Challenges and results in pediatric CI therapy
- experiences from only 30 years -

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Deutsches Hörzentrum

NIFE
Principles are unchanged
Cochlear Implant:
The “success story” of neuroprosthetic devices

History of Implant

Contact with the world of sound
Speech discrimination in a few
Speech discrimination in a majority
Speech discrimination in all

First
Then
Now
Future

Fig. 49. Photograph of the portable prototype speech processor developed by the University of Melbourne.
From cable to CI


➔ 1984 Graeme Clark (FDA approved)
& E. Lehnhardt 1. CI Hannover
Cochlear Implant Design

Design 1984 - 2010
Speech processor development
Providing CI in children

NHS

Tracking Init. therapy

Complete diagnostics

Cochlear Implant surgical procedure

Basic fitting

Life long Care eHealth

Inclusion

Reimplantation Congenital CI recipients

Molecular Inner Ear Therapy

experience based constant development

eHealth

future development
Percentage of children implanted before the age of 12 months in 8 countries between 2005 and 2015 (Cochlear®)
Age-at-implantation assessment of all children implanted at 5 European institutions (n = 490)
Early-Management of Hearing Impairment in children

- constant available
- reliable professionals
- building up confidence in therapy (CI cannot be tried out)
- preparing premedikation / reducing fear

Cave = increasing number in special cases
- children
- seniors
„Complete diagnostics in profound hearing impaired“

- within 6. / 7. month of life
- middle ear inspection after PC and Adenotomy
- Hearing Aid-audiology and evaluation
- ERA to register threshold
  - ABR, SN10, CAP, ECochG, ASSR
- radiology = CT and MRI
  - 3 Tesla, Spektroskopy
- logopedics developmental evaluation
- counseling parents
- additional diagnostics (neuropediatrics, genetics, …)
Audiological diagnostics

Middle ear

Outer haircells

Inner haircells

Pre-Synapsis

Post-Synapsis

Neurale tracks

Tympanom. Puretone audiom.

Puretone audiom.

OAE *

CM *

Stapediusreflex

ERA -acoustic ABR

c-ERA

Event related pot.
Development of neural plasticity

Verzögerung in der Hörbahnreifung
Reizantwort links bis 60 dB

M.M. Alter: 2 Monate

Verzögerung in der Hörbahnreifung
Reizantwort links bis 60 dB

M.M. Alter: 8 Monate
Development of Speech understanding

Wort- und Satzverstehen - open set-
im Alter von 2,5 Jahren
(Gr. 1 = 24 Monate, Gr. 2= 18 Monate postop.)
Results after 9 – 10 years

No signif. diff.

Low numbers

Further evaluation
Example:

Stenosis cochleare Apertur

*28.2.2007:
Normacusis right
congenital deaf left
Example:
Stenosis cochleare Apertur
Electrode Design
Insertion PROCEDURE
respecting intracoehlear structures
Bilateral CI in Children? – sequential -

Retrospective Study

- 251 congenital deaf children, age while study 4 - 20 years
- CI-time-period: 2 months up to 14 years
- 2. Side minimum 1 year
- Speech perceptive tests, last test result
- Freiburger Monosyllables, HSM-Sentence test in Silence and noise (10 dB S/N Ratio), Freefield 65 dB
- 110 answers
Results all children
Correlation 2. side ~ CI time period

Streudiagramm Einsilber 2. Seite

Korrelationskoeffizient
\[ r = -0.497 \]
\[ p = 0.00 \]

- Einsilber 2. Seite
- Linear (Einsilber 2. Seite)

CI time distance in years

Gesamtergebnisse aller congenital erhaltene Kinder
Monosyllables ~ Age (1. CI)

- Nearly all children with residual hearing (125-500 Hz with 60-100 dB)
Correlation Age (1. CI) ~ CI Time period

Alter 1. CI 0-2 Jahre

- ES 1. Seite
- ES 2. Seite
- HSM 2. Seite
- HSM-noise 2. Seite

< 5 > 5 all
time period (years)

< 3 > 3 all
time period (years)

consequences
Correlation Age (1. CI) ~ CI Time period

consequences
Correlation 2.CI and HA and CI time period

HG-Dauer 0-1 Jahr

HG-Dauer 1-4 Jahre

HG-Dauer 4-13 Jahre

< 5 year period (years)  > 5 year period (years)
SSD in children

Learning from MHH-data & 6th Europ Pediatric Conf.
1. Diagnostics 6th months = MRI 3 Tesla loop & ECochG
2. Experienced based counseling with parents networking
3. Options
   1. Immediately CI (direct coupling exercising!)
      Cautious parents
   1. CROS at age ability & interest in localisation
   2. CI latest 3 years of age
High-frequency deafness
Speech understanding after 6 months
Hybrid-L (n=80), Reference (n=165)
Higfrequency deafness in children
- residual hearing postop. -
pure tone audiometry – preop -

Frequenz (Hz)

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N = 63 patients

Age at implantation: 9,5 years
(Min. 3 years, Max. 18 years)
pure tone audiometry – 2 years postop -

Frequenz (Hz)

125  250  500  1000  1500  2000  3000  4000

dB

N = 63 patients

Age at implantation: 9.5 years
(Min. 3 years, Max. 18 years)
Speech understanding after 2 years

Sprachtests Verlauf

Testverfahren

- Einsilber
- Zahlen
- HSM Ruhe
- HSM 10db

EA
Kontrolle J1
Kontrolle J2

Prozent
Anatomical Indication Ranges

Measurements in 271 preop and 259 postop imaging datasets
Cochlear Coverage vs. Speech Perception

Wilcoxon test:

*  p < 0.05
** p < 0.01
*** p < 0.001
New concept: Partial Insertion

Different treatment options:

- **20 mm**
  - FLEX28 to contact #10
  - N=3

- **16 mm**
  - FLEX24 to contact #9
  - N=4
Surgical Procedure

1. Place fascia at contact #10, FLEX28
2. Very slow insertion is important to preserve residual hearing
3. Insert until fascia touches round window membrane
4. Fixation of electrode
Speech perception in noise

HSM in noise 10 dB SNR
N=3, EAS users postoperatively

+31%
Education abilities (published 1999)

The chart shows the distribution of various categories of hearing abilities and their integration into education. The categories are:

- CI < 2. Lj.
- CI 2-4 Lj.
- > 4. Lj.
- HG (keine CI)

The chart indicates:

- 69% of the population falls into the CI < 2. Lj. category.
- 52% falls into the CI 2-4 Lj. category.
- 29% falls into the > 4. Lj. category.
- 20% falls into the HG (keine CI) category.

Legend:
- Yellow: Gehörloseneinr.
- Orange: SH & Gehörloseneinr.
- Red: Schwerhörigeneinr.
- Light blue: Integration
- Green: Regeleinrichtung
Details of costs (published 1999)
Long-Term Outcomes, Education and Occupational Level in Cochlear Implant Recipients

Retrospective study

- **patients: N=933**
- Age at implantation: < 19 years *(between 1986 and 2000)*
- Outcome in 8 Categories of Auditory Performance (CAP) (Archbold et al. 1998)
- self-assessment-questionnaire with 8 categories:
  - living conditions and environment, therapy, educational background, school education, vocational training, occupation, job satisfaction and workplace
- Comparison of the data with national and international data of normal hearing peers
- Statistics: Kruskal-Wallis Test, Mann-Whitney-U Test, Spearman-Rho Correlation coefficient

Long-Term Outcomes, Education, and Occupational Level in Cochlear Implant Recipients Who Were Implanted in Childhood.
International Standard Classification of Occupation

ISCO-88 skill-levels

Mean skill level
Cl-user: 2.24
Normal hearing peers: 2.54
p=0.003

Example: to deep Insertion

bad understanding of monosyllables

After Revision
Example: Dysplasia

Revision
Challenges

- Variety of electrodes
  - anatomy
  - length
  - residual hearing
- Insertion procedure
  - intracochlear trauma
  - position
- Electrophysiology ~ outcome

➢ All electrodes
➢ available
➢ experiences
➢ Insertion procedure
➢ skilled
Longterm-Management, Fitting, ..... 

- „continously ongoing“ expertise  
- sufficient time for eCAP, Impedanz, Level, testing  
- complicationen  
- Prevention  
- Early detection  
- Neuroped. and / or other diagnostic ?
Focus on CI Therapy
Drug Delivery: Cochlear Catheter
Biohybrid-electrode in residual hearing
Save the Date:

21. Hannoverscher Cochlea-Implantat-Kongress
Medizinische Hochschule Hannover

Cochlea-Implantatmaßgeschneidert

13. - 14.09.2019
Medizinische Hochschule Hannover
Im Hörzal des
CNC Hannover
Feodor-Lynen-Straße 15
30625 Hannover

2. INTERNATIONAL SYMPOSIUM ON INNER EAR THERAPEUTICS
4-6 November 2019
Hannover/Germany

www.isiet.org