Austin Medical Sciences

Open Access

Austin Publishing Group

Review Article

First Days of the Cochlear Implant Fitting: From the First Fitting to the Impedancemetry

Petrov SM*
S.-Petersburg, Russian Federation, Russia

***Corresponding author:** Petrov SM, Russian Federation, S.-Petersburg, Str. Turku, h.5, fl. 240, Russia

Received: May 11, 2018; **Accepted:** June 18, 2018; **Published:** June 25, 2018

Abstract

This paper describes first steps of the audiologists and the Cochlear Implanted (CI) patients (and their parents) from the first fitting to the impedancemetry. This sequence of actions is based on the world experience, fifteen years own Clinical Practice with more than one thousand CI-patients and their parents, and on the results of own researches and a few patents. For vootiue (on the parent's ear) demonstration of CI-patients problems to their parents and for explanation of some features of auditory perception of CI-children we created demo-program MIMIC. MIMIC doesn't depend on type of implant. All (!) participants said that they begun to understand the issues of CI and the problems of their implanted children better. To facilitate understanding some issues and problems of the cochlear implantation we wrote "Instruction for audiologists and cochlear implanted patients". With some corrections our recommendations are acceptable ones for all patients with any type of implant.

Keywords: Cochlear implantation; First fitting; Sequence of fitting; MIMIC; Instruction for parents

Abbreviations

CI: Cochlear Implant; C-levels: Comfort Levels; T-levels: Threshold Levels; DIB: Diagnostic Interface Box; MCL: Most Comfortable Level; FS-4: Fine Structure-4; MIMIC: Demo-Program

Introduction

It is well known that a proper fitting of the cochlear implant processor is relevant to provide good quality in speech perception [1]. The programming of CIs is essential for good performance. However, no Good Clinical Practice guidelines exist [2]. Briefly our algorithm of the fitting is published earlier [3].

This article is the first steps in direction of creation of the guideline for CI fitting. Author has 15 years experience of Clinical Practice with more than one thousand implanted patients and their parents. The author has tens articles on topic of CI, a few patents for the processor fitting, demo-program for vootiue (i.e. on parent's own ear) demonstration of the problems of cochlear implanted patients to their parents [4] and "Instruction for audiologists…" [5] for facilitation of understanding of some issues and problems of CI. Opinions of readers of "Instruction" and participants of MIMIC are in the article [6]. Parent said that after reading of "Instruction" and participation in MIMIC they begun to understand their children better. N.B. MIMIC doesn't depend on type of implant.

The primary objective in the CI fitting of any type of implants is the right definition of the Most Comfortable Levels (MCLs) – maximal C-levels (Comfortable Levels) in the program of processor. At these parameters of the electrical stimuli CI-patient hears loud sounds near the threshold of discomfort. It should be borne in mind that discomfort is a subjective category, and therefore every patient has its own - different from other people – electrical MCL, so the parameters of fitting are individual ones. It is not the single cause of programs' difference between the patients. Another important parameter of fitting is the threshold level of electrical stimuli perception – T-level. At these parameters of the stimuli CI patient hears the quietest, hardly audible sound. We discussed the question of T-levels earlier [7].

Main purpose of fitting is right definition of C- and T-levels. This article is describing the beginning of this problem's decision.

Implant fitting of small children is the difficult task since they cannot reliably estimate the loudness of electrical stimuli. This article is mainly about fitting of these patients who can't give estimations of their sensations. Naturally if patient can comment their feeling you can take these estimations into account during a fitting. It facilitates a fitting but sometimes adult patients do not say correctly.

The first fitting is the procedure when implant of CI patients is turned on for the first time. At this event we begin procedure of CI fitting

How is the first fitting carried out?

The new processor of the patient is connected to the DIB (Diagnostic Interface Box) that works with the "Maestro" program. Other CI Firms use own "DIBs" (for example POD of "Cochlear"). A processor is connected to the wire of DIB, fitting antenna is connected to the corresponding output of DIB and is positioned over the magnet of the implant - slightly behind and above the auricle of patient. On the keyboard we type patient data, the Maestro program determines the implant. All these parameters are written in a processor.

Next step is the telemetry, namely the measurement the impedance of the electrodes of the implant and the voltage drop across them. These results are also stored in speech processor. They are used by the program of the processor, since the impedance values of the electrodes determine the load of the transmitter and, therefore, impact the stimulation parameters of CI.

Citation: Petrov SM. First Days of the Cochlear Implant Fitting: From the First Fitting to the Impedancemetry. Austin Med Sci. 2018; 3(2): 1026.

In rare cases during the telemetry there are some deviations from the norm. For example, the break of electrode (high impedance) – this electrode is immediately disabled and is not configured. In case of short circuit it is recommended to disable all except one of short circuited electrodes. But in my opinion it is necessary to examine more closely the question of disabling these electrodes. In case of disconnection of the electrodes the entire frequency range is redistributed between the remaining electrodes.

It is well known that impedance of electrodes is changed during time so you have to carry out telemetry periodically and on proposal of "Maestro" to save program - to do so. Programs with new telemetry are stored in a processor. It is obligatory to carry out telemetry at the end of every session of the fitting and to write programs with a new telemetry as appropriate maps.

Next step is setting of the parameters of the processor's programs. It can be done before telemetry.

Strategy of acoustical signal processing

There is a choice of different strategies. There are many strategies in different CI Firms. In the last years strategy FS4 have been developed in Austria. However no significant differences between old CIS and new FS4 strategies were found [8]. Our adult patients also did not feel the difference in sounding of CIS and FS4 strategies. We select the FS4.

Level of activation

We set 95% level of activation. In this case patient has the possibility to slightly increase the loudness of the program and to return to previous loudness levels. If that's not enough for selection of optimal program, patient has to return to 95% level of activation and to switch on the next program and look for the optimum levels of stimulation there. Naturally patients can decrease loudness of any program. It depends on range of activation.

Setting of lower level of activation is wrong because it leads to unnecessary reducing of the stimulation rate, and if you use the strategy FS4, there will be a decrease of the number of channels in which it operates. You can decrease or increase the level of the stimulation in any program. But these pluses or minuses are saved in all programs. This is written in our "Instruction for" [5].

Frequency range

Further we set the boundaries of the frequency range. The Austrian cochlear implant system can work in the frequency range 70-8500 Hz (in other Firms up to 10.000 Hz). The lower cut off frequency can be set from 70 to 350 Hz, the upper one – in the range of 3500-8500 Hz. Logically to assume that there is the best frequency range for the best speech perception. It is interesting to note that the first telephones worked with the frequency range of 300-3400 Hz.

We conducted a CI model study on the subjects with normal hearing for measurement of the words intelligibility in four frequency ranges of speech [9]. We have modeled four five-channel implants and compared words intelligibility in four frequency ranges: 350-6500, 250-6500, 250-8500 and 70-8500 Hz. The best intelligibility of words was achieved in the frequency range 250-6500 Hz.

On the basis of parallels between the perception of speech by implanted patients and perception of spectrally deprived speech by subjects with normal hearing [10] we can quite reasonably say that from these four frequency ranges the range 250-6500 Hz is the best one for the speech perception of CI-patients. An adult implanted patients also prefer the range 250-6500 Hz for speech perception. Also it is understandable from comparison of full speech spectrum and a frequency ranges. We do not claim that frequency range 250-6500 is the best range for CI speech perception. This issue requires further study.

Based on these results and considerations we set the frequency range from 250 to 6500 Hz. T-levels are set as 10% of C-levels. More details of the frequency range comparison are described in the article [9].

Further we set the parameters of the stimuli that will be used during the fitting of the CI. The duration of stimuli is 300 ms, the interstimulus intervals are 600 ms.

N.B. During fitting we shall frequently use the SWEEP stimulation of all channels. How? We select all channels and press "Enter". The SWEEP is a sequential stimulation of all electrodes from 1 to 12 and again. Later SWEEP stimulation of these parameters will be used during reflexometry. Except this practical use in the fitting we believe that the SWEEP-stimulation is even interesting for a child because he/she sequentially hears sounds of different spectrum from buzz to beep. Sometimes parents said that their child pulls them to my lab when he/she passed near its door. Perhaps baby is interested not only to hear but to hear sequential SWEEP stimulation too. It is known that subjects perceive frequency in accordance with the place theory and our article confirms this position too [11].

N.B. During the fitting you have to remember the intra operative threshold levels of stapedial reflex. And you must keep in mind that sometimes the visual threshold levels of reflexes (observed by the surgeon during operation) exceed the real thresholds which are obtained later in the fitting procedure, and this possible difference should be considered during fitting. Closely observe a behavior of the child!

Further. We select (mark) all channels and we create a current pulses of small amplitude 3 step up (0.6-0.7 dB) in all channels of CI. Step is one press of button arrow UP or DOWN. Further we carry out stimulation in SWEEP-mode with monitoring of the patient reaction. As the rule, the patient's reaction is not observed at small levels of stimuli. Program with these parameters of C-levels is stored as program number 1. Little patient can't evaluate perception of C-levels at the individual channels: "Loud, quiet or good", so during first days of fitting we increase C-levels by 0.6-0.7 dB (3 steps up) in all channels from the values of the previous program (C-levels grow parallelly). We repeat the stimulation and watch the reaction of the child. The program with these C-levels is stored as a program number 2. Similarly we create the third and fourth programs. If there is no reaction when we SWEEP-stimulate at the 4th program, we increase C-levels by 3 steps, SWEEP stimulate and create the following programs. During fitting at first day the reaction of patients is observed at some levels of stimulation: child guards, puzzled he turns to the mother, begins to turn his head, touches the transmitter on head, etc., i.e. patient clearly changes own behavior at some levels of the stimulation. In this case

we say: "Hears. Yes". Let it be program N6. Almost all parents notice this reaction too.

Sometimes parents have conscious (don't believe our words) and we demonstrate them the reaction of their child. How? We say: "Distract the child and watch." When the child switches attention to mom, we say to mother: "Look" and "suddenly" stimulate. Sometimes for obvious reaction we slightly increase (1-2 steps) C-levels of this program. And mom enthusiastically exclaimed: "Sure! Hears!

We are amazed and glad no less than parents. This program is stored too. Further we increase the C-levels (3 steps up) of this program and save new program under next number. Without SWEEP stimulation. Let it be the program N7. This is the end of the fitting at the first day. We remove the antenna from the head of patient. Show to child: "All is OK. Good for you".

Further we create a new configuration - 4 programs-maps in memory of a processor. Program N7 is written as the fourth MAP. The program N6 at which reaction was marked is written as MAP3. Programs N5 and N4 are written as MAP2 and MAP1 accordingly. C-levels of 2nd MAP and 1st MAPs are 3 and 6 steps lower of MAP3 respectively. Naturally numbers of programs may be others.

We give the following instruction-explanation to the parents:" By means of the buttons with 1-4 white circles in the middle of the Fine Tuner (remote control) you can switch programs. Loudness of programs is increased from first program to fourth program. The first program (MAPI) is the quietest one, fourth program (MAP4) at the fourth button is the loudest one. About all the other buttons of Fine Tuner you will read the "Instruction of Fine Tuner" and in our "Instruction" [5]. We give our "Instruction" to parents immediately after a surgery or in day of first fitting.

The main task of parents during fitting is to detect not too loud program. Parents have to remember common rule for the switching of the programs. When you increased a program you have to watch the reaction of the child. If you don't see a negative reaction, after some time you can switch to the next program. If you see a negative reaction, you have to switch to previous program. After one hour try the "loud" program again. If there is a negative reaction a few times, perhaps you are in a region of near optimal program.

Instruction for parents after first day of fitting. It is similar at all days of fitting.

1. Use the first program during 30 min – knob with one circle (for audiologist - MAP1 of configuration). Switch to second program. Monitor the child's reaction. As a rule during a few days of fitting there will not be a negative reaction. Remember common rule for the switching of the programs.

2. Use the second program (MAP2 of configuration) during 30 min. Switch to the third. Monitor the reaction. If there is no a negative reaction, then switch next program.

3. Use the third program (MAP3 of configuration) during 30 min. To switch on the fourth program (MAP4). Monitor the reaction. If there is no a negative reaction use this program. If everything is fine then enjoy it.

It is very possible that in the first day when you switch on the first program you will not see obvious reaction – do not be surprised and do not worry. "No need to hurry".

N.B. Before going to sleep - night or day – you need to switch a processor on to the first program and switch off the implant. You can switch off the implant when it is on the head of child or it is removed from a head. After a child's sleep you have to switch on implant in your hands, to make sure that the light bulb blinked one time, then to place it on ear. Constantly speaking in a normal voice within a few minutes (5-10) you have to switch from the first program to the second and further - to program used yesterday or to the working program before day bedtime. Why do you need to switch to the first program before a sleep? If you switch on the implant on the program normal yesterday or before daytime sleep the patient can show negative reaction and the child can refuse to wear the implant for a some period of time. As a rule, this passes off quickly enough, but it would better to avoid such position and after sleeping to begin the use of implant at the first program.

Why do you need to switch on processor after child's sleep in your hands? When you put the antenna of the switched implant to its place the sound appears somewhat smoother – not instantly as if you would switch on an implant on the head of child. Later, you can switch off-on processor directly on to the working program.

The second day

At first welcome baby. Ask parents about 4-th program (map 4). As a rule the parents did not see the slightest negative reaction at this program and they say that observed child's reaction at 4th map. "Child hears".

Your preparation for the further fitting. Open program at MAP3. Explain (show) to the child that he will hear single channel stimulation. Try some channels (one press knob "Enter"). You can check perception of one-channel sweep-stimulation (2-3 s press knob "Enter" at selected channel. If there is no negative reaction explain (show) to the child that he/she will hear sequence of sounds. Select all channels and perform sequential SWEEP stimulation of all channels. Like yesterday there is no negative reaction. Switch off SWEEP and open the program of MAP4.

Perform single channel stimulation, one-channel sweep-stimulation at a few channels. If there is no negative reaction explain (show) to the child that he/she will hear sequence of sounds, select all channels and perform sequential SWEEP stimulation of all electrodes. Observe reaction.

Further we increase the C-levels 3 steps up and repeat single channel stimulation, sweep-stimulation in some channels. If there is no negative reaction we perform the sequential SWEEP-stimulation of all channels. Save this program as number 8. Compare with the threshold levels of stapedial reflex during surgery. In the same manner create programs number 9 and 10. During a fitting carefully observe reaction of child.

Further we create new configuration. MAP4 of first configuration (program 7) is replaced to the place of MAP1 and we write programs 8, 9 and 10 as MAP 2, 3, 4. We place a processor on the head of child and sequentially activating MAPs 1-4 we check four MAPs during conversation with the parent. The main task of parents during this stage of fitting is to estimate these programs.

Similar manipulations are performed during next days of fitting. In the first few days after the first fitting a patients reach the fourth map without negative reaction. After a few days of fitting some parents tell us about successes at lessons with speech therapists. Task of speech therapist during fitting is to lure patient in hearing!

Observing reaction to a new - higher – levels of stimulation, taking into account the comments of parents we are performing the following fittings during a few next days. As the child independently and may unconsciously mastered in new sensation, from day to day child instinctively changes the assessment of their perception and that was loud yesterday can be normal or quiet today.

N.B. If during SWEEP-stimulation you see some negative reactions do not use the SWEEP further. It is very possible that these C-levels of some (or all) channels are higher than threshold levels of an intra operative reflexes. Time to perform the reflexometry.

So the main purpose of this fitting stage is to determine what the maximum program does not cause negative reactions. Parents have to switch program, to watch perception, after some time to switch next program, to watch perception and so on. Therefore the task of parents – carefully observe behavior of the child in different sound environments at different programs! End of this way is number of not too loud program. If patient shows negative reaction to some program several times it means that previous program is approximately optimal one.

N.B. Remember the threshold levels of reflex observed during surgery. In rare cases they are absent but more frequently they are higher than reflexes measured during the fitting.

Next step of fitting is a reflexometry. Reflexometry is carried out in accordance with our article [12]. In case of reflex's' absence our program SHCHUP is suitable one. But this is prolongation of the fitting procedure.

Some indications-advices

Parents can switch implant from any program to any program. If they want to know what the program does their child use now it is necessary to turn off-turn on a processor and to count: How many times does light of processor flash?

Sometimes it happens that parents have doubts in auditory perception of their child. What do we suggest them? In the morning to place the implant as usual, but don't switch on a supply. Almost immediately, the parents notice that the child feels abnormalities. Behavior of child shows that child feels that implant is not switched on.

We hope this article will be useful manual for the audiologists and the parents of cochlear implanted patients. Some details of fitting procedure can be corrected but main direction of fitting is acceptable one for any type of implants. Some special questions of the implants fitting after bilateral CI had been discussed earlier [13].

References

1. Vargas JL, Sainz M, Roldan C, Alvarez I, de la Torre A. Analysis of electrical thresholds and maximum comfortable levels in cochlear implant patients. Auris Nasus Larynx. 2013; 40: 260-265.
2. Vaerenberg B, Smits C, De Ceulaer G, Zir E, Harman S, Jaspers N, et al. Cochlear implant programming: A Global survey on the state of the art. Scientific World Journal. 2014.
3. Petrov SM, Shchukina AA. The algorithm of the fitting of the speech processors of cochlear implants. Vestn Otorinolaringol. 2012; 3: 15-19.
4. Petrov SM, Pisareva NY. Comb-Filtered Speech as a tool to demonstrate difficulties of speech perception and the importance of auditory training in cochlear implant users. Cochlear Implants International. 2013; 12: 48-52.
5. Petrov SM, Tsjuk AA. Instruction for Audiologists and Implanted Patients. 2015; 52.
6. petrov sm. for professionals working on the topic of cochlear implantation: opinions of readers of "instruction" and participants of MIMIC. Adv Treat ENT Disord. 2018; 2: 001-005.
7. Petrov SM. The threshold problem in implanted patients. Global Journal of Medical Research. 2017; 17: 21-23.
8. Schatzer R, Krenmayr A, Au DK, Kals M, Zierhofer C. Temporal fine structure in cochlear implants: preliminary speech perception results in cantonese-speaking implant users. Acta Otolaryngology. 2010; 130: 1031-1039.
9. Petrov SM, Gritsjuk MI. Modeling of cochlear implants with different frequency ranges by means of spectrally deprived speech. Journal of Otolaryngology-ENT Research. 2017; 6: 1-3.
10. Petrov SM. Perception of a spectrally deprived speech signal. Fiziol. 2003; 29: 17-20.
11. Petrov SM. The perception of the frequency of tonal stimuli in a lesion of the sound-perceiving apparatus. Fiziol Cheloveka. 1998; 24: 38-41.
12. Petrov SM. Practical implementation of the SWEEP-session of stimulation-registration in ci fitting. Adv Treat ENT Disord. 2017; 1: 13-15.
13. Petrov SM. Bilateral cochlear implantation: Indications for fitting of the implants. J Med Imp Surg. 2017; 2: 114.

Austin Med Sci - Volume 3 Issue 2 - 2018
Submit your Manuscript | www.austinpublishinggroup.com

Citation: Petrov SM. First Days of the Cochlear Implant Fitting: From the First Fitting to the Impedancemetry. Austin Med Sci. 2018; 3(2): 1026.