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RESEARCH ARTICLE

Effect of body position on electrocardiographic parameters in Labrador retriever dogs

Surangkhana Thanwongsa[1], Suriya Youyod[1], Sermsawat Imsopa[1], Wootichai Kenchaiwong[2],

Wichaporn Lerdweeraphon[2*]

[1]*Faculty of Veterinary Sciences, Mahasarakham University, Thailand*
[2]*Applied Animal Physiology Research Unit, Faculty of Veterinary Sciences, Mahasarakham University, Thailand*
[*]***Corresponding author*** *E-mail: wichaporn.l@msu.ac.th*

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Abstract

Objective: This study aimed to determine how body position influenced values of electrocardiographic (ECG) parameters in Labrador retriever dogs.

Materials and Methods: ECGs were recorded from 10 Labrador retriever dogs in 3 positions, right lateral (RL) recumbence, standing (ST) position, and left lateral (LL) recumbence). The standard bipolar limb leads (leads I, II, and III) and unipolar augmented limb leads (leads aVR, aVL, and aVF) were recorded. Amplitude and durations of P, QRS, and T wave, PR and QT intervals, mean electrical axis (MEA), and heart rate (HR) were measured from each recording.

Results: No significant difference was observed in P wave duration (P=0.69), P wave amplitude (P=0.88), PR interval (P=0.85), QRS duration (P=0.18), R wave amplitude (P=0.24), and HR (P=0.42) among the 3 positions. The values of T wave duration, T wave amplitude and QT interval were significantly decreased in ST position compare to RL recumbency (P=0.03, 0.01, and 0.02, respectively). The value of MEA was not significantly different in LL recumbence compared to RL recumbence. However, MEA was significantly decreased in the ST position compare to RL recumbency (P<.0001).

Conclusion: Our findings indicated that the mean electrical axis shift to leftward and with increasing incidence of a muscle tremor artifact in ECG recording with Labrador retriever dogs in standing position. It is necessary to assess ECG from a large number of dogs to establish reference values in other position. However, when investigators require accurate ECG measurement and interpretation of the amplitudes and MEA, recording with the dog in right lateral recumbence is recommended.

Keywords: Body position, dogs, electrocardiogram, Labrador retriever

Introduction

Electrocardiography (ECG) is a widely used non-invasive technique for recording the electrical activity of the heart by using electrodes attached to the body surface, placed on the limbs or chest. ECG can detect electrical activity in cardiac tissue by changes in the transmembrane electrical potential and therefore it is important to assess cardiac arrhythmias, diagnosing conduction abnormalities and cardiac chamber enlargement (Willis, 2018). Nevertheless, to be accurately interpreted, ECG should be recorded following guidelines, which include reference to the position of the body. Conventionally, animals are gently restrained in recumbent position on a nonconductive surface to eliminate electrical interference and must be relaxed and resting, with their limbs perpendicular to the long axis of the body. The ECG cables are attached directly to the animal's skin using electrode clips such as alligator clips and should be moistened with conductive gel or alcohol. On the forelimbs, the electrode clips are placed above the olecranon and on the hindlimbs the electrode clips are placed above the patellar tendon. Positioning of clips at these areas minimizes electrical interference of muscle activity (Tilley, 1995).

In dogs, right lateral recumbency is the standard position of body during recording and the normal reference values for the ECG have been determined based on this position (Martin, 2007). Sometimes large- size or aggressive dogs or dyspneic animals, can be difficult to restrain but use of sedative or anesthetic drugs is usually not recommended because they can alter the heart rate and rhythm directly, resulting in sinus bradycardia (Tilley, 2009). Therefore, it is necessary to obtain ECG recording with the dog in standing, left lateral recumbency or sternal recumbency. However, the effects of this unusual position alter some ECG parameters in dogs and cats (Coleman and Robson, 2005; Harvey et al., 2005; Rishniw et al., 2002). Because of a lack of reference ranges for ECGs recorded in other positions, the use of normal reference values for ECGs recorded from dogs in unusual positions may not be valid (Rishniw et al., 2002). Therefore, further study is required to establish reference ranges for ECGs recorded in standing position or left lateral recumbency, especially, in large breed dogs or respiratory distressed animals.

Obesity is one factor that associated with electrocardiographic abnormalities including various changes in P, QRS and T wave morphology, leftward shifts of cardiac axis and also reflect alterations in cardiac morphology (Fraley et al., 2005). Additionally, the most of Labrador retriever are obese dogs (Söder et al., 2019). Some authors reported that this breed has a deletion in the POMC gene is associated with bodyweight and has a high risk of obesity (Mankowska et al., 2017). Previously, investigators have studied the influence of body position on electrocardiographic recordings in Beagle, Dachshunds, Newfoundland, Boxer, and Cocker Spaniel dogs (Rishniw et al., 2002), in sled dogs (Stern et al., 2013) and in cats (Harvey et al., 2005). However, in obese dogs such as Labrador retriever, it is not clearly understood. Therefore, this study aimed to evaluate how ECG parameters change in Labrador retriever dogs depending on three positions, right lateral recumbency (standard ECG position), left lateral recumbency and standing position.

Materials and Methods

Ethical approval

All procedures on animals used in this study were approved by the Institutional Animal Care and Use Committee, Mahasarakham University, Thailand (Approval number: IACUC-MSU-010/2020).

Animals

We evaluated 10 Labrador retriever dogs with normal cardiovascular physical examinations and no history of cardiac disease (based on results of physical examinations and laboratory tests, including complete blood count and routine blood biochemistry), from the hospital population of the faculty of Veterinary Sciences, Mahasarakham University, Thailand. Animals' age ranged from 1 to 8 years with body weight of 30-40 kg.

Electrocardiographic Recordings

ECGs were recorded with a 3-channel ECG (Edan Instruments, Inc., VE-300, China) at paper speed of 25 mm/s and calibration of 10 mm/mV (a frequency range of 0.67-100 Hz and EMG Filter was off). Thermosensitive ECG paper with a total width of 50 cm and a recording width of 80 mm was used. One small square on the horizontal and vertical axis was equal to 0.04 s and 0.1 mV, respectively. Recordings were obtained for all the standard bipolar limb leads (leads I, II, and III) and unipolar augmented limb leads (leads aVR, aVL, and aVF). The recording electrodes were made of flattened alligator clips and were attached

to the skin at the distal to the elbows and at the level of slightly proximal to the stifle. All dogs had ECG recordings in the 3 different positions. Recordings were made in right lateral (RL) recumbency (standard position), immediately followed by standing (ST) position then left lateral (LL) recumbency. Each dog was restrained manually in RL and LL recumbency without any tranquilizer or anesthetic drugs, with forelimbs held perpendicular to the long axis of the body and hindlimbs held in a semiflexed position. For ST position recordings, dogs were allowed to stand with the limbs perpendicular to the ground. The electrodes were kept in the same position on the limbs in all positions, and 70% Ethyl alcohol was applied to the skin at the attachment sites of the clips before each recording. All ECG variables were analyzed from lead II. Amplitude and duration of P waves, QRS complexes, and T waves were measured together with PR and QT interval. Amplitude (recorded in millivolts) of P wave was measured from the upper edge of the baseline to the peak of the P wave. Duration (recorded in seconds) of P waves was measured at its inside, from the start to the end of the deflection from the baseline. P-R interval (recorded in seconds) was measured from the beginning of the P wave to the beginning of the Q wave (R wave, if no Q wave was present). QRS duration was measured from the beginning of the first deflection to the end of the final deflection of the QRS complex. R wave amplitude was measured from the top edge of the baseline to the peak of the R wave. T wave amplitude and duration were measured the same as analysis of P wave. QT interval was measured from the onset of the QRS to the end of the T wave. Heart rate (HR) was measured using R-R interval. The mean electrical axis (MEA) for each recording was calculated by the triangulation method with measurement of the QRS complex of leads I and III (Martin, 2007).

Statistical Analysis

Data are expressed as mean ± standard deviation (SD). Comparisons were statistically tested among 3 positions (RL recumbency (standard position), LL recumbency, and ST position) by using one-way ANOVA and an appropriate post hoc Schaffe's test with a significant criterion of p-value less than 0.05. SAS software university edition (SAS, Inc., Cary, NC, USA) was used for data analysis.

Results

ECG recordings in the 3 different positions (RL recumbency, LL recumbency, and ST position) are presented in Figure 1A, B and C, respectively. Results (mean ± SD) of all ECG parameters measured in this study are shown in Table 1. There was no significant difference observed in P wave duration (P=0.69), P wave amplitude (P=0.88), PR interval (P=0.85), QRS duration (P=0.18), R wave amplitude (P=0.24), and HR (P=0.42) among the 3 positions. The values of T wave duration, T wave amplitude and QT interval were significantly decreased in ST position compare to RL recumbency (P=0.03, 0.01, and 0.02, respectively). There were no significant difference in T wave amplitude and duration and QT interval between RL and LL recumbency. The value of the MEA was significantly decreased in the ST position compare to RL recumbency (P<.0001). This finding indicated that the MEA shifted to the left in ECGs recorded in ST position (Figure 2). However, no significant differences were found in MEA between RL and LL recumbency. The diagram in Figure 2 illustrates the mean and standard deviation of the MEA in the 3 different positions.

Discussion

The major finding of this study was that the body position of Labrador retriever dogs during ECG recording had no marked influence on most ECG parameters. However, ECG recording with the dog in standing position found that the mean electrical axis shifted to leftward and with increased incidence of muscle tremor artifact. Placement in right lateral recumbency improved the quality of the ECG recording by decreasing the incidence of the muscle tremor artefact. Recording in left lateral recumbency did not alter the HR, amplitude and duration of P, QRS, and T waves including the mean electrical axis which did not shift to leftward. All ECG parameters recorded in Labrador retriever dogs were found to be within the normal range in our study, comparable to values reported by earlier studies (Gugjoo et al., 2014; Mukherjee et al., 2015).

In this study, HR did not differ among the 3 body positions (RL=101.89 ±16.19, LL= 94.03 ±13.15, and ST=93.97 ±16.41 beats/min) as reported earlier (Stern et al., 2013). P wave duration, P wave amplitude, PR interval, QRS complex duration were not altered by changes in different body position similar to a previous report (Rishniw

Table 1. Mean (±SD) of electrocardiogram parameters recorded from 10 Labrador retriever dogs in the 3 different recumbencies.

ECG parameters	RL	LL	ST	p-value
P wave duration (s)	0.05 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	0.69
P wave amplitude (mV)	0.19 ± 0.06	0.18 ± 0.04	0.18 ± 0.07	0.88
PR interval (s)	0.14 ± 0.02	0.14 ± 0.02	0.13 ± 0.02	0.85
QRS duration (s)	0.04 ± 0.00	0.04 ± 0.00	0.04 ± 0.00	0.18
R wave amplitude (mV)	1.63 ± 0.40	1.43 ± 0.34	1.38 ± 0.28	0.24
T wave duration (s)	0.066 ± 0.02^{a}	0.058 ± 0.02^{ab}	0.044 ± 0.01^{b}	0.03
T wave amplitude (mV)	0.29 ± 0.10^{a}	0.20 ± 0.11^{ab}	0.16 ± 0.07^{b}	0.01
QT interval (s)	0.212 ± 0.02^{a}	0.208 ± 0.03^{ab}	0.184 ± 0.02^{b}	0.02
HR (beats/min)	101.89 ± 16.19	94.03 ± 13.15	93.97 ± 16.41	0.42
MEA (degrees)	68.80 ± 10.64^{a}	67.50 ± 16.42^{a}	42.50 ± 10.02^{b}	<.0001

RL=right lateral recumbency, LL=left lateral recumbency, ST=standing position, HR=Heart rate, MEA=Mean electrical axis, mV= millivolts, s= second

et al., 2002). HR, the amplitude of P wave, the duration of PR interval, and QRS complex duration were within the normal ranges proposed for dogs restrained in standard right lateral recumbency.

In our study, Lead II R-wave amplitude was not significantly different among 3 body positions (RL=1.63±0.40, LL= 1.43±0.34, and ST=1.38±0.28 mV). This finding was in accordance with Stern et al. (Stern et al., 2013) but was not supported by Rishniw et al. (Rishniw et al., 2002), who observed increased R wave amplitudes in lead II in ECGs from dogs in LL and ST position compared with recordings obtained in RL position. Some author indicated that a high-frequency cut-off filter (>100 Hz) should be used in dogs because the use of a high-frequency filter of 35 Hz together with a notch filter of 55 Hz, caused a major reduction in R- wave amplitude (Dvir et al., 2002). In cats, R wave amplitude was reduced in both sternal and LL recumbencies when compared with RL recumbency. If the R wave amplitude is decreased in a different position, the diagnosis of left ventricular enlargement can be missed. Therefore, the authors concluded that sternal and LL recumbencies should not be used for recording electrocardiograms (Harvey et al., 2005). We also observed that ECGs from Labrador retriever dogs in ST position had decreased T wave amplitude and duration and also reduced QT interval when compared with recordings obtained in RL position. These finding were most likely related to the higher incidence of muscle artefacts in the ECG recordings from standing dogs, with the ECG analysis incorrectly identifying an earlier or later time for the start and end of ventricular depolarization and repolarization, respectively. Therefore, the accurate measurement of the QT interval is dependent on the corrective identification of the end of the T wave (Nahas and Geffray, 2004).

In this study, the MEA shifted to the left in ECGs recorded in ST position. This effect was due to a change in the position of the heart within the thorax (Detweiler, 1993). This alters the distance between the heart and the ECG lead electrodes on the body surface. ECG recording with the dog in standing position causes the recording electrodes to be closer to the heart. ECGs recorded in LL position would be expected to displace the heart to the left (the heart rotates to the left consequently increasing the amplitude of leftward-directed vectors). However, recordings in LL position were not in keeping with this effect, as we found that MEA did not alter in LL position compared to RL position, similar to a previous report (Rishniw et al., 2002). This suggests that a physical change in cardiac position within the chest is not enough to explain LL position. However, some authors have reported that ECG re-

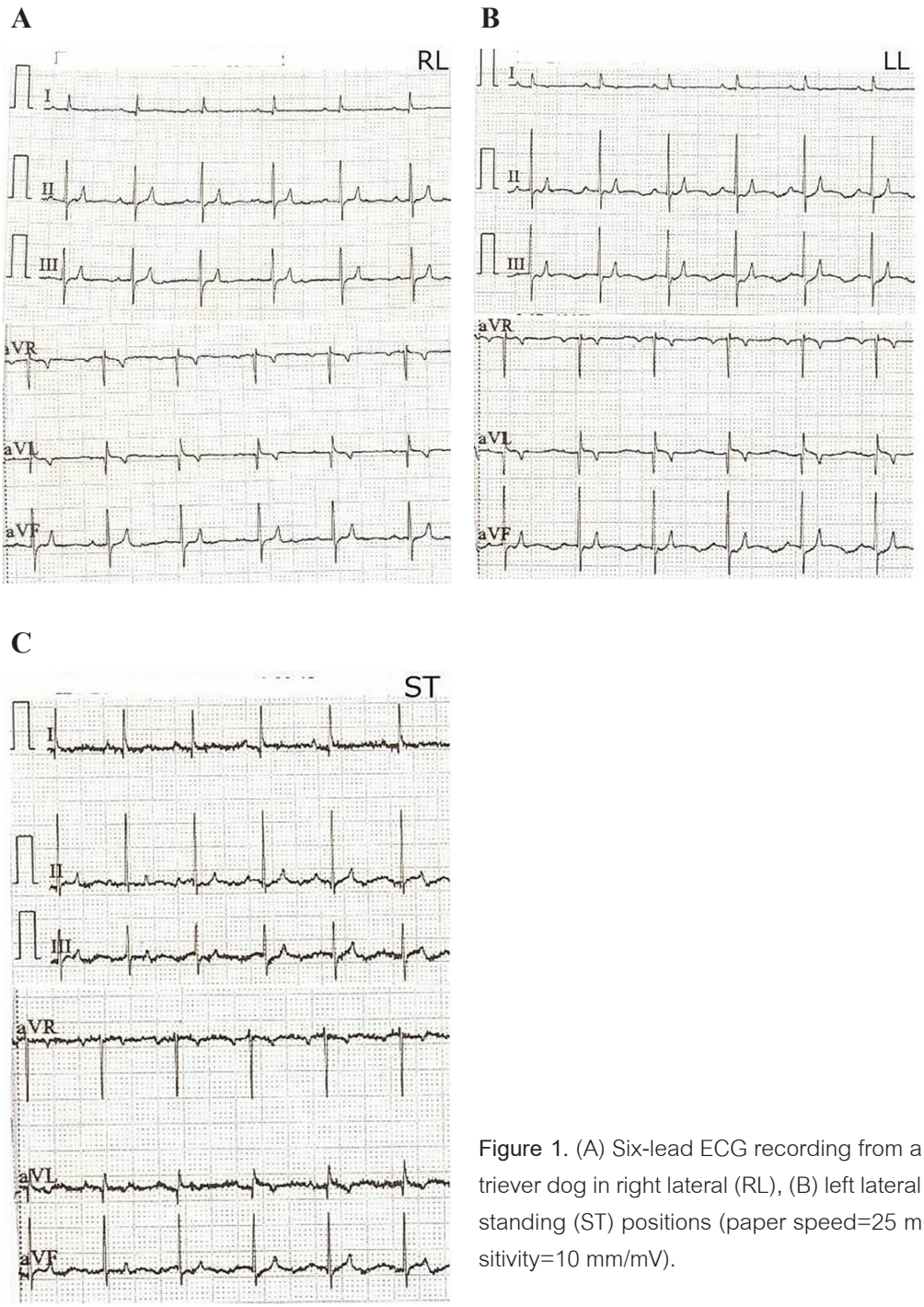


Figure 1. (A) Six-lead ECG recording from a Labrador retriever dog in right lateral (RL), (B) left lateral (LL), and (C) standing (ST) positions (paper speed=25 mm/s and sensitivity=10 mm/mV).

cording with the dog restrained in a hammock changed the mean electrical axis by the compression of the thorax and consequent displacement of the heart (Hanton and Rabemampianina, 2006). In cats, the MEA was only significantly different in LL recumbency compared with RL recumbency (standard references), the authors suggested that ECG recording with the cat in LL position should not be used for recording electrocardiograms (Harvey et al., 2005). The limitations of this study were the small number of dogs examined and that precluded the development of reference ranges for ECG parameters recorded in either ST or LL position. The filtering condition of the ECG recording might affect signal intensity. This study used a frequency range of 0.67-100 Hz (high-pass Filter=0.67 Hz and Low-pass Filter=100 Hz) for ECG recording in Labrador retriever dogs. Previously, investigators have shown

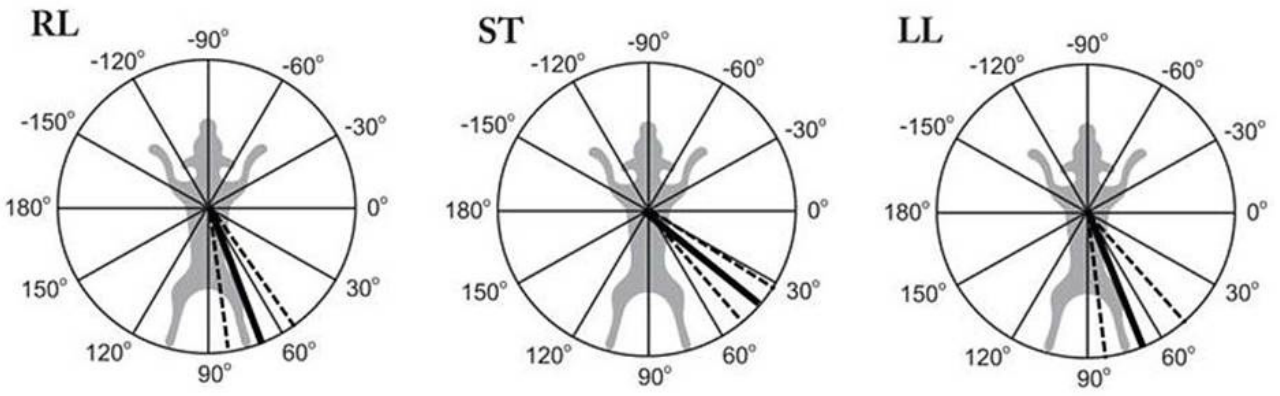


Figure 2. Mean (dark line) ± SD (dashed dark line) mean electrical axis (MEA) for right lateral (RL), standing (ST), and left lateral (LL) positions..

that high- and low-pass filtering of the ECG signal will affect amplitudes of P-QRS-T of the ECG recorded from cats (Schrope et al., 1995)

Conclusions

Our results suggest that the analysis of ECG from a large number of dogs is necessary to establish reference values in other position than right lateral recumbency. The investigators should not use reference ranges for ECG interpretation obtained in right lateral recumbency, when ECG recording is evaluated in other positions, particularly in ST position, because of the diagnosis of left heart enlargement can be missed in a normal dog. Further studies should develop reference ranges for ECGs recorded in ST or LL positions.

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Conflict of interest statement

The authors declare that we have no conflict of interests.

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