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Betimi i Hipokratit

Në çastin kur po hy në radhët e anëtarëve të profesionit mjekësor premtoj solemnisht se jetën time do ta vë në shërbim të humanitetit. Ndaj mësuesve do ta ruaj mirënjohjen dhe respektin e duhur. Profesionin tim do ta ushtroj me ndërgjegje e me dinjitet. Shëndeti i pacientit tim do të jetë brenga ime më e madhe. Do t'i respektoj e do t'i ruaj fshehtësitë e atij që do të më rrëfehet. Do ta ruaj me të gjitha forcat e mia nderin e traditës fisnike të profesionit të mjekësisë.

Kolegët e mi do t'i konsideroj si vëllezër të mi.

Në ushtrimin e profesionit ndaj të sëmurit tek unë nuk do të ndikojë përkatësia e besimit, e nacionalitetit, e racës, e politikës, apo përkatësia klasore. Që nga fillimi do ta ruaj jetën e njeriut në mënyrë apsolute. As në kushtet e kërcënimit nuk do të lejoj të keqpërdoren njohuritë e mia mjekësore që do të ishin në kundërshtim me ligjet e humanitetit. Këtë premtim po e jap në mënyrë solemne e të lirë, duke u mbështetur në nderin tim personal.

The Oath of Hippocrates

Upon having conferred on me the high calling of physician and entering medical practice, I do solemnly pledge myself to consecrate my life to the service of humanity. I will give my teachers the respect and gratitude which is their due. I will practice my profession with conscience and dignity. The health of my patient will be my first consideration. I will respect the secrets which are confided in me, even after the patient has died. I will maintain by all the means in my power, the honor and the noble traditions of the medical profession.

My colleagues will be my brothers.

I will not permit considerations of religion, nationality, race, party politics or social standing to intervene between my duty and my patient. I will maintain the utmost respect for human life from its beginning even under threat and I will not use my medical knowledge contrary to the laws of humanity. I make these promises solemnly, freely and upon my honor

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REHABILITATION IMPACT ON THE ARTICULATION OF CHILDREN WITH A COCHLEAR IMPLANT

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ABSTRACT

Background: Improving the articulation of children who have permanent or profound hearing loss simply does not come with cochlear implantation alone. Coherent, careful and comprehensive rehabilitation is required to achieve complete success.

Objective: The aim of this study is to show that rehabilitation is important for improving the articulation of children with a cochlear implant.

Material and methods: This study is a prospective and interventional clinical study involving 12 children with a cochlear implant from different socio-economic families.

Results: In first-born pediatric patients with CI after rehabilitation, less voice disorders and less voice deviations were detected compared to second-borns. All the second-born children were found to have very poor language production, language comprehension and vocabulary significantly below their age and poor articulation, that is, severe voice disorder. The degree of voice disorder is lower in children who went to rehabilitation for a longer period of time. Apart from weekly rehabilitation treatment frequencies, no other characteristics of the pediatric CI patients included in the study showed significance for predicting rehabilitation impact on articulation.

Conclusion: The results do not confirm a significant rehabilitation impact on the articulation of pediatric patients with CI.

Key words: children, patients, cochlear implant, rehabilitation, articulation.

INTRODUCTION

Many children in many different countries have been identified as having permanent or profound hearing loss. Today in the world 5% of the world's population or 430 million people face hearing loss, and of them 34 million are children. The number is constantly growing, and by the end of 2050 it is expected that there will be 700 million people in the world with severe impairment or complete hearing loss, of which about 55 million are expected to be children (WHO, 2023).

Deafness is a serious problem, because it entails many unwanted consequences and significantly affects the quality of life of the child. Hearing loss can affect language learning and acquisition, as a lack of speech perception can also affect speech understanding, cognitive development, emotional stability, (Ali & O'Connell, 2007), physiological functions, psychological state (Contrera et al., 2015), psycho-social adjustment and finally, on the overall health and well-being of these children (Punch & Hyde, 2011).

Cochlear Implant (CI)

A widely used hearing improvement technique in clinical practice is CI. A CI is a special high-tech electronic device that is surgically placed in the inner ear and aims to

provide a sense of sound for profoundly deaf or severely hard of hearing people (NIDCD, 2013). It is intended to perform the function of damaged or absent cochlear hair cells and works by direct electrical stimulation of auditory nerve fibers.

Figure 1 shows CI and briefly explains how it works.

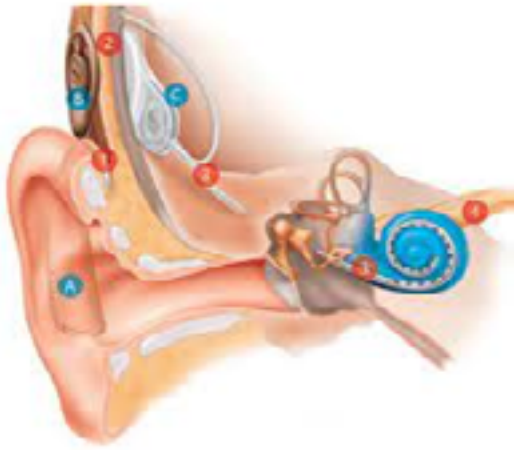

Figure 1. Parts of a cochlear implant and how it works

1. The microphone collects the sound and the sound processor (A) analyzes it and encodes it into a digital code.

2. The sound processor transmits the digitally encoded sound through the cable (B) to the implant (C) under the skin.

3. The implant converts the digitally encoded sound into an electrical signal and transmits it to an array of electrodes placed in the cochlea.

4. The implant's electrodes stimulate the auditory nerve fibers in the cochlea, which transmit sound signals to the brain to trigger the sensation of hearing (MedStar Health, 2022).

Many hearing-impaired children benefit significantly from CIs and advanced speech processing strategies (Levine et al., 2016), so cochlear implantation is considered one of the best options for returning such patients to the world of sound (Hanvey et al., 2016), and is particularly significant because it is considered a viable therapeutic option in cases of children with severe bilateral sensorineural hearing loss, who have not previously shown benefits from the use of other hearing aids (Lachowska al., 2010; Santos et al., 2011; Steven et al., 2011). Audiologists believe that CI is a great medical and engineering success that is more compatible with the human nervous system compared to any other prosthesis (Samadi, 2003) and allows the child to recognize speech sounds more easily, and oral language acquisition occurs faster and with less stress (Costa, Bevilacqua & Amantini, 2005). There is also an accepted opinion that CIs improve speech perception, have a positive effect on articulation (Kelsall et al., 2021), improve the hearing threshold of these children, allow them to better understand both speech and language (Spencer, 2003) and improve the quality of their life in general.

However, CI does not cure deafness, but provides a sense of hearing with the necessary quality for the perception of speech sounds (Costa, Bevilacqua & Amantini, 2005). Therefore, evaluating the effects of CI is a complex task. It is not enough just to implant a CI, but the post-operative rehabilitation process is just as important. The implant itself must be supported by a series of other activities, which will first support and then accelerate the learning process, in order to give a positive result on the articulation of these children. Therefore, special rehabilitation is needed to further develop the speech skills of children with a cochlear implant (Tye-Murray, 2009).

Rehabilitation

Once the child recovers from implantation and the CI is activated, the real journey begins. Consistent voice support with CI programming is required to ensure that the speech processor program is optimized and the implant is working properly. In addition, the child must receive early intervention treatments, which will focus on teaching the child how to associate his articulation with the auditory information he will receive from the CI. The process of rehabilitation of implanted children is complex and requires comprehensiveness in terms of methods, time of initiation and duration of rehabilitation, as well as in terms of the persons involved. The goal of rehabilitation is to ensure well-functioning communication in the family, in preschool and school age and later in life.

Because children missed much of the verbal content before CI, and because they rely more on nonverbal cues during interaction (Most & Aviner, 2009), methods related to visual information are needed to influence auditory performance. Thus, children will begin to integrate auditory and visual modalities, which can help facilitate the rehabilitation process between the interaction of the auditory lexicon and the visual lexicon. To strive to catch up with their peers, for children aged 2 to 3 years, the ideal

rehabilitation approach is the auditory-verbal listening approach, and for older children pronunciation training is necessary (Sichang & Rui, 2005). Using music, speech therapy and auditory training for correct articulation, teaching based on stories, creative play, are significant interventions in the rehabilitation of children with a cochlear implant. In this article it was imperative to consider how children with cochlear implants integrate both verbal and non-verbal inputs in speech perception and production.

Age at implantation is one of the main factors in the variability of rehabilitation outcomes on children's articulation (Boons et al., 2012). Many researchers who have studied the articulation abilities of implanted children at different ages support the idea that the earlier the implantation is done, the better the child's articulation development (Karovska Ristovska, 2021). They claim that implementation before 24 months of age improves articulation development in children (Colin et al., 2017) and that at the age of 18 months, the outcome is better than later (Gillis, Schauwers & Govaerts, 2002), and that implantation between 12-18 months of age increases the immediate outcome even more on the child's articulation in relation to later (Ali & O'Connell, 2007). Other researchers confirm this view when they claim that there is no statistically significant difference between typically developing children and children with cochlear implants for language comprehension and production after 4-7 years of age (Geers, Nicholas & Sedey, 2003). Hence, it seems very clear that the age of implantation is important for the linguistic behavior of the child.

Lack of auditory input from the environment and speech in early childhood disrupts the normal development of the auditory system and hinders the development of speech and language abilities (Thabet & Said, 2012). Therefore, contacts with others are also important in the process. First, family members, and other close adults, and then peers, whereby the child gradually develops a sense of self in relation to the psycho-social and physical world (Stern, 2000). The quality of the child's interaction with the family depends on several socio-economic factors, such as: socio-economic status (parents' employment - shorter time for interaction with children, income in the family - a requirement for visits to professionals and provision of quality treatments for the child, number of children and number of members in the family - a large family is a prerequisite for less care than a child with CI, education of parents - ignorance of parents about the benefits of CI can result in late implementation, a difficult rehabilitation process and the possibility of articulatory failure and etc. Success in rehabilitation largely depends on the commitment of the family and the family environment in which the child with CI develops.

Loneliness and lack of friendships lead to difficulties in communication, especially with other children (Cook et al., 2008). It can be noted that regular contact and interaction with peers allows children with CI to acquire articulation skills (Frønes, 1995). These auditory skills are essential to the production and development of speech and are seen as a natural result of incidental learning in everyday life situations (Bevilacqua & Formigoni, 2005). These contacts are especially important because children learn through play, and do not perceive the learning process as seriously as with adults.

But, articulatory training is also needed to optimize the use of auditory plasticity and the learning of speech patterns. It is necessary to continue and supplement the natural model of communication, which further develops children's communication skills (Tait, De Raeve & Nikolopoulos, 2007). In this direction, experts make a special contribution. In many cases, the task of the speech therapist is to convince the parents that post-implantation rehabilitation is crucial for the further social and emotional development of their child and that their role in the process of articulation development is vital for their child. In addition, the speech therapist is the person who most expertly teaches and helps the child, with which speech therapy participates with 54% of the impact of rehabilitation on the child's articulation (Moradi et al., 2021).

There are other aspects that should be taken into account, especially when the child has other comorbid conditions besides hearing loss. Each disability that is added to the deafness will present different characteristics that will affect the rehabilitation of the child's articulation.

OBJECTIVE OF THE STUDY

The main goal of the study is to identify, through the final results of the rehabilitation, the post-implantation parameters as accelerators of the success of the rehabilitation of children with a cochlear implant in the Republic of North Macedonia.

METHODS

Each rehabilitation session included activities designed to encourage the development of the child's age- and disorder-appropriate listening and speaking skills, as well as ongoing assessment of the child's adaptation to rehabilitation goals and ongoing monitoring and evaluation of the child's articulation achievements.

Study Population

In this study, the performance of 12 children with CI involved in rehabilitation treatments with different rehabilitation approaches was tested. The children are patients of PHI Institute for Rehabilitation of Hearing, Speech and Voice - Skopje, from where consent was obtained to conduct the study. The children were previously examined at the Ear, Nose and Throat Clinic in Skopje and they meet the criteria for participation in the study from several aspects.

Criteria for inclusion in the study

- • Neurological findings;
- • Audiometry;
- • ENT finding;
- • BERA (objective audiometry);
- • Assessment by a child psychiatrist regarding psychiatric disorders;
- • Psychological findings, assessment of mental functions;
- • Permission from parents to participate.

Exclusion criteria from the study

- • adult patients;
- • patients with postlingual hearing loss and
- • pediatric patients without parental permission to participate in the study.

Parameters Evaluated

Preoperative and postoperative parameters were evaluated. Preimplantation parameters, in the form of preoperative factors, are:

1. age at implantation;
2. gender;
3. time spent in deafness;
4. child born in order;
5. place of residence;
6. monthly income in the family;
7. level of education of the parents and
8. parents' hearing condition.

Postoperative factors:

1. time the child spends in social interaction;
2. time of starting rehabilitation in relation to cochlear implantation;
3. duration of rehabilitation process and
4. frequency of rehabilitation process.

Evaluated Achievements

Articulation achievements in pediatric CI patients were assessed in four ways. They are:

1. language production - average sentence length;
2. language comprehension and vocabulary;
3. the voice disorder and
4. the type of voice deviation.

Instruments for evaluation of rehabilitation effects

Achievements in articulation in pediatric patients with CI were evaluated with three tests. They are:

1. Mean length of utterance (MLU) - a simple measure of a child's syntactic development. It represents the ratio of total word turnover to total sentence turnover. For this test it is important to know the age of the child and determine the MLU, and then compare the result with their equivalent in the table of Miller (1981).

2. Peabody III - pictorial speech test, which is one of the most commonly used standardized tests. The test is individually administered and is designed for individuals ages 2-6 to individuals over 90 years of age. The test screens patients' speaking abilities and measures receptive and expressive speech achievement (Dunn & Dunn, 1997). It is easy to use after studying the manual. Administration time is relatively quick and scoring is simple. After the raw scoring, the results are compared with the norms and standards of the test.

3. Articulation test - based on Dj's Global Articulation Test of Kostić and S. Vladisavljević (Petrić, 2018) and adapted to Macedonian language (Sinadinovska, Ristova & Sinadinovski, 1990). With it, the number, type and degree of damaged voices can be detected, and in general, it tells us which voices in the child deviate from the desired pronunciation. The original test contains 30 words, while our test contains 31 words (for each letter of the alphabet). Words can be shaped according to the speaking area. So for example, in the original test for the

voice b is the word grandmother, and the same is used in our case, but for the voice h the original test uses the word forehead as opposed to eyes in our test. If the word contains two identical sounds, only the pronunciation of the first sound is evaluated. The word can be repeated 2-3 times, and the most appropriate pronunciation is noted. The sum of good, borderline and damaged or missing voices is scored. With this test, in addition to the evaluation of the phonemic structure, the quality of the pronunciation of each voice is also analyzed.

STATISTICAL ANALYSIS

The sample data were statistically processed with the statistical program SPSS version 26. First, the sample characteristics expressed as mean±SD for continuous variables and as numbers and percentages for categorical variables were analyzed. Correlations between the characteristics of pediatric patients and their articulatory abilities were examined with Pearson correlation and Knedall's tau-b (according to the type of variables), while their predictive power was examined with Linear Regression (for MLU) and Ordered Logistic Regression (for Peabody III results and the articulation test). All tests were conducted at a 95% confidence interval and values of $p<0.05$ were considered statistically significant.

RESULTS

Characteristics of the sample

Initially, the study was planned to include 40 children from Institute for Rehabilitation of Hearing, Speech and Voice - Skopje, but since only 12 parents gave their consent, the sample was reduced to 12 children. Sample characteristics are shown in Table 1.

Table 1. Patient Characteristics

Age, y	8.75±2.958	
Gender: male, n (%)	6 (50)	
Age of CI, y	4.17±1.267	
Period of deafness, y	4.05±1.642	
Child in order: first, n (%)	8 (66.7)	
Child in order: second, n (%)	4 (33.3)	
Environment: urban, n (%)	5 (41.7)	
Environment: rural, n (%)	7 (58.3)	
Income in the family, €	579.17±279.169	
Parents' education: primary/4 years, n (%)	1 (8.3)	
Parents' education: high/high, n (%)	3 (25)	
Parents with impaired hearing, n (%)	0 (0%)	
Social interaction of the child, h	7.58±1.832	
Starting rehabilitation before CI, y	0.25±0.452	
Rehabilitation period, y	4.33±2.015	
Frequency of rehabilitation treatments per week, n	2.67±0.888	
Duration of rehabilitation per week, min	123.75±43.439	
Results		
Language production, min	1.650±0.8857 (1-4.0)	
Language comprehension and vocabulary, n (%)	Expressed under the age	10 (83.3)
	Under the age	1 (8.33)
	Equivalent to age	1 (8.33)
Voice disorder, n (%)	Bad articulation	6 (50)
	Partially good articulation	6 (50)
	Good articulation	0 (0)
Type of voice deviation, n (%)	Omission	5 (41.6)
	Substitution	1 (8.3)
	Omission and substitution	4 (33.3)
	Omission, substitution and distortion	2 (16.7)

The sample consists of the same number of male and female respondents, i.e. 6 each (50%). The age of the sample is 8.75±2.958 years, and the youngest patient is 6 years old (4 patients or 33.3%), and the oldest is 15 years old (1 patient or 8.3%). The age of CI is 4.17±1.267 years (the youngest patient was 2 years old and the oldest was 6 years old), while the period of deafness in children is 4.05±1.642 years. The longest period of deafness is 6 years (3 patients or 25%), and the shortest is only 1 year (1 patient or 8.3%). The majority of the sample lives in rural areas, namely 7 (58.3%), and 5 (41.7%) in urban areas. According to the income of the family, the patients differ significantly, ranging from only 200 € (1 patient or 8.3%) to 1000 € (3 patients or 25%). Average incomes across the sample are €579.17±279.169. In terms of education, it varies considerably. In 1 patient (8.3%), the parents had completed 4 years of primary education, and in most cases, in 3 patients (25%), both parents had a higher education. 2 patients each (16.7%) have parents with completed primary or primary, secondary and secondary education and secondary and higher education. No patient has a hearing-impaired parent. Patients spend an

average of 7.58±1.832 hours per day in social interaction, and the minimum determined time is 4 hours (1 patient or 8.3%) and the maximum time is 10 hours (2 patients or 16.7%). Only 3 patients (25%) started the rehabilitation process 1 year before CI, while the remaining 9 (75%) immediately after implantation. The average period of starting rehabilitation for the sample is 0.25±0.452 years. Patients undergo rehabilitation for an average of 4.33±2.015 years. The shortest rehabilitation lasted only 1 year, while the longest rehabilitation lasted 8 years (in 1 patient or 8.3%). The patients went to rehabilitation treatments an average of 2.67±0.888 times a week, and the duration of these weekly treatments was 123.75±43.439 minutes. Even half of the patients went to rehabilitation twice a week, with treatments lasting 90 minutes, while 1 patient stands out from the group with 5 treatments and 225 minutes a week.

The length of language utterance in children 1.650±0.8857 minutes, and the results range from 1.0 in 4 children (33.3%) to 4.0 in 1 child (8.3%). In most of the children, the language comprehension and vocabulary was clearly below their age (10 or 83.3%), and in one of them (8.3%) the results were below the age and equivalent of the age. Bad and partially good articulation was diagnosed in 6 children each (50%), and unfortunately not a single child has good articulation ability. The most children had an omission (5 or 41.7%), then they thought of a substitution (4 or 33.3%), omission, substitution and distortion have 2 children (16.7%), and only one child (8.3%) has voice substitution.

The correlation coefficients between the characteristics of the pediatric patients with their language production, their language comprehension, and their voice disorder are shown in Table 2.

Table 2. Examination of correlations between characteristics of pediatric patients and the results of the three articulation tests

Characteristic	Language production	Language comprehension and vocabulary	Voice disorder	Type of voice deviation
Age, y	p=0.282 Pc=0.338	p=0.662 τ= -0.115	p=0.288 τ=0.284	p=0.453 τ= -0.188
Gender	p=0.540 Pc=0.197	p=0.174 Pc= -0.420	p=0.000 Pc=1.000	p=0.400 Pc=0.268
Age of CI, y	p=0.330 Pc=0.308	p=0.300 τ= -0.286	p=0.931 τ=0.024	p=1.000 τ=0.000
Period of deafness, y	p=0.405 Pc=0.265	p=0.315 τ= -0.270	p=0.867 τ= -0.046	p=0.591 τ= 0.137
Child in order	p=0.098 Pc= -0.500	p=0.348 Pc= -0.297	p=0.010 Pc= -0.707	p=0.160 Pc= -0.433
Environment	p=0.167 Pc=0.409	p=0.826 Pc=0.071	p=0.092 Pc=0.507	p=0.275 Pc=0.343
Income in the family, €	p=0.823 Pc= -0.073	p=0.158 τ= -0.369	p=0.745 τ=0.087	p=0.823 τ= -0.056
Education of parents	p=0.432 τ=0.186	p=0.745 τ= -0.085	p=0.808 τ=0.065	p=0.823 τ= -0.056
Social interaction of the child, h	p=0.256 Pc=0.356	p=0.183 τ=0.353	p=0.212 τ=0.337	p=0.147 τ=0.366
Starting rehabilitation before CI, y	p=0.372 Pc=0.284	p=0.394 τ= -0.252	p=0.371 τ= -0.239	p=0.493 τ=0.192
Rehabilitation period, y	p=0.875 Pc= -0.051	p=0.746 τ= -0.084	p=0.373 τ=0.235	p=0.050 τ= -0.477
Frequency of rehabilitation treatments per week, n	p=0.858 Pc=0.058	p=0.153 τ= -0.409	p=0.789 τ=0.078	p=0.413 τ= -0.223
Duration of rehabilitation per week, min	p=0.987 Pc=0.005	p=0.162 τ= -0.390	p=0.930 τ=0.025	p=0.336 τ= -0.256

From the correlation table we note only two significant correlations. The first shows that the degree of voice disorder is lower in children who were born earlier in the sequence (p=0.010; Pc= -0.707). Minor voice disorders and minor deviations were detected in first-born children compared to second-born children. Namely, very poor language production, language comprehension and vocabulary significantly below their age and poor articulation, i.e. severe voice disorder, were reported in all second-born children. Omission, distortion and substitution were found in all of them. The second correlation indicates the fact that the duration of rehabilitation significantly correlates with the type of voice disorder and that children who went to rehabilitation longer tend to improve their voice, that is, their voice disorder is less compared to those who went to rehabilitation for a shorter time (p =0.050; τ= -0.477).

We classified the predictors of achievement in articulation into three groups: demographic characteristics, socio-economic factors and rehabilitation factors. Their significance as predictors is shown in Table 3.

From the coefficients, we can ascertain the predictive role of only one variable, that of the type of voice disorder (r=0.000). Children who go to rehabilitation treatments more often tend to have milder voice disorders. Through none of the analyzed variables, that is, through any other characteristic of pediatric patients with CI, the rehabilitation impact on their articulation cannot be predicted. The prediction is so poor that no significance coefficients were even generated for some variables.

Table 3. Regression Analysis of Variables Potentially Influencing Articulation Results

Characteristic	Language production	Language comprehension and vocabulary	Voice disorder	Type of voice deviation
	p value	p value	p value	p value
Demographic characteristics				
Age, y	0.326	0.570	0.209	0.812
Gender	0.348	0.692	0.535	0.566
Age of CI, y	0.672	0.444	0.413	0.518
Period of deafness, y	0.672	/	0.780	0.425
Socio-economic factors				
Child in order	0.604	0.388	/	0.222
Environment	0.370	0.331	0.640	0.889
Income in the family, €	0.818	0.448	0.460	0.829
Education of parents	0.517	0.854	0.685	0.680
Rehabilitation factors				
Social interaction of the child, h	0.313	0.643	0.971	0.161
Starting rehabilitation before CI, y	0.270	0.815	0.977	0.272
Rehabilitation period, y	0.880	0.998	0.975	0.069
Frequency of rehabilitation treatments per week, n	0.183	0.917	0.858	0.000
Duration of rehabilitation per week, min	0.180	0.998	/	/

DISCUSSION

Hearing loss is a big problem, especially for children, because the world of silence limits them in every way and negatively affects the quality of life, which reflects on their overall health and well-being. But cochlear implantation brings hope to these patients, as it helps them regain hearing and articulation.

The cochlear implant is a technique used to improve hearing, which has given very good results in clinical practice. It is considered a very suitable hearing aid unlike other hearing aids and a CI is considered one of the best options for returning such patients to the world of sound, as CIs have been proven to improve speech perception, positively affect articulation, improve the hearing of these children, enable them to better understand both speech and language and improve the quality of their life as a whole.

But CI is not enough and must follow a hard and comprehensive rehabilitation treatment, in order to ensure functional communication in the family, in preschool and school environment and in general throughout life.

Children included in the study were observed to rely more on non-verbal cues during interaction, which is consistent with the findings of Most and Aviner (2009). However, although the recommendations of Sichang and Rui (2005) were followed for pronunciation training for children older than 3 years, the results were generally not as desired and expected. Although better results were observed in children in whom CI was implanted earlier, which is in accordance with the claim of Karovska Ristovska (2021), age does not correlate significantly with the outcome, which is in line with the claim of Geers, Nicholas and Sedey (2003).

Although according to Stern (2000) social interaction is important for these children, this study did not show a significant correlation with rehabilitation success. Not even speech therapy treatments, in terms of the frequency and duration of weekly treatments, correlate significantly with the rehabilitation outcome, although Moradi and his colleagues (2021) claim the opposite and attribute the greatest positive impact to speech therapy treatments. However, the results of regression tests showed that rehabilitation visits have a predictive role for the type of voice disorder ($p=0.000$). The relationship is positive and shows that children who go to rehabilitation treatments more often tend to have milder voice disorders. In addition, the study showed two significant correlations. One shows that the degree of voice disorder is lower in children who were born earlier in the sequence ($p=0.010$; $Pc= -0.707$). Minor voice disorders and minor deviations were detected in first-born children compared to second-born children. Namely, in all second-born children, very poor results were found according to the three analyzed aspects of articulatory abilities. Omission, distortion and substitution were found in all of them. The other significant correlation is from the rehabilitation aspect and shows that the duration of the rehabilitation significantly correlates with the type of voice disorder, which means that the degree of voice disorder is lower in children who went to rehabilitation longer ($p=0.050$; $\tau= -0.477$).

Apart from weekly rehabilitation treatment frequencies, no other characteristics of the pediatric CI patients included in the study showed significance for predicting rehabilitation impact on articulation.

Study Limitations

The biggest and most significant limitation of this study was the inability to obtain permission from multiple parents, which significantly reduced the sample from what was originally planned. This restriction entailed other restrictions. The reduced sample meant similar characteristics in terms of the birth order of the children in the families, as they were only first or second, and also all parents were without any hearing impairment, thus this characteristic was excluded from the examination. The children had similar voice disorders, that is, no child had good articulation, and according to the type of disorder, the children did not differ significantly. This caused non-significant results, and the inability to point out more important aspects of the rehabilitation impact on children's articulation.

CONCLUSION

There is no doubt that the cochlear implant is an opportunity for children from an early age to get the chance to develop hearing and articulation. Even though that rehabilitation plays an essential role in the process, there is always a risk that the implantation itself does not mean that the result is guaranteed.

So far, the results of our study did not give the expected results and did not show that the rehabilitation had a significant and positive impact on the children's language production, language comprehension, and vocabulary, nor on their voice disorder. Our further research study will show whether results will change by including additional participants.

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