REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

ASSESSMENT OF THE EFFECT OF COXLEAR IMPLANTATION ON LIFE QUALITY IN CHILDREN WITH SEVERE HEARING DISORDERS

Specialty: 3217.01 – Otolaryngology

Field of science: Medicine

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Baku – 2021

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GENERAL CHARACTERISTCS OF THE STUDY

Actuality of the problem. Severe neurosensory distress and deafness are hearing impairments that lead to disability due to complete or partial loss of communication and social disintegration[1].

According to the international assessment by the World Health Organization (WHO 2011), hearing loss is included to the group of serious diseases, including coronary heart disease, depression and Alzheimer's[2]. Based on materials taken from literature of XX century the number of patients with expressed hearing loss (severe hearing loss and deafness) is nearly 6%.

The development level and life quality of children, depend on the effectiveness and condition of the use of hearing. Modern high technology, adapted digital hearing aids and cochlear implants allow to hear better and communicate in different acoustic conditions. Thus, the formation of auditory perception and speech in children with hearing impairment does not depend only on the organization of properly selected hearing. At the same time, it depends on the correct method of organizing pedagogical rehabilitation, i.e. how the child is prosthetized with a hearing aid or cochlear implant.[3;4;5]

In most cases, such children have a phenomenon of increased volume (SGAF). Therefore, they experience unpleasant sensations

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during loud, sudden sounds and refuse to wear hearing aids. This, in turn, results in children not being able to use hearing aids. Only cochlear implantation helps this children.[6]

The cochlear implant processor encodes a wide dynamic range of sounds into more limited range electrical impulses so that quiet and loud sounds are received at a comfortable level. Thus, the cochlear implant allows to hear bass and high-frequency sounds, what is not possible even when using the most powerful hearing aid, and to perceive high sounds at a comfortable level. Therefore, children are happy to be able to hear constantly using a cochlear implant throughout the day.[7]

A wide arsenal of surgical, medical and physiotherapeutic means is used for treatment of hearing loss.[8] Today, cochlear implant (CI) is the most effective rehabilitation method in patients with severe hear loss and deafness. The effectiveness of cochlear implants in children, has been confirmed by numerous studies as well as in adults.[9]

Although cochlear implantation is a one-time surger, but a set of high-value measures that combine postoperative follow-up and long-term rehabilitation of patients is assessed as a complex.

The long-term rehabilitation can last from a few months to many years.[10;11;12]

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It is known that the prospects for the development of a set of measures for increasing the effectiveness of cochlear implantation should be not only pedagogical, but also aimed at improving of life quality.

The object of the study: 87 children undergoing cochlear implant surgery were selected as the object of the study, the study of the effectiveness of Cİ surgery and the assessment of their quality of life through questionnaires (SF-36, KIFI) was selected as a subject of the study.

The aim of the study: to increase the effectiveness of rehabilitation in patients after cochlear implantation and to assess of the life quality dynamics of patients using the cochlear implantation system.

The study objectives:

1. To develop a differentiated assessment method for effectiveness of hearing correction after cochlear implantation depending on speaking ability of patients;
2. To improve the adjustment algorithm of the speech processor of the cochlear implantation system at patients after cochlear implantation and to assess its effectiveness in relation to the development of hearing skills;
3. To determine the effectiveness of the use of a speech processor in the cochlear implantation system in relation to clear speech indicators in different patient groups after cochlear implantation with in the different patients groups;
4. To assess the life quality indicators at patients using the cochlear implantation systems.

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The methods of the study:

Anamnestic, otorhinolaryngological, radiological examination for assessment of hearing function, correction of cochlear implant speech processor adjustment parameters, auditory speech rehabilitation, methods of assessing quality of life through questionnaires.

The main provisions to be defended:

- An improved adjustment algorithm of the speech processor of the cochlear implantation system, which combines the definition of tonal limits of sound perception and clear speech, the survey of life quality of separate persons with neurosensory hard hearing allows to increase the effectiveness of cochlear implantation.
- Questionnaire of patients or their parents after cochlear implantation by specialists of audiology, surdology and auditory-speech departments of the Republican Medical Diagnostic Center in Baku with general and specific questionnaires on life quality (LQ) allows to dynamically assess the effectiveness of cochlear implantation in patients of different age groups, regardless of the existing neuropathology.

Novelty of the study. A comprehensive assessment of the perceptual characteristics of tonal and speech stimuli in patients after cochlear implant surgery was performed within the frames of the study course.

The speech processor adjustment algorithm of the cochlear implantation system in patients after cochlear implantation, was developed.

After cochlear implantation, a new method of speech audiometry in Azerbaijani language in the field of free sound (F.F.S.) was developed and approved.

The effects of cochlear implantation on patients' life quality have been demonstrated, and for the first time, a temporary regulatory framework for a cochlear implant system speech processor (SP) has been established in accordance with developed medical care standards.

Practical significance of the study. The cochlear implantation speech processor adjustment algorithm, developed and approved by us in the course of the study, can be used to increase the effectiveness of rehabilitation of patients after C.I. Data on the effects of cochlear implantation on quality of life of patients allow to predict the effectiveness of hearing rehabilitation in different age groups. The algorithm developed by us allows to reduce and embody the temporary use of diagnostics of hearing habits in patients after C.I.

This increases the effectiveness of rehabilitation in terms of saving material resources.

Approbation of study results. The results of the study were presented at the XXI International Scientific-Practical Conference in St. Petersburg (2019) and reported at the scientific-practical conference dedicated to A.M. Aliyev's anniversary (2018, 2019), at the scientific-practical conference dedicated to the 100th anniversary of T.A. Aliyev (2021).The first discussion of the scientific work was held at the interdepartmental (Otorhinolaryngology, Dentistry) meeting of the Faculty of Surgery of the Azerbaijan State Advanced Training Institute named after A. Aliyev (protocol №3, 15.03.2021), presented at the scientific seminar of the Dissertation Council ED 2.05 under the Azerbaijan Medical University (protocol №1, 27.09.2021).

Application of the results of the dissertation in practice. The achieved results have been used for treatment of patients with severe hearing pathologies by the clinical base of the Department of Otorhinolaryngology of the Medical Center named after M. Mirgasimov and at the "LOR Hospital" clinic. Materials of dissertation have been included to pedagogical process of Department of Otorhinolaryngology of the Azerbaijan State Advanced Training Institute named after A. Aliyev.

Name of the organization where the dissertation work is performed: The Azerbaijan State Advanced Training Institute named after A. Aliyev, "LOR Hospital" Clinic, The Republic Diagnostic Center.

Publications. The results of the dissertation have been published in 14 scientific-practical journals (including Scopus indexing database) in the relevant list of the Higher Attestation Commission, including 3 articles in foreign journals, 2 theses have been done in scientific conferences.

The volume and structure of the dissertation. The dissertation is written on 143 pages (167409 characters), consists of introduction (7 pages, 11577 characters), from the literature review (26 pages, 46957 characters), chapter "Materials and methods" (42 pages, 62034 characters), chapters reflecting the results of personal research (9 pages, 8968 characters, 21 pages, 24574 characters), results (7 pages, 10773 characters), conclusions (1 page, 1339 characters), practical recommendations (1 page, 1187 signs), bibliography and appendixes. The dissertation is illustrated with 19 tables, 20 figures, 12 graphs and 1 scheme. The bibliography includes 184 local and foreign sources.

MATERIALS AND METHODS OF THE STUDY

Our study, was conducted during 2014-2016 years and covered 152 children with neurosensory type, with severe hearing impairment, sent to examination by the Heydar Aliyev Foundation, 89 of which underwent the cochlear implantation surgery.

"87 patients aged 2-13 years (average age 5,4±1,8) were examined with a diagnosis of bilateral chronic neurosensory multi-severe hearing loss, relative deafness, and postoperative condition after unilateral cochlear implantation: women 44.8±5,3 (39 person), men 48,2±5,3 (48 person). The deafness duration was 2.2 + -1.7 years on average (6 months - 11 years).

Patients examined to address the issues were divided into two groups:

- I group - (1-5 years, 50 persons)
- II group - (elder than 5 years, 37 persons).

Group II is divided into two subgroups:

In subgroup A children without psychological disorders, who

freely answer questions about the quality of life and the effectiveness of the speech processor of the cochlear implant without the active participation of the parent (21 children);

In subgroup B children with general psychological developmental disorders, unable to assess the quality of personal life, assessing the effectiveness of cochlear implant with the active participation of parents (16 children). The presence of general psychological disorders (according to F 84, F 88, F 89,ICD) was detected by the city or regional psychological medical pedagogical commission.

Accurately collected anamnesis, as well as the results of instrumental examination methods made it possible to determine the etiology of aggravation in 88.5% of cases (78 person):(20.7%) suffered of hereditary syndromic pathology in 2 patients (23.5%), aggravation associated with intracranial birth trauma in 10 patients (11.5%), aggravation associated with neonatal hemolytic disease in 4 patients (4.6%), autoxic effect of antibiotics in 24.2% of cases. (21 people) vascular aggravation Deafness due to snail anomaly in 9 people (10.3%) 5.7% (5 people) The cause of traumatic brain injury was 6.9% (6 people) The cause of meningitis was 3.5% (3 person) (found).

The study was conducted in 3 stages: activation of C.I.'s speech processor, 3 and 9 months later. For all patients: Standard adjustment of the Cochlear Implant speech processor; In the field of free sound, tonal threshold audiometry and speech audiometry with oral articulation tables, Oldenburg phrase test (in the presence of vocabulary for listening experience and comprehension of speech material) were performed.

An adapted written version of the general SF-36 life quality assessment in Azerbaijan language Patients entered to the Group I (50 person) and Group II A (21 person) in 3 stages were offered. In addition, the Cochlear Implant Performance Index (CIPI) is a special survey on the quality of life of the above group of patients.

The Azerbaijani version of written questionnaire was conducted by specialists of the Republic Diagnostic Center in Baku

and Department of Otolaryngology of the State Advanced Training Institute for Doctors named after A. Aliyev. In the 2nd and 3rd stages (3 and 9 months after the activation of the speech process), the legal representatives of16 patients in the Group II sub-group B were offered to translate the hearing integration scale into Azerbaijan language and an adaptation questionnaire was offered. The design of the study is illustrated on the Table 5 («Meaningful Auditory Integration Scale»).

According to the matters of the study the unilateral the complex examination methods have been identified to study auditory function and quality of life in patients after unilateral cochlear implantation.

Examination protocol for patients consists of:

1) Collection of complaints and anamnesis, examination of the LOR organs;

2) Tonal audiometry in the field of free sound;

3) Speech audiometry in the field of free sound with balanced standard speech tables developed in Azerbaijan language by J.Y. Kazimov. OLSA test depending on using rate of speech habits;

4) Correction of the regulatory mechanisms of the speech processor of the cochlear implant;

5) Written questionnaire with Russian-language version of SF-36 general survey on quality of life, KIFI survey, integrated hearing scale (MAIS).

Endoscopic examination of the LOR-organs was performed with a CHAM-5000 combiner (Korea). The purpose of the examination is to exclude patients intended for the study group in case of detection of acute or chronic inflammation in the LOR-organs.

Tonal audiometry in the field of free sound was performed in accordance with the recommendations of the international standard GOSTRISO 8253-2-2012 in order to assess the effectiveness of auditory speech rehabilitation after cochlear implantation. “Acoustics. Audiometric tests. Audiometry in the field of free sound

with pure tones and thin-column test signals". Clinical audiometer EVIDENT3 (Germany) and sound amplifiers CANTON (Germany) were used for the study.

The life quality survey was conducted with the Azerbaijan version of the SF-36 general life quality survey, specific KIFI and MAIS surveys. Each survey has a brief section on personal information about patient: surname, name, patronymic, date of birth, age of deafness, cochlear implant the service life of the speech processor. Respondents were informed about the rules for completing the survey and set the expected results and objectives from the survey results.

Methods of the statistical processing of the study. Statistical processing program of survey results have been conducted by means of 6.0 version of statistical processing program (Stst Soft, Inc, USA). The quantity indicators were presented as median, upper and lower quartile (Me, LQ-UQ), average price and fallibility (M±m).

The value of quality attributes is expressed as a frequency in%. Non-parametric methods of statistical analysis were used in the comparison of quantitative and qualitative indicators: Wilcoxon criteria were used in related samples, Mann-Whitney (U) criteria were used in unrelated samples. Spearman's correlation coefficient was calculated. The critical level of statistically significant differences (α= 95%) was assumed to be equal to 0.05 during the testing of the zero hypothesis (zero hypothesis).

THE STUDY RESULTS AND DISCUSSION

As Emmanuel Kant rightly noticed: "If the lack of sight separates man from things, the absence of hearing separates man from man." The individual, as a fully social subject, is shaped byre two analyzers: sight and hearing: A highly specialized hearing analyzer related to thought and speech is unique. The social significance of hearing is determined by the fact that a guide to speech and social activity is formed on this basis. It is a tool that helps to get information from the world and society, and also connects people to society and creates communication. When the

formation of speech is delayed, the development of intellect is also delayed.

The study of the problem of hearing in medical science covers 100 years. Currently, hearing loss and deafness are considered not only clinical, but also the subject of social medicine. Thus, hearing is one of the important functions that ensure human development and communicative adaptation in society. At the present stage, the active development of clinical audiology serves to develop new methods and improve existing methods that allow the diagnosis of hearing disorders at the subcellular, cellular and organ levels.

Currently, there are many treatment methods for neurosensory distress, but from a methodological point of view, these methods are not effective, and there is a need to look for more advanced options for the prevention of this disease and its application to patients, the expected results have not yet been achieved. The medical application of new digital technology or modern implantation technologies to hearing prosthetics allows to address important rehabilitation issues of patients with hearing loss and deafness.

Taking into consideration that, in recent years, neurosensory aggravation is “getting younger” and mainly causes damage at a young age, which leads to a decrease or complete absence of professional ability and has a negative impact on life quality of the patient.

Modern statistic showed that Neurosensory disturbances damage the general auditory structure, the prevalence of which can reach 80%.

The numerous studies have approved the effectiveness of cochlear implantation in the rehabilitation of patients with severe hearing loss and deafness.

We selected 87 people with bilateral chronic severe neurosensory hearing loss, who were unilaterally cochlear implant applied by the traditional method. During the study, patients were divided into two age groups: adults (50 person) and children (37 person).

The second group was divided into 2 sub-groups due to the presence of concomitant general psychological developmental

disorders in some of the patients and the lack of a critical attitude to the answers to the questions.

A – children without any general psychological developmental disorders (n=21).

B – children with general psychological developmental disorders(n =16).

The effectiveness of cochlear implantation based on the results of filling out a questionnaire of the patient himself or his legal representative was evaluated by means of tone audiometry in free sound, speech audiometry SF-36, KIFI and "Hearing Integration Scale".

Statistically significant differences were noted in the measurement of tonal audiometry in the free sound field in all groups tested in dynamics within the frames of the study. During the activation of the speech processor of the cochlear implant, all research groups had high levels of tonal audiometry in the free sound field. This is due to sensory maladaptation during activation of the speech processor of the cochlear implant.

The results of quality of life examinations in dynamics

All patients were asked to fill out SF-36 questionnaires when they applied to “LOR Hospital” Clinic or on the first day of admission. (either personally by the patients themselves or by their parents, depending on the possibility of instruction). On average, approximately 15.7 ± 4.3 minutes were spent on completing the SF-36 questionnaire. It takes less time for parents to complete the questionnaire - 10.8 ± 3.2. Cochlear implantation at the stage of activation of the speech processor quality of life of representatives of group I and subgroup II-A were assessed by means of a written questionnaire using the SF-36 questionnaire. Patients were able to answer the questions presented to them accurately and adequately, representatives of subgroup II-B were not offered this questionnaire due to concomitant mental developmental disorders.

The best speech distinction was observed among patients in group I. In group II B, concomitant general psychological

developmental disorders and low speech discrimination were noted among patients due to lack of hearing experience before cochlear implantation. This fact is confirmed by other researchers.

It was detected that, the life quality level of patients in examined groups was higher than moderate due to all scales (50% and more). In this case, most of the scales were below the control value ($p \leq 0,05$). Statistical differences were noted between groups I, subgroups II-A, and the control group on the “emotional state” and “general health” scales ($p \leq 0,004$). This fact may be related to an object that studies the psychology of age – a developing person who changes in ontogeny (30).

In current period An extensive team of psychologists, educators, social workers, cultural workers and doctors is needed to find a way out of regularities and facts of psychological development of children, at a young and mature age, in old age.

Adolescence – the transition from childhood to adulthood – is characterized by the desire for independence and freedom, freedom from dependence on adults, and the right to show one's rights to others. The transition to adolescence is biologically related. The intensity of this stage of sexual maturity is emphasized by the concept of "hormonal storm".

Physical, physiological, psychological changes, the emergence of sexual desire make this stage even more difficult. This creates a special interest to the emotional status of teenagers (mood, the presence of depression, general indicators of anxiety and positive emotions, as well as personal health).

It should be noted that, even if, people with hearing impairments do not talk at the period of adolescence, adolescence as a whole is characterized by asynchrony, leaps, and disharmonious development. At the same time, statistical differences were noted between groups I and control groups on the scales of “physical activity” ($p \leq 0.05$). No differences in “physical activity” were found during the comparison of subgroup II A (with the ability to freely assess quality of life) and control group ($p \geq 0,05$), statistically

significant statistical differences were observed on the “emotional state” ($p \leq 0.004$) scales ($p \geq 0.05$).

3 months after activation of the speech processor of the cochlear implant, the quality of life of the respondents in group I and subgroup II-A was assessed in the form of a written questionnaire by SF-36 survey.

Thus, no statistically significant differences were found in the dynamics of the assessment on all scales in the two related selections in group I and subgroup II-A.

9 months later after activation of the cochlear implant's speech processor in all study groups improvements were observed due to SF-36 questionnaire scales, comparing the results of the survey statistically significant differences were found in 5 (“physical activity”, “physical role activity”, “emotional role activity”, “quality of life”, “general health” as well as “pain” scales) out of 8 scales in the two samples in dynamics of Group I ($p \leq 0,05$, $p \leq 0,001$).

When comparing the results of the survey in the dynamics of subgroup II-A, a statistically significant difference was found in 6 out of 8 scales in two samples. “Physical activity”, “activities with physical role”,“ activities with emotional role”, “viability”, “emotional status”, “general health status” and “pain ”scales. A statistically significant difference ($p \leq 0.05$, $p \leq 0.0001$) due the scales “physical activity”, “activities with physical role”,“ activities with emotional role”, “viability”, “general health status” was observed between the indicators of Group I and subgroup II-A. There was not significant difference in dynamics between indicators of the survey scales in the control group. The questionary results of patients of Group I and Subgroup II-A are given in Figure 10, 11. 3 and 9 months later after activation of the cochlear implantation speech processor cochlear implant activity index (CPI) questionnaire was offered to patients of Group Iand Subgroup II-A, also parents of Subgroup II-B patients. Azerbaijani version of questionary was used in Baku city by specialists of audiology, deafness and auditory communication of Republican Medical Diagnostic Center in and the department of otorhinolaryngology Azerbaijan State Advanced

Training Institute named after A. Aliyev. It was found that the activity index of the cochlear implant, which was low on all scales on the questionnaire after 3 months, improved after 9 months. This is reflected in the statistical processing of the results. In this case, the lowest rates were recorded in subgroups II-B. Low results in all groups may be related to the non-continuous use of the speech processor. However, in all study groups, the maximum score was noted by assessing the effectiveness of the cochlear implantation system in relation to the "work / school communication" scale.

At the same time, "telephone communication" indicators showed a statistically significant increase in group I, "use of visual aids" in sub-groups II-B.

Although subgroups II-B did not have the ability to freely assess quality of life due to the presence of concomitant pathologies (F 84, F 88, F 89, ICD), Dynamics of Cochlear Implant Performance Index questionnaire and a Hearing Integration Scale questionnaires were presented to their parents. It should be noted that, the results of the survey conducted in the research group were quite high, as it was 3 months later after the activation of the speech processor, and 9 months later.

Comparing the data of the survey process of the parents of patients from subgroup II-B correlations between the "Cochlear Implant Performance Index" and "Hearing Integration" questionnaires on the scales of Noise-Understanding Noise ($p \approx 0.04$) and Communication at Work in Education ($p \approx 0.004$) were found.

Thus, we have demonstrated significant progress in the dynamics of the auditory rehabilitation of patients after cochlear implantation (based on the results of tonal audiometry and speech audiometry in the field of free sound, the results of general and specific quality of life surveys).

The state of hearing function and characteristics of life quality indicators in dynamics

The best positive dynamics of hearing sensibility was observed among patients of Group II A. This is due to the fact that patients

have post lingual, hearing experience, as well as the regulatory features of the Cochlear Implantation speech processor in older patients. Besides it, some Chinese scientists have shown that there is no exact correlation between the time of onset of deafness and tonal audiometry.

Speech recognition indicators have also increased together with the improvement of hearing function through the Cochlear Implantation speech processor.

The best speech recognition indication was recorded among Group I patients. The lowest speech distinction was recorded in Group II B patients, due to concomitant general psychological developmental disorders and lack of hearing experience before cochlear implantation.

It is known that, besides distinguishing affects the ability to distinguish sounds, create speech, and speech cochlear implantation, also affects an important aspect of life such as an social activity of person.

For assessment of objective effect of cochlear implantation to adaptive relations as a human-society, reveals the possibility of using life quality surveys related to human health.

According to international standards of provision of medical care the concept of life quality related with health state is gaining great relevance. Surveys of life quality related with human health is always interesting for practical doctors as an indicator of efficiency of implemented treatment. For this purpose general and specific life quality questionnaires were prepared.

We suggest the possibility of using a general SF-36 survey related to a person's health status for assessment of efficiency of hearing and speech rehabilitation measures. The using experience of Azerbaijan version of the questionnaire shows that its approbation is sufficient in various fields of medicine, even in patients with hearing impairment.

The another interesting fact is that, although the number of post lingual patients was predominant in group II, life quality indicators due to all testing scales significantly differs from indicators of

Subgroup II-A. But, there are statistically significant differences due to the SF-36 survey scale on the "emotional state" and "general health" scales between Group I and Subgroup II-A during the activation of the speech processor and 9 months later. The following fact may be related with age features of observed patients: attitudes towards the emotional condition of adolescents as well as attitudes to personal health.

Before the cochlear implantation surgery in all patients there was diagnosed bilateral chronic aggravation, IV degree relative deafness based on complaints, anamnesis and instrumental examination methods.

Figure 1.Fixation of the active electrode at the entrance to the cochleostomy.

The general condition of all patients was satisfactory at the initial examination. The electrodes were inserted from the cochleostomy by C.I. surgery using the method of transmastoidal intervention on the snail in all patients. The postoperative period passed without complications. The speech processor was activated

and initial adjustment was performed 1 month later after the surgery (Figure 1).

No pathological changes were found in all patients during otomicroscopy.

The result of tonal audiometry in the dynamics in the field of free sound

Besides the SF-36 questionnaire of life quality a specific “Cochlear Implant Function Index” questionnaire was presented to all patients. This survey is used to assess the auditory rehabilitation of the English-speaking population in real acoustic conditions of the environment after cochlear implantation. As the result of implemented survey it became clear that 3 and 9 months later after activation of the speech processor of cochlear implant, the activity index was low in all groups, the lowest indicator was observed in Subgroup II-B. Such situation may be related with in consistent use of speech processor in all patient groups, lack of hearing experience in this group of patients, answering of the questionnaire by parents due to concomitant diseases such as general psychological developmental disorders in subgroups II-B. This leads to a condition called in psychology as the "failure of expectations" syndrome. Thus, habits and skills after cochlear implantation habits and skills after cochlear implantation do not match parental expectations in children with psychological disorders do not match with expectations of parents, and it leads to a biased assessment of the achievements of such children.

After activation of the speech processor, all patients underwent tonal audiometry in the free sound field (Table 1).

Paying attention to results given on the table 1we can see that the limit of tonal audiometry is lower in Group I than in Group II. This fact may be connected with the activation of the speech process and the establishment of the regulation card carried out in group II according to the subjective feelings of each major patient.

Difference of distribution of the results of tonal audiometry and dB in Group I, Subgroups II A and II B and control group was

statistically significant (p≥0,05). But, results in control group differed statistically significantly from the results of tonal audiometry mentioned in other groups (p≤0,05).

The general condition of all patients was satisfactory on re-examination.

In all patients no pathological changes were detected during otomicroscopy.

Table 1.

The results of tonal audiometry in the free sound field when activating the speech processor of cochlear implant in groups, dB

Frequency	Group I	Subgroup II-A	Subgroup II-B	Control group
500 Hs	↓35,4±5,2 →	↓35,8 ±3,4 →	↓40,8 ±7,9 →	→ *8,2±3,5 ↓
1000 Hs	↓35,8±7,9 →	↓40,2 ±5,8 →	↓40,9 ±5,8 →	→ *6,4±4,6 ↓
2000 Hs	↓45,9±8,4 →	↓50,2 ±7,9 →	↓50,4 ±6,4 →	→ *10,5±4,6 ↓
4000 Hs	↓55,3±8,9 →	↓55,3 ±11,5 →	↓60,2 ±7,9 →	→ *7,4±5,4 ↓
Average value of speaking frequency, dB	44,0 ±12,9 →	44,8± 14,9 →	47,7± 12,9 →	→ *7,4±1,7

Note: *with statistically significant difference (t≥2,0, *p≤0,05).

3 months later after cochlear implant activation and speech processor regulation all patients underwent tonal audiometry in the field of free sound (with an activated system of cochlear implant).

Subjective assessment of the quality of electroacoustic stimuli given to the patient while activating of speech processor was conducted according to electroacoustic reflexometry and nerve response telemetry. The results of tonal audiometry in the free sound

field 3 months later after activation of the speech processor of the cochlear implant for all study groups are given in Table 2.

Table 2.

The results of tonal audiometry in the free sound field 3 months later after activation of the speech processor of the cochlear implant, dB

Frequency	**Group I**	**Subgroup II-A**	**Subgroup II-B**	**Control group**
500 Hs	↓28,8±5,2 →	↓35,0±5,6→	↓32,7±7,9→	→ *8,2±3,5↓
1000 Hs	↓25,0±6,4→	↓30,6±5,8→	↓34,6±5,4→	→ *6,4±4,6↓
2000 Hs	↓30,6±8,2→	↓34,8±6,8→	↓35,8±5,2→	→ *10,5±4,6↓
4000 Hs	↓35,6±8,9→	↓35,2±7,2→	↓36,4±3,9→	→ *7,4±5,4↓
Average value of speking frequency, dB	30,8±8,8 →	33,8±6,9→	35,9±8,8→	→ *7,4±1,7

The statistical value of patients' hearing 9 months later after the activation of the speech processor was not different from the indicator observed 6 months ago (Table 3, graph.1).

The results in the control group 9 months later after DP activation of the cochlear implantation system differed statistically significantly from the results of tonal audiometry recorded in other groups ($p \leq 0,05$).

Related with this we suggested, for assessment of the effect-tiveness of auditory speech rehabilitation in patients of Subgroup II-B to use the "Hearing Integration Scale" too. The conducted surveys showed that the existing correlation between the indicators of the questionnaires "Understanding speech in noisy conditions" and "CIPI on communication scales at school" and "Hearing integration scale"

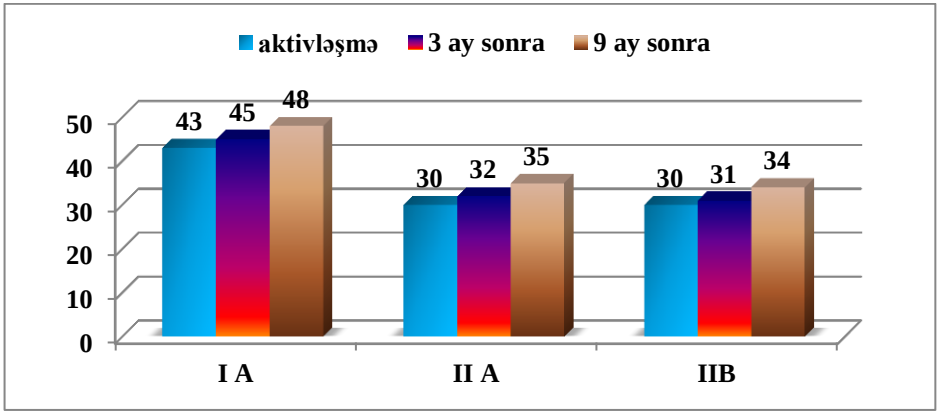
proves the effectiveness of the complex use of the above mentioned questionnaires.

Table 3.

Distribution of the results of tonal audiometry in the field of free sound in the control group 9 months later after DP activation of the cochlear implantation system, dB

Frequency	Group I	Subgroup II-A	Subgroup II-B	Control group
500 Hs	↓27,4 ± 4,1→	↓33,9 ± 5,2→	↓31,7 ± 8,1→	→*8,3 ± 2,8 ↓
1000 Hs	↓23,8 ± 6,2→	↓30,4 ± 6,2→	↓33,9 ± 6,1→	→*6,2 ± 3,6 ↓
2000 Hs	↓29,8 ± 7,8 →	↓33,9 ± 6,4 →	↓35,8 ± 4,8 →	→*11,5 ± 3,4 ↓
4000 Hs	↓34,6 ± 6,7 →	↓34,2 ± 6,8 →	↓36,2 ± 4,7 →	→* 8,6 ± 3,4 ↓
Average value of speking frequency, dB	28,9 ± 6,2 →	33,1 ± 6,2 →	34,4 ± 5,9 →	→ *8,6 ± 3,3

Note: *with statistically significant difference (t≥2,0, *p≤0,05).



Graph 1. Results of tonal audiometry in the field of free sound in dynamics.

Thus, based on the results of the SF-36 questionnaires the life quality indicators were quite high during the activation of the speech processor of the cochlear implant (50% and more).

Dislike the SF-36 questionnaire in the examined groups, low level (less than 50%) was noted on all tested scales of quality of life both during activation of the cochlear implant's speech processor and after 3 and 9 months. 3 months later after using C.I. speech processor improvement of some indicators of SF-36 questionnaire, also the scales of "emotional role activity", "social activity" and "viability" was noted: 4 of 5 patients (80%) were able to hold short talks with acquaintances after 3 months, 9 months later, they were able to talk freely even with strangers. The obtained data are also consistent with results of European researches. Evidence suggests that cochlear implantation may be more common for the elder people: The age limit should not be taken as the only contraindication, The health status of an elderly person who is a candidate for surgery should be assessed comprehensively.

Thus, an improved auditory algorithm measured by speech audiometry and tonal audiometry in the free sound field, at the same time the answered specific questionnaires confirms that the cochlear implantation is an effective method for the integration of patients with severe neurosensory hearing loss and deafness into the society of hearing people. Assessment of life quality indicators of patients after the cochlear implantation and cochlear implant efficiency allows to achieve certain results in relation to the correction of the rehabilitation program and the adjustment of the speech processor of the cochlear implant.

CONCLUSIONS

1. A differential method for determining the effectiveness of hearing correction after cochlear implantation has been developed. This method includes the measurement of the limits of tonal audiometry in the field of free sound, the measurement of the limits of speech differentiation depending on the degree of speaking skills [2,8];

2. The speech processor adjustment algorithm which we have improved allows us to evaluate the effectiveness of rehabilitation in patients after cochlear implantation. Determination of survey results using general and specific surveys of life quality completes the proof of the functional effectiveness of the cochlear implant [1,3,5];
3. Statistically significant improvements in speech differentiation in all study groups regardless of gender, age, concomitant pathology, degree of use of speech skills were identified using a cochlear implant speech processor [6,7,9].
4. According to the results of the survey, regardless of age and gender the life quality of participants in all study groups improves after cochlear implantation. In this case, the use of an adapted version of the general SF-36 survey on life quality, including specific Cochlear Implant Function Index and Hearing Integration Scale, allows not only to assess the quality of life of patients after cochlear implantation, but also to monitor the development of hearing skills [4,10,11].

PRACTICAL RECOMMENDATIONS

1. The effectiveness of rehabilitation after cochlear implantation for all patients should be assessed at each stage through an improved speech processor adjustment algorithm developed as a result of our study. After cochlear implantation, all patients should have free sound audiometry. This method is the most convenient and accessible examination method that allows quantitative measurement of hearing function;
2. Speech differentiation should be conducted among patients with adequate vocabulary and auditory experience. Questionnaires using general and specific life quality surveys should be performed in all patients after cochlear implantation;
3. It is important to follow the dynamics of the results achieved in the survey process. In this case, the objectivity of the results should be compared with the age of the respondents, as well as their success in the rehabilitation process;

4. It is advisable to use the interview method, which replaces the written questionnaire method, in patients who have difficulty in objectively assessing the questions asked when determining the quality of life;
5. When formulating clinical and economic standards of medical care after cochlear implantation, it is necessary to organize the timing of the adjustment sessions of the speech processor.

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The defense will be held on «29» December 2021 at «14» o'clock at the meeting of the Dissertation council ED 2.05

Address: AZ 1022, Baku city, A. Gasimzadeh street 14 (conference hall)

The dissertation is available in the library of the Azerbaijan Medical University.

The electronic versions of the dissertation and abstract are published on the official website of the Azerbaijan Medical University (www.amu.edu.az).

The abstract was sent to the required addresses on «25» November 2021

Signed for print: 17.11.2021

Paper format: 60 x 84 1/16

Volume: 35840

Number of hard copies: 20