Injection laryngoplasty with autologous fat in patients after laser cordectomy (preliminary report)

Laryngoplastyka iniekcyjna z wykorzystaniem autogennego tłuszczu u pacjentów po chordektomii laserowej (doniesienie wstępne)

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ABSTRACT: Transoral endoscopic laser surgery has been widely used in the treatment of the early stage of glottic cancer. Phonatory dysfunction is the main problem after cordectomy. The quality of voice depends on the extent of surgery, especially when resection involves the anterior commissure, vocal process, arytenoid or contralateral vocal folds. Many of surgery (phonosurgery) procedure is performed to improve the activity of the larynx phonatory function. One of them is the autologous fat injection. The aim of this study is evaluation of possibilities of injecting laryngoplasty with autogenous fat in patients after laser cordectomy to improve phonatory function of the larynx (preliminary report).

Two patients, underwent CO2 laser cordectomy type III because of T1aN0M0 glottic carcinoma. After surgery, respectively in the 7th and 8th month, patients were injected on autologous fat into the rest of the vocal fold. Before and after laryngoplasty phoniatric and subjective and objective evaluation of the voice were performed. As a result of the injecting laryngoplasty we observed improvement of the glottic closure, phonatory quality voice and voice perceptual improvement. Injecting laryngoplasty with autologous fat in patients after laser cordectomy is highly recommended, especially after type III laser cordectomy.

KEY WORDS: vocal fold carcinoma, cordectomy, autologous fat augmentation

STRESZCZENIE: Przezustna endoskopowa chirurgia laserowa znalazła różnorodne zastosowanie w leczeniu wybranych przypadków raka głosów w wczesnym stopniu zaawansowania klinicznego. Po chordektomii dochodzi do zaburzeń czynności fonacyjnej, a jakość głosu w dużej mierze zależy od rozległości zabiegu operacyjnego, szczególnie gdy resekcją jest objęte spoidło przednie, wyrostek głosowy, nalewka czy drugi fałd głosowy. Aby poprawić czynność fonacyjną krtni, wykonuje się wiele zabiegów chirurgicznych (fonochirurgicznych). Jednym z nich jest iniekcja autogennego tłuszczu. Celem niniejszej pracy jest ocena możliwości laryngoplastyki iniekcyjnej z wykorzystaniem autogennego tłuszczu u pacjentów po chordektomii laserowej, która ma poprawiać czynność fonacyjną krtni. Materiałem do niniejszej pracy były badania dwóch pacjentów po wykonanej chordektomii typu III z powodu raka fałdu głosowego w zaawansowaniu T1aN0M0. Pacjentom w siódmym i ósmym miesiącu po wykonaniu chordektomii wstrzyknęto tłuszcz do pozostalej części fałdu głosowego. Przed laryngoplastyką i po niej u pacjentów przeprowadzono badanie foniatryczne oraz obiektywną ocenę głosu. W wyniku laryngoplastyki iniekcyjnej u pacjentów uzyskano poprawę zwarcia fonacyjnego, jakości fonacyjnej głosu oraz percepcyjną poprawę głosu. Laryngoplastyka iniekcyjna z wykorzystaniem autogennego tłuszczu u pacjentów po chordektomii laserowej jest godna polecenia, szczególnie po chordektomii typu III.

SŁOWA KLUCZOWE: rak fałdu głosowego, chordektomia, augmentacja tłuszczem autogennym
INTRODUCTION

Transoral endoscopic laser surgery has found widespread use in the treatment of selected cases of early-stage glottic carcinoma (T1N0M0 and T2N0M0) and became an alternative for radiation therapy and external access laryngofissure surgery [1,2]. In 2000, the European Laryngological Society (ELS) identified five types of laser cordectomy procedures. The list was updated by addition of the sixth type in 2007 [3,4]. This classification has contributed to unification of surgical nomenclature, thus facilitating comparison of treatment outcomes obtained in different centers. Surgical interventions within the glottis lead to phonatory dysfunction. The quality of voice depends on the extent of surgery, especially when resection involves the anterior commissure, vocal process, arytendoid or contralateral vocal folds. Surgeries may lead to scarifications (pseudoglottis) that not only differ in their appearance, but also restrict the glottic closure and mobility, leading to potential disturbances in laryngeal aerodynamics. Today, compromise is sought between oncological radicality of surgery and the voice quality outcomes. Type I cordectomy, consisting only in the resection of the epithelium, and type II cordectomy, consisting in the resection of the epithelium, Reinke’s space and vocal ligament, are associated with minimum phonation disorders. Phonation disorders are somewhat more pronounced in type II cordectomies involving the resection of vocal fold up to one half of the width of the vocalis muscle [5,6]. Cordectomies of type IV, V and VI are associated with markedly more significant disturbances in voice quality [7]. Patients complain of hoarseness, vocal fatigue, dry throat, cough, feeling of foreign body within the throat, and sometimes of difficulties with swallowing. Thanks to the plasticity of the vocal system, cordectomies with limited surgical range usually allow for restoration of normal or nearly normal aerodynamic parameters and glottal closure [8]. Wider-range cordectomies require multidisciplinary management consisting in vocal therapy, pharmacotherapy and surgical (phonosurgical) treatment [9]. Pharmacotherapy often includes steroid, antibiotic, and anti-reflux therapies. Surgical treatment is indicated in cases of scarifications leading to glottal insufficiency as well as in cases of aspiration-related symptoms. The objective of surgery includes the achievement of optimum glottal closure and restoration of mucosal wave. Numerous surgical procedures are performed to improve the phonatory function; one of them consists in autologous fat injection [10,11,12,13,14,15,16]. The objective of this study is to evaluate the possibilities of injection laryngoplasty using autologous fat in patients after laser cordectomy to improve the phonatory function of the larynx.

MATERIAL AND METHODS

The study material consisted of 2 patients, 7 and 8 months after type III cordectomy due to stage T1aN0M0 vocal fold carcinoma (left-sided cordectomy was performed in both patients). After surgery, typical pharmacotherapy, physical therapy, and phoniatric rehabilitation were initiated in both patients with the objective to achieve the best possible voice quality. As no satisfactory results were obtained using these measures, decisions were made to subject the patients to surgical augmentation. Before augmentation, one patient reported significant voice weakness and easy fatigability while the other one reported mainly increased vocal fatigability. Videostroboscopic examination of the first patient revealed normal mobility of both vocal cords, boat-shaped glottal incompetence upon phonation, with no features of cancer recurrence. No stroboscopic effect was obtained due to the excess content of air in the generated voice, preventing determination of fundamental frequency (F0). The area of glottal incompetence during phonation was measured by endoscopic assessment using Diagnova software to obtain the resultant value of 20.9 mm² (Fig. 1). Acoustic assessment carried out using MDVP software led to the following values: F0 = 113 Hz, Jitter = 10.1%, Shimmer = 12.96%, NHR = 0.4. Maximum phonation time of vowel [a] (MPTa) was 4.9 s. The voice was perceptually assessed by 2 phoniatrists as moderately changed, slightly coarse, with moderate-breathiness and asthenia, produced with medium strain (G2 R1 B2 A2 S3). VHI score was 45. In the other patient, preoperative videostroboscopic assessment revealed normal mobility of vocal folds, mucosal wave on the right vocal fold and no mucosal wave on the left vocal fold. Glottal closure during phonation was incomplete, boat-shaped, with incompetence area of 4.2 mm² (Fig. 2). Acoustic assessment by MDVP revealed a fourfold increase in Jitter value (4.23%), twofold increase in Shimmer value (6.82%) and the NHR value at the upper limit of normal (0.14). Aerodynamic assessment revealed MPTa of 6 s. In the perceptual assessment, the voice was graded as G2 R1 B2 A2 S1. The patient assessed that his voice quality moderately reduced his quality of life (VRQoL score of 34 points).

The procedures were performed under general anesthesia. Adipose tissue for autologous injection was collected from the lower abdomen. After appropriate preparation, fat was injected by means of a special device and needle (Karl Storz GmbH & Co. KG, Tuttingen, Germany) bent at an appropriate angle so as not to restrict the surgical field, featuring an injection depth delimiter at the tip of the needle (Fig. 3). The injection was delivered in direct laryngoscopy under microscopic control. Adipose tissue was injected into the remains of the vocal folds laterally and deep from the vocal process and at ⅓ of the...
The injected volume was appropriate to produce hypercorrection, i.e. slight bulging of pseudoglottis. On the day after the augmentation, videostroboscopic evaluation of the first patient revealed a significant improvement of the phonation closure as well as slight limitation of the mobility of the left vocal fold. The area of the incompetence at the rima glottidis level was 3.4 mm² (Fig. 4). Acoustic assessment by means of MDVP revealed an improvement in the values of Jitter (2.98%), Shimmer (4.76%) and NHR (0.13). MPTa was elongated to 7.8 s. In the perceptual assessment, the voice was graded as G1 R1 B1 A1 S0.

Next outpatient follow-up assessment carried out 3 months after augmentation revealed the positive effects of augmentation being sustained despite the ongoing absorption of autologous fat. Videostroboscopic assessment revealed normal mobility of both vocal folds with mucosal wave being observed along the entire length of the right vocal fold. The area of glottal incompetence during phonation was still smaller than before augmentation and amounted to 12.8 mm². Jitter (5.27%) and Shimmer (11.4 %) reflected a voice quality that was still better than before the procedure. Maximum time of phonation of the vowel [a] was shortened to 3.2 s. In the perceptual assessment, the voice was graded as G2 R1 B2 A1 S1.

Phoniatric assessment of the patient 6 months after augmentation revealed phonation incompetence of rima glottidis of 8.3 mm² (Fig. 5). The value was better than the one measured in the previous assessment. This improvement as compared to previous assessment was due to the increased hyperfunction

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**Figure 1.** Endoscopic assessment of the pharynx including the measurement of the area of glottal incompetence during phonation (20.9 mm²) in a patient after left-sided cordectomy due to pharyngeal cancer (Patient 1).

**Figure 2.** Endoscopic assessment of the pharynx including the measurement of glottal incompetence during phonation in a patient after left-sided cordectomy due to pharyngeal cancer (Patient 2). The area of glottal incompetence is 4.2 mm².

**Figure 3.** A device and a needle (Karl Storz GmbH & Co. KG, Tuttlingen, Germany), bent at an appropriate angle so as not to restrict the surgical field, featuring an injection depth delimiter.

**Figure 4.** Endoscopic assessment of the pharynx including the measurement of glottal incompetence during phonation in Patient 1 on Day 1 after augmentation.
revealed improved glottal closure upon phonation (incompetence area of 3 mm$^2$). Slight incompetence was observed only in the posterior commissure. Moderate improvement in jitter value (3.69%) was observed compared to pre-augmentation values. MPTa was elongated to 7.3 s. In the perceptual assessment, the voice improved in all subscales of the GRBAS scale (G1 R0 B1 A1 S0). Patient’s assessment of the quality of his voice as well as voice-related quality of life were significantly improved (VRQoL score of 15).

During the next follow-up assessment (3 months after augmentation), the patient was still satisfied with the results of the phonosurgery procedure. Similar as in the case of the previous videostroboscopic assessment, slight incompetence was observed upon phonation in the posterior part of the glottis (1.5 mm$^2$) (Fig. 6). Acoustic assessment revealed sustained improvement in jitter (1.55%) and Shimmer parameters (5.074%) as compared to pre-augmentation values. Maximum phonation time of vowel [a] (MPTa) was maintained at 7.4 s. The result of perceptual assessment was close to the result obtained 2 months earlier (G1 R0 B1 A1 S1). The development of slight vocal strain might be due to better compensation of incompetence (lower phonation incompetence area) at the glottal level as compared to the previous assessment. VRQoL score was at the normal level of 11 points.

DISCUSSION

The material used for injection laryngoplasty as well as the procedure itself should meet certain predefined criteria: the material should be easily available, inexpensive and biocompatible while the surgical procedure should be simple and minimally invasive [11]. These requirements are met by autologous fat that has been widely used in various surgeries within the head and neck region [17]. Autologous fat is also widely used in laryngoplasty for: 1. unilateral laryngeal paresis or paralysis; 2. developmental defects of vocal folds (sulcus vocalis and congenital epithelial adhesion to the vocal ligament with failure to develop the Reinke's space and absent mucosal wave; 3. the treatment of scars caused by previous surgeries (benign or malignant changes of vocal folds; 4. the atrophy of vocal fold following radiation therapy; 5. after previous failure of implant-injection laryngoplasty (inflammatory reaction of laryngeal tissues involving tissue fibrosis)[13,14,15,16,17]. The interest in the use of fat as injectable material is increasing as fat tissues were found to possess characteristics typical of mesenchymal stem cells (MSC), i.e. regeneration and differentiation [18].

The first injection laryngoplasty using paraffin administered in direct laryngoscopy was reported by Brüning in 1911 [19].

In the second patient, phoniatric reassessment was performed one month after augmentation. Videostroboscopic evaluation of the left vestibular fold participating in the glottal closure during phonation. Probably, the involvement of the vestibular fold in phonation had a negative effect on the voice quality as reflected by increased values of jitter (up to 9.82 %) and Shimmer (up to 19.25 %) and the perceptual grading of G2 R2 B2 A1 S1. VHI increased to the value of 60 which may be explained by raised patient’s awareness of the changes and the quality of voice as compared to before augmentation.

Figure 5. The measurement of glottal incompetence area in Patient 1 six months after augmentation. On the left, rima glottidis is delimited by the protruding left vestibular fold.

Figure 6. The measurement of glottal incompetence area (1.5 mm$^2$) in Patient 2 three months after augmentation. Slight incompetence within the posterior rima glottidis region.
Autologous fat was used for the first time in injection laryngoplasty in vocal fold paresis by Mikaelian et al. [20] in 1991. In 2001, it was used by Zeitels et al. [21] after cordectomy due to vocal fold carcinoma.

Guven et al. [13] believe that the best period for fat injection is the first year after the cordectomy procedure. In this period, appropriate rehabilitation and stabilization of pseudoglottis may significantly improve the phonation function of the larynx. This period is also required for oncological follow-up as most recurrences are observed within one year after surgery. Villaret et al. [14] inject fat immediately after cordectomy as a part of the same procedure. They believe that injection of fat in the remaining part of the muscle following type III cordectomy is much easier than in the latter period, when the scars hamper the injection; in addition, patients do not require an additional surgical procedure.

Different opinions are held by different authors with regard to the injection site; some authors suggest a single injection in the remains of the vocalis muscle, others suggest two injections, one lateral and deep from the vocal process and the other anteriorly right under the remaining mucosa covering a part of the vocal fold, while yet another authors inject the fat into the periglottal space. The injected fat volume should be appropriate to produce hypercorrection, i.e. slight bulging of pseudoglottis. According to many authors, injection laryngoplasty using autologous fat in patients after laser cordectomy is highly recommended as it results in improved phonation closure and phonatory voice quality as well as perceptual improvement of the voice, particularly following cordectomies characterized by a small-range of tissue resection. In cordectomies with a larger range of tissue resection, the technique may be combined with simultaneous use of other phonosurgical techniques [5,11,13,14,15].

References


