Cricoid pressure prevents placement of the laryngeal tube and laryngeal tube-suction II

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Background. The laryngeal tube has a potential role in patients with a difficult airway, but cricoid pressure is required if the patient is at risk of aspiration. The effect of cricoid pressure on insertion of these devices is unknown.

Methods. In a randomized cross-over study, the laryngeal tube (25 patients) or the laryngeal tube-suction II (15 patients) was inserted with cricoid pressure applied on one occasion and with sham pressure on the other occasion. Adequacy of ventilation, time to achieve adequate ventilation, and the leak pressure were assessed.

Results. Ventilation was adequate in all patients when sham pressure was applied. Cricoid pressure significantly reduced the rate of adequate ventilation to 6 of 25 patients for the laryngeal tube \( P < 0.001; 95\% \) confidence interval (CI) for difference: 59–93\%) and to 5 of 15 patients for the laryngeal tube-suction II \( P < 0.05; 95\% \) CI for difference: 43–91\%). The median time taken to achieve adequate ventilation for the laryngeal tube was 10 s [inter-quartile range (IQR): 8–15] (range 5–26) for sham pressure and 25 s (15–32) (15–33) for cricoid pressure; the median leak pressure was 30 (IQR: 30–30) (range 20–30) cm H2O for sham pressure and 15.5 (14.3–20.5) (12–22) cm H2O for cricoid pressure.

Conclusions. Continuous cricoid pressure prevents correct placement of the laryngeal tube and the laryngeal tube-suction II such that placement and ventilation via these devices are ineffective. The effect of cricoid pressure on ventilation via these devices, after correct placement, remains unknown.


Keywords: airway, patency; complications, airway obstruction; equipment, airway; larynx, cricoid pressure

Accepted for publication: March 23, 2007

If it is not possible to ventilate the lungs after a rapid-sequence induction of anaesthesia and after failed tracheal intubation, there are serious risks of hypoxia and pulmonary aspiration of gastric contents. The laryngeal mask airway has been successfully used in patients in whom tracheal intubation or manual ventilation through a facemask had failed. However, there is difficulty in using the laryngeal mask in anaesthetized patients with an increased risk of aspiration, since cricoid pressure often prevents placement of the laryngeal mask. The laryngeal tube and the laryngeal tube-suction II (VBM, Medizintechnik, Germany) (Fig. 1) have been developed to secure a patent airway during either spontaneous breathing or controlled ventilation. The laryngeal tube consists of an airway tube with a small balloon cuff attached at the tip (distal cuff) and a larger balloon cuff at the middle part of the tube (proximal cuff). When the device is inserted, it lies along the length of the tongue and the distal tip is positioned in the hypopharynx to seal the oesophageal inlet. The laryngeal tube-suction II is similar, but with an additional lumen for the passage of a gastric tube.

Cricoid pressure might be expected to prevent insertion of the distal tip of the laryngeal tube into the hypopharynx, but this has not been studied. The aim of this study was to examine whether cricoid pressure impedes insertion of the laryngeal tube and the laryngeal tube-suction II.
Methods

We obtained institutional review board approval and written informed consent from all patients for this study. We studied the effect of cricoid pressure on insertion of the laryngeal tube in Part 1 and of the laryngeal tube-suction II in Part 2. Although we are principally interested in insertion of these devices in the emergency cannot-intubate and cannot-ventilate scenario, such a study would be both impractical and unethical. We therefore studied the ease of insertion during cricoid pressure in elective patients without a difficult airway.

Part 1: laryngeal tube

We studied 25 patients undergoing elective surgery, in whom neuromuscular block was required as part of the anaesthetic procedure. Patients with any pathology of the neck, or upper respiratory tract, or at risk of pulmonary aspiration of gastric contents were not studied. Before operation, the view of the oropharynx was assessed and scored according to Mallampati and colleagues9 and Samsoon and Young.10

In the anaesthetic room, an ECG, pulse oximeter, and blood pressure cuff were attached and an i.v. cannula was inserted. A firm silicone head ring, 4 cm in height, was placed under the patient’s occiput, but not under the neck. After pre-oxygenation, anaesthesia was induced with propofol and neuromuscular block induced with atracurium. Adequacy of neuromuscular block was confirmed with a peripheral nerve stimulator. Anaesthesia was maintained with sevoflurane in oxygen.

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In a cross-over design, we inserted the laryngeal tube with cricoid pressure applied on one occasion and with sham pressure applied on the other occasion. The order of application was randomized by tossing a coin. For cricoid pressure, an assistant applied pressure vertically to the cricoid cartilage with the index finger and the thumb of one hand on the cricoid cartilage and the other hand supporting the patient’s neck from below it (bimanual cricoid pressure).11 Cricoid pressure was started during mask ventilation and was released after all adjustments had been made and the laryngeal tube secured with tape or when the insertion procedure had been abandoned due to failed ventilation. For sham pressure, the assistant’s fingers and hands were similarly placed but without exerting any pressure on the cricoid cartilage. The assistants all had at least 4 yr of anaesthesia nursing experience. The assistant’s hand and the patient’s neck were covered with a cloth to blind the anaesthetist inserting the device as to whether cricoid pressure was being applied. We used a size 5 laryngeal tube when the patient was taller than 175 cm, a size 4 when the patient’s height was 155–175 cm, and a size 3 when the patient was shorter than 155 cm.4 Before insertion of a laryngeal tube, adequacy of ventilation using a facemask was confirmed. Ventilation was judged to be adequate when the chest expanded with a satisfactory compliance during inflations. If ventilation was inadequate, the patients were excluded from the study. We inserted the same laryngeal tube in the same manner, with and without cricoid pressure in each patient. No undue force was used for insertion.

Before insertion, cuffs of the laryngeal tube were deflated and a water-soluble lubricant was applied. The patient’s head was extended on the neck in the Magill12 or ‘sniffing’ position. The tip of the laryngeal tube was placed against the hard palate behind the upper incisors and slid down in the centre of the mouth until a resistance was felt or the second bold black line on the tube had just passed between upper and lower incisors. Only one attempt at insertion was allowed on each occasion. The cuffs were then inflated with a fixed volume of air (size 3, 60 ml; size 4, 80 ml; size 5, 90 ml) using a syringe provided by the manufacturer (VBM, Germany).4

After insertion of the laryngeal tube, we connected the breathing system and assessed the adequacy of ventilation by gently squeezing the reservoir bag, and observing the presence of end-tidal carbon dioxide waveforms and chest movement. If it was not possible to ventilate the lungs, we adjusted the position of the laryngeal tube by gently pushing or pulling the device and then reassessed the adequacy of ventilation. Time to achieve adequate ventilation, starting from picking up the laryngeal tube, was measured. We allowed up to 60 s for adjusting the position of the laryngeal tube to achieve adequate ventilation, before terminating the insertion attempt. We also set a lower oxygen saturation limit of 95%, below which we would have immediately terminated the procedure and resumed mask ventilation with 100% oxygen.

Part 2: laryngeal tube-suction II

In this part of the study, we studied 15 patients to assess the effect of cricoid pressure on insertion of the laryngeal tube-suction II. The study design was the same as in the Part 1 study of the laryngeal tube.
Statistical analysis

Our primary outcome measure was the success rate of ventilation after insertion of the laryngeal tube. The McNemar test (paired proportion test) was used to compare the success rate of adequate ventilation through the laryngeal tube with and without cricoid pressure. The 95% confidence interval (CI) for the success rate of ventilation between cricoid or sham pressures was calculated.

Previous studies have shown that the first attempt success rate of insertion of, and ventilation through, the laryngeal tube is 94–100%. We considered that a difference in the success rate of 30% with and without cricoid pressure would be clinically important. To detect this, with a power of 80% and \( P=0.05 \), approximately 55 patients would be required for two independent groups, that is, not a crossover design. In this cross-over study, we estimated that fewer patients would be required and therefore planned an interim analysis\(^{13,14} \) when complete data from 25 patients were available. \( P<0.025 \) was considered significant at interim analysis.\(^ {13,14} \) If there was no significant difference, we planned to continue the study and obtain data from 55 patients, and to regard \( P<0.034 \) as significant.\(^ {13,14} \)

After completion of the Part 1, we estimated that the difference in the success of ventilation would be much larger than 30% with the laryngeal tube-suction II in Part 2. To detect a difference of 70% in success rate of ventilation, with a power of 80% and \( P=0.05 \), approximately 15 patients would be required for an unpaired design. \( P<0.05 \) was considered significant.

Results

Part 1: laryngeal tube

We studied 25 patients (10 females and 15 males), aged 20–69 yr, with mean height 165 (sd: 9.4; range 150–181) cm and mean weight 75 (8.4; 56–92) kg. Mallampati score was 1 in eight patients, 2 in six patients, and 3 in 11 patients. Size 3 was used in eight patients, size 4 in 11 patients, and size 5 in six patients. Cricoid pressure was applied first in 13 patients, and sham pressure first in 12 patients. We were able to ventilate the lungs via a facemask, with or without application of cricoid pressure, in all patients.

After insertion of the laryngeal tube, ventilation was adequate in all 25 patients when sham pressure was applied, whereas it was adequate in only six patients when cricoid pressure was applied. Cricoid pressure significantly reduced the success rate of ventilation through the laryngeal tube (\( P<0.001; \) 95% CI for difference: 59–93%). With sham pressure, no adjustment of the laryngeal tube was required in 16 patients. It was necessary to insert the laryngeal tube deeper in one patient, and to withdraw the device slightly in the remaining eight patients. With cricoid pressure, in the six patients in whom ventilation was adequate after insertion of the laryngeal tube, no adjustment was needed in four patients, and deeper insertion was needed in two patients.

In patients in whom ventilation was adequate, the median time taken to achieve adequate ventilation was 10 [inter-quartile range (IQR): 8–15] (range 5–26) s for sham pressure and 25 [15–32] (15–33) s for cricoid pressure. The median leak pressure was 30 [IQR: 30–30] (range 20–30) cm H\(_2\)O for sham pressure (no gas leak at 30 cm H\(_2\)O in 22 patients) and 15.5 [14.3–20.5] (12–22) cm H\(_2\)O for cricoid pressure. No patient had an oxygen saturation of <95% at any time in this study.

Part 2: laryngeal tube-suction II

For laryngeal tube-suction II, we studied 15 patients (13 females and 2 males), aged 24–64 yr, with the mean height 161 (sd: 51; range 150–168) cm and the mean weight 61 (11.0; 48–85) kg. Mallampati score was 1 in 10 patients, 2 in four patients, and 3 in one patient. Size 3 was used in six patients and size 4 in nine patients. Cricoid pressure was applied first in seven patients, and sham pressure first in eight patients. We were able to ventilate the lungs via a facemask, with or without application of cricoid pressure, in all patients.

Ventilation via the laryngeal tube-suction II was adequate in all 15 patients when sham pressure was applied, but only in five patients when cricoid pressure was applied. Cricoid pressure significantly reduced the success rate of ventilation through the laryngeal tube (\( P<0.01; \) 95% CI for difference: 43–91%).

Discussion

We found that the application of cricoid pressure significantly reduced the success rate of ventilation through the laryngeal tube or the laryngeal tube-suction II.

Brain’s laryngeal mask airway has a potential role in patients in whom tracheal intubation has failed and ventilation via a facemask is difficult. One major problem with the use of the laryngeal mask is that cricoid pressure may hamper correct positioning of the device, as it prevents the distal part of the mask from occupying its proper position in the hypopharynx, just below the level of the cricoid cartilage. Some studies have shown that cricoid pressure indeed reduced the success rate of ventilation, whereas others have shown that cricoid pressure had little effect.

The laryngeal tube and the laryngeal tube-suction II also have potential roles in patients with difficult airways and during cardiopulmonary resuscitation. When correctly inserted, the distal cuff of the laryngeal tube should be positioned in the hypopharynx and, for the laryngeal tube-suction II, the tip of the device should be in the upper oesophagus. Therefore, cricoid pressure, in theory, hampers correct insertion of the device. Our
finding supported this theory. Failure to obtain adequate ventilation through the laryngeal tube under cricoid pressure was likely to be due to inadequate depth of insertion of the laryngeal tube, and not due to cricoid pressure itself, as cricoid pressure did not prevent adequate ventilation through the facemask in any patient. In several patients, the proximal cuff of the laryngeal tube was visible in the mouth after cuff inflation.

A limitation of the study is that despite randomization and our best attempts to blind the anaesthetist inserting the laryngeal tubes, they were still able to guess with great accuracy when cricoid pressure had been applied. Secondly, we had not determined the ease of conventional laryngoscopy, and it is in those patients with difficult laryngoscopy that laryngeal tubes may be useful as rescue devices. We had used a cross-over design to prevent any confounding due to differences in the ease of conventional laryngoscopy. Thirdly, we did not standardize the force applied to the cricoid cartilage, to reflect daily clinical practice. Nevertheless, the risk of excessive force was minimized by withdrawing patients in whom facemask ventilation was difficult when cricoid pressure was applied. Finally, our protocol did not include the effects of ventilation of applying cricoid pressure after insertion of the laryngeal tube (without cuff pressure).

In conclusion, continuous cricoid pressure prevents correct placement of the laryngeal tube and the laryngeal tube-suction II such that placement and ventilation via these devices are ineffective. The effect of cricoid pressure on ventilation via these devices, after correct placement, remains unknown.

References