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Impact of speech therapy on the improvement of voice quality in patients with unilateral vocal fold paralysis

Wpływ terapii logopedycznej na poprawę jakości głosu u chorych z jednostronnym porażeniem krtani

Anna Kuligowska[1], Barbara Jamróz[2], Joanna Chmilewska[2], Katarzyna Jędra[2], Tomasz Czernicki[3], Kazimierz Niemczyk[2]

[1]Students' General and Clinical Speech Therapy, Medical University of Warsaw
[2]Chair and Clinic of Otolaryngology, Medical University of Warsaw
[3]Department of Neurosurgery, Medical University of Warsaw

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ABSTRACT:

Aim of study: Evaluation of the speech therapy on voice quality in patients with unilateral vocal fold palsy.

Material and methods: The study group included 11 patients, 8 women and 3 men, in age between 16 to 72 years, with unilateral vocal fold palsy, diagnosed in ENT Department of Warsaw Medical University between 2017–2018. Each person completed questionnaires: the voice disability self-assessment scale (VHI), the voice-based quality of life (VRQoL) scale, the vocal tract discomfort scale (VTD). All questionnaires were completed twice, before and after the voice therapy. In addition, the acoustic analysis of the voice, the assessment of the maximum phonation time and the breathing tract were performed twice in each patient. Each of the patients had a voice rehabilitation consisting of a series of 10 meetings.

Results: Statistical analysis of the results of maximum phonation time, the self-assessment of voice disability, the quality of life depending on the voice, discomfort of the vocal tract voice acoustic analysis showed statistically significant differences in the results before and after rehabilitation ($p < 0.005$). In addition, the improvement of the respiratory tract was observed in the majority of patients.

Conclusions: Speech therapy significantly affects the voice quality of patients with unilateral laryngeal nerve palsy.

KEYWORDS: laryngeal paralysis, voice disorders, logopedic rehabilitation

STRESZCZENIE:

Cel pracy: Ocena wpływu terapii logopedycznej na jakość głosu u pacjentów z jednostronnym porażeniem krtani.

Materiał i Metody: Badaniem objęto 11 pacjentów, w tym 8 kobiet i 3 mężczyzn w wieku od 16 do 72 lat, diagnozowanych z powodu problemów z głosem w Klinice Otolaryngologii i Poradni Foniatrycznej SP CSK w latach 2017–2018. Każda osoba została poproszona o wypełnienie kwestionariuszy: skala samooceny niepełnosprawności głosu (VHI), skala jakości życia zależnej od głosu (VRQoL), skala dyskomfortu traktu głosowego (VTD). Powyższe kwestionariusze były wypełniane przez badanych dwukrotnie, przed rozpoczęciem rehabilitacji głosu oraz po niej. Ponadto u każdego z pacjentów została dwukrotnie wykonana analiza akustyczna głosu, ocena maksymalnego czasu fonacji oraz toru oddechowego. Każdy z chorych odbył rehabilitację głosu składającą się z cyklu 10 spotkań.

Wyniki: Analiza statystyczna wyników maksymalnego czasu fonacji, skali samooceny niepełnosprawności głosu, skali jakości życia zależnej od głosu, skali dyskomfortu traktu głosowego analizy akustycznej głosu wykazała istotne

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statystycznie różnice w wynikach przed rehabilitacją i po niej (p<0,005). Ponadto u większości pacjentów zaobserwowano poprawę toru oddechowego.

Wnioski: Terapia logopedyczna istotnie wpływa na jakość głosu pacjentów z jednostronnym porażeniem nerwu krtaniowego.

SŁOWA KLUCZOWE: porażenie krtani, zaburzenia głosu, rehabilitacja logopedyczna

LIST OF ABBREVIATIONS:

SP CSK – Independent Public Central Clinical Hospital
MPT – maximum phonation time
VHI – Voice Handicap Index
VRQoL – Voice Related Quality of Live
VTD – Vocal Tract Discomfort Scale

INTRODUCTION

Paralytic dysphoria is a voice disorder resulting from neurogenic damage to the neuromuscular structures of the larynx due to laryngeal nerve palsy or paresis [1]. Vocal fold palsy is manifested as its immobilization during breathing and phonation. It is the result of damage to a branch of the vagus nerve. Paralysis may be unilateral or bilateral.

The etiological breakdown distinguishes central and peripheral palsy. The most common cause of laryngeal infections are iatrogenic injuries, arising mainly from strumectomy. Often the result of these operations is damage to the recurrent laryngeal nerve, and sometimes the superior laryngeal nerve [2, 3]. As it is show by the research of various authors, these complications affect from 0.6% to 18% of patients in the first surgery, while for restrumectomy, the frequency increases from 20% to 30% [4, 5]. This is the second most common complication of thyroid surgery, shortly after intraoperative or postoperative bleeding [6]. Vocal fold palsy also includes idiopathic palsy, most often caused by a weakened immune system. Their number has grown over the last years [7].

As far as paralytic dysphonia is concerned, voice disorders are characterized by the presence of variously intensified symptoms, depending on the possibility of vocal fold abduction. Minor vocal disorders are characterized by a medial and median position of the vocal folds. In turn, intensified voice disorders occur when the vocal folds are in the intermediate position [8]. This is manifested by fatigability, weak voice, change in pitch and timbre, inspiratory wheezing associated with shortness of breath and a shortened phonation time. The voice becomes silent, soundless, it may be hoarse, dull, blowing [8]. In addition, excessive muscle tensing within the vocal tract is observed as an attempt to compensate for the function of the affected fold in patients with untreated paralytic dysphonia. This often causes discomfort associated with pain in the larynx area [4]. It should be remembered that apart from physical ailments, changes in the patient's psychosocial functioning constitute an important symptom for the patient's functioning [4, 6, 9]. This constitutes a serious argument for the need to include these patients in vocal rehabilitation as early as possible.

Damage to the recurrent laryngeal nerve does not only require laryngological and phoniatric diagnosis but also voice rehabilitation. Every patient suffering from voice disorders caused by paralytic dysphonia should report to a speech therapist in the shortest possible time from the occurrence of the problem in order to undergo a series of meetings aimed at rehabilitating the voice. Pharmacological or surgical treatment may be supported by voice therapy or provide an alternative treatment in the case of unsatisfactory results of rehabilitation for the patient.

The study aimed to assess the impact of speech therapy on voice quality, respiratory tract, pain within the vocal tract and voice self-assessment; in the group of paralytic dysphonia patients.

MATERIALS AND METHODS

Materials

The consent of the bioethical committee of Warsaw Medical University was obtained to conduct the study.

The study included patients diagnosed for voice problems in the Department of Otolaryngology and Phoniatric Clinic of SP CSK in 2017-2018. The study group comprised 11 patients, including 8 women and 3 men, aged 16 to 72. The average age was 48 years. Detailed characteristics of the study group are shown in Table I. All patients were diagnosed with iatrogenic unilateral vocal fold palsy. Detailed data is shown in Table II.

Methods

Each patient was examined according to a unified protocol. The interview included: voice self-assessment based on Voice Handicap Index (VHI), Voice-Related Quality of Life (VRQoL),

Tab. I. Characteristics of test group.

SEX		AGE			
Females	Males	Average ± SD		Median	Range
8	3	48,5±17,9		50	16–72
STIMULANTS*		**LARGE VOICE EFFORTS**		**PREVIOUS STUDY OF VOICE EMISSION**	
YES	NO	YES	NO	YES	NO
3	8	5	6	1	10

Characteristics of test group. *smoking

Tab. II. Scope of treatment together with a description of postoperative complications.

PALSY SIDE		REASON FOR PALSY				TIME FROM SURGERY TO REHABILITATION	
Right	Left	Partial strumectomy	Total strumectomy	Thyroid cancer resection	Parathyroid gland removal	AVERAGE (months)	RANGE (months)
5	6	3	6	1	1	2	1–9

Tab. III. Average, median, range and p-value of MPT result for groups before and after rehabilitation.

	AVERAGE ± SD	MEDIAN	RANGE	P
MPT before	7 ± 2,5	6,4	2,6-11	0,003
MPT after	15 ± 6	15	9-29	

Vocal Tract Discomfort (VTD). In addition, each patient underwent acoustic analysis of voice, evaluation of maximum phonation time and respiratory tract. Each patient underwent a voice rehabilitation consisting of a series of 10 meetings.

VHI is the most frequently used tool to investigate the impact of voice disorders on the patient's psychosocial functioning [10]. The scale has been divided into 3 parts, rated on a scale from 0 to 4, with 0 being "never" and 4 "always". The first one evaluates the self-assessment of the functional state (VHI-I), the second the self-assessment of the physical state (VHI-II), and the third the self-assessment of the emotional state (VHI-III). Obtaining from 0 to 30 points indicates a small disability of the voice, 31 to 60 points indicate an average disability of the voice, and above 61 points a significant disability of the voice [11].

VRQoL measures the impact of voice disorders on the voice quality of a patient's life. The questionnaire consists of 10 statements rated on a scale from 1 to 5, with 1 meaning "I never have a problem with it", and 5 "it couldn't be any worse". The lowest result is 10 points and the highest is 50. The higher the score, the worse the patient evaluates their voice-related quality of life. The questions and statements used in the questionnaire describe the socio-emotional and physical functioning of the patient [12]. VTD evaluates eight symptoms (burning, tension, dryness, pain, scratching, tenderness, irritation, a feeling of having a noodle stuck in the throat) in two subscales: frequency and tension. Both frequency and tension were determined by the patients themselves on a scale from 0 to 6. Each of the respondents was subjected to acoustic voice analysis using MDVP software (Multi-Dimensional Voice Program). Basic parameters were assessed, such as:

- F0 (basic mean frequency) – basic frequency in Hz;
- Jitter (evaluation index of relative basic frequency variation) – parameter of changes in the basic frequency;
- Shimmer (parameter for assessing amplitude modulation) – relative amplitude modulation;
- NHR (noise to harmonic ratio) – the ratio of noise to signal.

Next, the maximum time of phonation (MPT) was evaluated. After making a deep breath, the patient was asked for the longest possible phonation of the sound [a] at a convenient volume and pitch. The measurement is repeated three times, with a final selection of the best result. A result less than 10 seconds is interpreted as pathological. The correct result should fall around 20 seconds [13]. It should be remembered that the reliability of the result depends on whether the patient is given correct instructions [14].

The assessment of the respiratory tract was done palpatively. The patient was asked to breathe freely while counting up to 20 in his mind, and then during counting aloud. In this way, the respiratory tract was assessed during speech and at rest.

Tab. IV. Average, median, range and p-value of VHI result in all subscales for groups before and after rehabilitation.

	BEFORE REHABILITATION			AFTER REHABILITATION			
	AVERAGE ± SD	MEDIAN	RANGE	AVERAGE ± SD	MEDIAN	RANGE	P
VHI total	56 ± 26	56	2–89	25 ± 19	23	0–53	0,003
VHI I	16 ± 8,5	15	0–30	7 ± 6	6	0–37	0,007
VHI II	25,5 ± 9,5	27	2–37	13 ± 8	14	0–23	0,003
VHI III	14 ± 8	14	0–26	5 ± 6	2	0–17	0,005

Tab. V. Mean, median, range and p-value of VRQoL result for groups before and after rehabilitation.

	AVERAGE ± SD	MEDIAN	RANGE	P
VRQoL before	23 ± 6	23	13–31	0,003
VRQoL after	14 ± 5,56	13	4–22	

Tab. VI. Average, median, range and p-value of voice acoustic analysis for groups before and after rehabilitation.

	BEFORE REHABILITATION			AFTER REHABILITATION			
	AVERAGE ± SD	MEDIAN	RANGE	AVERAGE ± SD	MEDIAN	RANGE	P
Fo women	188,29 ± 55,78	193,65	91,62 – 252,97	209,16 ± 42,19	219,66	150,42 – 258,32	0,386
Fo men	140,40 ± 31,13	122,43	122,43 – 176,35	109,16 ± 7,31	113,02	100,73 – 113,73	0,198
Jitter%	5,29 ± 4,17	4,44	0,81 – 13,38	1,57 ± 1,39	1,65	0,38 – 5,33	0,050
Shimmer%	10,69 ± 8,04	7,61	2,74 – 27,15	3,31 ± 1,08	3,00	2,45 – 6,22	0,006
NHR	0,29 ± 0,24	0,18	0,10 – 0,85	0,12 ± 0,02	0,12	0,09 – 0,15	0,003

Each respondent underwent voice rehabilitation, which, according to the guidelines for treatment of voice disorders, was focused on the cooperation of a phoniatric doctor and a speech therapist [15]. The therapy process included a series of ten meetings with a speech therapist. The therapy took place in groups, once a week. Classes lasted 60 minutes. Prior to commencing rehabilitation, each patient was familiarized with the therapy program. Moreover, the therapist presented the principles of oral hygiene and comprehensive prevention to prevent speech disorders to patients. The role of a speech therapist was also to motivate the patient to perform exercises and give instructions regarding the patient's individual exercises at home to be done every day for about 20 minutes.

The therapy process began with proper posture exercises and relaxation exercises to relax the muscles of the neck and pectoral girdle. The next stage was breathing exercises. From the fifth meeting, traditional breathing exercises were accompanied by breathing and phonatory exercises using the Lax Vox method [16]. Subsequent exercises were based on a resonant cough, which the patient vocalized after breathing in and holding the air, and turning his head to the paralyzed side. This was followed by phonetic exercises using the maneuver described above. Initially, they were based on open syllables, for example: [pa], [ba], [ma], gradually moving to closed syllables, for example: [tak], [tok], [tek]. Each syllable had to resound in one exhalation as many times as possible. At a later stage, using the

same principles, short words were spoken, after making sure that the patient was ready. The rehabilitation also used such methods as the modified Masako and Valsalva maneuvers.

Statistical analysis methodology

Statistical analysis was performed using the Statistica 13.1 package. For each of the analyzed variables, compliance of the variable distribution with normal distribution was analyzed using the Shapiro-Wilk test. Variables VHI, MPT, VRQoL, frequency and severity of individual symptoms on the VTD, Jitter, Shimmer, NHR scales were analyzed using the Wilcoxon signed--rank test, assuming that these variables are dependent, have an ordinal character and are not consistent with normal distribution. In turn for variable F0, which is a quantitative variable and has a normal distribution, student's t-test for dependent variables was used. The analysis allowed to determine any statistically significant differences in the groups before and after rehabilitation. P <0.05 was considered statistically significant.

RESULTS

MPT [Tab. III]: The analysis of results showed statistically significant differences for groups before and after speech rehabilitation (p = 0.003). The average result of the maximum phonation time before rehabilitation was 7 seconds and 15 minutes.

VHI [Tab. IV]: Differences in the results of patients before and after rehabilitation proved statistically significant, taking into account both the overall score and individual subscales (p <0.005). Before rehabilitation, the average VHI score fell in the range of the average voice handicap, while after rehabilitation it indicated a minor voice handicap.

VRQoL [Tab. V]: Differences in the results of patients before and after rehabilitation proved to be statistically significant (p = 0.003). The average result before rehabilitation was 23 points, while decreasing to 14 points after.

VTD (Fig. 1): The overall score in the frequency and severity subscales decreased after rehabilitation, which is a statistically significant difference. For a frequency p = 0.01, and for intensity p = 0.006.

Acoustic analysis of voice [Tab. VI]: Comparison of the results of the acoustic analysis of voice before and after rehabilitation showed statistically significant differences for the Shimmer and NHR parameters (p <0.005). The other parameters were also improved, but they were not statistically significant differences (p> 0.005).

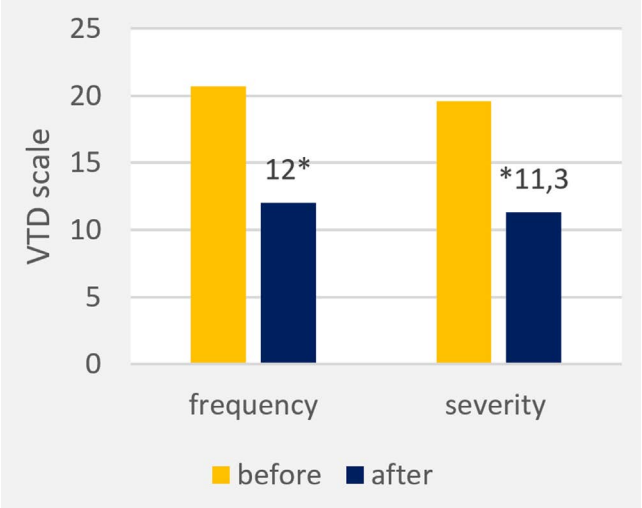

Fig. 1. The average general assessment of frequency and severity of symptoms on VTD scale before and after rehabilitation. *p<0.05

Respiratory tract: Before the beginning of rehabilitation, all patients were diagnosed with the peak respiratory tract in speech and at rest. After rehabilitation, 7 patients developed a thoracoabdominal respiration pattern, and 4 of them used a mixed pattern (thoracoabdominal with a top component).

DISCUSSION

There is a lack of research in Polish literature confirming the effectiveness of speech therapy rehabilitation in patients with paralytic dysphonia. Woźnicka et al. presented the results of such rehabilitation, which are based on the results of one patient [4]. However, there are no studies carried out on a larger group. Such reports can only be found in foreign literature. The above analysis proves useful, among others, due to the fact that it presents evidence for the effectiveness of voice rehabilitation, based on a group of patients and taking into account not only instrumental studies, but also the patient's subjective evaluation. The course of rehabilitation described in this work differs from the methods used by other researchers, although it includes come common elements. They include the basic component of rehabilitation, which also constitutes its first stage, namely the conversation regarding voice hygiene, proper voice emission, presentation of the correct respiratory pattern, correct posture and relaxation exercises. Similar recommendations can be found in many other works [4, 17, 18, 19, 20, 21]. However, there are differences between further stages of rehabilitation. Cough reflex was used only in two of the studies cited above [4, 19], and the head turn maneuver appeared in only one [19]. The next stage of rehabilitation is phonatory exercises, which in some works were replaced by vocal exerci-

ses [18, 21]. Till now, Lax Vox respiratory and phonic exercises were not used in patients with paralytic dysphonia, which were implemented in the described group since the fifth meeting. In addition, the modified Masako and Valsalva maneuvers were used for the first time. The therapeutic cycle included 10 meetings, which is a relatively small number, comparing the duration of rehabilitation described in the literature. In the study of Woźnicka, Ya-Chuan, Busto-Crespo [4, 20, 21], this was about 16 meetings, while other researchers adjusted the duration of therapy to each patient's individual needs. Thus, therapy could last from 6 up to 40 meetings [17, 19]. Rehabilitation used in this study took place in groups, which also constitutes a significant difference.

Detailed data on the effectiveness of rehabilitation is provided in a comparative analysis of results of tests performed before and after completion of the full therapeutic cycle. Results obtained in the scope of the maximum phonation time are identical with Jędra's study, which determined the degree of dysphonia in patients with vocal fold palsy, where the average MPT score was 8 seconds [9]. Ya-Chuan obtained a much higher MPT score (7 seconds before rehabilitation up to 23 seconds after rehabilitation), which may be due to dividing rehabilitation into three stages, where it was completion of the first stage that gave the opportunity to start another meeting or a greater number of therapeutic meetings [20]. However, doubling the average result of the maximum phonation time is a satisfactory achievement, which certainly greatly influences patients' respiratory efficiency. Results obtained on the VHI scale indicate a much better self-assessment of the patient's voice handicap, which contributes to the improvement of their psychosocial functioning. This is one of the most important evaluations, as it tells of the patient's satisfaction with the effects of rehabilitation. Similar results can be found in studies by Ya-Chuan and Cantarella, where the level of voice handicap before rehabilitation is assessed as medium or significant, decreased to a small disability [19, 20].

Till now, no one has used the VRQoL scale to describe the effectiveness of voice rehabilitation in patients with paralytic dysphonia. Therefore, the results obtained cannot be compared to other studies. In this study, after rehabilitation patients felt a significantly higher quality of life associated with the voice than before and this is a statistically significant difference. It is therefore worth using this tool in similar studies in the future. Ailments measured using the VTD scale improved after voice rehabilitation compared to results before rehabilitation. The frequency of symptoms from the vocal tract decreased from 20.7 points to 12. The severity of symptoms also improved (19.6 versus 11.3). These results can only be compared with the Woźnicka study [4], where the frequency of ailments decreased from 23 points to 5, and severity from 22 to 5. However, it is difficult to compare the average results obtained by a group of people with the results of one patient. Individual therapy usually brings better results than group therapy. However, the change in frequency and severity of symptoms from the vocal tract in this study is considerable and statistically significant.

Acoustic analysis of the voice showed statistically significant differences in relation to Shimmer and NHR parameters. The average result of Shimmer before rehabilitation was 10.69, and after rehabilitation 3.31. The mean NHR before rehabilitation was 0.29 and 0.12 after rehabilitation. Similar results, in particular in relation to the NHR parameter, were noted by Schindler (0.27 versus 0.14) [17]. This study included no statistically significant differences relating to the fundamental frequency (F0), which constitutes a further similarity to the results obtained in the field of acoustic analysis. On the other hand, Busto-Crespo noticed statistically significant differences only for the Jitter parameter, which turned out to be statistically insignificant in this study [21]. L D'Alatri and Ya-Chuan found statistically significant differences for all of the analyzed parameters [18, 20]. A very important element was also constituted by the assessment of the patient's respiratory track. Seven out of 11 patients developed a thoracoabdominal respiratory pattern. Four of them used a mixed, or thoracoabdominal, pattern with a peak component that was particularly active in spontaneous speech. Undoubtedly, improvement in the abnormal respiratory pattern used by most patients requires more time, as changing habits is an extremely difficult process during rehabilitation. None of the studies, however, describes whether and how the patients' respiratory pattern changed. Each of them, however, puts a lot of emphasis on learning correct voice emission.

The study of the impact of speech therapy rehabilitation on the voice quality of patients with unilateral vocal fold palsy is an essential aid for professionals dealing with the subject of voice disorders. This group will mainly include speech therapists who have the opportunity to learn about rehabilitation techniques, their effects and comparison to the results of other tests, which allows them to match the most effective therapy method to the individual needs of the patient. In addition, the group will also include phoniatricians who, beside pharmacotherapy or treatments, such as injection laryngoplasty or "medializing" prosthesis, will be able to propose participation in speech therapy rehabilitation to patients, preceded by becoming acquainted with its effects and real impact on the quality of voice. The applied therapeutic techniques significantly influenced the patients' voice quality, which is confirmed by instrumental and questionnaire studies. The group of subjects after rehabilitation showed improvement in voice emission, increased respiratory efficiency and respiratory-phonic coordination. Impro-

ved voice quality was observed in some parameters defined by acoustic voice analysis. Perhaps an extension of the therapeutic cycle would contribute to greater control over respiratory--phonic coordination during spontaneous speech that has not been proven in such a short time. In addition, this could also contribute to statistically significant differences in the F0 and Jitter parameters. A significant improvement occurred in the self-assessment of voice quality by patients after rehabilitation, measured by the results of VHI and VRQoL questionnaires, as well as in the frequency and severity of symptoms from the vocal tract, measured using the VTD scale. The patient's subjective assessment is very important, if not the most important parameter in assessing the effectiveness of rehabilitation. This is because the patient must feel good about the quality of his voice. Rehabilitation can be considered successful when the patient is satisfied with its effects.

To date, no research has been presented in the Polish literature on the effectiveness of voice rehabilitation in paralytic dysphonia on a larger group of patients. Such reports can be found only in foreign literature. The rehabilitation protocol in the above-mentioned study differs from those contained in the previously quoted articles. Differences lie not only in the use of certain techniques or maneuvers, which were not used by other researchers, but also in the form of therapy and its duration. The fact that the therapy was conducted in groups will gain both supporters and opponents. The undoubted advantage of group classes is the patient's mutual understanding and support, which significantly affects the results of rehabilitation. In addition, patients motivate each other to exercise and share their insights regarding their effectiveness. Another advantage is the possibility of conducting classes with more patients, which improves a speech therapist's work. The disadvantage of group therapy is less attention devoted to the individual. A speech therapist may devote incomparably more time to a given patient during individual meetings. A compromise seems to be adapting the form of therapy to a particular patient. Namely, patients who do not require increased attention and feel well in group activities, can successfully use such therapy. Others should arrange individual classes. The number of 10 therapeutic appointments turned out to be smaller compared to the studies quoted, but optimal for observing specific effects. Initially, the group of patients surveyed was almost half as large, which could affect the quality of the analysis. However, in the course of therapy some patients resigned from further rehabilitation, as the quality of their voice was not a problem for them; they were quicker to achieve a satisfactory voice quality and decided to stop rehabilitation, or they did not find dates of therapeutic appointments suitable.

CONCLUSIONS

Speech therapy significantly affects the voice quality of patients with unilateral vocal fold palsy. Logopedic rehabilitation had an impact on improving patients' voice emission, in most of them associated with the development of normal respiratory tract in speech and at rest. It also contributed to the increase in patients' maximum phonation time, comparing the results before and after rehabilitation, which significantly influenced their respiratory efficiency. The self-assessment of voice quality in most patients improved after completing the full therapeutic cycle. In addition, their voice-dependent quality of life increased. The frequency and intensity of symptoms from the vocal tract, measured in the VTD scale, decreased. Acoustic analysis of the voice showed statistically significant differences in the Shimmer and NHR parameters.

In summary, speech therapy rehabilitation has an impact on patients' voice quality with unilateral laryngeal palsy, assessed in both objective and subjective studies. Therefore, there is a need to develop the existing therapeutic techniques and carry out research on their effectiveness

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Corresponding author: Tomasz Czernicki; Klinika Neurochirurgii, Warszawski Uniwersytet Medyczny, ul. Banacha 1A, 05-077 Warszawa; Tel.: +48 22 599 25 75, +48 22 599 15 75; e-mail: tczernicki@wp.pl

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