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Correlation of Endotracheal Tube Size with Sore Throat and Hoarseness Following General Anesthesia

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Sore throat and hoarseness often follow general anesthesia administered *via* an endotracheal tube.[1–3] Numerous studies have investigated the role of cuff size and shape, cuff pressures, use of lubricant, method of tube sterilization, and other factors as contributing causes,[4–10] but the influence of tube size has not been systematically examined.

Larger endotracheal tubes in dogs exert higher pressures at the tube mucosal interface.[11] Additionally, large cuffs cause a greater area of mucosal trauma due to a large surface contact area—despite lower cuff pressure.[12] We hypothesized that smaller endotracheal tubes with proportionately smaller cuffs, lower pressures at the laryngeal interface, and less surface area for mucosal contact would reduce laryngeal damage and the incidence of sore throats and hoarseness. To test our hypothesis, we correlated the size of endotracheal tubes with the frequency of postoperative patient complaints of sore throat and hoarseness.

METHODS

After obtaining approval from the Human Subjects Committee of our institution and informed consent from patients, postoperative sore throat and hoarseness were evaluated in 101 adults, ages 17–85 yr. All patients underwent orotracheal intubation for surgical procedures not involving the head or neck and not requiring placement of a nasogastric tube. Patients were randomly assigned, according to the last digit of their birth year, to have their trachea intubated with either a large or small tube. For men, a 9.0-mm inner diameter polyvinylchloride tube (Portex, Inc., Wilmington, MA) was the "large" tube, and 7.0-mm was used to designate the "small" tube. In women, the "large" and "small" tubes were 8.5 mm and 6.5 mm, respectively. No lubricant was used, and cuffs were inflated to a volume 1 ml above that needed to prevent gas leak at 35 cm H_2O pressure. Cuff volumes were checked hourly and adjusted for volume changes due to N_2O diffusion into the cuff.[13] The anesthesiologist administered his or her preferred anesthetic, and completed a questionnaire to allow comparison of the groups by anesthetic, smoking history, intubation difficulty, coughing with the tube in place, length of procedure, patient position, spontaneous *versus* mechanical ventilation, use of muscle relaxants, and the use of an oral/nasal airway or esophageal stethoscope. The tracheas of all patients were extubated at the conclusion of the procedure. Patients were informed that tube size was randomized, but were unaware of the objectives of the study. Each patient was interviewed 24–48 h after the end of anesthesia by one of the authors who was unaware of the tube size used. Standardized questions of increasing specificity were employed to help control observer bias. Hoarseness and sore throat were graded on a 0–3 scale, as follows. sore throat: 0 = none, 1 = less severe than with a cold, 2 = similar to that noted with a cold, 3 = more severe than with a cold. Hoarseness: 0 = none, 1 = noted by patient, 2 = obvious to observer, 3 = aphonia. Comparisons between groups were performed using the Mann-Whitney U test.

RESULTS

Sixty-six men and 35 women were studied, reflecting the population seen at our hospital. There were no differences between the large and small groups with respect to age, choice of anesthetics, length of anesthetic, smoking history, difficulty with intubation, use of succinylcholine, patient position, type of ventilation, use of oral airway and/or esophageal stethoscope, or coughing with the tube in place. The only complication apparently due to the tube size was an inability to pass the large size tube in one female patient, who was excluded from the study. Sore throat and hoarseness may have

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TABLE 1. Correlation Between Tube Size and Postoperative Sore Throat and Hoarseness

	Tube Size	Sore Throat (Percent)	Hoarseness (Percent)
		($P < 0.02$)	($P < 0.2$)
Men	7.0	22	14
(n = 66)	9.0	45	24
		($P < 0.05$)	($P < 0.08$)
Women	6.5	22	28
(n = 35)	8.5	53	47
		($P < 0.002$)	($P < 0.05$)
Combined	Small	22	18
(n = 101)	Large	48	33

occurred as isolated complaints, or may have occurred in combination. Table 1 summarizes the incidence of sore throat and hoarseness in our population. Sore throat occurred in 22% of the combined small tube group and 48% of the large group. Breaking the incidence down by sex, the relative frequency of sore throat was similar in men and women. The severity of the sore throat is summarized by figure 1. The small tube sore throat incidence of 22% was nearly all rated level 1. The large tube group showed a significant shift toward more severe symptoms, with more than 25% of the group reporting a sore throat severity rating of 2. No patient rated his or her sore throat a 3. Thirty-three percent of all patients intubated with large tubes were hoarse, compared to 18% of patients who received a small tube. By sex, a higher incidence of this complaint was seen in female patients. Women reported hoarseness more than twice as frequently as males—37% *versus* 18% ($P < 0.05$). Figure 2 summarizes the severity of hoarseness. Although not statistically significant, a trend toward greater severity is suggested in the large-tube group. Again, as with sore throat, no patient was graded level 3.

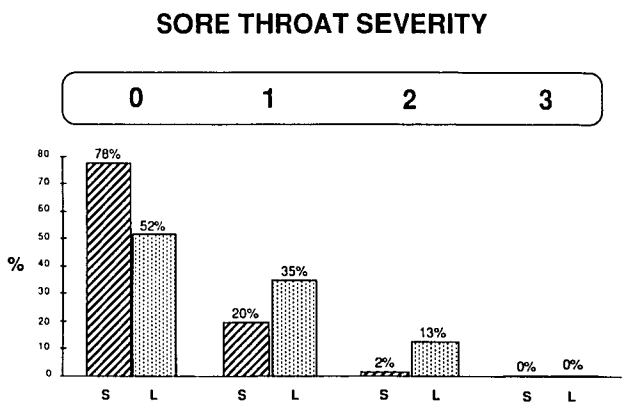

FIG. 1. Severity of sore throats. S = small endotracheal tube; L = large endotracheal tube. Numbers above graphs correspond to severity of symptoms. See text.

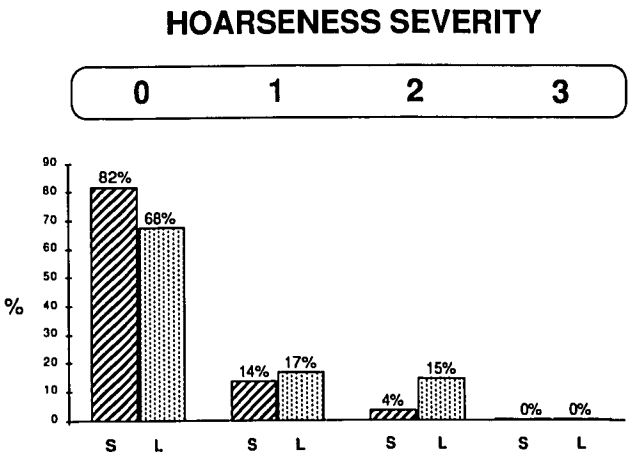

FIG. 2. Severity of hoarseness. S = small endotracheal tube; L = large endotracheal tube. Numbers above graph correspond to severity of symptoms. See text.

Table 2 correlates tube size with other factors which may have contributed to causing sore throats in our population. No statistically significant differences were seen between the groups in any of the measured parameters. Neither smoking nor use of succinylcholine was an independent factor leading to sore throat in our population, with 34% (21 of 61) of smokers and 34% (22 of 65) of patients with succinylcholine use having developed a sore throat. This value is identical to our overall incidence.

DISCUSSION

This study demonstrates that the incidence and severity of postoperative sore throat and hoarseness after endotracheal intubation is reduced by the use of smaller tubes. All of the tube sizes used in this study are commonly accepted for use and are considered safe for routine general anesthesia. The use of small tubes did not result in complications due to tube obstruction, kinking, or difficulty in maintaining adequate ventilation in the spontaneously breathing patient. We did not specifically measure changes in ventilation with the various tube sizes. However, it has been previously shown that, in patients with normal to slightly elevated minute ventilation, as in our patient population, smaller tubes do not add an unacceptable level of resistance to the airway.[14] Negligible decreases in minute ventilation and no change in functional residual capacity have been demonstrated to occur in normal anesthetized patients breathing through a tubular resistor equivalent to a 6-mm endotracheal tube.[15] Large tube complications, as previously mentioned, consisted of one female patient who had to be excluded from the study due to an inability to pass the larger tube. Even though the etiology of sore throat and hoarseness is multifactorial, we

TABLE 2. Correlation of Factors Known to Cause Sore Throat with Our Patient Population (All Values in Percent Except Where Noted)

	Esophageal Stethoscope	Oral Airway	Difficult Intubation	Coughing While Intubated	Mechanical Ventilation	Smoker	Succinylcholine	Length of Procedure (Min)
All Small Tubes	91	73	15	37	82	56	59	190
With ST	92	75	25	33	83	50	50	178
Without ST	90	72	12	38	81	58	64	199
All Large Tubes	93	78	11	33	82	73	70	182
With ST	91	73	18	45	86	68	63	148
Without ST	96	83	8	22	79	81	75	211

conclude that the size of the endotracheal tube is a significant contributor to overall patient satisfaction. When not constrained by the presence of copious or thick secretions, or by the need for a low resistance airway due to high inspiratory flow rates, postoperative patient comfort can be enhanced by choosing small endotracheal tubes.

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