

# The Effect of Vocal Rehabilitation on Patients with Vocal Cord Paralysis

Mila Bunijevac<sup>1,2</sup> , Andrijana Mikić<sup>3</sup> , Maša Đurišić<sup>4</sup> 

<sup>1</sup>College of Social Work, Department of Speech and Language Pathology, Belgrade, Serbia

<sup>2</sup>Sveti Vračevi Hospital, Bijeljina, Bosnia and Herzegovina

<sup>3</sup>Centre for Research and Analysis, Belgrade, Serbia

<sup>4</sup>College of Social Work, Department of Psychology, Belgrade, Serbia

ORCID ID: M.B. 0000-0002-0549-9467; A.M. 0000-0002-6711-1210; M.Đ. 0000-0002-5686-4575

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## ABSTRACT

**Objective:** The aim of this study is to examine voice characteristics by perceptual assessment of voices of patients with vocal cord paralysis before and after vocal rehabilitation.

**Materials and Methods:** 80 subjects participated in the study, of which 40 belonged to the experimental group and 40 to the control group. A subjective assessment of the voice using the GRBAS scale was performed. This instrument assesses the quality of the voice, that is, it determines the degree and severity of the disorder. Measures of central tendency, measures of variability, one-factor analysis of variance, t-test for independent samples, chi-square test and interclass correlation coefficient were applied in statistical data processing.

**Results:** Before vocal rehabilitation, severe (S) and moderate (G, R, B and A) voice changes were present in patients with vocal cord paralysis. After the vocal rehabilitation was completed, there was an improvement in voice quality on all subscales, i.e. in moderate (G, R, B and A) there was a noticeable absence of changes in the voice and in severe (S) there was a slight change in the voice.

**Conclusion:** Vocal rehabilitation aims to improve glottic occlusion without causing hyperkinesia, which is assisted by the abdominal breathing technique and improving the function of the internal muscles of the larynx. Vocal therapy is an indispensable part of the treatment of patients with paralysis of the vocal cords, and very often it is sufficient for a complete cure.

**Keywords:** Vocal cord paralysis, Perceptual assessment, Vocal rehabilitation

## INTRODUCTION

Paralysis of the vocal cords is a pathological condition where one or both vocal cords are limited in mobility or immobile. The immobility of the vocal cords can be the result of nerve damage or fixation in the cervical artenoid joint (1) as well as injury or scar changes in the larynx, especially on the back wall of the glottis. The number of patients with vocal cord paralysis is constantly increasing (2). Damage to the central and peripheral nervous system can cause unilateral or bilateral paralysis of n. vagus, its branches, or upper or lower laryngeal nerve (3). Paralysis of the vocal cords can occur in both children and adults. In children, it is most often a congenital malformation of the larynx, which is often associated with a

congenital malformation of the central nervous system (4) or is a consequence of trauma during childbirth (5). In adults, paralysis can be caused by trauma (surgical and non-surgical), tumors (pressure on the vagus nerve or laryngeal nerves), neurological and systemic diseases and causes of idiopathic origin (6). Paralysis of the vocal cords most often occurs as a symptom of some disease (5). It most often occurs after thyroid gland surgery, moreover it can be caused by factors of idiopathic origin, head and neck surgery, endotracheal intubation, tonsillectomy and various neurological disorders (5, 7, 8).

Unilateral paralysis of the vocal cords most often occurs after thyroidectomy (surgical intervention of the thyroid gland,

**Corresponding Author:** Mila Bunijevac **E-mail:** [bunijevacmila@yahoo.com](mailto:bunijevacmila@yahoo.com)

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one or both lobes), where the nerve is often cut or crushed. Paralysis of the left vocal cord occurs much more often than the right, the reason for this is the anatomical position of the left laryngeal nerve, i.e. the left recurrent nerve is longer and therefore more prone to injuries (9). With unilateral paralysis, the vocal cord is not able to occupy an intermediate position, which means that neither adduction nor abduction of the vocal cord is achieved during phonation (10, 11). Dysphonia is the leading symptom of unilateral vocal cord paralysis. The voice is characterized by hoarseness, especially in the early stages of paralysis, the range is narrowed, the intensity is reduced and the duration of the tone is shortened, which leads to vocal fatigue (7).

Bilateral paralysis of the vocal cords occurs much less frequently than unilateral paralysis of the vocal cords, and is most often caused by damage to the recurrent laryngeal nerve or a lesion of the nucleus of the n. vagus in the brain stem (6).

The treatment modality should be determined taking into account the time of injury, the patient’s expectations, the status of fluid or solid aspiration, and the compensation provided by the uninjured vocal cord. In some patients, recovery can be spontaneous in the first six to twelve months (12), and while in some patients surgical compensation is performed with a healthy vocal cord, some patients cannot recover with any of these techniques (6). In bilateral paralysis of the vocal cords, the general view is that surgical treatment is the only option. However, it has been shown that vocal and kinesitherapy give significant results, especially if it is a paramedian position of the vocal cords which did not reduce the breathing space to the level when tracheotomy is indicated. It is considered as the decisive choice of the patient (from a willingness and motivational aspect), building a pleasant atmosphere and trust.

The aim of this research was to determine voice characteristics by perceptual assessment of voices of patients with vocal cord paralysis before and after vocal rehabilitation.

**MATERIALS AND METHODS**

80 respondents participated in the research, of which 40 belonged to the experimental group and 40 to the control group (Table 1). The experimental group consisted of 32.5% male respondents and 67.5% female respondents, and the control group consisted of 42.5% male and 57.5% female respondents. The groups were equal according to gender

( $p>0.05$ ). The average age of subjects in the experimental group was  $M=58.2\pm16.7$ , and in the control group  $M=53.2\pm14.8$  years. Otherwise, considering the age of the respondents, the groups were equal ( $p>0.05$ ).

The research was conducted in the period from November 2019 to April 2022. All subjects were examined by an otorhinolaryngologist using the method of indirect laryngoscopy. After the established diagnosis, they were referred to the speech therapy clinic. The time of inclusion of patients in speech therapy treatment was after two months if caused by an injury and after one month if it was of idiopathic origin. Vocal rehabilitation was carried out individually, twice a week, lasting 30 to 45 minutes. The average duration of vocal therapy was from one month to three months. The aim of vocal rehabilitation was for the patient to master the technique of proper breathing, to remove tension in the neck and shoulder area, to establish adequate voice volume and pitch, and to provide and adopt guidelines for maintaining vocal hygiene.

The examination was conducted using the GRBAS scale (auditory – perceptual scale) designed in Japan. This instrument is standardized and reliable, and describes the quality of the voice through five qualitative parameters, which enables monitoring and comparison of the voice before and after vocal rehabilitation, as well as comparison with subjects of the control group. The instrument describes: the degree of hoarseness (Grade - G), roughness of the voice (Roughness - R), hoarseness in the voice whose source is turbulence caused by an irregular glottal wave (Breathiness - B), weakness in the voice, i.e. the auditory impression of hypokineticity or hypofunctionality in spontaneous phonation (Asthenia - A) and tension in the voice, that is, the auditory impression of excessive effort and tension in spontaneous phonation (Strain - S) (13). The parameters were assessed on a four-point scale with a grade from 0 to 3 (grade 0 - no changes in voice quality; grade 1 - mild changes in voice quality; grade 2 - moderately changed voice; grade 3 - pronounced changes in voice quality). The voices of the subjects were evaluated by three vocal therapists (speech therapists with many years of experience). The vocal therapists were in direct contact with the subject, at a distance of one meter, and evaluated the voice independently of each other. The subjective evaluation of voice quality using the GRBAS scale represents the analysis of the voice with one’s own sense of hearing, which is characterized by simplicity in application and economy.

Table 2 shows the results of the agreement test of three independent experts (speech therapists and vocal therapists who evaluated the voice of the subjects). Excellent agreement between raters was recorded, expressed by the interclass correlation coefficient. For the total score of the GRBAS scale, the values of the interclass correlation coefficient were very high (ICC=0.999, CI: 0.999, 1.000), as well as for the scales: G (hoarseness in the voice) (ICC=0.998, CI: 0.996, 0.998), R (roughness in voice) (ICC=0.994, CI: 0.991, 0.996), B (loudness in voice) (ICC=0.990, CI: 0.986, 0.993), A (weakness in voice) (ICC=0.997, CI: 0.995, 0.998) and S (voice tension) (ICC=0.999, CI: 0.999, 1.000).

**Table 1: General characteristics of the respondents**

	N=80	Groups		P
		Experimental N=40	Control N=40	
<b>Gender, n (%)</b>				
Male	30 (37.5%)	13 (32.5%)	17 (42.5%)	0.356 <sup>a</sup>
Female	50 (62.5%)	27 (67.5%)	23 (57.5%)	
<b>Age (AS±SD)</b>	55.7±15.9	58.2±16.7	53.2±14.8	0.165 <sup>b</sup>

**Table 2: Results of the inter-examiner GRBAS scale test**

	Estimated interrater reliability (95% CIs)
<b>GRBAS total score</b>	0.999 (0.999, 1.000)
<b>GRBAS subscale</b>	
G - Grade	0.998 (0.996, 0.998)
R - Roughness	0.994 (0.991, 0.996)
B - Breathiness	0.990 (0.986, 0.993)
A - Asthenia	0.997 (0.995, 0.998)
S - Strain	0.999 (0.999, 1.000)

The interclass correlation coefficient (ICC) was used to assess the reliability of the instrument itself. Among the methods of descriptive statistics, the arithmetic mean with associated standard deviation, measures of central tendency, measures of variability, as well as minimum and maximum were used. Frequency and percentages were used. In analytical statistics for testing differences between parameters, One-factor analysis of variance (ANOVA), t-test for independent samples, and chi-square test were used to examine the relationship between two categorical variables. Statistical processing and analysis were done in the computer program SPSS ver. 20 (Statistical Package for the Social Sciences).

## RESULTS

80 respondents participated in the research, 40 respondents belonged to the control group, and 40 to the experimental group. Paralysis of the vocal cords in the experimental group was most often present after thyroid gland surgery (45%), followed by unknown or idiopathic origin (45%) and after carotid artery surgery (10%) (Table 3).

**Table 3: Experimental group: comorbidities**

Comorbidities percentages	Percentages
After thyroid surgery 18 (45.0%)	18 (45.0%)
After carotid artery surgery 4 (10%)	4 (10%)
18 (45%) of idiopathic origin	18 (45%)
Total	40 (100%)

Paralysis of the left vocal cord was present in 25 patients, right vocal cord in nine patients and bilateral paralysis in six patients (Table 4).

**Table 4: Paralysis of the vocal cords**

Vocal cord paralysis	Percentages
Right vocal cord	9 (22.5%)
Left vocal cord	25 (62.5%)
Both side	6 (15%)
Total	40 (100%)

Table 5 shows the results of the experimental and control groups on the GRBAS scale before vocal rehabilitation. All parameters between groups on the GRBAS scale were statistically different. The control group had a mean value (zero), which was expected because the control group had a normal/unchanged voice quality that is associated with a 0 (zero) value of all assessed GRBAS scale parameters, (M=0.00 (0.00)),  $p < 0.0001$ . The experimental group showed worse overall results on the GRBAS scale (M=2.90 (0.14)) compared to the control group (M=0.02 (0.05)),  $p < 0.0001$ . The GRBAS scale parameter G (hoarseness in voice) was, as expected, more present in the experimental group (M=2.96 (0.13)) compared to the control group (M=0.00 (0.00)),  $p < 0.0001$ . A statistically significant difference between the two groups also existed on the R scale (voice roughness) ( $p < 0.0001$ ), where the experimental group had worse results (M=2.79 (0.34)) compared to the control group (M=0.00 (0.00)). The difference was also noted on scale B (loudness in the voice), where the subjects of the experimental group had worse results (M=2.75 (0.35)) compared to the control group (M=0.02 (0.07)),  $p < 0.0001$ . The subjects of the experimental group (M=2.99 (0.05)) compared to the control group (M=0.08 (0.22)),  $p < 0.0001$ , achieved a higher score on scale A (voice weakness). The results on the S scale (voice tension) were less favorable for the experimental group (M=3.00 (0.00)) compared to the control group. The results of the research of the experimental group showed the presence of severe and moderate changes in voice quality.

After the vocal rehabilitation was completed (Table 6), there were no statistically significant differences between the

**Table 5: Results of the GRBAS scale for the experimental and control groups before vocal rehabilitation**

	N=80	Groups		p*
		Experimental N=40	Control N=40	
<b>Total score of GRBAS scale</b>	1.46 (1.45)	2.90 (0.14)	0.02 (0.05)	<0.0001
<b>GRBAS subscale</b>				
G - hoarseness in voice	1.48 (1.49)	2.96 (0.13)	0.00 (0.00)	<0.0001
R - roughness in gas	1.40 (1.43)	2.79 (0.34)	0.00 (0.00)	<0.0001
B - hoarseness in voice	1.38 (1.4)	2.75 (0.35)	0.02 (0.07)	<0.0001
A - voice weakness	1.53 (1.48)	2.99 (0.05)	0.08 (0.22)	<0.0001
S - voice tension	1.50 (1.51)	3.00 (0.00)	0.00 (0.00)	<0.0001

\*: statistical significance

**Table 6: Results of the GRBAS scale for the experimental and control groups after vocal rehabilitation**

	N=80	Groups		p*
		Experimental N=40	Control N=40	
<b>Total score of GRBAS scale</b>	0.02 (0.05)	0.01 (0.04)	0.02 (0.05)	0.625
<b>GRBAS subscale</b>				
G - hoarseness in voice	0.00 (0.04)	0.01 (0.05)	0.00 (0.00)	0.320
R - roughness in gas	0.01 (0.06)	0.03 (0.09)	0.00 (0.00)	0.079
B - hoarseness in voice	0.01 (0.06)	0.01 (0.05)	0.02 (0.07)	0.562
A - voice weakness	0.05 (0.18)	0.03 (0.12)	0.08 (0.22)	0.208
S - voice tension	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	

\*: statistical significance

experimental and control groups on the GRBAS scale. Vocal rehabilitation was carried out individually, and lasted from one to three months. The values of the experimental group were measured after vocal rehabilitation, while the control group had one measurement.

Table 7 shows the average achieved results of the experimental group before and after treatment. There was a statistically significant improvement in the GRBAS total score after treatment (M= 2.9 (0.14) vs. M= 0.01 (0.04)), p<0.0001. Before the treatment, the achieved score on the G scale (hoarseness in the voice) was M= 2.96 (0.13), and after the treatment M=0.01 (0.05), p<0.0001. Before the vocal treatment on the R scale (roughness in the voice) the respondents had an average score of M=2.79 (0.34), and after the treatment M=0.03 (0.09), which is statistically significant (p<0 ,0001). Improvement after treatment was also noted on scale B (voice hoarseness) (p<0.0001), where the score decreased from M=2.75 (0.35) to M=0.01 (0.05). The average achieved value on scale A (weakness in the voice) before the vocal treatment was M=2.99 (0.05), and after the treatment M=0.03 (0.12), p<0.0001. And on the S scale (voice tension), a statistically significant improvement was achieved after the treatment (M=0.00 (0.00)) compared to the initial values (M=3.00 (0.00)), p<0.0001.

**Table 7: Results of the GRBAS scale for the experimental and control groups before and after vocal rehabilitation**

	Before vocal rehabilitation	After vocal rehabilitation	p*
<b>Total score of GRBAS scale</b>	2.9 (0.14)	0.01 (0.04)	<0.0001
<b>GRBAS subscale</b>			
G - hoarseness in voice	2.96 (0.13)	0.01 (0.05)	<0.0001
R - roughness in gas	2.79 (0.34)	0.03 (0.09)	<0.0001
B - hoarseness in voice	2.75 (0.35)	0.01 (0.05)	<0.0001
A - voice weakness	2.99 (0.05)	0.03 (0.12)	<0.0001
S - voice tension	3.00 (0.00)	0.00 (0.00)	<0.0001

\*: statistical significance

**DISCUSSION**

Paralysis of the vocal cords means the inability to move one or both vocal cords due to dysfunction of the innervation of the larynx. The leading symptom is dysphonia of varying

degrees, the voice is weak, monotonous, narrowed in range, and over time the patient feels tired in the voice (14). These voice disorders can negatively affect an individual’s emotional and physical functioning, i.e. their quality of life.

In this observational study, mostly female subjects were represented, that is, vocal cord paralysis occurs more often in women than in men, which is compatible with previous research (15, 16).

Thyroidectomy without identification of the recurrent nerve causes 5.4% of paralysis, half of which is irreversible (17), and surgery with identification of the nerve causes 3-8% of paralysis, but only about 1% is irreversible (18). Given that surgically caused paralysis of recurrence is most often not recognized at the time of injury, today the identification of the return nerve for thyroidectomy is mandatory. A large number of patients in our study with paralysis of the vocal cords were after thyroid surgery, but also of unknown etiology, i.e. idiopathic origin (11, 8). Paralysis of the left vocal cord is much more common than the right one (9, 10), the left recurrent nerve is longer and more prone to injury, while bilateral paralysis of the vocal cords is very rare and usually results from an injury to the upper laryngeal nerve (19, 8).

The GRBAS scale describes the characteristics of the voice and also the effectiveness of vocal rehabilitation. Analyzing the results of the perceptual assessment before vocal rehabilitation, we found that there was a statistically significant difference between the two groups of subjects on all the examined parameters. The values of the parameters of the GRBAS scale were statistically significantly higher in subjects with vocal cord paralysis, compared to subjects in the control group. Based on the obtained results, we can conclude that the code in patients with paralysis of the vocal cords, a greater degree of hoarseness, tension, hoarseness, weakness and hoarseness was observed in the voice. That is, severe (S) and moderate (G, R, B and A) voice changes were present in the patients. The results of research by the authors’ group (20) showed more severe changes in voice quality in patients with vocal cord paralysis on subscales G, R and B, while in another study (21) more severe changes in voice quality were also present on subscale S.

Before vocal rehabilitation, the parameter with the highest values was S (voice tension), which could also be observed in the study (22). Parameter A (weakness in the voice) had a high value, which was noticed by other authors (23, 24, 21, 25). Due to paralysis of the vocal cords, there is an incomplete closure of the glottis, which creates an excess of air during phonation, that is, hoarseness in the voice (B), which is also noticeable in other studies (26, 20). Roughness in the voice (R) as a consequence of irregular cycles, i.e. low mobility or immobility of the vocal cords also had a high value, which is compatible with other researches (24, 27). The parameter G (hoarseness in the voice) also had a high value, which was related to other parameters and varies depending on the voice disorder and is compatible with other researches (28, 29, 26, 30, 27, 32).

After the vocal rehabilitation was completed, the voice quality of the subjects of the experimental group improved, that is, there were no negative changes in voice quality. The control group had good results on all subscales of the GRBAS scale, as expected, because the control group had no pathological changes in the voice. In a study by other authors (32), patients with vocal cord paralysis recovered after vocal rehabilitation, and were able to achieve intelligible speech production. Hoarseness (G), tension (S), and weakness in the voice (A) improved and went from severe disturbance to mild or no voice changes. A significant voice improvement in patients with unilateral paralysis of the vocal cords after vocal therapy by subjective evaluation of the voice was found in a study by Santos et al. (33).

In a large number of studies in patients with vocal cord paralysis, vocal therapy improved the voice quality of these patients (34, 35, 14, 36), which positively affected their quality of life.

## CONCLUSION

With this study, we concluded that paralysis of the vocal cords has a negative effect on the general health and quality of life of the individual. However, vocal therapy as one of the treatment segments for patients with vocal cord paralysis can lead to significant improvement and even complete recovery. Team cooperation between the speech therapist - vocal therapist and phoniatriest, i.e. laryngologist is very important. Vocal rehabilitation aims to improve glottic occlusion without causing hyperkinesia, which is assisted by the abdominal breathing technique and improving the function of the internal muscles of the larynx. Each person, considering the age, etiology, duration of the paralysis, requires an individual approach, often involving several modalities of therapy simultaneously or individually. Success in the treatment of vocal cord paralysis is based on a very studious and dedicated approach, patience, superior care and prevention of complications, the main goal of which is to correct or restore the patient's voice to be loud enough, pleasant to listen to, so that it can be adequately used during daily life activities, which positively affects the quality of life.

**Ethics Committee Approval:** This study was approved by the Ethics Committee of Sveti Vračevi Hospital (Date: 07.09.2022, No: 4315-8/22).

**Informed Consent:** Written informed consent was obtained.

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