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# Med-EL- Cochlear Implanted Patients: Early Communicative Results

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## Introduction

- Positive benefits of cochlear implantation
  - Early age at implantation <sup>1</sup>
- There is significant variability in outcomes.

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# Effects of Cochlear Implantation

- Psychological
  - Identification of Environmental Sounds
  - Lip-Reading
  - Speech Perception & Discrimination
  - Speech Production
  - Language
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# Factors Affecting the Performance of Cochlear Implanted Patients

- Cause of hearing loss
  - Audiological factors
    - Number of surviving spiral ganglion cells.
    - Electrical dynamic range.
  - Implant technology
    - Type of the implant.
    - Speech processing strategies.
  - Child variables
    - Age of onset of hearing loss
    - Duration of deafness
    - Age at implantation
    - Mental abilities and communicative abilities
    - Associated medical condition and handicaps
    - Duration of cochlear implant use.
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# Factors Affecting the Performance of Cochlear Implanted Patients

- Motivation and expectations by child and parents.
  - Family stability and support.
  - Stimulating environment.
  - Rehabilitation program.
  - Educational setting.
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## Rationale

- Cochlear implants provide an improved auditory signal and enhance the development of speech-perception and production skills for profoundly deaf children.
- When ?

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## **Aim of the Study**

- Evaluate the early communicative skills' development of children with cochlear implants.
  - Present data of the results of early speech and language development of cochlear implanted subjects.
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## **Methodology: Protocol of Communicative Evaluation.**

Objectives:

- Determine the language and articulation problems.
- Describe communicative status.
- Define appropriate expectations of language skills following intervention.

Comprehensive

Subjective and Objective

Formal and Informal

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## **Methodology:**

### **Protocol of Communicative Evaluation.**

#### **I. Elementary Diagnostic procedures:**

1. Auditory Perceptual Assessment  
Informal language and speech evaluation
2. (Listening Skills Assessment)
3. Lipreading ability.

#### **II. Clinical diagnostic aids.**

1. Psychometric assessment.
  2. Formal language and articulation testing.
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## **Methodology:**

### **Protocol of Communicative Evaluation.**

#### **III. Additional Instrumental measures:**

- Aerodynamic measures
- Acoustic measures of voice.
- Spectral analysis.
- Visipitch.
- Nasometer.

Others



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# Subjects:

- Cochlear Implantees
    - 10 Prelingual
    - 1 Postlingual
  - Sonata implant from Medel, Austria
  - Fitted with Opus 2 speech processor.
  - The coding strategy was CIS.
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## Post implantation Profile

- Programming continued until aided response thresholds in free field reached 40 -50 dBHL using warble tones.
  - To achieve the above goal all the 12 electrodes were electrically stimulated with currents ranging from 12 to 55 charge units depending on the electrode and patient (Mean maximal stimulation was 36 charge units).
  - A charge unit = current unit in micro Ampere X pulse duration in micro seconds divided by 1000
  - The mean aided thresholds, in dBHL, at the four frequencies were as follows:

500 Hz	1000 Hz	2000 Hz	4000 Hz
45.9	45.5	40.9	43.6

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## Results

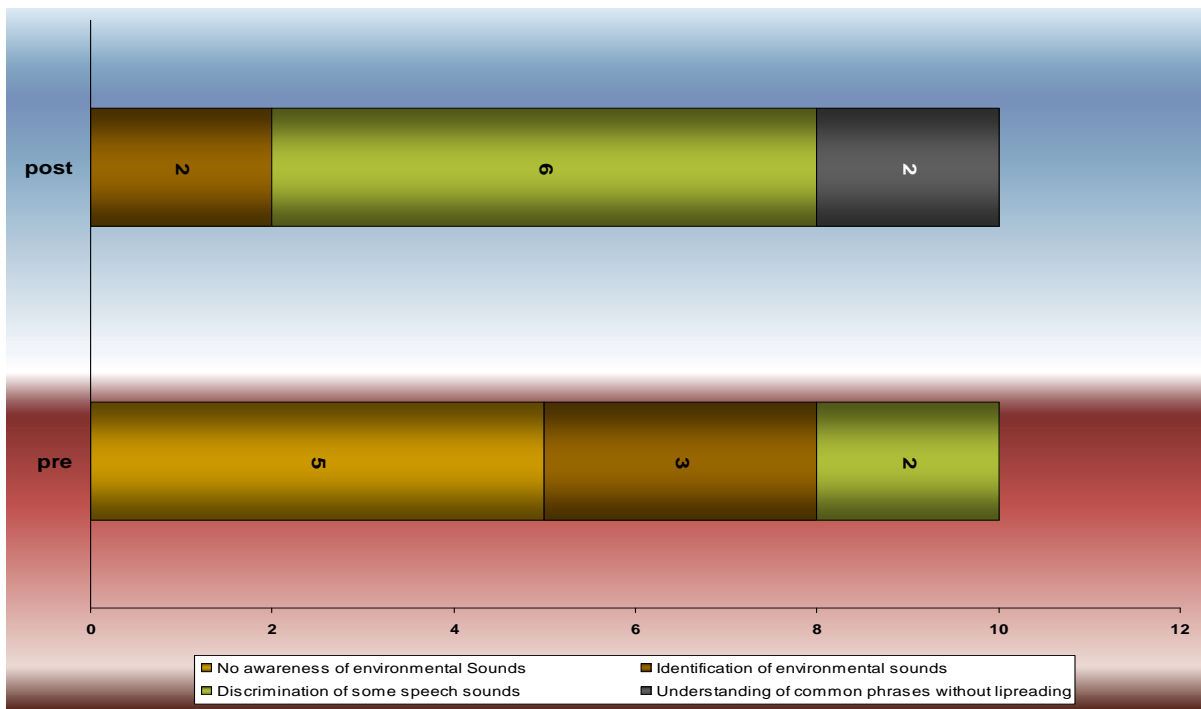
- ❑ Recently implanted
  - ❑ No post implantation therapy
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## Prelingual CI children

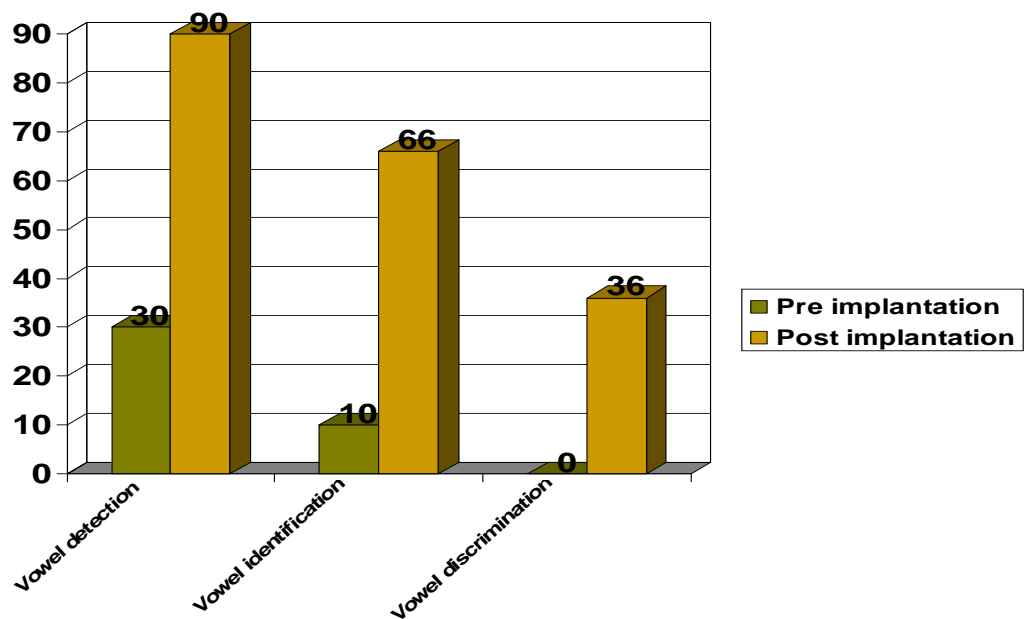
- ❑ Hearing loss diagnosed at age ranges 4 -18 months
  - ❑ Bilateral Hearing aid users.
  - ❑ Language Intervention Program
  - ❑ Age of Implantation  $64.5 \pm 21.5$
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# Auditory Perception



G.M. O'Donoghue, T.P. Nikolopoulos, S.M. Archbold, M. Tait, Cochlear implants in young children: the relationship between speech perception and speech intelligibility, *Ear Hear.* 20 (1999) 419—425.

# Speech Perception





# Post Cochlear Implantation Speech Perception

	A	B	E	M	N	n	N	n	Y	Z
<b>Vowel detection</b>	100	100	100	50	100	100	100	100	100	100
<b>Vowel identification</b>	100	0	100	0	100	100	30	100	30	100
<b>Vowel discrimination</b>	50	0	50	0	60	75	0	50	0	75
<b>Consonant detection</b>	100	/s/	100	0	100	100	0	100	/l/, /k/, /w/, /h/, /m/	100
<b>Consonant identification</b>	/s/, /ʃ/ /w/		/s/ /ʃ/ /w/		/s/ /ʃ/ /w/ /t/	100 Increase intensity		/s/, /ʃ/ /w/		100 Increase intensity

# Communicative Performance

- Prelingual
  - Language age < 24 months (6)
  - Language age > 24 months (2)
- Postlingual

# Communicative Performance

## Pre implantation

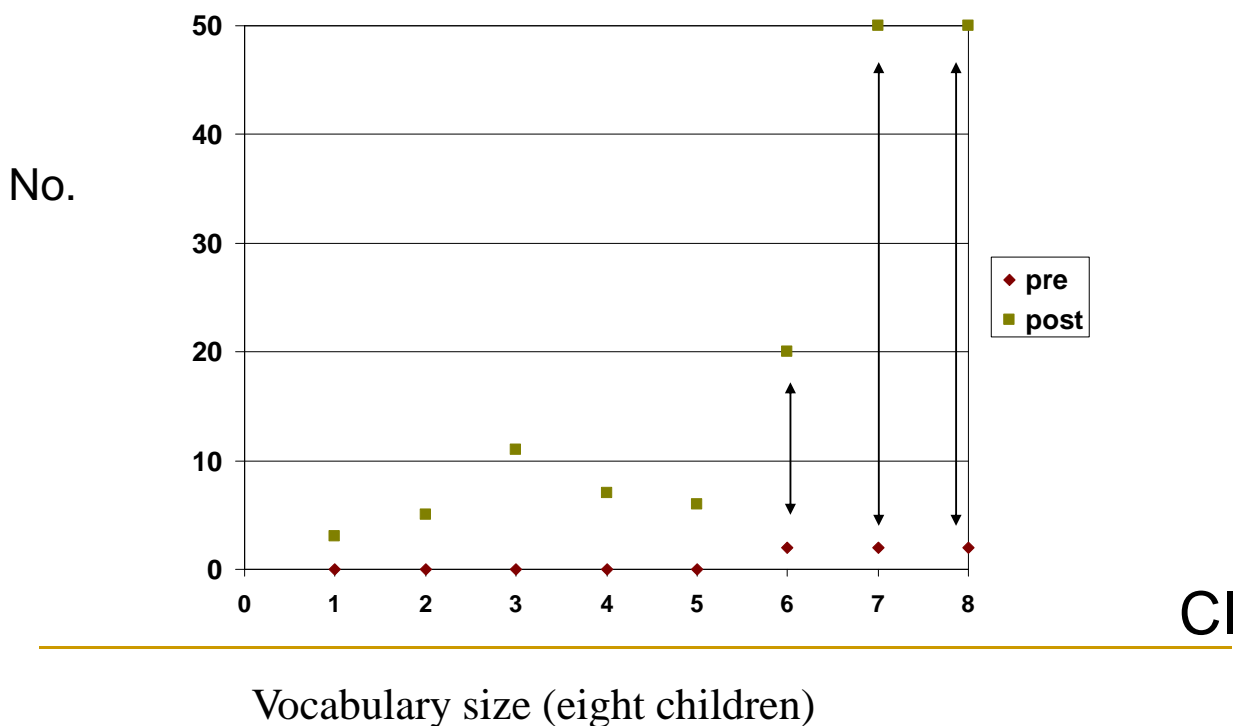
- Nonverbal: 5 children
- 2 words: 3 children
  - Monosyllabic words

Gesturing, Pointing  
nonverbal mode of  
communication.

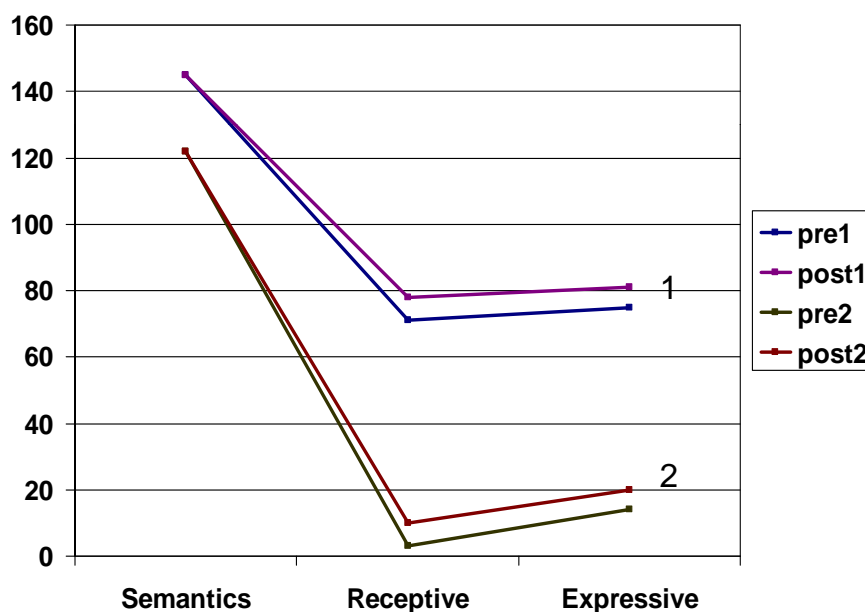
## Post implantation

- Mean: 8 words
- Mean : 40 words
- Two words combination and two word sentences.
- Minimal use of verbs, naming common objects with minimal intelligibility to strangers.
- Verbal with gesturing and use of lip reading, common phrases pairs of words (vowels)

## Vocabulary Size for children with labguage age <24 m.



## Two children Language age >24 months: Performance on formal language test: comparison between pre and post-implantation.



## Speech Production

- Intelligibility increased as reported by parents.
- Distortion of vowels, substitution and imprecision of consonants, devoicing.
- Increased sentence length to four word sentence.
- Perceptual decrease of voice irregularity and pitch variability.



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## Acoustic Analysis

- CSL
    - VOT:  $\approx 45$  msec
    - Vowel duration:  $\approx 250$  msec
    - Syllable duration:  $\approx 350$  msec
  - MDVP
    - $F_0$ :  $\approx 278$  Hz , Jitt:  $\approx 2.646$ , ShdB:  $\approx 0.423$ , NHR:  $\approx 0.156$
    - Nasalance score  $\approx 30\%$
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## Post lingual

- Male
  - Age: 18 years,
  - Hearing loss at age of 15 years.
  - Hearing aids
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## Speech Perception

### Pre implantation:

- No awareness of environmental sounds

### Post implantation:

- 100% detection of vowels
  - 100% discrimination
  - 100% identification
  - 0% discrimination of close spectral vowels
  - 100% detection and identification of consonants
  - difficulty to discriminate nasals/m//n/, fricatives /f//θ/, voicing characters e.g. /s//z/
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## Communicative Performance

### Pre implantation:

- Verbal mode of communication,
- Lipreading skills ensures adequate receptive skills
- Full expressive competency
- Full dependence on lip-reading

### Post implantation:

- Verbal mode of communication,
  - Full expressive competency.
  - Without lip-reading needs repetition to achieve full receptive formal tasks.
  - Understand common phrases and headlines of topic without lip-reading
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## Speech production:

### Pre implantation:

- Intelligibility:
  - Understood to strangers asked for clarification
- Phonology:
  - Devoicing of consonants, interdental sibilant
  - Long vowel duration, variable stress, pitch variability.



### Post implantation:

- Intelligibility:
  - Understood to strangers asked for clarification
- Phonology:
  - Devoicing of consonants, imprecision of consonants, interdental sibilant
  - Rapid rate of speech, decreased stress, pitch variability.

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## Acoustic analysis

### Pre implantation:

- VOT: mean 44.2 msec
- Vowel duration: mean 246.8 msec.
- Syllable duration: Mean 290 msec
- Mean sentence duration:
  - 2.999 sec
- Nasalance: 16.90%

### Post implantation:

- VOT: mean 42.96 msec
  - Vowel duration: mean 189.85 msec
  - Syllable duration: Mean 251 msec
  - Mean Sentence duration:
    - 1.379 sec
  - Nasalance: 30.86%
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## Acoustic analysis

### Pre implantion:

Visipitch:

- Habitual Fo: 122.05
- Lowest Fo: 108.93
- Highest: 143.67
- % voiced: 50.44%
- % unvoiced 21.60%
- % paused 27.98%

MDVP:

- Jitter%: 0.381
- ShdB: 0.127
- Shim: 1.481
- NHR: 0.1330

### Pos timplantation:

Visipitch

- Habitual Fo: 128.05
- Lowest Fo: 98.93
- Highest: 160.67
- % voiced: 51.86%
- % unvoiced 16.06%
- % paused 32.16%

MDVP:

- Jitter%:0.956
  - ShdB:0.181
  - Shim: 2.064
  - NHR: 0.1334
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## Conclusion

- Immediate speech scores as early as the first day of implant was found. Early Impact of cochlear Implantation more evident on prelingual than post lingual individuals.
  - Post lingual early difficulties may be due to auditory feedback difficulties for extrinsic voice control. Prelingually implanted children were able to benefit in voice adjustment earlier.
  - Children with prelingual residual hearing, developing vocabulary have shown marked increase in vocabulary acquisition.
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# Conclusion

- Vowel perception and production are easier to acquire.
  - Fricatives were easier to acquire than rest of consonants. Difficulties to perceive voicing cues and vowels with close acoustic features.
  - Consonant placing and manner of consonant production were the hardest skills to achieve.
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# Thank you

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