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Arterial blood gas analysis in labrador retriever dogs with upper and lower respiratory tract diseases*

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Abstract

Arterial blood gas analysis helps to assess the patient's ventilation and oxygenation status. Arterial blood gas variations in 12 awake Labrador retriever dogs with respiratory diseases were studied. The animals were further divided on the basis of clinical signs and radiography into those with upper and lower respiratory tract diseases. Arterial blood samples were collected from the dorsal pedal artery. The results were compared with arterial blood gas values of control dogs. Significant evidence of hypoxemia was noted with abnormal mean values in partial pressure of oxygen ($P < 0.01$), oxygen saturation ($P < 0.01$) and alveolar-arterial (A-a) gradient ($P < 0.01$) in dogs with upper and lower respiratory tract diseases. However, there were no significant changes in these values between animals with upper and lower respiratory tract affections.

Key words: *Arterial blood gas analysis, Upper and lower respiratory tract diseases, hypoxemia*

Arterial blood gas analysis (ABG) helps to measure the important physiological variables such as oxygen, carbon dioxide and pH, which are vital for normal organ function. It has also been used as the standard diagnostic and prognostic test for metabolic disturbances and respiratory failure (Byrne *et al.,* 2013). In dogs, arterial samples can be drawn from various locations including femoral artery, dorsal pedal, aural, sublingual and coccygeal arteries. The diagnosis of alterations in lung function is possible with ABG even before clinical and radiographic changes are apparent. Analysis of arterial blood gas helps to objectively measure the alveolar ventilation ($PaCO_2$) and oxygen exchange (PaO_2), efficiency of gas exchange (alveolar-arterial (A-a) gradient) and also determines the acid-base status of the patient (McKiernan, 2000). It is the gold standard test for evaluating the oxygenation and ventilation status of animals (Balakrishnan and King, 2014).

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Materials and methods

The study sample consisted of 12 Labrador retriever dogs of either sex presented to the Teaching Veterinary and Clinical Complex, Mannuthy with the clinical findings and radiographic evidences of respiratory diseases. Lateral view radiographs of neck and thorax were utilized for the study. Dogs with radiographic appearances of laryngitis, tracheitis, tracheal stenosis and tracheal collapse were grouped into those with upper respiratory tract diseases (Group A). Animals with pneumonia (bronchial, interstitial and alveolar pattern), pleural effusion and metastasis were grouped into those with lower respiratory tract diseases (Group B). Six apparently healthy adult Labrador retriever dogs (Group C) brought for routine check-up and vaccination were randomly selected to collect the reference values for arterial blood gas.

Animal was restrained without inducing stress and allowed to calm down in a quiet room. All the arterial samples were obtained from dorsal pedal artery (Figure. 1). The skin was clipped, prepared aseptically and the artery was punctured with a 25 G needle. Blood was collected anaerobically using a pre-heparinized one ml syringe (BD A-line) and capped with rubber stopper (after expelling small air bubbles if present). Analysis was done within five to ten minutes of sampling using Epoc blood gas analyser (Figure. 2). Alveolar-arterial (A-a) gradient was calculated from the formula, (A-a) gradient = 150-1.1($PaCO_2$)-PaO_2 (Balakrishnan and King, 2014). Values of arterial blood gas were compared with that of the control group of apparently healthy animals (Group C). Statistical analysis was carried out using SPSS software package version 24.0 with one way ANOVA and post hoc test for comparison between the groups and within groups.

Results and Discussion

Of the 12 animals used in the study, nine were males. The mean age and weight of these dogs were 4.58±0.49 years and 32.25±1.20 Kg respectively. The values of arterial blood gases from dogs with upper respiratory tract diseases (Group A), lower respiratory tract diseases (Group B) and control animals (Group C) are presented in Table 1.

The mean of the pH, partial pressure of oxygen (PaO_2), partial pressure of carbon dioxide ($PaCO_2$), oxygen saturation (SaO_2), bicarbonate concentration (HCO_3^-) and alveolar-arterial (A-a) gradient recorded in the control group in this study were in accordance with studies of Hoareau *et al.* (2012) and Waddell (2013). The mean of PaO_2 and oxygen

Figure 1. Arterial blood collection from dorsal pedal artery

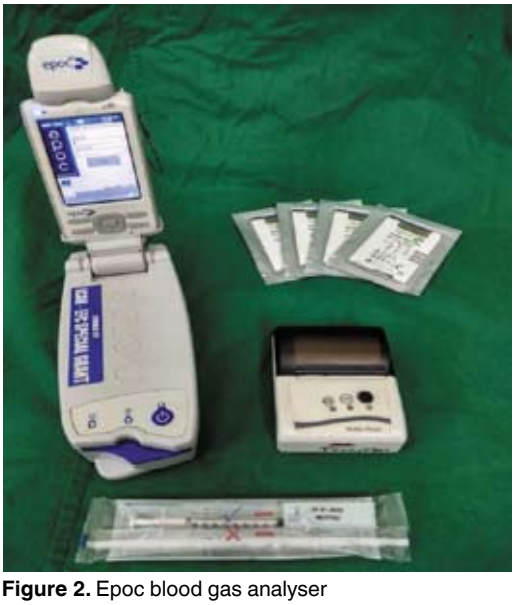

Figure 2. Epoc blood gas analyser

Table.1. Arterial blood gas measurement values of animals with upper respiratory tract diseases (Group A), lower respiratory tract diseases (Group B) and control animals (Group C)

	pH	PaO_2 (mm Hg)	$PaCO_2$ (mm Hg)	SaO_2 (%)	HCO_3^-(mmol/L)	A-a gradient (mm Hg)
Group A	7.39±0.01	77.60^{a}±3.49**	32.48±3.80	93.01^{a}±0.48**	19.71±0.90	36.66^{b}±5.46**
Group B	7.37±0.04	72.31^{a}±2.44**	35.86±4.92	90.15^{a}±1.39**	18.65±3.31	38.23^{b}±3.7**
Group C	7.40±0.00	101.78^{b}±1.13	35.25±1.07	96.73^{b}±0.80	21.33±0.49	9.44^{a}±1.62

* in columns represents significant difference with control group at p≤0.05 and ** at p≤0.01 Mean±SE bearing superscripts (a,b) within same column differ significantly.

saturation (SaO_2) in Group A and B were found to be significantly low (P < 0.01) in comparison to those values in the control group, but no significant change was found between Group A and B. In this study, hypoxemia was significant but A-a gradient was significantly higher in Group A and B when compared to Group C and similar results were reported by Wingfield *et al.* (1997) and Gonul *et al*. (2010). Arterial pH, $PaCO_2$ and HCO_3^- were not statistically significant between three groups (P = 0.57, 0.80 and 0.64, respectively) and these findings were corroborated with the findings of Cornelius and Rawlings (1981) and Padrid and Amis (1992). However, scrutiny of the data revealed low pH and increased values of $PaCO_2$ in two dogs with pneumonia when compared to the control group.

Hypoxemia could be related to low ventilation-perfusion mismatching, alveolar hypoventilation, low inspired oxygen and shunt or diffusion limitation. Low inspired oxygen and alveolar hypoventilation could be diagnosed by normal A-a gradient and rise in $PaCO_2$. However, these variations were not observed in this study. Hypoxemia with an increased A-a gradient could be due to the ventilation-perfusion mismatching and this condition occurs when ventilation in certain areas of lungs is not evenly matched with perfusion. Although respiratory acidosis was seen in severely affected dogs, it was not statistically significant and it might be due to the small population size (Wingfield *et al.*, 1997).

In conclusion, the present study revealed significant evidence of hypoxemia in dogs with respiratory diseases. Arterial blood gas analysis can thus be considered as a valuable tool that provides insight into the severity of respiratory dysfunction in animals with respiratory disease and to monitor the response to therapy over time.

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