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Does neuromonitoring affect voice quality in patients subjected to complete thyroidectomy?

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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ABSTRACT:

Introduction: Voice dysfunction is the most common complication of thyroid surgery. The use of intraoperative neuromonitoring (IONM) is to protect the recurrent laryngeal nerves, the damage of which causes voice dysfunction.

Aim: The aim of the study was to evaluate voice quality in patients who underwent complete thyroidectomy operated on with the application of IONM as well as a group of patients operated on with only macroscopic nerve visualization. In the analysis, clinical voice assessment was performed with particular focus on voice efficiency using the Voice Handicap Index (VHI), Vocal Tract Discomfort (VTD) and GRBAS scale.

Material and methods: The study group consisted of 205 patients operated on with IONM. The control group consisted of 162 patients subjected to surgery only with macroscopic visualization of recurrent laryngeal nerves, without IONM. During the follow-up period from 2 to 10 years after surgery, checkups were performed. Each patient who came for a checkup was subjected to perceptual voice evaluation with the use of the GRBAS scale, indirect laryngoscopy procedure and voice self-evaluation with two questionnaires (VHI and VTD).

Results: The frequency of vocal fold palsy did not differ significantly statistically in the study group and the control group. Both in the study group and in the control group, patients with vocal fold paralysis had statistically significantly higher results in the VHI and VTD questionnaires as well as in the GRBAS study.

Conclusion: Patients with recurrent laryngeal nerve injury show significant differences in the scope of voice handicap, both in the voice quality assessment with the use of the GRBAS scale, and self-evaluation questionnaires: VHI and VTD. All voice disorders evaluated with self-assessment are medium voice disability.

KEYWORDS: intraoperative neuromonitoring, recurrent laryngeal nerve, vocal cord, thyroidectomy, voice assessment, voice quality

ABBREVIATIONS

IONM – intraoperative neuromonitoring
VHI – Voice Handicap Index
VTD – Vocal Tract Discomfort

INTRODUCTION

Maintaining the correct voice quality is important for patients undergoing thyroid surgery [1]. Voice dysfunction, which is the most common complication of this procedure, is usually caused by vocal fold paralysis, as a result of an injury to the recurrent laryngeal nerve or the superior laryngeal nerve [2]. Voice changes can also occur in patients who have not had a nerve injury [3]. About 87% of patients experience changes in their voice after thyroidectomy [4]. It should be remembered that some postoperative voice disorders may be caused by an injury to the vocal folds during intubation.

Finally, it is worth emphasizing that dysphonia may also result from excessive traction and cutting of the infrahyoid muscles during the procedure, the use of diathermy or the postoperative scar itself [5]. Changes in voice characteristics significantly affect the quality of life and social interactions [6]. The most common symptoms occurring in patients are easy fatigue during phonation and difficulty in achieving high-frequency tones and sonority [7]. Among the above-mentioned symptoms, tone lowering is the most commonly reported problem in patient's assessment, both objective and subjective [8]. Much effort is put to prevent vocal cord paralysis. One of such preventive measures is using the intraoperative neuromonitoring, a tool designed to prevent the surgeon from injuring nerves during surgery.

AIM

The aim of the study was a comparative evaluation of voice quality in patients subjected to complete thyroidectomy and operated on with the application of intraoperative neuromonitoring and in a group of patients operated on with macroscopic nerve visualization alone. In the analysis of the material, clinical voice assessment was performed with particular focus on voice efficiency using the Voice Handicap Index (VHI), Vocal Tract Discomfort (VTD) scale and GRBAS scale.

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Tab. I. VHI questionnaire scores in the study and control group.

	STUDY GROUP (N = 153)	CONTROL GROUP (N = 122)	P (VALUE)
VHI: functional subscale (mean)	1.7 (4.1)	1.6 (4.1)	0.283
VHI: functional subscale (zero score)	101 (66.0%)	88 (72.1%)	0.277
VHI: physical subscale (mean)	3.7 (5.7)	3.1 (5.1)	0.184
VHI: physical subscale (zero score)	59 (38.6%)	49 (40.2%)	0.787
VHI: emotional subscale (mean)	1.6 (3.9)	1.3 (3.8)	0.008
VHI: emotional subscale (zero score)	93 (60.8%)	94 (77.0%)	0.004
VHI: combined result (mean)	7.0 (13.0)	6.0 (12.5)	0.042
VHI: combined result (zero score)	56 (36.6%)	49 (40.2%)	0.546

Tab. II. VHI questionnaire scores in the study group and the control group in relation to the presence of vocal fold paralysis found in the follow-up examination.

	STUDY GROUP – NO PARALYSIS (N = 145)	STUDY GROUP – PARALYSIS (N = 8)	P (VALUE)	CONTROL GROUP – NO PARALYSIS (N = 114)	CONTROL GROUP – PARALYSIS (N = 8)	P (VALUE)
VHI: functional subscale (mean)	0.9 (1.6)	17.1 (5.3)	< 0.001	0.6 (1.6)	15.4 (4.0)	< 0.001
VHI: functional subscale (zero score)	101 (69.7%)	0 (0.0%)	< 0.001	88 (77.2%)	0 (0.0%)	< 0.001
VHI: physical subscale (mean)	2.7 (3.4)	23.0 (3.8)	< 0.001	2.0 (2.6)	19.6 (3.5)	< 0.001
VHI: physical subscale (zero score)	59 (40.7%)	0 (0.0%)	0.024	49 (43.0%)	0 (0.0%)	0.021
VHI: emotional subscale (mean)	0.8 (1.7)	15.5 (6.5)	< 0.001	0.4 (1.3)	13.9 (5.2)	< 0.001
VHI: emotional subscale (zero score)	93 (64.1%)	0 (0.0%)	< 0.001	94 (82.5%)	0 (0.0%)	< 0.001
VHI: combined result (mean)	4.4 (5.7)	55.6 (12.6)	< 0.001	3.0 (4.7)	48.9 (9.6)	< 0.001
VHI: combined result (zero score)	56 (38.6%)	0 (0.0%)	0.027	49 (43.0%)	0 (0.0%)	0.021

Tab. III. VTD questionnaire scores in the study and the control groups.

	STUDY GROUP (N = 153)	CONTROL GROUP (N = 122)	P (VALUE)
Burning (frequency/intensity) (mean)	0.5 (0.8) / 0.5 (0.9)	0.6 (0.9) / 0.5 (0.8)	0.120 / 0.199
Tightness (frequency/intensity) (mean)	0.3 (0.7) / 0.3 (0.7)	0.2 (0.6) / 0.3 (0.7)	0.628 / 0.488
Dryness (frequency/intensity) (mean)	0.7 (1.1) / 0.7 (1.1)	0.6 (1.1) / 0.6 (1.0)	0.509 / 0.472
Aching (frequency/intensity) (mean)	0.3 (0.6) / 0.3 (0.8)	0.3 (0.6) / 0.3 (0.7)	0.443 / 0.450
Tickling (frequency/intensity) (mean)	0.5 (0.9) / 0.5 (1.0)	0.3 (0.7) / 0.4 (0.8)	0.124 / 0.163
Soreness (frequency/intensity) (mean)	0.3 (0.7) / 0.3 (0.7)	0.2 (0.6) / 0.2 (0.5)	0.169 / 0.162
Irritable (frequency/intensity) (mean)	0.5 (0.8) / 0.5 (1.0)	0.3 (0.7) / 0.4 (0.8)	0.213 / 0.204
Lump in throat (frequency/intensity) (mean)	0.5 (1.0) / 0.5 (1.0)	0.3 (0.8) / 0.3 (0.7)	0.016 / 0.017
VTD: total frequency (mean)	3.5 (4.8)	2.9 (4.6)	0.097
VTD: total intensity (mean)	3.6 (5.6)	2.9 (4.5)	0.139
VTD: total frequency (zero score)	46 (30.1%)	44 (36.1%)	0.292
VTD: total intensity (zero score)	46 (30.1%)	44 (36.1%)	0.292

MATERIALS AND METHODS

In the study, a group of 367 patients, including 312 (85.01%) female and 55 (14.99%) male patients, aged 18–79 years (median: 53 years) were made eligible and subjected to complete thyroidectomy due to non-toxic nodular goiter. The patients were operated on by one and the same surgeon. In the indirect laryngoscopy procedure performed by an ENT physician before surgery, no vocal fold mobility disorders or other voice disorders, not related to thyroid diseases, in the form of hoarseness, aphonia, dyspnea or laryngeal wheezing were found. Patients who underwent partial thyroidectomy operated on with minimally invasive techniques, patients operated on for overactive nodular goiter, recurrent goiter, cancer or suspected thyroid cancer, patients with clinical signs of vocal fold paralysis before surgery, and patients with central or peripheral nervous system disease that could cause an injury to the motor center or neuron were excluded from the study.

Tab. IV. VTD questionnaire scores in the study group and the control group in relation to the presence of vocal fold paralysis found in the follow-up examination.

	STUDY GROUP – NO PARALYSIS (N = 145)	STUDY GROUP – PARALYSIS PRESENT (N = 8)	P (VALUE)	CONTROL GROUP – NO PARALYSIS (N = 114)	CONTROL GROUP – PARALYSIS PRESENT (N = 8)	P (VALUE)
Burning (frequency/intensity) (mean)	0.4 (0.7)	2.2 (0.7)	< 0.001	0.5 (0.8)	1.8 (0.9)	< 0.001
Tightness (frequency/intensity) (mean)	0.1 (0.5)	2.2 (0.7)	< 0.001	0.2 (0.5)	1.4 (0.9)	< 0.001
Dryness (frequency/intensity) (mean)	0.6 (1.0)	2.6 (0.7)	< 0.001	0.5 (0.8)	3.0 (1.4)	< 0.001
Aching (frequency/intensity) (mean)	0.2 (0.5)	1.6 (0.9)	< 0.001	0.3 (0.6)	0.9 (1.0)	0.004
Tickling (frequency/intensity) (mean)	0.4 (0.8)	2.2 (1.2)	< 0.001	0.3 (0.6)	1.1 (1.1)	0.002
Soreness (frequency/intensity) (mean)	0.2 (0.6)	1.5 (0.9)	< 0.001	0.1 (0.5)	0.8 (0.9)	< 0.001
Irritability (frequency/intensity)) (mean)	0.4 (0.7)	2.0 (0.8)	< 0.001	0.3 (0.7)	1.2 (0.9)	< 0.001
Lump in throat (frequency/intensity) (mean)	0.4 (0.8)	2.8 (0.9)	< 0.001	0.2 (0.7)	1.6 (1.2)	< 0.001
Burning (frequency/intensity) (mean)	0.3 (0.7)	2.5 (1.2)	< 0.001	0.5 (0.7)	1.6 (0.9)	< 0.001
Tightness (frequency/intensity) (mean)	0.1 (0.5)	2.6 (0.7)	< 0.001	0.2 (0.5)	2.0 (1.5)	< 0.001
Dryness (frequency/intensity) (mean)	0.6 (1.0)	3.0 (0.9)	< 0.001	0.5 (0.8)	2.5 (1.1)	< 0.001
Aching (frequency/intensity) (mean)	0.2 (0.6)	1.9 (1.4)	< 0.001	0.3 (0.6)	1.0 (1.1)	0.003
Tickling (frequency/intensity) (mean)	0.4 (0.8)	2.9 (1.5)	< 0.001	0.3 (0.7)	1.4 (1.4)	0.001
Soreness (frequency/intensity) (mean)	0.2 (0.6)	1.9 (1.6)	< 0.001	0.1 (0.5)	0.8 (0.9)	< 0.001
Irritability (frequency/intensity) (mean)	0.4 (0.8)	2.9 (1.5)	< 0.001	0.3 (0.7)	1.2 (0.9)	< 0.001
Lump in throat (frequency/intensity) (mean)	0.4 (0.7)	3.2 (1.5)	< 0.001	0.2 (0.7)	1.1 (0.8)	< 0.001
VTD: total frequency (mean)	2.7 (3.5)	17.2 (4.7)	< 0.001	2.3 (3.8)	11.8 (5.8)	< 0.001
VTD: total intensity (mean)	2.7 (3.5)	20.9 (8.0)	< 0.001	2.3 (3.8)	11.6 (5.6)	< 0.001
VTD: total frequency (zero score)	46 (31.7%)	0 (0.0%)	0.106	44 (38.6%)	0 (0.0%)	0.05
VTD: total intensity (zero score)	46 (31.7%)	0 (0.0%)	0.106	44 (38.6%)	0 (0.0%)	0.05

The study group comprised of 205 patients, including 174 (84.9%) female and 31 (15.1%) male patients, aged 18–79 years (mean: 52.2 years; median 53 years) operated on with intraoperative neuromonitoring, according to the protocol of the International Neuromonitoring Study Group guidelines. The patients comprising this group underwent surgery during which macroscopic visualization of recurrent laryngeal nerves was performed; subsequently nerve identification was confirmed by intraoperative neuromonitoring.

The control group consisted of 162 patients, including 139 (85.8%) female and 23 (14.2%) male patients, aged 18–77 years (mean 51.6 years; median 54 years). The patients comprising this group were subjected to surgery with macroscopic visualization of the recurrent laryngeal nerves alone, without intraoperative neuromonitoring.

All surgeries were performed from the anterior cervical access. It should be noted that the superior laryngeal nerve was not routinely identified, and at the same time the preparation focused on preventing its damage. Each time, however, the recurrent laryngeal nerve was identified in its course.

In the post-operative period, all patients had medical interview and physical examination performed, with particular focus on clinical assessment of voice. Subsequently, during the same hospitalization, day 1 or 2 post-surgery, the patients were subjected to indirect laryngoscopy procedure.

The 153 patients from the control group (74.6% [153/205]) and 122 patients from the study group (75.3% [122/162]) participated in the follow-up examination, conducted 2 to 10 years (median: 6 years) post-surgery. Each of them was subjected to perceptual voice assessment using the GRBAS scale, an indirect laryngoscopy examination and self-administered voice assessment using two questionnaires (VHI and VTD).

STATISTICAL ANALYSIS

In the statistical description of the quantitative features, the arithmetic mean, standard deviation (SD), median, lower quartile (Q1), upper quartile (Q3) and the range of values (minimum and maximum) were used. The distributions of qualitative features are presented as frequencies and percentages. The normality of the distributions was verified by the Shapiro-Wilk test. As the analyzed distributions deviated from the normal distribution, the Mann-Whitney U test was used to compare the distributions of continuous features in the analyzed groups.

Tab. V. GRBAS study scores in the study group and the control group in relation to the presence of vocal fold paralysis found in the follow-up examination.

	NO PARALYSIS (N = 145)	PARALYSIS (N = 8)	P (VALUE)	NO PARALYSIS (N = 114)	PARALYSIS (N = 8)	P (VALUE)
Grade of hoarseness (GRBAS = G)			< 0.001			< 0.001
0. normal voice	141 (97.2%)	0 (0.0%)		113 (99.1%)	0 (0.0%)	
1. mild intensity	3 (2.1%)	0 (0.0%)		1 (0.9%)	0 (0.0%)	
2. moderate intensity	1 (0.7%)	3 (37.5%)		0 (0.0%)	6 (75.0%)	
3. severe intensity	0 (0.0%)	5 (62.5%)		0 (0.0%)	2 (25.0%)	
Vocal roughness (GRBAS = R)			< 0.001			< 0.001
0. normal voice	145 (100.0%)	0 (0.0%)		114 (100.0%)	0 (0.0%)	
1. mild intensity	0 (0.0%)	1 (12.5%)		0 (0.0%)	1 (12.5%)	
2. moderate intensity	0 (0.0%)	5 (62.5%)		0 (0.0%)	7 (87.5%)	
3. severe intensity	0 (0.0%)	2 (25.0%)				
Breathy voice (GRBAS = B)			< 0.001			< 0.001
0. normal voice	145 (100.0%)	1 (12.5%)		113 (99.1%)	4 (50.0%)	
1. mild intensity	0 (0.0%)	5 (62.5%)		1 (0.9%)	4 (50.0%)	
2. moderate intensity	0 (0.0%)	2 (25.0%)				
Asthenia (GRBAS = A)			< 0.001			< 0.001
0. normal voice	144 (99.3%)	0 (0.0%)		111 (97.4%)	2 (25.0%)	
1. mild intensity	0 (0.0%)	4 (50.0%)		3 (2.6%)	4 (50.0%)	
2. moderate intensity	1 (0.7%)	3 (37.5%)		0 (0.0%)	2 (25.0%)	
3. severe intensity	0 (0.0%)	1 (12.5%)				
Vocal strain (GRBAS = S)			< 0.001			< 0.001
0. normal voice	143 (98.6%)	0 (0.0%)		113 (99.1%)	0 (0.0%)	
1. mild intensity	2 (1.4%)	3 (37.5%)		1 (0.9%)	3 (37.5%)	
2. moderate intensity	0 (0.0%)	4 (50.0%)		0 (0.0%)	5 (62.5%)	
3. severe intensity	0 (0.0%)	1 (12.5%)				

The frequencies in the unrelated groups were compared using the chi-square test (if the expected frequencies were met) or the Fisher's exact test (if the expected frequencies were not met).

All the statistical tests performed were two-tailed. The P-value of < 0.05 was adopted as the criterion of statistical significance. The calculations were performed with R software ([English text:] version 3.6.0; R Core Team [2019]. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/).

RESULTS

The frequency of paralysis of at least 1 vocal fold in the study group and the control group was not statistically significantly different (the study group: 4.9% [10/205], the control group: 4.9% [8/162]; P = 0.979). There were no statistically significant differences between the study group and the control group in the frequency of paralysis occurrence of any of the folds in any of the positions (medial, paramedial, lateral). Bilateral paralysis of the vocal folds was only found in one patient (0.5%) from the study group.

In the follow-up examination, in the study group, paralysis regressed in two patients, including one with bilateral paralysis. In the control group, no changes in the vocal fold paralysis occurred and all injuries had to be considered persistent.

VHI QUESTIONNAIRE

As for the VHI questionnaire scores, a statistically significantly higher total score (P = 0.042) and emotional subscale score (P = 0.008) were found in the study group. The highest mean scores in both groups pertained to the physical subscale. As for the functional and emotional subscales, they were at a similar level (about 2 times lower than for the physical subscale). Given the maximum possible score in the VHI questionnaire is 120 points (30 questionnaire statements, a maximum of 4 points for a given statement), the scores obtained in the study group and the control groups

oscillated around very low levels. In particular, zero scores were achieved by 36.6% of patients from the study group and 40.4% of patients from the control group.

Both in the study group and the control group, the patients with vocal fold paralysis had statistically significantly higher scores (considerably higher) in the VHI questionnaire, both for the total and individual subscale scores. The highest scores were found for the physical subscale, and the lowest for the emotional subscale. The mean total score of the VHI scale, both for patients with paralysis in the study group (55.6 points) and the control group (48.9 points), is in the range of 30–60 points and should be defined as the average voice disability.

VTD QUESTIONNAIRE

As for the VTD questionnaire scores in the study group, a statistically significantly higher score was found for a lump in the throat (P = 0.016 for frequency and P = 0.017 for intensity). The highest mean scores were for the frequency of dryness (in the study group).

Given the maximum possible score in the VTD questionnaire was 48 points separately for frequency and intensity (8 questionnaire statements, a maximum of 6 points for a given statement), the scores obtained in the study group and the control group oscillated around very low levels and approximately 30% of patients achieved zero scores, therefore confirming the absence of symptoms in the VTD questionnaire.

Both in the study group and the control group, the patients with vocal fold paralysis had statistically significantly higher scores (considerably higher) in the VTD questionnaire, both for the total and individual symptoms studied by the VTD questionnaire.

In the study group, the patients with the vocal fold paralysis had the highest scores for the symptom of "lump in the throat (intensity)" and "dryness (intensity)", and the lowest for the symptom of "soreness (frequency)" and "aching (frequency)".

In the control group, the patients with the vocal fold paralysis had, on average, the highest scores for the symptom of "dryness (frequency)" and "dryness (intensity)" and the lowest for the symptom of "soreness (intensity)" and "soreness (frequency)".

GRBAS SCALE

As for the scores of the GRBAS study, no statistically significant differences between the study group and the control group were found for the following features: G (P = 0.562), R (P = 0.600), B (P = 0.525), A (P = 0.440) and S (P = 0.897). In both groups, more than 90% of the patients showed "normal voice" in all features studied. The most common disability was a variable G – "hoarseness" (most cases of severe intensity were also found in this case). No one, however, was found with severe intensity of a variable B – "breathiness".

Both in the study group and the control group, the patients with vocal fold paralysis had statistically significantly higher scores (considerably higher) in the GRBAS study, in every aspect of the study. Among patients with no vocal fold paralysis, more than 95% of patients had no symptoms, as examined by the GRBAS (they had normal voice) study, while in the study group, with a recurrent laryngeal nerve paralysis, each patient had a minimum of 3 abnormal scores.

DISCUSSION

A possible post-operative complication of thyroid surgery is the vocal fold paralysis, causing voice disorders. An efficient voice organ is an important organ of communication, creating and maintaining interpersonal relations, expressing feelings and emotions, as well as an occupational tool in most professions.

In the presented study, the voice quality was assessed by both the examiner and in self-assessment using selected, commonly available questionnaires. The studies by various authors describe changes in voice quality following thyroid surgery, occurring in 14.6% to 18.4% of patients and resolving after up to 1 year [9]. The majority of changes are not directly related to the complication of laryngeal nerve injury [10]. In order to avoid erroneous conclusions related to transient voice disorders, voice quality was assessed in the follow-up examination in a period of 2–10 years following surgery.

All patients who came for the follow-up examination were assessed with auditory voice perception using the GRBAS scale. No statistically significant differences between the study group and the control group were found for any of the following features: G (P = 0.562), R (P = 0.600), B (P = 0.525), A (P = 0.440) and S (P = 0.897). In both groups, more than 90% of the patients showed "normal voice" in all features studied. The most common disability was a variable G – "hoarseness" and rarely a variable B – "breathiness"

Both in the study and the control groups the patients with vocal fold paralysis had statistically significantly higher scores (considerably higher) in the GRBAS study, in every aspect of the study.

Higher scores for any aspect of the GRBAS scale were also observed in patients with vocal fold paralysis by other authors [11]. In their work, Barczyński et al. presented interesting research results. They noticed that patients operated on without intraoperative neuromonitoring experienced early voice changes much more often, already 2–3 weeks following surgery, than patients operated on with intraoperative neuromonitoring (IONM), achieving higher scores on the GRABS scale. However, after 3 months, there were no longer any differences between the two groups [12]. However, the authors explain these differences with a temporary paralysis of the external branch of the superior laryngeal nerve.

Increasingly more attention has recently been paid to patient's self-reported voice assessment on the basis of specialized questionnaires. One of them, introduced by Jacobson in 1997, is VHI. This self-administered scale is used for defining psychosocial

consequences of voice disorders. It applies to the impact of voice disorders on three areas of life: functional, emotional and physical. The functional one describes the influence of voice disorders on everyday socio-professional activity. The emotional one presents patient's feelings towards their own voice. The questions from the last domain pertain to the perceived physical complaints related to the vocal cord disorder [13].

In the presented work, all patients who participated in the follow-up examination were exposed to self-assessment with the VHI scale. Among 259 (94.2%) patients who presented a score between 0–30 points on the questionnaire, defined as mild voice handicap, up to 105 (38.2%) patients obtained a score of 0 points. The above-mentioned group did not have recurrent laryngeal nerve injury complications.

In the study group and in the control group, the patients with vocal fold paralysis had statistically significantly higher scores in the VHI questionnaire both in total and individual subscale scores. The mean total score for VHI questionnaire for patients with vocal fold paralysis was obtained in the study group and corresponded to 48.9 points. These scores are within the range of 30–60 points, which is defined as moderate voice disability. The data obtained show that the status of voice following the injury to the laryngeal nerve can significantly affect the quality of life, as perceived by the patient. Similar scores were obtained by Borel [8]. Delgado-Vargas et al. obtained higher scores on the VHI questionnaire for patients undergoing thyroid surgery compared to patients undergoing other surgical procedures [14]. Nasiri et al. presented an interesting study on the pre-operative administration of one dose of dexamethasone to protect postoperative voice disorders. The use of this method allowed for reducing the number of cases of voice disorders and improving the score on the VHI scale [15]. Lachanas et al., after using this method, did not achieve any improvement in reducing the number of post-operative voice disorders [16]. Therefore, the effectiveness of the above therapy cannot be clearly assessed.

Another scale of self-administered voice assessment used in the follow-up examination was the VTD scale [17]. It is a common, simple method used in the diagnosis of voice disorders. The VTD questionnaire pertains to the vocal tract symptoms including burning, tightness, dryness, aching, throat irritability, tickling, soreness and lump in the throat. These symptoms are assessed in the frequency and intensity subscales. In the presented study, the scores obtained in the study group and the control group oscillate around very low levels and approximately 30% of patients achieved zero scores, therefore confirming the absence of symptoms in the VTD questionnaire.

In the study group, the patients with vocal fold paralysis had a statistically significantly higher ($P < 0.001$) mean total score in the frequency subscale achieving 17.2 points compared to the group without vocal fold paralysis: 2.7 points. A statistically significant higher ($P < 0.001$) total score was achieved by the patients with the vocal cord paralysis also in the intensity subscale, corresponding to 20.9 points compared to the group without complications post-surgery: 2.7 points.

In the control group, patients with vocal fold paralysis had a statistically significantly higher ($P < 0.001$) total score in the frequency subscale, corresponding to 11.8 points compared to the group of patients without vocal fold paralysis: 2.3 points. In the intensity subscale, the patients with vocal fold paralysis also obtained a statistically significantly higher ($P < 0.001$) total score, corresponding to 11.6 points compared to the group of patients not experiencing complications post-surgery: 2.3 points.

In the study group, the patients with vocal fold paralysis had the highest scores for increased intensity of "lump in the throat" and "dryness" symptoms, and the lowest for "soreness" and "aching" symptom frequency.

In the control group, the patients with the vocal fold paralysis had, on average, the highest scores for frequency and intensity of the "dryness" symptom, and the lowest for frequency and intensity of the "soreness" symptom.

Araújo et al. reported that the most common symptoms occurring secondary to vocal fold injuries are: tickling, aching and lump in the throat, while symptoms including dryness, irritability and burning are characteristic for tissue damage or inflammatory lesions of the larynx and pharynx [17].

The impact of recurrent laryngeal nerve injury on patient's life, examined with self-administered questionnaire, showed significant differences in terms of voice handicap. These questionnaires are valuable tools in assessing the quality of voice following thyroid surgery as well as in monitoring the progress of rehabilitation and the effectiveness of treatment in patients with voice disorders of different etiologies.

CONCLUSIONS

1. Neuromonitoring does not reduce the number of recurrent laryngeal nerve injuries in relation to the nerve visualization alone, hence intraoperative neuromonitoring alone does not have a direct impact on the quality of voice in patients undergoing total extracapsular thyroidectomy;

2. A vast majority of patients without the retrograde laryngeal nerve injury do not present symptoms of voice quality deterioration in the clinical examination or in self-assessment questionnaires;

3. Patients with the recurrent laryngeal nerve injury show significant differences in terms of voice handicap both in the assessment of voice quality using the GRBAS scale and self-administered questionnaires: VHI and VTD;

4. All voice disorders, as assessed in the self-administered questionnaire, are characterized by moderate voice disability.

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