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Original Research Article

Effect of endotracheal intubation versus laryngeal mask airway on patient's quality of voice and swallowing

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ABSTRACT

Background: The aim of our study was to evaluate postoperative voice and swallowing disorders during the first postoperative week and to compare these findings between two anesthesia methods: endotracheal intubation tube (ETI) and laryngeal mask airway (LMA).
Methods: We conducted a prospective cohort study of patients who underwent laparoscopic cholecystectomy with ETI (n=103) and patients who underwent open hernioplasty or lower extremity varicectomy with LMA (n=100). All subjects underwent preoperatively and during the first postoperative week laryngeal imaging by videolaryngostroboscopy (VLS), filled in subjective evaluations of voice and swallowing complaints. In addition, acoustic voice analysis (AVA), maximum phonation time (MPT) measurement and perceptual voice evaluation were conducted.
Results: VLS showed visual changes in pharyngeal and laryngeal anatomy in 4 (4%) patients of the LMA group and 14 (13.6%) patients of the ETI group (p=0.02). No statistically significant postoperative subjective voice and swallowing changes were found in either group. In female patients AVA showed a statistically significant increase of the SPI value in the ETI group (p=0.037). In male patients we noted an increase in mean fundamental frequency (F_0) and decrease in MPT with both ventilation methods.
Conclusions: Both investigated ventilation methods can be regarded as practically equal. Although clinical signs showed more intense trauma in the ETI group, objective measurements and patient subjective evaluation of voice and swallowing function were similar in both groups.

Keywords: Endotracheal intubation, Laryngeal mask airway, Voice, Swallowing

INTRODUCTION

Early postoperative voice and swallowing problems are well-known and frequent complaints following general anesthesia. Up to 69% of patients complain short-term voice disorders after endotracheal intubation and 73% of patients show evident alterations in the laryngeal mucosa.[1,2] The incidence of dysphagia on the first postoperative day after general anesthesia varies from 10 to 20%.[3] In general, these complaints resolve in a few days or even lesser time, however some investigations have reported changes in voice and swallowing function even 6 month later.[4]

Laryngeal mask airway (LMA) has proven to have some advantages over endotracheal intubation (ETI) when comparing immediate postoperative laryngopharyngeal symptoms and voice quality.[5,6]

Most of the previous studies conducted in this field have concentrated on the first 24 hours and have shown evident differences between ETI and LMA in the immediate postoperative period.[7–9] Therefore, study of longer term complaints, including post hospitalization period, is necessary to evaluate their actual clinical impact.

Previous studies have focused largely on subjective complaints of laryngopharyngeal symptoms (throat pain, dysphonia and dysphagia) and have lacked of objective measurements and documented preoperative findings for comparison. Only a limited number of studies have used standardized questionnaires of voice and swallowing impairment, instead of general evaluation of laryngopharyngeal symptoms.

The aim of our study was to evaluate postoperative voice and swallowing disorders during the first postoperative week and to compare these findings between two anesthesia methods: endotracheal intubation tube and laryngeal mask airway.

METHODS

We conducted a prospective cohort study of patients who underwent laparoscopic cholecystectomy with ETI (n=103) and patients who underwent open hernioplasty or lower extremity varicectomy with LMA (n=100).

All participants of our study were recruited from the patients of the Surgery Clinic of Tartu University Hospital between September 2013 and December 2016 after signing the informed consent. Patients were excluded if they were under 18 years of age, presented a videostroboscopic finding of a preexisting vocal fold disease (benign lesions, vocal fold paresis, acute infection etc.), missed the postoperative follow-up visit or declined to participate in the study. Approval was obtained from the Research Ethics Committee of the University of Tartu, license no. 212/T-7.

All participants underwent short-term anesthesia lasting less than 130 minutes. As we undertook a non-randomized prospective study, we did not interfere with the daily routine of anesthetic management, i.e. the medical conditions remained unchanged. In both groups a single-use polyvinylchloride (PVC) endotracheal tube and laryngeal mask airway of appropriate size was used. The cuff was inflated up to a point of air-leakage stop and pressure was measured and recorded. Postoperative analgesic management followed the hospital's protocol. Data about the patients sex, age, type of surgery, type of anesthesia, overall time of intubation, number of insertions, tube size and cuff inflation pressure were obtained using standardized forms.

All subjects underwent preoperatively and during the first postoperative week laryngeal imaging by videolaryngostroboscopy (VLS), filled in subjective evaluations of voice and swallowing complaints. In addition, acoustic voice analysis, maximum phonation time measurement and perceptual voice evaluation were conducted at both study points.

VLS was performed during sustained vowel /e/ phonation using either a 90-degree rigid laryngoscope (Karl Storz model 8707 DA) or a flexible fiberoptic nasopharyngolaryngoscope (Kay Pentax model VNL 8-J10). Evaluation took place in the first postoperative week in order to have a better overview of the clinical significance of the impact of symptoms on patients quality of everyday life.

Subjective evaluation of voice and swallowing complaints was assessed by using voice handicap index and swallowing impairment score, respectively. Voice handicap index (VHI) is a standardized 30-item questionnaire developed by Jacobson et al in 1997, to evaluate the impact of voice disorder on the patient's quality of life.[10] Each answer is graded 0 (never) to 4 (always) depending on the severity of the voice problem and the sum ranges from minimum 0 to maximum 120. The score is divided into three subscales: physical, functional and emotional. Swallowing Impairment Score (SIS) is a series of questions related to the frequency of swallowing abnormality. It ranges from a minimum score of 0 (no swallowing alteration) to a maximum of 20 (highest swallowing impairment).[11]

Objective acoustic voice analysis (AVA) was performed by using the Multi-Dimensional Voice Program (MDVP) (Model 5105, version 3.1.7; KayPENTAX), measuring average fundamental frequency (F_0, Hz), mean percentage vocal jitter and shimmer, voice turbulence index (VTI), noise-to-harmonic ratio (NHR, dB) and soft phonation index (SPI). The microphone was positioned at a distance of approximately 20 cm from the patient's mouth. The level of environmental noise was <30 dB. Three voice tokens of sustained vowel/a/ at habitual pitch and loudness from the mid-portion were recorded for 4 seconds each. The most stable performance of the three trials was used for data analysis.

To evaluate glottic efficiency, under similar settings, maximum phonation time (MPT) was collected by having the patient sustain vowel/a/ for as long as possible on a single breath, following a maximum inhalation. Three trials were obtained and the longest of the three attempts was used for further data analysis.

Perceptual voice analysis was performed by an experienced phoniatrician using the Grade, Roughness, Breathiness, Asthenia and Strain (GRBAS) rating scale. The scale was developed by The Committee of Phonatory Function Tests of the Japan Society of Logopedics and Phoniatrics.[12] Each of the above mentioned voice aspect is rated on a four-point scale ranging from 0 (normal) to 3 (severely abnormal). The scale is recommended for both clinical and research purposes by the European Laryngeal Research Group and has proven inter- and intra-rater reliability.[13–15]

Statistical analysis was performed using the TIBCO Statistica™ version 10.0 software package. Data were expressed as mean (±SD) or median and range. Significant differences in the quantitative variables of independent samples were tested by Student´s t-test and Mann-Whitney test. Significant differences between groups for binomial variables were tested by Chi-Square test or Fisher´s exact test. Statistical significance was defined as a p value less than 0.05.

RESULTS

A total of 203 patients completed the study. The ETI group consisted of 100 patients (25 men, 75 women), age range 21 to 82 years. The LMA group consisted of 103 patients (82 men, 21 women), age range 22 to 82 years. Age distribution between the two anesthesia method groups was closely matched (p=0.343). Both groups were comparable in terms of duration of anesthesia and anesthetic management. Since gender distribution was unequal, we divided both groups by gender and compared the results accordingly to avoid a gender bias (Table 1).

VLS showed visual changes in pharyngeal and laryngeal anatomy (vocal fold hyperemia or hematoma, subglottic hematoma, vocal fold vibratory changes, movement disorder of vocal fold etc.) between the baseline and the postoperative findings in 4 (4%) patients of the LMA group and 14 (13.6%) patients of the ETI group (p=0.02).

Table 1: Baseline characteristics.

	Men			Women		
Variables	**LMA group (n=75)**	**ETI group (n=21)**	**P value**	**LMA group (n=75)**	**ETI group (n=21)**	**P value**
Age (years)	57.3	58.9	0.31	54.0	53.0	0.41
VHI	8.9	7.7	0.59	8.6	11.6	0.37
SIS	1.8	2.6	0.27	3.8	3.1	0.51
F_0 (Hz)	121.9	112.8	0.13	198.1	178.0	0.2
Jitter (%)	1.17	0.67	0.13	1.67	1.70	0.96
Shimmer (%)	5.49	4.65	0.31	5.56	6.68	0.5
NHR (dB)	0.15	0.14	0.07	0.16	0.17	0.72
VTI	0.05	0.05	0.96	0.04	0.05	0.12
SPI	17.04	17.38	0.89	20.65	16.26	0.18
MPT (sec)	22.7	23.2	0.86	19.2	13.6	0.001*

*statistically significant; LMA=laryngeal mask airway; ETI=endotracheal intubation; VHI=voice handicap index; SIS=swallowing impairment score; F_0=mean fundamental frequency; NHR=noise to harmonics ratio; VTI=voice turbulence index; SPI=soft phonation index; MPT=maximum phonation time.

Table 2: Comparison of pre- and post- operative acoustic analysis of female patients.

	ETI group			LMA group		
Variables	**Preoperative mean (±SD)**	**Postoperative mean (±SD)**	**P value**	**Preoperative mean (±SD)**	**Postoperative mean (±SD)**	**P value**
F_0 (Hz)	178.0 (±47.3)	185.4 (±47.4)	0.24	198.1 (±62.5)	192.4 (±53.9)	0.62
Jitter (%)	1.71 (±1.83)	1.83 (±2.12)	0.65	1.67 (±3.07)	1.65 (±2.75)	0.93
Shimmer (%)	6.68 (±5.48)	7.07 (±5.86)	0.66	5.56 (±4.43)	6.82 (±7.1)	0.29
NHR (dB)	0.17 (±0.11)	0.17 (±0.11)	0.87	0.16 (±0.06)	0.16 (±0.09)	0.8
VTI	0.05 (±0.02)	0.04 (±0.02)	0.44	0.04 (±0.02)	0.04 (±0.02)	0.9
SPI	16.26 (±7.63)	18.34 (±8.83)	0.04*	20.66 (±17.89)	14.55 (±5.77)	0.21
MPT (sec)	13.6 (±4.3)	13.19 (±4.2)	0.35	19.2 (±8.5)	18.3 (±8.9)	0.44

*statistically significant; LMA=laryngeal mask airway; ETI=endotracheal intubation; F_0=mean fundamental frequency; NHR=noise to harmonics ratio; VTI=voice turbulence index; SPI=soft phonation index; MPT=maximum phonation time.

Subjective evaluation of voice (VHI) showed no statistically significant postoperative deterioration irrespective of the ventilation method either in male or female patients. We found a trend of decline of subjective evaluation of swallowing function (SIS) in female patients in the ETI group (p=0.067). In male patients swallowing function showed no evident postoperative changes in either ventilation group.

In female patients acoustic voice analysis showed a statistically significant increase of the SPI value in the ETI group (p=0.037). In the LMA group no statistically significant changes were found in any of the investigated acoustic parameters (Table 2). In male patients we noted an increase in mean fundamental frequency (F_0) both in the ETI (p=0.034) and LMA (p=0.055) groups (Table 3).

Table 3: Comparison of pre- and post- operative acoustic analysis of male patients.

	ETI group			LMA group		
Variables	**Preoperative mean (±SD)**	**Postoperative mean (±SD)**	**P value**	**Preoperative mean (±SD)**	**Postoperative mean (±SD)**	**P value**
F_0 (Hz)	112.8 (±19.2)	118.6 (±19.2)	0.03*	121.9 (±22.5)	125.3 (±22.1)	0.055
Jitter (%)	0.67 (±0.27)	0.72 (±0.36)	0.57	1.17 (±1.33)	1.16 (±1.02)	0.93
Shimmer (%)	4.65 (±1.79)	4.64 (±1.80)	0.99	5.49 (±3.27)	5.64 (±3.27)	0.51
NHR (dB)	0.14 (±0.02)	0.14 (±0.02)	0.19	0.15 (±0.04)	0.15 (±0.05)	0.94
VTI	0.05 (±0.02)	0.04 (±0.02)	0.34	0.05 (±0.01)	0.04 (±0.01)	0.18
SPI	17.38 (±9.17)	15.63 (±8.07)	0.42	17.04 (±9.15)	16.5 (±8.72)	0.57
MPT (sec)	23.2 (±8.6)	18.5 (±5.5)	0.03*	22.7 (±8.89)	20.2 (±7.0)	<0.001*

*statistically significant; LMA=laryngeal mask airway; ETI=endotracheal intubation; F_0=mean fundamental frequency; NHR=noise to harmonics ratio; VTI=voice turbulence index; SPI=soft phonation index; MPT=maximum phonation time.

Table 4: Comparison of changes from the baseline values.

	Men			Women		
Variables	**LMA group mean (±SD)**	**ETI group mean (±SD)**	**P value**	**LMA group mean (±SD)**	**ETI group mean (±SD)**	**P value**
VHI	1.50 (±7.15)	1.64 (±4.26)	0.93	1.95 (±5.09)	-0.97 (±9.95)	0.2
SIS	-0.23 (±1.64)	0.32 (±2.55)	0.2	0.76 (±2.9)	-0.75 (±3.48)	0.07
F_0 (Hz)	-3.48 (±14.55)	+5.8 (±10.31)	0.54	5.7 (±40.55)	-7.39 (±45.49)	0.34
Jitter (%)	0.01 (±1.2)	-0.05 (±0.38)	0.82	0.02 (±0.8)	-0.12 (±1.99)	0.8
Shimmer (%)	-0.15 (±1.86)	0.01 (±2.58)	0.77	-1.27 (±4.16)	-0.39 (±6.35)	0.64
NHR (dB)	0.001 (±0.05)	0.01 (±0.03)	0.47	-0.03 (±0.05)	-0.003 (±0.12)	0.97
VTI	0.003 (±0.02)	0.004 (±0.02)	0.8	-0.001 (±0.02)	0.003 (±0.03)	0.77
SPI	0.54 (±7.66)	1.74 (±8.74)	0.58	6.1 (±15.01)	-2.08 (±7.05)	0.005*
MPT (sec)	2.55 (±5.68)	7.71 (±8.17)	0.21	0.92 (±4.16)	0.42 (±3.2)	0.63

*statistically significant; LMA=laryngeal mask airway; ETI=endotracheal intubation; VHI=voice handicap index; SIS=swallowing impairment score; F_0=mean fundamental frequency; NHR=noise to harmonics ratio; VTI=voice turbulence index; SPI=soft phonation index; MPT=maximum phonation time.

The MPT values were postoperatively significantly worse in male patients with both ventilation methods (ETI p=0.03; LMA p≤0.001), whereas female patients showed no decrease in MPT values in either group. Perceptual evaluation of voice (GRBAS) revealed no voice changes in any patient group.

When we compared changes from the baseline values in the evaluated parameters and scores between the two anesthesia methods, the only statistically significant difference occurred in SPI parameter for female patients (p=0.003) (Table 4). We detected also a marked difference in SIS score changes in female patients, but it was statistically not significant (p=0.07). Evaluation of changes revealed no difference between the two anesthesia methods regarding the F_0 and MPT values for either gender.

DISCUSSION

In the present study videostroboscopic evaluations revealed significantly higher incidence of postoperative pharyngolaryngeal trauma with the use of endotracheal intubation tube compared to laryngeal mask airway. Postoperative laryngeal injury may be caused either by direct intubation trauma (including hematoma, mucosal edema and dislocation or subluxation of the arytenoids) or by the operation itself when performed in the head and neck region.[16,17] Pathogenesis in our study most probably relates to pressure and inflammation induced by the tube and cuff. When pressure from the unyielding walls of the tube exceeds capillary pressure in the mucosa of the larynx, mucosal ischemia causes irritation, inflammation, congestion and edema already within the first few hours.[18] Several risk factors may contribute to this laryngeal injury, such as difficult airway, tube type and size, cuff design and pressure, duration of anesthesia, as well as demographic factors such as sex, weight, history of smoking and GERD.[19–21] Still, based on our clinical findings, we can conclude that although traumatic injury caused by ETI may take extra time to completely resolve, it causes no significant functional or emotional disturbances one week postoperatively.

Additionally, voice quality can be indirectly affected by anesthesia or postoperative pain and analgesia medications. In our study we found increased postoperative fundamental frequency and increased maximum phonation time in male patients with the use of both ventilation methods. This indicates it is caused rather by general anesthesia medications than the ventilation tube itself. Increased fundamental frequency can be explained by lowered sensation of subglottic pressure in the anesthetized larynx, which leads to pressed phonation and a rise in fundamental frequency. Administered anesthetic agents can also interfere with fine neuromuscular control and lead to impairment in voice tonality by this origin.[22] Furthermore, inhalation of anesthetic gases or intake of drying medications may also lead to desiccation of the vocal fold mucosa thus affecting the vocal signal. Similar results have been documented also previously by Zimmert et al who found increased F_0 in both ventilation method groups.[23] Likewise, the decreased MPT in our study can be secondary to anesthetic management. The post-operative effect of barbiturates, opioids and pain itself suppress breathing muscle function and therefore causes restricted or depressed ventilation, which leads to diminished phonation time.[24] Our results are consistent with those of Hamdan et al. who also found increased postoperative values of MPT irrespective of the ventilation method.[7]

In addition, the results of acoustic analysis in previous studies have revealed changes in perturbation parameters (shimmer, jitter etc.) and NHR scores, however none of these studies have documented changes in soft phonation index (SPI) parameter. SPI can be thought of as an indicator of how completely or tightly the vocal folds adduct during phonation.[25,26] It reflects the average ratio of low frequency (70–1600 Hz) harmonic energy to the higher frequency (1600–4500 Hz) harmonic energy for the voiced areas in the analyzed signal. Correlations have also been found between SPI and perceptual evaluation GRBAS scale grade (G) and breathiness (B) values.[27] Incomplete vocal fold adduction during phonation causes rapid air escape from the lungs, which can also lead to increased MPT values as discussed above. In this study we found increased postoperative SPI values in female patients who were intubated with the endotracheal tube. Comparison of the results between the two anesthesia methods revealed statistically significant difference. The fact that SPI values were increased only in female patients in the ETI group indicates, that it may have been caused by direct damage to the vocal cords. Female larynxes have been found to be more susceptible to mechanical trauma due to differences related to laryngeal physiology, anatomy, hormone differences and other non-laryngeal physiology and behavioral characteristics.[28] According to the developers of the software psychological stress could also be a factor that increases SPI. This also correlates with female gender as findings suggest that women tend to report higher levels of anxiety, which may contribute to their increased vulnerability to emotional stress and related disorders.[29,30]

Dysphagia and odynophagia are generally associated with the trauma caused by high cuff pressure, which leads to edema, inflammation and impaired laryngeal motility. Previous studies on swallowing function and dysphagia after general anesthesia have shown rather conflicting results. Several studies have associated laryngeal mask airway with a higher incidence of dysphagia compared to endotracheal intubation.[3,31] Our study showed a decline in the subjective evaluation of swallowing function in female patients, but it was detected in the endotracheal intubation group. This is consistent with the research by Chun et al and meta-analysis of Park et al.[5,32]

The limitation of our study was the absence of a standardized anesthesia protocol, which could have affected the outcomes due to different anesthesia management from patient to patient. Another limitation was the unequal gender distribution, which we solved by running separate analyses for males and females.

CONCLUSION

According to postoperative patient evaluation at one week from surgery, both investigated ventilation methods can be regarded as practically equal. Although clinical signs showed more intense trauma in the ETI group, objective measurements and patient subjective evaluation of voice and swallowing function were similar in both groups.

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REFERENCES

1. Mendels EJ, Brunings JW, Hamaekers AW, Stokroos RJ, Kremer B, Baijens LJ. Adverse laryngeal effects following short-term general anesthesia: A systematic review. Arch Otolaryngol Neck Surg. 2012;138(3):257-64.
2. Pröschel U, Eysholdt U. Kurzzeit-Veränderungen an Kehlkopf und Stimme nach Intubation. Laryngol Rhinol Otol. 2008;72(02):93-7.
3. Rieger A, Brunne B, Hass I, Brummer G, Spies C, Striebel HW, et al. Laryngo-pharyngeal complaints following laryngeal mask airway and endotracheal intubation. J Clin Anesth. 1997;9(1):42-7.
4. Friedrich T, Hansch U, Eichfeld U, Steinert M, Staemmler A, Schonfelder M. Recurrent laryngeal nerve paralysis as intubation injury? Chir Z Alle Geb Oper Medizen. 2000;71(5):539-44.
5. Chun B-J, Bae J-S, Lee S-H, Joo J, Kim E-S, Sun D-I. A prospective randomized controlled trial of the laryngeal mask airway versus the endotracheal intubation in the thyroid surgery: evaluation of postoperative voice, and laryngopharyngeal symptom. World J Surg. 2015;39(7):1713-20.
6. Van Esch BF, Stegeman I, Smit AL. Comparison of laryngeal mask airway vs tracheal intubation: a

systematic review on airway complications. J Clin Anesth. 2017;36:142-50.
7. Hamdan A, Kanazi G, Rameh C, Rifai H, Sibai A. Immediate post-operative vocal changes in patients using laryngeal mask airway versus endotracheal tube. J Laryngol Otol. 2008;122(8):829-35.
8. Radu AD, Miled F, Marret E, Vigneau A, Bonnet F. Pharyngo-laryngeal discomfort after breast surgery: comparison between orotracheal intubation and laryngeal mask. Breast. 2008;17(4):407-11.
9. Safaeian R, Hassani V, Movasaghi G, Alimian M, Faiz HR. Postoperative respiratory complications of laryngeal mask airway and tracheal tube in ear, nose and throat operations. Anesthesiol Pain Med. 2015;5(4):e25111.
10. Jacobson BH, Johnson A, Grywalski C, Silbergleit A, Jacobson G, Benninger MS, et al. The voice handicap index (vhi) development and validation. Am J Speech Lang Pathol. 1997;6(3):66-70.
11. Lombardi CP, Raffaelli M, D'Alatri L, Marchese MR, Rigante M, Paludetti G, et al. American Association of Endocrine Surgeons: Voice and swallowing changes after thyroidectomy in patients without inferior laryngeal nerve injuries. Surgery. 2006;140:1026-34.
12. Hirano M. Clinical examination of voice. Disord Hum Commun. 1981;5:1-99.
13. Dejonckere PH, Obbens C, de Moor GM, Wieneke GH. Perceptual evaluation of dysphonia: reliability and relevance. Folia Phoniatr (Basel). 1993;45(2):76-83.
14. DeJonckere PH, Crevier-Buchman L, Marie JP, Moerman M, Remacle M, Woisard V. Implementation of the European Laryngological Society (ELS) basic protocol for assessing voice treatment effect. Rev Laryngol Otol Rhinol. 2003;124(5):279-83.
15. De Bodt MS, Wuyts FL, Van de Heyning PH, Croux C. Test-retest study of the GRBAS scale: influence of experience and professional background on perceptual rating of voice quality. J Voice Off J Voice Found. 1997;11(1):74-80.
16. Stojadinovic A, Henry LR, Howard RS, Gurevich-Uvena J, Makashay MJ, Coppit GL, et al. Prospective trial of voice outcomes after thyroidectomy: evaluation of patient-reported and clinician-determined voice assessments in identifying postthyroidectomy dysphonia. Surgery. 2008;143(6):732-42.
17. Sariego J. Vocal fold hypomobility secondary to elective endotracheal intubation: a general surgeon's perspective. J Voice Off J Voice Found. 2010;24(1):110-2.
18. Gaynor EB, Greenberg SB. Untoward sequelae of prolonged intubation. Laryngoscope. 1985;95(12):1461-7.
19. Maktabi MA, Smith RB, Todd MM. Is routine endotracheal intubation as safe as we think or wish? Anesthesiology. 2003;99(2):247-8.
20. Kitahara S, Masuda Y, Kitagawa Y. Vocal fold injury following endotracheal intubation. J Laryngol Otol. 2005;119(10):825-7.
21. Mencke T, Echternach M, Kleinschmidt S, Lux P, Barth V, Plinkert PK, et al. Laryngeal Morbidity and Quality of Tracheal IntubationA Randomized Controlled Trial. Anesthesiology. 2003;98(5):1049-56.
22. Karcz M, Papadakos PJ. Respiratory complications in the postanesthesia care unit: A review of pathophysiological mechanisms. Can J Respir Ther. 2013;49(4):21-9.
23. Zimmert M, Zwirner P, Kruse E, Braun U. Effects on vocal function and incidence of laryngeal disorder when using a laryngeal mask airway in comparison with an endotracheal tube. Eur J Anaesthesiol. 2007;16(8):511-5.
24. Fu S, Lin W, Zhao X, Ge S, Xue Z. Quantitative Relationships between pulmonary function and residual neuromuscular blockade. BioMed Res Int. 2018;2018:9491750.
25. Koreman J and Putzer M. Finding correlates of vocal fold adduction deficiencies. Phonus 1997;3:155–78
26. Mathew MM, Bhat JS. Soft phonation index: a sensitive parameter? Indian J Otolaryngol Head Neck Surg Off Publ Assoc Otolaryngol India. 2009;61(2):127-30.
27. Bhuta T, Patrick L, Garnett JD. Perceptual evaluation of voice quality and its correlation with acoustic measurements. J Voice Off J Voice Found. 2004;18(3):299-304.
28. Hunter EJ, Tanner K, Smith ME. Gender differences affecting vocal health of women in vocally demanding careers. Logoped Phoniatr Vocol. 2011;36(3):128-36.
29. Bangasser DA, Valentino RJ. Sex differences in stress-related psychiatric disorders: neurobiological perspectives. Front Neuroendocrinol. 2014;35(3):303-19.
30. Kessler RC, Brown RL, Broman CL. Sex differences in psychiatric help-seeking: evidence from four large-scale surveys. J Health Soc Behav. 1981;22(1):49-64.
31. Venugopal A, Jacob RM, Koshy RC. A randomized control study comparing the pharyngolaryngeal morbidity of laryngeal mask airway versus endotracheal tube. Anesth Essays Res. 2016;10(2):189-94.
32. Park SK, Ko G, Choi GJ, Ahn EJ, Kang H. Comparison between supraglottic airway devices and endotracheal tubes in patients undergoing laparoscopic surgery: A systematic review and meta-analysis. In: Hanaoka. K, ed. Baltimore: Medicine. 2016;95(33):e4598.

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