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Is the bilateral cochlear implantation necessary for avoidance of auditory deprivation in deaf children?

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Abstract

The aim of the paper is to investigate the influence of the cochlear implantation in prelingual deaf children on maturation of the auditory pathways.

Auditory deprivation may result in morphological and physiological changes in the central auditory nervous system. In prelingual deaf children, some of these deafness-induced changes may be preventable or partially reversible by application of a cochlear implant (CI). It is without doubt that an early cochlear implantation in prelingual deaf children shows good evidence of speech reception and language development as well as speech production. In some studies, there is a clear benefit from binaural versus monaural hearing aid amplification in children with apparent auditory deprivation caused by a bilateral severe hearing impairment. Hence, there is the question whether, besides the expected benefits in directional hearing and improvement in speech recognition in noise, there is really a *need* for a bilateral cochlear implantation in prelingual deaf children to prevent or avoid a disturbance in auditory pathway on the otherwise not implanted side.

We are reporting on a congenitally bilaterally deaf boy who received a CI at the age of 3. His acquired audio-oral communication went very well. Unfortunately, at the age of 7, he suffered a heavy otitis media, which was resistant to intensive treatment with antibiotics, so that in the end an explantation of the cochlear implant and, then, an implantation in the opposite ear was necessary. The monitoring of effectiveness of rehabilitation was performed by the Kiel Children Profile.

Contrary to general opinion, after a small interval of stagnation, the boy fortunately did very well and had even better scores in the profile than before.

In our opinion, this report may indicate that if there is only one ear supplied with a cochlear implant there is no *absolute must* for a cochlear implantation on *both* sides to prevent or avoid an auditory deprivation on the otherwise not implanted auditory pathway. It may be an indication that

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we are not missing or losing a possible time window for the non-implanted ear in respect of a bilateral cochlear implantation.

Keywords: Cochlear implant; Auditory pathway; Speech development; Auditory deprivation

1. Introduction

Auditory deprivation may result in morphological and physiological changes in the central auditory nervous system [1–6]. In prelingual deaf children, some of these deafness-induced changes may be preventable or partially reversible by application of a cochlear implant (CI) [7–12]. It is without doubt that an early cochlear implantation in prelingual deaf children shows good evidence of speech reception, language development as well as speech production [13–16].

The aim of the paper is to investigate the influence of the cochlear implantation in prelingual deaf children on maturation of the auditory pathways.

In studies, there is a clear benefit from binaural hearing aid amplification versus monaural in children with apparent auditory deprivation caused by a bilateral severe hearing impairment [17–22].

The expected benefits of a bilateral cochlear implantation are obvious: directional hearing and improvement in speech recognition in noise.

Hence, there is the question whether besides these expected benefits there is really a *need* for a bilateral cochlear implantation in prelingual deaf children to prevent or avoid a disturbance in auditory pathway on the otherwise not implanted side.

2. Case report

We are reporting on a congenitally deaf boy who received a Nucleus cochlear implant CI24M at the age of 3 years and 10 months. His acquired audio-oral communication went very well.

Unfortunately, at the age of 7 years he suffered a heavy otitis media caused by pseudomonas aerogenosa, which was resistant to intensive treatment with antibiotics, so that in the end an explantation of the cochlear implant at the age of 7 years and 7 months was necessary. After an interval, we supplied him with a cochlear implant in the opposite ear at the age of 7 years and 9 months. On this ear he received a Nucleus CI24RCS Cochlear implant.

3. Kiel Children Profile

For some years, we have been carrying out evaluations on the effectiveness of our cochlear implant rehabilitation programme with a hearing and speech test battery called Kiel Children Profile on one profile which concludes all the usual tests recommended by the study group ‘‘Test Materials for CI Children’’ [23,24]. It is partially combined with the ‘‘Frankfurter Functional Hearing Test for Children’’ (FFHT) [25].

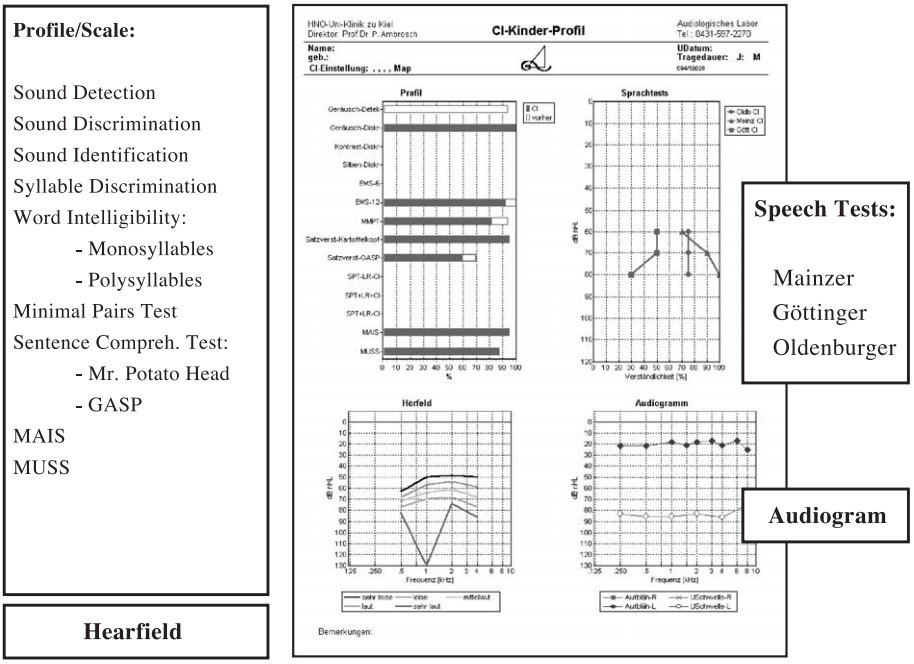

Fig. 1. Kiel Children Profile.

The Kiel Children Profile (Fig. 1) is administered preoperatively and after implantation in regular intervals. The audiological tests are presented to the children mostly by PC with a touch screen monitor and consist of, e.g. sound detection, discrimination and identification, syllable discrimination, word intelligibility subdetailed in monosyllabic and polysyllabic words, and a minimal pairs test as well as loudness scaling and aided thresholds.

Furthermore, we list the result of the sentence comprehension test like the German "Mr. Potato Head Task" (Kartoffelkopf test) with common phrases. This test requires the child to manipulate a toy and associated objects when asked various questions. There is also the "Glendonald Auditory Screening Procedure" (GASP) Sentence Test in a German version; everyday auditory and verbal behaviour was assessed with the questionnaires of "Meaningful Auditory Integration Scale" (MAIS) and "Minimal Use of Speech Scale" (MUSS).

We use several speech tests such as the Mainzer speech test in an open set form—the easiest test for small children—the Göttinger test and the Oldenburger rhyme test—the most difficult of all.

4. Results

Fig. 2 shows some results of the Kiel Children Profiles from the congenital deaf little boy, listed according to the various stages. At the age of 7 years and 7 months, having had

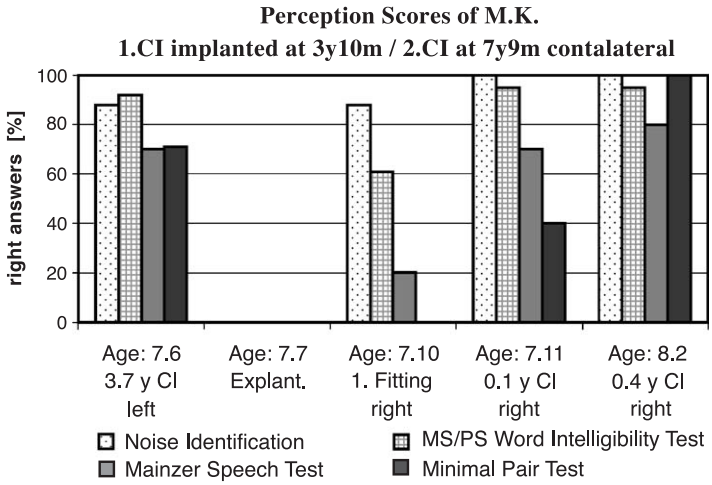

Fig. 2. Perception scores of a congenitally deaf boy who received a CI at the age of 3 years and 10 months on the right ear which was explanted at 7 years and 7 months and got a new CI on the left ear at 7 years and 9 months.

the cochlear implant for 3 years and 8 months; then explantation of the CI, followed by the first fitting of the cochlear implant which had been implanted in the opposite ear a month before; then after 1 month of wearing the new CI and after 4 months of use in the opposite ear. In the bar chart, the dotted bars indicate the scores of the noise discrimination, the checkered bars the monosyllable/polysyllable discrimination, the grey bars the Mainzer speech test and, finally, the black bars the minimal pairs test. As can be seen, after an interval all scores were similar and, furthermore, better than the scores produced with the first cochlear implant.

5. Discussion

Contrary to our fears and general opinion that an auditory pathway which has been unexploited for more than 7 years and 10 months would not function as well as a normally used auditory pathway [1–6] and that late Cochlear implantation would produce inferior results to those in early implantation, the results were different. After a small interval of stagnation, the boy fortunately did very well and had even better scores in the profile than before.

Of course, we have to bear in mind that the child did not have a deprivation of the total auditory system in this case because of the supply with a CI at the age of 3 years. However, as animal studies [1,3–5] show, there are discrete adverse differentiations and modulations in the central auditory pathways which could cause disturbances of the nonsupplied pathway followed by decreased speech perception.

Of course, we took into account that the upgraded cochlear implant in comparison to the explanted cochlear implant model may get better results, but in our opinion, this does not explain the good results.

Another thought is that we possibly do not have to worry that much about the decision on which side we want to implant.

6. Conclusion

In our opinion, this report may indicate that, if there is only one ear supplied with a cochlear implant at the ideal age of implantation [2,13,14,26,27], which should be under 3 years, there is no *absolute must* for a cochlear implantation on *both* sides to prevent or avoid an totally irreversibly auditory deprivation on the otherwise not implanted auditory pathway. It may be an indication that we are not missing or losing a possible time window for the non-implanted ear in respect of a bilateral cochlear implantation, although the binaural ability must also be taken into account.

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