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ARTYKUŁ ORYGINALNY / ORIGINAL ARTICLE

Results of surgical treatment in patients with sulcus vocalis

Efekty chirurgicznego leczenia u pacjentów z rowkiem głośni

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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Article history: Received: 05.09.2015 Accepted: 25.10.2015 Published: 15.12.2015

ABSTRACT:

Sulcus vocalis is one of the most difficult to treat benign vocal fold pathologies. Ford distinguished three types of sulci: I- superficial, II- vergeture and III- true sulcus vocalis. The aim of the study was to assess the results of surgical treatment in patients with sulcus vocalis.

Material of the study consisted of 24 patients with type II (16 subjects) and type III sulcus (8 subjects).

Methods: Videostroboscopy, perceptual voice assessment and objective acoustic voice analysis were performed before surgery and at 8 months of follow-up. All patients underwent surgical treatment as well as pre- and postsurgical voice therapy.

Results: Postsurgical stroboscopic examination showed statistically significant differences in symmetry and regularity of vibrations. Subjective perceptual voice assessment showed improvement in the grade of voice hoarseness, roughness, breathiness and strain.

Objective voice analysis showed statistically significant difference only in jita parameter, in contrast to other examined parameters - although their values decreased after surgery, the change was not statistically significant.

Conclusions: Surgical treatment of sulcus should be considered in patients with severe voice problems; however, the end results are not always entirely satisfactory.

KEYWORDS: sulcus vocalis, vergeture, injection laryngoplasty, hyaluronic acid

STRESZCZENIE:

Rowek głośni jest jedną z najtrudniejszych do leczenia łagodnych zmian patologicznych fałdów głosowych. Ford wyróżnia trzy typy rowka: I- powierzchowny, II –*vergeture* oraz III -*true sulcus vocalis*.

Cel: Ocena efektów leczenia grupy pacjentów z rowkiem głośni metodami chirurgicznymi.

Materiał stanowiła grupa 24 pacjentów z rowkiem głośni typu II (16 osób) i III (8 osób). Metoda: Przed- i 8 miesięcy po zakończonym leczeniu, przeprowadzono badanie videostroboskopowe, percepcyjną ocenę głosu oraz obiektywne badanie akustyczne głosu. Zastosowano leczenie chirurgiczne uzupełnione przed- i pooperacyjną rehabilitacją głosu.

Wyniki: W pooperacyjnym badaniu stroboskopowym obserwowano istotną statystycznie poprawę regularności i symetrii drgań fałdów głosowych. W ocenie percepcyjnej głosu uzyskano istotne statystycznie zmniejszenie stopnia chrypki, szorstkości, głosu chuchającego i napięcia w głosie. Obiektywna ocena głosu wykazała istotną statystycznie poprawę jedynie dla Jita; wartości pozostałych analizowanych parametrów akustycznych uległy zmniejszeniu, jednak różnica ta nie była istotna statystycznie.

Wnioski: Leczenie operacyjne rowka głośni powinno być rozważane u pacjentów ze znacznymi problemami głosowymi, jednak ostateczne wyniki nie zawsze są w pełni satysfakcjonujące.

SŁOWA KLUCZOWE: rowek głośni, vergeture, laryngoplastyka iniekcyjna, kwas hialuronowy

INTRODUCTION

The phenomenon described in this paper is known in English literature as sulcus vocalis or sulcus vergeture [2]. Based on clinical and histopathological features Bouchayer distinguished these two pathologies characterized by penetration of vocal fold epithelium into the structure of the fold accompanied by its adhesion to vocal ligament or muscle. Sulcus vergeture is a concavity at the free edge of the vocal fold lined with an atrophic epithelium [2,5]. Sulcus vocalis is a longitudinal pouch on the superior surface of the fold lined with a thickened and hyperkeratotic epithelium. Additionally, Ford distinguished a superficial type (type I) limited to the outermost layer, lamina propria, which does not cause a voice disorder. Type II in the Ford classification corresponds to sulcus vergeture, and type III – sulcus vocalis in the Bouchayer classification [4,5]. .

According to the literature frequency of occurrence of sulcus vocalis varies between 0.4% and 48%. The cause of such a disparity may lay in difficult diagnosis and possibility of overlooking the type I sulcus [14]. Etiology of the disease is a subject of constant discussion. Some authors advocate the congenital background, especially when the sulcus is accompanied by other pathologies, such as an *open epidermoid cyst*, or *mucosal bridge* and voice disorders persist since early childhood [1,15]. However, in some people symptoms of sulcus glottis appear later, after an upper respiratory tract infection due to chronic overstrain of the voice organ or chronic gastrointestinal reflux disease [2,5,6,13]. Typical symptoms include: voice hoarseness of varying severity, reduced intensity, fatigability and instability of voice or high voice pitch, particularly noticeable in men. Stroboscopic examination of the larynx usually reveals a fusiform glottal gap, arched, concave free edge of the vocal fold, significant reduction or absence of the mucosal wave as well as signs of secondary hyperfunction at a ventricular level. Pathological vascularization of the vocal fold is sometimes visible in the proximity of the sulcus [2,5,6,7].

Treatment methods differ depending on the severity of voice dysfunction and encompass conservative (voice rehabilitation) or surgical treatment. Surgical methods are individually chosen in every case and encompass injection laryngoplasty, surgical resection of the groove, type I thyroplasty with possible type III thyroplasty (Isshiki method) or a technique involving transverse cuts along the vocal fold [2,11,13,17]. Modern, recently developing therapeutic techniques include regeneration phonosurgery with application of materials influencing processes of regeneration within vocal fold structures [8].

AIM

To assess the results of surgical treatment in a group of patients with sulcus vocalis

MATERIAL

There were 58 cases of sulcus vocalis diagnosed at the Department of Audiology and Phoniatry IFPS between 2009 and 2014. Twenty-nine patients with type I sulcus that did not complain of voice problems and five patients with pathological sulcus (grade II and III) who had not reported to follow-up visits were excluded from the study.

The study material consisted of 24 patients with sulcus vocalis; mean age was 38.7 years (13 women and 11 men). Sixteen subjects were diagnosed with type II sulcus and eight with type III sulcus. In 10 cases sulcus was unilateral and bilateral in 14 cases. Other organic lesions were found in five subjects: bilateral fibrous mass of the vocal fold – 2 patients, unilateral Reinke's edema – 1 patient, epidermoid cyst – 1 patient, vocal fold scarring – 1 patient.

METHODOLOGY

All patients underwent laryngological and phoniatric examina¬tion, including laryngovideostroboscopy (LVS), perceptual voice assessment in the GRBAS scale and multidimendional acoustic voice analysis (MDVP) before and 8 months after surgical treat¬ment. LVS assessment was conducted using EndoStrob DX Xion 327 apparatus. In the study we subjectively assessed the degree of vocal fold closing during phonation, symmetry, regularity and amplitude of vibrations, as well as mucosal wave. The GRBAS scale of the Japanese Association of Speech-Language-Hearing Therapists described by Hirano in 1981 was used for voice assessment. This method assesses severity of hoarseness – G, roughness – R, breathiness – B, asthenia – A, and strain – S. Each of those param-

eters was defined on a four-grade intensity scale from 0 to 3. For subjective voice assessment we conduct¬ed a multidimensional voice analysis MDVP (Multidimensional Voice Program) using instruments by KAY CSL Company. In the analysis we used the sustained "a" vowel phonation recorded with an AKG capacitor microphone by KAY Company. Selected parameters describing physical voice properties were subject to analysis: mean baseline frequency Fo, parameters describing relative change in frequency (Jita, Jitt, PPQ, vFo), parameters assessing relative change in the amplitude (ShdB, Shim, APQ, vAm), and parameters of relative noise measurements (NHR, SPI).

All patients from the study group were subject to surgical treatment, including injection laryngoplasty in 2 patients, surgical detachment of the sulcus and sulcus detachment with augmentation in the remaining 20 cases. Surgery was performed in general endotracheal anesthesia using a Kleinsasser set. Glottal sulcus resection was performed using a CO2 laser (*Acublade micromanipulator, Lumenis*). Hyaluronic acid *Surgiderm 24 XP* by *Allergan* was injected through a 25 gauge (0.5 mm) intralaryngeal needle. Preparation was injected closest possible to the deep layer of lamina propria of the vocal fold in order to fill the atrophic superficial layer of lamina propria and even out the free edge of the fold. Injection sites were selected individually depending on the shape of glottal gap. Amount of injected hyaluronic acid amounted to 0.3-0.8 mL per patient, including 10-15% overcorrection. In the postoperative period patients were administered an antibiotic for 6 days and prohibited from talking for 5-7 days. Voice rest was recommended for 2 weeks after the procedure.

All patients underwent 8-10 sessions of voice therapy without satisfactory improvement before referral to surgical treatment. Speech therapy lasting 3-6 months (1-2 times a week) was implemented in the postoperative period in order to eliminate bad phonation habits and adverse compensational mechanisms.

Obtained results were subjected to analysis, which was conducted using the Shapiro-Wilk test, Wilcoxon matched pairs test, R Spearman correlation analysis, chi-square test and Yates correction for chi-square test. P values at a level of 0.05 were considered statistically significant.

RESULTS

Comparison of preoperative and postoperative results of the LVS study is presented in Table I. The assessment conducted at 8 months from the procedure revealed improvement with respect to all analyzed parameters. In a postoperative examination there was a significantly greater number of patients with symmetrical (p=0.0388) and regular (p=0.0171) vocal fold vibrations. However, the number of patients with full glottal closure, normal amplitude and mucosal wave did not increase significantly, although in subjective assessment of those parameters in stroboscopic examination improvement was observed in some subjects.

Subjective voice perception assessment in the GRBAS scale revealed improvement of voice quality after treatment (Table II). Statistically significant improvement was achieved with regard to the severity of hoarseness (p=0.0117), roughness (p=0.0163), breathiness (p=0.0277), and voice strain (p=0.0277). Only the reduction in voice asthenia was not statistically significant.

Tab. I. Results of subjective assessment of the LVS parameters

	BEFORE SURGERY	AFTER SURGERY
Symmetry		
Symmetrical	6	13
Asymmetrical	18	11
Regularity		
Regular	5	13
Irregular	19	11
Glottal closure		
Complete	6	11
Incomplete	18	13
Amplitude		
Increased	0	0
Normal	11	13
Reduced	13	11
Mucosal wave		
Normal	2	6
Mild	18	18
None	4	0

Comparison of the preoperative and postoperative results of selected objective acoustic parameters (MDVP) revealed statistically significant improvement for the Jita parameter only (p=0.0413) (Fig. 2, Fig. 8a,b). Values of the remaining analyzed acoustic parameters were reduced, although improvement was not statistically significant (Fig.1, Fig.3, Fig.4, Fig.5, Fig.6, Fig.7). The R Spearman correlation test yielded positive for frequency parameters – Jita, PPQ, and Fo (Table III).

DISCUSSION

Sulcus vocalis is a common, although diagnostically difficult benign pathology of the vocal folds [12]. It frequently remains undiagnosed or is suspected indirectly based on clinical features in the

Tab. II. Results of perceptual voice assessment in GRBAS scale

GRBAS SCALE	BEFORE SURGERY	AFTER SURGERY
Grade (G)		
0	0	4
1	14	17
2	8	3
3	2	0
Roughness (R)		
0	0	4
1	8	15
2	14	5
3	2	0
Breathiness (B)		
0	3	10
1	19	14
2	2	0
3	0	0
Asthenia (A)		
0	11	15
1	13	9
2	0	0
3	0	0
Strain (S)		
0	4	10
1	10	10
2	8	4
3	2	0

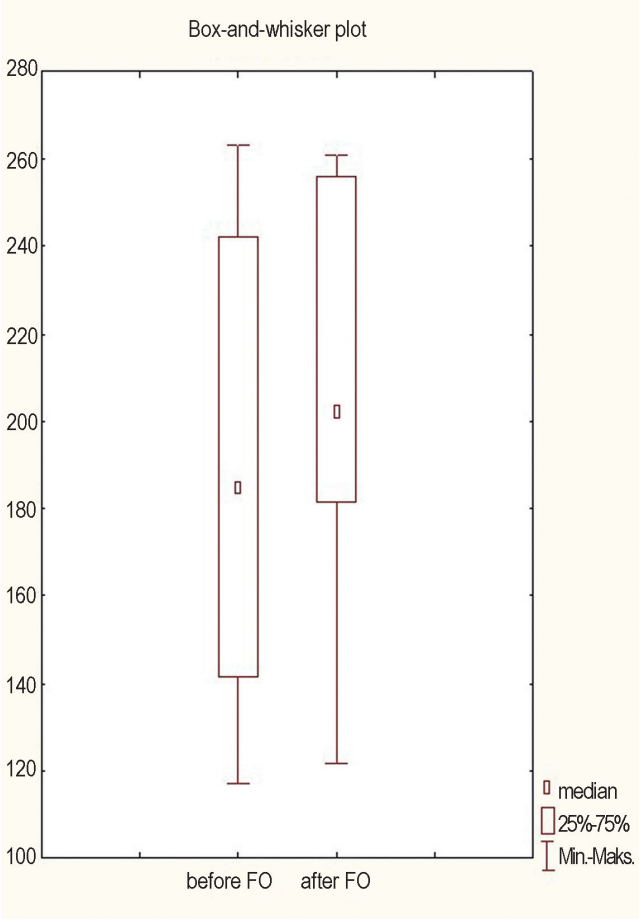

Fig. 1. Mean values of baseline frequency before and after treatment

Tab. III. Median values and ranges (minimum and maximum) of selected parameters of the MDVP study and p value obtained in Wilcoxon's matched pairs test and R Spearman's correlation. Statistically significant correlations are marked with *

		BEFORE SURGERY		AFTER SURGERY		RESULTS OF STATISTICAL ANALYSES	
	N	Median	Range	Median	Range	Wilcoxon's matched pairs test	R Spearman's correlation coefficient
Jita	14	95.0	34.2 - 343.2	70.3	18 - 149.1	0.0413*	0.5560*
Jitt	14	1.5	0.8 - 4.9	1.5	0.3 - 3	0.1578	0.4681
PPQ	14	0.9	0.4 - 2.8	0.9	0.2 - 1.7	0.0961	0.5824*
Fo	14	185.1	116.7 - 263.1	202.4	121.4 - 260.6	0.2719	0.7714*
vFo	14	2.3	1.4 - 11.9	2.5	0.9 - 3	0.1240	0.3146
ShdB	14	0.6	0.2 - 1.2	0.5	0.2 - 1.5	0.8752	0.2131
Shim	14	6.6	2.3 - 15.3	5.8	2.1 - 19.2	0.8200	0.1956
APQ	14	4.6	1.8 - 12.9	4.1	1.7 - 11.1	0.7298	0.0593
vAm	14	17.3	9.9 - 41.2	14.9	7.4 - 38.9	0.4703	-0.1516
NHR	14	0.2	0.1 - 1.2	0.1	0.1 - 0.2	0.0842	0.1300
SPI	14	15.7	5.1 - 29.8	14.3	8.8 - 27.9	0.3967	0.4505

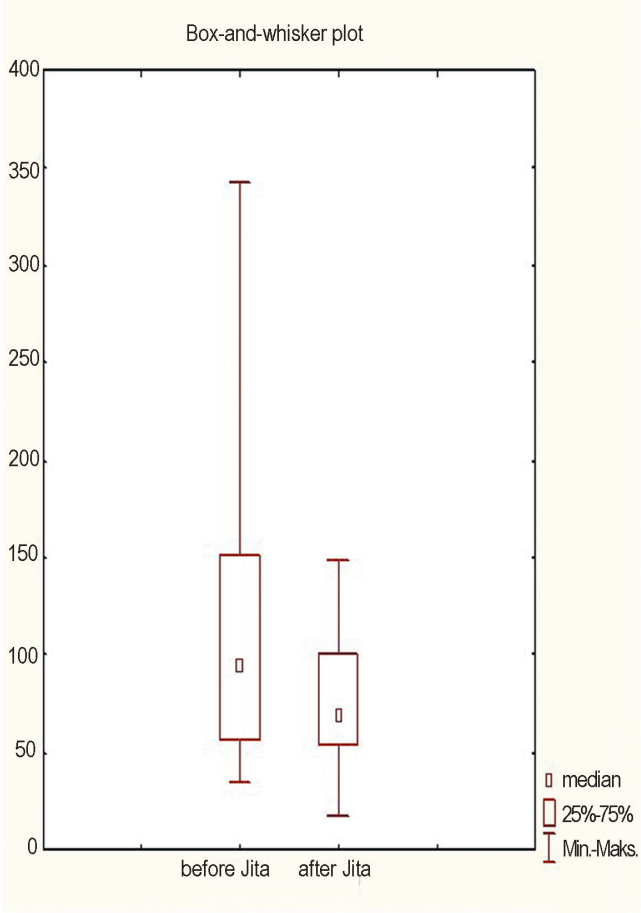

Fig. 2. Values of Jita before and after treatment

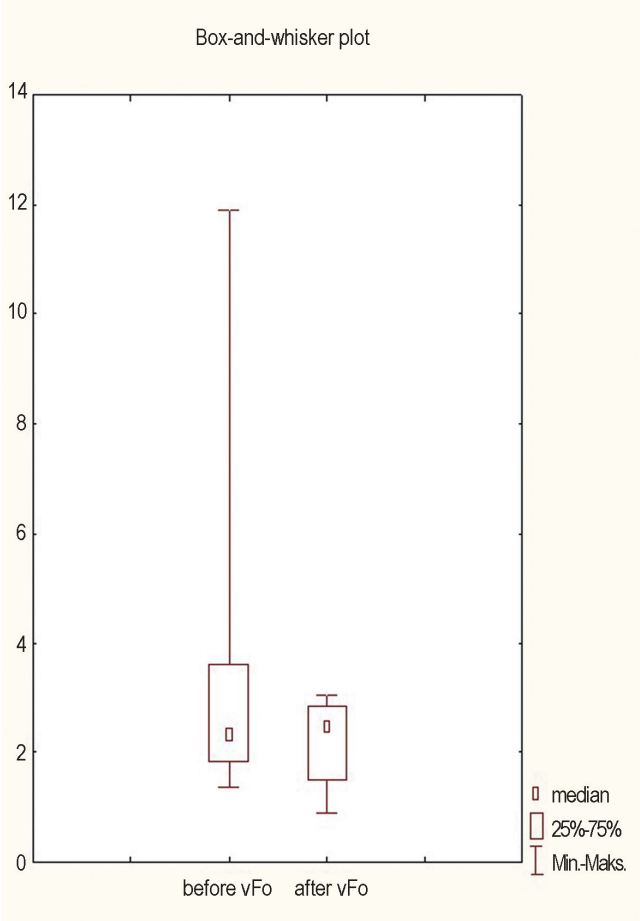

Fig. 3. Values of vFo before and after treatment

stroboscopic image of the larynx. Depth of epithelial penetration into the vocal fold determines the type of sulcus and severity of dysphonia. Histological studies show almost complete abolition of Reinke's space with adhesions between the bottom of the sulcus and a vocal fold (78-83%), excessive accumulation of collagen fibers with a reduction in the amount of hyaluronic acid, significantly more frequent occurrence of degenerative lesions of *lamina propria* (61-72%) and inflammatory infiltrations resulting in fibrosis (77-83%) in type II and type III sulcus [8,14]. It results in vocal fold stiffening with limitation or abolition of vibrations, indentation of the free vocal fold edge and incomplete glottal closing.

Current strategies of treatment of pathological sulcus vocalis mainly involve surgery and are aimed at improvement of laryngeal function through restoration ofmucosal wave and anatomical conditions at a glottal level [3,11,13,17]. Prospective studies conducted by Welham et al. showed that there is no single effective method of treatment and restitution of euphonic voice is practically impossible [16].

Surgical techniques of treatment of sulcus vocalis with hyaluronic acid injections used by the authors in 83% of subjects was concordant with the concept of Bouchayer, Cornut and Remacle, and was based on releasing adhesions between the epithelium and a vocal fold for improved vocal fold vibration. Hyaluronic acid injections were aimed at improving glottal closure, but also filling the atrophic Reinke's space with its natural component [1,2,3,9,11,13].

Results of the LVS examination, voice perception assessment and analysis of acoustic parameters in the studied group of patients show various degrees of improvement after 8 months from the procedure. However, it is only an improvement, not normalization of those parameters. In postoperative stroboscopic examination normal mucosal wave was observed in 24% of subjects compared to 8% before the procedure and reduced, but present mucosal wave in 76%. We also noted improvement with respect to the remaining parameters of vibration and glottal closure, which after surgery was complete in 46% of patients compared to 25% before surgery. Remacle et al. [13]

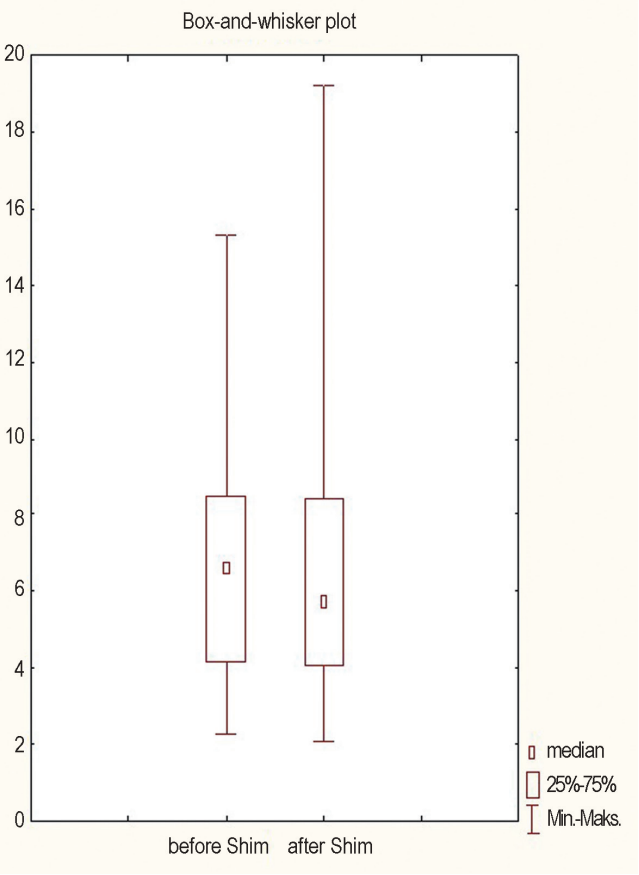

Fig. 4. Values of Shim before and after treatment

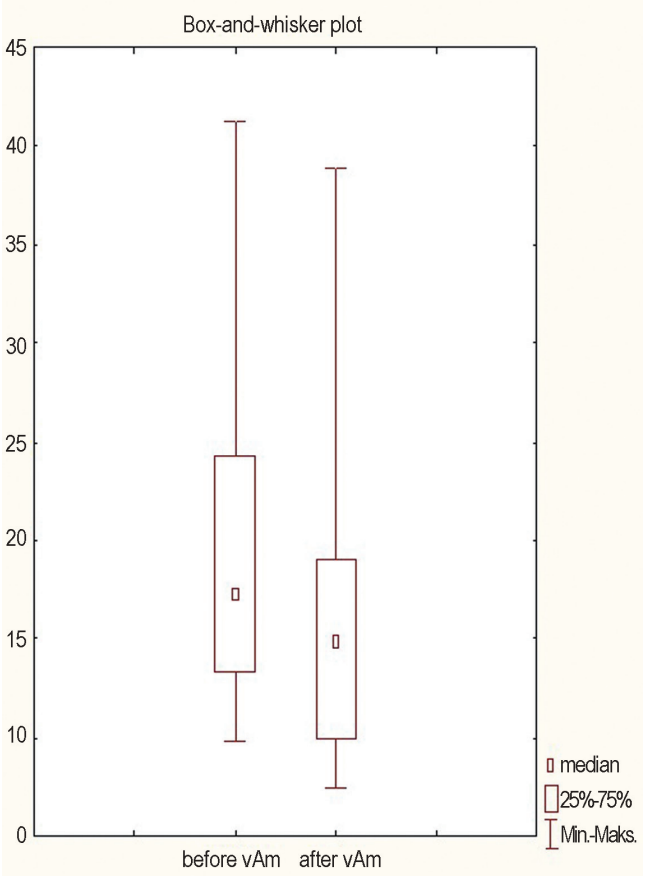

Fig. 5. Values of vAm before and after treatment

report similar observations. Yilmaz suggests that excision of atrophic sulcus epithelium instead of simple detachment prevents its recurrent adhesion to the ligament and noted cases of normalization of vocal fold vibration in long-term, 12-month follow-up, although in the entire material he failed to obtained statistically significant improvement with regard to mucosal wave, symmetry and regularity of vibrations [17]. Voices of patients from the study group assessed in the GRBAS scale became improved, but remained hoarse. On the other hand, all treated patients considered their voices stronger than before the procedure and experienced greater freedom and less voice fatigue while speaking.

Speech therapy is an integral part of carefully planned therapy in a patient with sulcus vocalis, which should be also undertaken as the first step of the therapeutic program [2,13,17]. Postoperative voice therapy reduces hyperfunction at a glottal level, influences return of fold vibrations and improves glottal closure. In the study group therapy encompassed a period 3-6 months after the procedure, although some authors recommend as much as 8 months of therapy and assessed the final effect after one year.

Recent years brought developments in reconstructive surgery, which appears to find application in treatment of sulcus vocalis. Hirano et al. and Kanazawa et al. obtained promising results using bFGF (*basic fibroblast growth factor*) material in a form of vocal fold injections or application of this material in a soaked gelatin sponge into a "pocket" of dissected sulcus. Both forms of application of bFGF led to improvement in the values of jitter and shimmer, although statistically insignificant, while the authors acquired improvement of the parameters of vocal fold vibrations in stroboscopic examination and full glottal closure 10 months after surgery [8,9]. Broad application of surgical techniques involving the use of regeneration biomaterials requires further clinical studies. However, it seems to be the only worthy of consideration alternative for previous imperfect methods of treatment.

CONCLUSIONS

- Sulcus vocalis is often difficult to diagnose in videolaryngostroboscopic examination. Sometimes

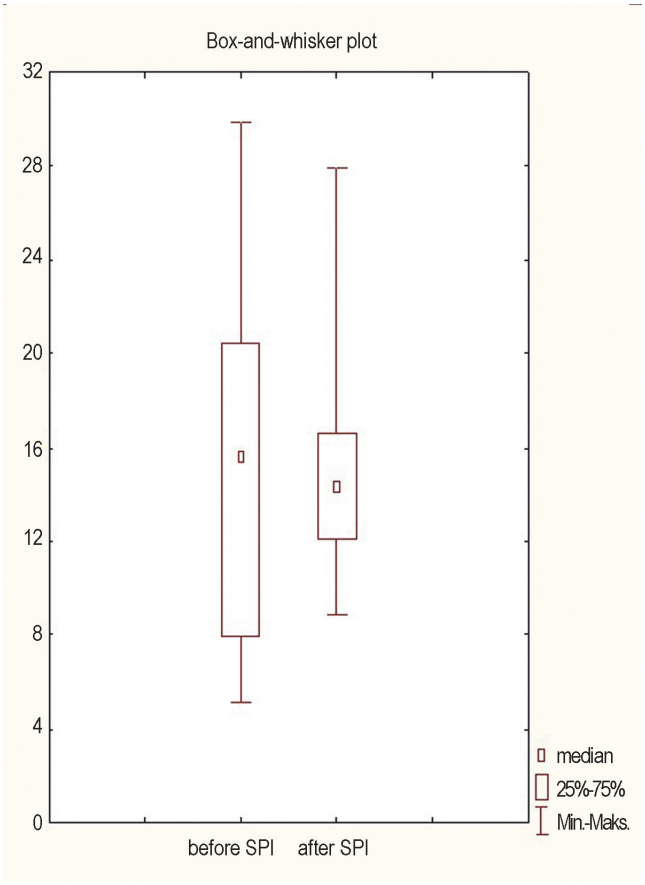

Fig. 6. Values of SPI before and after treatment

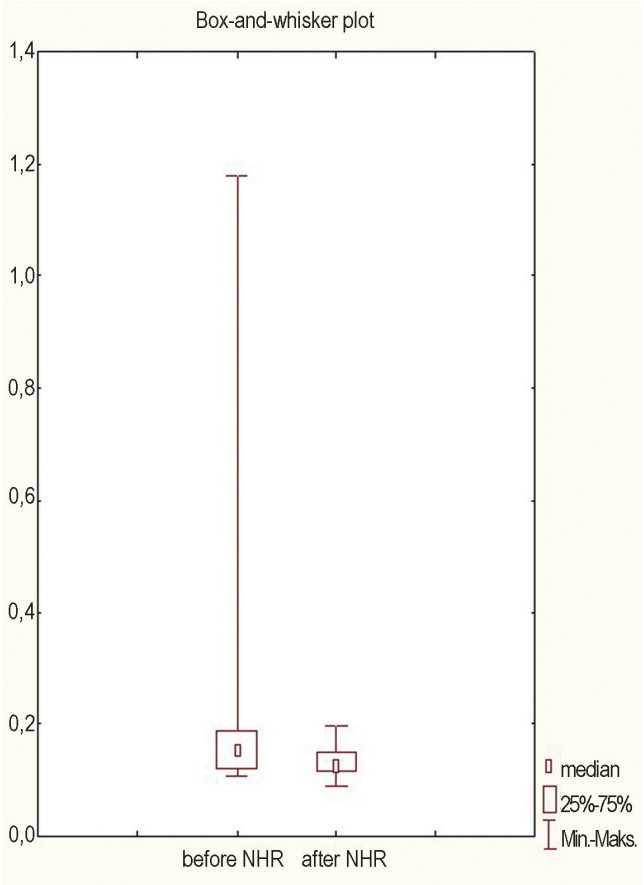

Fig. 7. Values of NHR before and after treatment

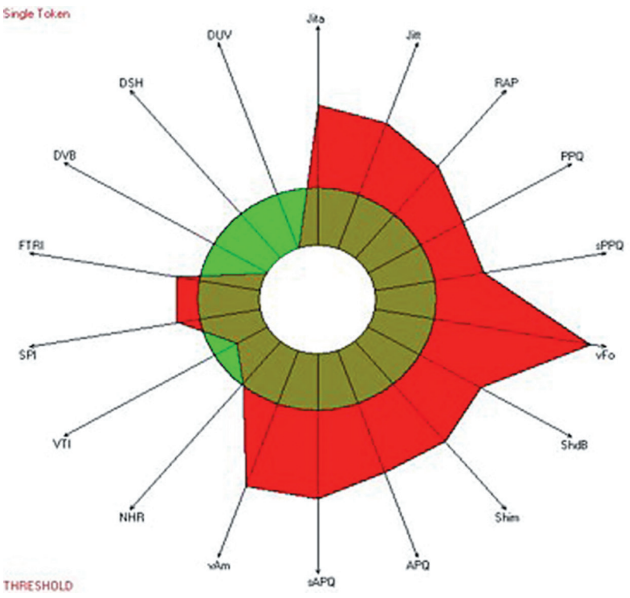

Fig. 8a. MDVP curve before treatment

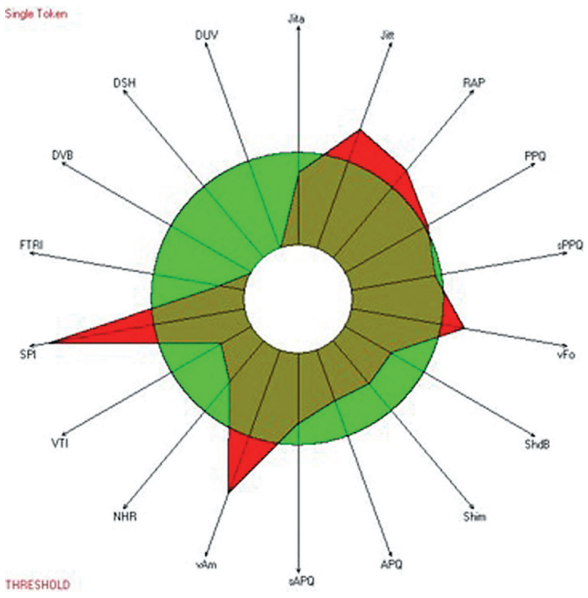

Fig. 8b. MDVP curve after treatment

only intraoperative assessment allows for stating the final diagnosis.

- Surgical treatment of sulcus vocalis should be considered in patients with significant voice problems; however, final outcome is not always fully satisfactory.
- Best therapeutic effects are obtained through a combination of surgical treatment and voice therapy.

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Word count: 2350 Tables: 3 Figures: 9 References: 17

Access the article online: DOI: 10.5604/00306657.1182613 Full-text PDF: www.otolaryngologypl.com/fulltxt.php?ICID=1182613

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Competing interests: The authors declare that they have no competing interests.

Cite this article as: Miaśkiewicz B., Szkiełkowska A., Piłka A., Skarżyński H.: Results of surgical treatment in patients with sulcus vocalis. Otolaryngol Pol 2015; 69 (6): 7-14