	10000	1	31111	7	32111	8	PDV*	//	PDV*	//

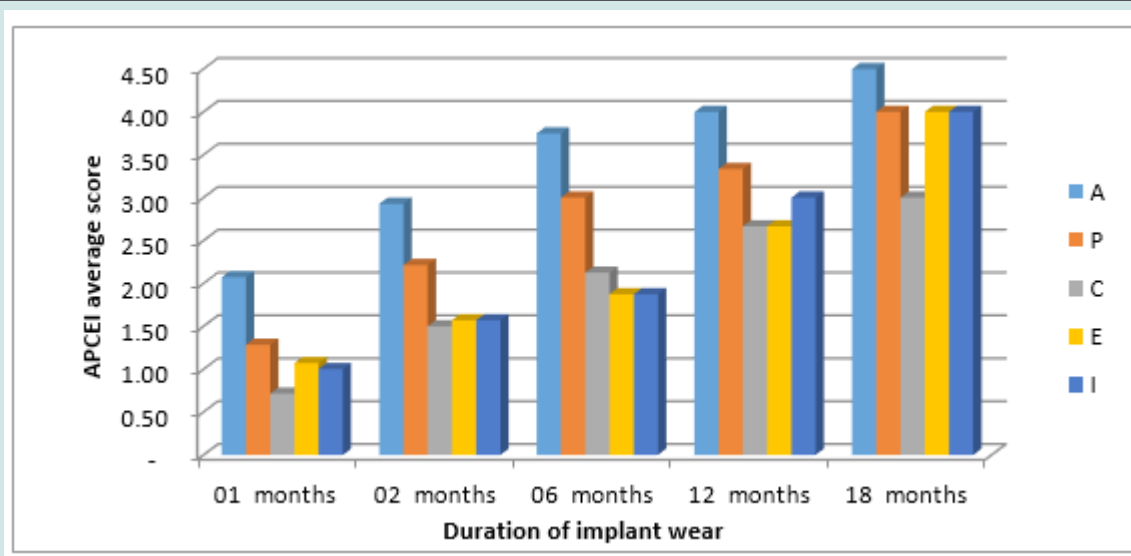
**Assessment of linguistic performance**

The assessment was done in all 14 children with prosthetic gain in all children (Table 3).

**Analysis of APCEI data by other variables**

The average APCEI score was better for children with a longer post cochlear implantation period and the comprehension domain had the lowest scores (Figure 3). The mean APCEI score has been plotted against the age of implantation in Figure 4, and we note better APCEI scores in children implanted in early childhood (2-6

to 5-9 years). There was a progressive variation in the sum of the APCEI scores over time as a function of regularity in speech therapy sessions. This is illustrated in Figure 5. In the last evaluations of our children with implants, we could see changes in language according to the APCEI score: Figure 6. Children with APCEI scores of around 18 had a vocabulary of more than 10 words and could construct simple sentences. Children with PACE scores around 14 had a vocabulary of less than 10 words and could pronounce them in isolation. Children with scores around 7 to 9 pronounced phonemes at best and at worst produced non-meaningful vocalizations.



**Figure 3:** According to the post-implantation age of the patients: Average APCEI score.

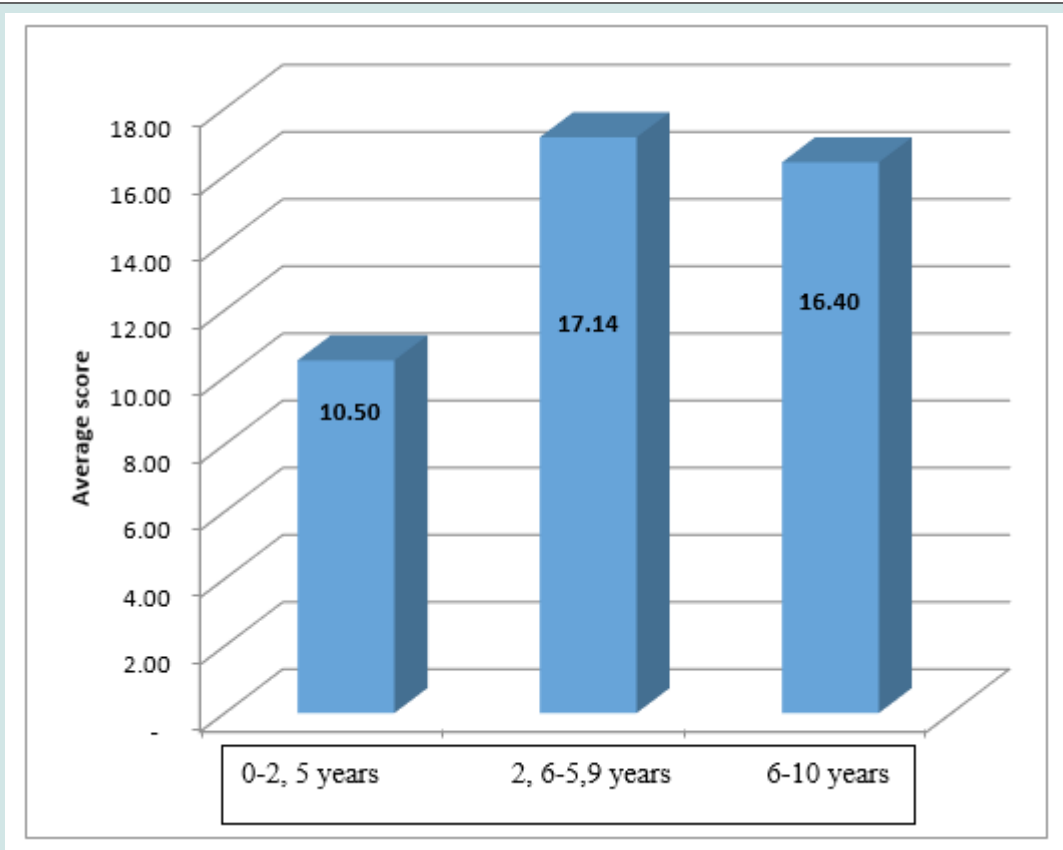


Figure 4: Average APCEI score as a function of age of implantation.

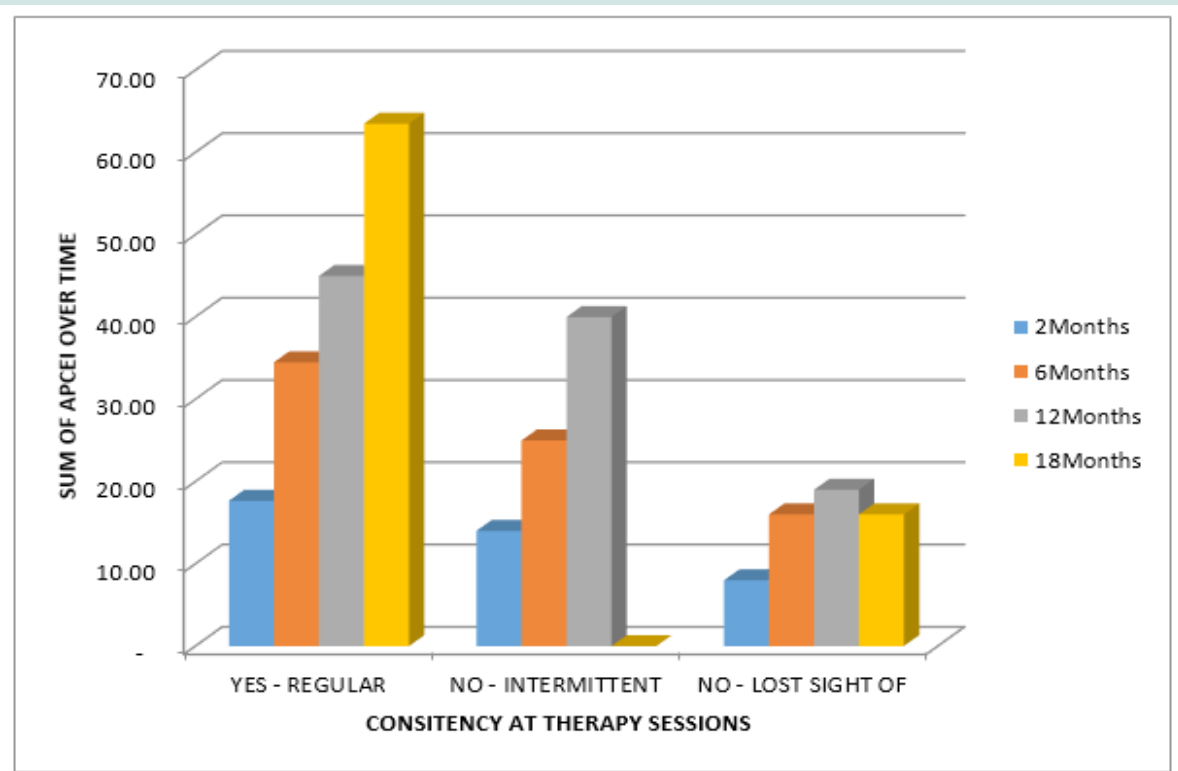


Figure 5: Changes in APCEI over time as a function of regularity in speech therapy.

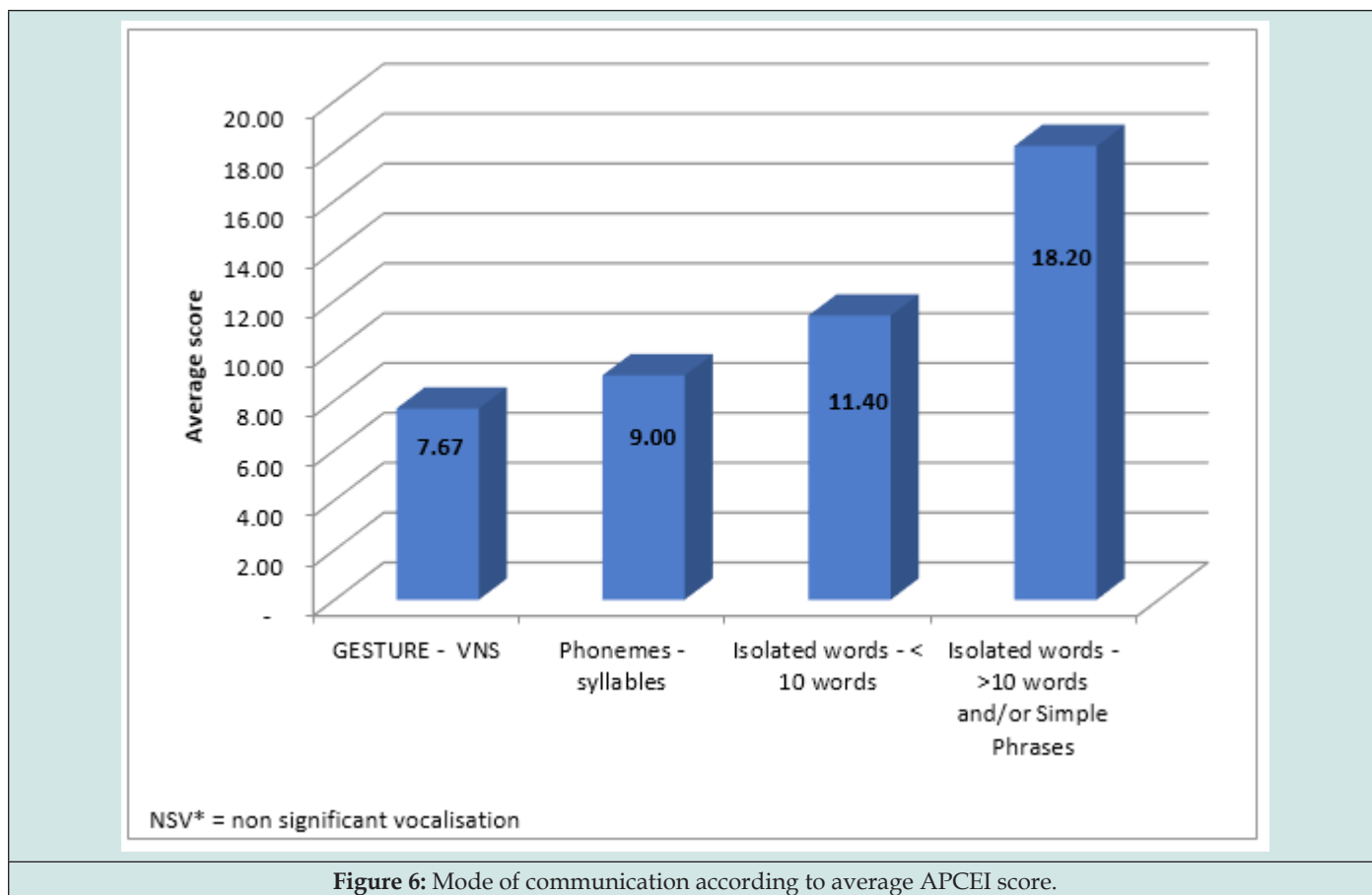


Figure 6: Mode of communication according to average APCEI score.

Table 3: Language assessment and prosthetic gain before and after implant.

Variables Communication mode	Pre-implant assessment	At end of assessment	
	Number (%)	Number (%)	
Gesture + mutism	1 (7.1)	0 (0)	
Gesture + non-meaningful vocalisation	9 (0.6)	3 (21.4)	
Phonemes / syllables	2 (14.3)	1 (7.1)	
Isolated words < 10 words	1 (7.1)	5 (35.7)	
Isolated words > 10 words and/or Simple Phrases	1 (7.1)	5 (35.7)	
Complexes phrases	0 (0)	0 (0)	
<b>Implementation of the audio phonatory loop (APL)</b>	<b>Yes</b>	<b>In progress</b>	<b>No</b>
N = 14 (%)	5 (35.7.)	3 (21.4.)	6 (42.8.)
Prosthetic gain	No	Yes	
N = 14	0 (0)	14 (100)	

## Discussion

On average, two speech therapy sessions were scheduled per week for the implanted patients, however many difficulties were encountered. The main challenges faced during the speech therapy sessions were:

- Irregularity at the sessions and/or stopping the sessions, due to uncooperative parents who were impatient to see results.
- Language barrier for children from English-speaking backgrounds.

c. Slow acquisition, probably due to the late age of implantation for some children.

### Assessment by the APCEI score

This score was evaluated at various follow-up times according to the length of time each patient had been wearing the implant. It should be noted that the factors influencing post-implantation language performance may be extrinsic or intrinsic. In our series, the progression of acquisition rates showed a high degree of variability from one subject to another. However, we have made some empirical observations in the analysis of our APCEI scores.

#### APCEI in retrospect

A South African study by Leroux et al. in 2016 showed that the perceptual and expressive performance of implanted children was better in 78% of children after three years and more [2]; in their series of 54 patients evaluated in 2014 with the APCEI score Hssaine found that all patients benefited from their implant with an average follow-up of 30.8 months [3]. In our series, the longer the patient wore the implant, the better the average score was, with a significant benefit after one year of follow-up.

#### APCEI based on consistency to therapy sessions

The evolution of the APCEI scores of patients who regularly attended speech therapy sessions showed a good evolution compared to those who were less regular. The discouragement of parents over the course of the sessions resulting in irregularity at the sessions can be justified by the lack of psychological support for them as recommended by the NAH[4]. It is recommended that particular attention be paid to supporting parents during the process of accepting the equipment as well as when the equipment is fitted, as their children's disability becomes immediately visible, and this may not be easy for some.

#### APCEI based on age at implantation

We noticed better scores for children implanted in early childhood. However, some older children who had been wearing hearing aids before implantation had good results, as did those who had a good aptitude for oral language. In contrast, the two children implanted as infants in our series had poor mean scores. In one case that could be explained by a very short follow-up (two months) and in the other by the fact that the sessions were abandoned after six months of follow-up, added to a suspicion of autism spectrum disorder. Indeed, the presence of additional disabilities to the deafness poses a problem in the pre-surgery evaluation and application of implantology, but also in the post-surgery follow-up. It is evident that a multidisciplinary approach (ENT, neurological, neuropsychiatric) is required for the follow-up of such patients. It is worth

emphasizing that some disabilities such as mental retardation and autism can be pauci-symptomatic and difficult to diagnose, especially at a very young age (less than 2 years old), whereas cochlear implantology tends to be performed at an increasingly early age. Hence the importance of informing parents that in 1/3 of the cases, other undiagnosed disabilities may be present in the child which may have a negative impact on the child's performance after cochlear implantation [5].

#### APCEI based on the mode of expression acquired at the end of the assessment

The higher the average APCEI score, the better the communicative performance, so children with an average score of around 18 showed an ability to form simple sentences and a vocabulary of more than ten known and commonly spoken words. For children with an average APCEI score of around 11, the performance was that of being able to pronounce phonemes effectively and a vocabulary pool that amounted to less than ten isolated words. For those with an average score of around 9, speech performance was limited to pronunciation of phonemes, listening training and vocal exercise. Finally, those with a score of around 7 still had gestural communication, accompanied by insignificant vocalisation, and for this reason they are still at the stage of discovering the world of sound.

### Conclusion

The APCEI score is a simple and reliable tool for assessing speech and language performance in cochlear implant children. Early age of implantation, attendance at speech therapy sessions, and duration of cochlear implant wear are factors that positively influence prosthetic gain and language acquisition. The results of the implanted children in our series appear to be good.

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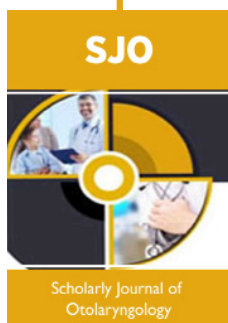
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