Laryngeal mask airway performance: effect of cuff deflation during anaesthesia

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Summary

We studied the effect of deflating the laryngeal mask airway (LMA) cuff *in situ* on recorded respiratory tidal ventilation in 30 spontaneously breathing anaesthetized patients. Another 26 patients were studied in whom the LMA cuff was undisturbed. Deflation of the cuff to a pressure of 22 mm Hg (below an estimated arteriolar perfusion pressure of the pharyngeal mucosa), by removing approximately 50% of the recommended cuff injection volume, had a minimal effect on tidal ventilation ($P > 0.9$). This manoeuvre may have a role in minimizing transmitted cuff pressure on the adjacent pharyngeal mucosa. Complete cuff deflation, however, resulted in a 17% decrease in mean tidal ventilation ($P < 0.05$), with two patients (6%) demonstrating a substantial leak around the cuff and airway obstruction. The practice of complete cuff deflation during the recovery period from anaesthesia cannot be recommended. (*Br. J. Anaesth.* 1996; 76: 456–458)

Key words

Complications, mucosal pressure. Equipment, masks anaesthesia.

The two principal functions of the cuff of the laryngeal mask airway (LMA) are to orientate the mask on inflation and to subsequently generate a low pressure seal around the laryngeal inlet. However, it has been shown to exert substantial pressures on the adjacent pharyngeal mucosa. This occurs even before full inflation with the manufacturer’s recommended injection volumes and despite apparent accommodation by the pharynx [1].

The morbidity resulting from such pressures exceeding mucosal capillary perfusion pressure remains undetermined. Intra-cuff pressure monitoring is currently recommended by the manufacturer to avoid postoperative throat discomfort [2]. Several methods of limiting intra-cuff pressure have been suggested, including submaximal cuff inflation or partial deflation of the cuff during anaesthesia. These manoeuvres have recently been endorsed by the inventor of the device, Dr A. I. J. Brain [3].

This study was undertaken to determine the effect of LMA cuff deflation during anaesthesia on LMA performance.

Methods and results

After obtaining Hospital Ethics Committee approval and informed consent, we studied 56 adult ASA I or II unpremedicated patients (29 males) presenting for elective minor surgery. Anaesthesia incorporating spontaneous ventilation via an LMA was appropriate and not contraindicated for any patient.

An appropriately sized LMA (3 for females, 4 for males) was checked [2] and the pilot tube connected via a three-way tap to a 50-ml Plastipak syringe and a Spectramed pressure transducer (PIOEZ) with a recorder. The same transducer was calibrated against a mercury column and the zero point determined before each study (non-linear error <2%). Each LMA cuff was evacuated to a pressure of ~20 mm Hg. The syringe volume was then adjusted to the manufacturer’s recommended injection volume (20 ml for size 3, 30 ml for size 4 LMA). This sealed system was not disrupted until the end of each study.

All patients were fasted and unpremedicated. Anaesthesia was induced with propofol 2–3 mg kg$^{-1}$ and fentanyl 1 g kg$^{-1}$. The LMA was inserted as described by the manufacturer [2] by one of the two investigators and the cuff inflated fully with the preset volume. Adequacy of placement was judged by the absence of any clinical or audible evidence of upper airway obstruction, examination of the capnography trace and the ease of positive pressure ventilation applied while the patients were apnoeic. The head and neck were then placed in a neutral position resting on one pillow. Anaesthesia was maintained with 1–2.5% isoflurane, and 60% nitrous oxide in oxygen; patients breathed spontaneously from a circle system. Each tidal volume was recorded during the study period using a Narkomed 4 (North American Drager) Spiromed positive displacement rotating lobe impeller (error $<\pm 10$ ml).

The patients were allocated to one of two groups (30 patients in group 1, 26 patients in group 2) and were studied 15 min after induction of anaesthesia. During this period, tidal volume recordings were...
made over 4 consecutive minutes. In group 1, for the first minute the LMA was undisturbed, for the second minute the cuff was deflated to a pressure of 22 mm Hg, for the third minute the cuff was fully deflated to −20 mm Hg, and for the fourth minute the cuff was re-inflated fully with the gas stored in the closed syringe system. Tidal volumes were recorded with the fresh gas flow turned off and the expiratory valve closed to make a closed circle system. Inflamed and expired isoflurane and nitrous oxide concentrations remained constant throughout the readings. In group 2, patients were treated identically but tidal volumes were recorded over four consecutive 1-min periods without the cuff being altered in any way.

Within-group data were analysed using two-way analysis of variance (ANOVA) for repeated measures (Micosoft Excel). A probability value of less than 0.05 was considered to be significant. Data are presented as mean (SEM).

There was no difference between the groups in terms of age (group 1, 37 (range 21–80) yr; group 2, 37 (19–75) yr), sex ratio (group 1, 18 males, 12 females; group 2, 11 males, 15 females) or body mass index (group 1, 27.5 (0.6) kg m⁻²; group 2, 25.4 (0.4) kg m⁻²).

Intra-cuff pressures after initial inflation were substantial and increased during anaesthesia as cuff volume increased with diffusion of nitrous oxide into the cuff. Reduction in intra-cuff pressure to 22 mm Hg required removal of approximately 50 % of the initial cuff volume (size 4 LMA 16.3 (1) ml; size 3 LMA 10.7 (0.6) ml).

The mean respiratory tidal volume recorded during the first minute of the study period, before cuff deflation, was taken as baseline and plotted as 100 %. Subsequently recorded mean tidal volumes were plotted as a percentage of these values (fig. 1). Mean tidal volume in patients in group 1 decreased to 95 % of the baseline value when the cuff was deflated to 22 mm Hg (P = 0.9). The response to this degree of deflation was variable, and in eight patients (26 %) tidal ventilation increased slightly.

When the cuff was deflated fully, mean tidal volume decreased significantly to 83 % of baseline (P = 0.035). At this time, two patients (6 %) had no recordable tidal ventilation with noisy and partially obstructed breathing. When the cuff was re-inflated fully, mean tidal ventilation increased to 110 % of the original baseline value, and any obstruction was relieved. This increase was not significant compared with the baseline mean tidal ventilation (P = 0.18).

There was no significant change in the recorded mean tidal volumes of patients in group 2 throughout the study period (fig. 1).

Comment

Inflating the LMA cuff to the volume recommended by the manufacturer [2] results in transmitted pressures on the pharynx in excess of mucosal capillary perfusion pressure [1]. The morbidity resulting from these high transmitted pressures on the pharyngeal mucosa is unknown. There have been isolated reports of trauma to the posterior pharyngeal wall, uvula and large tonsils, and compression of the hypoglossal nerve [4], lingual artery [5] and recurrent laryngeal nerve [6]. Intra-cuff pressure monitoring is recommended but no acceptable level is stipulated [2]. Several methods of limiting intra-cuff pressure have been suggested, including submaximal cuff inflation or partial cuff deflation during anaesthesia [3].

We have studied, in spontaneously breathing anaesthetized patients, the effect of deflating the LMA cuff in situ on recorded respiratory tidal volumes. Mean respiratory tidal ventilation decreased as LMA cuff volumes (and pressures) were reduced. This effect was minimal when the cuff was deflated to a pressure of 22 mm Hg with the withdrawal of approximately 50 % of the initial inflation volume. Complete cuff deflation resulted in a significant decrease in recorded tidal ventilation. This may have resulted from tidal ventilation escaping around the sides of the partially and fully deflated LMA cuff or a degree of upper airway obstruction, or both. Two patients (6 %) demonstrated a substantial leak around the LMA cuff with clinical evidence of upper airway obstruction. The practice of some anaesthetists and recovery nursing staff to fully deflate the LMA cuff during the period of recovery from anaesthesia cannot be supported. This practice is contrary to the manufacturer's instructions [2] which states that deflation should only be performed when "the patient can open their mouth on command". There was a return to baseline mean tidal ventilation when the cuff was re-inflated fully (with the same gas), to the original cuff volume.

There was no change in the tidal volumes recorded in group 2 throughout the study, which would exclude any chance alteration in the level of surgical stimulus or depth of anaesthesia as being responsible for the changes observed in group 1.

We have demonstrated that the cuff of the LMA may be deflated to a pressure of 22 mm Hg (i.e. below the arteriolar perfusion pressure of the
pharyngeal mucosa) with minimal effect on the recorded tidal ventilation, in spontaneously ventilating patients. The effect of this manoeuvre should, however, be assessed for each individual patient. Full deflation of the cuff results in a significant decrease in recorded tidal ventilation. The practice of complete cuff deflation during recovery from anaesthesia cannot be recommended.

References