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Analysis of factors on voice quality in thyroidectomy patients

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Abstract. – OBJECTIVE: Vocal cord paralysis (VCP) is a serious complication in thyroidectomy operations; however, its management remains unclear. The present study evaluated the voice parameters of patients who underwent surgery using Intraoperative Neurophysiologic Monitoring (IONM).

PATIENTS AND METHODS: A total of 52 patients (41 females and 11 males) who underwent a total thyroidectomy operation were evaluated using objective and subjective voice analysis examinations before and after surgery. Acoustic parameters, such as Fundamental Frequency (F0), Shimmer, Jitter, Noise-to-Harmonic ratio (NHR), and aerodynamic parameters, including S/Z ratio and maximum phonation time (MPT), were analyzed. Objective findings, including the VHI-10 (Voice Handicap Index) and V-RQOL (Voice-Related Quality of Life), were also analyzed. The relationship between voice parameters and IONM values was investigated.

RESULTS: The objective analysis (acoustic and aerodynamic parameters) showed no difference ($p>0.05$). However, the subjective analysis, which involved the VHI-10 and V-RQOL measures, revealed a significant difference before and after the operation ($p<0.05$). The Spearman correlation analysis showed that the NHR postoperative 1st-month parameter negatively correlated ($rho=-0.317$, $p<0.059$), while the F0 postoperative 6th-month parameter positively correlated ($rho=0.347$) with the amplitude difference before and after dissection (Right R2-R1 difference) for the right RLN measured in IONM.

CONCLUSIONS: Patients who are planning to undergo a thyroidectomy procedure should undergo voice assessment during both the preoperative and postoperative periods. IONM could improve voice quality outcomes.

Key Words:
Thyroidectomy, Voice disorders, Voice quality, Neuromonitoring.

Introduction

Thyroid operations still have serious complications that impact patients' quality of life and can result in voice disorders after thyroidectomy procedures. There are various reasons for dysphonia, with recurrent laryngeal nerve (RLN) injury being the most significant cause of voice changes[1]. Furthermore, another cause of postoperative dysphonia is partial loss of nerve function, which can lead to vocal fold paresis. The incidence of RLN palsy occurs in 0-4% of cases and is more likely to occur in patients with a history of multiple surgeries, thyroid cancer, and Graves' disease[2,3]. The injury to the external branch of the superior laryngeal nerve (EBSLN) impairs the motor function of the cricothyroid muscle, resulting in voice disturbances.

RLN exploration and visual identification are accepted as the gold standard methods for preserving the nerve[4]. Despite the increasing usage of IONM in patients undergoing thyroidectomy, the use of IONM as a standard of care is still debated[5]. However, some studies[6,7] have revealed that the use of IONM in thyroidectomy surgery decreases the likelihood of temporary or permanent nerve injury. Thyroidectomy patients may present with voice disorders, at least transiently, 80% of the time[8]. Due to the growing popularity of IONM among surgeons, it plays a crucial role in enhancing voice outcomes. The standard of care for evaluating a patient's voice before and after surgery should include comprehensive examinations and assessments to improve voice outcomes.

Quantitative evaluation of voice quality after a thyroidectomy is challenging. Although the exam-

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ination of the vocal cords performed in the postoperative period is used as an indicator of hoarseness, it is not sufficient on its own. In the literature, there is a limited number of studies that objectively evaluate voice quality after thyroidectomy.

This study aims to discuss various parameters of objective and subjective voice disorders in patients who have undergone thyroidectomy. Acoustic parameters, aerodynamic parameters, VHI-10, and V-RQOL were analyzed. In addition, we reviewed the correlation between IONM and voice parameters.

Patients and Methods

This study was conducted with adult patients who were scheduled to undergo a primary total thyroidectomy between May 2019 and March 2021 at Mugla Training and Research Hospital. Acoustic voice analysis was performed preoperatively and postoperatively during the first, third, and sixth months using a Zoom© iq7 microphone with 48 kHz/16-bit audio bit quality and 120 dB sound pressure level (Zoom Corp., Chiyoda, Tokyo, Japan). The vocal cords were evaluated using fibrolaryngoscopy. The phonatory evaluation was conducted using a computer program called Praat© (Amsterdam University, Netherlands) and a highly sensitive microphone. Patients with a history of vocal cord paralysis and/or a previous unilateral or bilateral total thyroidectomy were excluded from the study. Long-acting muscle relaxants were not used during the surgery. Patients' voice parameters were recorded in an isolated room with ambient noise levels of less than 40 dB. All the recordings were consistently made in a seated position, with the microphone positioned 15 cm away from the mouth. Participants were instructed to produce the vowel "a" sound at a comfortable volume and sustain it for at least 3 seconds with a stable pitch in order to measure the maximum phonation time (MPT). The participant was then asked to sustain the phonation of the "s" and "z" sounds for as long as possible. The "s" value is divided by the "z" value to calculate the S/Z ratio (SZR). Patients performed the task while sitting upright. Once the recordings were obtained, the following parameters of voice production were measured: Jitter, Shimmer, NHR, SZR, MPT, and F0.

The patient completed the Turkish versions of the VHI-10 and V-RQOL self-questionnaires during the preoperative evaluation. These questionnaires were also administered during the postoperative period, at the 1st, 3rd, and 6th months, respectively. VHI-10 includes 10 items, and patients were asked to select one of the five grades (0-4 points) ranging from never (0) to always (4) in order to measure the following subscales: functional, physical, and emotional. The V-RQOL consists of a 10-item quality-of-life survey assessing voice disorders' impact. It is a validated and accurate tool rated on a scale from 1, indicating no problem, to 5, indicating the worst possible problem. The tool is distributed across two subscales: social-emotional and physical functioning.

During all the operations, all RLNs were dissected and identified throughout the nerve. The superior thyroid artery and vein were individually ligated to prevent injury to the EBSLN. The strap muscles were not cut during the surgery. IONM was performed with the NIM® 3.0 system (Medtronic®, Minneapolis, Minnesota, USA). For intermittent neural stimulation, the parameters were set to 1-2 mA and performed using standard unipolar probes. The event threshold was set at 100 μA, and a loss of signal (LOS) was defined as a response below the threshold of 100 μV according to literature. Standard IONM was performed as a four-step procedure for recurrent laryngeal nerve (RLN) identification. The steps included V1, R1, R2, and V2. Predissection (R1, V1) and postdissection (R2, V2) IONM waveforms of the right and left sides' vagal nerve and RLN were applied.

Statistical Analysis

Statistical analysis was performed using the SPSS software package for Windows (Statistical Package for Social Sciences, version 22.0, IBM Corp., Armonk, NY, USA). The normality of quantitative variables was analyzed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Quantitative variables were expressed as either mean ± standard deviation (SD) or a median value with an interquartile range (IQR), depending on whether they fit the normal distribution or not. The electrophysiological parameters and voice outcomes were compared using the Spearman correlation test. The Wilcoxon signed-rank test was used to compare pre-dissection and post-dissection parameters. Differences between continuous variables were assessed using the Mann-Whitney U test. The Friedman test was used with repeated measures. A p-value lower than 0.05 was considered statistically significant.

Table I. Demographic and preoperative FNAC results of patients.

Gender	Female (%)	41 (78.8)
	Male (%)	11 (21.1)
Age (±SD)		49.83 (11.98)
Preoperative FNAC results	MNG (%)	30 (57.7)
	Toxic MNG (%)	4 (7.7)
	Graves' disease (%)	3 (5.8)
	Follicular neoplasm (%)	2 (3.8)
	PTC (%)	13 (25)

SD: Standard Deviation, FNAC: Fine Needle Aspiration Cytology, MNG: Multinodular Goiter, PTC: Papillary Thyroid Cancer.

Table II. Comparison of preoperative and postoperative 1st month, 3rd month, and 6th month period measurements in patients without signal loss in IONM.

	Preoperative	PO 1st month	PO 3rd month	PO 6th month	*p**
SZR	1 (0.83-1.06)	1 (0.78-1.02)	1 (0.85-1.04)	1 (0.98-1.03)	0.400
MPT	11.4 (9.44-15.02)	11.14 (8.14-14.5)	11.76 (8.32-14.97)	12.14 (8.95-14.96)	0.157
Shim	2.31 (1.70-3.81)	2.40 (1.86-3.58)	2.90 (1.93-3.51)	2.84 (2.17-3.95)	0.105
Jitt	0.28 (0.21-0.39)	0.30 (0.21-0.43)	0.30 (0.22-0.45)	0.32 (0.25-0.43)	0.425
F0	209.6 (161.5-233.5)	188 (144.1-222.9)	201.6 (156.7-225.1)	200.5 (141.4-236)	0.625
NHR	0.00915 (0.00555-0.01847)	0.01028 (0.00530-0.01757)	0.01152 (0.00618-0.02442)	0.01165 (0.00543-0.02145)	0.464
VHI-10	0 (0-3)	1 (0-6.5)	0 (0-1.2)	0 (0-0)	**<0.001**
V-RQOL	10 (10-14)	10.5 (10-15.25)	10 (10-11)	10 (10-10)	**0.004**

*: Friedman test, SZR: S/Z ratio, MPT: maximum phonation time, Shim: Shimmer, Jitt: Jitter, F0: Basal frequency, NHR: Noise Harmonic Ratio, VHI-10: Voice Handicap Index, V-RQOL: Voice Related Quality of Life.

Results

In this prospectively designed study, a total of 68 patients met the study criteria at baseline. Four patients had a history of thyroidectomy operations, and a completed thyroidectomy was performed. Patients who underwent a concurrent thyroidectomy were excluded from the study. Total thyroidectomy was planned for 62 patients preoperatively. Four patients were excluded because of a planned staged thyroidectomy due to loss of signal. Two patients were excluded from the study at their request to withdraw from the study. As a result, 52 patients were included in the study (Figure 1).

Of the patients, 41 (78.8%) were female and 11 (21.2%) were male. The average age was 49.83 (±11.98). When the patients were evaluated according to their preoperative fine needle aspiration cytology (FNAC) results, 30 (57.7%) patients were found to have benign results, 2 (3.8%) were found to have follicular neoplasms, and 13 (25%) patients were found to have malignant results. Patient demographics are shown in Table I.

A statistically significant difference was found in at least one comparison of the measurements made in the VHI-10 questionnaire during the preoperative and postoperative periods, which were conducted at the 1st month, 3rd month, and 6th month (p<0.001). A statistically significant difference was found in at least one comparison during the postoperative 1st-month, 3rd-month, and 6th-month evaluation using the V-RQOL questionnaire (p=0.004). When each of the other acoustic parameters was evaluated individually, no statistically significant difference was found between the preoperative and postoperative periods at the 1st, 3rd, and 6th months (p>0.05 for each parameter) (Table II).

In the VHI-10 questionnaire, a statistically significant difference was observed between the preoperative and postoperative 1st month periods (p=0.047), and patients showed higher scores. There was a statistically significant difference between the postoperative 1st and the 3rd month; patients had lower scores, indicating improvement (p=0.009). There was no statistically significant difference between the 3rd and 6th month postoperatively (p=0.059), but there was improvement observed in the questionnaire. We observed significant differences between the 1st and 6th month in the questionnaire (p=0.002), indicating improve-

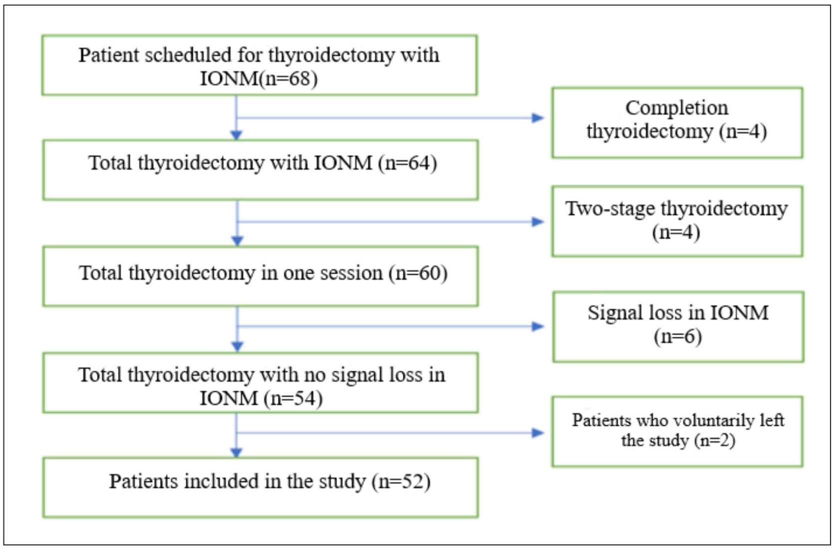

Figure 1. Flowchart for patient inclusion.

ment. The questionnaire was used to compare the preoperative period and postoperative period at the 3rd month (p=0.946) and the preoperative period and postoperative period at the 6th month (p=0.195), showing no significant difference. In the 3rd postoperative month, the VHI-10 questionnaire indicated the same values as the preoperative evaluation (Table III).

The results of the V-RQOL questionnaire did not indicate a difference between the preoperative period and postoperative 1st month (p=0.341). Although there was a negative trend in the survey, the difference was not significant. The difference between the preoperative period and postoperative 3rd month was also not significant (p=0.067). A significant difference was found between the postoperative 1st and the postoperative 3rd month and between the postoperative 1st and 6th month, showing an improvement; a similar improvement was obtained when comparing the preoperative period with the postoperative 6th month (p=0.010, p<0.001, and p=0.002). In addition, V-RQOL showed significant improvement from the 3rd to 6th month (p=0.09); we can conclude that, in the postoperative period, the questionnaire showed an improvement in a positive direction (Table III).

The SZR, VHI-10, V-RQOL, MPT, Shimmer, and Jitter parameters were evaluated during the postoperative 1st, 3rd, and 6th month. Values measured with IONM did not show a statistically significant correlation with the amplitude difference before and after dissections of both the right and left RLN and vagus nerves (p>0.05 for each parameter) (Table IV).

The NHR postoperative 1st-month parameter showed a statistically significant negative correlation (Spearman's *rho*=-0.317) with the amplitude difference before and after dissection of the right RLN, as measured using IONM (p=0.022). F0 parameter at the postoperative 1st month and 6th month showed a positive correlation (Spearman's *rho*=0.362, p=0.008 and *rho*= 0.347, p=0.012, respectively) for the right RLN, and furthermore, the F0 postoperative 6th month parameter showed a statistically positive correlation (Spearman's *rho*=0.281, p=0.043) for the left vagus, with the amplitude difference before and after dissection of both nerves (Table IV).

Table III. Comparison of VHI-10 and V-RQOL questionnaires by month.

	Po- 1st month	Po- 3rd month	Po- 6th month	1st -3rd	1st -6th	3rd -6th
VHI-10	**0.047**	0.946	0.195	**0.009**	**0.002**	0.059
V-RQOL	0.341	0.067	**0.002**	**0.010**	**<0.001**	**0.009**

VHI-10: Voice Handicap Index, V-RQOL: Voice Related Quality of Life. Po: Preoperative.

Table IV. Correlation analysis of intraoperative nerve monitoring and acoustic parameters.

		RR2-RR1 Diff	LR2-LR1 Diff	RV2-RV1 Diff	LV2-LV1 Diff
SZR 1st month	*rho*	0.127	0.004	-0.169	-0.125
	p	0.368	0.975	0.231	0.377
SZR 3rd month	*rho*	-0.154	-0.213	-0.002	-0.058
	p	0.277	0.130	0.990	0.685
SZR 6th month	*rho*	0.004	-0.264	-0.066	0.033
	p	0.976	0.058	0.643	0.819
VHI-10 1st month	*rho*	0.090	-0.135	0.049	-0.059
	p	0.526	0.341	0.731	0.677
VHI-10 3rd month	*rho*	-0.047	-0.185	-0.176	-0.073
	p	0.740	0.190	0.213	0.608
VHI-10 6th month	*rho*	-0.195	-0.140	-0.092	-0.053
	p	0.166	0.321	0.516	0.708
V-RQOL 1st month	*rho*	0.006	-0.225	-0.087	-0.035
	p	0.965	0.109	0.539	0.805
V-RQOL 3rd month	*rho*	0.055	-0.199	-0.011	-0.117
	p	0.700	0.157	0.434	0.408
V-RQOL 6th month	*rho*	0.043	-0.063	-0.058	-0.138
	p	0.763	0.657	0.680	0.330
MPT 1st month	*rho*	-0.196	0.157	0.047	-0.163
	p	0.163	0.265	0.743	0.247
MPT 3rd month	*rho*	-0.159	0.071	0.055	-0.136
	p	0.260	0.618	0.700	0.335
MPT 6th month	*rho*	-0.070	0.189	-0.042	-0.127
	p	0.622	0.180	0.768	0.371
SHIM 1st month	*rho*	-0.048	-0.102	0.133	-0.028
	p	0.734	0.472	0.347	0.843
SHIM 3rd month	*rho*	-0.074	-0.148	0.053	-0.031
	p	0.603	0.295	0.709	0.827
SHIM 6th month	*rho*	-0.127	0.052	0.097	-0.037
	p	0.370	0.716	0.494	0.795
JITT 1st month	*rho*	-0.005	-0.272	0.089	-0.082
	p	0.974	0.051	0.532	0.565
JITT 3rd month	*rho*	-0.143	-0.214	0.041	-0.192
	p	0.311	0.128	0.770	0.173
JITT 6th month	*rho*	-0.044	-0.117	0.067	-0.151
	p	0.754	0.410	0.638	0.284
F0 1st month	*rho*	0.362	0.019	-0.063	0.238
	p	**0.008**	0.892	0.659	0.089
F0 3rd month	*rho*	0.260	-0.116	-0.190	0.205
	p	0.063	0.411	0.178	0.145
F0 6th month	*rho*	0.347	-0.093	-0.002	0.281
	p	**0.012**	0.514	0.988	**0.043**
NHR 1st month	*rho*	-0.317	-0.148	0.151	-0.166
	p	**0.022**	0.297	0.285	0.238
NHR 3rd month	*rho*	-0.166	-0.183	0.059	-0.130
	p	0.238	0.194	0.680	0.359
NHR 6th month	*rho*	-0.222	0.102	0.074	-0.118
	p	0.114	0.472	0.601	0.404

rho: Spearman Correlation, SZR: S/Z ratio, VHI: Voice Handicap Index V-RQOL: Voice Related Quality of Life, MPT: Maximum Phonation time, SHIM: % shimmer, NHR: Noise Harmonic Ratio, F0: Basal Frequency, JITT: Jitter.

Discussion

It is crucial to assess the vocal cord functions of patients who will undergo a thyroidectomy in both the preoperative and postoperative periods, as VCP may be asymptomatic or may be absent in patients with a voice disorder following thyroidectomy[9,10]. In the postoperative period, vocal cord examination will determine the presence or absence of VCP after thyroidectomy. This examination is crucial as it helps to initiate voice therapy or surgical treatment promptly in cases where VCP is detected[11]. Surgical and non-surgical treatments have been shown[12] to be more effective if VCP is diagnosed before 6 months.

Bilateral VCP is the most serious complication after a thyroidectomy. Bilateral VCP can be diagnosed intraoperatively at a rate of 16%[13]. When LOS develops in patients using IONM, bilateral VCP can be prevented by changing the surgical strategy. If contralateral lobectomy is performed when unilateral LOS develops, the risk of developing bilateral VCP has been found to be 17%[14,15]. In our study, gradual thyroidectomy was decided in 4 patients. Complementary thyroidectomy was performed in three of these patients, resulting in the recovery of VCP. The main purpose of opting for staged thyroidectomy was the prevention of bilateral VCP. As a result, none of the patients in the group developed bilateral VCP.

Voice disorders that occur after thyroidectomy operations can have a negative impact on quality of life. However, it is important to note that RLN paralysis is not the sole cause of voice disorders. The incidence of voice disorders in patients without RLN damage ranges from 30% to 87%[16,17]. Gür et al[18] found that the subjective voice impairment rate was 42.8% in patients with signal loss and an intact RLN after surgery. In the guidelines[19] for improving voice quality after a thyroidectomy, it is strongly recommended that patients should undergo evaluation for a voice disorder between the second week and the second month following the procedure.

There are many causes of voice disorders after a thyroidectomy. While the most common injuries are RLN injury and EBSLN injury, other factors such as cricothyroid muscle injury, strap muscle injury, hematoma formation, laryngotracheal fixation, and intubation-related injuries may also cause voice disturbances[20-26]. Even if the RLN and EBSLN are not injured, patients may still experience voice disturbances[23,27].

The current study revealed that there were no significant differences between the acoustic parameters and aerodynamic parameters during the preoperative period and the 1st, 3rd, and 6th months postoperatively. Theoretically, the MPT and perturbation values are expected to be affected by damage to the RLN, while the F0 value is expected to be affected by damage to the EBSLN. In a study by Hong and Kim[21], it was found that the F0 value, MPT, and perturbation parameters did not change significantly in the postoperative period following thyroidectomy operations. However, another study[28] reported an increase in Shimmer, Jitter, and NHR parameters on the 2nd postoperative day in patients without VCP after thyroidectomy (TT), while the F0 value decreased. Also, it has been shown that while other parameters improved in the 3rd postoperative month, the F0 value remained significantly lower. In the study conducted by Sinagra et al[29], it was found that the F0 value in the second month after surgery differed significantly from the preoperative period. However, this difference improved in the fourth and sixth months after surgery but did not reach the preoperative values. In addition, this study observed that the Shimmer value was affected in the second postoperative month. Dönmez et al[30] found no statistically significant difference between the preoperative and postoperative 3rd-week values of acoustic parameters such as Jitter, Shimmer, and F0 in their study in which RLN and EBSLN were monitored. In a meta-analysis[31] evaluating the parameters of F0, Shimmer, Jitter, MPT, and NHR in patients without RLN injury who underwent thyroidectomy, a significant deterioration in F0, Shimmer, and MPT values was observed during the first 3 months after surgery compared to the preoperative period. However, there was no significant difference in Shimmer and NHR between the postoperative and preoperative periods. In a prospective study[32] of 44 patients without RLN damage, no significant difference was found in the S/Z parameter during the postoperative first week and third month compared to the preoperative period. In addition, Sorenson and Parker[33] showed that the S/Z value increased in patients with a VCP pathology. Unexpectedly, in our study, no significant difference was found in the S/Z parameter before and after surgery.

Within 24 hours after endotracheal intubation, patients may experience pharyngolaryngeal pain[34,35], laryngeal edema[36], an increase in acoustic and aerodynamic parameters, a decrease in MPT, an increase in Jitter and Shimmer values[37], and a decrease in F0 value[38]. It has been shown[39] that voice disturbance due to endotracheal intubation improves after the 1st week. In our study, patients were evaluated one month after surgery to exclude voice disorders caused by endotracheal intubation.

Our data showed that, when the VHI-10 questionnaire was compared in the preoperative and postoperative 1st month, a significant difference was found, showing higher scores in impairment. The VHI-10 questionnaire returned to the preoperative level at the 3rd month postoperatively, and there was no significant difference between the preoperative level and the 3rd-month postoperative level. It was determined that the improvement continued in the postoperative 6th month, but there was no significant improvement when comparing it to the preoperative period. In a previous study[30] that monitored the RLN and EBSLN, it was determined that there was no significant difference in the values of the VHI-10 questionnaire between the preoperative and postoperative third week. It is stated that the score of the VHI-10 questionnaire is largely independent of acoustic parameters[40-42]. The VHI-10 questionnaire evaluates the impact of voice disorders on the patient's perceived quality of life. Kletzien et al[43] demonstrated that the extended version of the VHI-10 questionnaire achieved its highest score during the second week after surgery and returned to normal levels later in the postoperative period. Nisha et al[44] evaluated the extended version of the VHI-10 questionnaire in two patient groups: those who underwent hemithyroidectomy and total thyroidectomy, and those who did not experience postoperative VCP. The study found that in the total thyroidectomy group, the preoperative level was only reached by the 6th month postoperatively. In the hemithyroidectomy group, the highest score was reached in the second week, and there was no significant difference in the 6th week compared to the preoperative period. In our study, we found no significant difference in acoustic and aerodynamic parameters between the postoperative and preoperative periods. However, the VHI-10 questionnaire showed a significant difference, indicating that no single parameter should be relied upon for the evaluation of voice disorders.

When the V-RQOL questionnaire was compared to the preoperative period and postoperatively for the 1st month, no significant difference was observed between the two time periods. There was a significant decrease in the score during the 3rd month compared to the 1st month after the surgery. A significant decrease was also found in the questionnaire score at the 6th month postoperatively compared to the 3rd month postoperatively. Moreover, it was determined that there was a significant difference in V-RQOL between the postoperative 6th month and the preoperative period. The V-RQOL had a lower score, and voice was improved in the postoperative 6th month compared to before the operation.

The physical subgroup of the long version of the V-RQOL was compared among patient groups with benign thyroid nodules, hypothyroidism, and hyperthyroidism. It was found[45] that the V-RQOL score was significantly higher in patients with benign thyroid nodules compared to the other groups. The researchers attributed this to the RLN press, and we used it to explain the preoperative V-RQOL in our study. In another study, Wojtczak et al[46] did not detect a significant difference before and after surgery in the VHI-10 and V-RQOL questionnaires in the patient group whose EBSLN and RLN were monitored and who did not develop VCP. Koga et al[47] compared the patient group before thyroidectomy with the patient group before cholecystectomy using the V-RQOL questionnaire. The V-RQOL questionnaire scores were found to be higher in patients before undergoing a thyroidectomy, showing a statistically significant difference. In our study, we found that the V-RQOL questionnaire scores tended to decrease in the postoperative period. There was a significant difference between the scores before the operation and at the postoperative 6th month, indicating an improvement in the postoperative 6th month. This can be attributed to the removal of RLN compression.

It was determined that the F0 parameter in the postoperative 1st month correlated with the amplitude difference before and after the right RLN dissection and that the F0 parameter in the postoperative 6th month correlated with the amplitude change measured before and after the left vagus dissection. We could not find any studies related to this in the literature. The relationship between dysphonia and the F0 parameter, which is associated with the length and tension of the vocal cords, and the NHR parameter, which measures the harmony of the vocal cords, can be explained by the fact that dysphonia is characterized by an increase in these values.

Conclusions

While the complications associated with thyroidectomy have been diminished, the impact on voice quality as assessed through objective means continues to be a topic of discussion and debate. Subsequent investigations ought to be undertaken to improve the quality of the voice through the employment of IONM as a standard instrument in the operating room. Preoperative evaluations of patients consisting of both objective and subjective voice analyses can provide valuable information about a patient's baseline condition, which can serve as a reference for postoperative analyses. It is noteworthy that most voice parameters had returned to their preoperative levels by the

6th month following surgery, emphasizing the importance of the clinician devoting time to voice disorder discussions with the patient during this period. Advanced methods for measuring voice parameters enable a more detailed examination of the impact of thyroid surgery on voice quality. Future studies will establish more objective and quantifiable criteria for evaluating voice quality.

Conflict of Interest

The authors declare that they have no conflict of interest.

Ethics Approval

This study was approved by the Ethics Committee of the Mugla Training and Research Hospital, with the approval number 08/I, dated 02/05/2019. The study was conducted following the Helsinki Declaration and its latest amendments.

Informed Consent

All individuals participating in the study were informed, and their consent was obtained.

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Authors' Contributions

All authors contributed substantially to the work reported and have read and agreed to the published version of the manuscript.

Data Availability

The supplementary materials generated during the current study are available upon request.

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