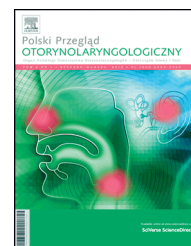


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Original research article/Artykuł oryginalny

Voice rehabilitation with the application of massage device “Medical 2VR” in patients after total laryngectomy



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ABSTRACT

Aim: The aim of the study was to evaluate the effectiveness of a deeply invasive massager Medical 2VR, Cyberbiomed as a supportive voice rehabilitation method in patients after total removal of the larynx. **Background:** Voice loss after total laryngectomy due to laryngeal cancer seems to be the main disadvantage of that surgical procedure for majority of patients. Neck lymphoedemas, soft tissues fibrosis and restricted mobility around the shoulder girdle due to surgical procedures and radiotherapy are the factors impeding the process of voice rehabilitation. **Materials and methods:** The study was conducted on a group of 80 patients after total laryngectomy treated in Outpatient Clinic and Department of Otolaryngology of the Medical University of Silesia in Katowice in 2009–2011. Assessment of voice parameters, measurements of neck circumference and pressure in the opening of sphincter of oesophagus mouth were performed. The nature of the emitted voice and speech volume was analyzed. **Results:** The results showed that in 90% of patients a significant reduction of neck lymphedema was observed. Also, various voice parameters and pressure in the opening of sphincter of oesophagus improved. **Conclusions:** Invasive massager Medical 2VR results in reduction of the voice rehabilitation period and shorter learning process of substitute speech in patients after total laryngectomy.

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Intorduction

Voice loss after total laryngectomy due to laryngeal cancer seems to be the main disadvantage of that surgical procedure for majority of patients [1]. It has been found that in patients, whom a complete removal of the larynx was performed, there is a higher risk of depression in comparison to patients who underwent a different type of treatment and it can result in limited social life [2]. In order to improve the quality of life for these people, it is important to begin voice rehabilitation as soon as possible. Many factors influence the process. Complete removal of the larynx, especially combined with simultaneous lymphadectomy and radiotherapy – both primary and complementary (postoperative) – can cause neck lymphoedemas, soft tissues fibrosis and restricted mobility around the shoulder girdle [3]. The occurrence of these factors significantly impedes the process of voice rehabilitation in the patients [4]. Therefore, it is extremely important to introduce new methods accelerating the process of voice rehabilitation in patients after total laryngectomy.

The aim of the study was to evaluate the effectiveness of a deeply invasive massager Medical 2VR, Cyberbiomed as a supportive voice rehabilitation method in patients after total removal of the larynx.

Materials and methods

The study was conducted on a group of 80 patients (68 men and 12 women, with an average age of 67.3) who were treated in the Outpatient Clinic and Department of Otolaryngology, Medical University of Silesia in the years 2009–2011. The therapy was followed by voice rehabilitation sessions in rehabilitation centres throughout the country. All patients underwent rehabilitation with the application of the deeply invasive massager Medical 2VR, Cyberbiomed.

The patients were divided into three groups:

Group I – patients before rehabilitation with the application of the massage device,

Group II – patients directly after rehabilitation with the application of the massage device,

Group III – patients 3 months after rehabilitation with the application of the massage device.

Subjective assessment of voice parameters, measurements of pressure in the opening of sphincter of oesophagus mouth as well as measurements of neck circumference were performed in all patients. The nature of the emitted voice with its classification into: sonorous, dull or hoarse was analyzed. The evaluation of voice production mechanism established two types of voice – the one produced without effort (free voice) and forced voice (due to excessive involvement of additional respiratory muscles of patient's chest in phonation process). Speech volume in conversational speech was analyzed in three study groups. Phonation was categorized as soft, medium or loud. The study was conducted at the phonation of vowel 'a' Additionally, measurement of neck circumference was taken using a tape as well as measurement of pressure in the opening of sphincter of

oesophagus mouth with Cyberbiomed's device for graphic visualization of pressure course in the opening of sphincter of oesophagus mouth.

Rehabilitation was initialized 3 weeks after complete wound healing or after minimum 3 months from the end of radiotherapy. The rehabilitation period lasted 3–5 weeks.

Rehabilitation process was performed with the application of deeply invasive massager Medical 2VR, Cyberbiomed LLC (Fig. 1). It is a double – resonance device utilizing a unique VR technology developed and applied for the first time by an American company 'CyberBioMed LLC'. The VR technology uses mechanical resonance of rehabilitated centre with simultaneous protection from the appearance of standing wave by moving it inside the centre with an electronically given frequency. The device is powered by accelerator – type microprocessor controller, and it generates mechanical wave of regulated frequencies between 15 and 300 CPS. Parameters of the device are controlled by microprocessor system. The application of variable difference of frequencies in resonators protects patients from the appearance of the harmful standing wave.

The massager was placed tightly and securely, yet comfortably, around patient's neck without leaving any free space after fastening. Resonators were laid evenly in areas of the greatest oedema of a neck. In order to maintain aseptic conditions, the device was covered with disposable polyethylene protective items.

Patients received the massage after the removal of tracheostomy tube ensuring that the work of the device had not been transferred to the tube and there had been no possibility to irritate or mechanically damage tracheostomy hole at the same time.

Rehabilitation was divided into three stages.

Stage one – a gentle massage at low frequencies with minimal power of the device; treatment time: maximum 1 min, twice daily, in the morning and evening; time intervals between the treatment sessions – not less than 8 h; rehabilitation period – 4–5 days.

Stage two – treatment time: 5 min, twice daily; time intervals between the treatment sessions – not less than 1 h – the same as in stage one; rehabilitation period – 3–5 days.

Stage three – treatment time: maximally 15 min, twice a day; time between treatment sessions the same as in stage one; rehabilitation period up to 2 weeks.



Fig. 1 – Medical 2VR massage device, Cyberbiomed

A great attention was paid to the mucosal secretion and sputum expectorated from tracheostomy. The appearance of fresh blood or blood clots was an indication to the termination of the therapy. Other contraindications for using the massager were as follows: purulent skin lesions on the neck, pharyngocutaneous fistula, dermatoses preventing from using any pressure on pathological changes.

Data received were analyzed by STATISTICA 9.0 program, StatSoft Inc. Student's t-test for independent samples or multi-way contingency tables were applied in the analysis of variables. Correlation of the variables was analyzed with χ^2 test. The equality of variances in different samples was assessed with Leven's test. The results were statistically significant when $p < 0.05$.

Results

The results showed that in 72 patients (90%), who underwent voice rehabilitation with the application of the massage device, a significant reduction of neck lymphedema was observed. The measurements of the neck circumference revealed that it was (on average) up to 4.34 ± 0.17 cm smaller in comparison to the neck circumference before rehabilitation ($p < 0.001$) (Table I). When analyzing the results of pressure in the opening of oesophagus mouth before and after the voice rehabilitation, a statistically significant ($p = 0.013$) increase in the number of patients with lower pressure (Group II) was found (Table II). At the same time, a decrease in the number of patients from group II and III, whose pressure in the opening of oesophagus mouth before applying the massager was average ($p = 0.003$) and high ($p = 0.002$), was observed. The number of patients with low pressure in the opening of sphincter of oesophagus mouth increased 2.5 times in a 5-week period of rehabilitation with the application of the device. The evaluation of the voice nature in patients undergoing rehabilitation indicated that the number of persons with sonorous voice had increased 11 times immediately after using the massager ($p < 0.001$) (Table III). Furthermore, the number of patients with free voice increased as well as the voice volume

Table I – Measurements of the neck circumference in the patients

Study group	Neck circumference Mean \pm SD [cm]
I	47.02 \pm 2.62
II	44.85 \pm 2.26
III	42.68 \pm 2.45
Δ I vs II	2.17 \pm 0.36
Δ I vs III	4.34 \pm 0.17
I vs II	$p = 0.002$
I vs III	$p < 0.001$

Table II – Measurement of pressure in the opening of sphincter of oesophagus mouth

Study group	Pressure in the opening of sphincter of oesophagus mouth [number of patients]		
	0.7–5.3 kPa (5–40 mmHg)	5.3–10.7 kPa (40–80 mmHg)	10.7–12.1 kPa (80–90 mmHg)
I	20	46	14
II	35	32	8
III	51	27	2
I vs II	$p = 0.013$	$p = 0.027$	NS
II vs III	$p = 0.011$	NS	NS
I vs III	$p < 0.001$	$p = 0.003$	$p = 0.002$

NS – not significant.

increased in rehabilitated patients ($p < 0.001$). Only 8% of patients did not develop substitute speech in a 5-week period of rehabilitation (Table III).

Discussion

The treatment of laryngeal and hypopharyngeal cancer inevitably results in iatrogenic injuries. The patient should be aware of possible loss or reduction of voice, difficulties in swallowing, change in the way of breathing, pain and

Table III – Subjective voice assessment

Study group	Nature of the voice [number of patients]			Voice production mechanism [number of patients]		Phonation volume [number of patients]			Lack of substitute speech [number of patients]
	Sonorous	Flat	Hoarse	Strained	Easy	Silent	Medium	Loud	
I	5 (6%)	35 (44%)	40 (50%)	70 (88%)	10 (12%)	55 (69%)	23 (29%)	2(2%)	16 (20%)
II	54 (68%)	10 (12%)	16 (20%)	48 (60%)	32 (40%)	32 (40%)	36 (45%)	12 (15%)	10 (12%)
III	55 (69%)	9 (11%)	16 (20%)	50 (61%)	30 (39%)	32 (40%)	37 (46%)	11 (14%)	7 (8%)
I vs II	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p = 0.033$	$p = 0.012$	
II vs III	NS	NS	NS	NS	NS	NS	NS	NS	
I vs III	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p = 0.022$	$p < 0.001$	

NS – not significant.

Dźwięczny matowy ochryply party swobodny cicha średnia głośna.

psychological tensions associated with operative treatment. Voice loss seems to be the most intolerable of all mentioned problems [5, 6].

About 10–20% of patients after total removal of the larynx are unable to learn to speak despite the voice rehabilitation (the learning of oesophageal speech, voice prostheses, electronic larynx) [7, 8]. The learning process of substitute speech can be delayed or even totally reduced by excessive thickness of tissues in the neck and submandibular region due to lymphostasis (lymphoedema) [9]. In order to improve the quality of voice rehabilitation after total laryngectomy, it is important to minimize the effects of an extensive surgical treatment, radiotherapy or chemotherapy. The application of mechanical resonance technique in deeply invasive massager Medical 2VR improves blood and lymph flow. Therefore, it supports better blood supply and nourishment of the tissues and reduces lymphoedemas and venostasis. Accelerating the process of metabolism in basal layer of the skin leads to faster regeneration of damaged epidermal cells. An increase of temperature in the areas of laryngeal tissues results in haemangiectasia, efficient blood supply in muscular tissue and its enhanced elasticity and resilience. It particularly concerns nape and neck muscles, muscular coat of oesophagus as well as mimical and tongue muscles. The massage allows to comminute and remove fat cells from excessively developed subcutaneous tissue of submandibular region [10]. In our study, 90% of patients showed a significant reduction of the neck circumference after rehabilitation with the application of massager. The values of pressure in the opening of sphincter of oesophagus mouth, which do not extend 80 mmHg, are crucial in voice rehabilitation [11]. It has been found that the better quality of substitute speech is an effect of greater expression of mouth and face movements [5]. Muscles relaxation by reducing physiological stress effects not only supports rehabilitation process, but it also improves physical endurance and self-confidence [4, 5]. The application of massager Medical 2VR, Cyberbiomed not only refines voice rehabilitation, but it also leads to faster return to active social life in patients after total laryngectomy. Deeply invasive massager, if regularly used, tones the skin, decreases tension of the oesophageal muscles and significantly improves blood supply in the operated area. Possible complications after the use of the massager include pharyngocutaneous fistula and irritation of mucous membrane of the tracheostomy. However, none of above side effects were observed in the study.

Conclusions

The application of the invasive massager Medical 2VR in voice rehabilitation in patients after complete removal of the larynx:

1. Reduces lymphoedema of the neck.
2. Improves elasticity and blood supply in soft tissues of the neck.
3. Decreases pressure in the opening of sphincter of oesophagus.
4. Reduces the period of voice rehabilitation and accelerates the learning process of substitute speech.

5. Improves general physical endurance and the quality of life.

Authors' contributions/Wkład autorów

According to order.

Conflict of interest/Konflikt interesu

The work was not funded by the Clinic of Otolaryngology of the Medical University of Silesia. The device concept was developed by Cyberbiomed. The costs of development and implementation were incurred by Cyberbiomed.

Financial support/Finansowanie

None declared.

Ethics/Etyka

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; EU Directive 2010/63/EU for animal experiments; Uniform Requirements for manuscripts submitted to Biomedical journals.

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