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Bilateral Cochlear Implantation: Indications for Fitting of the Implants

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Abstract

The article describes the sequence of actions during fitting of the cochlear implants after the bilateral cochlear implantation. For fitting and equalization of the loudness of two implants we use method SHCHUP. We discuss the question of auditory deprivation and the necessary wearing of the hearing aid (HA) at opposite ear till second CI. This article is based on fifteen years' experience of Clinical Practice with more than one thousand cochlear implanted patients with MEDEL implants. The General principles and methods of fitting are applicable to any type of implants.

Keywords: Bilateral cochlear implantation; Fitting; Auditory deprivation; Hearing aid; SHCHUP

Introduction

In recent years the number of patients for whom a cochlear implantation (CI) was performed in the second ear is steadily increasing. In some cases (child) patients themselves want the second ear: "Why have I one?" But the, question about second operation is decided by parents. One of the arguments "PRO" for the second operation is, like this: "In case of failure of one implant, child will hear during time of its repair". Some parents have asked me: "What's your advice?" I said: "Do it". They did.

As a rule, second surgery is carried out a few years after first surgery, while, in rare cases, it is done at the same time. Although there is improvement with a second cochlear implant even after a long implantation interval, short intervals lead to better results [1,2]. Enough has been written about the undoubted advantages of binaural hearing in bilateral CI. We will not repeat the same.

But it should be emphasized that bilateral CI provides the same hearing on both ears and not as if simultaneous wearing the CI and hearing aid (HA). Taking into account most frequent hearing losses of CI candidates (near deafness) and results of hearing aid (HA) rehabilitation (not too good or near zero) it is very possible that HA is used not for efficient bimodal hearing [3]. Positive result of lateralization only doesn't mean success of bimodal hearing for speech perception (Lobbying of interests of the HA companies?).

The first fitting of the second implant is the same procedure like after the first operation [4]. There are, however, some features like, management of both implants can be done from one remote control unit, or you can manage separately with the two units. In the first case you select an existing patient from the list of patients in the "Maestro" and the corresponding items are filled in the usual way. In the second case, the procedure of registration of the patient in the program "Maestro" is the same one when you fitted the first implant. Before the first fitting of the second implant, the audiologist should know the settings of the first implant with the intention that in the second implant it is necessary to set the same frequency range, the same activation level and the same coding strategy. Note, however, that according to the Austrian data "no significant differences between the FS4 and CIS strategies were found" [5].

Giving such instructions, we default assume that the electrode chains are fully inserted in the cochlea in both sides. It should be noted that in recent years the problems of the full insertion had been solved. And here's why. A few years ago during insertion of an electrode chain into the cochlea it cannot be inserted completely. This position had happened in the past years and in such cases insertion had been stopped. I even have a separate item on the registration card: "How many electrodes were not inserted?" I suggested to the surgeon to slightly twist the chain clockwise and counterclockwise around its axis, simultaneously pushing it forward. Surgeon, doubting the success, yet did so and was very surprised by the result – chain of the electrodes is easily advanced into the cochlea. Director of the ENT Institute, being at surgery, accepted my idea. Since then, the question of the full insertion was not raised - the surgeon simply twirled the chain by sliding the tip from the point of stop. Since that time I deleted the item from the registration card: "How many electrodes were not inserted?" It is necessary. Before fitting the second implant you need to talk with the child and to get his (her) confirmation that he (she) likes the first implant. Further we explain to the child that now we will fit second (other ear) implant and will do it as good as the first one but not immediately. Especially we warn the child that at first days of the fitting a second implant will be worse than the first one. But the first implant is good one and the second implant we will do the same.

It should be noted that in some cases, despite warnings and explanations, children are clearly disappointed with the result of activation of the implant after fitting at the first day, and in rare cases nearly to failure to wear. Some children are even ready to cry. Then we switch on the first implant and reassure the baby that a second implant will be the same as the first one, but not immediately. The child agrees and after all the convincing, nods. In the days that followed fitting is facilitated.

As so the patient has the experience of using the implant, he has experience of loudness estimation, we understand him better so the process of fitting will be faster than the fitting of the first implant.

During the fitting procedure, after 3-4 days of the second implant fitting you need to look configuration of the first implant, i.e., to estimate the parameters of the its optimal program. You need to carry out reflexometry (method SWEEP) [6] and to determine approximately

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how most comfortable levels (MCLs) of optimal program differ from the thresholds of stapedial reflex. Why approximately? Because the differences MCLs-threshold levels of reflexes are different ones in all channels [7].

We will use these data in the preparation of configuration, i.e., a sequence of maps in the second implant. Let's return to the fitting of the second implant. Further, following "Algorithm of fittings" [4], you need to carry out reflexometry on the second ear and create programs so that they were close by most comfortable levels (MCLs) of relevant programs at the first ear. The task of parents: to identify the optimal program for the second implant.

Assessment of most comfortable sound pressure levels (SPLs). Further we assess and adjust levels with the help of our program SHCHUP [1]. SHCHUP are the first letters of Russian word TOUCH. We use the special stepped-noise stimuli corresponding to the four neighboring channels of the implant – 1-4, 5-8, 9-12 i.e., three bands in low, middle and high frequency regions. Use of cans, drums, musical instruments, speech etc. with unknown spectra and sound pressure levels serves only to create the illusion of a scientific approach to the fitting. Sometimes we see opposite recommendations of audiologist and the speech therapist for changing of the MCLs in high or low frequency regions of implant program. Same audiologist can get opposite results at morning and evening investigations. It is interesting to note that there are no recommendations for the MCLs adjustments in channels of the middle frequencies. Is there always the optimal setting in this region?

Or is the reason the other one? We measure most comfortable SPLs of these three 4-channel stepped sound stimuli [1]. The great advantage of this method is the ease of execution. We are slowly increasing SPL of stepped noise and observe a reaction of patient. We can slightly touch threshold of discomfort at any SPL (90, or 97, or 102 dB SPL…) and immediately decrease intensity of sound. To touch, to notice beginning of negative reaction and quickly to decrease SPL of stepped noise. Child's feedback is carefully observed. Reactions of child are similar ones at equal loudness of stepped sounds of different frequency bands. For example, at SPL near discomfort level child begins to hide face, frowns, conceal himself, turns head to mother with question in eyes, and stretches his arm to antenna and so on.

Or we cannot achieve (touch) discomfort at 105 and more dB SPL. After measuring of the most comfortable SPLs of three 4-channel stepped stimuli we regulate electrical MCLs in appropriate channels. We increase electrical MCLs in that channels where patient did not feel discomfort at intensity level more than 105 dB SPL. We decrease MCLs if patient felt discomfort at level less than 105 dB SPL. We did not change MCLs in channels if patient estimated sound MCL at level around 105 dB SPL. We create configuration with this program as map number 2. A few hundreds of CI-patients were fitted using SHCHUP.

It should be noted that as so the high SPLs are used in SHCHUP there is no need to use a very soundproof chamber. We successfully used circumaural headphone in our practice. I think it is possible to create "Device for cochlear implant fitting" with 3, 5 or more 4-channel bands for any models of implant.

The task of parents: to identify the optimal program for the second implant. During fitting a speech therapist have to engage with second implant mainly. First implant is placed on ear but antenna is not on appropriate place. In any moment you can attach the antenna to hear in order to explain the task or to correct errors. And to repeat that we are doing a second implant as good as the first one. Let parents identify the optimal program for the second implant.

So, we know the optimal programs of both implants. Now we should equalize the loudness of two implants. When you assess the loudness while simultaneously wearing two implants you should begin the comparison with programs (maps) smaller than the unilaterally optimal ones, as with two ears simultaneously the sound is perceived louder.

It should be noted that the method SHCHUP is very convenient in case of bilateral cochlear implantation for comparison of loudness in both ears. Mother puts ear cushions of phone above the processor placed behind the patient's ear. We measure most comfortable SPLs. Then the phone is transferred to the other ear and the test is repeated on it with the same frequency band. Reactions are the same ones at the same loudness level in right and left ears. The results obtained on first and the second ears are recorded. Then the test is repeated with the other frequency bands in the same manner. We do some corrections of MCLs and give task to parents to define optimal programs on two implants. They have to observe the child's behavior at different combinations of programs on two implants. Comparison is begun at first programs at both ears.

Now consider the question of recommended wearing of HA on the second ear after first CI. There is opinion that HA is necessary in order to avoid impact of deprivation of the auditory nerve, which can be caused by long absence of sound stimulation. In other words, wearing of the HA is needed to maintain the health of the nerve till second CI.

I had fitted more than one thousand patients so I have a lot of young patients who did not wear the HA on non-operated ear till the second CI. However, all their parents noted improvement of perception after the second implantation, i.e., deprivation didn't impact. This is in General however; I do have many patients, the results of which can be seen to get a pretty clear idea. Let's look four out of them.

The patient was CI operated in the 7 years old. Second CI was done 8 years later. After the first surgery, the patient refused to wear HA and did not use the HA for a single day of 8 years between the surgeries. Till second CI he set in the front row of classroom and was very attentive to the speeches of the teachers. After second CI he sat at the back of classroom and had not problems with speech perception of teachers. I quote the words of the farther, who only pleased and it makes no sense to think of. As you can see there is a clear positive effect of the second CI and the absence of a "deprivative" changes of the auditory nerve in the second ear after 8 years no use of HA on this non-operated ear.

The patient lost his hearing at 29 years old. Parents bought him the best (and expensive) at that time HA, but he didn't use HA not a single day since beginning of hearing loss because he felt only the tickling. 1st CI (8 channels) was done after 6 deaf years. The result of the first CI was not too good - he looked lips, asked again and so on. 2nd CI was done 7 years (12 channels) later at second ear. He had preferred second implant the next day [1] after the first fitting. Moreover, after the first and single fitting of this implant he did not come to the correction of fitting till I did not invite him. He came two weeks later but I made only a minor correction. Since then, he has not come to me to fitting during 5 years. He does not favor the first CI as it follows from a telephone conversation with him. By the way, he doesn't use the first implant. There is clearly a positive result of a second CI after 13 years no use HA on this ear, i.e., there is a clear absence of a "deprivative" changes of the auditory nerve. It is interesting to note that the adult patient: 1. - was fitted only once and 2- 8 channels is clearly worse than the 12. It becomes clear why the latest models of implants have a number of electrodes 16 (USA), 20 (France) and more (China, Korea).

Patient lost his hearing at age 12 years old. He did not wear HA not a single day of the 27 years till the first CI. Second CI was done 2 years later. 27 years auditory deprivation did not affect performance in the auditory nerve, either first or second ears.

The patient lost his hearing at age 28 years old. He wore the HA during one year but he heard the BOO-BOO only (his words). And next 27 years he did not use HA. After 28 of deafness CI was done. In the first years after the CI he has finished doctoral thesis. Now I speak with him by phone i.e., 28 years of auditory deprivation did not affect the condition of the auditory nerve.

It is possible to prolong similar examples, but we'll stop here – 4 patients are sufficient sample. We did not consider it necessary to collect digital data of speech audiometry of these patients. Undisputable and obvious result of their successful speech perception is their ability to easily talk on the phone.

What conclusions can be drawn from consideration of these four patients? Not wearing of the HA on the non-operated ear during 8, 13 and 27 years don't affect the positive outcome of CI in the second ear. Not wearing of the HA on the deaf ear for 28 years did not affect the result of unilateral CI. Consequently, a frequently cited argument that HA should be used in the opposite ear against the harmful impact of deprivation on the auditory nerve in closer examination is not convincing.

It should be noted that simultaneous wearing the HA and CI give an undeniable improvement of the patient's ability to determine the direction to the source of the sound [8]. This result is bright and very impressive one for parents. However, this is not the positive sign for use hearing aid in the sense of increasing the intelligibility of speech and is not an indication to purchase the best model of digital HA. Priority of HA use with CI is not localization but intelligibility and thus the integration of the child in a speech environment.

Conclusion

In conclusion we can say that the fitting of the second implant within two weeks after the first connection is not the end of fitting. Further participation of parents in selection of the best combination of programs at both ears is very important part of binaural CI.

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