Vocal quality after transoral CO_2 laser cordectomy

Original Article

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Article received on July 13, 2023.
Accepted for publication on August 13, 2023.

Abstract

Objectives: To assess vocal quality in patients undergoing transoral laser microsurgery (TLM) of the larynx with CO2 laser according to the type of cordectomy.
Study Design: Cross-sectional observational study.
Methods: Patients who underwent TLM for glottic squamous cell carcinoma (SCC) were divided into Group A (type III cordectomy) and Group B (types IV-V). The following parameters were assessed: fundamental frequency (F0), jitter, shimmer, maximum phonation time (MPT), GRBAS scale, and Voice Handicap Index-10 (VHI-10).
Results: Sixteen patients were enrolled, 8 in Group A and 8 in Group B. Patients in Group B had a higher VHI-10 compared to those in Group A. The values of G (grade), R (roughness), and S (strain), as well as acoustic parameters, were generally worse in Group B.
Conclusion: The type of TLM has a long-term impact on vocal quality, with a significant effect on quality of life. Keywords: laryngeal microsurgery; cordectomy; vocal assessment.

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Introduction

Malignant tumors of the glottic region are the most common head and neck tumors, with the most frequent being squamous cell carcinoma (SCC)[1]. Early stage glottic tumors (ESGT) can be detected on time because of the early onset of symptoms and have a good oncological prognosis[2]. The treatment of these tumors includes transoral CO_2 laser microsurgery (TLM) and local radiotherapy (RT)[3]. The European Laryngology Society (ELS) classifies TLM into six types of cordectomy: Type I subepithelial, Type II subligamental, Type III transmuscular, Type IV total, Type V extended, and Type VI anterior comissurotomy[4,5]. TLM is a highly effective and safe treatment modality for patients with

ESGT with survival rates similar to those of RT[1–3,6–9]. The main differences between the two treatments are the side effects and functional outcomes. TLM is the most frequently chosen modality because it is less costly and has less post-treatment side effects. The voice is often altered by the treatment, in addition to being compromised by the disease, and this has important implications for communication, social interaction, and the patient's quality of life. Considering the good prognosis of the disease, voice quality plays a key role in the choice of treatment and patient counseling. The literature describes three main methods of evaluating voice-related outcomes: acoustic analysis, perceptual analysis, and self-perceptive scales[10]. Studies on the impact of treatment on the voice quality-related outcomes often have short follow-up periods or are based on cross-sectional observational data obtained from few patients. More studies on this topic are necessary to improve counseling of patients on the various treatment modalities for ESGT. The objective of the present study was to perform a long-term assessment of voice quality in patients with glottic SCC from our institution according to the type of cordectomy performed .

Materials and Methods

This was a cross-sectional observational study conducted from February 2012 to February 2022, in which patients undergoing TLM for stage Tis, T1, or T2 glottic SCC were evaluated.

All patients were evaluated in an otorhinolaryngology consultation, together with a speech therapist. The patients were divided according to the type of procedure performed into Group A (type III cordectomy) and Group B (type IV-V cordectomy).

Acoustic and aerodynamic parameters were assessed, namely fundamental frequency (F0), jitter, shimmer, and maximum phonation time (MPT). Computational analysis was performed based on the isolated phonation of three sustained vowel sounds, /a/, /u/, and /i/. In addition, perceptual data were collected, according to the GRBAS scale (grade, roughness, breathiness, asthenia, and strain), in which each of these parameters is scored from 0 to 3 (0=normal and 3=severe disturbance)[11]. Voice analysis was always performed by the same team consisting of an otorhinolaryngologist and speech therapist but cordectomy was performed by different surgeons. The minimum follow-up time was 12 months after cordectomy.

Subjective voice assessment was performed through a self-administrated Voice Handicap Index-10 (VHI-10) questionnaire. VHI-10 has been validated for Portuguese, and is an instrument that quantifies the consequences of a voice disturbance as perceived by the speaker[12]. This questionnaire uses a 5-point Likert scale (0 = never; 5 = always). A score from 0 to 50 can be obtained; the higher the score the higher the subjective negative impact of the voice quality.

Patient and tumor data were obtained retrospectively from the clinical records. The analyzed variables were age, sex, type of treatment, and smoking habits in pack-years (PY). Patients who underwent adjuvant radiotherapy or other surgical procedures such as laryngectomy were excluded, along with those with recurrence .

Statistical analysis was performed using the Excel software with XLSTAT tool and the Mann-Whitney U test was used to compare the results between the two groups. The level of significance was set at 0.05.

Results

Sixteen patients were recruited, the majority were men (93.75%, n=15) and the mean age was 71 years. These patients were divided into two groups according to the type of cordectomy: Group A (type III cordectomy) with eight patients and Group B (type IV-V cordectomy) with eight patients. The patients were followed for a mean period of 61.8 months after the surgery (standard deviation [SD] 28.42). Group A included mostly patients with T1 glottic SCC (n=7), and only one patient had carcinoma in situ (Cis). Group B comprised three patients with T2 glottic SCC, four patients with T1 glottic

Table 1
Demographic data

Patients	N=16
Men	n=15 (93.75%)
Women	n=1 (6.26%)
Mean age	71 years (± 8.9)
Time since surgery	61.8 months (±28.42)
Tumor stage	
Carcinoma *in situ* (Tis)	n=2
T1	n=11
T2	n=3

SCC, and one patient with Tis glottic SCC.

Table 2 summarizes the results of the voice assessment. With regard to the self-perceptive voice assessment, the mean VHI-10 score was 7.13 (SD 5.83) in Group A and 14.88 (SD 4.99) in Group B (p value=0.011). The mean period since surgery was similar between the two groups. The mean PY was higher in Group A than in Group B (56.25), although all patients stopped smoking after the surgery.

With regard to the GRBAS scale rating, the greatest difference was obtained for parameter "S" (voice strain), although there

Table 2
Voice assessment results

GROUP	A (Type III cordectomy)	B (Type IV-V cordectomy)	P value
N=16	n=8	n=8	
Mean age	73.25	68.75	
PY	56.25	38.63	
Time interval since surgery (months)	63.25	60.5	
GRBAS scale			
G – grade	2,25	2,50	0,765
R - roughness	2,25	2,38	1,000
B - breathiness	0,88	0,75	0,984
A - asthenia	1,25	1,12	0,779
S - strain	1,62	2,37	0,124
Parameters of acoustic analysis			
F0 /a/ (Hz)	200,25	230,13	0,645
F0 /u/ (Hz)	207,75	194,25	0,859
F0 /i/ (Hz)	237,50	215,25	0,700
MPT /a/ (s)	5,18	8,15	0,505
MPT /u/ (s)	5,76	8,43	0,505
MPT /i/ (s)	6,95	8,40	0,980
Jit /a/ (%)	1,19	1,89	0,592
Jit /u/ (%)	1,05	1,24	0,645
Jit /i/ (%)	1,13	1,74	0,555
Shi /a/ (%)	3,85	4,08	0,523
Shi /u/ (%)	2,80	2,26	0,505
Shi /i/ (%)	2,63	3,42	0,528
/s/ (s)	7,19	10,99	0,342
/z/ (s)	6,31	8,29	0,665
Self-perceptive evaluation			
VHI-10	7,13	14,88	**0,011**

PY – pack-years; F0 – fundamental frequency; MPT – maximum phonation time; Jit – jitter; Shi – shimmer; VHI-10 – voice handicap index 10

was no statistically significant difference (p=0.124). The results of the acoustic analysis, as shown in Table 2, were also not statistically different between the two groups.

In the evaluation by video laryngostroboscopy, four patients exhibited a web in the anterior commissure (two patients in Group A and two in Group B). It is worth noting that the patients with a web had a mean VHI score of 12, which is similar to the mean score obtained for all patients (11). In the GRBAS scale, these patients had a higher value of "R" (roughness) than the mean value for all patients (2.75 vs 2.31).

Discussion

During microsurgery of the larynx in cases of ESGT, tumor eradication needs to be a priority and the success of the treatment is measured by the rate of disease control and survival[13,14]. However, it is important to consider the impact of surgery on vocal cord function, which can have a significant effect on the patient's quality of life. Most studies on voice quality in patients with ESGT have focused on the comparison between surgery, namely TLM, and RT. In this context, the results are divergent, with some studies showing better voice outcomes after surgery[15,16], while others favored RT[17,18]. A recent systematic review by Colizza et al., which encompassed 24 studies 1027 patients, showed that patients who underwent type I or II cordectomy have a better voice quality in terms of the perceptual parameters, acoustic parameters, and VHI score than those who underwent type III, IV, and V cordectomy[19]. These results were expected because excisions that include the vocal ligament lead to fibrosis, thus affecting the mobility of the vocal cord mucosa. In fact, more extensive cordectomies (III-V) aggravate organ disturbance by reducing the volume of the vocal cord due to excision of parts of the thyroarytenoid muscle. Although this muscle does not participate per se in the vibratory mechanism involved in voice production, it allows the approximation of the vocal cords and closure of the glottis, and thereby facilitates the aerodynamic mechanism.

In the present study, the patients underwent at least a type III cordectomy because the main goal of the surgery was effective disease control, i.e., obtaining larger margins. Therefore, similar to other studies[20,21], cases of type III cordectomy were separated from cases with more aggressive excision in which the vocal cord is completely excised (type IV) or the excision is extended to other structures such as the contralateral vocal cord, ventricle, and subglottis (type V). In the present study, type III cordectomy was performed for smaller Tis and T1 tumors, whereas type IV and V cordectomies were performed for larger tumors. Group B had three patients with T2 SCC. The most significant difference between the two groups was observed in the self-perception of voice change: the VHI-10 score was significantly higher in Group B (14.88 vs 7.13, p=0.011) than in Group A. These results show that a complete or extended resection of the vocal cord may imply a greater deficit in voice quality in the long-term because the VHI scale is one of the most consistently used tools to assess the impact of voice change on the quality of life[20]. There were no statistically significant differences in the other analyzed parameters. With regard to the perceptual assessment of voice using the GRBAS scale, the values of "G", "R", and "S" were higher in Group B than in Group A. The result for "S" was the closest to a statistically significant difference (p=0.124). This finding corresponds to secondary muscle tension dysphonia (MTD), with muscle supercompensation due to glottic insufficiency. Patients with MTD usually demonstrate substantial changes in "G", "R", and especially "S"[22,23]. Although MTD is not a strictly defined entity, procedures that remove a large volume of the vocal cord are expected to cause greater compensation by increasing the tension in the laryngeal and paralaryngeal muscles[24]. This should be one of the components of intervention in these patients by speech therapists as it may help in improving the voice quality.

The analysis of the acoustic parameters did not show statistically significant differences

between the two groups. A lower MPT in Group A may be explained by the fact that these patients were heavier smokers. Smoking plays a key role in the etiology of chronic obstructive and restrictive lung disease, and MPT reflects not only the ability of the glottis to close but also lung function[25]. The objective parameters of voice analysis, such as shimmer and jitter, tended to be worse in Group B (with the exception of shimmer in vowel /u/). This trend was also observed in studies that compared the types of cordectomy and can be explained by the greater compromise of the vibration process, which is the result of more extensive resection[13,20]. This study has some limitations, namely the fact that pre- and postoperative changes were not compared. The fact that different types of cordectomies performed by surgeons were categorized into only two groups is another limitation because the different types of cordectomies have distinct anatomical implications. In addition, the time between surgery and evaluation was not standardized, although all cordectomies were performed at least one year before the evaluation. Lastly, the sample size was smaller than what we would have liked, which may have prevented statistically significant results for some of the comparisons.

Given the relevance of the impact of laryngeal surgery on the voice quality and consequently, on the quality of life, further studies are necessary to assess the effect of each type of cordectomy and improve the recommendations.

Conclusion

The type of cordectomy, characterized by the extent of vocal cord resection, determines the quality of voice in the long term. Patients who underwent type III cordectomy had a better score for voice quality self-perception, which has important implications for the patients' quality of life, than patients who underwent type IV-V cordectomy. Although eradicating the disease is the most important goal, voice quality should also be considered while selecting the type of surgery or treatment.

Conflict of interest

The authors declare no conflict of interest regarding this article.

Data confidentiality

The authors declare that they followed the protocols in use at their working center regarding the publication of patients' data.

Funding

Thus study did not receive any contribution, funding or grant.

Availability of scientific data

There are no publicly available datasets related to this study.

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