Laryngo-pharyngeal complaints after use of the laryngeal mask airway

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Purpose: To compare the incidence of dysphagia, dysphonia and sore throat following anesthesia, using the laryngeal mask airway (LMA), among patients receiving intermittent positive-pressure ventilation (IPPV) and those breathing spontaneously (SV) and with two different concentrations of nitrous oxide (N_2O) in oxygen.

Methods: In a prospective trial, 120 patients (ASA I-III, 16-70 yr, > 60 kg) undergoing minor peripheral surgery were randomised into four groups with respect to type of ventilation and N_2O concentration (50% or 66%) received. Cuff pressure measurements were monitored continuously. Twenty-four hours after surgery, patients were questioned for sore throat, dysphagia and dysphonia.

Results: At 30 min post-LMA insertion, increases in cuff pressure were 35.2 ± 17.1 mmHg (22.8%) vs 50.1 ± 16.3 mmHg (32.7%) in patients breathing 50 and 66% N_2O , respectively ($P < 0.01$). There were no differences in cuff pressure increment between patients in the SV and IPPV groups. Cuff pressure values at the end of surgery depended on the duration of surgery and on the concentrations of N_2O . The overall incidence of postoperative discomfort at 24 hr was dysphagia 11%, dysphonia 11% and sore throat 28.8%. Only two patients reported sore throat as more than mild. There was no relationship between cuff pressure and laryngo-pharyngeal complaints. The incidence of dysphonia in the groups receiving IPPV was higher than that in the groups with spontaneous ventilation (17.2 vs 5%, $P < 0.05$).

Conclusion: Post-operative discomfort is related to the type of ventilation but not to variation in LMA cuff pressure.

Objectif : Comparer, à la suite d'une anesthésie réalisée avec un masque laryngé (ML), l'incidence de dysphagie, de dysphonie et de mal de gorge chez des patients sous ventilation à pression positive intermittente (VPPI) ou sous ventilation spontanée (VS) qui ont reçu deux concentrations différentes d'un mélange de protoxyde d'azote (N_2O) et d'oxygène.

Méthode : Lors d'un essai prospectif, 120 patients (ASA I-III, 16-70 ans, > 60 kg), admis pour une chirurgie périphérique mineure, ont été répartis en quatre groupes selon le type de ventilation et la concentration de N_2O (50 % ou 66 %) reçus. La pression, au tensiomètre, était enregistrée continûment. Vingt-quatre heures après la chirurgie, les patients ont répondu à un questionnaire sur le mal de gorge, la dysphagie et la dysphonie.

Résultats : À 30 min après l'insertion du ML, l'augmentation de pression était de $35,2 \pm 17,1$ mmHg (22,8 %) vs $50,1 \pm 16,3$ mmHg (32,7 %) pour des inhalations de N_2O à des concentrations de 50 et 66 % respectivement ($P < 0,01$), sans différence d'augmentation entre les patients des groupes VS et VPPI. À la fin de la chirurgie, la pression était fonction de la durée de l'intervention et de la concentration de N_2O . L'incidence globale d'inconfort postopératoire à 24 h était : dysphagie, 11 %; dysphonie, 11 % et mal de gorge, 28,8 %. Les maux de gorge étaient bénins, mais plus importants chez deux patients seulement. Il n'y avait pas de relation entre la pression, au tensiomètre, et les douleurs laryngo-pharyngées. L'incidence de dysphonie était plus élevée dans les groupes de patients sous ventilation spontanée (17,2 vs 5 %, $P < 0,05$).

Conclusion : L'inconfort postopératoire est relié au type de ventilation, mais non à la variation de pression notée avec l'emploi du ML.

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Accepted for publication November 28, 1998

THE cuff of the laryngeal mask airway (LMA) is manufactured from medical grade silicone rubber, a substance which rapidly absorbs volatile anesthetic agents, nitrous oxide (N_2O) and carbon dioxide (CO_2).^{1,2} In usual clinical practice, inflation of the LMA cuff is with room air and, hence, during the course of anesthesia N_2O may enter the cuff and produce an increase in cuff volume and pressure.³

Although, initially, the LMA was used almost exclusively with spontaneous breathing, recently its use with controlled ventilation has become more frequent. However, comparative studies of increments of cuff pressure with spontaneous ventilation and with controlled ventilation, using different concentrations of N_2O , have not been carried-out. The present study was designed to compare the effects of LMA cuff pressure and mode of ventilation with respect to post-operative laryngo-pharyngeal discomfort.

Methods

In vitro study

Six #4 LMAs (The LARYNGEAL MASK Company Ltd., Nicosia, Cyprus) were selected for study. Each LMA was identified, for the course of the study and was inflated to check for evidence of cuff asymmetry. To check for micro-leaks, the spontaneous deflation pressure characteristics of each LMA was determined. The pilot tube was attached via a three-way tap to a pressure transducer (Supermon 7210, Kontron Instruments Ltd, Watford, Herts, UK) which was calibrated and zeroed. The LMA cuff was then deflated to -25 mmHg and inflated with 40 ml room air. The cuff pressure was recorded every 15 min over three hours.

Clinical study

Approval from the Hospital Ethics Committee and informed patient consent were obtained. The patients ($n=120$; male and female, ASA I-III, >60 kg, aged between 16-70 yr) were undergoing elective surgery for which the use of the LMA was considered appropriate, and in whom the use of muscle relaxants was not essential. Patients were scheduled for minor peripheral surgery in which the duration of anesthesia was expected to be at least 30 min.

The exclusion criteria were a history of previous upper abdominal surgery, known or symptomatic hiatus hernia, esophageal reflux, peptic ulceration, morbid obesity, any symptoms of upper respiratory tract infection and a preoperative $\text{SpO}_2 < 92\%$ while breathing ambient air.

Once the LMA to be used had been selected, by sequential numbering, its pilot tube was attached via a

three-way tap to the pressure transducer and the cuff was evacuated to a baseline pressure of -25 mmHg.

Before induction of anesthesia, the patients were randomly allocated (assignment in sealed envelopes) to one of four groups of 30 patients. Group 1: patients breathing spontaneously a mixture of N_2O 50% in O_2 ; Group 2: patients breathing spontaneously a mixture of N_2O 66% in O_2 ; Group 3: lung ventilation with intermittent positive-pressure ventilation (IPPV) and N_2O 50% in O_2 ; Group 4: IPPV with N_2O 66% in O_2 . At the conclusion of the study, each LMA had been used 20 times, 60 patients had been included in each type of ventilation (spontaneous or controlled) and 60 patients had received each of the N_2O concentrations.

In the operating room, patients were premedicated with 10 mg metoclopramide *iv*. Anesthesia was induced with $1 \mu\text{g}\cdot\text{kg}^{-1}$ fentanyl and $2.5 \text{ mg}\cdot\text{kg}^{-1}$ propofol. Approximately one minute later, the LMA was inserted according to the technique described by Brain.⁴ The mask was lubricated with sterile jelly (K-YTM, Johnson-Johnson Ltd., Maidenhead, UK), which did not contain local anesthetic. All patients were placed supine with the head straight and the breathing system tubing was supported to prevent traction on the mask. The LMAs were inflated according to the manufacturer's instructions with 30 ml air. The cuff pressures were continuously monitored and the measurements were recorded at intervals of five minutes until cessation of N_2O administration.

Anesthesia was maintained with isoflurane 0.8 to 1.5 vol.%, together with the $\text{N}_2\text{O}/\text{O}_2$ mixture decided for each group. Inspired gases were humidified and warmed with heat and moisture exchangers (HME). In Groups 1 and 2 no muscle relaxants were administered and ventilation was manually assisted only when $\text{P}_{\text{ET}}\text{CO}_2$ exceeded 45 mmHg. In Groups 3 and 4, after the insertion of the LMAs, neuromuscular blockade was induced with $0.3 \text{ mg}\cdot\text{kg}^{-1}$ atracurium and subsequent incremental doses were given as necessary. Positive pressure ventilation was applied with a tidal volume of $8 \text{ ml}\cdot\text{kg}^{-1}$ and a respiratory rate was adjusted to maintain $\text{P}_{\text{ET}}\text{CO}_2$ at 35-40 mmHg. In these groups the muscle relaxation was reversed with atropine and neostigmine in those cases in which it was considered necessary.

The difference between the programmed tidal volume and the expired volume was noted (Capnomac Ultima, Datex-Engstrom, Helsinki, Finland). The ventilation parameters were modified if the airway pressure exceeded 20 cm H_2O or when the difference between the programmed and the expired tidal volume exceed 15%.⁵

Care was taken to ensure that the LMA was not dis-

TABLE I Patient characteristics (mean (SD) [range]), succesful insertion of the LMA on the first attempt, duration of surgical interventions and lower values of oxygen saturation in each group.

	Group 1 (n = 30) N ₂ O 50% - SV	Group 2 (n = 30) N ₂ O 66% - SV	Group 3 (n = 29) N ₂ O 50% - IPPV	Group 4 (n = 29) N ₂ O 66% - IPPV
Sex (M/F)	23/7	24/6	19/10	20/9
Age (yr)	47.2 (15.5) [22-68]	43.6 (17.4) [16-65]	49.8 (18.1) [22-68]	44.8 (14.4) [23-66]
Weight (Kg)	75.7 (8.2)	75.5 (8.4)	78.7 (9.2)	77.3 (8.6)
Height (cm)	168.8 (6.7)	172 (6.2)	170.8 (7.9)	172.2 (7)
First attempt insertion (n)	26	26	27	28
Duration of anaesthesia (min)	52.2 [30-95]	55.2 [30-102]	57.5 [35-82]	58.5 [32-89]
Lower values of SpO ₂ (%)	96.3 (1.2) [95-98]	96.4 (1.4) [96-98]	95.8 (1.5) [94-97]	96.1 (1.3) [95-97]

SV = spontaneous ventilation; IPPV = intermittent positive-pressure ventilation.

TABLE II Intracuff pressures (mmHg).

	Group 1 (n = 30) N ₂ O 50%-SV	Group 2 (n = 30) N ₂ O 66%-SV	Group 3 (n = 29) N ₂ O 50%-IPPV	Group 4 (n = 29) N ₂ O 66%-IPPV
Initial	155.8 (18)	152.3 (17)	154.8 (18)	151.4 (16)
10 min	170.7 (18)	173.1 (17)	169.8 (19)	175.3 (17)
20 min	181.2 (17)	187.0 (17)	181.9 (18)	192.8 (17)
30 min	189.9 (16)	198.7 (15)	191.2 (18)	205.3 (16)
End of surgery	195 (18) [165-229]	208 (20) [177-245]	201 (17) [168-236]	210 (18) [183-246]
Increase (initial up to 30 min)	34.1 [21.9%]*	46.4 [30.4%]†	36.4 [23.5%]‡	53.9 [35.6%]

SV = spontaneous ventilation; IPPV = intermittent positive-pressure ventilation. Intracuff pressures are expressed as mean (SD) [range] (%).

* $P < 0.05$ with respect to Groups 2 and 4. † $P < 0.05$ with respect to Group 3. ‡ $P < 0.05$ with respect to Group 4.

TABLE III Incidence of laryngo-pharyngeal complaints in each group of patients.

	Group 1 = N ₂ O 50% - SV		Group 2 = N ₂ O 66% - SV		Group 3 = N ₂ O 50% - IPPV		Group 4 = N ₂ O 66% - IPPV	
	n	(%)	n	(%)	n	(%)	n	(%)
Sore throat	11	(36.6)	8	(26.6)	8	(27.6)	7	(24.1)
Dysphonia	2	(6.6)	1	(3.3)	5	(17.2)	5	(17.2)
Dysphagia	3	(10)	1	(3.3)	4	(13.8)	5	(17.2)

SV = spontaneous ventilation; IPPV = intermittent positive-pressure ventilation.

There were no significant differences among groups.

turbed during surgery. At the end of surgery the cuff was deflated and the LMAs were removed when the patient was able to respond to verbal commands. In no case was pharyngeal suction performed. Duration of surgical intervention was defined as the time between placement and removal of the LMA.

Monitoring included ECG, indirect blood pressure and pulse oximetry, inspiratory and end-tidal gases concentration. Dipyrone, 2g, *iv*, or ketorolac trometamol, 30 mg, *iv*, initially with increments as needed, were used for postoperative analgesia.

Twenty-four hours after surgery patients were interviewed to determine the incidence and severity of laryngo-pharyngeal complaints. These included dys-

phonia (hoarseness), dysphagia (difficulty with swallowing provoked by drinking) and sore throat (constant pain, independent of swallowing). The patients were specifically asked about the presence/absence of these symptoms in the postoperative period. Sore throat was evaluated as: score 0 = no complaints at all, score 1 = mild sore throat, score 2 = moderate sore throat, score 3 = severe sore throat.

Statistical comparisons were performed by multiple analysis of variance (MANOVA). Specific differences were isolated by Newman-Keul's test. Intragroup comparisons were performed using Student's paired t test. Categorical variables were compared using Chi-squared test and Fisher's exact test for small samples.

FIGURE Increments in intra-cuff pressure in the first 30 min of surgical intervention

SV = Spontaneous ventilation. IPPV = intermittent positive-pressure ventilation.

* $P < 0.01$

Continuous data are reported as mean $\pm$ standard deviation (SD) and range where necessary. Probability values < 0.05 were considered statistically significant.

Results

No macro-leaks or asymmetries were detected in any LMA. The initial cuff pressure *in vitro* was 218 ± 6.5 mmHg which decreased after three hours to 113 ± 4.4 mmHg. The spontaneous deflation characteristics of the cuffs were similar in all six LMAs.

The groups were similar in the distribution of sex, age, weight, height and duration of surgical intervention (Table I). Insertion of the LMA was successful on the first attempt in 107 cases (89.2%). Two patients were excluded from the study for excessive gas leakage around the mask/larynx interface. The quality of the airway and oxygen saturation was satisfactory at all times (Table I).

The mean initial cuff pressure was 153.6 ± 17 mmHg and was similar for the four groups. The cuff pressure values increased progressively in all subject groups (Table II). The maximum cuff pressure values at the end of each procedure reached a mean of 203.5 ± 18.3 mmHg and depended not only on the patient group but also on the duration of anesthesia.

Cuff pressures were re-assessed with respect to a) type of ventilation and b) concentration of N_2O employed (Figure). The difference in the percentage increase in cuff pressure after 30 min from the begin-

ning of the surgical intervention, between patients breathing 50 and 66% N_2O , was statistically significant ($P < 0.01$).

Postoperative analgesic management was comparable in the four groups. The overall incidence of sore throat was 28.8%, dysphonia 11% and dysphagia 11% (Table III). The incidence of dysphonia in the combined groups receiving IPPV was higher than that of the groups with spontaneous ventilation (17.2% vs. 5%; $P < 0.05$).

Sore throat had an overall score of 0.30 points and was mild in 94.5% of patients who suffered from it. Two patients (one each from Groups 2 and 3) reported sore throat of moderate intensity. The distribution was similar in all four groups. There was a higher tendency in younger patients to complain of sore throat as was in those patients subjected to more prolonged surgical interventions.

Discussion

After initial deflation of the LMA cuff to -25 mmHg and inflation to the volume recommended by the manufacturers, we obtained similar values of cuff pressure as did other authors.^{6,7} In contrast to Wright *et al.*⁸ (who did not establish a fixed baseline value for deflation of the LMA), we encountered differences between pressures reached at 30 min with the different concentrations of N_2O used. However, the differences in cuff pressures among the four groups were not correlated with postoperative discomfort. The relationship between intracuff pressure and the incidence of sore throat is a current controversy. In several studies^{6,9,10} where similar findings have been reported, including data on wider ranges of intracuff pressures (30 - 180 mmHg),¹¹ no relationship between the two variables was observed. In contrast, Brain *et al.*¹² recommend cuff pressures of 60 cm H_2O (44.1 mmHg) to avoid laryngo-pharyngeal discomfort. Those who advocate a causal relationship,^{13,14} subscribe to the hypothesis that the pressure exerted by the LMA is transferred to the pharyngeal mucosa with a concomitant decrease of pharyngeal perfusion¹⁵ which might lead to post-operative sore throat. However, direct measurement on the middle part of the outside of the LMA demonstrated that extracuff pressure exerted on the pharyngeal wall is approximately 25 mmHg and does not correlate with intracuff pressure.¹⁶ Further, there is indirect evidence that pharyngeal mucosal pressures may decrease despite an increase in cuff pressure, suggesting that the pharynx may adapt to the presence of the LMA.^{6,17}

Since the purpose of our study was to assess the incidence of complications under conditions of standard clinical practice, no postoperative opioids were used for

minor peripheral surgery, as is usual in our hospital. Patients in whom placement of the LMA required a second attempt (which may exacerbate the incidence of sore throat) were not excluded from our study. Despite this, the observed incidence is similar to that reported by Dingley *et al.*¹⁸ and Brimacombe and Berry.¹⁰

The incidence of sore throat with the use of LMA has been reported between 0 and > 50%^{13,19} and may be attributable to different methodologies. Postoperative sore throat following anesthesia with LMA is multifactorial and its incidence can be influenced by: the depth of anesthesia at the moment of insertion, the method of insertion,¹⁸ the number of attempts at placement, the presence of HME in the circuit and other general factors such as: sex,⁹ duration of anesthesia,⁹ type of postoperative analgesia and the interview method used to collect the data.²⁰ The mode of ventilation (spontaneous or controlled) in the study of Cork *et al.*,²¹ as with the present study, does not influence the incidence of postoperative sore throat.

The overall incidence of dysphagia was 11% and was not severe enough to impede oral intake. In our patients, the appearance of the swallowing reflex during emergence from anesthesia with the LMA *in situ* was not an important factor in the production of dysphagia given that in another study¹¹ in which the LMA had been removed while the patients were at the stage of being unresponsive to pharyngeal stimulation, the incidence of dysphagia recorded (and described as the prominent symptom) was higher than in our study.

The LMA does not traverse the vocal cords and, hence, the incidence of dysphonia is less than that induced by tracheal intubation.⁹ This advantage accounts for the recommendation for its use in singers.²² Nevertheless, direct contact of the LMA with the vocal cords and the arytenoid cartilage may occur in some cases²³ and dysphonia may occur, albeit with varying incidence. The characteristics of dysphonia have been assessed using acoustic waveform analysis²⁴ and it has been suggested that it may follow the administration of cold and dry inspiratory gases.⁹ This does not apply in the present study since we used HME in all patients. However, the increased incidence in patients with controlled ventilation is of note. Muscular relaxation in the patients of Groups 3 and 4 was not complete at any time since the surgical interventions did not require it. The vocal cords, partially adducted, would have received impacts from the intermittent flow of gasses from the respirator causing micro-traumas that would be increased with prolonged intervention times. The vocal cords are unidirectional entrance valves that offer resistance to pressure provoked by the flow of cold gasses from the

exterior, but not to that returning from the distal zone during exhalation.²⁵ With spontaneous breathing this trauma is not produced since the contraction of the posterior cricoarytenoid muscles during inspiration abduces the vocal cords and widens the glottal chink.

In conclusion, the different concentrations of N₂O in the anesthesia mixture induce different cuff pressure but the values are not related to postoperative laryngopharyngeal complaints. We found an increased incidence of dysphonia in patients with IPPV. Thus, the proposed advantage of LMA with this mode of ventilation for patients who require special care of their vocal cords, is doubtful.

Acknowledgements

We wish to thank Dr. Peter R. Turner for editorial assistance.

References

- 1 Fielding R, Salamonsen RF. Solubility of volatile anaesthetics in silicone rubber. *J Memb Sci* 1979; 5: 319–26.
- 2 Hughes R, Jiang B. The permeabilities of carbon dioxide, nitrous oxide and oxygen and their mixtures through silicone rubber and cellulose acetate membranes. *Gas Sep Purif* 1995; 9: 27–30.
- 3 Lumb AB, Wrigley MW. The effect of nitrous oxide on laryngeal mask cuff pressure. *In vitro* and *in vivo* studies. *Anaesthesia* 1992; 47: 320–3.
- 4 Brain AIJ. Laryngeal mask misplacement- causes, consequences and solutions (Letter). *Anaesthesia* 1992; 47: 531–2.
- 5 Figueredo E, Vivar-Diago M. Reduction of gas leaks from laryngeal masks with controlled ventilation. (Spanish) *Rev Esp Anestesiol Reanim* 1998; 45: 209–10.
- 6 Asai T, Howell TK, Koga K, Morris S. Appropriate size and inflation of the laryngeal mask airway. *Br J Anaesth* 1998; 80: 470–4.
- 7 Brimacombe J, Berry A. Laryngeal mask airway cuff pressure and position during anaesthesia lasting one to two hours. *Can J Anaesth* 1994; 41: 589–93.
- 8 Wright ES, Filshie J, Dark CH. Laryngeal mask cuff pressure and nitrous oxide. *Anaesthesia* 1992; 47: 713–4.
- 9 Rieger A, Brunne B, Hass I, *et al.* Laryngo-pharyngeal complaints following laryngeal mask airway and endotracheal intubation. *J Clin Anesth* 1997; 9: 42–7.
- 10 Brimacombe J, Berry A. Insertion of the laryngeal mask airway - a prospective study of four techniques. *Anaesth Intensive Care* 1993; 21: 89–92.
- 11 Rieger A, Brunne B, Striebel HW. Intracuff pressures do not predict laryngopharyngeal discomfort after use of the laryngeal mask airway. *Anesthesiology* 1997; 87: 63–7.

- 12 *Brain AIJ*. Pressure in laryngeal mask airway cuffs (Letter). *Anaesthesia* 1996; 51: 603.
- 13 *Burgard G, Möllhoff T, Prien T*. The effect of laryngeal mask cuff pressure on postoperative sore throat incidence. *J Clin Anesth* 1996; 8: 198–201.
- 14 *Lacroix O, Billard V, Bourgain JL, Debaene B*. Prevention of postoperative sore throat during use of the laryngeal mask airway. *Br J Anaesth* 1996; 76(Suppl. 2): 16.
- 15 *O'Kelly SW, Heath KJ, Lawes EG*. A study of laryngeal mask inflation. Pressure exerted on the pharynx. *Anaesthesia* 1993; 48: 1075–8.
- 16 *Hamakawa T, Nakamura S, Kawasaki S, Takasaki M*. Intracuff pressure of the LM and pressure on the pharynx. (Japanese) *J Clin Anesth (Rinsho-Masui)* 1993; 17: 1165–7.
- 17 *Marjot R*. Pressure exerted by the laryngeal mask airway cuff upon the pharyngeal mucosa. *Br J Anaesth* 1993; 70: 25–9.
- 18 *Dingley J, Whitehead MJ, Wareham K*. A comparative study of the incidence of sore throat with the laryngeal mask airway. *Anaesthesia* 1994; 49: 251–4.
- 19 *O'Neill BL, Foley EP, Chang A*. Effects of humidification of inspired gases with the laryngeal mask airway. *Anesthesiology* 1994; 81: A52.
- 20 *Harding CJ, McVey FK*. Interview method affects incidence of postoperative sore throat. *Anaesthesia* 1987; 42: 1104–7.
- 21 *Cork RC, Depa RM, Standen JR*. Prospective comparison of use of the laryngeal mask and endotracheal tube for ambulatory surgery. *Anesth Analg* 1994; 79: 719–27.
- 22 *Harris TM, Johnston DF, Collins SRC, Health ML*. A new general anaesthetic technique for use in singers: the Brain laryngeal mask airway versus endotracheal intubation. *J Voice* 1990; 4: 81–5.
- 23 *Pothmann W, Füllekrug B, Schulte am Esch J*. Fibreoptic determination of the position of the laryngeal mask. (German) *Anaesthesist* 1992; 41: 779–84.
- 24 *Lee SK, Hong KH, Choe H, Song HS*. Comparison of the effects of the laryngeal mask airway and endotracheal intubation on vocal function. *Br J Anaesth* 1993; 71: 648–50.
- 25 *Sasaki CT, Isaacson G*. Functional anatomy of the larynx. *Otolaringol Clin North Am* 1988; 21: 595–612.