VILNIUS UNIVERSITY

IVETA PAULAUSKIENĖ

THE CORRELATION BETWEEN MORPHOLOGICAL AND FUNCTIONAL LARYNGEAL CHANGES AND THE PARAMETERS OF SHORT–TERM ENDOTRACHEAL INTUBATION

Summary of Doctoral Dissertation

Biomedical Sciences, Medicine (06B)

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VILNIAUS UNIVERSITETAS

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GERKLŲ MORFOLOGINIŲ IR FUNKCINIŲ POKYČIŲ SĄSAJOS SU TRUMPALAIKĖS ENDOTRACHĖJINĖS INTUBACIJOS PARAMETRAIS

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INTRODUCTION

It was Friedrich Trendelenburg who was the first to perform endotracheal anaesthesia in 1869 using thracheostomy cannula [Brandt L., 1986]. The first orotracheal intubation was performed by William MacEwen in 1878. Although this method had saved a lot of lives, in 1880 the pioneer of the method, MacEwen, published papers in British medical journals containing a description of both the benefits and shortcomings of endotracheal intubation [MacEwen W, 1880].

150 years have passed since the first endotracheal intubation, and while the methods of intubation, tools, and materials have changed and improved, it remains difficult to avoid complications. The most frequent complications following endotracheal intubation are: vocal fold haematoma, granuloma, arytenoid lesions or even vocal fold paralysis [Weber S, 2002; Mencke T, et al., 2003]. Hoarseness is another frequent postintubational complication. According to various researchers, its frequency varies from 14.4 to 50 % [Winkel E and Knudsen J, 1971; Harding CJ and McVey FK, 1987; Joorgensen LN, et al., 1987; Herlevsen P, et al., 1987; Stout DM et al., 1987; Stride PC, 1990; Jones MW, et al., 1992; Christensen AM, et al., 1994; Joshi GP, et al., 1997; McHardy FE and Chung F, 1999; Higgins PP, et al., 2002; Wu CL, et al., 2002]. Long−term or even permanent hoarseness is observed in 1 % of all intubated patients [Jones MW, et al., 1992]. Complicated intubation amounts to just over one third (38 %) of all complicated cases [Weber S, 2002]. These data presume the fact that the majority of lesions appear during casual procedures or after them, and that the frequency of long−term hoarseness after intubation shows the relevance of postintubational complications. Therefore it is important to evaluate all the mechanisms and consequences of laryngeal injury in order to perform endotracheal intubation as safely as possible.

The effect of the short−term intubation on the larynx, as well as its morphology and function has not been examined systematically. It is still not known whether the vocal function changes due to direct traumatizing of the vocal gap or whether is influenced by other extralaryngeal factors. It is still unclear which laryngeal injuries appear first after extubation; or what the relation between laryngeal lesions and qualitative voice parameters is.

AIM AND OBJECTIVES

Aim of the study: to notice and evaluate primary laryngeal functional and morphological changes following short–term endotracheal (orotracheal) intubation for patients who had no laryngeal pathology before intubation; and to evaluate the correlation between intubation parameters and the experience of an anesthesiologist.

Objectives of the study:

1. To notice and to evaluate vocal and laryngeal symptoms after extubation and estimate the dependence of these changes on the parameters of the intubation tube, the number of intubation attempts, the duration of anesthesia and the experience of an anesthesiologist.
2. To assess the changes in the main vocal acoustic and aerodynamic characteristics after extubation and to evaluate their relation to the parameters of the endotracheal intubation and the experience of an anesthesiologist.
3. To evaluate laryngeal morphological changes following short–term intubation and to assess their correlation to the parameters of the intubation tube, the number of intubation attempts, the duration of anesthesia and the experience of an anesthesiologist.
4. To asses stroboscopic findings of the vocal folds during the early postextubation period and to find the relation of these findings to the parameters of the intubation tube, the number of intubation attempts, the duration of anesthesia and the experience of an anesthesiologist.
5. To evaluate the relation between the acoustic characteristics of the voice and morphological laryngeal findings after extubation.

SCIENTIFIC NOVELTY OF THE STUDY

This is the first prospective study that has properly evaluated the correlation between short−term endotracheal intubation and the morphological and functional laryngeal changes following extubation during the early postextubational period (1−2 hours after extubation) and one day after. The main parameters of the endotracheal anesthesia, which cause morphological and functional laryngeal changes, were assessed; the primary morphological laryngeal changes, appearing immediately after extubation and one day after, were also evaluated in this scientific study. The relation between postextubation laryngeal changes and the main vocal acoustic characteristics were assessed too. In addition, the stroboscopic changes of the vocal folds were assessed, both straight after extubation and 24 hours following it. The results of this study are important not only for otorhinolaryngologists but also for anesthesiologists in their daily work, while informing patients, especially vocal professionals, about the possible complications, and for choosing the intubation tube.

METHODS

Participants of the study

The scientific work was performed in 2009−2012 at the Centre of Ear, Nose and Throat Disease in Vilnius University Hospital Santariskiu Klinikos. The permission of the Biomedical Research Committee of Ethics in Vilnius region was received. 222 patients from various regions of Lithuania were included in this prospective study. All the patients underwent scheduled operations under general anaesthesia and intubation for ear or nose pathology. The participants were chosen incidentally and successively, those who corresponded to the inclusion criteria and agreed to attend the research. All the participants signed the informed consent form before their inclusion in the study.

Inclusion criteria:

- signed informed consent form,
- more than 16 years of age,
- ear or nose surgery,
- general endotracheal anaesthesia used at the time of surgery,

- surgery and intubation – scheduled.

Exclusion criteria:

- upper or lower respiratory tract infection at the time of research,
- pharyngeal or laryngeal disease diagnosed at the time of the study,
- laryngeal surgery or trauma in the past.

4 adult patients were excluded from the further investigation: 1 participant signed the informed consent form, however, refused the second examination after the operation, 3 people complained of nausea, vomiting, and vertigo; therefore, a thorough examination technically could not be performed. The data of 17 examined children (aged from 16 to 18) were not included into the final analysis (The group was not representative due to the small sample size).

Process of the study

The participants were examined 3 times:

- on the day of the surgery before endotracheal intubation,
- 1–2 hours after extubation,
- 24 hours after extubation.

Subjective examination

1. Vocal and pharyngeal symptoms were evaluated for all participants during every examination:
    - Hoarseness ("yes" or "no", if the patient complained of hoarseness, he described it as light, moderate or severe);
    - Vocal fatigue, globus pharyngeus, intention to clear the throat ("yes" or "no");
    - Throat pain (from 0 to 10 points according to the severity of the pain);
2. Additional anamnestic data, influencing vocal function the most were collected:
    - Smoking, allergy, GERD symptoms, frequent laryngitis, frequent upper respiratory tract diseases, difficulty in breathing through the nose;
    - Singing habits ("likes" or "dislikes singing").

Objective examination

1. Videolaryngoscopy was performed and the morphological lesions of the larynx were evaluated. Videolaryngoscopy was performed using a 70º angle rigid laryngoscope (model No 9106) with a Toshiba 3CCD camera (model No. JK–TU62H G, KayPentax Medical Company, USA). The vocal folds were evaluated: their edge and smoothness (local or diffuse thickening of the mucosa); vascular injection, dilatation, injection with dilatation, mucosal oedema. Vocal folds injuries: haematoma (unilateral, bilateral; in the left or right side). Other lesions or masses of the vocal folds or larynx: damage in tissue integrity, ulcerations, granulomas, vocal fold paresis, or dislocations of the arytenoid cartilages.
2. Videostroboscopy was performed using a stroboscope RLS 9100B with a Toshiba 3CCD camera (model No. JK–TU62H G, KayPentax Medical Company, USA) while the patient was phonating in a pitch and at a volume which felt comfortable. 6 parameters of the movement of the vocal folds and vocal gap were estimated:
   - The vocal gap, its closure and form of opening: closed, a gap in the anterior third (ventral), a gap in the posterior third (dorsal), a gap of a "distaff" form (oval), incomplete closure through the whole length (longitudinal), a gap of irregular shape, a gap in the shape of a sandglass;
   - Vocal gap constriction (anterior−posterior);
   - Mucosal wave ("apparent", "weakened", "no wave");
   - Regularity;
   - Symmetry (phases);
   - Amplitude.
3. Acoustic vocal and speech analysis was performed using the 'Visit Pitch' program (Digital Strobe Voice Analysis program KayPentax Medical Company, USA). All vocal records (3 times each) were performed in the same room, where surrounding noise did not exceed 50 dB. The vocal signal was registered directly to a condenser microphone while the patient was sitting comfortably and holding it 15 cm from the mouth and at an angle of approximately 45º; the vowel sound

"a" was produced for a minimum of 3 seconds at a comfortable pitch and volume for the patient. The following parameters were evaluated:

- Fundamental frequency (Fo), Hz;
- Relative average perturbation (RAP), %;
- Shimmer (shimmer), %;
- Noise to harmonic ratio (NHR), dB;
- Voice turbulence index (VTI), dB. All these parameters were measured while the patient produced a continuous vowel sound "a" for a few seconds at a comfortable pitch and loudness.
- Speaking fundamental frequency (SFo), Hz;
- Maximal speaking fundamental frequency (SFo max), Hz;
- Minimal speaking fundamental frequency (SFo min), Hz;
- Speaking fundamental frequency range (SFo range), estimated in semitones while the patient dictated the names of the months in a voice comfortable for him.

4. An aerodynamic examination was performed and the maximum phonation time was registered in seconds (MPT), calculated by asking the patients to take a deep inhalation before phonating the vowel "a" for as long as possible at a pitch and volume which was comfortable for the patient. After the process of the procedure had been demonstrated to the patient, 3 MPT attempts were performed by the patient, the longest of which was chosen for the analysis. MPT was registered using a 'Real–Time Pitch' program (Multi–Speech program, KayPentax Medical Company, USA).

Parameters of intubation anesthesia

All the patients underwent scheduled operations under general endotracheal anaesthesia and were extubated just after the surgery. Short–term anesthesia, lasting less than 240 minutes, was chosen. All the participants were intubated with the same intubation in Tube tubes with polyvinylchloride (PVC), large volume, and low pressure cuff with Murphy's eye (Intersurgical Ltd., Berkshire, UK). The intubation parameters were estimated by an independent assessor (anesthesiologist). The following parameters were assessed:

- The number of intubation attempts;
- The duration of intubation in minutes (min.);
- The size of the intubation tube (inner tube diameter ID, mm);
- The cuff volume, cm^3;
- The cuff pressure, cmH_2O;
- The experience of the anesthesiologist was classified in accordance with the working experience of the doctor (resident−doctor, doctor with working experience of less than 5 years and experienced an anesthesiologist with more than 5 years' experience).

Statistical analysis

Statistical analysis was performed using Statistical package for Social sciences 'SPSS Inc'19 version (USA). The frequencies of nominal and ordinal variables and relative frequencies measured as percentage were indicated while describing data, as well as the mean value and standard deviation, the confidence interval (CI) of 95% of mean value, and the biggest and the lowest value for interval variables. The independence of nominal and ordinal variables was tested using chi square (χ^2), if the rate of observation was marginal (<3), the Fisher criterion was applied. The Shapiro−Wilk test was used to evaluate the normality of the distribution of interval variables. More than half of the interval variables from the analyzed data did not spread under normal distribution. The means between the interval variables of two independent samples was compared using the Mann−Whitney−Wilcoxon test, while the Kruskall−Wallis test was applied to variables of three or more independent samples.

Repeated measures ANOVA was used to analyze data from several measurements of the same subject and, if the distribution of the data did not correspond to the normal dispersion, the Friedman test was used. The least significant difference (LSD) criterion was applied for multiple comparisons. The McNemar test was used to estimate the difference of the feature rate of paired observation.

The Spearman correlation coefficient (r) was counted to estimate the correlation between the interval and ranking variables. The correlation was estimated as 'very weak' if $r < 0.2$, 'weak' if r was 0.2–0.39, 'moderate' if the value of r was 0.4–0.69, 'strong' if r was 0.7–0.79 and 'very strong' when $r > 0.8$. Regression analysis was chosen to evaluate the relationship of independent variables towards the dependent variables. A significance level of 0.05 was chosen for checking statistical hypothesis.

RESULTS

Clinical characteristics of the participants

218 patients of various ages were examined in this prospective study: 17 children (from 16 to 18 years of age), 13 boys and 4 girls; 201 adult patients – 143 men and 58 women.

Only the data of adult participants were analyzed. The distribution by gender is represented in Figure 1.

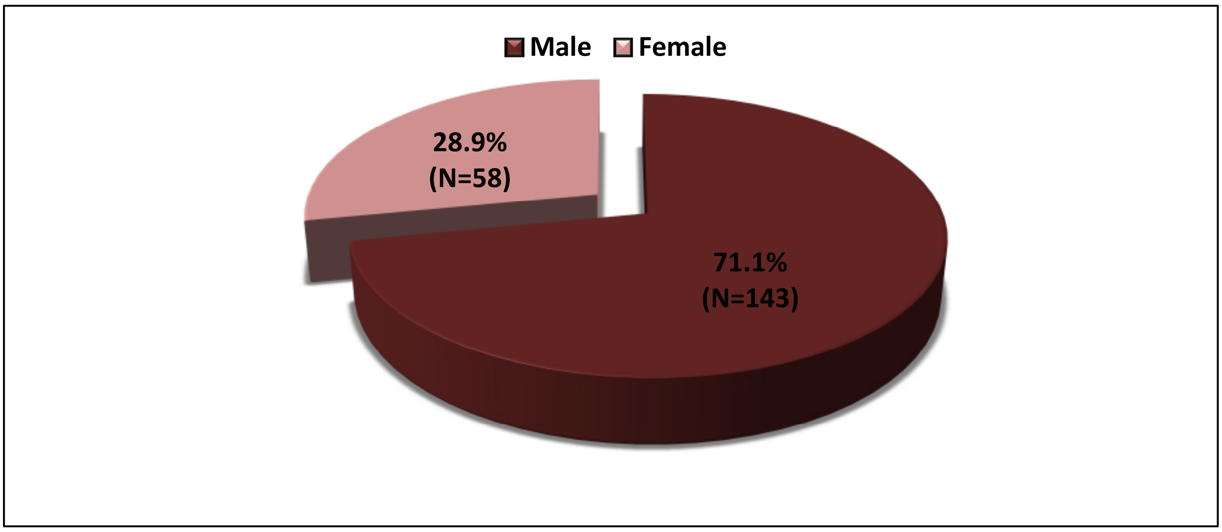

Fig. 1 The distribution by gender.

The youngest participant was 18 years old, the oldest – 77 years (the mean age – 36.81±14.49 years). The female age range was 19–71 years (the mean age – 38.05±14.63 years), while the males ranged from 18–77 years old (mean 36.31±14.45 years); there was no statistically significant difference between the mean age of males and females (P=0.441). The majority of the participants (52.7 %) were composed of patients younger than 35 years of age. The distribution of participants according to the age group and gender is represented in Figure 2.

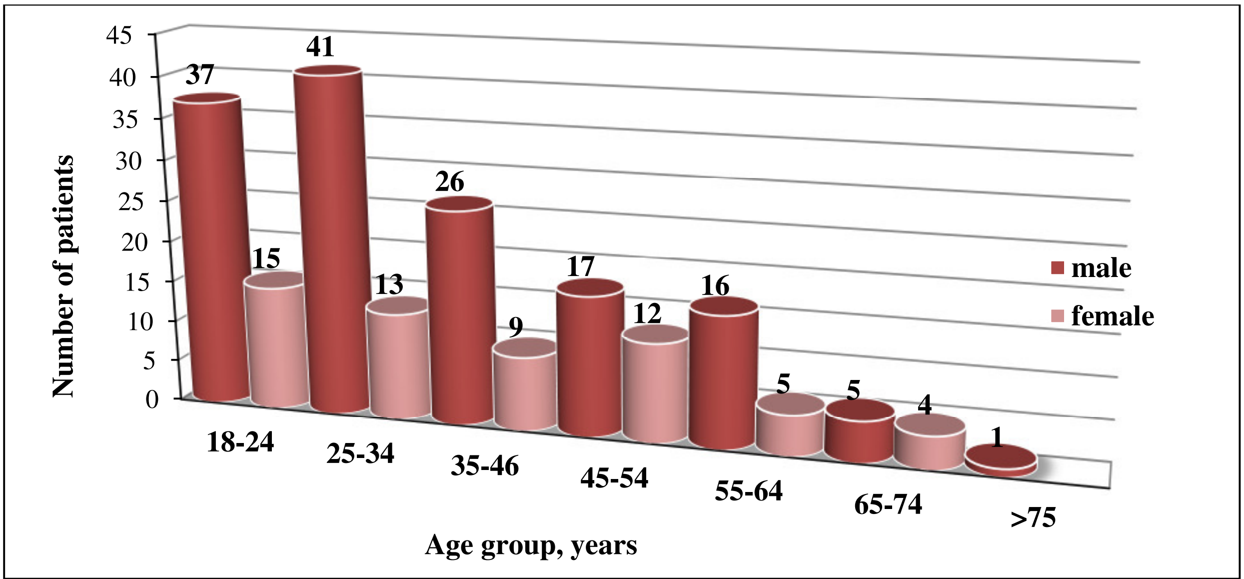

Fig. 2 The distribution of participants according to age groups and gender

94 patients (46.8 %) underwent surgery for ear and 107 (53.2 %) for nose pathology. Men were operated on for nose disease 1.5 times more than women, and this difference was statistically significant (P=0.002), whereas women had 1.4 times more ear surgery.

After evaluating the anamnestic data which had an influence on laryngeal morphology and vocal function, a statistically significant difference was found between the number of males and females complaining of obstructive nose breathing, frequent laryngitis and smoking (Table 1).

Table 1. A comparison of male and female anamnestic data

Anamnestic data	Male (N=143)	Female (N=58)	P
Smoking	52 (36.4%)	10 (17.2%)	0.008
Symptoms of GERD	33 (23.1%)	19 (32.8%)	0.156
Allergy	18 (12.6%)	12 (20.7%)	0.144
Frequent laryngitis	5 (3.5%)	8 (13.8%)	0.007
Difficult nose breathing	95 (66.4%)	27 (46.6%)	0.009
Singing habits	53 (37.1%)	29 (50.0%)	0.091
Upper respiratory tract diseases	47 (32.9%)	22 (37.9%)	0.493

There were 2.15 times more males smokers than females. Frequency of difficulty breathing through nose was 1.43 higher in men than in women (P=0.008), while frequency of having laryngitis in women was reliably 3.84 times higher than in men (P=0.007). The parameters of endotracheal anesthesia are represented in Table 2.

Table 2. The parameters of the endotracheal anesthesia

Parameters of intubation	**Min**	**Max**	**Mean ± SD**
All participants (N=201)			
No. of intubation tube, ID mm	6.0	8.5	7.73 ± 0.44
Cuff volume, cm³	3	18	7.62 ± 2.09
Cuff pressure, cmH_2O	12	78	32.81 ± 9.33
Duration of anesthesia, min	15	240	71.29 ± 40.65
Number of intubation attempts	1	3	1.07 ± 0.32
Male (N=143)			
No. of intubation tube, ID mm	7.0	8.5	7.95 ± 0.24
Cuff volume, cm³	3.0	18.0	7.99 ± 2.23
Cuff pressure, cmH_2O	12	78	33.12 ± 9.78
Duration of anesthesia, min	15	240	70.03 ± 40.72
Number of intubation attempts	1	3	1.08 ± 0.37
Female (N=58)			
No. of intubation tube, ID mm	6.0	7.5	7.17 ± 0.30
Cuff volume, cm³	3.0	10.0	6.73 ± 1.35
Cuff pressure, cmH_2O	16	55	32.05 ± 8.13
Duration of anesthesia, min	15	210	74.40 ± 40.64
Number of intubation attempts	1	2	1.03 ± 0.18

The mean diameter of tube used for males intubation was wider by 0.78 mm and the inflated cuff mean volume was higher by 1.25 cm³ in males than those in females. In most cases (62.2 %), anesthesia was performed by experienced anesthesiologists with more than 5 years of experience, in a quarter of cases (25.9 %), it was performed by resident−doctors, and in 11.9 % of cases, it was done by anesthesiologists with less than 5 years' experience.

Pharyngolaryngeal symptoms

It was estimated that all pharyngolaryngeal symptoms assessed were troubling patients 1−2 hours and 24 hours after extubation more than comparing to the rate of the symptoms before the surgery, and the difference was statistically significant (P<0,001) (Table 3). During the early postextubation period (after 1−2 hours) patients complained of hoarseness (82 %), a throat clearing sensation (64.2 %), *globus pharyngeus* (51.2 %) and throat pain (50.7 %). The rate of these complaints lessened after a day; however, hoarseness, the throat clearing sensation and a sore throat still troubled more than 40 % of patients.

1−2 hours after extubation, one third (38.8 %) of hoarse patients complained of severe hoarseness, while the remaining patients described it as light. In contrast, the day after, only 0.8 % of participants complained of severe hoarseness.

Table 3. A comparison of pharyngolaryngeal symptoms before intubation, and 1−2 and 24 hours after extubation

Time	Hoarseness N (%)	Vocal fatigue N (%)	Throat clearing N (%)	Globus pharyngeus N (%)	Throat pain N (%)
Before intubation	7 (3.5)	0 (0)	27 (13.4)	10 (5.0)	9 (4.5)
1-2 hours after extubation	165 (82.0)	60 (29.9)	129 (64.2)	103 (51.2)	102 (50.7)
24 hours after extubation	97 (48.3)	19 (9.5)	96 (47.8)	52 (25.9)	87 (43.3)
P value*	<0.001	<0.001	<0.001	<0.001	<0.001
P value†	<0.001	<0.001	<0.001	<0.001	<0.001

* P value – comparing the changes before intubation and 1−2 hours after extubation.
†P value – comparing the changes before intubation and 24 hours after extubation.

After dividing the patients according to the severity of the postextubation throat pain from 1 to 10 points, it was estimated that 1−2 hours after extubation, light (1−3 point) pain was dominating (64.7 %). 27 (26.5 %) of patients complained of moderate throat pain (4−7 point). Only 9 (8.8 % of all patients complaining of throat pain) were troubled with severe (8−10 point) throat pain. One day after extubation, more than two thirds (71.3 %) of 87 patients complaining of throat pain, reported only 1−3 points on the scale of pain intensity. Meanwhile, the frequency of severe pain lessened 2.5 times comparing to 1−2 hours after extubation (P>0.05). The intensity of throat pain (in points) before and after surgery is represented in Figure 3.

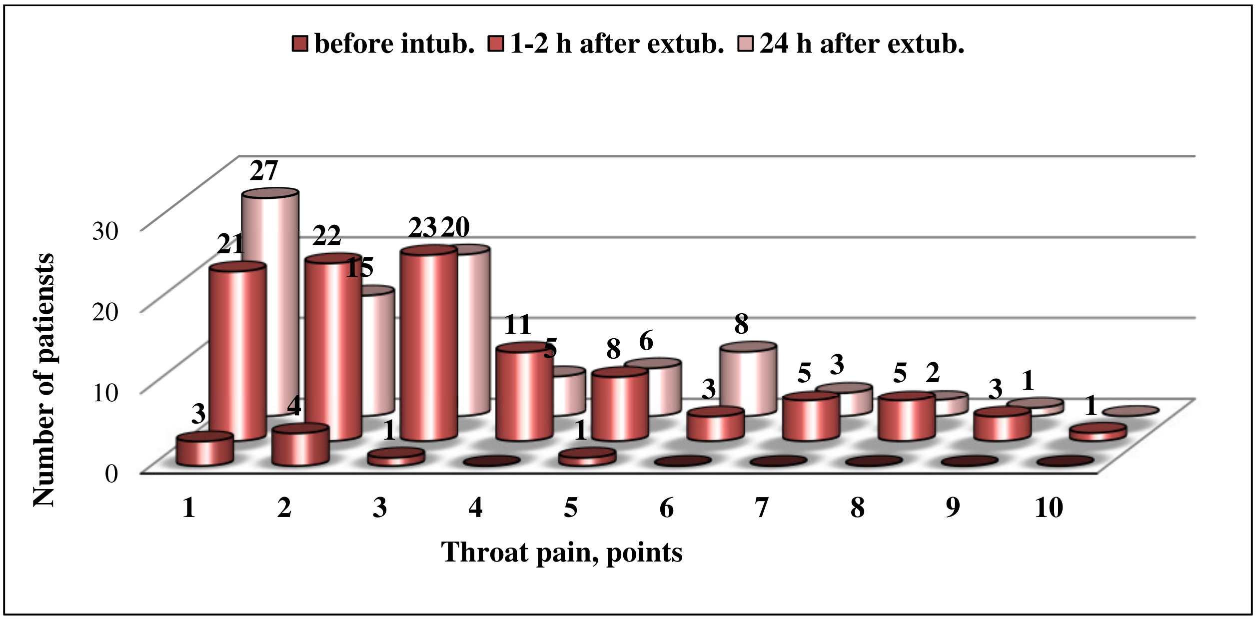

Fig. 3 Throat pain intensity before and after extubation

After comparing the rate of the pharyngolaryngeal symptoms between genders before intubation, it was assessed that *globus pharyngeus* troubled females 3.7 times more than males (P=0.026) (Table 4). Women and men complained of sore throat almost equally (P<0.05) (Table 4). Participants were divided according to the intensity of the pain: 3 men complained of 1–point throat pain, 2 of 2–point intensity and 1 of 3–point intensity throat pain; 2 females expressed 2–point throat pain and 1 female reported suffering 5–point pain. After examining this patient's throat and larynx with an endoscope, no obvious pathology was found.

All pharyngolaryngeal complaints were more frequent after extubation compared to the preoperative period, especially 1–2 hours after extubation. However, a statistically significant difference between genders was only found concerning throat pain 1–2 hours after extubation (Table 4). Female throat pain was 1.4 times more frequent than male (P=0.018), whereas the day after, the throat pain of men and women was almost equal and did not differ significantly (44.8 % and 42.7 % respectively, P>0.05); however, throat pain still remained almost 10 times more frequent than before the surgery.

Table 4. A comparison of male and female pharyngolaryngeal symptoms before intubation, and 1−2 and 24 hours after extubation

Symptom	Male (N=143)	Female (N=58)	P
Hoarseness			
Before intubation	6 (4.2%)	1 (1.7%)	0.386
1–2 hours after extubation	117 (81.8%)	48 (82.8%)	0.875
24 hours after extubation	71 (49.7%)	26 (44.8%)	0.535
Vocal fatigue			
Before intubation	0	0	
1–2 hours after extubation	38 (26.6%)	22 (37.9%)	0.111
24 hours after extubation	12 (8.4%)	7 (12.1%)	0.419
Throat clearing			
Before intubation	16 (11.2%)	11 (19.0%)	0.143
1–2 hours after extubation	93 (65.0%)	36 (62.1%)	0.691
24 hours after extubation	65 (45.5%)	31 (53.4%)	0.304
Globus pharyngeus			
Before intubation	4 (2.8%)	6 (10.3%)	0.026
1–2 hours after extubation	75 (52.4%)	28 (48.3%)	0.592
24 hours after extubation	36 (25.2%)	16 (27.6%)	0.724
Throat pain			
Before intubation	6 (4.2%)	3 (5.2%)	0.762
1–2 hours after extubation	65 (45.5%)	37 (63.8%)	0.018
24 hours after extubation	61 (42.7%)	26 (44.8%)	0.778

The dependence of pharyngolaryngeal symptoms on anamnestic data and the parameters of endotracheal intubation

The analysis reveals that vocal fatigue 1−2 hours after extubation significantly depends on smoking and inner diameter of intubation tube: the odds ratio of vocal fatigue for smokers 1−2 hours after extubation was 1.95 times bigger than non−smokers; and odds ratio of vocal fatigue 1−2 hours after extubation lessened 2.17 times when using an intubation tube which was 1 size wider. 24 hours after extubation, vocal fatigue significantly depended on the intubation tube size and cuff volume: the odds ratio of vocal fatigue 24 hours after extubation lessened 3.7 times when using an intubation tube which was one size bigger and the odds ratio increased 1.29 times when the cuff volume increased by 1 cm^3 (Table 5).

No dependence between the throat clearing sensation 1−2 hours and 24 hours after extubation and parameters of intubation was identified; however, a significant correlation between throat clearing sensation 1−2 hours after extubation and body mass index (BMI) was found; and 24 hours after extubation there was a correlation between smoking and the intention to clear the throat before surgery. The odds ratio of the intention to clear the throat 1−2 hours after extubation was 1.09 times bigger for patients whose BMI was greater than 1 kg/m2; whereas the odds ratio of to the sensation of throat clearing 24 hours after extubation was 2.46 times bigger for patients who also had this intention before surgery. The odds ratio of the intention to clear the throat 24 hours after extubation was lower for smokers compared to non−smokers.

1−2 hours after extubation, *globus pharyngeus* was significantly related to the cuff volume and *globus pharyngeus* before the surgery: the odds ratio of *globus pharyngeus* 1−2 hours after extubation rose 1.29 times when the intubation tube size increased by 1 cm^3; what is more, the likelihood of *globus pharyngeus* 1−2 hours after extubation was 5.52 times bigger for those who had *globus pharyngeus* before surgery compared to those who did not complain about it. It was estimated that when the duration of the anesthesia was lengthened, every minute of anesthesia raised the odds ratio of *globus pharyngeus* 24 hours after extubation 1.01 times (Table 5).

No dependence between hoarseness 1−2 hours after extubation and the parameters of intubation, anamnestic data, age, BMI, and hoarseness before the operation was identified. However, a significant correlation was found between throat pain 1−2 hours after extubation and smoking, obstructive nasal breathing, or upper respiratory tract diseases (Table 5). The analysis revealed that the odds ratio of throat pain 1−2 hours after extubation for patients with obstructive nasal breathing before the surgery was significantly (2.04 times) lower compared to those who had normal nasal breathing before the surgery. Moreover, the odds ratio of throat pain 1−2 hours after extubation for patients with upper respiratory tract infections was 3.02 times greater, while 24 hours after surgery the odds were 2.74 times greater compared to those who had no respiratory tract infections.

Table 5. The dependence of the pharyngolaryngeal symptoms on age, anamnestic data, the parameters of the endotracheal anesthesia, and BMI.

Symptom	Regression coefficient	Regression coefficient CI	P
Vocal fatigue 1-2 hours after extubation			
Size of intubation tube	0.46	0.23 – 0.97	0.050
Smoking	1.95	1.00 – 3.88	0.032
Vocal fatigue 24 hours after extubation			
Size of intubation tube	0.27	0.09 – 0.79	0.018
Cuff volume	1.29	1.05 – 1.60	0.018
Throat clearing 1-2 hours after extubation			
BMI	1.09	1.02 – 1.17	0.018
Intention to clear the throat before surgery	2.46	1.00 – 6.09	0.094
Throat clearing 24 hours after extubation			
Smoking	0.04	0.23 – 0.84	0.012
Intention to clear the throat before surgery	2.46	1.00 – 6.09	0.051
Frequent laryngitis	3.21	0.82 – 12.53	0.093
Globus pharyngeus 1-2 hours after extubation			
Cuff volume	1.29	1.10 – 1.51	0.002
Cuff pressure	0.97	0.94 – 1.00	0.078
Globus pharyngeus before surgery	5.52	1.10 – 27.68	0.038
Globus pharyngeus 24 hours after extubation			
Upper respiratory tract disease	1.92	0.96 – 3.84	0.064
Frequent laryngitis	0.14	0.02 – 1.16	0.068
Duration of anesthesia	1.01	1.00 – 1.02	0.027
Hoarseness 1-2 hours after extubation			
GERD symptoms	0.47	2.19 – 1.01	0.052
Hoarseness 24 hours after extubation			
GERD symptoms	0.57	0.29 – 1.12	0.104
Smoking	0.47	0.25 – 0.91	0.025
Cuff volume	1.17	1.01 – 1.36	0.034
Throat pain 1-2 hours after extubation			
Allergy	0.42	0.17 –1.04	0.062
Upper respiratory tract disease	3.02	1.57 – 5.80	0.001
Smoking	0.46	0.24 – 0.88	0.019
Obstructive nasal breathing	0.49	0.62 – 0.90	0.022
Throat pain before surgery	7.26	0.83 -63.55	0.073
Throat pain 24 hours after extubation			
Upper respiratory tract disease	2.74	1.50 – 4.98	0.001

It was ascertained that various pharyngolaryngeal symptoms following extubation depended on the intubation parameters (intubation tube size, cuff volume, duration of anesthesia), smoking, obstructive nasal breathing, upper respiratory tract diseases and BMI.

Voice acoustics

It was revealed that 1–2 hours and 24 hours after extubation, the majority of voice acoustic characterisctics changed and differed significantly comparing to the preintubational parameters (Table 6).

Table 6. A comparison of acoustic parameters before intubation, compared with 1–2 and 24 hours after extubation

Parameter	Before intubation	1-2 hours after extubation	24 hours after extubation
Fo, Hz	165.70 ± 68.19 [b]	164.69 ± 67.87 [c]	171.0 ± 70.73 [b, c]
RAP, %	0.69 ± 0.52 [a]	0.95 ± 0.77 [a, c]	0.76 ± 0.56 [c]
Shimmer, %	4.60 ± 2.11 [a]	5.43 ± 3.64 [a, c]	4.55 ± 2.06 [c]
NHR, dB	0.15 ± 0.04 [a]	0.16 ± 0.07 [a, c]	0.14 ± 0.03 [c]
VTI, dB	0.04 ± 0.02 [b]	0.05 ± 0.04 [c]	0.04 ± 0.01 [b, c]
SFo, Hz	138.31 ± 41.38 [b]	136.55 ± 41.85 [c]	141.7 ± 42.12 [b, c]
SFo min, Hz	107.95 ± 30.81 [a]	100.86 ± 28.05 [a, c]	107.49 ± 29.78 [c]
SFo max, Hz	269.99 ± 70.99	257.89 ± 72.15	270.5 ± 71.16
SFo range, ST	15.70 ± 6.47	15.92 ± 6.21	15.56 ± 6.04
MPT, s	18.11 ± 5.80 [a]	16. 00 ± 6.73 [a, c]	17.94 ± 6.2 [c]

a – $P<0.05$ comparing the parameters before intubation and 1–2 hours after extubation
b – $P<0.05$ comparing the parameters before intubation and 24 hours after extubation
c – $P<0.05$ comparing the parameters 1–2 hours and 24 hours after extubation

During early postextubation period (1–2 hours after extubation) the biggest changes were seen in the acoustic parameters which define vocal quality or objective (frequency and amplitude) perturbation parameters: RAP and shimmer. The vocal gap noise parameters: NHR changed marginally and VTI varied statistically insignificantly. The shortening of MPT after extubation shows the reduction in the effectiveness of use of subglottic air flow in the vocal gap.

It was revealed that particular acoustic parameters connect with very strong and intense correlation links before intubation and after extubation (the strongest links were between Fo, SFo, SFo min and MPT) (Table 7).

Table 7. The Spearman correlation coefficient (r) of acoustic parameters before intubation and after extubation

Parameter	Before intubation and 1-2 hours after extubation	Before intubation and 24 hours after extubation	1-2 hours and 24 hours after extubation
Fo, Hz	0.801**	0.858**	0.815**
RAP, %	0.452**	0.586**	0.394**
Shimmer, %	0.323**	0.410**	0.385**
NHR, dB	0.146*	0.257**	0.330**
VTI, dB	0.132	0.115	0.145*
SFo, Hz	0.870**	0.874**	0.842**
SFo min, Hz	0.704**	0.790**	0.644**
SFo max, Hz	0.165*	0.057	0.189**
SFo range, ST	0.282**	0.250**	0.292**
MPT, s	0.706**	0.713**	0.773**

** $P<0.0001$
* $P<0.05$

The acoustic parameters of males and females were analyzed separately. 1−2 hours after extubation, the mean RAP of male patients was higher by 0.23 % ($P<0.0001$), mean shimmer was higher by 0.79 % ($P=0.012$) and the mean NHR was bigger by 0.01 dB ($P=0.004$) than those before the surgery (Table 8). Whereas the mean SFo min decreased by 2.39 Hz ($P=0.001$) and mean MPT decreased by 2.39 s ($P<0.0001$) in males compared to the respective parameter before intubation (Table 8).

Table 8. A comparison of male acoustic parameters before intubation, compared with 1−2 hours and 24 hours after extubation

Parameter	Before intubation	1-2 hours after extubation	24 hours after extubation
Fo, Hz	127.98 ± 28.98^{b}	128.8 ± 30.54	132.47 ± 29.52^{b}
RAP, %	$0.52 \pm 0.35^{a, b}$	$0.75 \pm 0.66^{a, c}$	$0.61 \pm 0.48^{b, c}$
Shimmer, %	4.36 ± 1.74^{a}	$5.15 \pm 3.51^{a, c}$	4.31 ± 1.93^{c}
NHR, dB	0.15 ± 0.04^{a}	$0.16 \pm 0.06^{a, c}$	0.14 ± 0.03^{c}
VTI, dB	0.04 ± 0.01	0.05 ± 0.05^{c}	0.04 ± 0.01^{c}
SFo, Hz	115.34 ± 19.67^{b}	114.10 ± 22.35^{c}	$118.30 \pm 19.35^{b, c}$
SFo min, Hz	92.84 ± 13.00^{a}	90.45 ± 11.86^{a}	93.3 ± 13.84
SFo max, Hz	259.99 ± 74.46	248.29 ± 78.64	260.74 ± 76.81
SFo range, ST	16.99 ± 6.50	16.51 ± 6.45	16.52 ± 6.10
MPT, s	19.54 ± 5.86^{a}	$17.47 \pm 6.95^{a, c}$	19.42 ± 6.18^{c}

a – $P<0.05$ comparing the parameters before intubation and 1−2 hours after extubation
b – $P<0.05$ comparing the parameters before intubation and 24 hours after extubation
c – $P<0.05$ comparing the parameters 1−2 hours and 24 hours after extubation

24 hours after extubation, the male mean Fo of was reliably greater by 4.49 Hz (P=0.012) compared to the mean Fo before intubation (Table 8). The day after extubation, shimmer, NHR, SFo min and MPT were similar to their initial readings, but the mean RAP remained reliably higher by 0.09 % (P=0.026) and the mean Fo – higher by 2.96 Hz (P=0.007) compared to the respective parameters before intubation (Table 8).

During the early post extubation period the female mean RAP was significantly higher by 0.33 % (P=0.007) and the mean SFo range – greater by 1.95 ST (P=0.016) than before the surgery (Table 9).

Table 9. A comparison of acoustic parameters before intubation, compared with 1–2 hours and 24 hours after extubation

Parameter	Before intubation	1-2 hours after extubation	24 hours after extubation
Fo, Hz	258.68 ± 43.09	253.19 ± 51.38	265.98 ± 49.77
RAP, %	1.11 ± 0.63 [a]	1.44 ± 0.82 [a, c]	1.11 ± 0.59 [c]
Shimmer, %	5.20 ± 2.74	6.11 ± 3.89	5.13 ± 2.26
NHR, dB	0.15 ± 0.05	0.17 ± 0.10 [c]	0.14 ± 0.04 [c]
VTI, dB	0.05 ± 0.02 [a, b]	0.04 ± 0.01 [a]	0.04 ± 0.02 [b]
SFo, Hz	194.94 ± 21.37 [b]	191.91 ± 22.77 [c]	199.40 ± 23.05 [b, c]
SFo min, Hz	145.19 ± 30.44 [a]	126.54 ± 38.30 [a, c]	142.45 ± 29.77 [c]
SFo max, Hz	294.66 ± 54.77	281.55 ± 45.35	294.54 ± 47.35
SFo range, ST	12.50 ± 5.18 [a]	14.43 ± 5.34 [a]	13.21 ± 5.23
MPT, s	14.59 ± 3.86 [a]	12.39 ± 4.46 [a, c]	14.31 ± 4.54 [c]

a – P<0.05 comparing the parameters before intubation and 1–2 hours after extubation
b – P<0.05 comparing the parameters before intubation and 24 hours after extubation
c – P<0.05 comparing the parameters 1–2 hours and 24 hours after extubation

Meanwhile, the mean VTI was statistically significantly lower by 0.01 dB (P=0.021), the mean SFo min lower by 18.65 Hz (P<0.0001) and the mean MPT shorter by 2.29 s (P<0.0001) compared to respective parameter before the intubation (Table 9).

The day after extubation, the female RAP, VTI, SFo min and MPT recovered and did not differ significantly from respective parameters before surgery; however, the mean Fo remained greater by 4,46 Hz (P=0.004) than the same parameter before the intubation occurred.

The study revealed that the peculiarities of the changes in the acoustic parameters in both males and females were the same before intubation and after extubation and did not depend on gender. 24 hours after extubation, SFo min and MPT recovered, though the difference in Fo for men and women (Figure 3) and the increase in Fo for men was statistically significant.

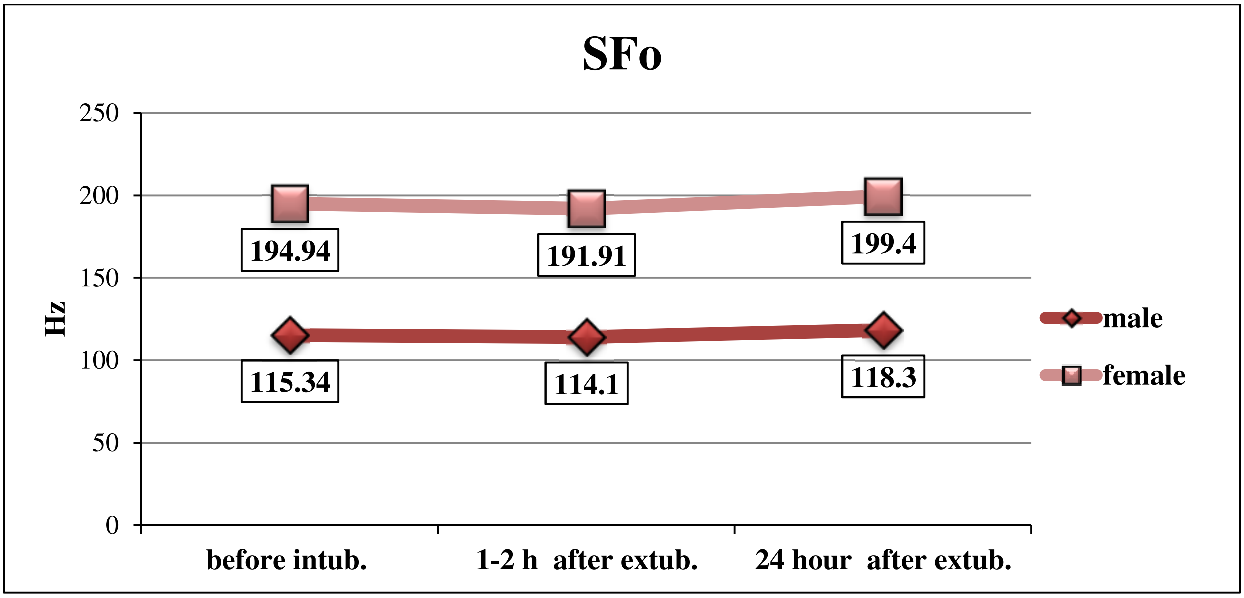

Figure 3. The difference of the mean values of SFo before and after extubation

A statistically significant moderate reverse correlation was established between the intubation tube size and Fo (r=-0.608, P<0.001), the intubation tube size and SFo (r=-0.684, P<0.01) 1–2 hours after extubation (Table 10).

Table 10. The correlation coefficients of vocal acoustics and endotracheal intubation parameters 1–2 hours after extubation

Parameter	Duration of anesthesia, min	Cuff volume, cm^3	Cuff pressure, cmH_2O	Size of tube, mm
Fo, Hz	0.118	-0.185**	-0.074	-0.608**
RAP, %	-0.020	-0.119	-0.038	-0.321**
Shimmer, %	0.032	-0.008	-0.012	-0.134
NHR, dB	0.045	0.044	-0.057	0.099
VTI, dB	-0.197*	0.106	0.017	0.116
SFo, Hz	0.092	-0.227**	-0.038	-0.684**
SFo min, Hz	0.060	-0.161*	-0.018	-0.365**
SFo max, Hz	-0.082	0.003	0.006	-0.189**
SFo range, ST	-0.148*	0.115	0.018	0.086
MPT, s	-0.148*	0.106	0.026	0.303**

* p<0.05
** p<0.001

A weak reverse correlation was found between the intubation tube size and RAP, the intubation tube size and SFo min. The rest of the correlations are illustrated in Table 10.

Table 11. The correlation coefficients of vocal acoustics and endotracheal intubation parameters 24 hours after extubation

Parameter	Duration of anesthesia, min	Cuff volume, cm^3	Cuff pressure, cmH_2O	Size of tube, mm
Fo, Hz	0.037	-0.206**	-0.067	-0.651**
RAP, %	-0.001	-0.148*	-0.070	-0.393**
Shimmer, %	0.001	0.001	0.007	-0.181*
NHR, dB	0.032	0.145*	0.111	0.051
VTI, dB	-0.020	0.006	0.094	0.102
SFo, Hz	0.077	-0.231**	-0.067	-0.710**
SFo min, Hz	0.136	-0.170*	0.011	-0.591**
SFo max, Hz	0.052	-0.090	-0.045	-0.198**
SFo range, ST	0.001	0.062	-0.045	0.207**
MPT, s	-0.055	0.162	0.100	0.332**

* p<0.05
** p<0.001

24 hours after extubation, a significantly strong reverse correlation was found between the intubation tube size and SFo 1−2 hours after extubation (r=-0.710, P<0.01), while a moderate reverse correlation between the intubation tube size and Fo (r=-0.710, P<0.01) was discovered, as well as between the intubation tube size and SFo min (r=-0.591, P<0.01) (Table 11). The rest of the correlations are illustrated in Table 11.

A statistically significant relationship between vocal acoustic parameters and anesthesia parameters (the duration of anesthesia, the cuff volume and cuff pressure) was found (Table 12).

Table 12. The correlation between acoustic parameters 1−2 hours after extubation and parameters of intubation

Parameter	Parameter	Determination coeficient, R^2	Regression coeficient, b	P
Fo, Hz	Cuff volume	0.06	-6.73	0.004
SFo, Hz	Cuff volume	0.07	-4.81	0.001
SFo min, Hz	Cuff volume	0.04	-2.44	0.011
MPT, s	Duration of anesthesia	0.03	-0.02	0.040

A statistically significant relationship between Fo, SFo, SFo min and the cuff volume was revealed: for every 1 cm^3 increase in a cuff volume, a Fo decrease by 6.73 Hz, SFo decrease by 4.81 Hz and SFo min – by 2.44 Hz is predicted, holding all other variables constant (Table 12). A statistically significant relationship between MPT and the duration of the anesthesia was found: for every 1 min increase of anesthesia duration, the MPT shortening by 0.02 s is predicted. A day after extubation, no correlation was discovered between the acoustic parameters and the duration of anesthesia, cuff volume, and cuff pressure.

Vocal fold morphology

4 types of vocal fold lesions were found in the early postextubation period: vocal fold haematoma (Figure 4), the thickening of the vocal fold margin (Figure 5), vocal fold oedema (Figure 6), vocal fold vascular injection or injection with dilatation (Figure 7). No other laryngeal lesions following extubation were found.

195 (95.5 %) patients' vocal fold margin was smooth before the surgery, and 9 (4.5 %) had an irregular margin of the fold. 17 (8.5 %) patients had some vocal fold lesions 1−2 hours after extubation: the vocal fold margin was irregular for 12 (6.0 %) patients and 5 (2.5 %) had vocal fold oedema. 24 hours after extubation 15 (7.5 %) patients had these vocal fold lesions: 13 (6.5 %) patients had irregular vocal fold margin and 2 (1.0 %) – vocal fold oedema. 107 (53.2 %) patients had normal vocal fold vessels, vascular injection was seen in 68 patients (33.8 %) and vascular injection with dilatation – in 47 (23.4 %) patients. 24 hours after extubation, 78 (38.8 %) patients had vocal fold vascular injection and 46 (22.9 %) had vascular injection with dilatation.

Fig. 4 Haematoma of the left vocal fold

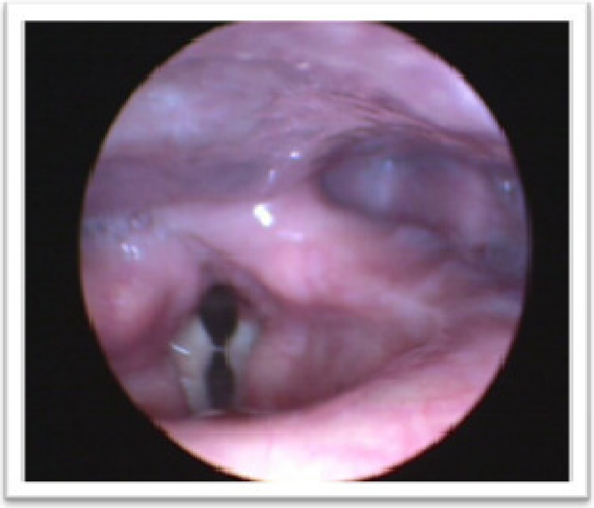

Fig. 5 The thickening of the vocal fold margins

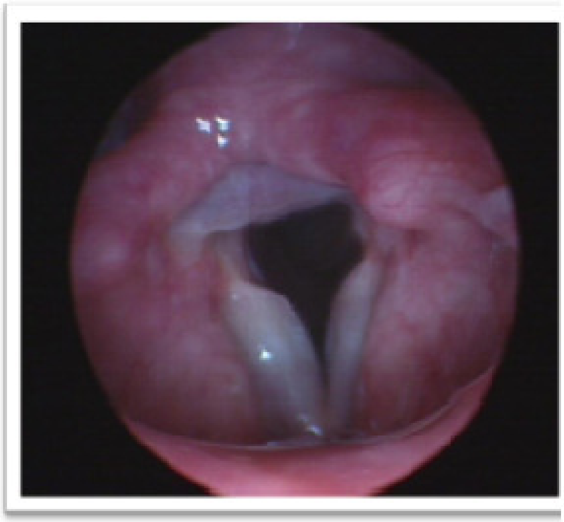

Fig. 6 Vocal fold oedema

Fig. 7 Vocal fold vascular injection with dilatation

After analyzing the changes in the vocal fold and its margin after extubation, it was found that the biggest morphological change (lesion) during early postextubation period was vocal fold mucosal vascular injection with dilatation, whereas the other lesions (thickening of the margin or oedema) were rarer. It was revealed that all day after extubation, vocal fold vascular injection with dilatation was significantly (1.8 times) more frequent than before surgery; and vocal fold oedema was significantly more frequent just 1–2 hours after extubation ($P<0.01$). Vocal fold haematoma was observed in 3.5 % of all participants: 4 patients had it on the left vocal fold, 2 – on the right and 1–

on both sides. Regarding in vocal fold lesions 1−2 hours and 24 hours after extubation, there was no difference between men and women (P>0.05), which is why the acoustic data of all patients were analyzed. After comparing the acoustic parameters according to the findings related to the vocal folds before intubation and 1−2 hours after extubation, no significant differences between the vocal parameters and vocal fold lesions were found.

Comparing acoustic parameters according to vocal fold marginal lesions 24 hours after extubation, it was found that mean NHR was significantly greater by 0.03 dB in patients with an irregular vocal fold margin; and mean MPT – shorter by 4.13 s than in the smooth vocal fold margin group (P<0,05). Female vocal fold vascular injection with dilatation 1−2 hours after extubation was significantly related to 12.4 Hz lower Fo compared to men who had no vascular injection.

When comparing acoustic parameters by vocal fold vascular lesions 1−2 hours after extubation, it was found that the mean VTI was higher by 0.02 dB in females with vocal fold vascular injection with dilatation than in women who had vocal fold vascular injection alone or normal vocal fold vessels; the mean SFo min was 36.15 Hz lower in females with vocal fold vascular injection with dilatation compared to women with normal vocal fold vessels.

Comparing acoustic parameters by vocal fold vascular lesions 24 hours after extubation, it was revealed that the male mean SFo was significantly by 6.28 Hz lower in men who had vocal fold vascular injection with dilatation compared to those with vocal fold vascular injection. No statistically significant difference between the acoustic parameters 24 hours after extubation and vascular changes in the vocal fold was found. The means of anesthesia parameters according to vocal fold vascular changes can be found in Table 13.

The mean diameter of tube used for patients, who had no vascular injection 1−2 hours after extubation, was less wide by 0.24 mm than participants who had vocal fold vascular injection 1−2 hours after extubation; and less wide by 0.29 mm compared to those who had vocal fold vascular injection with dilatation 1−2 hours after extubation.

Table 13. A comparison of anesthesia parameters and vocal fold vascular changes after extubation

Parameter	Without vascular injection	With vascular injection	With vascular injection and dilatation
1-2 hours after extubation			
No. of intubation tube, mm	$7.57 \pm 0.50^{a,b}$	7.81 ± 0.37^{a}	7.86 ± 0.36^{b}
Cuff volume, cm³	7.25 ± 1.93	7.90 ± 2.15	7.82 ± 2.20
Cuff pressure, cmH_2O	33.39 ± 9.28	32.09 ± 10.32	32.98 ± 7.71
Duration of anesthesia, min	61.84 ± 29.22^{a}	79.00 ± 46.95^{a}	74.89 ± 43.92
24 hours after extubation			
No. of intubation tube, mm	$7.55 \pm 0.47^{a,b}$	7.87 ± 0.36^{a}	7.78 ± 0.42^{b}
Cuff volume, cm³	7.25 ± 1.97	7.86 ± 2.11	7.85 ± 2.21
Cuff pressure, cmH_2O	33.23 ± 9.10	31.05 ± 9.08^{c}	35.09 ± 9.76^{c}
Duration of anesthesia, min	$62.47 \pm 30.82^{a,b}$	76.09 ± 43.15^{a}	77.93 ± 48.31^{b}

a – P<0.05 comparing group without vascular injection and on group with it
b – P<0.05 comparing group without vascular injection and group with vascular injection and dilatation
c – P<0.05 comparing group with vascular injection and group with vascular injection and dilatation

The mean duration of anesthesia was by 17.17 minutes longer in patients who had vocal fold injection 1−2 hours after extubation than in patients who had no vascular lesion. The mean diameter of tube used for participants, who had no vascular injection 24 hours after extubation, was by 0.31 mm narrower and the mean duration of anesthesia was by 13.62 minutes shorter compared to patients, who had vascular injection 24 hours after extubation. The mean diameter of tube used for participants with no vascular injection 24 hours after extubation was by 0.23 mm narrower and the mean duration of anesthesia was by 15.47 minutes shorter than for patients who had vascular injection with dilatation a day after extubation (Table 13).

No correlation was found between vocal fold marginal lesions 1−2 hours and 24 hours after extubation and the parameters of endotracheal anesthesia. It was found that 1−2 hours after extubation, the possibility of vocal fold marginal lesions was significantly lower for patients who had smooth vocal fold margin before the surgery (P=0.039). A statistically significant correlation was found between vocal fold vascular changes 1−2 hours after extubation and the duration of the anesthesia (P=0.012), and vocal fold vascular lesions before the surgery (P=0.003). 1−2 hours after extubation the possibility of vocal fold vascular lesions was significantly greater for those patients whose duration of anesthesia was longer; and lower for patients who had no vascular injection until the operation. A statistically significant correlation was found between vocal fold vascular lesions 24 hours after extubation and the duration of the anesthesia (P=0.015), the number of intubation attempts (P=0.04) and vascular lesions before intubation (P<0.0001). 24 hours after extubation the possibility of vocal fold vascular lesions was significantly greater for patients with a shorter duration of anesthesia, who were not intubated at the first attempt; and lower for patients who had no vascular injection prior to the surgery.

Videostroboscopy

The study showed that 1−2 and 24 hours after extubation, the rate of stroboscopic vocal folds findings changed compared to the rate before intubation: irregular, asymmetric vocal fold mucosal wave, incomplete closure of the vocal gap and vocal gap constriction was observed significantly more frequently. Vocal fold mucosal wave was observed in all patients before intubation, 1 patient (0.5 %) had no mucosal wave 1−2 hours after extubation, however, it recovered 24 hours after extubation.

182 (90.5 %) patients had symmetrical amplitude of the right and left vocal folds before intubation, in 19 (9.5 %) cases it was asymmetrical. 1−2 hours after extubation, the asymmetrical amplitude of the vocal folds was observed 1.2 times more often than before surgery, and 24 hours after extubation – 1.1 times more often – respectively for 23 and 21 patients (11.4 % and 10.4 %), however, these changes were not statistically significant (P>0.05).

107 (87.1 %) patients had a regular vocal fold mucosal wave before the surgery, in 26 (12.9 %) of cases it was irregular. During early postoperative period, an irregular vocal fold mucosal wave was observed 3.63 times more – for 94 (46.8 %) patients (P<0.0001). A day after extubation, irregular vocal fold mucosal wave was observed 1.8 times rarer compared to 1−2 hours after extubation – for 52 (25.9 %) patients (P<0.0001), however, significantly more frequent than before intubation (P<0.0001).

In 183 (91.0 %) cases the vocal fold mucosal wave was symmetrical before the surgery and in 18 cases (9.0 %) it was asymmetrical. 1−2 hours after extubation, twice as many patients, 36 (17.9 %), had an asymmetrical vocal fold mucosal wave (P<0.0001).

24 hours after extubation an asymmetrical vocal fold mucosal wave was observed in 24 (11.9 %) of cases.

The vocal gap was closed for 154 (76.6 %) patients before the surgery, in 47 (23.4 %) of all cases the closure of the vocal gap was incomplete: most often, in 26 from 47 cases (55.3 %) this incomplete closure was observed in the posterior third, in 16 (34.0 %) cases "distaff" shape vocal gap was observed, on 2 occasions (4.26 %) the vocal gap was open though the whole length, twice (4.26 %) it was in shape of sandglass, and in 1 case (2.12 %) – incomplete closure was seen in the anterior third. During stroboscopy 1–2 hours after extubation, the incomplete closure of the vocal gap was diagnosed significantly more often (3.04 times) than before the surgery – in 143 (71.1 %) patients (P<0.0001). 74 (51.75 %) of them had incomplete closure of the posterior third of the vocal gap, 54 times (37.76 %) a "distaff" shape vocal gap was seen, in 6 (4.20 %) cases the vocal gap did not close through all the length, in 6 (4.20 %) cases – incomplete closure was observed in the posterior and middle thirds, in 2 patients (1.4 %) the vocal gap was in the shape of a sandglass and in 1 case (0.7 %) – the anterior third of the vocal gap did not close completely. 24 hours after extubation, stroboscopy revealed that incomplete closure of the vocal gap was significantly rarer (1.6 times) than 1–2 hours after extubation – in 89 patients (44.3 %) (P<0.0001). Vocal gap changes and the shape of incomplete closure before intubation and after extubation are represented in Figure 8.

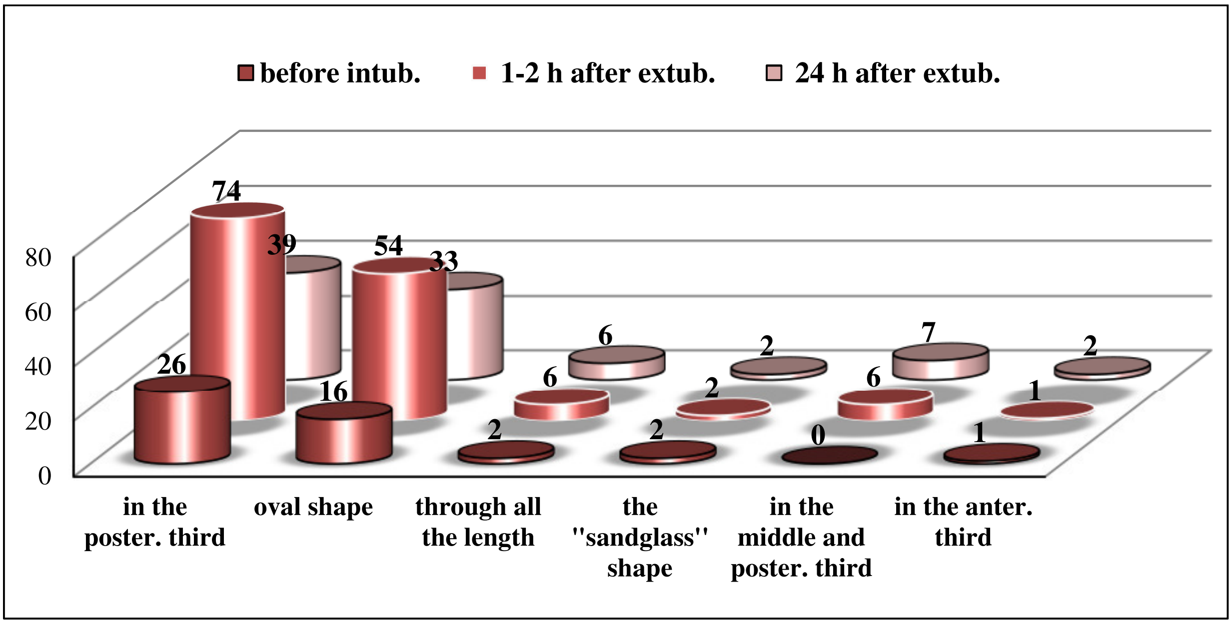

Fig. 8 The incomplete closure of the vocal gap before and after extubation

The patients’ distribution to the groups according to the constriction of the vocal gap changed significantly 1–2 hours after extubation compared to the distribution before intubation (P=0.011), as well as the distribution 24 hours after extubation compared to the distribution 1–2 hours after extubation (P<0.0001).

In 65 cases (32.3 %) vocal gap constriction was not observed, 67 times (33.3 %) it was light, 35 times (17.4 %) – moderate, in 34 cases (16.9 %) there was severe constriction of the vocal gap. 1–2 hours after extubation 48 patients (23.9 %) had no vocal gap constriction, in 75 cases (37.3 %) it was light, 42 times (20.9 %) it was moderate and 36 times (17.9 %) there was severe constriction of the vocal gap. 24 hours after extubation the constriction of the vocal folds was observed as light in 76 cases (37.8 %), moderate – in 41 (20.4 %) and severe for 25 patients (12.4 %). Figure 9 represents the rate and severity of vocal gap constriction before intubation and after extubation.

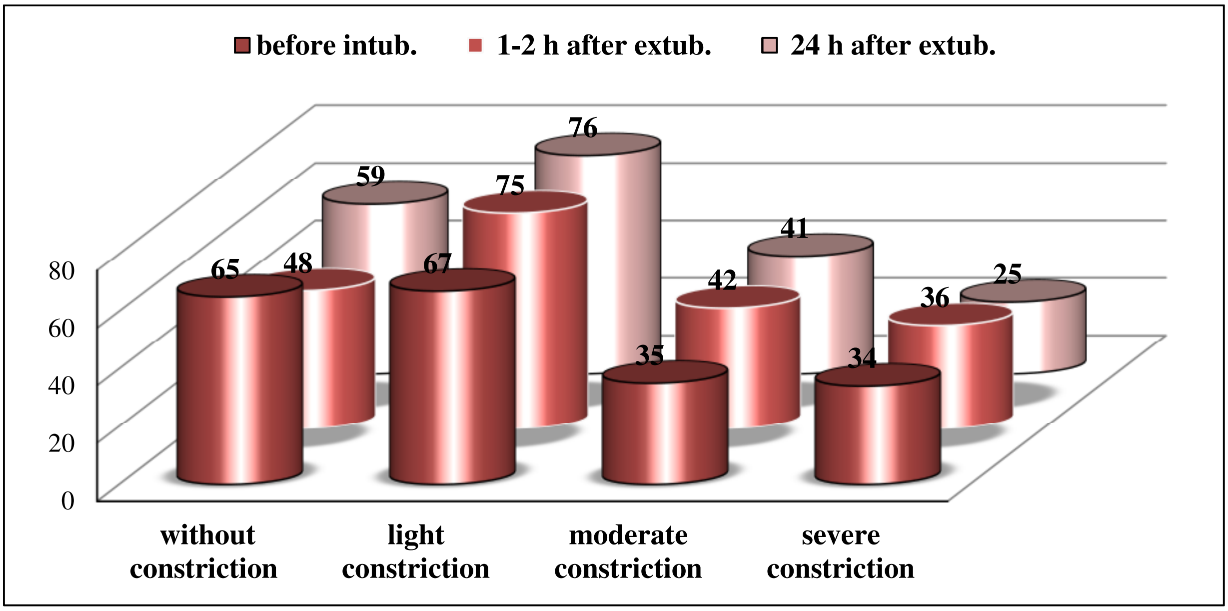

Fig. 9 Vocal gap constriction before intubation and after extubation

After dividing patients according to their vocal fold amplitude and the regularity of vocal fold mucosal wave and symmetry, the acoustic parameters were compared between them. The acoustic parameters of all patients were compared 1–2 hours and 24 hours after extubation and the asymmetrical amplitude of the vocal folds, irregular or asymmetrical vocal fold mucosal waves were equally frequent in male and female groups (P>0.05). The acoustic parameters after extubation did not differ significantly between patients with asymmetrical vocal fold amplitude and those with symmetrical vocal fold amplitude. Fo 1−2 hours after extubation was significantly lower (22.47 Hz) when the vocal fold wave was irregular than when it was regular (P=0.013), whereas a day after, those differences disappeared. It was revealed that Fo 1−2 hours after extubation was significantly lower (22.78 Hz) for patients with an asymmetrical vocal fold mucosal wave compared to those with a symmetrical one; other acoustic parameters did not differ.

No significant difference in the rate of incomplete gap closure in male and female groups was found. 1−2 hours after extubation, incomplete closure of the vocal gap was observed significantly more often in women (P<0.0001): the vocal gap did not close completely in 93.1 % of women and 62.2 % of men. A day after extubation, incomplete vocal fold closure was seen in 70.1 % of women and 33.6 % of men; therefore, the acoustic parameters under the incomplete closure in male and female groups were analyzed separately.

RAP was significantly greater (0.35 %) and shimmer 1.83 % greater when comparing males showing incomplete closure of the vocal gap 1−2 hours after extubation with those males with normal gap closure. Comparing females with complete and incomplete vocal gap closure, no significant differences of acoustic parameters were seen 1−2 hours after extubation.

The acoustic parameters 24 hours after extubation did not differ significantly when comparing the male group with complete vocal gap closure and those with incomplete closure of the vocal gap. A day after extubation, RAP was significantly greater (0.56 %) and shimmer − 1.38 % greater in the female group with incomplete vocal gap closure compared to the group with normal closure (P<0,05).

The acoustic parameters were also compared after grouping them by vocal gap constriction. When gap constriction was light, the irregularity of the amplitude 1−2 hours after extubation was significantly greater than when it was moderate, though less compared to severe constriction; NHR was also lower compared to severe vocal gap constriction (P<0.05). A day after the extubation, shimmer was equal between the group with light constriction and the group of absent constriction, and was significantly lower comparing to the group of moderate constriction (P<0.05). In contrast, RAP 24 hours after extubation was significantly lower in the group with no constriction compared to those with moderate constriction; and Fo was lower than for patients with light vocal gap constriction (P<0.05).

The analysis of the videostroboscopic data and acoustic parameters revealed that when the mucosal wave was irregular and asymmetric 1–2 hours after extubation, the most frequent changes were seen in Fo, which shows the direct importance of the vocal fold mucosal wave vibration characteristics on the formation of the voice, that is, of the Fo. Meanwhile, given the vocal gap pressure after extubation, most of the changes are seen in the vocal perturbation parameters: the irregularity of the amplitude, RAP and NHR showing a direct connection between these acoustic parameters and the biomechanics of vocal gap closure; and MPT, reflecting disturbances during the early postoperation period, not only on laryngeal structures, but also on possible extralaryngeal ones.

The parameters of anesthesia were also compared between the patient group with vocal fold lesions seen on stroboscopy and those with no injuries. In order to estimate the influence of the anesthesia on the stroboscopic findings, information about patients, in whom no stroboscopic finding was seen was analyzed. The parameters of anesthesia for 182 patients with symmetrical vocal fold amplitude before intubation and 175 patients with a regular mucosal wave before intubation were analyzed. No statistically significant difference was seen analyzing the mean duration of the anesthesia, the mean size of intubation tube, the mean cuff volume and the cuff pressure between patients who represented symmetrical and asymmetrical vocal fold amplitude, and regular and irregular vocal fold mucosal wave. The anesthesia parameters of 183 patients whose vocal fold mucosa wave before the intubation was symmetrical were analyzed. Patients whose asymmetrical vocal fold mucosal wave was diagnosed 1–2 hours after extubation, were intubed with 0.27 mm wider intubation tube compared to patients in whom a symmetrical vocal fold mucosal wave was observed. The mean duration of the anesthesia, the mean intubation tube size, and the mean cuff volume and cuff pressure did not differ significantly among patients who had a symmetrical and asymmetrical vocal fold mucosal wave 24 hours after extubation. Since the rate of incomplete vocal gap closure in male and female groups differed significantly, the parameters of the anesthesia under vocal gap closure in male and female groups were analyzed separately. The parameters of the anesthesia 1−2 and 24 hours after extubation did not differ when compared males and females whose vocal gap was closed or closed incompletely.

Table 14. The correlation between the parameters of anesthesia and vocal gap constriction

Parameter	Vocal gap constriction			
	Absent	**Light**	**Moderate**	**Severe**
1-2 h after extubation				
No of tube, mm	7.74 ±0 .47	7.77 ± 0.43	7.71 ± 0.37	7.64 ± 0.49
Cuff volume, cm³	7.53 ± 2.31	7.54 ± 2.15	8.13 ± 1.97	7.33 ± 1.76
Cuff pressure, cmH_2O	32.58 ± 9.01	31.33 ± 7.19 [a]	35.52 ± 11.07 [a]	33.03 ± 11.04
Anesthesia, min	70.1 ± 28.56	74.93 ± 47.93[a]	58.57 ± 30.87[a,b]	80.14 ± 45.46[b]
24 h after extubation				
No of intub. tube, mm	7.81 ± 0.40[c]	7.68 ± 0.45	7.79 ± 0.40[b]	7.56 ± 0.49[b,c]
Cuff volume, cm³	7.78 ± 2.51	7.39 ± 1.84	7.99 ± 2.14	7.36 ± 1.57
Cuff pressure, cmH_2O	31.86 ± 8.64	32.51 ± 7.45	33.83 ± 11.76	34.28 ± 11.59
Anesthesia, min	71.19 ± 35.55	71.78 ± 44.43	71.59 ± 44.59	69.6 ± 35.03

a - $P<0.05$ comparing groups with light and moderate constriction
b - $P<0.05$ comparing groups with moderate and severe vocal gap constriction
c - $P<0.05$ comparing groups without and with severe vocal gap constriction

The mean duration of the anesthesia was significantly shorter by 16.36 minutes in patients with moderate vocal gap constriction 1−2 hours after extubation than in patients with light vocal gap constriction, and by 21.57 minutes shorter than in patients who had severe vocal gap constriction 1−2 hours after extubation (Table14). However, the cuff pressure was 4.19 cmH_2O bigger when compared patients with moderate vocal gap constriction 1−2 hours after extubation with those having light constriction. The mean duration of the anesthesia, the mean cuff volume and cuff pressure did not differ among patients who were diagnosed with different constriction of vocal gap 24 hours after extubation, though patients with no vocal gap constriction and moderate constriction were intubated with bigger intubation tubes (0.25 cm and 0.23 cm respectively) compared to patients who were diagnosed with severe vocal gap constriction (Table 14).

When analyzing the relation between incomplete vocal gap closure and constriction after extubation and the parameters of endotracheal intubation, it was found that incomplete vocal gap closure 1−2 hours after extubation significantly depended on the cuff pressure and the experience of anesthesiologist (Table 15). If the cuff pressure was bigger by 1 cmH_2O, the odds ratio of incomplete closure of the vocal gap lessened 1.04 times. When intubation is performed by a resident−doctor, the odds ratio of incomplete closure of the vocal gap 1−2 hours after extubation increased 3.45 times. The incomplete closure of the male vocal gap 24 hours after extubation did not depend significantly on the parameters of anesthesia.

Table 15. The correlation between the symptoms of male vocal gap injury and parameters of endotracheal anesthesia

Stroboscopic finding	Regression coefficient	Regression coefficient CI	P
Incomplete vocal gap closure 24 hours after extubation			
Cuff pressure	0.96	0.92 – 1.00	0.049
Resident−doctor	3.45	1.32 – 9.00	0.012
Vocal gap constriction 1-2 hours after extubation			
Duration of anesthesia	1.01	1.00 – 1.03	0.050
Vocal gap constriction before intubation	78.30	21.79 – 281.35	<0.0001
Vocal gap constriction 24 hours after extubation			
Duration of anesthesia	1.01	1.00 – 1.02	0.088
Vocal gap constriction before intubation	38.10	13.37 – 108.60	<0.0001

Vocal gap constriction 1−2 hours after extubation was significantly dependent on vocal fold constriction before intubation and the duration of the anesthesia. The odds ratio of vocal gap constriction was 78.3 times greater 1−2 hours after extubation and 38.1 times greater 24 hours after extubation when comparing men with vocal gap constriction before intubation to those who had no constriction before the surgery. When the duration of anesthesia was lengthened by 1 minute, the odds ratio of vocal gap constriction increased 1.01 times (Table 15). No statistically significant correlation was found between the parameters of anesthesia and the incomplete closure of female vocal gap 1−2 and 24 hours after extubation. The analysis revealed that female vocal gap constriction 1−2 and 24 hours after extubation did not depend on the parameters of the anesthesia; however, it correlated significantly to vocal gap constriction before the intubation (b=19, P=0.01 and b=48.75, P=0.01 respectively).

CONCLUSION

1. Short−term endotracheal intubation is an invasive procedure, thus having a significant effect on laryngeal morphology and function. The main parameters of endotracheal anesthesia which cause morphological and functional laryngeal changes are the size of the intubation tube, the cuff volume and the duration of anesthesia.
2. Pharyngolaryngeal symptoms: hoarseness, a throat clearing sensation, globus pharyngeus and throat pain troubles from 50 to 80 % of patients 1−2 hours after extubation. Even 24 hours after extubation, pharyngolaryngeal symptoms remain an important cause of discomfort for more than 40 % of patients.
3. Primary morphological laryngeal lesions following extubation (vocal fold vascular injection with dilatation, haematoma, oedema or the thickening of the vocal fold mucosa) has significant influence on the main acoustic voice parameters. Prolonged duration of anesthesia and a greater number of intubation attempts are related to the greater likelihood of vascular lesions of the vocal folds.
4. During early postextubation period, the vocal fold vibration amplitude and frequency changes the most: RAP, shimmer, and NHR increase, while MPT decreases. SFo remains significantly changed for both males and females 24 hours after extubation.
5. Short−term intubation influences the vibratory characteristics of the vocal fold mucosa and disturbs the biomechanics of the vocal gap closure: an irregular, asymmetric vocal fold mucosal wave, the incomplete closure of the vocal gap and vocal gap constriction were observed 1−2 and 24 hours after extubation.

GERKLŲ MORFOLOGINIŲ IR FUNKCINIŲ POKYČIŲ SĄSAJOS SU TRUMPALAIKĖS ENDOTRACHĖJINĖS INTUBACIJOS PARAMETRAIS

Šiuolaikinė endotrachėjinė nejautra yra santykinai saugi intervencija, tačiau jos poveikis gerklų morfologijai ir funkcijai tebėra reikšmingas. Pointubacinės komplikacijos dažniausiai yra grįžtamos, tačiau riboja pacientų gyvenimo kokybę. Ilgalaikis ar net pastovus užkimimas būdingas 1 proc. visų intubaciją patyrusių pacientų. Apsunkinta intubacija sudaro tik daugiau nei trečdalį visų komplikuotų atvejų, taigi, dauguma pažeidimų atsiranda įprastų kasdienių procedūrų metu ar po jų, o ilgalaikio užkimimo dažnis po ekstubacijos rodo pointubacinių komplikacijų problemos aktualumą. Gerklų morfologinių ir funkcinių pokyčių tyrimas suteikia vertingą galimybę pažinti gerklų funkcionavimo principus po intervencijos, pagerinti diagnostikos kokybę ir poekstubacinių komplikacijų prevenciją.

Tai pirmoji prospektyvinė studija, išsamiai įvertinusi trumpalaikės endotrachėjinės intubacijos ir gerklų morfologinių bei funkcinių pokyčių po ekstubacijos sąsajas tiek ankstyvuoju poekstubaciniu laikotarpiu (praėjus 1−2 val. po ekstubacijos), tiek ir po paros. Šiame moksliniame darbe nustatyti svarbiausi endotrachėjinės nejautros parametrai, sukeliantys pointubacinius gerklų pokyčius, įvertinti pirminiai morfologiniai gerklų pažeidimai ir stroboskopiniai radiniai, atsirandantys iškart po ekstubacijos ir jų pokyčiai po paros, nustatytas pažeidimų ryšys su pagrindiniais balso akustiniais parametrais.

Darbo tikslas: pastebėti ir įvertinti pirminius gerklų funkcinius ir morfologinius pokyčius po trumpalaikės endotrachėjinės intubacijos pacientams, neturėjusiems gerklų patologijos prieš intubaciją, ir nustatyti šių pakitimų sąsajas su intubacijos parametrais ir gydytojo anesteziologo patirtimi.

Darbo uždaviniai:

1. Pastebėti ir įvertinti balso ir gerklės simptomus po ekstubacijos ir nustatyti šių pakitimų priklausomybę nuo intubacinio vamzdelio parametrų, intubacijos bandymų skaičiaus, trukmės ir gydytojo anesteziologo patirties.

2. Nustatyti pagrindinių balso akustinių ir aerodinaminių rodiklių pokyčius po ekstubacijos ir įvertinti jų ryšį su endotrachėjinės anestezijos parametrais ir gydytojo anesteziologo patirtimi.
3. Įvertinti gerklų morfologinius pokyčius po trumpalaikės endotrachėjinės intubacijos ir nustatyti šių pakitimų priklausomybę nuo intubacinio vamzdelio parametrų, intubacijos bandymų skaičiaus ir trukmės bei gydytojo anesteziologo patirties.
4. Įvertinti balso klosčių stroboskopinius radinius ankstyvuoju poekstubaciniu laikotarpiu ir nustatyti šių radinių sąsajas su intubacinio vamzdelio parametrais, intubacijos bandymų skaičiumi, trukme ir gydytojo anesteziologo patirtimi.
5. Įvertinti ir nustatyti balso akustinių parametrų ryšį su gerklų morfologiniais radiniais po ekstubacijos.

Darbo metodika

Mokslinis darbas atliktas 2009–2012 metais Vilniaus universiteto ligoninės Santariškių klinikų Ausų, nosies, gerklės ligų centre. Į šį prospektyvinį tyrimą įtraukti 222 pacientai, kurie buvo operuoti dėl nosies ar ausies patologijos taikant planinę bendrą intubacinę nejautrą. Tiriamieji buvo pasirinkti atsitiktinai, einantys iš eilės, atitinkantys pasirinktus įtraukimo kriterijus ir sutikę dalyvauti tyrime. Analizuoti 201 suaugusio paciento duomenys. Visi pacientai buvo ištirti 3 kartus: operacijos dieną prieš intubaciją, praėjus 1–2 val. ir 24 val. po intubacinio vamzdelio pašalinimo. Buvo įvertinti balso ir gerklės simptomai bei anamnezės duomenys, galintys turėti įtakos gerklų morfologijai ir funkcijai. Atlikta akustinė balso ir kalbos analizė, balso aerodinaminis ištyrimas. Atlikta videolaringoskopija ir videostroboskopija, nustatyti morfologiniai ir funkciniai gerklų pažeidimai. Vertinti endotrachėjinės nejautros parametrai: intubacijos trukmė, bandymų skaičius, intubacinio vamzdelio dydis, manžetės tūris, slėgis, anesteziologo patirtis.

Statistinis duomenų įvertinimas

Statistinė analizė atlikta statistikos programų paketu SPSS 19 versija. Nurodyti nominaliųjų ir ranginių kintamųjų dažniai ir santykiniai dažniai procentais, o intervalinių kintamųjų – vidurkiai ir standartiniai nuokrypiai, vidurkio 95 proc. pasikliautinieji intervalai (PI), mažiausios ir didžiausios reikšmės. Nominaliųjų ir ranginių kintamųjų nepriklausomumui tikrinti taikytas chi kvadratu *(χ^2)* kriterijus, o jeigu stebėjimų dažnis buvo mažas, taikytas Fišerio (*Fisher)* tikslusis kriterijus. Intervalinių kintamųjų pasiskirstymo normališkumui įvertinti taikytas Šapiro–Vilko (*Shapiro–Wilk*) testas. Dviejų nepriklausomų imčių intervalinių kintamųjų vidurkių skirtumai buvo palyginti naudojant Mano−Vitnio−Vilkoksono (*Mann–Whitney–Wilcoxon*) kriterijų, trijų ir daugiau nepriklausomų imčių – Kruskalo−Voliso (*Kruskal–Wallis*) kriterijų.

Blokuotiems duomenims analizuoti taikyta blokuotųjų duomenų dispersinė analizė, o jeigu duomenų pasiskirstymas neatitiko normaliojo skirstinio, taikytas Frydmano (*Friedman*) kriterijus. Daugkartiniams lyginimams naudotas aposteriorinis Fišerio (Fisher) mažiausiai reikšmingo skirtumo (*LSD*) kriterijus. Porinių stebėjimų požymio dažnio skirtumams įvertinti naudotas Maknemaro (*McNemar*) kriterijus.

Ryšiams tarp intervalinių bei ranginių kintamųjų nustatyti apskaičiuotas Spirmeno (*Spearman*) koreliacijos koeficientas (*r*). Siekiant įvertinti nepriklausomų veiksnių įtaką priklausomam kintamajam taikyta regresinė analizė: daugybinė regresija, jei priklausomas kintamasis intervalinis ir daugybinė logistinė regresija, jei priklausomas kintamasis nominalusis. Tikrinant statistines hipotezes, buvo pasirinktas reikšmingumo lygmuo 0,05.

TYRIMO REZULTATAI

Ištirti 201 suaugę asmenys: 143 vyrai ir 58 moterys nuo 18 iki 77 metų. 94 pacientai (46,8 proc.) buvo operuoti dėl ausies ir 107 (53,2 proc.) – dėl nosies patologijos. Vyrai 1,5 karto dažniau buvo operuoti dėl nosies, o moterys – 1,4 karto dažniau operuotos dėl ausies patologijos (p=0,002). Vertinant anamnezės duomenis, nustatyta, kad vyrai 2,15 karto dažniau nei moterys rūkė (p=0,008), 1,43 karto dažniau skundėsi apsunkintu kvėpavimu per nosį (p=0,009), o moterys 3,84 karto dažniau sirgo laringitu (p=0,007).

Faringolaringiniai simptomai

Po ekstubacijos tiek praėjus 1–2 val., tiek ir po 24 val. visi tirti faringolaringiniai simptomai pacientus vargino dažniau palyginti su simptomų dažniu prieš intubaciją (p<0,001). Ankstyvuoju poekstubaciniu periodu tiriamieji dažniausiai skundėsi užkimimu (82 proc.), noru atsikrenkšti (64,2 proc.), „kąsnio“ pojūčiu gerklėje (51,2 proc.) ir gerklės skausmu (50,7 proc.). Po paros šių simptomų dažnis sumažėjo, tačiau užkimimas, noras atsikrenkšti ir gerklės skausmas tebevargino daugiau nei 40 proc. tirtų asmenų. Tarp lyčių skyrėsi tik gerklės skausmo dažnis praėjus 1−2 val. po ekstubacijos, moterims jis buvo 1,4 karto dažnesnis nei vyrams (p=0,018). Rasta, kad įvairūs faringolaringiniai simptomai po ekstubacijos priklauso nuo intubacijos parametrų (intubacinio vamzdelio diametro, manžetės tūrio, anestezijos trukmės), rūkymo, apsunkinto kvėpavimo per nosį, viršutinių kvėpavimo takų susirgimų ir kūno masės indekso.

Balso akustika

Ankstyvuoju poekstubaciniu periodu labiausiai pakito akustiniai rodikliai, nusakantys balso kokybę, arba objektyvūs (dažnio ir amplitudės) perturbacijos parametrai: santykinis pagrindinio tono neperiodiškumo vidurkis ir amplitudės nereguliarumas. Vyrų ir moterų akustinių rodiklių skirtumo tendencija prieš operaciją ir abiem poekstubaciais laikotarpiais buvo tokia pati ir nepriklausė nuo lyties. Nors po paros šie akustiniai balso parametrai atsistatė, tačiau pagrindinis kalbamosios kalbos tonas tiek vyrams, tiek moterims išliko pakitęs (p<0,05). Praėjus 24 valandoms po ekstubacijos nustatyta stipri atvirkštinė koreliacija tarp intubacinio vamzdelio numerio ir pagrindinio kalbamosios kalbos tono (r=-0,710, p<0,01), vidutinio stiprumo atvirkštinė koreliacija tarp intubacinio vamzdelio numerio ir pagrindinio balso tono tiek po 1−2 val. tiek ir po paros (r=-0,608 ir r=-0,651, p<0,001). Praėjus 1−2 val. po ekstubacijos nustatyta pagrindinio balso tono (p=0,004), pagrindinio ir žemiausio kalbamosios kalbos tonų priklausomybė nuo manžetės tūrio (p=0,001 ir p=0,011), maksimalaus fonacijos laiko priklausomybė nuo anestezijos trukmės (p=0,040). Po paros akustinių rodiklių priklausomybės nuo anestezijos parametrų nerasta.

Balso klosčių morfologija

Ankstyvuoju poekstubaciniu laikotarpiu rasti keturi balso klosčių pažeidimų tipai: balso klostės hematoma (3,5 proc.) balso klostės krašto nelygumas (sustorėjimas) (6 proc.), balso klosčių edema (2,5 proc.), balso klosčių kraujagyslių injekcija (37,3 proc.) ir injekcija su dilatacija (23,4 proc.). Nustatyta, kad visą parą po ekstubacijos balso klostės kraujagyslių injekcija su dilatacija buvo 1,8 karto dažnesnė nei prieš operaciją, o balso klostės krašto edema dažnesnė buvo praėjus 1−2 val. po operacijos (p<0,01). Rasta balso klosčių kraujagyslinių pažeidimų po ekstubacijos priklausomybė nuo anestezijos trukmės (p=0,012) ir balso klosčių kraujagyslinių pažeidimų buvimo prieš operaciją (p=0,003) tiek po 1−2 val. po ekstubacijos, tiek ir po paros (atitinkamai p=0,015 ir p<0,0001) bei balso klosčių kraujagyslinių pažeidimų po 24 val. po ekstubacijos priklausomybė nuo intubavimo bandymų skaičiaus (p=0,040).

Pirminiai morfologiniai gerklų pokyčiai po ekstubacijos reikšmingai keičia pagrindinius balso akustikos parametrus: vyrams, kuriems rasta kraujagyslių injekcija su dilatacija, pagrindinį kalbamosios kalbos toną praėjus 1−2 val. ir 24 val. po ekstubacijos, o moterims − žemiausią kalbamosios kalbos toną 1−2 val. po ekstubacijos (p<0,05).

Videostroboskopija

Praėjus 1–2 val., tiek ir 24 valandoms po ekstubacijos dažniau buvo stebima nereguliari, nesimetriška balso klosčių gleivinės banga, nepilnai užsidarantis balso plyšys, balso plyšio konstrikcija (p<0,05). 1−2 val. po ekstubacijos 1 pacientui (0,5 proc.) nestebėta gleivinės banga, tačiau būklė atsistatė po paros. Ankstyvuoju poekstubaciniu periodu nesimetriška balso klosčių gleivinės banga buvo stebima 2 kartus, o nereguliari − 3,63 karto dažniau (p<0,0001). Nepilnai uždaras balso plyšys nustatytas 3,04 karto, o balso plyšio konstrikcija − 1,13 karto dažniau negu iki intubacijos (p<0,0001 ir p=0,012). Dažniausiai po ekstubacijos buvo nepilnai užsidaręs užpakalinis balso plyšio trečdalis – 51,75 proc. ir „verpstės“ formos balso plyšys − 37,76 proc. tiriamųjų.

Labiausiai balso klosčių vibracinės savybės po ekstubacijos priklausė nuo intubacinio vamzdelio dydžio (p=0,013), balso plyšio konstrikcija siejosi su intubacijos trukme, intubacinio vamzdelio dydžiu ir manžetės slėgiu, o nepilnas balso plyšio užsidarymas – su manžetės slėgiu ir gydytojo anesteziologo patirtimi (p<0,05). Jeigu intubaciją atlieka gydytojas rezidentas, balso plyšio nesandarumo 1−2 val. po ekstubacijos galimybė padidėja 3,45 karto (p=0,012).

Videostroboskopinių duomenų ir akustinių parametrų analizė parodė, kad esant nereguliariai ir nesimetriškai balso klostės gleivinės bangai po ekstubacijos praėjus 1−2 val. pakinta pagrindinis balso tonas ($p<0,05$), rodantis tiesioginę balso klosčių gleivinės bangos vibracinių savybių svarbą balso, t.y. pagrindinio balso tono formavimuisi, o esant balso plyšio įtampai po ekstubacijos, labiausiai kinta balso perturbacijos parametrai: amplitudės nereguliarumas ir santykinis pagrindinio tono neperiodiškumo vidurkis, triukšmo−harmonikų santykis ($p<0,05$), kas rodo tiesioginį šių akustinių parametrų ryšį su balso plyšio užsidarymo biomechanika, o maksimalaus fonacijos laiko pokyčiai ($p<0,05$) − ne tik laringinių, bet ir galimai ekstralaringinių struktūrų trikdžius ankstyvuoju pooperaciniu laikotarpiu.

IŠVADOS

1. Trumpalaikė endotrachėjinė nejautra yra invazinė procedūra ir jos poveikis gerklų morfologijai bei funkcijai yra reikšmingas. Svarbiausi endotrachėjinės nejautros parametrai, sukeliantys gerklų morfologinius ir funkcinius pokyčius, yra intubacinio vamzdelio dydis, manžetės tūris ir anestezijos trukmė.
2. Faringolaringiniai simptomai: balso užkimimas, noras atsikrenkšti, „kąsnio“ pojūtis gerklėje, gerklės skausmas, vargina nuo 50 iki 80 proc. pacientų 1−2 val. po ekstubacijos. Net praėjus 24 val. po ekstubacijos, faringolaringiniai simptomai išlieka reikšminga diskomforto priežastimi daugiau nei 40 proc. pacientų.
3. Pirminiai morfologiniai gerklų pokyčiai po ekstubacijos (balso klosčių gleivinės kraujagyslių injekcija su dilatacija, hematoma, edema ir balso klosčių gleivinės nelygumas) statistiškai reikšmingai keičia pagrindinius balso akustikos parametrus. Ilgesnė anestezijos trukmė, didesnis intubavimo bandymų skaičius susiję su didesne balso klosčių pažeidimų galimybe.
4. Ankstyvuoju poekstubaciniu laikotarpiu labiausiai pakinta balso klosčių virpesių dažnio bei amplitudės parametrai: padidėja santykinis pagrindinio tono neperiodiškumo vidurkis, amplitudės nereguliarumas, triukšmo–harmonikų santykis ir sutrumpėja maksimali fonacijos trukmė. Pagrindinis kalbamosios kalbos tonas tiek vyrams, tiek moterims išlieka statistiškai reikšmingai pakitęs 24 val. po ekstubacijos.

5. Trumpalaikė intubacija keičia balso klosčių gleivinės vibracines savybes ir sutrikdo balso plyšio užsidarymo biomechaniką: tiek po 1–2 valandų, tiek praėjus parai po ekstubacijos stebima nereguliari, nesimetriška balso klosčių gleivinės banga, nepilnai užsidarantis balso plyšys ir balso plyšio konstrikcija.

PUBLICATIONS AND PRESENTATIONS

Publications

Paulauskienė I, Lesinskas E, Petrulionis M. Effect of short–time endotracheal intubation on morphological variations of vocal folds. Medicinos teorija ir praktika. 2012;18(2):223–228. Lithuanian.

Paulauskienė I, Lesinskas E. Laryngopharyngeal complaints following short-term endotracheal intubation: peculiarities of males and females. Acta Medica Lithuanica. 2012;19(2):51–57.

Paulauskiene I, Lesinskas E, Petrulionis M. The temporary effect of short-term endotracheal intubation on vocal function. Eur Arch Otorhinolaryngol. In press 2012; DOI: 10.1007/s00405-012-2130-4. No. EAORL- D-12-00239.1.

Presentations

1. Paulauskienė I, Lesinskas E, Petrulionis M. „The temporary effect of short-term endotracheal intubation on vocal function“. 1st Congress of CE-ORL-HNS Barcelona, Spain, 2–6 July, 2011.
2. Paulauskienė I, Lesinskas E, Petrulionis M. „The temporary effect of short-term endotracheal intubation on vocal function“. 5th Baltic Otorhinolaryngology Congress Riga, Latvia, 16–18 September, 2011.
3. Paulauskienė I, Lesinskas E. „The temporary effect of short-term endotracheal intubation on vocal function“. International Conference „Evolutionary medicine: New solutions for the old problems “, Vilnius University Vilnius, Lithuania, 12–15 June, 2012.
4. Paulauskienė I, Lesinskas E. „The temporary effect of short-term endotracheal intubation on vocal function“. 9th International Congress of the European Laryngology Society Helsinki, Finland, 13–16 June 2012.

CURRICULUM VITAE

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Education

2008–2012 PhD studies, Vilnius University, Faculty of Medicine

1995 Passed examination for otorhinolaryngology Vilnius University, Faculty of Medicine, Vilnius, Lithuania

1992–1995 Residency in otorhinolaryngology Vilnius University

1986–1992 Received Medical degree of MD in Vilnius University, Faculty of Medicine, Vilnius, Lithuania

1978–1984 Music school, piano class

1975–1986 Secondary school, Zarasai

Working experience

1995– to present. Otorhinolaryngologist in ENT Department Vilnius University Hospital Santariskiu klinikos

Publications

5 scientific publications in Medical printing,

2 scientific publications in Medical printing (ISI):

Petrulionis M, Valeviciene N, Paulauskiene I, Bruzaite J. Primary Extracranial Meningioma of the Sinonasal Tract Acta Radiol. 2005.

Paulauskiene I, Lesinskas E, Petrulionis M. The temporary effect of short-term endotracheal intubation on vocal function. Eur Arch Otorhinolaryngol. In press 2012.

Trainings

2010 05 – 23rd International Course on Laser Surgery in Otorhinolaryngology Namur, Belgium

2010 04 – 4th International Course on Laryngostroboscopy and Fiberendoscopic Phonosurgery Cesena, Italy

2009 12 – Advanced Stroboscopy Workshop NewYork, USA

2009 09 – training at ENT Clinic of Justus Liebig University Giessen, Germany

2009 04 – 14th International Workshop on Laser Voice Surgery Paris, France

2008 03 – ICH GCP Basic Training

2008 01 – Phonosurgery course Lyon, France

Languages

Mother tongue: Lithuanian

Other languages:

Reading skills: Russian, English, German, Polish – excellent

Writing skills: Russian – excellent, English, German – good, Polish – basic

Verbal skills: Russian – excellent, English – very good, Polish, German – basic