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The Effect of Endotracheal Tube Size on Post-Extubation Sore-Throat and Hoarseness in Patients Undergoing Laparoscopic Surgeries: A Randomized Clinical Trial

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Abstract

Background: An endotracheal tube (ETT) plays a critical role in maintaining a secure and open airway, ensuring proper ventilation and oxygenation throughout the surgical procedure.

Aim: The present study was conducted with aim to evaluate the impact of endotracheal tube size on post-intubation sore throat and hoarseness in patients undergoing laparoscopic surgeries.

Method: This randomized clinical trial was conducted at Ghaem and Imam Reza hospitals in Mashhad, Iran. Patients were randomly allocated into four groups using block randomization: two intervention groups (6.5 mm for males, 6 mm for females) and two control groups (7.5 mm for males, 7 mm for females). We monitored the incidence of sore throat and hoarseness at 1-, 6-, and 24-hours post-surgery.

Results: A total of 160 patients (with mean age 45.01 ± 10.33 years) were evaluated. Gender distribution was similar between the two groups (25.6% in control and 25% in intervention group were female). There were no significant differences between the two groups in terms of gender, age, BMI, underlying diseases, duration of surgery, duration of anesthesia, Malampathi score, Cormack-Lehane grade, the use of NG tubes and oral airways, indicating homogeneity. The incidence of hoarseness one hour after surgery was significantly lower in the intervention group (7.5%) compared to the control group (20%) ($p<0.05$). Additionally, the sore throat at 6 hours post-surgery was significantly lower in the intervention group than in the control group ($p<0.05$), but was not significant at 1 and 24-h post-surgery.

Implications for Practice: Using a smaller tracheal tube size reduces the incidence of sore throat and hoarseness after laparoscopic surgery.

Keywords: Postoperative Hoarseness, Postoperative Sore Throat, Tracheal Intubation, Tracheal Tube Size

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Introduction

An endotracheal tube (ETT) plays a critical role in maintaining a secure and open airway, ensuring proper ventilation and oxygenation throughout the surgical procedure. Inserted into the trachea, the ETT prevents aspiration of gastric contents, facilitates administration of inhalational anesthetic gases, and allows for controlled mechanical breathing (1). By providing a reliable conduit for air exchange, the ETT helps anesthesiologists maintain precise control over respiratory parameters, making it an indispensable tool in modern anesthesia practice (2). Postoperative sore throat (POST) is a common side effect of ETT after general anesthesia (3, 4). Although POST has been regarded as a relatively minor complication, recent studies indicate that it affects up to 62% of patients following general anesthesia and although it typically resolves on its own, it can lead to symptoms such as dyspnea and dysphagia, reduced patient satisfaction with anesthesia, and even prolonged hospital stays (3). Several factors can affect POST incidence, including the choice of airway device, procedure duration, anesthesia agents, evaluation methods, and patient characteristics such as gender, smoking history, postoperative nausea, presence of blood stains on ETT, and presence of natural teeth (5, 6).

The occurrence of postoperative complications may be linked to surgical procedures and overall physical health (7). Endotracheal intubation is the most frequent cause of POST, as the process can lead to the inflammation of the tracheal mucosa, resulting in sore throat, however, the exact cause remains unclear (5, 8). Several intubation-related factors including the size, shape, and material of the tube, as well as the cuff pressure and intubation techniques contribute to POST and play a role in postoperative hoarseness (6). Research suggests that smaller ETT sizes with cuff pressures between 20–30 cm H2O, rather than relying on the traditional method of palpating the pilot balloon, can significantly reduce POST and discomfort, particularly among women in the post-anesthesia care unit (PACU) (9-11).

A systematic review and meta-analysis evaluated the impact of ETT size on POST in female patients undergoing general anesthesia. Analyzing data from three trials involving 509 participants found that using a smaller ETT (6.0 mm) significantly reduced the incidence of POST in both the immediate postoperative period and at 24 hours after surgery. It also lowered the rate of pharyngeal hemorrhage (PH) in the post-anesthesia care unit, though no significant difference was observed for PH at 24 hours. These findings suggest that a smaller ETT may improve postoperative comfort in female patients (10). A 2025 review assesses existing literature on ETT size selection for adults undergoing general anesthesia in elective surgeries. It suggests that smaller tubes may improve patient comfort and recovery outcomes, but emphasizes that current research is limited by high risk of bias and low to moderate certainty of evidence. Consequently, it highlights an urgent need for more rigorous, high-quality studies to better inform clinical practice and optimize patient care (12). According to literature, adjusting the ETT cuff pressure to 25 cm H2O reduces POST and coughing compared to the pilot balloon palpation method (13). Despite this, a knowledge gap exists regarding the specific impact of different tracheal tube sizes on intubation-related complications, such as POST. This study was conducted with aims to compare various ETT sizes during laparoscopic surgery, specifically assessing whether smaller tubes (6.5 in men and 6.0 in women) can effectively reduce the incidence of POST and hoarseness compared to the standard sizes (7.5 in men and 7.0 in women).

Methods

This randomized clinical trial was conducted at Ghaem and Imam Reza hospitals in Mashhad, Iran. Patients were randomly selected from who inferred for elective laparoscopy surgery. All participants provided written informed consent prior to their inclusion in the study, and their data was managed with strict confidentially. Patient names were anonymized and replaced with codes identifiers to ensure privacy protection. Patients referred for laparoscopic surgeries at Ghaem and Imam Reza university hospitals were recruited for this study.

The sample size was calculated using PASS software based on a prior study by Cho et al. (11), which reported an incidence rate of 31.8% for POST in patients intubated with larger tubes and 0.6% in those with smaller tubes, and considering an α=0.05, β=0.2, and a possible dropout; therefore, the minimum sample size was calculated as 36 patients per group. Among a total of 356 patients undergoing laparoscopic surgeries, 160 possessed the eligibility criteria and were randomly allocated into four groups using block randomization from sealedenvelope.com (Figure 1). Using random permuted blocks rout, blocks of 4 and 8 subjects in sealed envelopes were used and treatment

assignments were masked (labeled as Group A, B, C, D without revealing actual interventions). In the intervention group (as case group), male and female patients received 6.5 mm and 6.0 mm ETTs, respectively, while, identical patients in the control group, received 7.5 mm and 7.0 mm ETTs, respectively.

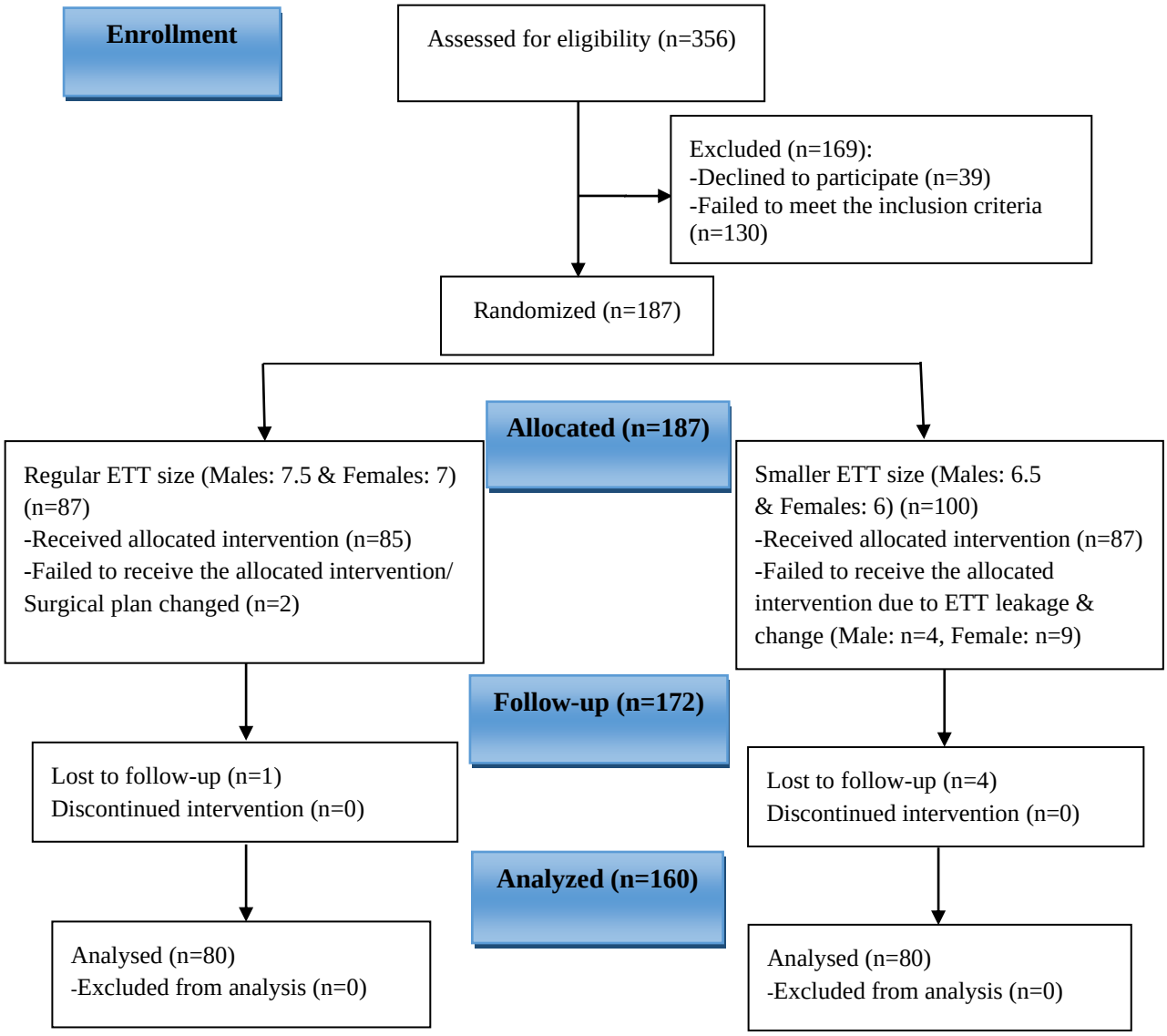

Figure 1. CONSORT flow chart of patient recruitment, allocation, and analysis

Patients who were candidates for laparoscopic cholecystectomy were under general anesthesia with endotracheal intubation. Patients undergoing oral endotracheal intubation and elective surgery in the supine position and aged 18 to 60 years, with a body mass index (BMI) of less than 35 kg/m^2, and classified as ASA physical status I or II were included. Patients with the following conditions were excluded: any history of allergies or respiratory diseases including severe acute exacerbation of COPD, status asthmaticus, tracheomalacia or severe airway collapse, upper airway obstruction due to tumor or severe edema, recent respiratory infections or colds within the past month, esophageal reflux, a Cormack-Lehane grade IV during laryngoscopy, experiencing hemodynamic instability or compromised oxygenation during anesthesia, requiring more than two attempts at laryngoscopy for intubation, needing re-intubation due to overinflation of the tracheal tube cuff, and undergoing surgeries lasting longer than three hours. Patients with a history of anomalies or surgery in the pharynx or mouth were also excluded from the study. Also, considering the significant variations in pain thresholds among different individuals, the study has made efforts to exclude addicts and patients who have previously used painkillers.

Standard anesthesia induction was equally performed. The model was an anesthesia machine and was Medec and calibrated within the last month. Ventilator settings were calibrated according to each patient's ideal body weight (IBW), and a lung-protective strategy was consistently applied. Preoxygenation was performed using a face mask with 100% oxygen at an oxygen flow rate of 6-8 L/min for at least three minutes. Propofol (1.5–2 mg/kg, IV), Atracurium (0.5 mg/kg, IV), Sufentanil (0.2–0.3 µg/kg, IV slowly over 30–60 sec), and Midazolam (0.02–0.05 mg/kg, IV) were used to induce anesthesia in all patients. Intubation was performed using Macintosh Laryngoscope blade size 3 or 4, depending on anatomy. Direct visualization, bilateral auscultation, and $ETCO_2$ monitoring was done to confirm correct intubation and accurate ventilation. On a volume-controlled ventilation, the following setting was applied: tidal volume: 6-8 ml/kg body weight; respiratory rate: 12-14/min; FiO_2 of 0.5-1.0; PEEP: 5 cmH_2O; I/E ratio: 1:2; and target $ETCO_2$: 35-45 mmHg. Intraoperative maintenance was carried on using Propofol (100-15 µg/kg/mi based on BIS (target: 40–60)), Remifentanil (0.05–2 µg/kg/min, continuous IV infusion), and Atracurium (0.1 mg/kg every 20 minutes).

The adequacy of neuromuscular blockade was assessed using a Train-of-Four (TOF) device, and the ETT cuff pressure was measured using a cuff manometer (VBM cuff pressure gauge with hook) every 30 minutes until the end of the surgery and maintained between 20 and 25 cm H_2O. The anesthesiologist adjusted the anesthesia machine settings based on the patient's weight and end-tidal CO_2 ($ETCO_2$) levels. Laryngoscopy was performed with a Macintosh blade by an anesthesiology resident (with over 2 years of experience), and the Cormack-Lehane grade was documented. Lubricant or local anesthesia was not used during intubation. All patients were extubated after the operation with a reversible injection of neostigmine and atropine.

Following the administration of a reversal agent, all patients were extubated in a semi-conscious state. Any occurrence of respiratory complications—such as bronchospasm or laryngospasm—during extubation led to the exclusion of the patient from the study, as previously stipulated in the exclusion criteria that encompassed intraoperative respiratory events.

The primary outcomes were the incidence of POST and hoarseness assessed based on patient self-reporting at 1-, 6-, and 24-hours post-surgery. To ensure an unbiased assessment, the evaluation was carried out by an independent observer not involved in the surgical or anesthetic procedures. The intraoperative clinical data including the ETT size, Malampati and Cormack-Lehane grades, airway pressure at the beginning of surgery and every 30 minutes after that, and the total duration of intubation as well as blood stains on the tracheal tube or in saliva upon extubation, using adjuncts such as nasogastric tubes (NGT) or oral airways, and any intubation-related complications or issues were also recorded for each patient. In case of nausea and vomiting, ondansetron was used, but the drug regimen was the same for all people. Patients were extubated while awake. Pain explained to the patient based on a pain scale: "If the worst pain you have ever experienced in your life is 10 and the numbness is 0, what would you rate your pain on a scale of 1 to 10?". Pain intensity was classified using a numerical rating scale, with scores interpreted as follows: 0 indicated no pain, 1–3 denoted mild pain, 4–6 represented moderate pain, and 7–10 reflected severe pain.

Data were analyzed using SPSS (Chicago, IL, USA) (version 24). The Chi-square test (or Fisher's exact test) was used to compare the incidence of sore throat between the two groups in each gender, the Paired t-test (or Wilcoxon) was used to compare the mean sore throat within a group, and the repeated measure ANOVA (or Fried test) was used to compare the mean sore throat between the two groups at different time points. $P<0.05$ was considered statistically significant.

Ethical Consideration

This study was extracted from the research project and approved by the ethics committee of Mashhad University of Medical Sciences (ethics code: IR.MUMS.IRH.REC.1402.112) and registered at the Iranian Registry of Clinical Trials (IRCT20230825059253N1).

Results

Out of a total of 356 patients undergoing laparoscopic surgeries, 160 participants met the inclusion criteria and their data were analysed. Patients in the intervention and control groups were homogeneous in terms of gender (p=0.124) and age (p=0.124) (Table 1).

Table 1: Gender and age distribution among the study participants

Gender	ETT Size	N (%)	Age Mean (Range)
Male	7.5	41 (25.6)	48 (40-55)
	6.5	40 (25)	46 (38-55)
Female	7	39 (24.4)	44 (35-53)
	6	40 (25)	42.5 (33.25-52.75)
P-value		0.124*	0.124**

*Chi-square test, ** Kruskal-Wallis test

Table 2: Distribution of Mallampati and Cormack-Lehane scores, BMI, and comorbidities among the study participants

Variable	Control (n=80)	Case (n=80)	P-value*
Mallampati Class			
I	3 (3.8)	10 (12.5)	
II	46 (57.5)	43 (53.8)	0.209
III	29 (36.3)	24 (30)	
IV	2 (2.5)	3 (3.8)	
Cormack-Lehane Grade			
I	16 (20)	5 (6.3)	0.574
II	50 (62.5)	48 (60)	
III	14 (17.5)	19 (23.8)	
BMI (kg/m^2)			
<18.5	1 (1.25)	4 (5)	
18.5-24.9	31 (38.75)	31 (38.7)	0.209
25-29.9	36 (45)	35 (43.7)	
30-34.9	12 (15)	10 (12.5)	
Comorbidities			
Diabetes Mellitus	17 (21.3)	10 (12.5)	0.14
Hypertension	14 (17.5)	16 (20)	0.685
Smoking	14 (17.5)	19 (23.7)	0.329
Thyroid Disease	8 (10)	3 (3.8)	0.118
Chronic Liver Disease	1 (1.3)	4 (5)	0.173
Neurologic Disease	2 (2.6)	2 (2.5)	>0.99
Anesthesia Time (min)	101.8±20.7	100.9±20	0.761
Surgery Time (min)	71.2±22.7	72.3±19.7	0.692
NGT	20 (25)	18 (22.5)	0.71
Oral Airway	46 (57.5)	42 (52.5)	0.525
Blood Stain on ETT/in saliva	9 (11.3)	12 (15)	0.761
Post-Extubation Hoarseness			
1 h	16 (20)	6 (7.5)	0.022
6 h	3 (3.8)	2 (2.5)	0.65
24 h		Not Seen	
Post-Extubation Sore Throat			
1 h, No	22 (56.4)	33 (82.5)	
Mild	9 (23.1)	5 (12.5)	0.058
Moderate	6 (15.4)	2 (5.1)	
Severe	2 (5.1)	-	
6 h, No	27 (69.2)	36 (90)	
Mild	10 (25.6)	4 (10)	0.046
Moderate	2 (5.1)	-	
Severe	-	-	
24 h, No	34 (87.2)	39 (97.5)	
Mild	5 (12.8)	1 (2.5)	0.083
Moderate	-	-	
Severe	-	-	

*Chi-square test; Quantitative variables are presented as mean ± standard deviation (SD), qualitative variables are expressed as frequency (percentage)

No significant difference was found between the two study subgroups in Mallampati and Cormack-Lehane scores as well as the BMI (Table 2). The distribution of comorbidities including the diabetes mellitus, hypertension, smoking, thyroid disease, chronic liver disease, and neurologic disease were also homogeneous among the study groups (Table 2). No significant difference was seen in the anaesthesia and surgery time, having a NGT or an oral airway, and any blood stain on the ETT or in the patient's saliva (Table 2).

The incidence of hoarseness one hour after surgery was significantly lower in the intervention group (7.5%) compared to the control group (20%) ($P<0.05$). No complaint of hoarseness was recorded 6 and 24 hours after surgery. The sore throat at 6 hours post-surgery was significantly lower in the intervention group than in the control group ($P<0.05$), but was not significant at 1 and 24 h hours after surgery.

The end-inspiratory airway pressures (Plat) at various situations (post-intubation, post-CO2-insufflation, 30-minute post-intubation, and pre-extubation) were homogeneous among the case and control groups in both genders (Figure 2-A&B). However, the peak inspiratory pressures at various situations were significantly higher in both male and female patients with smaller ETT sizes (Figure 2-C&D). Airway pressure was measured by the anesthesia machine or device. Intra-abdominal pressure was continuously monitored and maintained within safe limits; the surgical team was not permitted to exceed the set pressure threshold. Furthermore, the endotracheal tubes used were uniform in type, manufacturer, and gender-specific size.

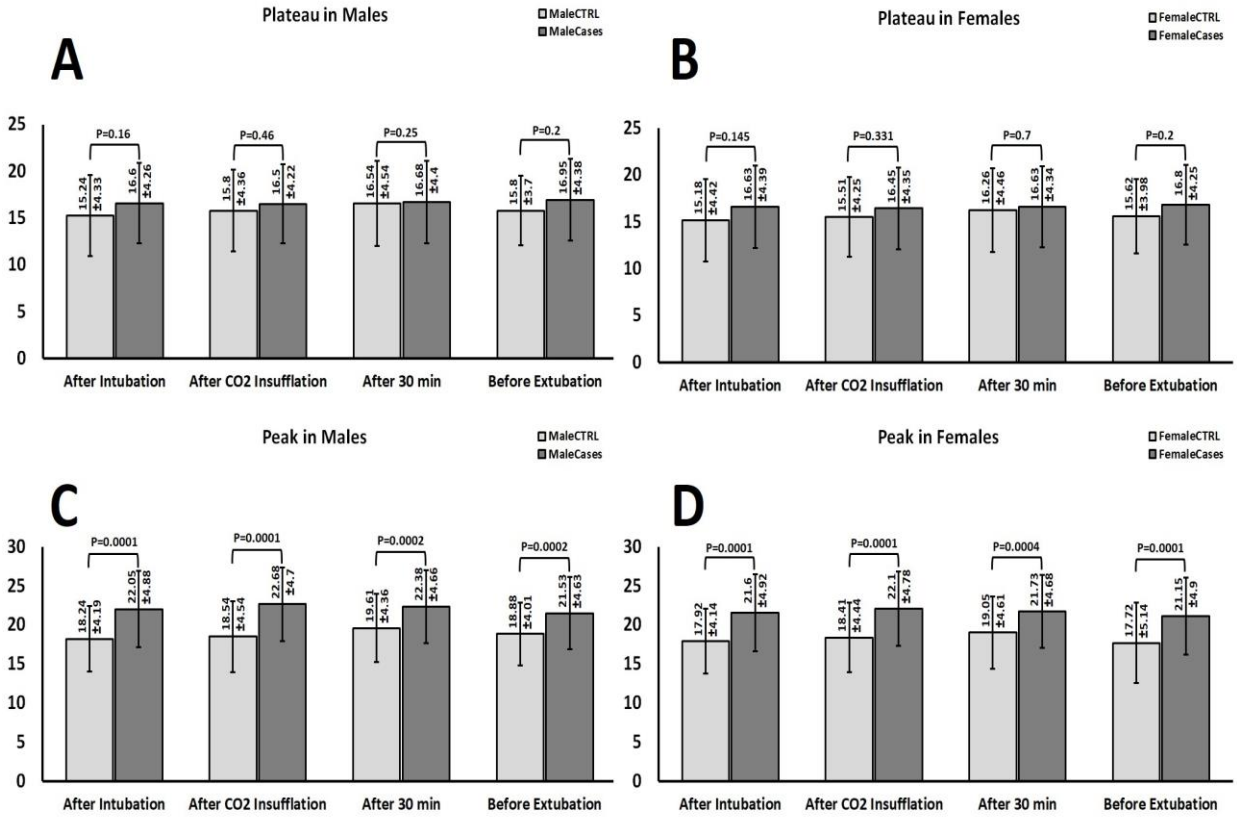

Figure 2: Comparison of plateau and peak airway pressures in male and female participants at different time points, A) plateau in Males, B) plateau in Females, C) Peak in Males, and D) Peak in Females

Discussion

The purpose of the present study was to investigate the impact of using smaller ETTs on post-extubation hoarseness and sore throat among patients undergoing laparoscopic surgeries under general anesthesia. Smaller ETTs may result in increased airway resistance and work of breathing. Typically, a 6.5 or 7-mm ETT is used for females and a 7.5 or 8-mm ETT is used for males. The findings suggest that using smaller ETTs can effectively reduce postoperative hoarseness and sore throat.

Notably, patients intubated with smaller ETTs showed reduced hoarseness one hour postoperatively, supporting the hypothesis that smaller tubes cause less tissue damage, thus reducing inflammation and irritation. The discussion also touches upon the multifactorial nature of postoperative hoarseness. However, direct manipulation of the vocal cords during intubation is a likely contributor. Other factors, such as dry anesthetic gases, cuff pressure, and the inherent mechanics of airway management, also play significant roles (13). ETT size can significantly affect the incidence of postoperative hoarseness. Previous studies have further supported the connection between tracheal tube size and the likelihood of POST and hoarseness, identifying the complexity of factors influencing these outcomes (14). Moreover, the comparison of findings from different studies sheds light on the ongoing debate in the anesthesiology community. Zhu et al.'s work, which indicates that smaller ETTs (6.0 mm instead of regular 7.0 mm) are associated with a lower incidence of postoperative hoarseness in female patients (15), contrasts with Jung et al.'s findings, which suggest no significant difference based on tube size (16). These discrepancies highlight the necessity for further research, as variations in methodology, patient populations, and surgical settings can all contribute to differing results. The role of cuff pressure is also particularly noteworthy. As indicated, maintaining cuff pressure below 30 cm H_2O can mitigate the incidence of hoarseness and sore throat, suggesting that both ETT size selection and careful cuff pressure management are important.

As highlighted in Hu et al.'s systematic review, the use of a 6.0 mm ETT is associated with significantly lower incidence of POST (49%) compared to a 7.0 mm ETT (61%). This finding is consistent across multiple studies, indicating that smaller ETTs lead to reduced trauma to the tracheal mucosa, which is crucial in minimizing inflammatory responses and subsequent pain. (10). An earlier study by Stout et al. corroborates these findings, demonstrating that in women, the use of smaller ETTs (6.5 mm) resulted in lower incidence of postoperative hoarseness and sore throat compared to larger tubes (8.5 mm) (14). This finding emphasizes the importance of tube size in women, who may have anatomically smaller airways, making them more susceptible to injury from larger tubes. Jaensson et al. reported significant differences in POST incidence based on tracheal tube size, with 51% patients intubated with 7.0 mm ETT experiencing sore throat compared to only 27.1% with a 6.0 mm ETT (17). These differences suggest that even a 1 mm reduction in ETT size can significantly impact the patient outcomes.

The study regarding post-thyroidectomy patients indicates a concerning trend with larger ETTs: a 22% incidence of sore throat with a 7.0 mm ETT compared to 78% with an 8.0 mm ETT suggests that type of surgery and the specific anatomy of patient also play a role in determining the suitable tube size (19). According to the findings of Obsa et al., patients intubated with ETTs of 7.5 mm or larger are 1.5 times more likely to develop sore throat post-surgery (19). These findings align with our study results that using a smaller tracheal tube during laparoscopic surgeries significantly reduced POST, particularly within the 6-hour post-operation. This increased risk underscores the need for careful selection of ETT sizes based on the individual's anatomy and the type of procedure performed. The results of the current study affirm the existing literature by showcasing that using a smaller tracheal tube during laparoscopic surgeries leads to a significant reduction in POST, particularly within the 6-hour post-operation. This aligns with the notion that minimizing airway trauma using appropriately sized ETTs can facilitate better postoperative recovery. These results should encourage anesthesiologists to prioritize patient comfort and recovery by selecting ETT sizes tailored to each patient's needs. Some limitations to this pilot study need to be acknowledged. The results may not apply widely to all patient populations, as it was a single-center study. Additionally, this study did not address several factors influencing the outcomes, such as intubation without neuromuscular blockades, high cuff pressure, coughing during intubation, suction before intubation, and the need for airway maneuvers post-intubation. Future research should aim to further clarify these relationships, possibly incorporating larger sample sizes or diverse populations to ensure the generalizability of findings and investigate additional factors that may influence postoperative complications related to airway management.

Implications for practice

The present study found that using smaller tracheal tubes significantly reduces the incidence of postoperative hoarseness and sore throat in both men and women undergoing laparoscopic surgery. The smaller tubes lowered hoarseness one hour after surgery and reduced sore throat at 6 hours post-

surgery. These results suggest that smaller tracheal tubes can minimize postoperative complications resulting from trauma and prolonged intubation. Further research with larger and diverse populations is needed to confirm these findings and explore the impact of different tube sizes on postoperative outcomes.

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Conflicts of interest
The authors declared no conflict of interests.

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Authors' Contributions
A.M contributed to conceptualization, methodology, formal analysis and investigation, and data gathering. P.N performed writing - original draft preparation. A.S.H and M.T conducted supervision on the study. M.A contributed to writing - review and editing. All authors checked and approved the final version of the manuscript for publication in the present journal.

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