

# Pharyngolaryngeal Morbidity with the Laryngeal Mask Airway in Spontaneously Breathing Patients

## Does Size Matter?

Deirdre M. Grady, F.F.A.R.C.S.I.,\* Fiona McHardy, F.R.C.A.,\* Jean Wong, F.R.C.P.C.,† Fengling Jin, M.D.,‡  
Doris Tong, F.R.C.P.C.,† Frances Chung, F.R.C.P.C.‡

**Background:** Currently, the manufacturer of the laryngeal mask airway (LMA™; Laryngeal Mask Company, Ltd., Northfield End, Henley on Thames, Oxon, United Kingdom) recommends using as large a mask size as possible. The aim of this study was to compare the incidence of pharyngolaryngeal morbidity after the use of a large (size 5 in males and size 4 in females) or small (size 4 in males and size 3 in females) LMA in spontaneously breathing patients.

**Methods:** A total of 258 male and female patients were randomly assigned to insertion of a large or small LMA while breathing spontaneously during general anesthesia. After insertion of the LMA, a "just-seal" cuff pressure was obtained, and intracuff pressure was measured at 10-min intervals until just before removal of the LMA. The 2- and 24-h incidence of postoperative sore throat, pain, hoarseness, dysphagia, and nausea and vomiting was assessed. Complications after LMA removal, including body movement, coughing, retching, regurgitation, vomiting, biting on the LMA, bronchospasm, laryngospasm, or the presence of blood on the LMA, were recorded.

**Results:** The use of a large LMA was associated with a higher incidence of sore throat in both sexes (20% vs. 7% in men, 21% vs. 5% in women;  $P < 0.05$ ) and a higher incidence of hoarseness in male patients at 2 h postoperatively (21% vs. 9%,  $P < 0.05$ ). There was a higher incidence of sore throat in male patients at 24 h postoperatively with the use of a large LMA (26% vs. 12%,  $P < 0.05$ ). There was no difference in the incidence of complications of LMA removal or other pharyngolaryngeal morbidity, such as difficulty swallowing, drinking, and eating, or nausea and vomiting, between male or female groups at any time period with the use of a large LMA.

**Conclusions:** Selection of a small laryngeal mask airway (size 4) in spontaneously breathing male patients may be more appropriate to limit the occurrence of sore throat on the first postoperative day. All patients had a fourfold increased risk of developing sore throat when a large LMA was used.

MAJOR mortality and serious morbidity in the ambulatory population are rare. Hence, less serious but more common postoperative adverse outcomes such as sore throat have assumed greater importance. Sore throat present at 24 h postoperatively has been shown to be a

predictor of postoperative functional level after ambulatory anesthesia.<sup>1</sup>

With increasing use of the laryngeal mask airway (LMA), it is important to identify and quantify the incidence of minor pharyngolaryngeal morbidity associated with its use. Previous publications have quoted a sore throat incidence ranging from 0 to 29% with LMA use.<sup>2-6</sup> However, to our knowledge, there have been no prospective, randomized, controlled studies to date specifically comparing the incidence of sore throat with the use of different sizes of LMA.

Originally, the manufacturer of the LMA recommended insertion of size 3 LMA in children and small adults weighing more than 30 kg, size 4 in normal adults, and size 5 in large adults.<sup>7</sup> More recently, Brain and other investigators have recommended the routine use of a larger LMA (*i.e.*, size 5 in males and size 4 in females).<sup>8-13</sup> Many of these studies cite lower oropharyngeal leak pressure during positive pressure ventilation as the primary reason for this recommendation. However, it may be more appropriate to use a smaller LMA in spontaneously breathing patients, in whom leak pressures are less critical to effective functioning of the LMA.

There are conflicting reports in the literature regarding limitation of laryngeal mask cuff pressure and the incidence of postoperative sore throat symptoms. One study showed that reducing cuff pressure to the minimum pressure required to prevent air leakage reduced sore throat incidence from 8 to 0%.<sup>3</sup> Another study, however, concluded that limitation of intracuff pressure did not reduce the incidence of sore throat, hoarseness, or dysphagia.<sup>14</sup>

We hypothesized that by using a larger LMA, which has a larger cuff size relative to the hypopharynx, a lower inflation volume would be needed to provide an adequate seal in spontaneously breathing patients. This would lead to a lower intracuff pressure and possibly a lower incidence of postoperative pharyngolaryngeal complaints.

We therefore conducted a prospective, double-blind, randomized, controlled study to compare the incidence of postoperative sore throat, hoarseness, dysphagia, and nausea and vomiting in males and females after the use of a large (size 5 in males and size 4 in females) or small LMA (size 4 in males and size 3 in females) in patients breathing spontaneously during general anesthesia. Our

\* Clinical Research Fellow, † Staff Anesthesiologist, ‡ Research Fellow, § Professor of Anesthesiology.

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Address reprint requests to Dr. Chung: Department of Anesthesia, Toronto Western Hospital, 399 Bathurst Street, Toronto, Ontario, M5T 2S8, Canada. Address electronic mail to: Frances.Chung@uhn.on.ca. Individual article reprints may be purchased through the Journal Web site, www.anesthesiology.org.

secondary objectives were to compare LMA intracuff pressures and complication rates of LMA insertion and removal with a large and small LMA.

## Materials and Methods

A total of 258 adult ambulatory patients, American Society of Anesthesiologists physical status I-III, who were scheduled to undergo short (< 1-2 h) surgical procedures with general anesthesia using an LMA were included in the study. Institutional Ethics Committee (University Health Network, Toronto, Ontario, Canada) approval was obtained, and all patients gave informed written consent. Exclusion criteria included patients with a history of recent (within the previous month) sore throat or upper respiratory tract infection or contraindications to the use of an LMA. Contraindications included morbidly obese patients, patients with increased risk of regurgitation-aspiration, or those with a potentially difficult airway.

Patients were randomized to receive either a large (size 5 in males and size 4 in females) or small (size 4 in males and size 3 in females) LMA. Computer-generated block randomization, using randomization blocks of 10, was used.

The LMAs were not tested for microleaks before use. However, they were tested for macroleaks by submersion in water before use. Before insertion, the pilot tube of each LMA was attached *via* a three-way tap to a 50-ml syringe and an airway pressure manometer (MSG Inc., Iowa). The manometer was calibrated by our engineering department and tested for leaks on three occasions during the study. The manometer was set to zero before each case, and the LMA cuff was evacuated to a baseline pressure of -25 mmHg. The LMA cuff was lubricated using a water-based gel.

Anesthetic management was standardized. Monitoring was applied before induction and included an electrocardiograph, pulse oximeter, capnograph, and noninvasive blood pressure monitor. Patients were preoxygenated, and anesthesia was induced with 1 µg/kg fentanyl and 2-2.5 mg/kg propofol. Anesthesiologists (n = 7) with a more than 5-yr anesthesia practice inserted the LMAs. The patient's head and neck was placed in the sniffing position, and the LMA was inserted using the standard technique as described by the manufacturer.<sup>7</sup> LMA insertion conditions judged by the anesthesiologists to be "easy," "fair," or "difficult," and number of LMA insertion attempts were recorded. This judgment was left to the discretion of the individual anesthesiologist. Failure to insert the LMA after three attempts required a switch to a smaller LMA or tracheal intubation. Complications of LMA insertion, including body movement, coughing, hiccuping, retching, laryngospasm, and regurgitation, were recorded by an unblinded observer.

After insertion, the LMA cuff was inflated with the maximum recommended inflation volumes of air (20, 30, and 40 ml air for size 3, 4, and 5 LMA, respectively).<sup>7</sup> The cuff was then gradually deflated by increments of 2 ml of air until a "just-seal" pressure was obtained. The absence of an audible leak at 10-cm H<sub>2</sub>O inflation pressure and synchronized expansion of the chest on positive pressure ventilation and capnography ascertained an adequate seal. Inflation pressure at 10 cm H<sub>2</sub>O was chosen because this is the minimum pressure that has been recommended to protect the larynx from aspiration.<sup>15</sup> The pressure manometer and 50-ml syringe remained attached to the LMA until the end of anesthesia, and cuff pressure was monitored and recorded at 15-min intervals during the case.

Anesthesia was maintained with 0.5-2% inspired concentration isoflurane in 66% N<sub>2</sub>O and oxygen using a spontaneous ventilation technique *via* a circle system. The fresh gas flow rate was maintained at 3 l/min. Additional bolus doses of 25 µg fentanyl were given or the inspired isoflurane concentration was increased or decreased to maintain the patient's hemodynamic variables within 20% of baseline values.

At the end of the surgical procedure, anesthesia was discontinued and the patient was administered 100% oxygen. The LMA was removed when patients were able to obey commands and open their mouths fully. Cuff pressure was measured and recorded immediately before removal of the LMA. The LMA cuff was then fully deflated to a pressure of -25 mmHg before LMA removal. The time interval between discontinuation of nitrous oxide and the last intracuff pressure measurement was not recorded. Complications after LMA removal, including body movement, coughing, retching, regurgitation, vomiting, biting on the LMA, bronchospasm, laryngospasm, or the presence of blood on the LMA, were recorded by an unblinded observer.

Postoperative pain management in the postanesthetic care unit and the ambulatory surgery unit (ASU) was standardized. A 1-2-mg bolus dose of intravenous morphine sulfate or 300 mg acetaminophen with 30 mg codeine (1-2 tablets) was given for pain. A 25-50-mg intravenous dose of dimenhydrinate was given for nausea and vomiting. Monitoring and discharge of patients in the postanesthetic care unit and ASU was conducted in a standard manner. Patients were discharged with a prescription for 300 mg acetaminophen with 30 mg codeine (1-2 tablets every 4 hours as needed).

Patients were blinded to the size of LMA used intraoperatively. An unblinded research assistant interviewed patients at 2 and 24 h postoperatively using a standardized questionnaire. Patients were interviewed to determine the incidence and severity of postoperative symptoms such as pain, sore throat, hoarseness, difficulty swallowing, difficulty drinking, difficulty eating, and nausea and vomiting. The severity of these variables was

**Table 1. Patient Characteristics**

	Men, LMA Size 5 (n = 86)	Men, LMA Size 4 (n = 87)	Women, LMA Size 4 (n = 42)	Women, LMA Size 3 (n = 43)
Age (yr)	42 ± 13	44 ± 14	41 ± 16	44 ± 16
ASA status I/II/III	64/21/1	59/27/1	24/18/0	25/18/0
BMI (kg/m <sup>2</sup> )	27 ± 3	29 ± 6	27 ± 6	26 ± 4
Duration of procedure (min)	42 ± 15	38 ± 13	42 ± 14	39 ± 14
Duration of PACU stay (min)	66 ± 20	65 ± 20	71 ± 17	72 ± 16
Duration of ASU stay (min)	56 ± 25	55 ± 21	64 ± 26	55 ± 17

Values are expressed as mean ± SD or number and percentage, whichever is applicable.

LMA = laryngeal mask airway; ASA = American Society of Anesthesiologists; BMI = body mass index; PACU = postanesthesia care unit; ASU = ambulatory surgery unit.

assessed using a visual rating scale ranging from no symptom severity (0) to worst imaginable symptom severity (10). Sore throat was defined as "pain or discomfort in the throat." Hoarseness was defined as "a change in voice quality."

#### Statistical Methods

Separate analyses were conducted among men and women. Intention-to-treat analysis was performed. Continuous variables were compared between the groups with different LMA sizes using the Student *t* test, and categorical variables were compared using the chi-square test. To adjust for differences in the distribution of potentially confounding variables between the groups, multiple logistic regression was used, including variables representing sex, age, body mass index, and duration of the procedure in addition to the variable representing the size of LMA. To identify additional independent predictors of sore throat, a separate logistic model was built using backward elimination and including variables representing LMA size, sex, age, use of laryngoscope, body mass index, duration of procedure, number of LMA insertion attempts, presence of blood on LMA after removal, and pharyngeal mucosal pressure. *P* < 0.05 was considered statistically significant. All analyses were conducted using SAS statistical software (version 6.12; SAS Institute Inc., Cary, NC).

## Results

Two hundred fifty-eight patients were included in the study (173 men and 85 women; table 1). Of the 173 men, 86 received a size 5 LMA and 87 received a size 4 LMA. Of the 85 women, 42 received a size 4 LMA and 43 received a size 3 LMA. Patient characteristics, type of surgery performed, and duration of stay in the postanesthetic care unit and ASU are described in table 1. The demographic characteristics did not differ significantly among the four patient groups.

The measured LMA intracuff air pressure was higher in the groups with the smaller LMA (size 4 among men and size 3 among women) than in the groups with the larger LMA (size 5 among men and size 4 among women) at both insertion and removal (table 2). The LMA intracuff pressure was higher in patients with the smaller LMA throughout the procedure in both men and women (figs. 1 and 2). The intracuff pressure showed a significant increase, an average of 25 cm H<sub>2</sub>O, during the procedure (*P* < 0.05). The calculated mean difference in intracuff air pressure between the larger and smaller LMA groups was 15 and 13 cm H<sub>2</sub>O in men and women, respectively. Mean cuff volume increase during the procedure and cuff volume at the end of the procedure did not differ significantly between large and small LMA groups. Mean cuff volume increase was low in all groups (table 2). This may be related to the end measurement being made

**Table 2. Intraoperative LMA Cuff Measurements**

	Men, LMA Size 5 (n = 86)	Men, LMA Size 4 (n = 87)	Women, LMA Size 4 (n = 42)	Women, LMA Size 3 (n = 43)
Cuff pressure after insertion (P0; cm H <sub>2</sub> O)*	63 ± 43	79 ± 53	69 ± 50†	100 ± 48
Cuff pressure before removal (P1; cm H <sub>2</sub> O)*	87 ± 45‡	105 ± 55	92 ± 51†	124 ± 43
Cuff pressure after removal (P2, <i>in vitro</i> ; cm H <sub>2</sub> O)*	40 ± 50‡	72 ± 61	51 ± 60†	94 ± 53
Pharyngeal mucosal pressure (P1–P2; cm H <sub>2</sub> O)*	48 ± 18‡	33 ± 28	42 ± 21†	29 ± 20
Mean cuff pressure increase during operation (P1 to P0; cm H <sub>2</sub> O)*	25 ± 27	26 ± 26	23 ± 21	24 ± 26
Cuff inflation volume (V0; ml)	27 ± 8	25 ± 8	21 ± 6	20 ± 5
Volume of air in cuff at end of operation (V1; ml)	28 ± 9	28 ± 14	22 ± 6	22 ± 5
Mean cuff volume increase during operation (V1 to V0; ml)	1 ± 5	3 ± 12	2 ± 3	2 ± 3

\* Pressure measurements were completed for 69 size 5 men, 71 size 4 men, and all women. † *P* < 0.05 among women, comparing size 4 and size 3. ‡ *P* < 0.05 among men, comparing size 5 and size 4.

LMA = laryngeal mask airway.

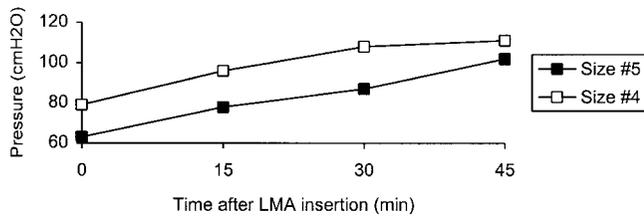


Fig. 1. Laryngeal mask airway (LMA) intracuff pressure by LMA size and time during operation among men ( $n = 140$ ).

sometime after discontinuation of nitrous oxide as the time interval between discontinuation of nitrous oxide and cuff volume measurement was not controlled in our study.

The incidence of intraoperative complications, such as coughing, retching, laryngospasm, and bronchospasm, was not significantly different between the groups (table 3). However, the LMA had to be changed to a smaller size more often in men with LMA size 5 compared with men with LMA size 4 (8% vs. 1%,  $P < 0.05$ ). Conditions of LMA insertion, as described by the anesthesiologists, was significantly more often “fair” and “difficult” as opposed to “easy” in the groups with the larger LMA than in the groups with the smaller LMA among both men and women. The number of patients with more than one insertion attempt was also significantly higher in men with LMA size 5 than in men with LMA size 4 (fig. 3).

In the ambulatory surgical unit, the incidence of sore throat was significantly higher in patients with larger LMA (20% vs. 7% among men,  $P < 0.05$ ; 21% vs. 5% among women,  $P < 0.05$ ; tables 4 and 5). Hoarseness was also more frequent in men with LMA size 5 than in men with LMA size 4 (21% vs. 9%,  $P < 0.05$ ). In women, LMA size was not associated with the occurrence of hoarseness. The incidence of other symptoms did not differ significantly between patients with larger or smaller LMA.

The 24-h incidence of sore throat was higher in men with LMA size 5 than in men with LMA size 4 (26% vs. 12%,  $P < 0.05$ ; table 5). There was no difference in the 24-h incidence of sore throat between women with LMA size 4 and women with LMA size 3 (20% vs. 21%). Other postoperative symptoms, such as difficulty swallowing, drinking, and eating, or nausea and vomiting, occurred with similar frequencies among patients with larger and smaller LMA, in both men and women.

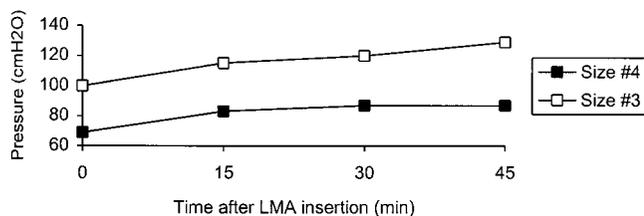


Fig. 2. Laryngeal mask airway (LMA) intracuff pressure by LMA size and time during operation among women ( $n = 85$ ).

The incidence of sore throat showed an increasing trend in both the ASU and at 24 h with an increasing number of LMA insertion attempts (fig. 3). When we compared the incidence of sore throat between patients with a large and small LMA, excluding patients with more than one insertion attempt, we found that the difference in sore throat incidence was still significant in men in the ASU. The incidence was 19% versus 6% ( $P < 0.05$ ) in men with LMA size 5 and size 4, respectively.

Comparing patients with and without sore throat, male patients with sore throat in the ASU underwent longer procedures ( $49 \pm 14$  min vs.  $39 \pm 14$  min,  $P = 0.001$ ). After controlling for the effects of sex, age, body mass index, and procedure duration, multiple logistic regression showed that patients with a large LMA had a four-fold increased risk of developing sore throat in the ambulatory surgical unit (odds ratio, 3.9; 95% confidence interval, 1.6–9.1). The risk of developing sore throat at 24 h, however, did not significantly differ with the size of LMA used (odds ratio, 1.6; 95% confidence interval, 0.8–3.1).

A separate logistic model was used to identify independent predictors of sore throat. Variables representing LMA size, sex, age, use of laryngoscope, body mass index, duration of procedure, number of LMA insertion attempts, and presence of blood on LMA after removal were included. Using a backward elimination technique, only the size of LMA was independently associated with the occurrence of sore throat in the ambulatory surgical unit. A similar analysis using sore throat at 24 h as outcome revealed that only duration of procedure was associated with the development of sore throat. For each 10-min increase in duration, the risk of developing sore throat increased by 33% (odds ratio, 1.33, 95% confidence interval, 1.03–1.71).

## Discussion

This study demonstrated that the use of a large LMA was associated with a higher incidence of sore throat in both sexes and a higher incidence of hoarseness in male patients at 2 h postoperatively. There was a higher incidence of sore throat in male patients at 24 h postoperatively with the use of a large LMA. However, use of a large LMA was associated with a lower intracuff pressure. There was no difference in the incidence of other postoperative symptoms such as difficulty swallowing, drinking, and eating, or nausea and vomiting in male or female patients during any time period when a large LMA was used.

There was an increased incidence of sore throat at 24 h in male patients (26% vs. 12%), but no difference was found in the incidence of sore throat in female patients at 24 h (20% vs. 21%). The difference in incidence of sore throat at 24 h may have been caused by the docu-

**Table 3. Intraoperative Complications**

	Men, LMA Size 5 (n = 86)	Men, LMA Size 4 (n = 87)	Women, LMA Size 4 (n = 42)	Women, LMA Size 3 (n = 43)
<b>LMA insertion</b>				
Insertion conditions				
Easy	42 (49%)*	77 (89%)	27 (64%)†	40 (93%)
Fair	35 (41%)*	10 (11%)	9 (21%)†	2 (5%)
Difficult	9 (10%)*	0	6 (14%)†	1 (2%)
No. of insertion attempts				
1	70 (81%)*	79 (91%)	34 (81%)	37 (86%)
2	7 (8%)*	8 (9%)	6 (14%)	5 (12%)
3	9 (10%)*	0	2 (5%)	1 (2%)
Had to change size	7 (8%)*	1 (1%)	2 (5%)	1 (2%)
Laryngoscope used				
Intubated	2 (2%)	0	1 (2%)	0
Body movement	2 (2%)	0	0	0
Coughing	11 (13%)	6 (7%)	4 (10%)	5 (12%)
Hiccups	2 (2%)	3 (3%)	0	2 (5%)
Retching	2 (2%)	2 (2%)	5 (12%)	1 (2%)
Laryngospasm	0	0	0	0
Regurgitation	4 (5%)	2 (2%)	0	3 (7%)
	1 (1%)	6 (7%)	1 (2%)	1 (2%)
<b>LMA removal</b>				
Body movement	1 (1%)	0	2 (5%)	0
Coughing	10 (12%)	9 (10%)	6 (14%)	6 (14%)
Retching	4 (5%)	1 (1%)	1 (2%)	4 (9%)
Regurgitation	0	0	0	0
Vomiting	0	0	0	0
Biting on LMA	11 (13%)	12 (14%)	6 (14%)	2 (5%)
Bronchospasm	2 (2%)	0	1 (2%)	0
Laryngospasm	0	0	1 (2%)	0
Blood on LMA	4 (5%)	0	1 (2%)	5 (12%)

\*  $P < 0.05$  among men, comparing size 5 and size 4. †  $P < 0.05$  among women, comparing size 4 and size 3.

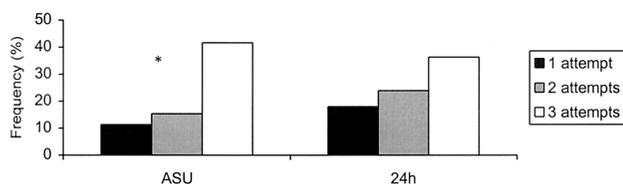
LMA = laryngeal mask airway.

mented differences in laryngopharyngeal anatomy and physiology between males and females.<sup>16,17</sup> However, the number of female patients studied was insufficient to detect a statistical difference in the incidence of sore throat at 24 h. This may be the reason why we did not show a higher incidence of sore throat at 24 h in female patients when a large LMA was used. In ambulatory surgical patients, the occurrence of sore throat is an additional source of patient discomfort and may increase patient dissatisfaction after ambulatory anesthesia.<sup>18</sup>

There was also an increased incidence of hoarseness in male patients in the ASU when size 5 LMA was used (21% vs. 9%). Another study also found a higher incidence of hoarseness in a low-intracuff-pressure group (30 mmHg).<sup>14</sup> Our results show no correlation between intracuff pressures and the incidence of postoperative sore throat or hoarseness. Therefore, routine intracuff pres-

sure monitoring during anesthesia is neither necessary nor beneficial in reducing postoperative laryngopharyngeal complaints.<sup>14,20</sup>

Using multiple logistic regression, our results showed that patients had a fourfold increased risk of developing sore throat in the ASU when a large LMA was used. Trauma to the soft tissues during LMA insertion may account for the higher incidence of postoperative sore throat and hoarseness in the immediate postoperative period. Our study did show that the anesthesiologists inserting the laryngeal masks had more difficulty inserting the size-5 LMA. With the large LMA, the number of male patients with more than one insertion attempt was greater (18% vs. 9%), and the LMA was changed to a smaller size more frequently (8% vs. 1%). In male and female patients, 51 and 35% of large LMA insertions were described as "fair" and "difficult" by the anesthesiologists, versus 11 and 7% of small LMA insertions. These findings are different from those of Brimacombe and Keller.<sup>9</sup> They concluded that sizes 4 and 5 LMA were "easy" to insert in both males and females. However, our patients were not paralyzed. The same investigators suggested that using a mask that is too small may result in local soft tissue damage caused by poor fit around the laryngeal inlet or misplacement into the upper esophagus or the glottic inlet.<sup>12</sup> The lower incidence of sore throat with a smaller LMA in our study suggests that local



**Fig. 3. Frequency of sore throat by number of laryngeal mask airway (LMA) insertion attempts. \*  $P < 0.05$  comparing sore throat frequencies among patient with different number of LMA insertion attempts.**

**Table 4. Symptoms in the Ambulatory Surgical Unit (ASU)**

Symptoms in ASU	Men, LMA Size 5 (n = 86)	Men, LMA Size 4 (n = 87)	Women, LMA Size 4 (n = 42)	Women, LMA Size 3 (n = 43)
Sore throat	17*	6	9†	2
Pain or discomfort anywhere	67*	61	34	35
Hoarseness	18*	8	9	12
Difficulty swallowing	6	2	2	0
Difficulty drinking	4	1	1	0
Difficulty eating	5	1	1	0
Nausea	7	3	4	5
Vomiting	0	0	1	0

\*  $P < 0.05$  among men, comparing size 5 and size 4. †  $P < 0.05$  among women, comparing size 4 and size 3.

LMA = laryngeal mask airway.

soft tissue damage or laryngeal displacement is unlikely to occur with a smaller LMA.

Voyagis *et al.*<sup>13</sup> found that the peak pressure at which airway leak occurred with positive pressure ventilation was greater using a gender-related method of LMA size selection (size 5 in males and size 4 in females) in 300 patients. Other studies found that a larger mask (size 4 in females and size 5 in males) provided a better seal than a smaller size.<sup>10,11</sup> However, in a more recent study, use of a large mask (size 5 in males and size 4 in females) was associated with a greater risk of the cuff being positioned in the oral cavity. This may interfere with surgical procedures such as adenotonsillectomy or result in a higher incidence of postoperative sore throat.<sup>19</sup>

The incidence of sore throat in our study was higher than that found by Burgard *et al.*,<sup>3</sup> who showed a reduction in the incidence of postoperative sore throat from 8 to 0% by monitoring and adjusting cuff pressure to the minimal pressure required for air-tightness. However, there were methodologic differences between the two studies. Burgard *et al.* studied female patients only, selected LMA size according to patient weight, and administered a muscle relaxant to patients. Muscle relaxation may lead to easier insertion of the LMA or, alternatively, a reduction in tone in the pharyngeal musculature and better accommodation to a larger LMA.

In our study, longer procedures were identified as factors predictive of sore throat in males at 24 h. This

finding indicates that sore throat occurring at 24 h is produced by a different mechanism than that which occurs in the early postoperative period in the ASU. Sore throat in the early postoperative period seems to be related to direct pharyngeal trauma, whereas sore throat at 24 h is related to a longer duration of anesthesia.

One potential criticism of our study is that more than one anesthesiologist inserted the LMA, and thus the anesthesiologists' LMA insertion skills may have varied. However, all of the anesthesiologists had considerable experience in LMA insertion and more than 5 yr of anesthesia practice. Even when patients in whom there was more than one attempt at LMA insertion were excluded from the analysis, there was still a higher incidence of sore throat in male patients in the ASU when size 5 LMA was used. Another potential problem with our study is that leak pressure should have been identical between groups after LMA placement, *i.e.*, 10 cm H<sub>2</sub>O. To achieve this value we inflated the cuff to the maximum recommended volume and then deflated it until an audible "just-seal" leak pressure of 10 cm H<sub>2</sub>O was obtained. A problem with this technique is that leak pressure can increase when cuff volume is reduced from the maximum recommended volume.<sup>21</sup> Another potential problem with our study is that the intracuff pressures recorded in our study at a leak pressure of 10 cm H<sub>2</sub>O were much higher than those recorded in previous studies.<sup>9</sup> This could mean there was a high incidence of

**Table 5. Postoperative Symptoms at 24 h**

Symptoms at 24 h	Men, LMA Size 5 (n = 86)	Men, LMA Size 4 (n = 87)	Women, LMA Size 4 (n = 42)	Women, LMA Size 3 (n = 43)
Sore throat	21*	10	8	9
Pain or discomfort anywhere	69*	61	35	36
Hoarseness	5	8	6	4
Difficulty swallowing	4	3	1	3
Difficulty drinking	4	2	0	3
Difficulty eating	3	3	0	3
Nausea	5	5	8	7
Vomiting	2	2	2	1
Returned to normal activity	16 (20%)	27 (32%)	6 (15%)	8 (19%)

\*  $P < 0.05$  among men, comparing size 5 and size 4.

LMA = laryngeal mask airway.

malpositioning of the laryngeal masks in our study or that the methodology used to determine leak pressure was inadequate.

In conclusion, the use of a large LMA was associated with a higher incidence of sore throat in both sexes and a higher incidence of hoarseness in male patients at 2 h postoperatively. The use of a large LMA (size 5) was associated with a higher incidence of sore throat in male patients at 24 h postoperatively. All patients had a four-fold increased risk of developing sore throat when a large LMA was used. However, using multiple logistic regression, sore throat at 24 h was related to a longer duration of anesthesia and not LMA size. Airway-sealing pressure is less critical to effective functioning of the laryngeal mask in spontaneously breathing patients. In male patients, selection of a "small" laryngeal mask airway (size 4) may be more appropriate to limit the occurrence of postoperative symptoms such as sore throat and hoarseness.

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