Use of the Laryngeal Mask Airway in Laboratory Cats

Takashi Asai, M.D., Ph.D.; Kohei Murao, M.D.; Takeshi Katoh, M.D.; Koh Shingu, M.D.

IN animal experiments, the study design may require avoidance of the use of neuromuscular blocking agents. Tracheal intubation without the use of a neuromuscular blocking agent may frequently cause straining ("buckling") or laryngospasm, particularly in cats, and may markedly increase arterial pressure and heart rate. Topical application of a local anesthetic to the airway may suppress the stimulatory effects of tracheal intubation, but there is a significant increase in the plasma concentration of the local anesthetic. These can be potential confounding factors during experiments.

In humans the stimulatory effects of insertion of the laryngeal mask are considerably smaller than those of tracheal intubation. Although the use of laryngeal mask in dogs or cats has been reported, there have been no reports assessing the efficacy of this device compared with tracheal intubation in animals. Therefore the main aim of our study was to see if it is feasible to use the laryngeal mask in laboratory cats by comparing (1) the ease of insertion of the laryngeal mask and a tracheal tube, (2) the incidence of complications associated with insertion of device, and (3) their efficacies during spontaneous breathing and controlled ventilation.

Materials and Methods

After obtaining the institutional animal research ethics committee approval, we used 60 cats (weight, 2.5–5.0 kg). Each unrestrained cat was placed in a transparent box containing 4.5–5.0% sevoflurane in oxygen. The minimum alveolar concentration of sevoflurane in cats has been reported to be 2.6. The concentration in the box was confirmed using the Capnomatic Ultima (Datax, Helsinki, Finland). Ten minutes later, the cat was taken from the box and placed in the right lateral decubitus position. A facemask was applied, and 5% sevoflurane in oxygen was given; the lungs were assisted manually using a Jackson-Rees system. Probes for an electrocardiograph were inserted into the limbs. Ten minutes after application of the facemask, the cats were randomly allocated (by tossing a coin) into one of two groups, and either a size 2 laryngeal mask or a tracheal tube without a cuff (internal diameter, 5.5 mm; Mallinckrodt, Athlone, Ireland) was inserted. In the endotracheal tube group a size 2 Macintosh laryngoscope was used, and the motility of the vocal cords at laryngoscopy was scored into three grades: abducted, moving, and adducted. When the vocal cords were adducted, anesthesia was maintained for another 3 min before attempt at tracheal intubation.

All attempts at insertion of the test device were done by one researcher, who had had more experience in tracheal intubation than in insertion of the laryngeal mask. The number of attempts at insertion of the test airway was recorded. If either insertion of or ventilation through the test airway had failed after three attempts, insertion was judged as failure. The incident of straining (either "bucking" or coughing) after insertion of the test airway, the heart rate before insertion of the airway, and the maximum heart rate after insertion were recorded. Anesthesia was maintained with sevoflurane at the end-tidal concentration of 3.5% in oxygen 6 l/min. In 40 of 60 cats, 20 cats in each group, vecuronium, 1 mg, was given intravenously after insertion of the test airway. In this group of cats after injection of vecuronium, anesthesia was maintained with 3.5% sevoflurane in oxygen, and the lungs were ventilated mechanically using a ventilator (AR-300, Acma, Tokyo, Japan). Tidal volume was set to 20 ml/kg, and ventilatory frequency was adjusted to maintain the "target" end-tidal P CO2.

* Research Associate.
† Professor.
Received from the Department of Anesthesiology, Kansai Medical University, Moriguchi City, Osaka, Japan. Submitted for publication October 17, 1997. Accepted for publication January 30, 1998.
Address reprint requests to Dr. Asai, Department of Anesthesiology, Kansai Medical University, 10-15 Fumizono-cho, Moriguchi City, Osaka, 570-8507 Japan. Address electronic mail to: asai@tak.kmu.ac.jp

Key words: Anesthetic techniques, equipment; tracheal intubation.
Table 1. Number of Attempts Required for Insertion of a Tracheal Tube or Laryngeal Mask

<table>
<thead>
<tr>
<th>Airway</th>
<th>Number of Attempts</th>
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<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Tracheal tube (n = 31)</td>
<td>15</td>
</tr>
<tr>
<td>Laryngeal mask (n = 29)</td>
<td>28</td>
</tr>
</tbody>
</table>

(PE\textsubscript{CO\textsubscript{2}}) of 3.6 - 4.4 kPa, which was slightly lower than the normal value in awake cats.\textsuperscript{8}

Once the cat was paralyzed, a cannula was surgically inserted into the femoral artery. Fifteen minutes after the start of mechanical ventilation, arterial blood was obtained to measure partial gas pressures. The peak inflation pressure, the PE\textsubscript{CO\textsubscript{2}}, and ventilatory frequency, and any incidents of hypoxia, airway obstruction, air-leak, apparent gastric insufflation, or dislodgment of the device were recorded.

Chi-square for trend was used to compare the number of attempts at insertion of the test airway, and Fisher’s exact test was used to compare the incidence of coughing after successful insertion of the airway between groups. The 95% confidence intervals were obtained for the difference in the success rate of the insertion of the test airway at the first attempt and for the incidence of straining.

The changes in the heart rate deviated significantly from the normal distribution. Therefore, the Mann-Whitney U test was used to compare the change in the heart rate between the groups; the 95% confidence interval for the mean heart rate at each point and that for the difference in the median heart rate were calculated. The other continuous data were normally distributed; therefore, confidence intervals for difference in the mean values were obtained for these. $P < 0.05$ was considered significant.

Results

The body weights of cats were similar between groups (endotracheal tube group: mean, 3.5 [range, 2.5–5.0] kg; laryngeal mask airway group: 3.4 [2.5–4.9] kg).

The number of attempts at insertion of the laryngeal mask was significantly fewer than that at tracheal intubation ($P < 0.001$) (table 1): tracheal intubation was successful on the first attempt in only 15 of 31 cats (48%), whereas the laryngeal mask was inserted successfully on the first attempts in 28 of 29 cats (97%) (table 1).

The vocal cords were always either moving (26 cats) or closing (5 cats) when a laryngoscope was inserted in the endotracheal tube group. Straining occurred in 25 of 30 cats (83%) after tracheal intubation, but in only 5 of 28 cats (18%) after insertion of the laryngeal mask.

The mean heart rate before insertion of the test airway was similar in the two groups (mean, 144 beats/min in both groups). After tracheal intubation, the heart rate markedly increased (mean, 163 beats/min), whereas after insertion of the laryngeal mask there was no significant change in the heart rate (mean, 143 beats/min). The increase in the heart rate was significantly greater after tracheal intubation than after insertion of the laryngeal mask ($P < 0.0001$; 95% confidence interval for difference, 7–17% of the preinsertion heart rate).

During spontaneous respiration a patent airway was maintained without any maneuvering of the airway (e.g., jaw thrusting or positioning of the head and neck) in all cats in both groups; no hypoxia or hypercapnia occurred in any cat. After injection of vecuronium, ventilatory frequency required to maintain the target $\text{PE}_{\text{CO}_2}$, the peak inflation airway pressure, and the partial pressures of arterial blood oxygen and carbon dioxide were similar in the two groups (table 2). In no cat did hypoxia, airway obstruction, a marked air-leak, gastric insufflation, or dislodgment of the device occur in either group throughout the study period.

Table 2. Values of the Respiratory Variables in Anesthetized and Paralyzed Cats [Mean (SD), and 95% Confidence Limits (CI) for Difference between Tracheal Tube Group and Laryngeal Mask Group]

<table>
<thead>
<tr>
<th></th>
<th>Endotracheal Tube</th>
<th>Laryngeal Mask</th>
<th>95% CI for Difference (endotracheal tube group – laryngeal mask group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{PE}_{\text{CO}_2}$ (kPa)</td>
<td>3.9 (0.15)</td>
<td>3.9 (0.13)</td>
<td>[−0.08, 0.09]</td>
</tr>
<tr>
<td>Ventilatory frequency (breaths·min\textsuperscript{−1})</td>
<td>19.3 (3.2)</td>
<td>21.7 (2.5)</td>
<td>[−4.3, −0.6]</td>
</tr>
<tr>
<td>Peak inflation pressure (cm H\textsubscript{2}O)</td>
<td>7.0 (1.5)</td>
<td>6.5 (1.4)</td>
<td>[−0.4, 1.5]</td>
</tr>
<tr>
<td>Arterial partial pressure of oxygen (kPa)</td>
<td>62.2 (6.5)</td>
<td>60.8 (5.1)</td>
<td>[−2.4, 5.2]</td>
</tr>
<tr>
<td>Arterial partial pressure of carbon dioxide (kPa)</td>
<td>4.2 (0.4)</td>
<td>4.4 (0.4)</td>
<td>[−0.47, 0.07]</td>
</tr>
</tbody>
</table>

Tidal volume was set to 20 ml·kg\textsuperscript{−1} and ventilation frequency was adjusted to maintain the “target” $\text{PE}_{\text{CO}_2}$ (3.6–4.4 kPa).

Anesthesiology, V 88, No 6, Jun 1998
Discussion

In anesthetized cats that were breathing spontaneously, it was almost always possible to insert the laryngeal mask at the first attempt, whereas a few attempts often were required for tracheal intubation (despite the fact that we had more experience in tracheal intubation). In addition tracheal intubation frequently caused straining and markedly increased heart rate, whereas insertion of the laryngeal mask was associated with a considerably lower incidence of coughing and no significant increase in heart rate.

The laryngeal mask was as effective as the tracheal tube in maintaining a patent airway. When a facemask is used, the support of the jaw often is required to maintain a patent airway in cats. In contrast to our study, once inserted successfully, the laryngeal mask always provided a patent airway without the support of the jaw. During mechanical ventilation there were no marked differences between the laryngeal mask and tracheal tube in terms of peak inflation pressure and adequacy of ventilation (table 2).

It was somewhat surprising that the laryngeal mask generally provided a patent airway in cats, whose anatomic shapes differ considerably from human anatomy. We did not study if the position of the mask was correct in those cats, although in humans the mask often provides a patent airway even if it is not placed in the correct position. In no cats did the laryngeal mask dislodge or did airway obstruction occur during anesthesia.

In a preliminary observation we found that when cats weighed less than 2.5 kg, it was sometimes difficult to maintain a patent airway using the size 2 laryngeal mask, possibly because the mask was too large in this group of cats. Although the size 1 laryngeal mask might be suitable for such small animals, we did not study this formally.

In conclusion, the laryngeal mask is potentially useful in laboratory cats and possibly in veterinary anesthesia practice.

References