TJVS Turkish Journal of Vascular Surgery

Turk J Vasc Surg 2023;32(2):78-82
DOI: 10.9739/tjvs.2023.04.014

Available online at www.turkishjournalofvascularsurgery.org

Original Article

Postoperative objective and subjective voice analysis in patients who underwent carotid endarterectomy and carotid body tumor resection

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Received: Apr 24, 2023 Accepted: Jun 21, 2023 Published online: Jul 15, 2023

Abstract

Aim: This study aimed to compare voice changes after Carotid endarterectomy (CEA) and Glomus body tumor resection with objective instrumental and acoustic assessments.
Material and Methods: A total of 14 patients underwent CEA or glomus carotid tumor resection at our institution between 2009 and 2013. Among the 14 patients, two patients were excluded due to vocal cord paralysis. This study was applied to 12 patients.
Patients were called retrospectively, and objective and subjective voice parameters were measured and compared. Voice handicap index was used to measure subjective voice parameters. Objective voice analysis was performed for patients by using Multi-dimensional voice programming (MDVP), a computer-aided program.
Results: A total of 12 patients were included in the study. Five patients underwent carotid endarterectomy. Glomus tumor resection was performed on seven patients. Of the patients who underwent carotid endarterectomy, four were male and one was female. Three of the patients who underwent glomus tumor resection were male and four were female.
Voice handicap index (VHI) showed that two patients who underwent glomus tumor resection experienced moderate problems and the patients who underwent CEA had no obvious problems. Patients who underwent glomus carotid tumor resection obtained higher values in all MDVP parameters than those who underwent CEA.
Conclusion: Despite the small number of patients, it can be said that glomus tumor resection in neck surgery, that is, tumor surgery, causes more voice changes than carotid endarterectomy operations. The elevated objective sound parameters found in this study necessitate that patients should be informed regarding the potential of developing postoperative dysphonia, especially those who rely on their voice as their profession (e.g. sound artists, teachers, politicians).

Keywords: Glomus tumor, carotid endarterectomy operation, voice handicap index, multi-dimensional voice programming (MDVP), N. larynges sup

CITATION
Kahraman U, Balcioglu O, Ertugay S, Oguz E, Posacioglu H. Postoperative objective and subjective voice analysis in patients who underwent carotid endarterectomy and carotid body tumor resection. Turk J Vasc Surg. 2023;32(2):78-82.

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INTRODUCTION

In the last decade, an increase in the popularity of stent-dependent procedures was observed worldwide; however, carotid endarterectomy (CEA) remains the most commonly performed treatment for carotid stenosis [1]. Glomus body tumors are the most common extra-adrenal paraganglioma [2]. Despite not originating directly from the arterial wall, it is supplied by the external carotid artery [2]. Mass compression-related complications necessitate surgical resection of even small-sized tumors to prevent gradual enlargement [2]. However, cranial nerve damage is a complication of CEA, with incidence rates of 5%-19.8% [3]. The superior recurrent laryngeal nerve (SRLN) and hypoglossal nerve are the most commonly affected local nerves, which result in voice alterations such as hoarseness, voice fatigue, and phonation loss after carotid surgery [3]. Currently, several studies have reported the results of voice alterations after CEA. However, comprehensive research that evaluates voice changes after CEA versus glomus carotid tumor resection remains lacking.

This study aimed to compare voice changes after CEA and glomus body tumor resection with objective instrumental and acoustic assessments.

MATERIAL AND METHODS

A total of 14 patients underwent CEA or glomus carotid tumor resection at our institution between 2009 and 2013. Among the 14 patients, two patients were excluded due to vocal cord paralysis; finally, 12 patients were included in this study.

An experienced vascular surgery team performed all operations under general endotracheal anesthesia, followed by a standard carotid endarterectomy approach. After the skin incision, electrocautery was used to dissect the connective tissue; to prevent nerve injuries, mayo scissors were used for dissection of the arterial surroundings. Special attention was paid to the hypoglossal nerve, vagus nerve, and SRLN and the sub adventitial dissection in glomus tumor cases. All operations were performed successfully with no complications, and patients were routinely discharged. Primary closure technique was applied to all carotid endarterectomy cases. All of the glomus tumors were type 2 according to the shamblin classification. The embolization process was not pursued before the Carotid body tumor resection. All were surgically resected.

Bleeding, cranial nerve injuries, and stroke complications were not seen in these glomus tumor cases. The patients were then called from their homes and objective and subjective sound analyses were applied to them.

The study was performed in compliance with the law and regulations of the country. This study was approved by the Ege University Faculty of Medicine Clinical Research Ethics Committee on 25.08.2014 with the decision number 14-7/8. All participants provided their informed consent.

Voice Handicap Index (VHI)

Subjective voice analysis was performed for all patients. The Voice Handicap Index (VHI) was used to determine the frequency of problems patients experienced because of a voice disorder. Patients answered the questionnaire independently. In the VHI, four responses correspond to the frequency with which individuals who have voice disorders experience problems in their daily lives; 0: no; 1: rarely; 2: sometimes; 3: almost always; 4: always. A score of 0–30 indicates that patients have no evident problems regarding their voice; 31–60 indicates a moderate problem, which may be commonly caused by a vocal cord nodule, polyp, or cyst; and 61–120 indicates that patients experience serious problems in their daily lives due to pathologies that cause an advanced voice disorder such as cord vocal paralysis. VHI is divided into three subcategories with 10 items each: functional (f), physical (p), and emotional (e) problems.

Subsequently, objective voice analysis was performed for patients by using Multi-dimensional voice programming (MDVP), a computer-aided program.

MDVP- Parameters & Their Implications

Parameters occasionally related to frequency perturbation can be referred to as “jitter”. This parameter is related to vocal cord vibration irregularity. This irregularity in the fundamental frequency is called a frequency perturbation or jitter. In the sound sample, changes from period to period were analyzed.

Parameters related to voice amplitude perturbation are referred to as “shimmers”.

APQ (Amplitude Perturbation Quotient), Fo (Average Fundamental Frequency), Jita (Absolute Jitter), Jitt (Jitter Percent), PPQ (Pitch Period Perturbation Quotient), RAP (Relative Average Perturbation), sAPQ (Smoothed Amplitude Perturbation Quotient), Shim (Shimmer Percent), sPQ (Smoothed Pitch Period Perturbation Quotient).

All of the above mdvp parameters are related to hoarse and breathy voice.

The instruments used in the patients are a flexible nasopharyngoscope and stroboscope and Multi- dimensional voice programming, a computer-aided program, and microphone. The analysis data were obtained by converting the voice recordings to the .wav format for the MDVP acoustic analysis program. For comparison studies, Fo - Average Fundamental Frequency, Shim,

Jitt, PPQ - Pitch Period Perturbation Quotient, sAPQ - Smoothed Amplitude Perturbation Quotient were obtained from each voice sample.

Statistical Analysis

The data obtained in this study were collected and analyzed in a computer environment using SPSS 18.0, (SPSS Inc., Chicago, IL, USA) The descriptive statistics of the data are expressed as mean, standard deviation (SD), percent (%), odds ratio (OR), 95% confidence interval (CI) minimum- maximum, median, and interquartile range (IQR). Independent sample t-test and Mann–Whitney U tests were used to analyze quantitative data, while qualitative data were analyzed using the chi-square test.

Fischer's exact test was used when the chi-square conditions were met. Receiver operating characteristic curve analysis was used to determine the discrimination power of the test and the appropriate positivity threshold, to monitor the quality of laboratory results and to compare the performance of ≥ two diagnostic or laboratory tests. The effects of multiple independent factors were analyzed using Cox analysis. Statistical significance was set at $p<0.05$.

RESULTS

Twelve patients were included in the study. Five patients underwent carotid endarterectomy. Glomus tumor resection was performed on seven patients. Of the patients who underwent carotid endarterectomy, four were male and one was female. Three of the patients who underwent glomus tumor resection were male and four were female. 66% of the patients in the study were older than 55 years. Four patients younger than 55 years of age participated in the study.

Voice handicap index (VHI) showed that two patients who underwent glomus tumor resection experienced moderate problems and patients who underwent CEA had no obvious problems (Table 1).

Table 1. Voice handicap index results

Diagnosis	functional (f) sum	physical (p) sum	emotional (e) sum
Glomus Tm.	7	6	0
Glomus Tm.	0	2	0
Glomus Tm.	25	21	22
Glomus Tm.	0	4	0
Glomus Tm.	1	3	3
Glomus Tm.	11	12	9
Glomus Tm.	21	30	31
CEA	1	8	2
CEA	5	4	0
CEA	1	0	0
CEA	9	2	3
CEA	0	7	12

Particularly, patients who underwent glomus tumor resection obtained higher scores on vocal cord vibration and sound amplitude tests than patients who underwent CEA (Table 2).

Table 2. Results of objective sound parameters

Diagnosis	FO	JITT	SPPQ	SHIM	APQ
Glomus Tm.	1.291.340	25.020	33.670	109.900	109.960
Glomus Tm.	2.219.880	18.530	12.850	49.360	58.340
Glomus Tm.	2.095.580	0.8720	0.6220	24.150	22.480
Glomus Tm.	1.017.770	25.980	23.430	113.750	107.880
Glomus Tm.	1.880.070	146.160	88.350	165.730	115.800
Glomus Tm.	1.805.050	0.5590	0.7410	80.560	105.920
Glomus Tm.	1.255.930	14.070	10.240	50.340	62.350
CEA	2.068.310	23.990	15.130	72.070	81.510
CEA	1.169.700	18.780	13.420	77.770	69.520
CEA	1.510.360	34.830	23.040	49.690	52.240
CEA	1.049.970	23.050	22.250	118.030	112.710
CEA	1.088.600	19.270	12.950	95.670	90.810

Compared with patients who underwent CEA, patients of both sexes who underwent glomus tumor resection had an increase in sPPQ and jitter parameters. It is shown in Figure 1 and Figure 2.

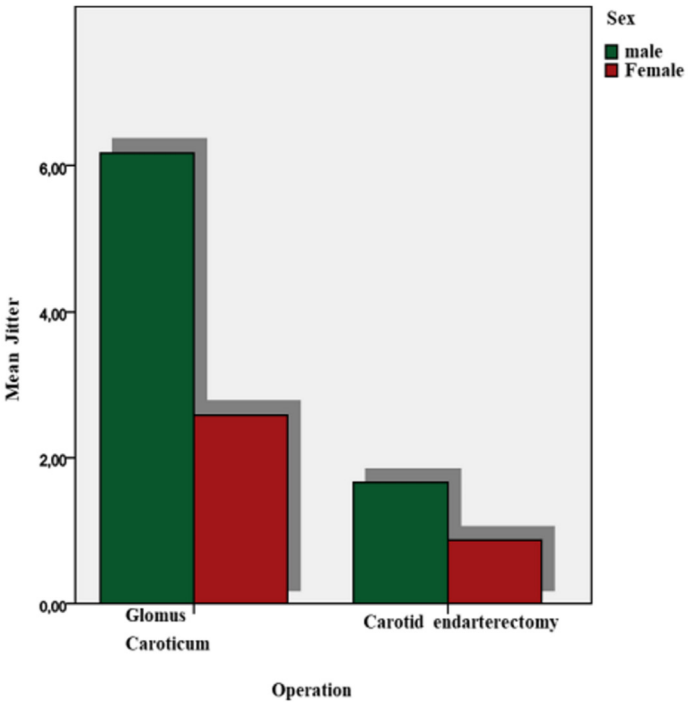

Figure 1. Comparison of carotid endarterectomies and Glomus Tumors by Jitter parameter

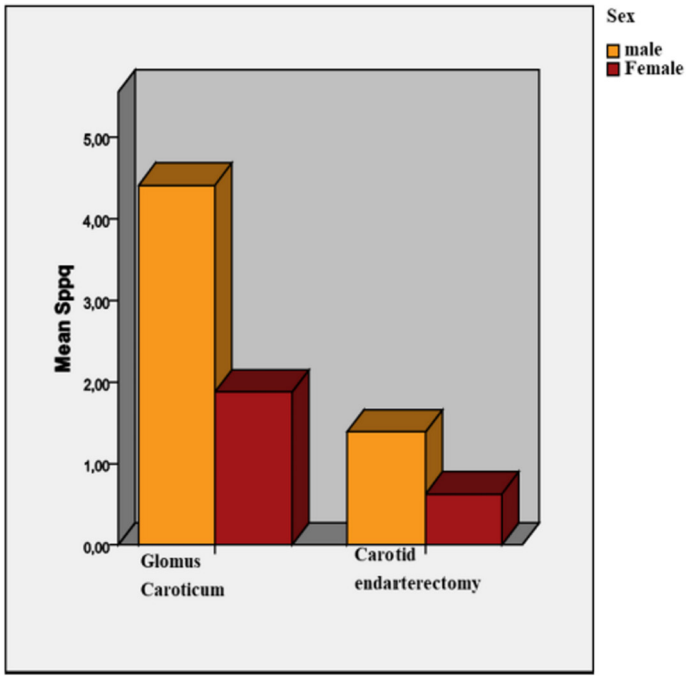

Figure 2. Comparison of carotid endarterectomies and Glomus Tumors by sPPQ parameter

The Mann–Whitney U test revealed a significant difference in the jitter and sPPQ parameters between patients who underwent glomus tumor resection and CEA. Particularly, patients who underwent glomus tumor resection obtained higher scores on vocal cord vibration and sound amplitude tests than patients who underwent CEA.

The Mann–Whitney U test revealed a significant difference in the jitter and sPPQ parameters between patients who underwent glomus tumor resection and CEA (0.05< p-value) (Table 3).

Table 3. Comparison of objective parameters and voice handicap index results of carotid endarterectomies and Glomus Tumors according to Mann Whitney U Test

	fo	Jitter	Sppq	Shimmer	App	f	p	e
P value	0.291	**0.042**	**0.042**	0.935	0.808	0.459	0.289	0.613
Exact Sig. (2*)	0.343	0.048	0.048	1	0.876	0.53	0.343	0.639

DISCUSSION

We found that among the seven patients who underwent glomus tumor resection, two experienced moderate problems based on the voice handicap index. In contrast, patients who underwent CEA experienced no obvious problems. Except for the two patients, these findings indicate that patients may not notice subjective sound problems. The two patients who experienced moderate sound impairment may have been affected by the operation; however, their problems did not significantly affect their lifestyle related to sound.

The Mann–Whitney U test found significant differences in jitter and sPPQ parameters between patients who underwent glomus tumor resection and CEA. Particularly, the vocal cord vibration and sound amplitude of patients who underwent glomus tumor resection were more affected by the operation than those of patients who underwent CEA. These two surgical operations differ in their effect on the surrounding tissues. Particularly, glomus tumor resection significantly affects the surrounding tissue more than CEA. This may indicate that glomus tumor resection is a potential risk factor for developing postoperative dysphonia. Since there is no publication on this subject, we can say this with the data we have.

Injury of the outer branch of the superior laryngeal nerve (ESSLN) may also be responsible for subtle voice changes that are very difficult to assess [4]. In the case of ESSLN deficiency, changes in the fundamental frequency (Fo) of the voice and difficulties in producing high-frequency vocal sounds due to the lack of the cricothyroid muscle can damage the patient's voice [4]. This can be a nuisance for professional voice users [4].

It is also necessary to look at the causes of dysphonia in these operations [5]. These are damage to the superior laryngeal nerve

and its external branches, the size of the mass that can damage the superior laryngeal nerve, the use of electrocautery, temporary nerve conduction disorders, cricothyroid muscle movement disorder, mucosal damage, edema caused by hematoma, and lymphatic and venous drainage damage [5].

Limitations

Calling the patients after the operation and making objective and subjective voice analyses and the lack of a control group are the limitations of the study. In addition, the small number of patients is another limitation of the study.

CONCLUSION

Despite the small number of patients, it can be said that glomus tumor resection in neck surgery, that is, tumor surgery, causes more voice changes than carotid endarterectomy operations. The elevated objective sound parameters found in this study necessitate that patients should be informed regarding the potential of developing postoperative dysphonia, especially those who rely on their voice as their profession (e.g. sound artists, teachers, politicians).

Ethics Committee Approval: The study protocol was approved by the Ege University Faculty of Medicine Clinical Research Ethics Committee (date/no: 25.08.2014/14-7/8).

Patient Consent for Publication: A written informed consent was obtained from all patients.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: All authors contributed equally to the article.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

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