

Anesthesia for Intranasal Surgery: A Comparison Between Tracheal Intubation and the Flexible Reinforced Laryngeal Mask Airway

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The purpose of the study was to assess the suitability and safety of the flexible reinforced laryngeal mask airway (FRLMA) for intranasal surgery (INS) anesthesia. A secondary objective was to compare the incidence of complications of removal of the FRLMA with tracheal extubation in awake and anesthetized patients. One hundred fourteen ASA physical status I and II patients requiring INS were randomly assigned into three groups: Group I = FRLMA, Group II = endotracheal tube (ET) extubated awake, and Group III = ET extubated deeply anesthetized. In Group I, the incidence of coughing and oxyhemoglobin desaturation at removal was significantly reduced compared with that in Groups II and III ($P < 0.05$). There were no episodes of postremoval laryngospasm in Group I; in Group III, the incidence was 19% ($P < 0.05$), whereas in Group II, it was 6% (not significantly different). The

number of patients with oxyhemoglobin desaturation $\leq 92\%$ on admission to the postanesthesia care unit was 0% in Group I, 26% in Group II ($P < 0.05$), and 16% in Group III (not significantly different). At bronchoscopy, the incidence of blood visible in the airway was low and similar among the three groups (3%, 6%, and 3%, respectively). There were no significant differences in the incidence of airway complications between Groups II and III. **Implications:** We compared airway management for intranasal surgery anesthesia using a new device, the flexible reinforced laryngeal mask airway, with the current standard of tracheal intubation. The study demonstrates that the flexible reinforced laryngeal mask airway can provide a safe, protected airway with a smoother emergence from anesthesia than tracheal intubation.

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At emergence from anesthesia for intranasal surgery, the anesthesiologist is faced with a dilemma. Protection of the airway from aspiration of blood requires the return of active protective airway reflexes, with tracheal extubation when the patient is fully awake. However, this is usually accompanied by excessive coughing, which may increase the risk of postoperative bleeding.

The laryngeal mask airway (LMA) has become an important adjunct to airway management since its introduction in 1988 (1-4). Prototype flexible reinforced laryngeal mask airways (FRLMA) with

longer, smaller-diameter tubes for otorhinolaryngologic and dental anesthesia were described in 1990 (5). Because the larynx is not directly stimulated, respiratory and cardiovascular reflex responses to placement (6-8) and removal¹ of the LMA are reduced compared with those after tracheal intubation. The LMA is well tolerated during return of consciousness, and awake removal is the preferred technique (9,10). Successful use of the FRLMA for adenotonsillectomy was reported in 1993 (11), and for nasal surgery in 1995 (12).

The primary purpose of this study was to determine whether using the FRLMA for anesthesia for intranasal surgery (INS) can reduce the incidence of airway complications at emergence compared with tracheal intubation without compromising airway protection. A secondary objective was to compare the incidence of

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¹ Joshi GP, Morrison SG, Gajraj NM, et al. Hemodynamic changes during emergence from anesthesia: use of the laryngeal mask vs endotracheal tube [abstract]. *Anesth Analg* 1994;78:S185.

complications of tracheal extubation in awake and anesthetized patients.

Methods

With institutional review board approval, informed consent was obtained from 114 ASA physical status I or II adult outpatients undergoing endoscopic INS or septoplasty. Exclusion criteria were obesity, chronic obstructive pulmonary disease, and history of gastroesophageal reflux disease and previous gastric surgery. Patients were randomly assigned into one of three groups: Group I = size 4 FRLMA breathing spontaneously and removed awake; Group II = tracheal intubation with a RAE preformed cuffed endotracheal tube with intermittent positive pressure ventilation (IPPV) and extubated awake; and Group III = tracheal intubation with spontaneous breathing and extubated deeply anesthetized. Standard monitoring was applied. Outputs of noninvasive blood pressure, pulse oximeter, capnometer, and expired anesthetic concentration monitors were interfaced with a laptop computer, recorded at 15-s intervals, and linked through customized software that includes a word processing program to record demographic data and details of anesthesia at the time of surgery.² Significant events in the conduct of anesthesia and surgery and adverse events, such as coughing, were recorded by a research assistant.

After the administration of gallamine 10 mg IV, induction of anesthesia was accomplished in each group with fentanyl 1.0 µg/kg, metoclopramide 10 mg, and propofol 3.0–4.0 mg/kg. The purpose of the larger than usual dose of propofol was to promote adequate jaw relaxation and suppression of upper airway reflexes. In Group I, the FRLMA was inserted after confirmation of adequacy of jaw relaxation, with the index finger placed at the junction of tube and cuff. The mask was advanced by pressure against the hard palate to follow the oropharyngeal curve, advancing the tube with the other hand (9). Airway patency was confirmed by assessing compliance while hand-ventilating and by observing chest movement and the capnograph. To stabilize the mask and to minimize the risk of aspiration of blood accumulating in the pharynx, a moistened gauze throat pack was placed in the oropharynx under direct vision. With onset of spontaneous breathing, the pattern of respiratory movement was observed to detect signs of partial airway obstruction. The tube was then taped to the chin. In Groups II and III, tracheal intubation was performed after the administration of succinylcholine 1.5 mg/kg. Anesthesia was maintained with 50% N₂O/50% O₂ and

isoflurane with spontaneous ventilation in Groups I and III and mechanical ventilation in Group II. Depth of anesthesia was standardized, adjusting the minimum alveolar anesthetic concentration for isoflurane and 50% N₂O in Groups I and II to approximately 1.5. In Group III, depth of anesthesia was adjusted to control the cough reflex. The patient was positioned with the table tilted 10° head-up. Topical anesthesia with 4% cocaine-soaked nasal packs was applied by the surgeon and was supplemented as necessary by an injection of 1% lidocaine with 1:200,000 epinephrine. Blood loss was measured in a graduated burette. At the conclusion of surgery, with anesthesia maintained, fiberoptic endoscopy was performed through a fiberoptic elbow adapter to inspect the interior of the laryngeal mask above the larynx or the tracheal tube to its tip. Immediately before turning the patient to the lateral position, the operating table was leveled, the throat pack was removed, and a bite block was inserted between the molar teeth.

At emergence, full monitoring was continued, and anesthesia was maintained to a depth sufficient to suppress coughing provoked by movement. All patients were turned to the lateral decubitus position. Inhaled anesthesia was then discontinued and O₂/air (4L/4L) was administered in Groups I and III with spontaneous ventilation and in Group II with mechanical ventilation maintained to ensure adequate respiratory exchange and excretion of anesthesia. Patients were left undisturbed until the return of spontaneous purposeful movement indicated imminent return of consciousness. Oropharyngeal suction preceded extubation. The FRLMA was removed with the cuff inflated or deflated immediately before removal, when the patient could open his or her mouth on command. In Group II patients, extubation was performed when the patient responded to commands and made purposeful attempts to remove the endotracheal tube. After extubation, O₂/air (4 L/4 L) was administered via a face mask. In Group III patients, tracheal extubation was performed at a depth of anesthesia sufficient to suppress the cough reflex response to movement to the lateral position and cuff deflation. The pharynx was aspirated and an oropharyngeal airway was inserted. The airway was maintained with jaw thrust, and the O₂/air mixture was administered via a face mask until the return of purposeful movement and rejection of the oropharyngeal airway. Discharge criteria from the operating room (OR) were a normal respiratory pattern and volume, SpO₂ ≥98%, and appropriate response to verbal stimuli. On admission to the postanesthesia care unit (PACU), SpO₂ was measured, and routine care, including the use of a standardized PACU score (13), was provided by nurses blinded to the method of airway management. A chest radiograph was obtained 30 min after admission to the PACU and was interpreted by a blinded radiologist. A telephone survey was performed on the first day after

² Dain SL, Smith BD, Webster AC. A laptop computer based intra-operative physiological data acquisition system [abstract]. Can J Anaesth 1992;39:A31.

Table 1. Demographic Data

	Age (yrs)	Weight (kg)	Gender		ASA physical status		Reactive airway disease		Procedure
			M	F	I	II	Smoker	Asthma	
Group I (n = 35)	43.02 ± 12.86	73.48 ± 13.47	23 (66)	12 (34)	16 (46)	19 (54)	10 (29)	7 (20)	Polypectomy 20 (57) Septoplasty 12 (34) Ethmoidectomy 3 (9)
Group II (n = 34)	41.94 ± 12.25	77.27 ± 12.70	21 (62)	13 (38)	18 (53)	16 (47)	7 (21)	6 (18)	Polypectomy 15 (44) Septoplasty 14 (41) Ethmoidectomy 5 (15)
Group III (n = 32)	42.77 ± 12.69	81.29 ± 13.62	21 (66)	11 (34)	16 (50)	16 (50)	9 (28)	6 (19)	Polypectomy 14 (44) Septoplasty 10 (31) Ethmoidectomy 8 (25)

Values are n (%).

surgery to determine the incidence of sore throat, hoarseness, and coughing.

To compare the three groups, Fisher's exact test was used for nonparametric outcomes. Because the difference in the percentage of subjects undergoing polypectomy, septoplasty, and ethmoidectomy was considered potentially clinically meaningful, a separate analysis of variance was performed for each type of surgery. Blood loss was log-transformed to improve equality of variance among the three groups, and statistical comparisons were based on the log-transformed values. In cases in which the among-groups test was statistically significant, pairwise comparisons were used to identify where the differences occurred. To adjust for multiple comparisons, a Bonferroni correction was made for pairwise comparisons of dichotomous outcomes, and Tukey's honestly significant differences test was used for continuous outcomes. A *P* value <0.05 was considered to be statistically significant.

Results

Demographic data and surgical procedures are shown in Table 1. Of the 114 patients recruited into the study, 3 patients in Group I, 1 from Group II, and 2 from Group III were withdrawn because of unsatisfactory computer records. Two patients were withdrawn from Group II and one from Group III for protocol violations. Four patients in Group III were withdrawn from the study because of inadequate control of the cough reflex and hypoventilation. These were converted to IPPV with neuromuscular blockade. Postoperative chest radiograph was inadvertently omitted in two patients in Group I, one patient in Group II and three patients in Group III. Blood loss is shown in Table 2.

Responses to the different methods of airway management and statistical comparisons of perioperative and postoperative data are shown in Tables 3 and 4. In Group I, insertion of the FRLMA was difficult in three

Table 2. Blood Loss and Surgery Time

	Group I (n = 35)	Group II (n = 34)	Group III (n = 32)
Blood loss (mL)			
Polypectomy	270 ± 235	160 ± 87	175 ± 95
Septoplasty/ ethmoidectomy	131 ± 72	131 ± 121	159 ± 124
Surgery time			
Polypectomy	69 ± 25	60 ± 15	55 ± 13
Septoplasty/ ethmoidectomy	53 ± 18	58 ± 21	58 ± 20

patients, two of whom had the paradoxical breathing pattern characteristic of partial upper airway obstruction, although neither had hypoxia or hypercarbia. In one of these patients, the proximal rim of the cuff was visible during pharyngoscopy and packing, and, on fiberoptic endoscopy, the distal rim of the cuff partially obscured the larynx. In two other patients, breathing was stertorous without other signs of upper airway obstruction or inadequate respiratory gas exchange.

Cough after intubation was more frequent in Group III (*P* < 0.05), as neuromuscular blockade decreased before inhaled anesthesia was established. During maintenance of anesthesia, defined as the period between the beginning and end of surgery, the average expired isoflurane concentration was similar in the three groups. In Groups I and II, the average expired isoflurane at the time of extubation was similar. In Group III, the average expired isoflurane concentration at extubation was 1.37% ± 0.35% (Table 3).

In Group I, the incidence of coughing and oxyhemoglobin desaturation at removal was significantly reduced compared with that in Groups II and III (*P* < 0.05). There were no episodes of postremoval laryngospasm in Group I; in Group III, the incidence was 19% (*P* < 0.05), whereas in Group II, it was 6% (not significantly different [NS]). At bronchoscopy, the incidence of blood visible in the airway was low and

Table 3. Perioperative Data

	Group I (n = 35)	Group II (n = 34)	Group III (n = 32)
Intubation			
Difficult	3 (9)	2 (6)	0
Cough	3 (9)	7 (21)	12 (37)*
Maintenance			
Partial upper airway obstruction	2 (6)	0	0
Bronchospasm	0	2 (6)	1 (3)
Expired isoflurane concentration (%)	1.04 ± 0.19	1.10 ± 0.21	1.17 ± 0.26
Endoscopy			
Blood	1 (3)	2 (6)	1 (3)
Extubation			
Cough	3 (9)	29 (85)‡	19 (59)‡
Laryngospasm	0	2 (6)	6 (19)*
Desaturation	0	6 (18)‡	6 (19)‡
Expired isoflurane concentration (%)	0.17 ± 0.05	0.15 ± 0.04	1.37 ± 0.35*
End of anesthesia to patient exits OR (min)	10.74 ± 4.55	14.85 ± 5.58‡	12.16 ± 3.64†

Values are n (%).
OR = operating room.
* Significantly different from Groups I and II ($P < 0.05$).
† Significantly different from Group II ($P < 0.05$).
‡ Significantly different from Group I ($P < 0.05$).

Table 4. Postoperative Data

	Group I (n = 35)	Group II (n = 34)	Group III (n = 32)
PACU			
Oxyhemoglobin $\text{SpO}_2 \leq 92\%$ on admission	0	9 (26)*	5 (16)
PACU score ≤ 6 on admission	4 (11)	8 (24)	6 (19)
Chest radiograph	(n = 33)	(n = 33)	(n = 29)
Atelectasis	4 (12)	10 (30)	5 (17)
Postoperative Day 1			
Sore throat	25 (71)	23 (68)	21 (66)
Hoarseness	5 (14)	15 (44)*	12 (37.5)*
Coughing	4 (11)	11 (32)	6 (19)

Values are n (%).
PACU = postanesthesia care unit.
* Significantly different from Group I ($P < 0.05$).

similar among the three groups (3%, 6%, and 3% respectively). The number of patients with oxyhemoglobin desaturation $\leq 92\%$ on admission to the PACU was 0% in Group I, 26% in Group II ($P < 0.05$), and 16% in Group III (NS). There were no significant differences in the incidence of airway complications between Groups II and III.

The time from discontinuing inhaled anesthesia to the patient's departure from the OR was less in Group I than in Group II (10.74 ± 4.55 vs 14.85 ± 5.58 min; $P < 0.05$). Comparing Groups II and III, the time from discontinuing inhaled anesthesia to the patient's return to the PACU was longer in Group II (14.85 ± 5.58 vs 12.16 ± 3.64 min; $P < 0.05$). On chest radiograph, the differences in atelectasis reported in each group were not significant. In one patient in Group II, the

radiographic appearance suggested aspiration. There were no clinical sequelae.

On the first postoperative day, patients in all groups reported a high incidence of sore throat (Table 3). However, the incidence of hoarseness on the first postoperative day was reduced in Group I compared with Groups II and III; there were no significant differences between Groups II and III.

Discussion

Acceptance of the FRLMA as a safe practical alternative to tracheal intubation for intranasal surgery requires that placement be relatively facile, that position of the mask be stable throughout surgery, and that the airway be protected from the risk of aspiration of blood accumulating in the pharynx. Thorough familiarity with using the standard LMA is a prerequisite, but the flexibility of the FRLMA makes insertion more difficult, with the risk of partial upper airway obstruction unless the mask is fully inserted into the hypopharynx. Adequate jaw relaxation and suppression of upper airway reflexes are essential.

During maintenance of anesthesia, there was no evidence of instability of the FRLMA or increased contamination of the lower respiratory tract. During emergence from anesthesia, our results indicate that, compared with endotracheal anesthesia, airway management was easier using the FRLMA. Compared with tracheal extubation, coughing was reduced in incidence and intensity, and compared with awake tracheal extubation, the time to patients' fitness to leave the OR was reduced. The uncomplicated course of emergence from anesthesia was continued into the

PACU. Our observations concur with those Brain et al. (9) and Brimacombe and Brain (10) that LMA removal can safely be deferred until the patient reaches the PACU with potential further saving of OR time.

The serious complications of tracheal extubation tend to receive less attention than those of tracheal intubation (14). Management of tracheal extubation after nasal surgery is complicated by potential airway contamination from postsurgical bleeding. Bleeding may be aggravated by the venous congestion that accompanies coughing and bucking and by upper airway obstruction from nasal packing. The high incidence of reactive airway disease in this patient population due to asthma and smoking (19% and 26%, respectively, in our study) further complicates control of adverse airway reflexes. In four patients with reactive airway disease in our study, spontaneous breathing with tracheal intubation was abandoned because of vigorous cough reflex activity. Obstructive pulmonary edema after awake tracheal extubation after septoplasty in otherwise healthy patients has occurred twice in our institution in the same year. This has focused our attention on management of extubation after nasal surgery.

Evaluation of tracheal extubation in awake and anesthetized patients has been examined in children (15,16) but not in adults. In these pediatric studies, oxyhemoglobin saturation early after extubation was higher in patients extubated deeply anesthetized. However, there was no difference in the incidence of postoperative laryngospasm, excessive coughing, breath-holding, airway obstruction requiring assisted positive pressure ventilation, or arrhythmias between the two groups. In comparing adult patients extubated awake and deeply anesthetized, we detected no difference in oxyhemoglobin saturation early after tracheal extubation or in the incidence of cough and laryngospasm.

Compared with removal of the FRLMA, awake tracheal extubation was accompanied by excessive coughing with increased risk of bleeding, increased incidence of oxyhemoglobin desaturation early after extubation, delay in patients' fitness to discharge from the OR, and increased incidence of oxyhemoglobin desaturation on admission to the PACU. Compared with removal of the FRLMA, tracheal extubation in patients deeply anesthetized was accompanied by increased incidence of coughing, laryngospasm, and oxyhemoglobin desaturation early after extubation. Maintenance of a patent airway via an oropharyngeal airway, face mask, and jaw thrust with the patient in the lateral position was physically demanding.

The high incidence of sore throat in each group on the first postoperative day is similar to that reported

after endotracheal anesthesia using throat packs (17) but considerably exceeds the 10% reported using the standard LMA in adults (18).

These results indicate that the FRLMA not only provides a safe, stable, protected airway during anesthesia for intranasal surgery, but also offers clinically significant advantages over endotracheal anesthesia.

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