

Assessing the Short-term Effects of Endotracheal Intubation on Voice Change and Acoustic Parameters: A Prospective Observational Study

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ABSTRACT

Aims and objectives: (1) To examine vocal symptoms and acoustic changes perceived within 24 hours after endotracheal intubation and (2) to find the association between these changes and endotracheal tube (ET) parameters and determine which parameter affects voice the most.

Materials and methods: A prospective analysis of 75 patients was done. They were examined preoperatively, and 2 and 24 hours postoperatively. The vocal symptoms of hoarseness, vocal fatigue, loss of voice, throat clearing (hawking), globus pharyngeus, throat pain, and the acoustic variables mainly average fundamental frequency, shimmer, harmonic noise ratio (HNR), and maximum phonation time (MPT) were assessed. The ET parameters considered were duration of anesthesia, number of attempts at intubation, size of the tube, ET cuff volume, and mean cuff pressure.

Results: Approximately 60% of patients with cuff volume above 3 cm³ and 80% of patients with more than two intubation attempts developed postoperative vocal fatigue, while 70% with mean cuff pressure above 20 cm of water developed postoperative hawking.

Conclusion: The ET parameters, mean cuff pressure, and ET cuff volume are the most important variables that are associated with the increase in vocal symptoms. An increase in the value of these parameters is associated with more postoperative discomfort.

Keywords: Acoustic analysis, Endotracheal tube, Hoarseness, Intubation, Jitter, Larynx, Shimmer, Vocal folds, Voice.

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INTRODUCTION

Most of the major surgical procedures in ENT require endotracheal intubation to provide general anesthesia (GA) and intermittent positive pressure ventilation (IPPV). Voice changes occurring after endotracheal intubation are a common finding which leaves patients with unpleasant postoperative recovery and overall experience. By selecting proper endotracheal tube (ET) parameters, this can be reduced to a great extent. Most of the voice changes associated with endotracheal intubation including acoustic parameters are short-lasting and baseline recovery occurs within a period of 24 hours without any long-lasting sequelae in the majority of cases.^{1,2} There have been studies to investigate the laryngotracheal morphological and histological changes associated with prolonged intubation.¹⁻³

The purpose of this study is to (1) assess the immediate changes in the voice and acoustic parameters occurring after endotracheal intubation, and (2) to correlate these changes with the endotracheal tube and acoustic parameters, and (3) to find the acoustic parameter which is affected most.

MATERIALS AND METHODS

A prospective analysis was conducted on patients admitted for routine ENT surgeries at our tertiary referral center. A total of 86 patients were included in the study after taking written, informed, and valid consent. Out of 86, 48 patients were males (56%), while 38 patients were females (44%). The patients ranged from 19 to 68 years, with an average of 37 years. All the patients were subjected to rigid laryngoscopic examination prior to surgery to exclude any vocal fold lesions and/or morphological abnormalities in the vocal folds as well as postoperative vomiting and/or retching. All the surgeries related to the vocal folds and neck surgeries that

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require dissection in the proximity of recurrent laryngeal nerves like thyroid and parathyroid surgeries were also excluded. Single senior anesthetist has done all the intubations to minimize chances of interpersonal variations. The anesthetist has evaluated the patients preoperatively for any difficult laryngeal exposure while intubating using modified Mallampati classification (MMC).⁴ All the patients were evaluated preoperatively in the morning before surgery, immediately 2 hours after the surgery, and 24 hours following the surgery. Every time the analysis of voice was done in a soundproof room, to minimize chances of surrounding ambient noise distorting the readings. The recording was done with the patient in seating position in a chair, both during the preoperative and postoperative time. After 24 hours, 75 patients (42 males and 33 females) remained

in the study for evaluation, as 7 patients had vomited in the postoperative period, while 4 patients had an excessive cough in the postoperative period. Patients were asked about the presence or absence of the following vocal complaints: hoarseness, throat pain, vocal fatigue, loss of voice, throat clearing, and globus pharyngeus (foreign body sensation in the throat). The acoustic analysis of the voice was done using "Dr Speech voice analysis software" (Seattle, Washington). A microphone was placed at a distance of 15 cm from the mouth of the patient to record the vocal signal directly into the system. The average fundamental frequency, shimmer, harmonic noise ratio (HNR), and jitter were measured by asking the patient to sustain vowel "ah" for 3 seconds. To calculate the maximum phonation time (MPT), they were instructed to hold the vowel /a/ as long as they could, after taking a maximal inhalation. All the patients underwent general anesthesia with the insertion of an ET through the oral cavity. The following parameters were recorded: the size of the endotracheal tube, number of attempts at intubation, duration of anesthesia, ET cuff volume, and mean cuff pressure, which was calculated as an average of the cuff pressure at intubation and extubation (Table 1).

RESULTS

86 patients were evaluated preoperatively of which 75 remained for the 24-hour evaluation. The age of the participants ranged

Table 1: Parameters assessed for the study

Vocal symptoms	Acoustic parameters	Endotracheal tube (ET) parameters
Hoarseness	Maximum phonation time (seconds)	Size of the tube
Throat pain	Average fundamental frequency (Hz)	Number of attempts at intubation
Vocal fatigue	Shimmer (%)	ET cuff volume (cm ³)
Loss of voice	Harmonic noise ratio (dB)	Mean cuff pressure (cm of water)
Throat clearing	Jitter (%)	Duration of anesthesia (hours)
Globus pharyngeus		

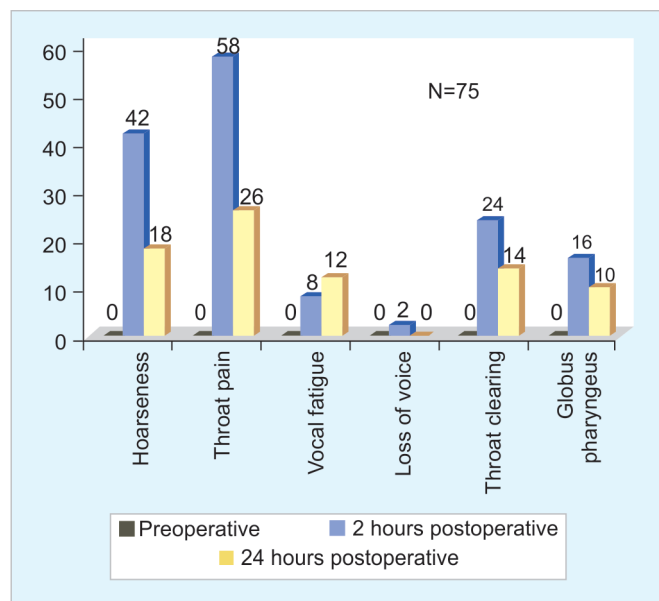


Fig. 1: Vocal symptoms of the patients (values are in percentage)

from 16 to 70 years, with a mean of 38.2 ± 3.2. There were 68.6% (59) males and 31.3% (27) females in the study. The duration of anesthesia ranged between 120 minutes and 420 minutes. The ET sizes used for intubation ranged from sizes 6 to 7.5 for females and 7 to 8.5 for males.

There was a significant increase in the incidence of each of the vocal symptoms; namely, hoarseness, throat pain, vocal fatigue, throat clearing, and globus pharyngeus, 2 hours after GA, except for the loss of voice. However, the frequencies of these symptoms decreased within 24 hours. None of the patients had any vocal complaints in the preoperative period. 42% of patients had hoarseness 2 hours postoperatively which reduced to 18% in the 24 hours postoperative period. While 58% of patients had throat pain 2 hours postoperatively this reduced to 26% in the 24 hours postoperatively. Similarly, 8% of patients had vocal fatigue, 24% had throat clearing, and 16% had globus pharyngeus in the immediate 2 hours postoperative period, while it came back to levels of 12%, 14%, and 10% in the 24 hours postoperative period, respectively (Fig. 1).

Vocal symptoms two hours after surgery was also correlated with the number of attempts at intubation, ET cuff volume, mean cuff pressure, size of the tube, duration of anesthesia and extubation quality. Overall, amongst the endotracheal tube related parameters, the number of intubation attempts at intubation were associated with vocal fatigue (*p* value 0.041) (Fig. 2), ET cuff volume with vocal fatigue (*p* value 0.037) (Fig. 3) and mean cuff pressure with throat clearing (*p* value 0.030) (Fig. 4).

With respect to the acoustic parameters, no significant change was noted in their values over a period of 24 hours (Table 2).

DISCUSSION

The respiratory, neuromuscular, and to a little extent the endocrine system works in coordination for the production of voice. For human beings, the source for the production of sound is pulmonary air, which while passing through the infraglottic tract produces vibrations of vocal folds. The supraglottic tract and muscles of articulation are responsible for providing the characteristic voice quality of each individual. Orotracheal intubation can causing physical and structural changes in vocal folds and supraglottic

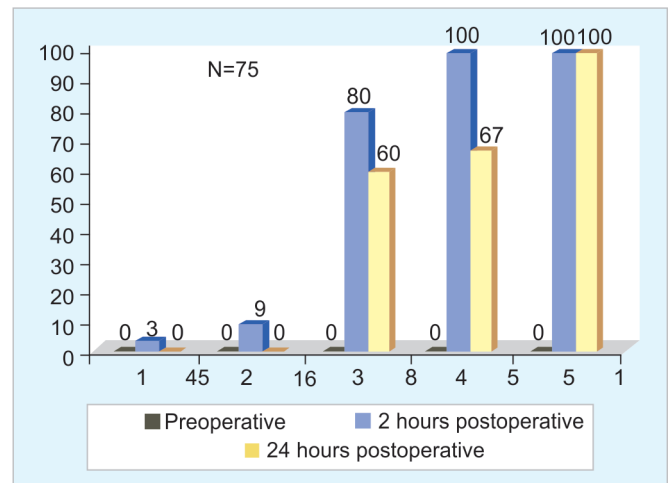


Fig. 2: Relationship of vocal fatigue with increase in number of intubation attempts (on x-axis = number of intubation attempts, on y-axis = percentage of patients developing vocal fatigue. The values in box are number of patients)



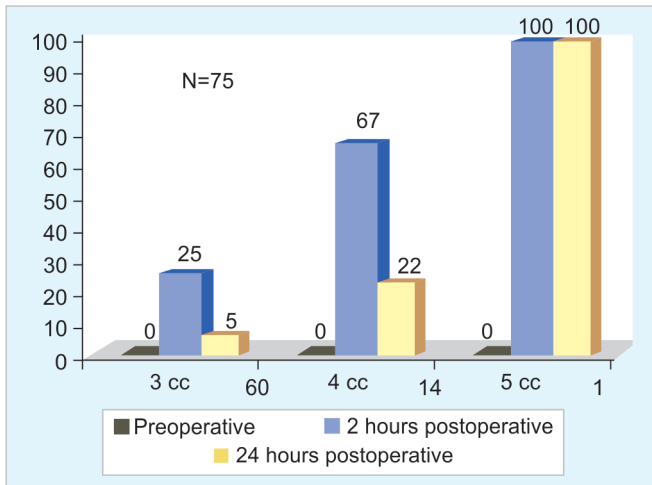


Fig. 3: Relationship of vocal fatigue with increase in ET cuff volume (on x-axis = ET cuff volume, on y-axis = percentage of patients developing vocal fatigue. The values in box are number of patients)

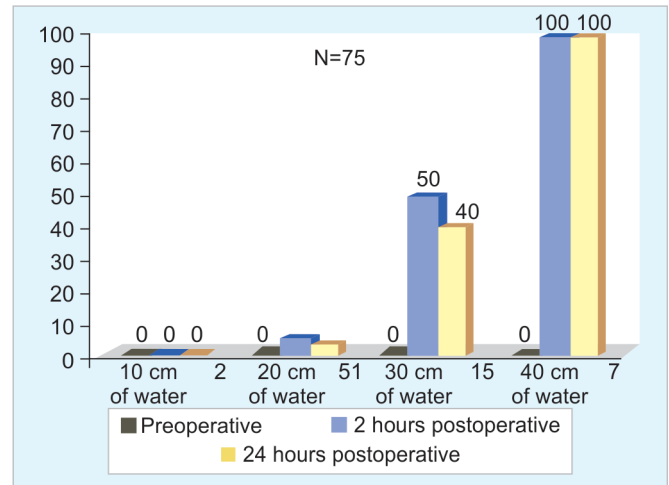


Fig. 4: Relationship of throat clearing with increase in mean cuff pressure (on x-axis = mean cuff pressure, on y-axis = percentage of patients)

Table 2: Mean values of acoustic parameters

	Preoperative	2 hours postoperative	24 hours postoperative
Maximum phonation time (seconds)	13	11.4	12
Average fundamental frequency (Hz)	234	221.32	246.49
Shimmer (%)	3.48	3.96	3.86
Harmonic noise ratio (dB)	16	15.2	15.35
Jitter (%)	0.29	0.43	0.43

tract and this subsequently can affect voice and phonatory behavior.⁵ Anesthetic gases and medications such as atropine, cause dehydration of the laryngeal mucosa, and can result in an increase in the vocal fold viscosity and impaired vibration.⁶⁻⁸ The incidence of laryngeal trauma ranged between 6.3% and 80%.^{9,10}

The extent of trauma can range from mere edema of the vocal fold, to vocal fold paresis, hematoma, lacerations, and granuloma formation. The trauma can occur while inserting the endotracheal tube, during the intubation, or while extubating.¹¹⁻¹⁵ Consequently, such as the size of the tube, size of the larynx, cough pressure, and duration of anesthesia, are important in the interpretation of vocal symptoms postoperatively. In our study, indicated a close association between mean cuff pressure and throat clearing. The value of the mean cuff pressure was significantly greater in those who had increased throat clearing 2 hours after extubation than those otherwise. Likewise, vocal fatigue increased as the cuff volume and the number of attempts of intubation increased.

Voice quality can be affected by the changes in the respiratory and neuromuscular systems, such as musculoskeletal tenderness of intercostal muscles will cause pain during phonation affecting the voice quality. In our study, the most common vocal symptoms postextubation were throat pain and hoarseness, and to lesser extent were throat clearing, globus pharyngeus, and vocal fatigue.

For the acoustic parameters, review of literature showing the studies conducted by Horii and Fuller,¹⁶ Gleeson and Fourcin,¹⁷ Yonick et al.¹⁸ showed a significant decrease in mean fundamental frequency with a significant increase in shimmer and jitter.

Our study having 75 patients, which is one of the largest studies undertaken has shown no significant changes in the acoustic parameters over a period of 24 hours' time postextubation. Very few acoustic analysis studies¹⁶⁻¹⁸ have looked at acoustic variables before intubation and within 24 hours postextubation. Our study had a maximum number of patients and we had analyzed the association between endotracheal tube size and mean cuff pressure; however after that, we have not found any significant association between these two factors.

The findings in our study showed a significant association between ET cuff volume and the number of intubation attempts with vocal fatigue, also a significant association was present between mean cuff pressure and postoperative throat clearing. None of the acoustic parameters showed any significant changes over a period of 24 hours postextubation.

CONCLUSION

The endotracheal tube parameters, mean cuff pressure, and ET cuff volume are the most important variables that are associated with the increase in vocal symptoms. An increase in the value of these parameters is associated with more postoperative discomfort.

COMPLIANCE WITH ETHICAL STANDARDS

- Written, informed, and valid consent was taken from all patients in the study.
- The study complies with the respective ethical standards of the institute.

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