

## Use of the Laryngeal Mask Airway as an Alternative to the Tracheal Tube During Ambulatory Anesthesia

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We designed a prospective, randomized, multicenter study to compare anesthetic requirements, recovery times, and postoperative side effects when a laryngeal mask airway (LMA) was used as an alternative to the tracheal tube (TT) during ambulatory anesthesia. After induction of anesthesia with midazolam 2 mg, fentanyl 1 µg/kg, and propofol 2 mg/kg, 381 patients were randomly assigned to receive either an LMA ( $n = 207$ ) or TT ( $n = 174$ ) for airway management. In patients assigned to the TT group, succinylcholine 1 mg/kg or a nondepolarizing muscle relaxant was administered to facilitate tracheal intubation. Anesthesia was maintained with volatile anesthetics in combination with nitrous oxide 60% and oxygen. The average time to placement of the two airway devices (5 min) and the failure rates (1%) were similar in the two groups. Although there was a significant decrease in the intraoperative fentanyl requirement in the LMA group, the difference was of little clinical significance. Furthermore, there were no differences

in the volatile anesthetic requirements. The time from end of surgery to removal of the airway device (5 min) was also similar in the two study groups. Although duration of the postanesthesia care unit stay and time to ambulation were significantly shorter in the LMA group, there were no differences in the times to "home readiness." The incidence of nausea and vomiting and the need for rescue antiemetic treatments in the postoperative period were similar in the two airway management groups. However, the incidence of postoperative sore throat was significantly greater in patients receiving the TT (versus the LMA). In conclusion, this study suggests that the LMA is a useful alternative to the TT for airway management during ambulatory anesthesia. Implications: Use of the laryngeal mask airway can obviate the need for insertion of a tracheal tube for many ambulatory surgery procedures, and thereby decrease the incidence of postoperative sore throats.

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**M**any investigators have suggested that the laryngeal mask airway (LMA) offers advantages over the tracheal tube (TT) for ambulatory surgery procedures (1). A recent meta-analysis of randomized, prospective trials reported that the use of

the LMA device was associated with decreased anesthetic requirements and lower incidence of postoperative side effects compared with the TT (2). However, there are no prospective, randomized clinical trials assessing the effects of the choice of airway management device on the anesthetic, analgesic, and muscle relaxant requirements, the incidence of postoperative side effects, and the recovery profile after ambulatory surgery in routine clinical practice.

Therefore, a prospective, randomized, multi-center trial was designed to test the hypothesis that the use of the LMA device was associated with reduced anesthetic and analgesic requirements, earlier awakening, and decreased recovery times when used as an alternative to the TT in outpatients undergoing peripheral surgery.

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## Methods

After obtaining institutional review board approval and informed consent, 381 adult outpatients (ASA physical status I or II) scheduled for elective peripheral surgery requiring general anesthesia were enrolled in this five-site, multicenter, randomized, single-blind study. The patients' airways were managed either with an LMA (Group 1) or a TT (Group 2), as determined by a table of random numbers. Patients with a contraindication to the use of either airway device were excluded from the study. Patients with anticipated airway difficulties, those at increased risk of regurgitation (e.g., history of gastroesophageal reflux, hiatal hernia, previous gastric surgery, or obesity), those with local pharyngeal or laryngeal pathology (e.g., tumor, abscess, hemangioma), or those with decreased lung compliance were excluded from the study.

General anesthesia was induced with midazolam 2 mg intravenously (IV), followed by fentanyl 1  $\mu$ g/kg IV, and propofol 2 mg/kg IV. Lidocaine 20–40 mg IV was administered to prevent pain on injection with propofol. In Group 1, the LMA was inserted after the loss of the eyelash reflex and relaxation of the jaw. The size of the LMA was determined according to the patient's weight (as recommended by the manufacturer). The standard recommended insertion technique (i.e., the LMA was placed with its back pressed against the hard palate and advanced over the tongue) was used by anesthesiologists experienced in the use of this device. If there was difficulty in the insertion of the LMA, the patient's head was repositioned and a supplemental dose of propofol 0.5 mg/kg was administered. If a third attempt was required, the LMA was inserted using a back-to-front technique and/or administering succinylcholine. If the LMA could not be positioned on the third attempt, it was recorded as a treatment failure and the airway was managed using a TT.

In Group 2, succinylcholine 1–1.5 mg/kg, or rocuronium 0.6 mg/kg or mivacurium 0.25 mg/kg, was administered to facilitate the placement of the TT. If there was difficulty in the placement of the TT, a stylet was used. If the TT could not be placed on the third attempt, the LMA was inserted to secure the airway. The number of attempts at insertion and the number of failures with each device, as well as the time from induction to successful airway placement, was recorded. The lungs were manually ventilated until spontaneous respiration resumed except in those patients receiving rocuronium or mivacurium.

Anesthesia was maintained with volatile anesthetics (desflurane or isoflurane) in combination with nitrous oxide (N<sub>2</sub>O) 60% in oxygen. The concentration of the volatile anesthetic was adjusted to provide adequate anesthesia as indicated by the absence of purposeful

movements and hemodynamic stability, with hemodynamic variables maintained within 15% of the pre-induction values. Supplemental doses of fentanyl (25–50  $\mu$ g IV) were administered if the volatile anesthetic alone failed to maintain adequate hemodynamic stability. Monitoring consisted of mean arterial pressure and heart rate, hemoglobin oxygen saturation, end-tidal carbon dioxide values, and end-tidal volatile anesthetic concentrations.

The volatile anesthetic requirement (minimum alveolar anesthetic concentration [MAC] per hour) was calculated using the end-tidal concentrations and the time interval at that concentration. At the end of surgery, residual neuromuscular blockade was reversed with neostigmine and glycopyrrolate if deemed clinically necessary. The airway device was removed when the patient was able to follow simple commands. The time intervals from the end of surgery until removal of the airway device, transfer from the operating room, and transfer from the postanesthesia care unit (PACU) were recorded. The times from admission to the PACU to oral intake, ambulation, and "home readiness" were also noted. The incidence of side effects and the need for therapeutic interventions, as well as the analgesic requirements in the PACU and the Phase II (step-down) unit, were recorded. The patients were contacted 24 h after surgery to inquire regarding the incidence and need for treatment of side effects, as well as their satisfaction with the anesthetic experience.

Data are expressed as mean values  $\pm$  SD. Parametric variables were analyzed using the Student's *t*-test, and the nonparametric variables were analyzed using the Mann-Whitney *U*-test or  $\chi^2$  test with Yates' continuity correction, as appropriate. A *P* value of less than 0.05 was considered statistically significant.

## Results

There were no significant differences in demographic characteristics, type of surgery, or duration of anesthesia and surgery between the two airway management groups (Table 1). There were also no differences in the two groups with respect to the doses of propofol and fentanyl used at induction of anesthesia (Table 2). The times from induction of anesthesia to placement of the airway device were also similar in the two groups (Table 2). The first time insertion rate for the LMA was 91%, whereas that for the TT was 88%, and there was no difference in the failure rate (1%) of the two airway devices (Table 2). Fifteen (7%) patients received succinylcholine to facilitate the placement of the LMA. In the TT group, 55 (32%) patients received either mivacurium or rocuronium. There were no differences in the requirements (MAC/hour) for volatile anesthetics between the two airway groups; however,

**Table 1.** Demographic and Clinical Characteristics in the Two Airway Management Groups

	Laryngeal mask airway	Tracheal tube
No. of patients	207	174
Gender (female/male)	112 /95	102 /72
Age (yr)	39 ± 15	40 ± 14
Height (cm)	167 ± 11	166 ± 11
Weight (kg)	73 ± 17	76 ± 16
Duration of surgery (min)	57 ± 42	67 ± 55
Duration of anesthesia (min)	87 ± 46	97 ± 62
Type of surgical procedure		
Ophthalmologic	2 (1)	3 (2)
Plastic and ear, nose, and throat	7 (3)	13 (7)
Gynecologic	66 (32)	50 (29)
Orthopedic	48 (23)	48 (28)
Urologic	25 (12)	14 (8)
Superficial surgery <sup>a</sup>	49 (24)	39 (22)
Vascular	10 (5)	7 (4)

Values are means ± SD or numbers (percentages).

<sup>a</sup> Includes herniorrhaphy, hemorrhoidectomy, and breast biopsy.

**Table 2.** Insertion Characteristics of the Airway Device, Anesthetic Requirements, and Recovery Profiles in the Two Study Groups

	Laryngeal mask airway	Tracheal tube
Anesthetic drugs and doses		
Propofol (mg)	146 ± 37	147 ± 42
Fentanyl at induction (μg)	91 ± 32	100 ± 27
Volatile anesthetics (MAC[%]/hour)	1.7 ± 1.1	1.8 ± 1.4
Fentanyl during maintenance (μg)	148 ± 78*	168 ± 94
Insertion attempts	1 (1-3)	1 (1-3)
Number of failures	3 (1)	2 (1)
Stylet used	2 (1)*	22 (13)
Time from induction of anesthesia to successful placement of the airway device (min)	5 ± 3	5 ± 3
Recovery times		
End of surgery to extubation (min)	5 ± 4	6 ± 4
Enter PACU until transfer to the step-down unit (min)	58 ± 45*	74 ± 76
Enter PACU to first oral intake (min)	74 ± 57	75 ± 54
Enter PACU to ambulate (min)	95 ± 61*	112 ± 70
Enter PACU to "fit for discharge" (min)	133 ± 69	132 ± 73

Values are expressed as means ± SD, numbers (percentages), or numbers (range).

MAC = minimum alveolar anesthetic concentration, PACU = postanesthesia care unit.

\*  $P < 0.05$  compared with the tracheal tube group.

the need for fentanyl was greater in the patients receiving the TT (Table 2). Three patients in the TT group required reversal drugs because of residual neuromuscular blockade.

The time intervals from the end of surgery to removal of the airway device were similar in the two groups. Although the duration of PACU stay and time to ambulation were significantly shorter in the LMA group, there was no difference between the groups with respect to the time to first oral intake or the time to home readiness (Table 2). The incidence of nausea and vomiting and the need for rescue antiemetic treatments in the early postoperative period were similar in the two groups (Table 3). However, the incidence of

nausea during the 24-h follow-up period was significantly higher in the TT group (Table 3). The incidence of postoperative sore throat was also significantly higher in the TT group (Table 3). The postoperative analgesic requirements were similar in the two study groups, and there were no clinically detectable incidences of regurgitation or aspiration of gastric contents during this study.

## Discussion

Large observational studies have reported high success rates and low complication rates when the LMA

**Table 3.** Side Effects in the Two Airway Management Groups

	Laryngeal mask	
	airway	Tracheal tube
PACU and Phase II unit		
Nausea	28 (14)	23 (13)
Antinausea treatment	9 (4)	6 (3)
Vomiting	15 (7)	8 (5)
Antiemetic treatment	6 (3)	3 (2)
Sore throat	19 (9)*	38 (22)
24-h follow-up period		
Nausea	15 (7)*	27 (16)
Vomiting	14 (7)	11 (6)
Sore throat	34 (16)*	45 (26)

Values are expressed as numbers (percentages).

PACU = postanesthesia care unit.

\*  $P < 0.05$  compared with the tracheal tube group.

was used for airway management during general anesthesia (3,4). Although the safety and efficacy of the LMA has been well documented, there is a lack of large-scale, prospective, randomized studies to support its use in "routine" clinical practice. A recent meta-analysis comparing the LMA and the TT indicated that there were deficiencies in previously published studies, including errors in study design and a lack of homogenous data, which precluded meaningful comparisons between the two airway devices (2).

One of the criticisms of previous studies related to the clinical use of the LMA. It was suggested that the role of the LMA could only be established through studies in which the device was used correctly (5). Brimacombe (2) suggested that adult studies with first-time insertion rates of less than 90% and overall success rate of less than 95% may reflect suboptimal use of the device. The first-time insertion rate of 91% and success rate of 99% suggests an optimal use of the device in this study. The failure rate of 1% observed in this study compares favorably with other recently published studies (3,4).

Previous studies have shown that propofol provides better conditions for insertion of the LMA than thiopental (6). When propofol was administered to unpremedicated patients, the dose requirement for LMA insertion often exceeded 2.5 mg/kg (6). Analogous to the present study, concomitant administration of midazolam and fentanyl reduced the propofol dose required for LMA insertion (7). The incidence of coughing and airway obstruction, as well as failure of LMA insertion, is significantly reduced by pretreatment with IV lidocaine (8). The time to successful placement of the LMA in this study (5 min) was shorter than the time interval reported by Cork et al. (9) (8.8 minutes). This difference may be due to more experienced anesthesiologists inserting the LMA device or differences in the anesthetic techniques. Using a similar anesthetic technique, Swann et al. (10) reported similar LMA insertion times.

The anesthetic requirement in patients receiving the LMA was similar to those in whom the face mask was used for airway management (12). Fuji et al. (11) reported that the LMA produces less sympathetic stimulation than the TT on insertion. The sevoflurane requirements for insertion of an LMA were lower than those for tracheal intubation (13), and, therefore, acceptable conditions for placement of the LMA were achieved earlier than those for tracheal intubation (1.7 vs 4.7 minutes) (14). Swan et al. (10) suggested that the LMA may be tolerated at "lighter" levels of anesthesia than the TT. Similarly, Wilkins et al. (15) reported that it was tolerated at lower end-tidal concentrations of isoflurane at the end of surgery with the LMA than a TT. In a small series, Cork et al. (9) reported an increased anesthetic requirement with tracheal intubation (versus LMA placement) due to increased stimulation from the TT and probably from "central sensitization" of stimuli induced by laryngoscopy and tracheal intubation. In this multicenter study, however, the volatile anesthetic requirement (MAC/hour) was found to be similar with the two airway devices. Although the fentanyl requirement was significantly lower in the LMA-treated patients, this difference is not clinically significant. Due to the lack of a "depth of anesthesia" monitor to ensure that patients were being maintained at comparable levels of anesthesia during the maintenance period, anesthesia providers administered anesthetic and analgesic drugs based on clinical signs. Therefore, differences in the anesthetic and analgesic requirements may have been obscured because of the lack of precise titration of these drugs.

For many outpatient procedures, muscle relaxation is not required. To avoid the side effects of muscle relaxants and reversal drugs, practitioners are increasingly using the LMA as an alternative to the TT for airway management during superficial ambulatory surgery procedures. Smith and White (12) reported that compared with the face mask and oral airway, use of the LMA in patients undergoing knee arthroscopy resulted in improved hemoglobin saturation and eliminated fatigue, and allowed the anesthesiologist to perform other tasks, such as drug administration and record-keeping. However, the airway can be effectively managed using a face mask and/or oral airway with the patient breathing spontaneously for many minor outpatient procedures (e.g., breast biopsy, cone biopsy). Additional studies comparing the LMA and the face mask are clearly needed.

One of the major criticisms of this study is that the anesthetic techniques were not identical in the two study groups. However, the two airway devices were evaluated when they were used as a part of a standard general anesthetic technique during routine clinical practice. The primary aim of this multicenter study was to provide an adequate depth of anesthesia, with