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Effects of cuff pressure on changes in airway morphology after use of the laryngeal mask airway

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Introduction

The efficacy and safety of the laryngeal mask airway (LMA) have been established. The LMA is used to aid in the management of difficult airways and is applied in various operations and prolonged anesthesia [1,2]. Previously we reported a case of airway obstruction after removal of the LMA [3]. In this case the lateral cervical radiographs showed airway obstruction due to a thick retropharyngeal wall at the level of the third and fourth cervical spines. In addition, enormous edema was detected near the root of the tongue, blocking the airway. Other complications have been reported, presumably caused by the pressure exerted by the LMA cuff on the pharyngeal tissue [4–6]. LMA cuff pressure rises under general anesthesia when nitrous oxide is used [7]; adjusting the cuff pressure is recommended during anesthesia to minimize the ill effects of the compressive force exerted on the pharyngeal surface mucosa. The relationship between postoperative pharyngeal pain and internal pressure of the cuff has been reported [8,9], but how changes in pharyngeal morphology after removal of the LMA are related to the cuff pressure has not been clarified. We hypothesized that changes in airway morphology may occur after the use of LMA that may be prevented by adjusting the cuff pressure. The purpose of the present study was to investigate the changes in airway morphology that occur after the LMA is withdrawn and the effect on these changes of adjusting the cuff pressure. To achieve this, pharyngeal morphology was examined on lateral cervical radiographs that show the thickness of the retropharyngeal wall and the morphological state of the airway around the root of the tongue before and after anesthesia for the two groups of patients.

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Materials and methods

The study was carried out in Mitsui Memorial Hospital. The study was approved by the ethics committee of the hospital. Sixteen patients rated as ASA 1 or 2 scheduled for gynecologic or breast surgery received a detailed explanation of the study and subsequently gave their consent. They were allocated randomly to the two groups. For the cuff-adjusted group, the internal cuff pressure was adjusted every 30 min so that an air leak developed when the airway pressure exceeded 15 cm H_2O with manual ventilation. For the cuff-unadjusted group, the cuff pressure was adjusted only once, at the time of LMA placement, so that a leak occurred at an airway pressure of 20 cm H_2O.

The subjects received intramuscular injection of 0.5 mg of atropine and 50 mg of hydroxyzine 30 min before they were admitted to the operating room. Following epidural catheterization, anesthesia was induced with 5 $mg \cdot kg^{-1}$ of thiopental, followed by muscle relaxation with 1 $mg \cdot kg^{-1}$ of succinylcholine. A no. 3 LMA with a cuff that had been deflated was manually inserted. Mepivacaine was administered through an epidural catheter, and anesthesia was maintained with 2 $\ell \cdot min^{-1}$ of oxygen, 4 $\ell \cdot min^{-1}$ of nitrous oxide, and 0.5% to 2.0% of sevoflurane under spontaneous ventilation assisted manually. At the end of surgery, when it was confirmed that the patient had regained consciousness, the LMA was removed. Lateral cervical radiographs were taken before anesthesia and about 60 min after LMA removal without the pillow. Retropharyngeal wall thickness was measured at the thinnest portion at

Table 1. Comparison of the data for patients in the cuff-adjusted and -unadjusted groups (mean ± SD)

Group	Age (yr)	Body height (cm)	Body weight (kg)	Amount of infusion fluid (l)	Blood loss (ml)	Duration of laryngeal mask airway (LMA) placement (min)
Adjusted	46 ± 7	155 ± 3	53 ± 6	1.3 ± 3.3	256 ± 190	97 ± 22
Unadjusted	42 ± 13	155 ± 5	51 ± 5	1.5 ± 0.6	236 ± 343	94 ± 21

Table 2. Retropharyngeal wall thickness (RWT) and airway diameter (AD) before LMA placement and after its removal (mean ± SD)

Group	Time of measurement	RWT at the C_3 level (mm)	RWT at the C_4 level (mm)	AD at the root of the tongue (mm)	AD at the tracheal opening (mm)
Adjusted	Before	3.8 ± 1.3	5.6 ± 3.0	12.6 ± 3.3	17.2 ± 3.0
	After	4.1 ± 1.2*	5.9 ± 2.8*	9.8 ± 3.2*	14.8 ± 2.6*
Unadjusted	Before	4.1 ± 1.4	6.1 ± 3.4	11.5 ± 2.4	16.0 ± 4.6
	After	4.5 ± 1.3*	6.8 ± 3.9*	8.9 ± 1.7*	12.4 ± 2.7*

* $P < 0.05$ compared with before

Table 3. Changes in retropharyngeal wall thickness (ΔRWT) and airway diameter (ΔAD) for the adjusted and unadjusted groups (mean ± SD [range])

Group	ΔRWT at the C_3 level (mm)	ΔRWT at the C_4 level (mm)	ΔAD at the root of the tongue (mm)	ΔAD at the trachael opening (mm)
Adjusted	0.38 ± 0.35 [0–1]	0.31 ± 0.37 [0–1]	2.6 ± 2.2 [0–7]	2.5 ± 2.1 [1–7]
Unadjusted	0.44 ± 0.5 [0–1]	0.75 ± 0.89 [0–2]	2.6 ± 2.2 [0–6]	3.6 ± 3.5 [1–9]

the anterior surface of the third and fourth cervical vertebrae, and airway diameters were measured at the narrowest portion at the root of the tongue and at the tracheal opening. The conditions around the pharyngeal region were evaluated by comparing these dimensions before and after anesthesia.

The results were expressed as means ± SD. For statistical analyses, the unpaired *t*-test was used for intergroup comparisons and the paired *t*-test for comparisons before and after surgery. $P < 0.05$ was considered to indicate a statistically significant difference.

Results

As shown in Table 1, no significant intergroup differences were found in age, body composition, amounts of fluid administered, surgical blood loss, or time during which the LMA was in place. Insertion of the LMA was smooth in all cases and caused no bleeding on the pharyngeal surface mucosa. The measurements made at multiple sites of the airway before LMA insertion and after its removal are shown in Table 2. Both groups showed significant changes in each parameter. Table 3 shows the difference between the two groups before and after anesthesia for each parameter; the mean changes in thickness of the retropharyngeal wall and the tracheal opening diameters for the unadjusted group were greater than those for the adjusted group. However, these intergroup differences were not significant.

Discussion

Significant changes occurred in retropharyngeal wall thickness and airway diameter after the use of the LMA, indicating that adjusting the cuff pressure did not produce significant differences in changes in airway morphology after removal of the LMA.

General anesthesia may influence airway diameter at the root of the tongue due to changes in the muscle tonus. A likely explanation for the slight change in retropharyngeal wall thickness is that the LMA cuff pressure exceeds the perfusion pressure of the pharyn-

geal mucosa, causing ischemia and eventual edema. It is known that the administration of nitrous oxide raises LMA cuff pressure and may also exaggerate the change in airway morphology. In this study, adjusting the cuff pressure had a statistically nonsignificant effect on the changes in laryngeal morphology. It should be noted, however, that this was the result of the small number of patients and the fact that the LMA was in place for less than 2 h. A study with a large number of subjects may change the significance of the result. One topic for a future study would be the consequences of using the LMA for a longer period. Another factor to be considered in relation to the use of the LMA is the considerable volume effect exerted by the cuff of the LMA and the fact that pressure on the mucous membrane may persist even after the cuff has been deflated.

Airway obstruction [3] and paresis of the recurrent laryngeal nerve [4], hypoglossal nerve [5], and lingual nerve [6] have been reported as complications that develop after use of the LMA. All of the patients described in these reports had been exposed to nitrous oxide, the LMA cuff had been inflated to a set level when it was inserted, and the cuff pressure had not been adjusted during anesthesia. The LMA cuff is normally inflated to an air pressure of 20 ml at no. 3 and 30 ml at no. 4, but the cuff content is often reduced when an adjustment is made to create an air leak at an airway pressure of 20 cm H_2O. Thus, it is recommended that the cuff pressure be adjusted after placement of the LMA to reduce the stress that is applied to the mucous membrane.

It is believed that pharyngeal pain associated with the use of the LMA is caused by compression by the cuff and subsequent injuries to the mucosal surface, in addition to the damage inflicted at the time of LMA placement. There are conflicting reports on this subject: (a) some state that the frequency of such injuries is reduced by maintaining a low cuff pressure [9], whereas (b) others insist that the adjustment has no significant effect [8]. One notes in these reports, however, that there is a difference in the method of adjusting the cuff pressure: in (a) the adjustment was made with the maintenance of air tightness as the criterion, whereas in (b) the cuff pressure was measured and adjusted with the aim of keeping it low. If one considers the effect of cuff compliance, the upper threshold at which airtightness is maintained, rather than the cuff pressure, is more likely to reflect the pressure applied to the mucous membrane. Therefore air tightness was used as the basis for our adjustments.

In conclusion, the changes in pharyngeal airway morphology before and after anesthetic procedures were compared between the cuff pressure "adjusted" and "unadjusted" groups. Significant changes in pharyngeal airway morphology were noted after the use of the LMA, but it was not confirmed that adjusting the cuff pressure had a significant effect on these morphological changes.

References

1. Benumof JL (1992) Laryngeal mask airway: indication and contraindication. Anesthesiology 77:843–846
2. Verghese C, Brimacombe JR (1996) Survey of laryngeal mask airway usage in 11 910 patients: safety and efficacy for conventional and nonconventional usage. Anesth Analg 82:129–133
3. Sonoda S (2001) Airway obstruction after removal of laryngeal mask airway. Anesth Resuscit 37:59–60
4. Lloyd Jones FR, Hegab A (1996) Recurrent laryngeal nerve palsy after laryngeal mask airway insertion. Anaesthesia 51:171–172
5. Nagai K, Sakuramoto C, Goto F (1994) Unilateral hypoglossal nerve paralysis following the use of the laryngeal mask airway. Anaesthesia 49:603–604
6. Laxton CH (1996) Lingual nerve paralysis following the use of the laryngeal mask airway. Anaesthesia 51:869–870
7. O'Kelly SW, Heath KJ, Lawes EG (1993) A study of laryngeal mask inflation: pressures exerted on the pharynx. Anaesthesia 48:1075–1078
8. Rieger A, Brunne B, Striebel HW (1997) Intracuff pressures do not predict laryngopharyngeal discomfort after use of the laryngeal mask airway. Anesthesiology 87:63–67
9. Buurgard G, Molhoff T, Prien T (1996) The effect of laryngeal mask cuff pressure on postoperative sore throat incidence. J Clin Anesth 8:198–201