A New Method of Inhalation Anesthesia with Nasopharyngeal Insufflation in Rat Experiment

Konosuke Yamasaki1), Kazuto Kuroe1), and Ryozo Kamimura2)

1) Department of Orthodontics, Kagoshima University Dental School, 8–35–1 Sakuragaoka, Kagoshima 890-8544, and 2) Institute of Laboratory Animal Sciences, Faculty of Medicine, Kagoshima University, 8–35–1 Sakuragaoka, Kagoshima 890-8520, Japan

Abstract: We have established a new method of anesthesia with nasopharyngeal insufflation for intraoral procedure in rodents. Twelve male Wistar rats weighing 330–390 g were used in this study. Insertion of a feeding tube 1.0 mm in diameter coated with 2% xylocaine jelly was inserted into the nasal cavity approximately 25 mm from the naris, and anesthetization with mixed gas of 100% oxygen with 3–4% enflurane at 0.25–0.5 l/min flow rate was achieved. Using this anesthetic method, a chronic experiment comprising 1-h/day experimental procedure was carried out for 14 days. This method enabled, 1) simple and safe operation of the induction, emergence and anesthetic depth, 2) experimental procedures on the dental/oral region, 3) avoidance of the dyspnea and tachypnea, and 4) avoidance of cumulative effects in daily anesthesia.

Key words: Inhalation anesthesia, Nasopharyngeal insufflation, Rat

Intraperitoneal anesthesia by injection has been generally applied to animal experiments using rats. It is a useful method for both constitutional [4, 6] and intraoral procedures [5]. However, it is difficult to achieve precise control of anesthetic depth. Error of targeted site [3], a significant reduction in heart rate and left ventricular systolic function [8] and a significant increase in albumin leakage in the abdominal region [7] have all been reported. Inhalation anesthesia with orotracheal intubation or a proper respirator mask has also been reported [1, 2]. However, the tube or mask of anesthesia, which is necessary for carrying anesthetic gas to the targeted site, hinders most experimental procedures in the oral/dental region.

We established a simple new method of inhalation anesthesia with nasopharyngeal insufflation under spontaneous respiration for the rat, which enabled intraoral procedures to be performed. Fourteen days of chronic experiment comprising 1-h/day experimental procedure, including dental/orthodontic treatment with this inhalation anesthetic method, was successively carried out without death of a rat caused by anesthesia.

Twelve male Wistar rats weighing 330–390 g (supplied by Kyudo Co., Kumamoto, Japan) were used in this study. They were housed in a room kept at 24°C under a 12-h light-dark cycle. Food and water were provided ad libitum. Prior to the experiment, the rats were allowed to acclimatize to the new environment for one week.

The daily anesthetic procedure, Anesthetic System...
(Meratech 2, Acoma Co. Ltd., Tokyo, Japan) used in this experiment was as follows.

1. Accommodation in a sealed plastic bag with 100% oxygen gas mixed with 5% enflurane for 5 min.
2. Insertion of an indwelling feeding tube 1.0 mm in diameter (Fig. 1, Indwelling Feeding Tube for Infant, #3Fr, Atom Medical Corporation, Tokyo, Japan) coated with 2% xylocaine jelly (Fujisawa Pharmaceutical Co. Ltd., Osaka, Japan) to the pharynx approximately 25 mm from the naris.
3. Anesthetization with mixed gas of 100% oxygen with 3–4% enflurane at 0.25–0.5 l/min flow rate.
4. Alteration of 100% oxygen gas mixed with 3–4% enflurane to 100% oxygen at the end of the intraoral procedure.

The present study was carried out after receiving permission from the Committee of Animal Experimentation, Kagoshima University Dental School.

The induction stage was accomplished in 5–10 min without any difficulty. Nasal hemorrhage on insertion of the tube occurred in three rats for 14 days, however, the bleeding stopped in a few minutes. At the anesthetic stage, neither dyspnea nor tachypnea was observed. The intraoral procedure was performed for approximately 1 h without any complications. All rats had emergence from anesthesia within 5 min after the anesthetic gas was discontinued and flushed with 100% oxygen. Throughout 14 days of the experiment, all rats survived. Daily inhalation anesthesia continued for 14 days making it possible to accomplish all the intraoral procedures for our research successfully.

Before establishing this method of the nasopharyngeal insufflation for the rat, conventional intraperitoneal anesthesia with injection of ketamine (80 mg/kg) and xylazine (10 mg/kg) was applied; however, over 10% of the rats died during 14-day chronic experiments. This daily intraperitoneal anesthesia with injection might induce various errors i.e., missing the targeted site [3], significant reduction in heart rate and left ventricular systolic function [8] and significant increase in albumin leakage in the abdominal region [7]. Furthermore, the accumulative damage of the daily anesthesia on the rats for 14 days could increase mortality. After established the method of the nasopharyngeal intubation, all rats survived without any problem.

This nasopharyngeal insufflation for inhalation anesthesia enabled, 1) simple operation of the induction, emergence and anesthetic depth corresponding to the individual rat condition, 2) experimental procedures on the dental/oral region, 3) avoidance of dyspnea and tachypnea, and 4) avoidance of cumulative effects of daily anesthesia. The results of this study demonstrate improvements in animal safety and experimental efficiency under inhalation anesthesia with nasopharyngeal insufflation.

The insertion of the tube was carefully and smoothly achieved. However, nasal hemorrhage was observed in some rats. One of the possible causes of the nasal hemorrhage could be due to the fragility of nasal mucosa of rats. Another possible cause could be due to the shape and the material of the feeding tube. The tube in this experiment is used for feeding immature infants and is made of soft chloroethylene with a rounded tip. However, improvements in the shape and material of the tube, e.g. increased softness, would reduce the risk of nasal hemorrhage.

Fig. 1. The indwelling feeding tube used for nasopharyngeal insufflation. This tube has a rounded tip shown in the zoomed circle on the left side.
From the results of the present study, we conclude that this inhalation anesthesia was useful and safe in the rat experiment accompanied with the intraoral procedure even when it was chronic. This simple method will be easily applied to anesthesia in other small animals, too.

References