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Voice Handicap Index (VHI) changes after endotracheal intubation in head and neck, and abdominal surgery

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Abbreviations

AS	– abdominal surgery
BMI	– body mass index
PGS	– parotid gland surgery
POM1	– first postoperative measurement
POM2	– second postoperative measurement
POM3	– third postoperative measurement
TT	– total thyroidectomy
VHI-E	– Voice Handicap Index, emotional domain
VHI-F	– Voice Handicap Index, functional domain
VHI-P	– Voice Handicap Index, physical domain

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Abstract

Background and purpose: *Endotracheal intubation can carry a risk of mechanical trauma of laryngeal structures. Common postoperative symptoms can include voice changes, vocal fatigue, hoarseness, stridor, sore throat etc. Injuries can be caused by inappropriately chosen endotracheal tube size, longer duration of surgery, type of surgery, and some patient specific factors. The objective of this study is to examine effects of endotracheal intubation and different types of surgery on subjective voice quality measures in different postoperative time points. Also, some patient and operation specific factors will be examined.*

Material and methods: *Study included 80 adult patients, divided into three groups: parotid gland surgery, total thyroidectomy, and abdominal surgery. Sociodemographic data (age, gender, body mass index) were collected. Voice handicap index was used to assess functional, physical, and emotional impact of voice changes to patients' lives. Anesthesia parameters were collected in the perioperative period.*

Results: *Significant changes in perceived symptoms were detected in all three groups of subjects, in different forms and duration. Perceived symptoms are the longest in patients who underwent total thyroidectomy, while the highest parameters in the first postoperative measurement are in patients who underwent parotid gland surgery.*

Conclusions: *Endotracheal intubation has an impact on perceived voice changes that occur after surgery in the head and neck area. Changes perceived after abdominal surgery were milder and shorter. Patient and surgery related factors have an important impact on intensity and duration of symptoms.*

INTRODUCTION

Endotracheal intubation is a generally safe medical procedure that is commonly used during general anesthesia. It has a function of maintaining airway patency by inserting a tube through the mouth or nose into the trachea. While it is an essential procedure for airway management during all types of surgeries, in some cases, especially when it is prolonged, can carry a risk of mechanical trauma of laryngeal structures, and cause injuries of larynx and pharynx *(1).* Some of those injuries include mucosal laceration, hematoma, or cricoarytenoid joint dislocation *(2,3).*

Common postoperative symptoms after endotracheal intubation can include voice changes, vocal fatigue, hoarseness, stridor, sore throat, difficulties clearing secretions, swallowing and breathing disorders *(4,5).* Previous researches have shown that the probability of injuries increases, with larger or inappropriately chosen endotracheal tube size (6), and longer duration of surgery *(2,7,8).* Most of previous researches focus on studying complications after a long duration of endotracheal intubation. However, the same injuries occur even after a short general anesthesia *(9).* In fact, those kinds of postoperative complications, especially hoarseness and vocal disorders, can be present in 14% to 50% of patients subjected to short lasting endotracheal intubation *(2,10,11).*

Earlier data indicate that postoperative voice disorders, especially if they are long-term, can have a great impact on performance and life quality among some patients *(12,13).* Voice is a unique characteristic of each person that offers plenty of information to the social environment. Just by voice, people can easily detect some basic information about someone's identity, such as their gender, age, health status, origin, socioeconomic group, dominance or submissiveness in social relationships, personality, attitudes, and emotions *(14).* Therefore, voice disorders, especially when they are prolonged, can have a negative impact on different areas of a person's life, including functional, physical, and emotional aspects.

For that reason, early recognition, and treatment of voice disorders after endotracheal intubation is important for clinical practice, improving life quality of patients and speeding up the overall recovery. One way to measure that kind of impact of postoperative voice disorders is through subjective voice quality evaluation.

Therefore, the aim of this study is to investigate the effects of endotracheal intubation and different types of surgery on subjective voice quality measures, and impact that voice disorders can have on voice related life quality, especially in different postoperative time points. Besides that, we will also aim to explore connection between those subjective voice measures and some patient and operation specific factors like, gender, surgery duration, tube size and patient's body mass index (BMI).

MATERIAL AND METHODS

Participants

Included participants were patients scheduled for elective head and neck surgery at the Department of Otolaryngology and Head and Neck Surgery, Phoniatric Reference Center or abdominal surgery at One-day surgery at the University hospital center Zagreb. All included patients signed informed consent for participation. The inclusion criteria were age of patients, they needed to be between 18 and 70 years old, normal preoperative voice status, and normal laryngeal status. Patients with preoperatively diagnosed pathologic vocal cord findings (nodules, polyps, vocal cord paralysis), as well as patients with postoperative injuries of the vocal cords, recurrent and superior laryngeal nerve, patients with laryngopharyngeal reflux, and patients in whom postoperative evaluation of the voice cannot be performed due to uncooperativeness were excluded from the study. Patients were divided in three groups: 30 patients were scheduled for parotid gland surgery (PGS), 30 for total thyroidectomy (TT), and 20 for abdominal surgery (AS). All operations were performed by experienced surgeons with more than 100 annual procedures under general anesthesia.

Endotracheal intubation

Direct laryngoscopy with standard metal Macintosh blade laryngoscope or indirect/video laryngoscopy with available device (single use with Macintosh plastic blade or reusable optical stylet) was used for intubation according to the anesthesiologist in charge discretion, as the endotracheal tube size also. Reinforced cuffed endotracheal tubes are routinely used for all thyroid and parathyroid surgeries. Anesthesiologists in charge were blinded for ongoing study, and the data were collected retrospectively. However, all the procedures included in this study have been standardized. Induction agents included sufentanil, propofol and rocuronium. Maintenance was done with sevoflurane with or without continuous remifentanil infusion. Reversion of the neuromuscular block was routinely performed before extubation.

Voice Handicap Index (VHI)

For self-assessment of voice, the Croatian version of Voice Handicap Index (VHI) questionnaire was used. The questionnaire was locally adapted and validated by Bonetti and Bonetti (15). Data was collected in four time points: 1. Preoperative measurement - before surgery; 2. POM1 (First postoperative measurement) - on the second day after surgery; 3. POM2 (Second postoperative measurement) - 14 days after surgery, and 4. POM3 (Third postoperative measurement) - one month after surgery. The VHI scale consists of 30 items that measure three factors: the functional domain (VHI-F; 10 items), the physical domain (VHI-P; 10 items), and the emotional domain (VHI-E; 10 items). The scale can also be observed as a single factor instrument. The functional domain measures the participant's assessment of how well they function depending on their voice. Examples of items are "People have a hard time understanding me in a noisy room" or "Difficulties with my voice limit my personal and social life." The physical domain refers to the participant's assessment of the quality of their voice, i.e. what its characteristics are and what impact it has on their physical functioning. Examples of items include "My voice sounds squeaky and dry." or "I feel like I have to strain to speak." The emotional domain measures the emotional effects that voice problems have on the participant. Examples of items include "My voice makes me feel tense when I talk to others." or "My voice problem

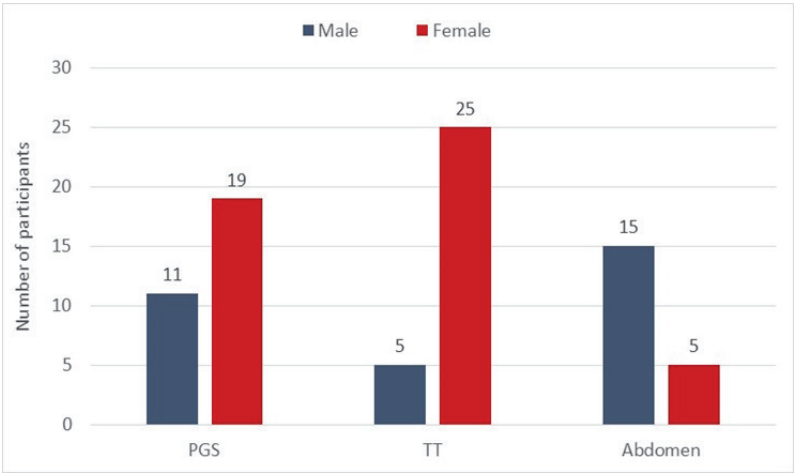

Figure 1. *Male and female ratio in surgery type groups*

upsets me." Answers are presented on a Likert type scale that assesses the degree of agreement with each statement from 0 ("never") to 4 ("always"). Results up to 10 on each subscale indicate there is no voice disorder. The scale and its subscales have high reliability and validity.

Statistical analysis

Chi square test was used to detect differences in gender between surgery type groups. Differences in average tube size, duration of surgery, age and BMI of participants, between surgery type groups, were tested by one way ANOVA. Repeated measures ANCOVA with factors between groups was used to determine if there are significant differences in postoperative measurements, between surgery type groups, and their interaction. Gender was kept under statistical control as covariate. Correlations between surgery duration, tube size, patient's BMI and voice parameters, were tested by Pearson correlation. Data analysis was performed in SPSS 21 *(16).*

RESULTS

Initially, we tested if groups were homogeneous by gender. Since male and female ratio in three surgery groups was significantly different (χ^2= 17.292, p=.000),

Table 1. *Descriptives and differences between surgery groups in Tube size, BMI, Duration of surgery, and the age of participants*

		N	M	SD	Min	Max	F	Sig.
Tube size	PGS	30	7.38	0.486	6.00	8.00	7.222	.001
	TT	30	7.08	0.349	6.50	7.50		
	Abdomen	20	7.50	0.363	7.00	8.00		
	Total	80	7.30	0.440	6.00	8.00		
BMI	PGS	30	25.98	3.465	16.98	32.49	2.255	.112
	TT	30	27.38	4.832	19.81	36.33		
	Abdomen	20	25.10	2.478	21.20	31.00		
	Total	80	26.28	3.912	16.98	36.33		
Duration of surgery	PGS	30	125.67	46.549	45.00	225.00	21.491	.000
	TT	30	126.50	29.687	70.00	180.00		
	Abdomen	20	65.40	23.598	25.00	135.00		
	Total	80	110.91	44.184	25.00	225.00		
Age	PGS	30	51.87	14.251	27.00	86.00	1.673	.195
	TT	30	53.07	12.630	29.00	78.00		
	Abdomen	20	46.25	13.230	18.00	65.00		
	Total	80	50.91	13.521	18.00	86.00		

Table 2. *Descriptive statistics for included voice parameters*

	N	Min	Max	M	SD	Skewness	Kurtosis
VHI-F	80	0	1	.03	.157	6.202	37.396
VHI-F, POM1	80	0	25	8.39	5.839	.764	.436
VHI-F, POM2	80	0	12	3.10	2.949	1.035	.755
VHI-F, POM3	80	0	12	1.49	2.338	1.941	4.557
VHI-P	80	0	2	.06	.291	5.127	28.158
VHI-P, POM1	80	0	32	13.08	8.920	.431	-.852
VHI-P, POM2	80	0	20	5.44	4.741	.603	-.149
VHI-P, POM3	80	0	20	2.98	3.731	1.533	3.831
VHI-E	80	0	3	.08	.382	6.356	45.056
VHI-E, POM1	80	0	34	9.83	7.837	.932	.331
VHI-E, POM2	80	0	13	3.68	2.924	.919	.805
VHI-E, POM3	80	0	10	1.55	2.294	1.605	1.968
VHI	80	0.00	5.00	.1625	.66454	5.647	36.970
VHI Total, POM1	80	0.00	87.00	31.2875	20.39309	.509	-.650
VHI Total, POM2	80	0.00	45.00	12.1875	8.67135	.999	1.499
VHI Total, POM3	80	0.00	38.00	6.0000	7.53053	1.451	2.821

gender remained the factor that needed to be kept under statistical control in further analyses. More females were undergoing head and neck surgeries, and more males were detected in abdominal surgery group (Figure 1).

The same was tested for Tube size, BMI of participants, duration of surgery and age. Descriptives and results of one-way ANOVA are presented in Table 1. Significant differences were found when it comes to tube size and surgery duration.

Since tube size is directly correlated to gender (females usually get smaller diameter tube) and surgery duration is highly dependent on type of surgery, those two factors were not included in ANCOVA.

Descriptive indicators, including Skewness and Kurtosis for voice parameters in all points of time are shown in Table 2. We did not use the Kolmogorov Smirnov test to test the distribution normality. Given that repeated measures ANCOVA is a robust analysis, an overview of skewness and kurtosis as indicators of the distributions is sufficient.

In Table 2, we can see that all the preoperative results indicate absence of voice related problems. In POM1 means changed and patience are displaying higher results on VHI scale and its subscales, indicating that they developed postoperative voice disorder. In each next measurement, results are again becoming closer to normal (Table 2).

When it comes to distributions of results, the commonly accepted consensus is that skewness should range from -1 to 1, and kurtosis between -2 to 2. However, many authors allow wider ranges. Schmider et al. *(17)* consider that values between -2 and 2 for skewness and -7 and 7 for kurtosis are acceptable for analysis of variance. According to that criterion, we can see that all indicators fall within acceptable range of distribution, except preoperative measurements. Of course, since the study included only patients who did not show signs of preoperative voice disorders, initial scores on VHI scale and subscales are all close to zero with very small variance, which is the reason for such results. However, since preoperative measurement served as a selection criterion and it is not included in further analyses, those results do not represent a problem.

Considering distributions of the results in preoperative measurement, to examine the changes in first postoperative measurement compared to preoperative measurement, Wilcoxson Sign rank test was performed (Table 3).

Based on results in Table 3 we can see that significant differences between preoperative and first postoperative measurement were detected in all domains of VHI scale (functional, physical and emotional) and on the total score as well.

As mentioned earlier, repeated measures ANCOVA was performed to calculate the main effect of time and type of surgery and their interaction. Gender was kept under control as covariate. Results are shown in table 4. Mauchly's test of sphericity showed that assumption of sphericity was not satisfied for any of the voice parameters, so Greenhouse-Geisser correction was applied.

According to results, there is a significant main effect of time for all VHI subscales except the emotional do-

Table 3. *Wilcoxon Sign Rank test between preoperative and first postoperative measurement*

	N	Mean	Std. Deviation	Wilcoxon Sign Rank test (p)
VHI-F	80	0.03	0.157	.000
VHI-F, POM1	80	8.39	5.839	
VHI-P	80	0.06	0.291	.000
VHI-P, POM1	80	13.08	8.920	
VHI-E	80	0.08	0.382	.000
VHI-E, POM1	80	9.83	7.837	
VHI Total	80	0.16	0.665	.000
VHI Total, POM1	80	31.29	20.393	

Table 4. *Results of repeated measures ANOVA: main effects of time, type of surgery, and their interaction on voice parameters*

	Main effect of time				Main effect of surgery				Interaction			
	F	df	p	ηp2	F	df	p	ηp2	F	df	p	ηp2
VHI-F	10.058	1	.001	.117	18.974	2	.000	.333	6.717	3	.001	.150
VHI-P	10.237	1	.001	.119	37.308	2	.000	.495	14.339	3	.000	.274
VHI-E	2.268	1	.127	.029	8.851	2	.000	.189	9.692	3	.000	.203
VHI Total	9.486	1	.001	.111	25.089	2	.000	.398	14.035	2	.000	.270

main. Also, a significant main effect of surgery was found for all scales. Interaction effects are statistically significant for VHI-F (F=6.717, p=.000), VHI-P (F=14.339, p=.000), and VHI Total (F=14.035, p=.000), while there is no significant interaction of time and type of surgery for Emotional domain of VHI (VHI-E). Effect sizes are the highest for surgery type, ranging from ηp2=.189 for VHI-E to ηp2=.495 for VHI-P.

Interaction effects can be observed on Figures 2 to 5. Interaction effect of time and type of surgery on VHI-F results are shown in Figure 2. Bonferroni post hoc test was used to test pairwise comparison for factor of time. Results showed that VHI-F results differ significantly in all 3 measurements. In the graph we can see that as the time passes, the reported symptoms of voice disorder become less. The main effect of surgery is also visible, with a significant difference between the group undergoing abdominal surgery, and the other two groups (tested by Tukey post-hoc comparison). In all three measurements, patients undergoing abdominal surgeries reported the mildest symptoms. By POM3, recovery curve shows

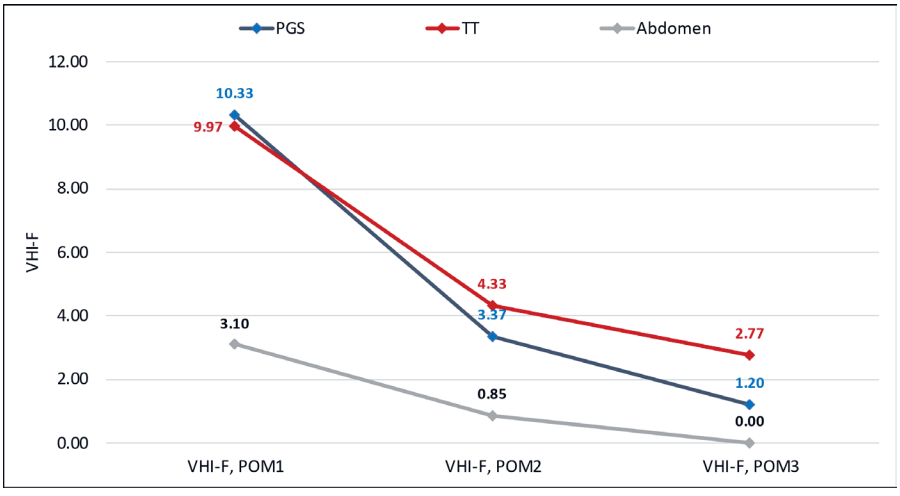

Figure 2. *Interaction effect of time and surgery type on VHI-F*

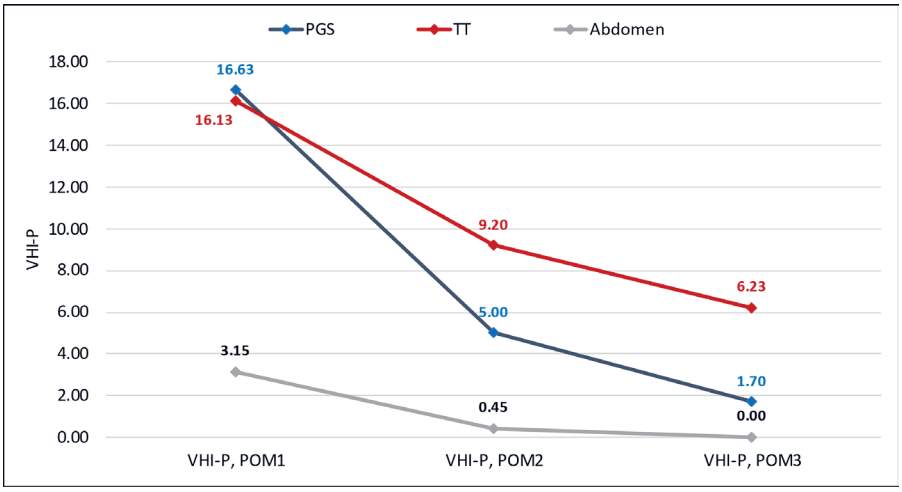

Figure 3. *Interaction effect of time and surgery type on VHI-P*

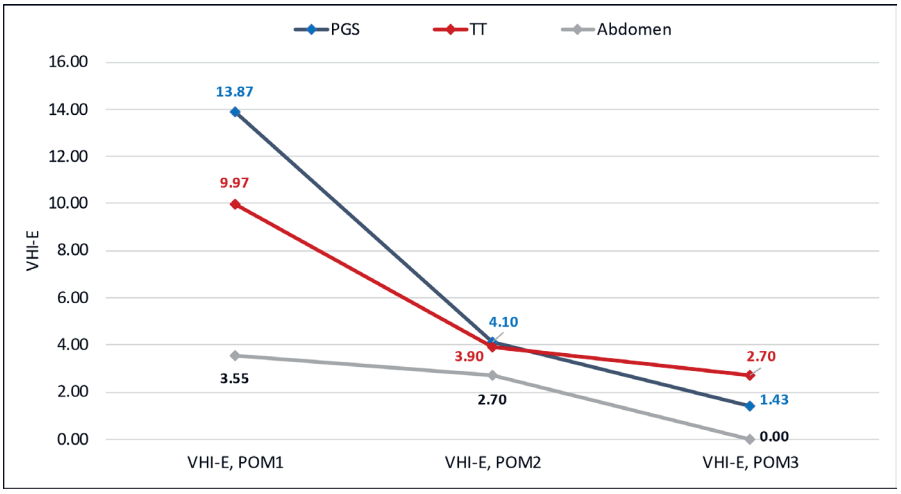

Figure 4. *Interaction effect of time and surgery type on VHI-E*

faster recovery in patients who had PGS and Abdominal surgeries, while the highest intensity of symptoms is reported by patients undergoing TT.

Same results for VHI-P are presented in Figure 3.

A significant main effect of time and surgery type was found for VHI-P (Table 3). Bonferroni post hoc comparison showed that all three postoperative measurements differ significantly from each other. In POM1, some voice disorder symptoms occur in all three groups of participants, and over the time they become lower. When it comes to the main effect of surgery, a significant difference was found between all three groups (Tukey post hoc comparison). Although the abdominal surgery group shows very mild symptoms, they are significantly higher than in preoperative measurement (Table 3). Highest results are detected in the parotid gland surgery group, but by POM2 that group recovers faster than the TT group. By POM3, recovery occurs in participants who underwent parotid gland and abdominal surgery, while voice symptoms in TT are still present.

In Figure 4. we can see the same data for VHI-E subscale. Although we can see a clear recovery trend when it comes to emotional voice related symptoms, no significant main effect of time was found. However, Bonferroni pairwise comparisons showed that all points of time do differ significantly. This can happen because the main effect of time tests whether the overall mean differences across time points are significantly different while pairwise comparisons test the difference between specific time points rather than across all time points simultaneously. If the variance is spread across the time points in a way that does not create a strong enough overall effect, the main effect may not reach significance despite of existing differences. The main effect of operation is significant, and according to Tukey post hoc comparison, there is a significant difference between abdominal surgery group

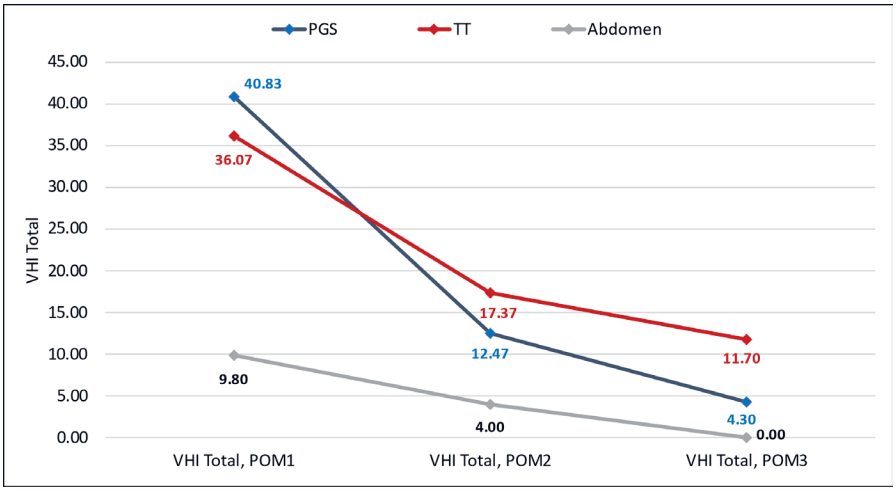

Figure 5. *Interaction effect of time and surgery type on Intensity*

and the remaining two groups. Interaction between time and type of surgery is significant as well: we can see that in POM1 PGS has the most intense symptoms, but by POM3 they show better recovery than the TT group.

Finally, the same data was presented for the whole VHI scale. Interaction effects of time and surgery on total VHI score can be observed in Figure 5.

When total score is taken into consideration, all effects (both main effects, and interaction) are significant. According to the Bonferroni post hoc test, there is a significant difference in general VHI score among all three measurements over time. A significant main effect of surgery was found as well. Tukey post-hoc comparison found a significant difference between the abdominal surgery group and the remaining two groups. In POM1, the PGS group reported the most intense average symptoms. In POM2, the PGS group shows significant recovery, while the TT group again shows more persistent symptoms which persist till POM3.

In Table 5 we can see Pearson correlations between patient related factors (Gender, Age, BMI), surgery and anesthesia procedure (tube size, duration of surgery) and VHI scores, for each postoperative point in time and independently from surgery type.

In POM1, significant positive correlations were found between gender and VHI-P score (r=.238, p<.05), gender and VHI-E score (r=.259, p<.05), and gender and VHI total score (r=.244, p<.05). In all three cases, female patients have higher VHI scores. Furthermore, significant positive correlations were found between duration of surgery and all VHI scores (VHI-F: r=.446, p<.01; VHI-P: r=.417, p<.01; VHI-E: r=.329, p<.01; VHI Total: r=.436, p<.01) and BMI and VHI-P score (r=.261, p<.05).

Pearson correlation coefficients, for POM2 can be observed in Table 6.

Significant positive correlations were found between gender and VHI-P, and gender and VHI total score, again

Table 5. *Correlation matrix for POM1*

	Gender	Age	Duration	Tube size	BMI	VHI-F, POM1	VHI-P, POM1	VHI-E, POM1
Age	.046							
Duration	.135	.211						
Tube size	-.422**	-.021	.076					
BMI	-.018	.281*	.136	.046				
VHI-F, POM1	.142	.130	.446**	-.016	.192			
VHI-P, POM1	.238*	.101	.417**	-.074	.261*	.737**		
VHI-E, POM1	.259*	.088	.329**	.012	.129	.697**	.717**	
VHI Total, POM1	.244*	.115	.436**	-.032	.219	.877**	.924**	.897**

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*

Table 6. *Correlation matrix for POM2*

	Gender	Age	Duration	Tube size	BMI	VHI-F, POM2	VHI-P, POM2	VHI-E, POM2
Age	.046							
Duration	.135	.211						
Tube size	-.422**	-.021	.076					
BMI	-.018	.281*	.136	.046				
VHI-F, POM2	.097	.082	.382**	-.121	.168			
VHI-P, POM2	.270*	.109	.413**	-.300**	.231*	.668**		
VHI-E, POM2	.149	-.099	.086	-.110	.015	.421**	.351**	
VHI Total, POM2	.229*	.055	.383**	-.240*	.191	.850**	.891**	.667**

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 7. *Correlation matrix for POM3*

	Gender	Age	Duration	Tube size	BMI	VHI-F, POM3	VHI-P, POM3	VHI-E, POM3
Age	.046							
Duration	.135	.211						
Tube size	-.422**	-.021	.076					
BMI	-.018	.281*	.136	.046				
VHI-F, POM3	.145	.196	.240*	-.125	.247*			
VHI-P, POM3	.271*	.226*	.277*	-.346**	.283*	.786**		
VHI-E, POM3	.226*	.133	.237*	-.059	.176	.721**	.612**	
VHI Total, POM3	.247*	.215	.283*	-.229*	.271*	.920**	.927**	.833**

pointing that women have more intense symptoms in POM2. Duration of surgery is significantly correlated with all VHI scores except emotional domain (VHI-E), while tube size shows significant negative correlations with Physical domain (VHI-P: r=-300) and Total VHI score (r=-.240). Negative correlations here point out that patients that had smaller tube diameter have greater symptoms in the second POM. However, it is important to realize that smaller tube sizes are used on female patients, therefore, this finding is just pointing out that women have more persistent symptoms after surgery. BMI is positively correlated with the physical domain of VHI scale.

Correlations for POM3 can be observed in Table 7.

Significant positive correlations in POM3 were again found for gender and all VHI scales except functional. Also, a positive correlation between age and VHI-P was found, indicating that older patients have more persistent symptoms in the physical domain. Duration of surgery is again correlated with all VHI scales, while tube size, again correlates negatively with symptoms in the physical domain and with total VHI score. BMI is positively corelated with all VHI scores except emotional, showing that patients with higher BMI have more persistent functional and physical symptoms.

DISCUSSION

There is limited number of researchers that are studying complications after short-term endotracheal intubation. Previous research is mostly focused on injuries and disorders after long-term intubation. However, some authors are confirming that even short intubation can cause injuries and temporary symptoms that include voice changes *(1,2,3,18)*. Factors that are contributing to development of these complications are rarely studied and therefore, still mostly unknown.

Some patient specific factors, like tracheal diameter (which is usually smaller in female patients), sex, and BMI *(19)* can affect the development and duration of postoperative voice disorders as well. Furthermore, different types of surgeries can increase the chance of complications due to position of head during operation. For example, during most head and neck surgeries a patient's

head is in a position that requires frequent adjustment *(5)* with extended neck or rotated neck to one side. Besides position of the head during surgery, surgery itself can be a risk factor for development of postoperative voice disorders. One of the examples is thyroid gland surgery, which is performed on the structures in proximity of vocal cords, and therefore increases the risk of their injuries, consequently, resulting in postoperative voice disorders *(5)*. Previous studies found that the frequency of voice disorders after thyroidectomy, especially in the early postoperative period, ranges from 16% to 87% (20). Risk is even greater when total thyroidectomy (TT) is performed *(21)*. Voice disorders after thyroidectomy, even without direct injury of the laryngeal nerve, tend to last long, sometimes even 6 to 18 months after the surgery, in over 20% patients *(22)*.

Although earlier researches showed significant correlation between objective voice-quality assessments (such as acoustic analysis), perceptive measures (evaluations from experts) and self-assessment measures, when we speak about specific voice parameters, objective and perceptive voice evaluations often have some advantages over self-assessment tools *(23)*. However, they cannot give us insight into patients' subjective symptoms or which areas of their lives, and to what extent, are affected by postoperative voice disorders.

As earlier mentioned, Voice Handicap Index is a widely used method of subjective voice analysis, but there is very little research on VHI changes after thyroidectomy. Le and colleagues investigated voice changes in patients undergoing thyroidectomy at a single institution via telephone to complete the Voice Handicap Index-10 Survey *(24)*. They found on 308 patients that long-term follow-up of patients after thyroidectomy suggests that more than 30% without nerve injury report dysphonia. The authors state that the VHI as a measurement instrument can be used to assess quality of life.

There is even less research on voice disorders after intubation of patients after other head and neck surgeries, excluding thyroidectomies. There is only one study in the literature that compares voice quality depending on the type of head and neck surgery. Sung and colleagues prospectively analyzed the voice outcomes of 155 serial thyroidectomy patients for up to 2 years *(25)*. The control group consisted of 69 patients who underwent parotidectomy. Self-assessment voice symptom scores (VSS) increased from day 1 after surgery in both groups, and returned to pre-operative levels by 24 months in the thyroidectomy group and after 1 week post-operatively in the parotidectomy (control) group. The post-operative VSS of the thyroidectomy group was significantly higher than that of the control group up to 12 months post-operatively. They concluded that impairment of voice function may persist for more than 18 months after thyroidectomy even in patients without RLN palsy. Endotracheal intubation can affect voice outcomes adversely for 1 week post-operatively.

Our study investigates such a factor's role in postoperative recovery and voice related functionality after short-term endotracheal intubation. Results suggest that all patients, no matter which surgery they were subjected to, develop some voice related symptoms that influence their everyday life. However, patients that were undergoing abdominal surgeries develop significantly milder symptoms and recover quickly, while head and neck patients develop more intense disorder which lasts longer after the operation. The most intense voice symptoms in first POM are reported from patients that were undergoing parotid gland surgery, which is closely followed by patients undergoing total thyroidectomy. Symptoms persist the longest with patients that had TT, and many of them are still reporting it one month after operation. Those findings indicate that not only intubation plays the role in voice disorder development and persistence but also the type of surgery. Since, TT is performed on the area that is in close anatomical proximity of vocal cords it apparently leaves more damage to surrounding structures resulting in more persistent symptoms after surgery. This pattern is detected in all three domains of VHI scale and the total VHI score as well, meaning that endotracheal intubation, postoperatively, has a significant effect on functional, psychical, and emotional aspects of patients' lives, but all those domains are also affected by surgery type, not just by intubation.

Besides that, patient and surgery related factors proved to be important in symptoms intensity and persistence. Female patients, in general, report stronger symptoms through all three measurements. However, it is important to note that head and neck surgery (particularly TT) groups included more females, while abdomen surgeries group included mostly men. Therefore, the observed gender difference in symptoms might be due to type of operation. Duration of surgery turned out to have the highest correlations with all VHI domains, indicating that longer surgery results with more intense and longer persisting symptoms in functional, physical, and emotional domain. Previous researches consistently confirmed these findings that longer exposure to intubation causes more intense voice disorders *(2,7)*.

Significance of certain factors and vocal symptoms changes somewhat with time. For example, older patients have more intense physical symptoms in third postoperative measurement, which suggests that they are recovering slower than younger patients. Furthermore, several studies have shown that age is one of the most important risk factors for the development of voice disorders after thyroidectomy. As a rule, older patients develop voice disorders more often and they last longer. Sahli et al. found that patients older than 65 years have a significantly higher percentage of various postoperative complications,

while age over 50 years is an independent factor influencing the increased incidence of voice disorders after thyroidectomy (26). In their study, Kovach and colleagues found on 2632 patients that in multivariable analysis, factors associated with an abnormal VHI-10 score included age 45 to 54 years (27). They concluded that the high prevalence of abnormal voice per validation with the VHI-10 emphasizes the need for heightened awareness of voice abnormalities following surgery and warrants consideration in the preoperative risk-benefit discussion, planned extent of surgery.

Similar are the findings when it comes to BMI, which, in first postoperative measurement, correlates only with physical domain, while in second and third measurement also correlates significantly with functional domain. These findings suggest that people with higher BMI return their vocal functionality slower than people with lower BMI.

CONCLUSION

Voice disorders, especially when they last long, can have a significant impact on different life domains. Endotracheal intubation, although generally safe procedure, even in short lasting surgeries, can have an impact on vocal changes which can then affect functional, physical, and emotional aspects of patients' lives. However, other factors have a significant contribution to intensity and duration of symptoms. Those factors include type and duration of surgery, gender, and BMI. Surgeries in the head and neck area in comparison to abdominal surgery usually result with more intense and more persistent symptoms of vocal disorders. Due to lack of studies about short term intubation effects on vocal disorders, more research is needed to confirm these findings. It is important that clinical practitioners take in consideration those factors and take all additional precautions to prevent postoperative complications. In order to work on prevention, early detection, and effective treatment of postoperative voice disorders, a multidisciplinary approach, the collaboration of anesthesiologists, surgeons, and speech therapists in the postoperative evaluation and support of patients with voice disorders, is needed.

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