# Improvement of $SpO_2$ by Using a Percussion Ventilator During Propofol Induction in Dogs

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## ABSTRACT

Percussion ventilation (PV) can be used during induction of anesthesia and may be able to overcome the disadvantage of hypoxia associated with propofol induction. The objective of this study was to evaluate $SpO_2$ during propofol induction in patients with and without PV. Sixteen dogs were divided into two groups: a PV group [PV (+)], and a conventional induction group [PV (-)]. In the PV (+) group, pulsed-pure oxygen from a percussive ventilator was administered for 20 seconds through the external nares by a small face mask during propofol induction. Mean $SpO_2$ levels after induction in the PV (-) and PV (+) groups were 74% and 93%, respectively. A significant difference was observed between the two groups ($p < 0.001$). The results of our study indicate that PV during propofol induction is useful for preventing hypoxia.

## INTRODUCTION

General anesthesia is a common procedure during veterinary medicine treatment. To maintain general anesthesia, a short-acting anesthetic drug and inhalation anesthesia are used for induction and maintenance. Propofol is often used as the induction agent.

In dogs, propofol produces rapid, yet smooth and excitement-free anesthesia induction when administered slowly intravenously, and transient respiratory depression is common (Plumb 2008; Sams et al, 2008).

Many studies in human medicine have shown the effectiveness of preoxygenation and denitrogenation to prevent hypoxia (Ginimuge et al, 2009). Breathing pure oxygen for 3–5 minutes or deep breathing itself can result in preoxygenation (Ginimuge et al, 2009). In veterinary medicine, some authors have recommended preoxygenation before induction in some situations, such as for animals with pulmonary lesions (Pascoe and Bennett, 1999). To the best of our knowledge, only one report by McNally et al. (2009) described the efficacy of 3 minutes of preoxygenation with respect to time to desaturation. However, this method is time-consuming and cannot be performed in dogs because of face mask refusal.

Before intubation, conventional ventilation cannot be used because of air leakage; however, once the patient has been intubated and connected to the anesthesia unit (respiratory circuit closed), conventional ventilation can be used. One method of high-frequency ventilation, percussion ventilation (PV), involves the delivery of a pulsatile flow of gas to the lungs during inspiration (Pryor, 1999). It can be used even with an open respiratory circuit.

Using this principle during anesthetic induction, the nitrogen in the lungs is expired when pure oxygen is inhaled rapidly. This preoxygenation and denitrogenation may be able to overcome the disadvantage of hypoxia associated with propofol. Although use of a full face mask is not practical during intubation, a small mask covering only the patient's nose is not a hindrance. The objective of this study was to evaluate oxygen saturation during propofol induction in patients with and without PV.

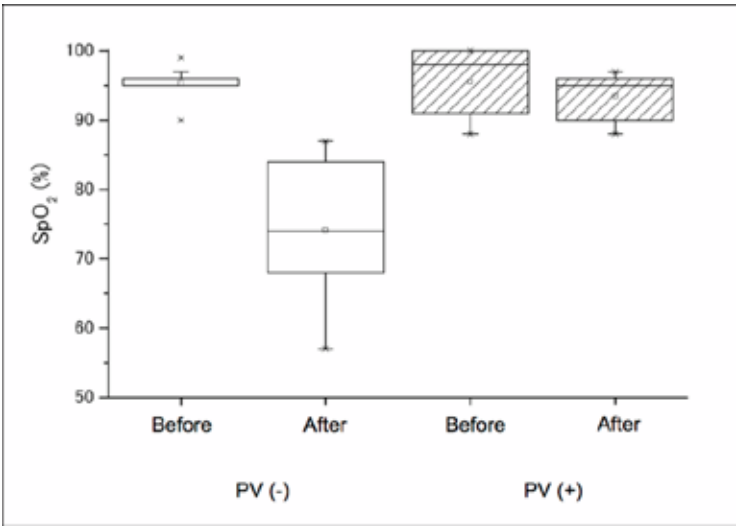
***Figure 1.*** *Preoxygenation and denitrogenation using percussive ventilation (PV). Pulsed-pure oxygen from a percussion ventilator was administered through the external nares by using a small anesthesia mask.*

## MATERIALS AND METHODS

Sixteen client-owned dogs with a malignant tumor that presented to the Oncology Department of Azabu University Veterinary Teaching Hospital for radiation therapy treatment from April 2010 to June 2010 were included in the study. Animals with obstructive nasal diseases, such as nasal stenosis or nasal tumors, and with anemia, defined as a packed cell volume [PCV] < 38%, were excluded in this study The dogs were randomly divided into a PV group (PV (+); n = 7) and a conventional induction group (PV (-); n = 9). Each animal was premedicated with Atropine sulfate (0.025 mg/kg, subcutaneous [SC]; Atropine Sulfate Injection 0.5 mg; (Mitsubishi Tanabe Pharma Corporation, Osaka, Japan).

Before induction, the arterial oxygen saturation ($SpO_2$) estimated by pulse oximetry was measured by placing the pulse

***Figure 2.*** *Comparison of SpO2 (%) before and after propofol induction with or without percussive ventilation (PV) [PV (+) and PV (-), respectively]. A significant difference was observed between the two groups after induction (Mean difference, p = 0.0009; Mean mean, p = 0.0006).*




oximeter probe on the lip or ear and using an anesthetic monitor (Bioscope AM120; Fukuda ME Kogyo Co., Ltd., Tokyo, Japan). The $SpO_2$ showed constant wave patterns on the monitor. Once propofol (6–8 mg/kg, IV; Rapinovet™; Schering-Plough Animal Health Co., Ltd., Tokyo, Japan) was administered to induce anesthesia, propofol administration was discontinued, and endotracheal intubation was performed with ease. The administered dose and period of propofol induction were measured for each dog. The $SpO_2$ value after induction was the lowest value measured during the period immediately following completion of propofol administration until completion of intubation and pure oxygen administration. The period after completion of propofol administration to the $SpO_2$ after induction value was determined. Immediately after intubation, dogs were administered assisted artificial respiration to improve hypoxia. Anemic dogs were excluded due to the effect on $SpO_2$ measurement (Lee et al., 1991).

In the PV (+) group, pulsed-pure oxygen from a percussion ventilator (IPV®-1C; Percussionaire Japan Co, Ltd., Tokyo, Japan) was administered for 20 seconds through the external nares by a small face mask for cats (Shin-Ei Industries, Inc., Saitama, Japan) during propofol induction. The frequency of ventilation was 200 cycles/minute, the working pressure was 13 psi, and the airway pressure was kept at approximately 5 cm $H_2O$.

The data collected included age, body weight, $SpO_2$ measurement before induction, propofol dose administered, duration of propofol induction, $SpO_2$ after induction, and period after completion of propofol administration to $SpO_2$ measurement.

The matched pairs t-test was used to compare $SpO_2$ in the PV (+) and PV (-) groups. Student's t-test was used to analyze body weight, dose, and the duration of propofol induction in both groups. The level of significance was set at $p < 0.05$. Data were analyzed using JMP® (ver. 8.02) statistical software (SAS Institute Inc., Cary, NC, USA).

## RESULTS

Sixteen dogs that underwent radiotherapy treatment were used for this study. The following breeds were represented Border Collie (n = 3), Golden Retriever (n = 2), Shih Tzu (n = 2), and one each of Beagle, Bouvier des Flandres, Chihuahua, French Bulldog, German Shepherd Dog, Irish Setter, Pomeranian, West Highland White Terrier, and Yorkshire Terrier. Overall, 13 dogs were male and three were female. The PV (-) group had nine dogs, and the PV (+) group had seven dogs. The mean ± the standard deviation (SD) for age, body

weight, administered propofol dose, and the total time of propofol induction in the PV (-) group were 10.8 ± 3.1 years, 19.5 ± 15.6 kg, 5.7 ± 1.9 mg/kg, and 46.8 ± 25.8 seconds, respectively. The mean ± the SD for age, body weight, administered propofol dose, and the total time of propofol induction in the PV (+) group were 10.4 ± 1.8 years, 17.9 ± 12.7 kg, 5.8 ± 1.4 mg/kg, and 53.6 ± 15.5 seconds, respectively. There were no significant differences between the groups.

The anatomic site of $SpO_2$ probe placement before anesthesia was the lip (n = 5) and ear (n = 4) in the PV (-) group, and the lip (n = 1) and ear (n = 6) in the PV (+) group. The time to $SpO_2$ measurement after induction in the PV (-) and PV (+) groups was 40.7 ± 35.6 and 40.1 ± 14.0 seconds, respectively. There was no significant difference between the groups. Mean ± SD $SpO_2$ levels before and after induction in the PV (-) group were 95.3% ± 2.5% and 74.1% ± 10.4%, respectively, and were 95.6% ± 4.7% and 93.4% ± 3.3%, respectively, in the PV (+) group (Fig. 1). This difference was significant (mean difference, $p = 0.0009$; Mean mean, $p = 0.0006$) in both groups, and the PV (-) group had a lower SpO2 than the PV (+) group.

## DISCUSSION

PV was easily applied (20 seconds) during induction due to loss of consciousness. In this study, PV during propofol induction was useful to prevent hypoxia. The $SpO_2$ of the PV (-) group after induction decreased approximately 20% compared to the value before induction, but the $SpO_2$ of the PV (+) group did not decrease significantly. The $SpO_2$ values after induction were significantly different between the two groups.

PV is useful in human medicine. Based on the manual for the percussive ventilator used in this study, optimum conditions are 35–40 psi, 15–20 minutes/one series, four or more series/day, and continuation for at least 2 consecutive days. In this study, we used PV at a working pressure of 13 psi, which was lower than the optimum condition (35–40 psi), at an airway pressure that was low (5 cm $H_2O$), and for a short manipulation time (20 seconds). Thus, we believe these setting parameters were safe for dogs during the induction period in this study.

Research data indicate that pulse oximeters are fairly accurate in some conditions (Jacobson et al., 1992; Matthews et al., 2003). Jacobson et al (1992) reported that the mean difference (± SD) between $SpO_2$ and $SaO_2$ for pooled data was small (-0.06% ± 6.8%), but $SpO_2$ tended to underestimate high $SaO_2$ values (greater than or equal to 70%) and overestimate low $SaO_2$ values (less than 70%) in dogs. Matthews et al (2003) reported that accuracy and failure rates (failure to produce a reading) varied widely from model to model, and generally, among the models tested in the clinically relevant range (90–100%), the root mean squared difference ranged from 2–5%. The present data appear to be accurate and reliable because the model was the same, and all of the control data and the data after percussive ventilation were within the range of 90–100%.

There were a few limitations in this study. Animals with obstructive nasal diseases such as nasal stenosis or nasal tumor were not included. Additionally, oxygen saturation was measured using an $SpO_2$ probe, not by blood gas analysis. Furthermore, the sample size was small. The only preanesthetic medication used was atropine because the dogs were discharged after radiation treatment on the same day.

Based on the results of this study, PV can be easily administered during induction due to loss of consciousness, and a brief application of PV may be useful to prevent hypoxia during propofol induction.

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