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A comparison of postoperative sore throat after use of laryngeal mask airway and tracheal tube

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Abstract
Purpose. We compared the degree of postoperative sore throat (PST) after use of a laryngeal mask airway (LMA; by two insertion techniques) and a tracheal tube (TT) in adult patients.
Methods. Eighty-six adult patients undergoing surgery of an extremity were randomized into three groups. The LMAs (size 4 for men, 3 for women) and TTs were lubricated with 2% lidocaine gel. After the induction of anesthesia, an LMA with the cuff deflated was inserted and then the cuff was inflated in group A, an LMA with the cuff inflated was inserted in group B, and the trachea was intubated using vecuronium in group C; staff anesthesiologists performed all these methods. LMA cuffs were inflated with the maximum recommended volume of air. TT cuffs were inflated with the minimum volume of air without gas leakage at 20 cmH_2O pressure. The mode of ventilation depended on the individual anesthesiologists. Blood traces on the devices were examined after their removal. PST was rated immediately after anesthesia and on the first postoperative day, using a three-point score and a 100-mm visual analog scale, respectively.
Results. Most of the patients receiving an LMA breathed spontaneously and those receiving a TT underwent controlled ventilation. The ratio of positive blood traces on devices, as well as the degree of PST immediately after anesthesia, was similar in the three groups; however, on the first postoperative day, the severity of PST was greater in the LMA groups than in the TT group ($P = 0.016$). The severity of PST was similar with the two LMA insertion techniques.
Conclusion. In the conditions of our study, LMAs inserted with the cuff either fully inflated or deflated worsened PST compared with TTs.

Key words Airway management · Anesthesia · Complications

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Introduction

Patients may suffer discomfort from postoperative sore throat (PST), a common complication after general anesthesia [1,2]. The incidence of PST varies with the airway management procedure during anesthesia [2]. Several direct comparative studies have indicated that the laryngeal mask airway (LMA) is less invasive than the tracheal tube (TT) regarding PST in adults and children [3–5]. To the contrary, LMA did not decrease PST compared with TT in two studies of adults and children [6,7]. The advantage of the LMA, concerning PST, over TT remains controversial.

In our clinical practice, we have found PST with LMAs inserted using the standard technique to be more severe than that with TTs. The standard insertion technique described in the manufacturer's instruction manual states that the LMA cuff should be tightly deflated before insertion. An alternative LMA insertion technique with a fully inflated cuff has reduced pharyngeal mucosal trauma and, consequently, has lowered the incidence of PST compared with the standard technique [8]. The purpose of the present study was to directly compare the degree of PST in adult patients among those with a TT, an LMA inserted with the standard technique, and an LMA inserted with the inflated cuff.

Patients and methods

After the Ethics Committee's approval and patients' informed consent were obtained, 86 patients, aged 16 to 79 years, American Society of Anesthesiologists (ASA) physical status I or II, scheduled for elective orthopedic surgery of an extremity (to be performed with the patient in the supine position, and requiring general anesthesia) at Kumamoto University Hospital, were enrolled in this randomized single-blind trial. Patients

with sore throat, history of gastroesophageal reflux, and contraindications to either LMA or TT were excluded from the study. A modified Mallampati classification [9] was used to assess oropharyngeal anatomy in all patients. The patients were allocated to one of three study groups, using the spots on a die ("1" and "6" for group A; "2" and "5" for group B, and "3" and "4" for group C) before the operative day. The patients in groups A and B received an LMA insertion and those in group C, the tracheal intubation.

Patients were premedicated with atropine and midazolam. Anesthesia was induced with propofol at $2\,mg{\cdot}kg^{-1}$ and 100 μg of fentanyl. No muscle relaxants were used for the LMA insertion. Vecuronium at $0.1\,mg{\cdot}kg^{-1}$ was given prior to the tracheal intubation. All LMA insertions and tracheal intubations were performed by staff anesthesiologists skilled in both procedures.

The LMA Classic (Laryngeal Mask Company, Oxon, UK), size 3 for women and size 4 for men [8], was used in this study. The LMA cuff was fully deflated and then lubricated with 2% lidocaine gel (Xylocaine Jelly; AstraZeneca, Osaka, Japan) on the posterior aspect in preparation. In group A, the LMA was inserted with the cuff fully deflated according to the standard technique. The cuff was then inflated with 20 ml and 30 ml air for size 3 and size 4, respectively. In group B, the LMA cuff was fully inflated with the same volume of air as in group A before insertion, and the LMA was inserted using the method described by Wakeling et al. [8]. In brief, the back of the inflated cuff was kept close to the hard palate during insertion to facilitate easy passage around the posterior pharyngeal wall in one smooth movement until resistance was felt as the tip of the LMA reached the base of the hypopharynx. Patients who required more than one insertion attempt were excluded from the study. After the LMA insertion, the position of the LMA was evaluated using both the oropharyngeal leak pressure and the fiberoptic scoring system described by Keller et al. [10]. The oropharyngeal leak pressure was determined by closing the pop-off valve of the semi-closed respiratory circuit at a fixed gas flow of $3\,l{\cdot}min^{-1}$, and noting the airway pressure at which gas leakage occurred into the mouth. For fiberoptic scoring, a bronchofiberscope was passed to a position just proximal to the mask aperture bars and the view was scored as follows: 4, only vocal cords seen; 3, vocal cords plus posterior epiglottis seen; 2, vocal cords plus anterior epiglottis seen; 1, vocal cords not seen.

In group C, men were intubated with an 8.0-mm and women a 7.5-mm inner diameter polyvinylchloride tube with a high-volume, low-pressure cuff (Hi-Lo tracheal tube; Mallinckrodt Medical, Chihuahua, Mexico). The tip and cuff portion of the TT was lubricated with 2% lidocaine gel. Patients who required more than one intubation attempt were excluded from the study. The TT cuffs were inflated with air to the minimum volume required to prevent gas leakage at 20 cm H_2O pressure after the tracheal intubation.

Anesthesia was maintained with sevoflurane, nitrous oxide, oxygen (inspired oxygen concentration, 50%) and fentanyl, combined with or without continuous epidural infusion of 2% lidocaine. The main mode of respiration depended on the individual anesthesiologists, and, consequently, patients either breathed spontaneously or underwent controlled ventilation. Inspired gas was warmed and humidified with a passive heat-moisture exchanger (Pharma Mini Port; Pharma Systems, Knivsta, Sweden).

At the removal of the LMA or the extubation after surgery, the presence or absence of blood on the surfaces of the LMAs and TTs was assessed. Any blood at all on the LMAs and TTs was considered a positive finding. In the recovery area, the anesthesiologists evaluated the oriented patients' complaints of sore throat, using a three-point scale as follows: 2, continuous throat pain; 1, throat discomfort; 0, no complaints at all. Most of the patients receiving epidural catheterization were continuously given bupivacaine, with or without fentanyl, to the epidural space until the second postoperative day.

On the first postoperative day, patients were individually interviewed to determine their complaints of sore throat and wound pain, on a 100-mm visual analog scale (0, no pain; 100, the worst imaginable pain). Analgesics used postoperatively until the evaluation of PST were recorded.

Parametric variables were analyzed using Student's *t*-test or one-way analysis of variance, and nonparametric variables were analyzed using the Mann-Whitney *U*-test, Kruskal-Wallis test, or χ^2 test, as appropriate for independent samples. Visual analog scores were treated as nonparametric data. A P value of less than 0.05 was considered significant.

Results

Four of the patients enrolled in group A were excluded, as more than one attempt at LMA insertion was required. The deflated LMAs were successfully inserted in two or three attempts in the excluded patients.

There were no significant differences in the patient characteristics, type of surgery, duration of surgery and anesthesia, modified Mallampati classification, anesthesia method, and total fentanyl dose during surgery among the three groups. The main mode of respiration during surgery was significantly different among groups A, B, and C ($P < 0.0001$). All patients breathed sponta-

Table 1. Patient characteristics and demographic data

	Group A; deflated LMA (n = 28)	Group B; inflated LMA (n = 29)	Group C; TT (n = 25)
Age (years)	41 ± 21	46 ± 23	43 ± 20
Height (cm)	162 ± 7	162 ± 12	163 ± 12
Weight (kg)	59 ± 10	65 ± 12	64 ± 15
Sex; n (%)			
Male	14 (50)	14 (48)	14 (56)
Female	14 (50)	15 (52)	11 (44)
Modified Mallampati classification; n (%)			
I	5 (18)	7 (24)	4 (16)
II	18 (64)	17 (59)	18 (72)
III	5 (18)	5 (17)	3 (12)
IV	0 (0)	0 (0)	0 (0)
Type of surgery; n			
Arthroscopic surgery of the knee	13	12	10
Anterior cruciate ligament reconstruction	7	5	6
Total knee arthroplasty	2	6	4
High tibial osteotomy	1	3	2
Others	5	3	3
Duration (min)			
Surgery	121 ± 71	122 ± 57	129 ± 59
Anesthesia	173 ± 75	177 ± 66	182 ± 65
Anesthesia; n (%)			
General alone	14 (50)	10 (34)	7 (28)
General plus epidural	14 (50)	19 (66)	18 (72)
Total fentanyl, (μg), median [range]	100 [50–200]	100 [50–200]	100 [50–450]
Mode of respiration; n (%)			
Controlled	0 (0)	3 (10)	24 (96)
Spontaneous	28 (100)	26 (90)	1 (4)

Values are means ± SD unless noted
LMA, laryngeal mask airway; TT, tracheal tube

Table 2. Oropharyngeal leak pressure and distribution of fiberoptic scores for the inserted laryngeal mask airway (LMA)

	Group A; deflated LMA (n = 28)	Group B; inflated LMA (n = 29)	P
Oropharyngeal leak pressure (cmH_2O)	21 ± 6	19 ± 5	0.151
Fiberoptic score; n (%)			0.820
4	5 (18)	5 (17)	
3	4 (14)	2 (7)	
2	15 (54)	18 (62)	
1	4 (14)	4 (14)	

Values are means ± SD unless noted
Fiberoptic scores: 4, only vocal cords visible; 3, vocal cords plus posterior epiglottis visible; 2, vocal cords plus anterior epiglottis visible; 1, vocal cords not visible

neously in group A, and three patients received intermittent positive pressure ventilation and the others breathed spontaneously in group B. On the other hand, in group C, all patients, except for one who breathed spontaneously, received intermittent positive pressure ventilation (Table 1).

No significant differences in the position of the inserted LMA, assessed by the fiberoptic score and the oropharyngeal leak pressure, existed between groups A and B (Table 2).

Patients neither coughed nor moved vigorously at the LMA insertion. The mucosal trauma, assessed by traces of blood on the LMAs and TTs, was similar in groups A, B, and C (Table 3). The severity of PST on the three-point scale, assessed when patients were in the recovery area immediately after surgery, did not differ among groups A, B, and C. Durations between the end of anesthesia and the assessment on the first postoperative day in groups A (28 ± 5 h), B (28 ± 3 h), and C (28 ± 5 h) were comparable. There was a significant difference

Table 3. Percentage of patients with blood on their laryngeal mask airways (LMAs) and tracheal tubes (TTs) after removal, and distribution of grades of postoperative sore throat determined when patients were in the recovery area

	Group A; deflated LMA (n = 28)	Group B; inflated LMA (n = 29)	Group C; TT (n = 25)	P
Traces of blood; n (%)	5 (18)	3 (10)	4 (16)	0.705
Postoperative sore throat when in the recovery area; n (%)				0.321
Grade 2	21 (75)	19 (66)	12 (48)	
Grade 1	1 (4)	3 (10)	8 (32)	
Grade 0	6 (21)	7 (24)	5 (20)	

Grades: 2, continuous throat pain; 1, throat discomfort; 0, no complaints at all

Table 4. Postoperative analgesic management until the evaluation of PST on the first post operative day

	Group A; deflated LMA (n = 28)	Group B; inflated LMA (n = 29)	Group C; TT (n = 25)	P
Epidural analgesia; n (%)				0.275
Yes	13 (46)	19 (66)	16 (64)	
No	15 (54)	10 (34)	9 (36)	
Total dose of each analgesic (mg), median [range]				
Loxoprofen	120 [0–180]	120 [0–240]	120 [0–180]	0.551
Diclofenac	0 [0–100]	50 [0–100]	0 [0–100]	0.312
Pentazocine	0 [0–15]	0 [0–15]	0 [0–15]	0.216
Number of analgesics required; n (%)				0.625
0	0 (0)	2 (7)	1 (4)	
1	14 (50)	10 (34)	12 (48)	
2	10 (36)	11 (38)	9 (36)	
3	4 (14)	6 (21)	3 (12)	

LMA, laryngeal mask airway; TT, tracheal tube

in the severity of PST, assessed on the 100-mm visual analog scale, among groups A, B, and C, using the Kruskal-Wallis test (P = 0.016; Fig. 1). The Mann-Whitney U-test revealed that group C (with the TT) had a reduced severity of PST compared with both groups A and B (with the LMA; P = 0.007 and 0.013, respectively). The inflated cuff at the LMA insertion (group B) did not attenuate the severity of PST compared with the deflated cuff (group A).

Postoperative analgesic management until the evaluation of PST on the first postoperative day was comparable in groups A, B, and C (Table 4). There was no significant difference in the number of patients who received epidural analgesia. In the current study, three analgesics (loxoprofen, diclofenac, pentazocine) were prescribed postoperatively by the physician in charge of each patient on the ward. The total dose of each analgesic and the number of analgesics required until the evaluation of PST on the first postoperative day were comparable in the three groups. No significant difference in wound pain on the first postoperative day was found among the patients in the three groups (Fig. 1).

Discussion

The main findings of this study were that airway management with an LMA during anesthesia did not alleviate PST, or rather, it worsened PST in comparison with TT in the conditions used in this study. Moreover, no benefit regarding PST was found in regard to the LMA insertion technique with the fully inflated cuff when compared with the standard technique.

Whether an LMA is superior to a TT regarding PST is a question that remains unsolved. A few prospective and direct comparative studies of LMAs and TTs have been performed. Joshi et al. [3] demonstrated that the incidence of PST 24 h after ambulatory surgery was significantly greater in adult patients receiving a TT than in those receiving an LMA. Fujii et al. [4] showed similar results in children aged 1 to 12 years who underwent elective surgery. One large prospective study found that PST was reported in 12.1% of 5264 consecutive ambulatory surgical patients aged 12 years and older who were interviewed by telephone 24 h after the surgery [2]. In that study, 45% of patients receiving a TT and 18% of patients receiving an LMA had PST [2]. Saeki et al. [5] also provided analogous data, in which, on the first post-

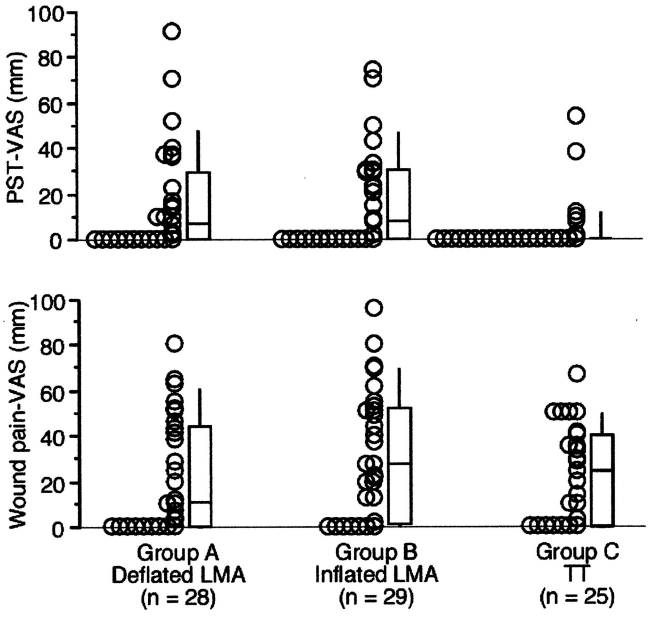

Fig. 1. Postoperative sore throat (*PST*) and wound pain, assessed using a 100-mm visual analog scale (*VAS*), on the first postoperative day. A significant difference was found in the PST-VAS score ($P = 0.016$), but not in the wound pain-VAS score ($P = 0.452$), among the three groups. *Open circles* indicate VAS scores of individual patients. *Boxes* depict median values and quartile ranges, and *vertical bars* show 10th and 90th percentiles. *LMA*, laryngeal mask airway; *TT*, tracheal tube

operative day, complaints of PST were made by 45% of the patients who had received TTs and 15 % of those who had had an LMA inserted. On the other hand, Rieger et al. [6] concluded that there were no significant differences between the two methods in the overall incidence of PST, evaluated by a number of symptoms (continuous throat pain, dysphonia, dysphagia, and pharyngeal dryness) and severity in adult patients. Splinter et al. [7] also showed that the overall incidence of PST on the first postoperative day was not significantly different between LMA and TT groups in children aged 3 to 12 years. To our knowledge, however, no reports have mentioned that the TT is superior to the LMA for airway management during surgery in regard to PST.

Only one study reported that insertion of an LMA already fully inflated with the maximum recommended volume of air showed lower incidences of both macroscopic blood after removal and PST, compared with the LMA being fully deflated before insertion and then inflated with the same volume of air (the standard technique) [8]. In that study, because the number of LMA insertion attempts was similar in their two groups, a softer leading edge may have reduced trauma to the pharynx, resulting in the differences. On the other hand, Brimacombe and Berry [11] found that LMA insertion with the inflated cuff did not lower the incidence of PST compared with the fully deflated cuff. In their work, the fully deflated cuff resulted in more successful insertion within 10 s than the inflated cuff, and they found that the fully deflated cuff was superior to the inflated cuff in terms of fiberoptic positioning [11]. In our study, all insertion failures were seen in the standard-technique group with the fully deflated cuff, but no difference in fiberoptic positioning was found between the two techniques in patients successfully inserted with an LMA in one attempt. Furthermore, we did not find any difference in the incidence of blood traces or in the severity of PST between the two LMA insertion techniques (with the fully inflated cuff and uninflated cuff). Even when we included the four excluded patients in the standard-technique group, in our findings, there was no significant difference in fiberoptic positioning, the incidence of blood traces, and the degree of PST between the two insertion techniques (data not shown). A larger study is needed to resolve the issue concerning the possible superiority of LMA insertion with the inflated cuff.

PST following LMA insertion and tracheal intubation is considered to be due to trauma to the larynx and pharynx [1]. However, it is not easy to identify the critical factors contributing to the difference in mucosal trauma and the severity of PST between LMAs and TTs because the LMA and the TT impinge on the pharyngeal wall in different manners and involve different mechanisms for their conformation to the upper airway [12]. Moreover, even with the use of a face mask for airway management, 8% of patients complained of sore throat [13,14]. We think that the etiology of PST with the use of the LMA and TT is multifactorial, and our study design would have not standardized all the factors related to PST.

The influence of the size and cuff pressure of the devices on PST is complicated. We chose a fixed-size LMA (size 4 for men and size 3 for women). Several investigators have recently recommended a larger LMA (size 5 for men and size 4 for women) to reduce postoperative oropharyngeal morbidity [15–18], because of lower oropharyngeal leak pressure during positive pressure ventilation. To the contrary, Grady et al. [19] have concluded that a large LMA (size 5) was associated with a higher incidence of sore throat in spontaneously breathing men 24 h postoperatively. In our study, the cuff volumes of the LMA and TT, initially adjusted to the maximum recommended volume and the minimum volume without gas leakage at 20 cmH_2O pressure, respectively, were not manipulated, and the cuff pressure was not measured during the procedure. Nitrous oxide diffusion into the cuff inflated with air increases the cuff pressure on the pharyngeal or tracheal mucosa [20,21]. The severity of PST in the TT group (in which the initial cuff volume was adjusted to the minimum) may have

been less than that in the LMA groups. Cuff pressure limitation reduces the incidence of PST in intubated patients [1,22,23]; however, there are conflicting reports as to whether the limitation of LMA cuff pressure reduces PST [1,24–26]. The influence of the conditions of the LMA and TT cuffs on our results showing that PST was more severe in LMA than in TT is still uncertain.

In our study, the mode of ventilation depended on individual anesthesiologists and, consequently, most of the patients receiving an LMA breathed spontaneously and those tracheally intubated underwent controlled ventilation. Figueredo et al. [26] reported that intermittent positive-pressure ventilation worsened postoperative oropharyngeal discomfort in patients receiving an LMA compared with spontaneous breathing, but Cork et al. [27] demonstrated that neither of the two modes of ventilation favored the use of either device. Therefore, at least the mode of ventilation would not have affected PST with LMA in our study.

In our study, a number of anesthesiologists inserted the LMAs and TTs, and the anesthesiologists' skills may have varied. All the staff anesthesiologists had considerable anesthesia experience, and the patients in whom more than one attempt at LMA insertion was required were excluded (four patients in group A), because the incidence of PST showed an increasing trend immediately and 24 h after LMA removal with an increasing number of attempts [19].

One potential problem is the duration of the procedure. The mean duration of the procedure was approximately 120 min in our study, and this was considerably longer than that in the study of Joshi et al. [3], in which the mean duration of the procedure was 60 min, and the LMA reduced PST. We found no difference in PST between the devices immediately after removal, but there was more severe PST in the LMA groups compared with the TT group on the first postoperative day. Grady et al. [19] indicated that PST early after LMA removal seemed to be related to direct pharyngeal trauma, whereas PST on the first postoperative day was related to a longer duration of LMA insertion. The relatively longer duration of the procedure in our study may have affected PST assessed on the first postoperative day. One study stated that PST after the use of an LMA was not related to the duration of the procedure [28].

We lubricated the LMAs and TTs with gel containing 2% lidocaine. It remains to be concluded whether the use of a lubricant containing a local anesthetic is beneficial in the reduction of PST after tracheal intubation [1]. It has been suggested that lidocaine may irritate or damage the tracheal mucosa [29], and the use of saline or a water-based lubricant such as K-Y Lubricating Jelly (Johnson and Johnson, Maidenhead, UK) has been preferred [1]. In the use of an LMA, lidocaine gel did not reduce the incidence of PST, but increased the incidence of hoarseness, tongue paresthesia, nausea, and vomiting [30]. There is a possibility that lidocaine gel, being in contact with a wider area of the oropharynx, was responsible for the higher degree of PST in the LMA group than in the TT group. It is unclear to what extent the lubricant that we used affected our results.

Patients concentrate on symptoms directly related to the operative site and do not immediately associate PST with anesthesia and surgery [1]. It is suggested that PST can be influenced by the type of postoperative analgesia [26]. In particular, the systemic administration of analgesics would reduce PST. However, few earlier investigations paid attention to wound pain and postoperative pain management in the assessment of PST in patients receiving LMAs and TTs. It is crucial that the severity of wound pain and the postoperative pain management should be consistent in groups where PST is compared.

In conclusion, we demonstrated that an LMA inserted with the standard technique or with the cuff fully inflated was similar to a TT in terms of PST immediately after anesthesia, but that LMAs showed rather unfavorable effects on the first operative day in adult patients under the conditions of this current study.

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