Intermittent positive pressure ventilation vs spontaneous ventilation during isoflurane anaesthesia in sulphur-crested cockatoos

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Introduction

Veterinarians are required to work with animals from a variety of taxonomic groups and are frequently presented with an avian patient that requires general anaesthesia for procedures including complete physical examination, venipuncture, diagnostic work up, or medical/surgical treatments. The basic principles of anaesthetic management that govern mammalian anaesthesia also apply to birds, although specific anatomical and physiological differences must be considered (Curro, 1998). Isoflurane was used in this study because it is currently the preferred anaesthetic agent for birds in veterinary practice (Heard, 1997a and b). Because of the anatomy and structure of the avian respiratory system, even healthy birds may not be properly oxygenated when anaesthetized and placed in dorsal recumbency. Intubation and the use of intermittent positive pressure ventilation (IPPV) is recommended in anaesthetized patients (Sedgwick, 1980), however, little research has been carried out on IPPV in birds compared to mammals. Therefore, the aim of this study was to determine if IPPV increases the depth of anaesthesia.

Experimental protocol

Six sulphur-crested cockatoos *(Cacatua galerita galerita*) were anaesthetized and intubated using isoflurane and oxygen. Heart rate, blood pressure, cloacal temperature and respiratory rate were determined and did not change significantly during the study. The study was approved by the University of Queensland Animal Ethics Committee and the Department of Environment.

In the control study, anaesthetised birds were allowed to inhale 3.0% isoflurane spontaneously (SV) for 10 min before being disconnected from the anaesthetic machine and the endotracheal tube connector tapped every 5 s with the index finger. The time taken for the birds to wake up were recorded. The birds were immediately reconnected to the anaesthetic machine and anaesthesia was allowed to stabilise for 5 min before the procedure was repeated 4 more times.

In another study, birds inhaled 1.5% isoflurane and after the first SV anaesthesia run, the birds were reconnected to the circle absorber for 5 min, before being IPPV at 6 breaths/min for 10 min at 4 cmH_2O pressure. The birds were then disconnected from the anaesthetic machine. The time taken for the return of spontaneous respiration and wake up was recorded. After the second SV anaesthesia run, IPPV rate was 12 breaths/min. This procedure was repeated in all the birds using 3.0% isoflurane concentration and the results recorded.

Results

Although there was a slight increase in wake up time with repeated consecutive SV runs, the difference was not significant and the mean wake up time for all the birds was 167 ± 53 s. The time taken for wake up increased for both SV and IPPV at 1.5% inspired isoflurane. Similarly, at 3.0% inspired isoflurane, there was a difference in the wake up time for both SV and IPPV runs (Table 1).

Table 1. Mean values ± SD for wake up times after either spontaneous (SV) or intermittent positive pressure ventilation (IPPV) in 6 cockatoos during 1.5 % and 3.0% isoflurane anaesthesia.

Type of respiration	*Wake up time (s)*	
	1.5 % Isoflurane	*3.0% Isoflurane*
SV	96 ± 28	135 ± 45
IPPV-6	114 ± 46	184 ± 37
SV	128 ±32	182 ±52
IPPV-12	195 ± 26	371 ± 132
SV	183 ±87	228 ±104

Some birds developed apnoea after IPPV at 6-breaths/min, but all the birds developed apnoea after IPPV at 12 breaths/min. The times for the return of spontaneous breathing was higher after IPPV at 12 breaths/min, compared to 6 breaths/min during either 1.5% or 3.0% isoflurane anaesthesia.

Discussion

Anaesthesia in the cockatoos was rapidly induced and recovery was rapid. IPPV in anaesthetized birds has advantages, although veterinary textbooks on anaesthesia suggest that volatile anaesthetics can accumulate in the air sac system during spontaneous respiration of birds anaesthetised with inhalation anaesthetics (Sap *et al.*, 1993). Contrary to this opinion, the present study and studies by Sap *et al.*, (1993), do not support this suggestion.

The monitored reflexes that appeared during recovery from isoflurane anaesthesia suggest that there is a dose-related delay in recovery. Reflexes appeared earlier after 1.5% isoflurane anaesthesia than after 3.0%. IPPV delayed the appearance of the reflexes more than SV. Also, the IPPV rate influenced the appearance of the reflexes, they appeared earlier during IPPV at 6 breaths/min than at 12 breaths/min. There was a dose-related prolongation of recovery from anaesthesia that was well marked during IPPV and increased with higher IPPV rates.

The apnoea that was observed in all birds after IPPV at 12 breaths/min and in some birds after IPPV at 6 breaths/min, was probably due to IPPV and not SV overcoming the apnoeic threshold in the birds that became apnoeic. Also, birds have been reported to be very sensitive to CO_2 concentrations, and depletion of CO_2 causes acute apnoea (Ludders *et al.*, 1989). IPPV at 12 breaths/min possibly caused depletion of arterial CO_2 resulting in apnoea in all the birds. The prolongation of return of spontaneous respiration at a higher dose of isoflurane was not as significant as IPPV rate, implying that there is a dose-related delay in return of SV after apnoea.

In conclusion, isoflurane anaesthesia in the cockatoos is rapidly induced and recovery is rapid. A continuous delivery of inhalant anaesthetic is suggested for a longer duration to prevent wakening, especially during the induction phase. IPPV increases the depth of anaesthesia in a rate and dose-related manner and prolongs recovery from anaesthesia.

High rates of IPPV and higher doses of isoflurane cause apnoea, and apnoea prolongs recovery from anaesthesia. A peak pressure of 4 cmH_2O is adequate during IPPV in cockatoos, however cockatoos may continue to breathe spontaneously at low IPPV rates. IPPV provides an opportunity to use lower isoflurane concentrations to achieve anaesthesia.

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