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FUNCTIONAL RECOVERY OF VOICE FUNCTION IN PATIENTS WITH LARYNGEAL DYSFUNCTION: OBSERVATIONAL STUDY

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Abstarct: Introduction: Functional recovery of voice function in patients with laryngeal dysfunction is a slow and lengthy process that is associated with changes in social and economic living conditions. The serious functional damage can also lead to disorders in swallowing and respiratory function. It is believed that paresis passes into definitive if continues for more than 10-12 months due to irreversible changes in the tissues. According to literature data, spontaneous recovery in unilateral vocal cord paralysis is observed in 40% of cases. Low frequency currents with adjustable parameters are frequently used in the practice of electro diagnostics and electrical stimulation in damage of the neuromuscular system and in particular in laryngeal paresis and paralysis. In recent decades, an increase in the number of patients suffering from diseases associated with laryngeal dysfunction was noted by many authors. Interruption of nervous pulsation to laryngeal structures leads to sensory and motor disorders and development of subsequent paralysis of the muscles. Treatment depends on the cause, the severity of the symptoms and time of onset of the disease. It includes non-operative and operative treatment. Non-operative treatment is with good results and should precede surgery.
Purpose: The purpose of this study is to objectify the therapeutic options of neuromuscular elektro-phonatory stimulation /NMEPS/ in patients with laryngeal dysfunction.
Materials and methods: The study included 21 patients with unilateral dysfunction of n. laryngeus recurens after surgery of the thyroid gland. Patients with complete denervation were excluded from the study. Procedures are preceded by electro-diagnostic in direct laryngoscopy to establish the extent of damage of the nerve and to determin the coefficient of accommodation (ACC) and variable parameters for stimulus currents. Therapeutic session is implemented in two stages: (1) 'heating' with galvanic current, and (2) real NMEPS selective stimulation of the damaged muscle, leaving untreated antagonists or neighboring healthy muscles, accompanied by active and targeted implementation of Förster phonatoric exercises, coughing and breathing. Treatment is organized in courses for 10 days, 20 procedures per course.
Results: The results before and after completion of therapeutic course by assessing changes in the coefficient of accommodation(ACC), voice quality, degree of hoarseness, coughing efficiency, presence of dysphagia are reported. After statistical processing of the obtained results a statistical dependence in relation to dysphonia before and after NMEPS therapy was established (p=0.0001), which is expressed in improvement of medium to mild dysphonia. In relation to dysphagia we found improvement from average-heavy to light form of dysphagia and absence of any symptoms of it after treatment, but there are patients with no change observed (44.4%) and statistical dependence (p=0.005) Patients with dysfunction regarding the effectiveness when coughing, before treatment they were: 16.7%, with severe dysfunction, 50.0% with moderate to severe and 33.3% with light. After NMEPS therapy improvement in the condition of patients with moderate-heavy to light form was observed. The non-parametric analysis proved statistical dependence (Z=3.58 ;p=0.0001). All patients were asked to assess the quality of their voice according to the Linkert five-point rating scale. In the beginning of the therapy 44.4% of the patients ranked their voice quality as poor, 50.0% as moderate and 5.6% as good. After treatment improvement in self-assessment of voice quality from moderate to very good and statistical dependence (p=0.0001) was observed.
Conclusion: The results of the observational study prove that NMEPS therapy is effective for functional recovery in complex treatment of laryngeal dysfunction. Because of the small number of patients included in the study for better objectifying of the effects of the neuro muscular elektro-phonatory stimulation, the studies should continue.
Keywords: Laryngeal dysfunction, Neuro muscular electro-phonatory stimulation, Unilateral recurrent laryngeal nerve paresis, Phonatoric functional exercises

1.INTRODUCTION

Functional recovery of voice function in patients with laryngeal dysfunction is a slow and lengthy process that is associated with changes in social and economic living conditions. The serious functional damage can also lead to

disorders in swallowing and respiratory function. It is believed that paresis passes into definitive if continues for more than 10-12 months due to irreversible changes in the tissues.

Low frequency currents with adjustable parameters are frequently used in the practice of electro diagnostics and electrical stimulation in damage of the neuromuscular system and in particular in laryngeal paresis and paralysis [1,2,3,4]. In recent decades, an increase in the number of patients suffering from diseases associated with laryngeal dysfunction was noted by many authors [5]. Interruption of nervous pulsation to laryngeal structures leads to sensory and motor disorders and development of subsequent paralysis of the muscles. According to literature data, spontaneous recovery in unilateral vocal cord paralysis is observed in 40% of cases [6].

The symptoms of paralysis of the vocal cords and larynx include: changes in the voice quality, hoarseness, noisy breathing, choking and coughing when swallowing solid food, liquids or saliva, inability to speak loudly, loss of reflex vomiting, ineffective cough, etc.

Treatment depends on the cause, the severity of the symptoms and time of onset of the disease. It includes non-operative and operative treatment. Non-operative treatment is associated with drug therapy with a corticosteroid agents, voice therapy with speech therapist, applying of preformed physical factors – electro stimulation. Non-operative treatment is with good results and should precede surgery [7,8,9,10,11,12]. According M. L. Harries et al. improved voice-related quality of life and level of patient satisfaction of treatment have been perhaps more important than any objective change [13].

2.MATERIALS AND METHODS

The study included 21 patients with unilateral dysfunction of n. laryngeus recurens after surgery of the thyroid gland. Patients with complete denervation were excluded from the study. Procedures are preceded by electro-diagnostic in direct laryngoscopy to establish the extent of damage of the nerve and to determin the coefficient of accommodation (ACC) and variable parameters for stimulus currents. Therapeutic session is implemented in two stages: (1) 'heating' with galvanic current, and (2) real NMEPS selective stimulation of the damaged muscle, leaving untreated antagonists or neighboring healthy muscles, accompanied by active and targeted implementation of Förster phonatoric exercises, coughing and breathing.

Treatment is organized in courses for 10 days, 20 procedures per course. Criteria for inclusion and exclusion: Inclusion criteria: age over 18 years; lack of malignancy; unilateral damage of vocal cords; onset – not longer than 6 months of current complaints. Excluded from the study were patients with complete denervation, hearing loss, cognitive deficit, decompensated heart disease, incl. pacemaker, pregnancy and other contraindications for electrotherapy. During the study there were 3 drops-out: two patients were living in other cities and were experiencing difficulties to travel and one refused to continue therapy for unknown reasons. Treatment course - underwent by 18 patients.

Description of treatment with NMEPS method: The methodology of neuromuscular electro phonatory stimulation was developed by J. Pahn [11]. It is a combination therapy of low frequency electrical stimulation current with adjustable parameters accompanied by active targeted implementation of phonatoric exercises Förster.11 The combination of vocal exercises, coughing and breathing is specially selected depending on the degree of damage. Patient simultaneously receives electrical impulses and makes relevant exercise recorded on a CD, which effectively corrects central nervous regulation on the basis of the feedback. Therapeutic procedures are preceded by electro diagnostics for initial determination of the extent of the damage and follow up of the recovery process, by determining the factor of adaptability (ACC-Accommodation coefficient) and the variable parameters for stimulus currents (current strength, shape and pulse duration and pause). It takes place during direct laryngoscopy (under NMEPS) for monitoring of motor response to stimulation pulses with rectangular and triangular shape and length of 1000 ms.

Therapeutic session is implemented in two stages: the so called "Heating" and real NMEPS selective stimulation: STAGE I The neutral electrode is fixed at the rear occipital region, the active electrode in the median area of the larynx. Galvanic current to achieve vasodilatation and active local hyperemia, by influencing the vasomotor nerves and increase the secretion of vasodilator substances is applied. The improved local blood flow leads to improved local trophic and metabolic activity of tissues. In the area of the cathode increased excitability, as a result of a change in the membrane potential of the cells is observed [14]. STAGE II Real neuromuscular electro phonatoric stimulation /NMEPS / therapy includes: current exponential (or triangular) form of pulse of neo faradic current or amplitude modulated current midrange. The strength of the stimulating current is minimal, close to the sensory threshold. Selective stimulation of the injured muscle is carried out without influencing antagonists or adjacent healthy muscle. This stimulation is caused by key for manual management and accompanied by fonatoric functional exercise, coughing and breathing.

Specific features of the NPS methodology are:
1.Individually adapted characteristics of the stimulation current;
2.Manual control of stimulation;
3.The parameters of the stimulating current can be changed depending on the change of state of the apparatus detected by the neuromuscular electro diagnostics.
Therapeutic targets of NMEPS therapy:
1.Recovery of motor and sensory systems;
2.Maintaining voice regulatory engram;
3.Maintaining the functional status of muscles, counteracting atrophy as a result of not exercising;
4.Maintenance and restoration of damaged nerve structures;
5.Prevention of capsular fibrosis arytenoids joints; Maintaining and improving the sensitivity and auditory cinemotoric areas.

3.RESULTS

Patients were diagnosed by determining the ACC, scale of voice evaluation (dysphonia degree), efficiency of coughing, presence of dysphagia and they were asked to assess the status of their voice on a five point scale of Likert. After electro diagnostics by direct laryngoscopy for all patients the following parameters were determined:
- Reobasis in mA, ie intensity of the current with rectangular pulses (1000ms), leading to minimal contraction;
- Galvanic-tetanus threshold in mA, ie intensity of the current with triangular pulses / 1000 ms /, needed to cause minimal contraction; ACC (coefficient of accommodation) before and after therapy.

In the absence of damage to the values of ACC are between 3 and 6. Values below 3 show a decreasing ability to accommodate and the beginning of denervation. Values below 1 correspond to complete denervation and loss of flexibility. According to the values of ACC patients were divided into five groups: GROUP I - Very severe damage ACC <1; GROUP II - Severe damage ≤1 ACC <1.5; GROUP III Average damage 1.5≤ ACC> 2; GROUP IV - Light damage ≤ ACC 2<2.5; Group V Very light damage 2,5≤ACC<3. Therapy subjected patients from groups III and IV.

Ratio of accommodation coefficient, degree of dysphonia, coughing efficiency, degree of dysphagia, self-assessment of voice status according to five point scale of Likert of all patients were identified.

For statistical analysis of the results SPSS v13 was used. Methods used: descriptive statistics, groups were evaluated according to the method of Mann-Whitney (Mann-Whitney), and associated groups with the method of Wilcoxon (Wilcoxon).

In the observational study 21 patients were included. Treatment course was fulfilled by 18 patients with average age of 49.44 ± 8.5 years (Mean ± SD) (37 ÷ 71). The average duration of complaints (Mean ± SD) is 4.28 ± 1.2 months (2 ÷ 6). No statistically significant correlation between the extent of the damage and its duration which may be due to the small number of patients included in the study.

Prior to therapy for all patients by direct laryngoscopy were identified Reobasis mA, Galvanic-tetanus test in mA and coefficient of flexibility, and the data is presented in tabl. 1.

Table 1 Reobasis, Galvanic- Tetanus Test, ACC

Indicator	Min	Max	Mid
Reobasis mA	5,6 mA	8,1 mA	7,12 mA
Galvanic Tetanus Test	9,2mA	16,9mA	12,95mA
Accommodation Coefficient ACC	1,4	2,3	1,81

According to accommodation coefficients patients were divided into five groups, and treatment was applied to patients with moderate damage, according to ACC (1.5 ≤ ACC > 2) 27.8% and Light damage (2 ≤ACC <2.5) 72.2% (Tabl. 2).

Table 2 Denervation Degree in Groups According to ACC

	Distribution in %		
Denervation Degree	Total	Female	Male
I Group Very Severe Damage ACC <1	-	-	-
II Group Severe Damage 1 ≤ ACC <1,5	-	-	-
III Group Moderate Damage 1,5 ≤ACC >2	27,8%	16,7%	11,1%
IV Group Light Damage 2 ≤ACC <2,5	72,2%	38,9%	33,3%
V Group Very Light Damage 2,5 ≤ ACC< 3	-	-	-

After statistical processing of the obtained results it is found that there is a statistical dependence in relation to dysphonia before and after therapy with NMEPS (Z=3.87; p=0.0001), which is expressed in an improvement of the moderate to light dysphonia Fig.1.

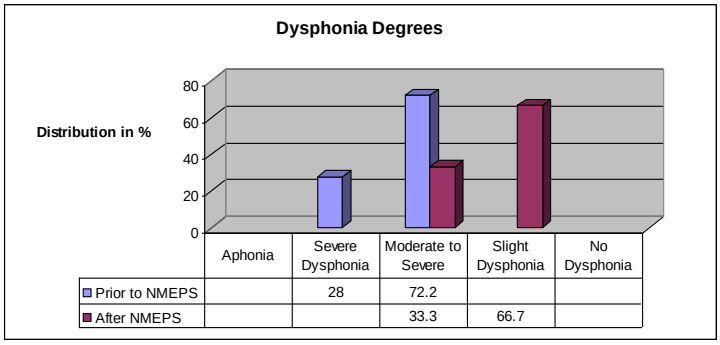

Fig.1 Rating functional damage of the voice (dysphonia)

Regarding the difficulties in swallowing in the beginning of the treatment course the majority of the patients were with moderate difficulties (33.3%), light (61.1%) and absence (5.5%) of dysphagia. Fig.2.

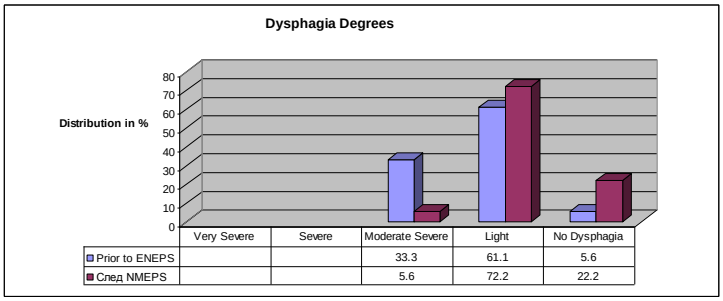

Fig.2. Rating functional difficulty in swallowing (dysphagia)

It was found that there is a statistical dependence (Z=2.82; p=0.005), before and after treatment with NMEPS which is expressed in an improvement of medium-severe to light dysphagia and absence of such, but there are patients with no change reported (44.4%). Fig.2.

Patients with dysfunction according to effectiveness when coughing prior to treatment were divided by the strength of symptoms into five groups, with severe dysfunction there were 16.7%, 50.0% moderate and light 33.3%. The non-parametric analysis made shows statistical dependence (Z=3.58; p=0.0001), which is expressed in an improvement of moderate to light forms. Fig.3.

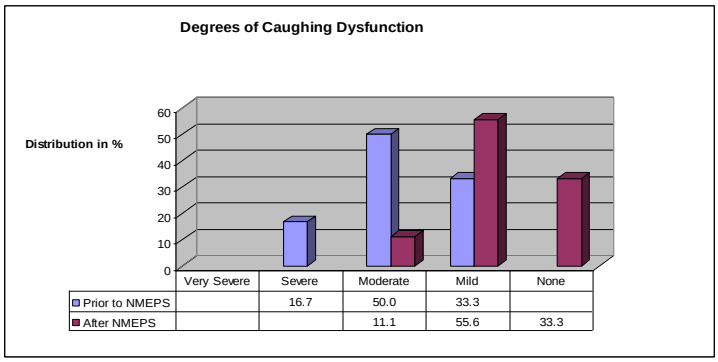

Fig. 3 Effectiveness of coughing

All patients were asked to assess the voice quality before and after treatment on a five point scale of Likert. At the beginning of therapy, 44.4% self assessed their voice quality as poor, 50.0% as average and 5.6% as good. Data is presented in Fig. 5.

The statistical processing of the data proves that there is a correlation (Z=3.86; p=0.0001), which is expressed in the improvement of voice quality from moderate to very good. Fig.4

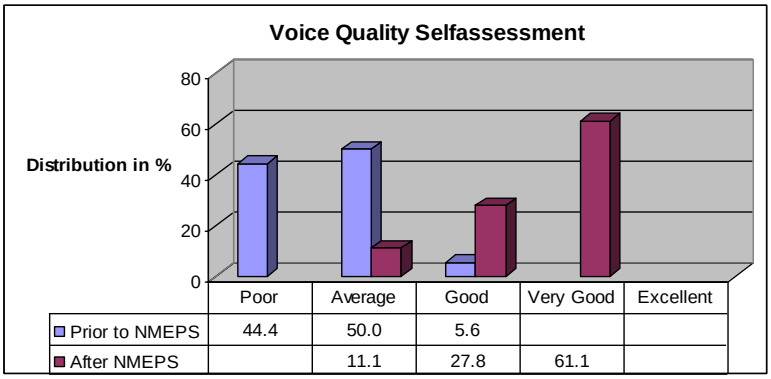

Fig.4 Self-assessment of the status of voice on a five point scale of Likert.

4. DISCUSSION

The application of pulse currents to induce nerve excitation and subsequent muscle contraction helps to improve blood circulation, trophic processes, prevents the accumulation of lactic acid in the muscles, affects the activity of the brain by forming a motive dominant, helps restore efferent connections in CNS-effector body, prevents the atrophy of muscles in the larynx and development of fibrotic processes therein. The advantage of NMEPS treatment is expressed in successful combination of active implementation of phonatoric exercises controlled by the patient and stimulation of damaged muscle. A study by Schleier E. et al (1980) established better therapeutic results when combining electrical stimulation phonatoric functional exercise [15]. Another study made in 1998 by Kruse E. (1998) the better effect of the combinative therapy in vocal paresis is proved [9]. Romanenko SD. et al. (2001) reported a good therapeutic effect in the treatment of 42 patients with URLNP with stimulating currents combined with phonatoric exercises achieved. In the control group of 32 patients the classical methods of electro stimulation with dynamic currants was applied. The effect of the treatment was assessed by changes in vocal acoustic parameters and stroboscopic parameters. According to the author it is very essential the place of application of electrodes for the stimulation. Better treatment results are achieved when location is paramedian compared to lateral and intramedian [16]. Ptok M. in 2008 to conducted a prospective randomized study of 90 patients with URLNP and reported better performance with NMEPS therapy for patients with unilateral paresis of the recurrent laryngeal nerve with Voca Stim compared to voice therapy with speech therapist held without electro-stimulation. The reported improvement in the second group according to the author can be explained with spontaneous recovery of the nerve [4]. According to Harries ML et al.[13] improving vocal- related quality of life and the degree of satisfaction of the treatment is probably more important than any objective change, which was proved by the self assessed voice quality in the treated group.

5. CONCLUSION

The results of the observational study indicate that NMEPS therapy is effective for functional recovery in complex treatment of laryngeal dysfunction. Because of the small number of patients included in the study for better objectifying of the effects of the neuro muscular elektro- phonatory stimulation, the studies should continue.

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