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A Device for Recording the Electroacoustic Characteristics of a Cochlear Implant

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Annotation. The tester included in the delivery package is used for the primary check of the cochlear implantation system. If the tester's light flashes in time with the spoken words during the test, but it does not light up between the words, the implant is working. The standard tester does not provide information about the operation of individual channels of the implant, only some general idea. For a more detailed analysis of the implant operation, the following tester model is used, with which the response from each electrode can be seen on the oscilloscope screen. There is no registration of test results. In this article, we propose to create a device for recording the operability of individual channels in real-world conditions of the implant. With its help, we obtain information about the electroacoustic characteristics of the implant and the microphone, which should remain unchanged.

Keywords: cochlear implant, testing, electroacoustic characteristics of the implant

The tester included in the delivery package is used for the primary check of the cochlear implantation system. During the test, the antenna of the implant is applied to the tester, which has a magnet too. The implant turns on, words are spoken into the microphone, and the tester's light is monitored. If the light flashes in time with the spoken words, but it does not light up between the words, then the implant is working. The standard tester does not provide information about the operation of individual channels of the implant, only some general idea. Obviously, more detailed information is needed about the electroacoustic characteristics of the implant, which should remain unchanged throughout its use.

The following tester model is used for a more detailed analysis of the implant operation. The antenna of the implant is also attached to the magnet of this model, stimuli are provided from the Maestro program, and from the tester's output, you can see the response from each electrode on the oscilloscope screen. There is no registration of test results. It is necessary to create a device for recording the functionality of the microphone and the functioning of individual channels of the implant. We propose to create a “Device for recording the electroacoustic characteristics of a cochlear implant.” To do this, you need to create a program in which all the maximum levels of stimulation in all channels of the implant are the same and equal, for example, 500 cu. The threshold levels are 10% of the maximum. It is possible that these levels will need to be changed during the development of the device. The block diagram of the device is shown in Fig. 1.

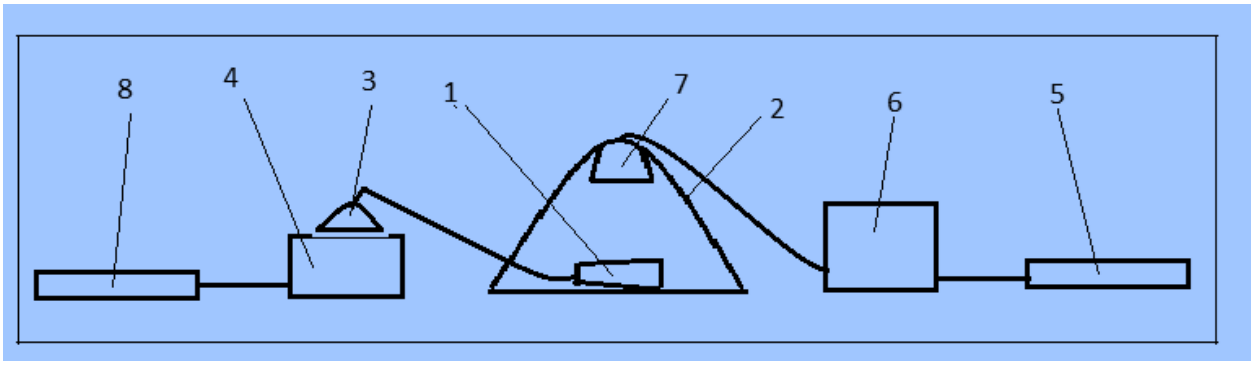

Fig. 1. Block diagram of a device for recording the electroacoustic characteristics of a cochlear implant

Notation in the drawing: 1 - processor, 2 - circumaural headphone, 3 - the antenna of the implant, 4 – tester, 5 - computer, 6 - amplifier, 7 - head phone emitter, 8 - computer

The processor (1) is placed under the ear pad of the headphone (2). The antenna (3) of the implant is located on a long wire on the tester (4). Test stimuli are created in the «Adobe Audition» program of the computer (5) and fed to the amplifier (6). Sound stimuli from an acoustic radiator are fed to the microphone of the implant. SPL of stimuli is 80-90 dB. The intensity levels of the test stimuli are set using artificial ear 4153 "Bruel & Kjar". The tester senses electromagnetic pulses from the antenna. The electrodes, i.e. the recording channels, are switched sequentially. The test result is saved on the computer (8). This data is the passport data of this CI. It is also important that they contain an assessment of the quality of the implant microphone. These characteristics of CI should remain unchanged during the entire time of using the implant.

We suggest considering 2 testing methods.

In the first case, white noise (WN) of constant spectral density is used as a stimulus, which is created in the «Adobe Audition» program. With the help of an amplifier, the intensity of output signal is set to 80-90 dB SPL. The tester senses electromagnetic pulses from the antenna. The electrodes, i.e. the recording channels, are switched sequentially. With a functioning implant, the test result is a stepwise sequence of 12 columns of increasing height. This is due to the fact that the bandwidth of single-channel bands increases from low-frequency to high-frequency channels. In case of the electrode is switched off for one reason or another, there will be no response to the recording. The registration does not depend on the width of the frequency range, since the frequency bands processed in disconnected channels are distributed over all other operating channels.

The condition of the electrodes (short circuit, disconnection of the electrodes) is assessed based on the results of telemetry and correlated with the results of electroacoustic testing. Thus, during testing, only switching of the recording channels is carried out, i.e. the electrodes from which the response is recorded.

This test method can be done differently. The «Adobe Audition» program creates a sequence of 12WN stimuli with a duration of 10 s with an interval of 5 s between them. Testing is carried out with a white noise bands of 80-90 dB SPL. The recording channels are switched in the time interval between stimuli. With a functioning implant, the test result is a sequence of 12 columns of increasing height.

In the second method of testing the implant, a sequence of frequency bands cut out of white noise is used as a stimulus. First of all, telemetry is performed. In accordance with its results, the boundary frequencies and the numbers of the working channels of the implant are recorded. Next, using the comb filtering program, frequency bands are cut out of white noise in accordance with the previously recorded boundary frequencies of the operating channels. The number of bands and their width are determined by the number of operating channels and the frequency range of the implant. The duration of band stimuli is 10-15 seconds. These bands are recorded sequentially in an «Adobe Audition» audio file. Then, at the same position of the amplifier volume control, we change the band amplitudes in the «Adobe Audition» program so that the SPLs of the single-channel signals at the amplifier output are the same (say, 80-90 dB SPL). In accordance with the maplaw of CI program, the processor generates pulses of the same amplitude for the stimuli of equal SPL . This sequence of single-channel bands of equal SPL of 80-90 dB and an interval between them of 5-10 seconds is used to check the operability of the cochlear implantation system. During recording the channels are switched in the time interval between stimuli. With a functioning implant, the test result is a sequence of 12 columns of equal height.

If some electrodes are disconnected, the corresponding channels of the implant are not tested. The test result is saved on the computer. This is the passport data of this CI. They must remain unchanged during the entire time of using the implant.

The parameters of the stimuli — intensity, duration — are not clearly specified now. The optimal parameters should be selected when designing the device and testing it in operation. It should be noted that since the test uses high levels of sound intensity, there is therefore no need to use a special soundproof camera. The pad of circumaural headphone is quite enough.

I am private entrepreneur (OGRNIP №313472531000028) so I propose my participation in creation of this device.

Conclusions

1. Using the proposed device, the entire electroacoustic path of cochlear implant is checked completely through separate channels — from the microphone to the antenna emitter, inclusive.

2. The proposed device will allow recording the characteristics of cochlear implant and evaluating their stability over time. The electroacoustic characteristics of the implant should remain unchanged throughout its use.

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