British Journal of Anaesthesia 1998; **81**: 186–187

Influence of cuff volume on oropharyngeal leak pressure and fibreoptic position with the laryngeal mask airway

C. KELLER, F. PÜHRINGER AND J. R. BRIMACOMBE

Summary

We studied the size 4 laryngeal mask airway (LMA) to test the hypothesis that oropharyngeal leak pressure and fibreoptic position improves with increasing cuff volume. After LMA insertion, 50 anaesthetized adult patients had the cuff inflated in 5-ml increments to 40 ml. Oropharyngeal leak pressure was optimal at 15 ml and decreased at higher volumes. The fibreoptic position was optimal at 0–20 ml and deteriorated at higher volumes. Gastric insufflation was detected more frequently when the cuff volume exceeded 20 ml. We conclude that inflation of the size 4 LMA to the maximum recommended volume provides suboptirnal conditions and that this value should be reduced from 30 to 20 ml. (*Br. J. Anaesth.* 1998; **81**: 186–187)

Keywords: equipment, masks anaesthesia; measurement techniques; fibreoptic

The laryngeal mask airway (LMA) forms a circumferential low pressure seal with the periglottic tissues and provides fiberoptic access to the vocal cords. The manufacturer recommends that the cuff is inflated with the minimal volume of air required to provide an effective seal,[1] but it is common practice to inflate the cuff with the maximum recommended volume, as illustrated in several trials.[2 4] There are no published data investigating the relationship between cuff volume and oropharyngeal leak pressure. In addition, the effect of increasing cuff volume on fibreoptic view is unknown. We tested the hypothesis that oropharyngeal leak pressure and fibreoptic position improve with increasing cuff volume up to the maximum recommended.

Methods

Fifty consecutive ASA I–II adult patients in whom the LMA was considered suitable were included in this study. Ethical committee approval and informed consent was obtained. A standard anaesthetic was given and routine monitoring applied. A size 4 LMA was used for all patients. Anaesthesia was induced with fentanyl 1–3 $\mu g\ kg^{-1}$ and propofol 2.5–3.5 $mg\ kg^{-1}$. Anaesthesia was maintained with 100% oxygen and a propofol infusion at 6–8 $mg\ kg^{-1}\ h^{-1}$ until testing was complete. A single experienced LMA user (1200 insertions) inserted/fixed the LMA according to the manufacturer's instructions. The pilot balloon was attached via a three-way tap to a 5-ml syringe and a calibrated pressure transducer. Cuff volumes were increased in 5-ml increments up to a maximum of 40 ml (10 ml more than recommended). Oropharyngeal leak pressure was determined by closing the expiratory valve of the circle system at a fixed gas flow of 3 litre min^{-1}, and noting the airway pressure in the anaesthetic breathing system at which gas leak occurred into the mouth. Air entering the stomach at the oropharyngeal leak pressure was detected by auscultation in the epigastrium. The view of the cords was scored fibreoptically from 1 cm above the mask aperture bars by a single investigator (FP) using an established scoring system: score 4, only cords; score 3, cords plus posterior epiglottis; score 2, cords plus anterior epiglottis; score 1, cords not seen, but function adequate.[5] Oropharyngeal leak pressures, intracuff pressures, gastric insufflation and fibreoptic scores were recorded at zero volume and after each additional 5 ml and when the patient was apnoeic. Statistical analysis was with paired t test (with Bonferroni adjusted probability) and chi-squared test. Significance was taken as $P<0.05$.

Results

All patients enrolled in the study were included in the analysis. There were no failed insertion attempts. The mean (range) for age was 37 (19–62) yr and mean (SD) weight and height were 75 (10) kg and 171 (19) cm respectively. The male:female ratio was 31:19. The results for oropharyngeal leak pressure, intracuff pressure, gastric insufflation and fibreoptic position with increasing cuff volume are presented in table 1. Oropharyngeal leak pressure was highest at 15 ml and declined thereafter, the difference becoming significant when comparing the oropharyngeal leak pressure at 20 and 25 ml (mean difference 1.5 cm H_2O, 95%CI 0.7, 2.2). Oropharyngeal leak pressure increased in 1 of 50 (2%) patients after the maximum recommended volume was exceeded. There was an exponential increase in intracuff pressure with increasing cuff volume. Gastric insufflation was detected more frequently when the cuff volume exceeded 20 ml (none of 250 [95%CI 0, 1] *vs* 4 of 200 [95%CI 1, 4], $P=0.02$). The oropharyngeal leak pressures at which gastric insufflation was detected

C. KELLER, MD, F. PÜHRINGER, PHD, MD, Department of Anaesthesia and Intensive Care Medicine, Leopold-Franzens University, Innsbruck, Austria. J. BRIMACOMBE, MB, CHB, FRCA, MD, Department of Anaesthesia and Intensive Care, University of Queensland, Cairns Base Hospital, Cairns 4870, Australia.
Accepted for publication: February 25,1998.
Correspondence to J. R. B.

Table 1 Oropharyngeal leak pressure (OLP), intracuff pressure (ICP), gastric insufflation (GI) and fibreoptic score (FOS) with increasing intracuff volume. Values for OLP and ICP are mean (95% confidence intervals). Fibreoptic score: 4 = only vocal cords visible, 3 = vocal cords plus posterior epiglottis, 2 = vocal cords plus anterior epiglottis, 1 = vocal cords not seen[5]

	Intracuff volume (ml)								
	0	5	10	15	20	25	30	35	40
OLP (cm H_2O)	12 (10, 13)	16 (14, 17)	19 (18, 21)	22 (20, 23)	22 (20, 23)	20 (19, 21)	19 (17, 19)	18 (16, 18)	17 (16, 18)
ICP (cm H_2O)	−29 (−34, −23)	15 (12, 17)	34 (30, 38)	58 (53, 63)	88 (80, 96)	126 (118, 134)	183 (175, 190)	240 (231, 249)	306 (295, 316)
GI (*n*)	0	0	0	0	0	1	2	0	1
FOS (*n*)									
4	15	15	10	9	7	3	4	0	0
3	29	30	38	40	42	44	41	42	40
2	4	4	2	0	0	0	0	0	0
1	2	1	0	1	1	3	5	8	10
Median	3.143.18	3.16	3.14	3.1	2.94	2.88	2.68	2.6	

were 13–30 cm H_2O and only when the fibreoptic view was score 1. The fibreoptic score was highest at 0–20 ml and deteriorated thereafter, the difference becoming significant when comparing the fibreoptic score at 30 and 35 ml ($P = 0.03$). In no patient did the fibreoptic view improve after 20 ml was exceeded. There was no significant correlation between age, height, weight and body mass index and either oropharyngeal leak pressure or fibreoptic score.

Discussion

These data suggest that the LMA functions better at sub-maximal cuff volumes and that the optimal volume for the size 4 LMA is 15–20 ml. Increasing cuff volume to 25 ml and above does not improve seal pressure or fibreoptic view, commonly results in a deterioration in both, and may increase the risk of gastric insufflation. In theory, the efficacy of the seal depends on the fit between the oval-shaped groove surrounding the glottis and the oval-shaped cuff of the LMA. The fibreoptic view depends on the alignment of the LMA bowl and glottis and the extent to which the epiglottis is downfolded during insertion. We postulate that the soft low volume cuff is better able to fit into the variable contours of the periglottic groove than the tense high volume cuff. It has been shown that increasing the cuff volume of the LMA displaces the larynx anteriorly.[4] It is also likely that at higher cuff volumes the wedge-shaped tip is displaced from the wedge-shaped hypopharynx causing proximal displacement of the cuff, movement of the epiglottis into the bowl and exposing the oesophageal inlet. This would explain the deterioration in fibreoptic view and the greater gastric insufflation at greater cuff volumes.

We conclude that inflation of the size 4 LMA to the maximum recommended volume provides sub-optimal conditions and that this value should be reduced from 30 to 20 ml. Researchers assessing efficacy of seal or fibreoptic position may have underestimated these values if the cuff was inflated to the maximum recommended volume.

References

1. Brimacombe J, Brain AIJ, Berry A. *The laryngeal mask airway instruction manual.* Henley-on-Thames: Intavent Research Limited, 1996.
2. Devitt JH, Wenstone R, Noel AG, O'Donnell RRT. The laryngeal mask airway and positive-pressure ventilation. *Anesthesiology* 1994; **80**: 550–555.
3. Wakeling HG, Butler PJ, Baxter PJC. The laryngeal mask airway: a comparison between two insertion techniques. *Anesthesia and Analgesia* 1997; **85**: 687–690.
4. Nandwani N, Fairfield MC, Krarup K, Thompson, J. The effect of laryngeal mask airway insertion on the position of the internal jugular vein. *Anaesthesia* 1997; **52**: 77–83.
5. Brimacombe J, Berry A. A proposed fiber-optic scoring system to standardize the assessment of laryngeal mask airway position. *Anesthesia and Analgesia* 1993; **76**: 457.