Simplified rat intubation using a new oropharyngeal intubation wedge

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ENDOTRACHEAL INTUBATION CAN easily be performed on most medium-sized experimental animals, such as rabbits and dogs, under general anesthesia with an infant-sized laryngoscope (no. 2-3) and endotracheal tube (no. 3-4). However, in smaller animals, such as rats, the intubation technique is more difficult because the rat has a much smaller inlet for an endotracheal tube. Most methods of endotracheal intubation require elaborate, specially designed equipment (1, 3, 5, 6, 8–11) that is not always available, is usually expensive, and always requires considerable practice before sufficient skill for successful intubation without complications is acquired. Here we report a simple method that requires only a specially designed oropharyngeal intubation wedge made from a 3-ml plastic syringe, a readily available piece of equipment. The technique requires little effort to master and has a very high success rate. In addition, the rat can be intubated in any position without having to be anchored to the operating table, and its vital signs can be maintained easily to avoid complications during intubation.

MATERIALS AND METHODS

The experimental protocol was reviewed and approved by the National Science Council of the Republic of China and the College of Medicine, National Cheng Kung University.

Specially designed oropharyngeal intubation wedge. Our method of intubating the rat trachea relies on the use of a specially designed oropharyngeal intubation wedge made from the barrel of a standard 3-ml plastic syringe (Becton Dickinson, Singapore). The roof of the wedge is 1 cm long, the bottom is 2.5 cm long, and the wedge angle is 25° (Fig. 1). The fingerholds of the syringe remain and can be used to manipulate the head and neck of the rat after insertion and fixation of the wedge to the oropharyngeal cavity (Fig. 2).

Animal preparation and intubation procedure. The rats were anesthetized with Pentothal (sodium thiopentone, Abbott, Sydney, Australia; 50 mg/kg ip) and placed in supine position without fixation to the operating table. The mouth of the anesthetized animal was opened by hand or mosquito clamp. Next, the oropharyngeal intubation wedge was inserted with the bottom touching the rat’s tongue and the roof touching its palate. The tip of the wedge was inserted to the level of the epiglottis and vallecula (Fig. 3). The wedge was easily fixed firmly in the oropharyngeal cavity by natural pressure from the incisors: the inner surface of the edge of the syringe to the lower incisors and the outer to the upper incisors. No additional fixation was needed. The oropharyngeal intubation wedge was held in a thumb and index finger pinch while the other fingers held the rat’s head (Fig. 2). This allowed the animal to be manipulated freely. An ordinary table lamp was an adequate light source when the light was concentrated on the ventral area of the rat’s neck near the pharyngoepiglottic region. With the tip of the oropharyngeal intubation wedge in the vallecula, elevating the tip by depressing the fingerholds allowed the experimenter to observe the epiglottis and larynx with the help of the light from the table lamp. The movement of the vocal cords, the most significant sign of the entrance of the trachea, could easily be seen. The wedge and light source provided an excellent view, including a distinct contrast between the white vocal cords and the red surrounding tissue. A 16-gauge intravenous catheter (45 mm length; 20-mm hub; 1.7-mm ID) with a...
70-mm-long wire stylet with a 30-mm hub (Insyte, Becton Dickinson, Sandy, UT) was used as the endotracheal tube. After the 5-mm-long, sharp tip of the stylet was cut off, the end of the catheter with the stylet was then inserted through the oropharyngeal wedge directly into the entrance of the trachea. The stylet was then withdrawn, and the catheter was advanced into the trachea 2–3 cm farther (Fig. 4). The oropharyngeal intubation wedge was then removed, and the catheter was tied to the incisors or sutured to the surrounding area. The catheter hub was connected to the respirator, and the expansion and collapse of the chest confirmed that the catheter was in the trachea.

Monitoring of the vital signs and measurement of the size of the airway. No new animals were used or killed for this study. Our data are taken from three different evoked-potential experiments unrelated to the cardiopulmonary mechanism. From the 86 Sprague-Dawley or Wistar rats used in these experiments, we randomly chose 18. Before the final procedure of each of these primary evoked-potential experiments, the intubation procedures we describe here were performed and the animals’ vital signs were monitored. The ventilation was controlled with an IPPB Respirator UR-100 (Shin-Ei Industry, Tokyo, Japan) that was set at a tidal volume of 5 ml/kg and respiratory rate of 40 breaths/min with 100% O₂ and 0.5 l/min flow rate. A femoral artery was also cannulated with a 22-gauge catheter for continuous monitoring of heart rate and blood pressure and sampling for blood-gas analysis. The data of these vital signs were collected immediately and 30 min after the mechanical ventilation. The rats were otherwise undisturbed during the 30 min. Next, the final phases of the evoked-potential experiments, all of which required postmortem analysis, were completed.

After completion of the primary evoked-potential experiment, and after a lethal overdose of Pentothal, each of the 18 animals was dissected. The length of the oropharynx and trachea and the diameter of the trachea were measured. The length of the oropharynx and trachea was defined as the sum of the distance from the upper incisors to the vocal cords plus...
the distance from the vocal cords to the bifurcation of the trachea. All measurements were made with a caliper (Mitsu-
toyo, Tokyo, Japan).

RESULTS

A total of 18 adult Sprague-Dawley or Wistar rats, weighing between 300 and 530 g, used in three exper-
iments investigating evoked potential and using this intubation technique for ventilation or anesthesia were reviewed. No rat died or suffered any respiratory prob-
lem from intubation to extubation, and all withstood the surgical procedures of the experiments.

The intubation procedure was simple and quick. In particular, the insertion of the endotracheal catheter into the trachea was very easy because the oropharyn-
geal intubation wedge and the light penetrating from the ventral area of the neck allowed a clear, direct view of the epiglottis and vocal cords (the entrance of the trachea). With the endotracheal catheter in place, the rat could be ventilated or could undergo general anes-

Fig. 3. Schematic illustration of the wedge inserted into the oropharyngeal cavity. Note how upper and lower incisors naturally hold the wedge in place. (Cross sec-
tion of trachea is shown at top left.)

Fig. 4. Lateral roentgenogram shows the wedge (arrowheads; the wedge was coated with radiopaque material) in the oropharyngeal cavity and the endotracheal catheter (arrow) inserted through the wedge into the trachea.
thesis by administration of inhalative anesthetics. The time required to complete the intubation was <30 s, and the total ventilation duration was >3 h, without difficulty in extubation or recovery. The procedure was also simplified by the fact that the rat’s upper airway after application of the oropharyngeal intubation wedge could be manipulated easily, which provided a very versatile approach to the entrance of the trachea.

None of the 18 rats randomly selected for this study showed any significant change in vital signs from the beginning of the intubation procedure until 30 min after the ventilation. All parameters were stable and within normal range (Table 1).

The postmortem examination showed the endotracheal catheter to be at the correct site, with the tip at about the junction of the middle and distal third of the trachea. The catheter was patent in all examined rats. The individual body weights and oropharynx and trachea measurements are shown in Fig. 5. Because the measurements were made from a curved surface, precision was impossible. The average length of the oropharynx was 3.03 ± 0.25 cm (range 2.8–3.5 cm) and of the trachea was 3.58 ± 0.43 cm (range 3.0–4.5 cm). The ranges of the oropharynx and trachea lengths are narrow and show no statistically significant correlation with body weight. From these data and the actual results in these experiments, the oral intubation wedge we used was suitable to all the rats, regardless of size or weight.

DISCUSSION

The choice of animal to use in experiments cannot be made just to meet the goals and designs of the experiment. Several factors in many curricula limit the choice, such as expense, lack of adequate facilities and equipment, and limited experience with different kinds of animals. In addition, the ethical concerns of individual researchers and animal rights advocates have caused those involved in animal study generally to avoid using primate species (4) and even domestic animals such as dogs and cats. It is not surprising, then, that the rat’s appearance in scientific experiments is increasing. A review of the Journal of Orthopaedic Research from 1982 to 1999 showed the rat and rabbit are the two most frequently used in animal studies. It seems reasonable to focus some research on techniques and devices that might introduce greater simplification and speed in animal studies, might free the animal subjects of unintentionally caused pain, and might significantly reduce the meaningless deaths of animals used in surgical procedures (2).

The rat’s experience (8), as well as the development of many other methods (1, 3, 5, 6, 9–11), clearly shows that a 90% success rate could not be obtained by Stark et al.’s (7) blind intubation technique for the rat. A reliable intubation probably can be achieved with a variety of devices, such as a fiber-optic, miniature, or human laryngoscope; a head-mounted, mirror-reflected, adjustable-focus light; a surgical microscope; a fiber-optic illuminator with an attached flexible light guide; an otoscope with an incorporated light source; or some other special and expensive device (1, 3, 5, 6, 8–11). However, one of these devices may be not available in every laboratory, so we think that a simple and inexpensive method of intubation under direct vision is warranted.

Our newly designed oropharyngeal intubation wedge overcomes all the mentioned problems associated with other intubation devices. First, it is made from a common 3-ml syringe, which is cheap and available almost everywhere. Second, using the wedge is easy. Third, when inserted, it does not overstimulate the mucous wall of the upper airway. During intubation procedures requiring more time or insertion of a fiber-optic light source into the pharyngeal cavity, an abundance of mucus may be produced and cover the laryngeal cavity. This mucus may interfere with visualization and insertion of an endotracheal tube into the trachea. This problem is never encountered with the oropharyngeal intubation wedge because the procedure requires a very short time and because only the endotracheal catheter will touch the pharyngeal wall. Fourth, the subsequent expansion of the oropharyngeal cavity is both reliable and static. Fifth, because the rat does not need to be fixed to the operating table, it can be manipulated into any position suitable for observation of the cavity. Direct visibility of the epiglottis and the movement of the vocal cords are guaranteed by both

### Table 1. Average of vital signs immediately and 30 min after intubation

<table>
<thead>
<tr>
<th>Vital Sign</th>
<th>Immediately After Intubation</th>
<th>30 Minutes After Intubation</th>
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<tbody>
<tr>
<td>MBP</td>
<td>110.9 ± 23.2</td>
<td>101.7 ± 9.1</td>
</tr>
<tr>
<td>HR</td>
<td>226.8 ± 36.7</td>
<td>244.7 ± 10.6</td>
</tr>
<tr>
<td>pH</td>
<td>7.37 ± 0.03</td>
<td>7.4 ± 0.03</td>
</tr>
<tr>
<td>PaO2</td>
<td>304.9 ± 65.8</td>
<td>318.1 ± 34.9</td>
</tr>
<tr>
<td>PaCO2</td>
<td>38.3 ± 4.4</td>
<td>40.3 ± 3.4</td>
</tr>
</tbody>
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Values are means ± SD. MBP, mean blood pressure; HR, heart rate; PaO2, arterial PO2; PaCO2, arterial PCO2.
the ability to adjust the rat’s neck and the light from the ventral aspect of the neck. The blind method offers none of these advantages, and few of them are available with the other ingenious intubation devices reported. Sixth, the procedures in this technique seem natural and cause less distress to the animal subject’s respiration than other intubation methods. Finally, even if the intubation cannot be accomplished smoothly and quickly by the beginner, the airway will be kept properly open by the oropharyngeal intubation wedge, and the rat will not die meaninglessly.

The endotracheal tubes used for the rats in our study were 14- to 16-gauge intravenous catheters; 16 gauge is preferred in most studies (1, 3, 5–11), and a plastic catheter from 45 to 60 mm long is recommended. The results in our study closely correlated with the suggestions of other researchers. From vocal cords to bifurcation, the trachea in rats weighing 300–530 g was 3.58 mm on average (range 3.0–4.5 mm). The variations in length correlated well with body weight. The 70- to 90-mm long malleable gauge wire needle within the plastic catheter is used as a stylet after the sharp end is cut off at the same length level or 1–2 mm shorter than the plastic catheter (8, 11). The wire provides stiffness and aids in direction control. However, the stylet should be withdrawn once the catheter crosses the vocal cords to avoid any inadvertent trauma to the trachea.

In summary, our experience and the anatomic and physiological examinations in this study proved this new method of intubation using the oropharyngeal intubation wedge to be very low-cost, simple, safe, and effective.

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