

Electrocardiographic Studies on Bradycardia and Its Management in Dogs

Navjeet Singh Brar¹, Neetu Saini², Sujata Turkar², and Sushma Chhabra³

¹M.V.Sc Scholar, Department of Veterinary Medicine, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, INDIA

²Professor, Department of Veterinary Medicine, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, INDIA

³Principal Scientist, Directorate of Livestock Farms, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, INDIA

*Corresponding Author: sainin26@gmail.com

How to cite this paper

Brar, N. S., Saini, N., Turkar, S., & Chhabra, S. (2025). Electrocardiographic Studies on Bradycardia and Its Management in Dogs. *International Journal of Livestock Research*, 15(7), 42–49.

Received : Jul 30, 2024
Accepted : Jul 10, 2025
Published : Jul 31, 2025

Copyright @ Brar *et al.*, 2025

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).
<http://creativecommons.org/licenses/by/4.0/>



Abstract

Bradycardias are defined as a heart rate of less than 70 beats per minute in large breeds & less than 60 beats per minute in small breeds without apparent variations in the R-R interval. Twenty-nine dogs of different breeds presented to the Small Animal Veterinary Clinics at GADVASU, diagnosed with bradycardia (36-65 bpm) on auscultation and affected by various disease conditions, were selected for the present study. Bradycardias were categorized into four groups: hypothermia-induced bradycardia (n = 6), vagal tone-induced bradycardia (n = 6), CNS-induced bradycardia (n = 8), and the other group (n = 9). Diagnosis was based on Physical examination, auscultation of the heart, blood pressure monitoring, electrocardiography, hematological and biochemical analysis to identify the underlying cause of the bradycardia. Treatment of Dogs with Bradycardia was initiated with different protocols, such as atropine/glycopyrrolate, warm fluids, amlodipine, calcium gluconate, insulin, and dextrose, depending upon the cause of bradycardia.

Keywords: Atropine, Bradycardias, Dogs, Electrocardiography, Hypothermia, High Vagal Tone.

Introduction

Bradycardias are abnormal cardiac rhythms that are marked by a delayed heartbeat and originate from a decrease in the production or conduction of impulses by the heart's specialized conduction system (Devine *et al.*, 2006). In dogs, Brady arrhythmias can result in syncope, abrupt cardiac failure, exercise intolerance and heart failure. Electrocardiography is a non-invasive diagnostic technique used for diagnosis of arrhythmias in dogs (Saini, 2015). In dogs, sinus bradycardia, sinus arrest, sinoatrial block, sick sinus dysfunction or syndrome (SSS), and atrioventricular (AV) blocks are the most prevalent bradycardias. Similarly, Devine *et al.* (2006) documented that reduced sinus rates and varying degrees of AV block can result from elevated vagal tone. Certain arrhythmias require treatment with anti-arrhythmic medications and other therapeutic techniques based on the underlying etiology, while arrhythmias of non-cardiac etiology require treatment of the primary disease (Moise, 2020).

Materials and Methods

29 dogs with bradycardia due to different etiological factors of non-cardiac origin were included in this study. Dogs were categorized into 4 groups i.e. hypothermia induced bradycardia, High vagal tone induced bradycardia, CNS induced bradycardia and Others group based on physical examination, auscultation of heart, blood pressure monitoring, electrocardiography, hematological and biochemical analysis. The management was done based on the underlying etiology of the diseases. Treatment of Dogs with Bradycardia was done with different treatment protocols such as atropine/glycopyrrolate, warm fluids, amlodipine, calcium gluconate, insulin and dextrose depending upon the cause of bradycardia. Treatment with atropine was given to total 17 Dogs (6 with increased vagal tone, 7 with CNS lesions, 2 with superficial pyoderma, 1 drug induced and 1 with hypocalcemia). Treatment with glycopyrrolate was given to 1 dog (with CNS lesion). Treatment with calcium gluconate was given to 2 dogs (with hyperkalemia). Treatment with warm fluids was given to 6 dogs (with hypothermia). Treatment with amlodipine was given to 1 dog with hyperviscosity syndrome. Treatment with 50% dextrose was given to 1 dog with hypoglycemia.

Results and Discussion

Out of 29 cases of bradycardia, it was observed that bradycardia caused by others group (Metabolic, drugs induced, physiological) was found in 9 (31%) dogs followed by neurogenic bradycardia in 8 (27.5%), hypothermia and vagal induced bradycardia was found in 6 (20.6%) dogs each. Various treatment protocols were employed for treatment of different bradycardia cases. Treatment with Atropine was given to total 17 Dogs (6 with Increased vagal tone, 7 with CNS lesions, 2 with superficial pyoderma, 1 drug induced and 1 with hypocalcemia) and it was observed that 15 animals survived during the treatment and 3 animals (with CNS lesion) died during the treatment (Table 1). Treatment with glycopyrrolate was given to 1 dog (with CNS lesion). It was observed that the dog died during the treatment (Table 1). Treatment with calcium gluconate was given to 2 dogs (with hyperkalemia) (Fig. 1 a and b) The treatment was given and it was observed both dogs survived after treatment (Table 1). Treatment with warm fluids was given to 6 dogs (with hypothermia). It was observed that the 5 dogs survived, and 1 died during the treatment (Table 1). Treatment with amlodipine was given to 1 dog (with hyperviscosity). It was observed that dog survived during the treatment. Treatment with insulin and dextrose was given to 1 dog (with hypoadrenocorticism). It was observed that the dog survived during the treatment (Table 1). Treatment with 50% dextrose was given to 1 dog (with hypoglycemia). It was observed that the dog survived during the treatment (Table 1).

In the present study, the mean values of heart rate and other electrocardiographic parameters were calculated both before and after treatment of different types of bradycardia in dogs. It was observed that in dogs with hypothermia-induced bradycardia mean values Heart rate was 87.83 ± 8.67 bpm after treatment which was significantly higher than mean value of the heart rate of 57 ± 4.29 bpm before treatment however there was no significant difference observed in mean values of other ECG parameters in dogs (Table 2) (Fig 2a and b)

In dogs with vagally induced bradycardia, mean values heart rate was 155.6 ± 17.2 bpm after treatment which were significantly higher than mean value of heart rate 56.71 ± 4.03 bpm before treatment whereas there was no significant difference observed in mean values of other ECG parameters in dogs (Table 2).

In dogs with CNS induced bradycardia mean values heart rate was 121.9 ± 21.7 bpm after treatment which were significantly higher than mean value of heart rate 56.14 ± 3.47 bpm before treatment whereas there was no significant

difference observed in mean values of ECG parameters in dogs (Table 2).

In dogs with bradycardia induced by others group mean values heart rate was 136.6 ± 10.7 bpm after treatment which were significantly higher than mean value of heart rate 54.89 ± 4.46 bpm before treatment whereas there was no significant difference observed in mean values of other ECG parameters in dogs (Table 2) (Fig. 3 a and b; 4a and 4b).

Table 1: Different treatment protocols for the management of Bradycardia in dogs

Treatment protocol	Etiology (n-29)	No. of animals	Drugs used	Prognosis
1	Vagal Tone	6	Atropine	Survived
2	CNS Lesion	7	Atropine	5 Survived, 2 died
3	CNS Lesion	1	Glycopyrrolate	Died
4	Hypoglycemia	1	50% dextrose	Survived
5	Hypothermia	6	Warm Fluids	5 Survived, 1 Died
6	Hyperviscosity	1	Amlodipine	Survived
7	Hypoadrenocorticism	1	Insulin and dextrose	Survived
8	Hyperkalemia	2	Calcium gluconate	Survived
9	Hypocalcemia	1	Atropine	Survived
10	Superficial pyoderma	2	Atropine	Survived
11	Drug induced	1	Atropine	Survived

Aslam *et al.* (2006) observed that after rewarming, cardiac arrhythmias typically go away on their own. Atropine often has no effect on hypothermia induced bradycardia. Rishniw *et al.* (1996) concluded that when dogs with vagally mediated bradycardia are administered 0.02 mg of atropine/kg via IV, IM, or SC, the result is usually AV block and perhaps a short aggravation of ventricular bradycardia. Ward (1950) described that Atropine sulfate, administered at 0.1 mg/kg as an anticholinergic treatment, has been used in a number of individuals with extremely severe closed head injuries. Significant and reliably repeatable clinical improvement was attained. Little (2005) observed that hypoglycemia can lead to diffuse stimulation of the parasympathetic nervous system. Profound bradycardia may result from hypoglycemia. Bradycardia and circulatory failure were quickly resolved upon intravenous infusion of a glucose solution to rectify the hypoglycemia, suggesting that the hypoglycemia was the source of these abnormalities. Spalla (2014) studied that in dogs, hypoadrenocorticism is a rare endocrine condition. Every eight hours, an intravenous bolus of 25% dextrose solution (2 g of dextrose for each unit of regular insulin) and regular insulin (0.25 U/kg [0.11 U/lb]) were given and dog responded to the treatment.

Table 2: Electrocardiographic parameters before and after treatment of bradycardia in dogs

ECG parameters	CNS lesion (n=8)		Hypothermia (n=6)		Others (n=9)		Vagal tone (n=6)	
	Before	After	Before	After	Before	After	Before	After
Heart rate (bpm)	56.14±3.47 (42-65)	121.9±21.7 (44-210)	57±4.29 (36-65)	87.83±8.67 (60-120)	54.89±4.46 (36-74)	136.6±10.7 (100-182)	56.71±4.03 (40-72)	155.6±17.2 (68-200)
P wave amplitude (mV)	0.171±0.028 (0.1-0.3)	0.157±0.022 (0.1-0.2)	0.280±0.037 (0.2-0.4)	0.266±0.042 (0.1-0.4)	0.164±0.014 (0.1-0.2)	0.157±0.027 (0.1-0.3)	0.142±0.029 (0.1-0.3)	0.166±0.333 (0.1-0.3)
P wave duration (sec)	0.031±0.004 (0.02-0.05)	0.035±0.003 (0.02-0.05)	0.034±0.002 (0.01-0.04)	0.030±0.002 (0.02-0.04)	0.040±0.003 (0.01-0.06)	0.038±0.002 (0.03-0.05)	0.031±0.002 (0.02-0.04)	0.038±0.003 (0.03-0.05)
PR interval (sec)	0.123±0.260 (0.06-0.22)	0.108±0.019 (0.08-0.22)	0.120±0.012 (0.08-0.16)	0.011±0.009 (0.08-0.14)	0.116±0.024 (0.0-0.24)	0.100±0.009 (0.06-0.14)	0.114±0.005 (0.1-0.14)	0.093±0.009 (0.07-0.12)
R wave amplitude (mV)	1.157±0.219 (0.3-2)	1.143±0.240 (0.3-2.2)	2.233±0.219 (1.3-2.9)	1.497±0.341 (0.28-2.6)	1.933±0.298 (0.9-4)	1.586±0.156 (0.9-2.2)	1.257±0.149 (0.4-1.5)	1.443±0.173 (0.7-2.2)
QRS duration (sec)	0.035±0.002 (0.02-0.04)	0.038±0.003 (0.02-0.05)	0.045±0.005 (0.03-0.06)	0.038±0.003 (0.03-0.05)	0.045±0.004 (0.04-0.08)	0.042±0.03 (0.03-0.06)	0.038±0.003 (0.02-0.05)	0.040±0.003 (0.02-0.05)
Q wave (mV)	0.275±0.047 (0.2-0.4)	0.225±0.047 (0.1-0.3)	0.225±0.062 (0.1-0.4)	0.250±0.086 (0.1-0.5)	0.386±0.114 (0.1-1)	0.275±0.031 (0.2-0.4)	0.393±0.130 (0.05-0.9)	0.420±0.124 (0.1-0.7)
ST segment (sec)	0.105±0.035 (0.04-0.2)	0.060±0.005 (0.06-0.08)	0.10±0.040 (0.06-0.18)	0.070±0.010 (0.06-0.10)	0.075±0.011 (0.03-0.12)	0.063±0.010 (0.03-0.10)	0.064±0.009 (0.04-0.1)	0.060±0.007 (0.04-0.10)
T wave amplitude (mV)	0.342±0.05 (0.2-0.5)	0.320±0.066 (0.1-0.5)	0.46±0.17 (0.1-1)	0.333±0.123 (0.1-0.8)	0.356±0.05 (0.1-0.6)	0.322±0.049 (0.1-0.6)	0.285±0.05 (0.1-0.5)	0.271±0.060 (0.1-0.6)
T wave duration (sec)	0.057±0.009 (0.04-0.1)	0.044±0.007 (0.02-0.06)	0.080±0.021 (0.04-0.14)	0.073±0.016 (0.02-0.12)	0.070±0.012 (0.03-0.14)	0.053±0.005 (0.03-0.08)	0.057±0.007 (0.04-0.08)	0.040±0.004 (0.02-0.06)
QT interval (sec)	0.26±0.027 (0.2-0.34)	0.190±0.038 (0.1-0.28)	0.320±0.036 (0.2-0.44)	0.223±0.029 (0.1-0.3)	0.238±0.05 (0.1-0.6)	0.191±0.020 (0.1-0.3)	0.194±0.019 (0.1-0.24)	0.171±0.015 (0.1-0.24)
Corrected QT interval	0.275 (0-0.367)	0.260 (0-0.323)	0.329 (0-0.464)	0.272 (0.155-0.359)	0.216 (0.112-0.321)	0.233 (0.133-0.344)	0.202 (0.100-0.268)	0.268 (0.212-0.300)

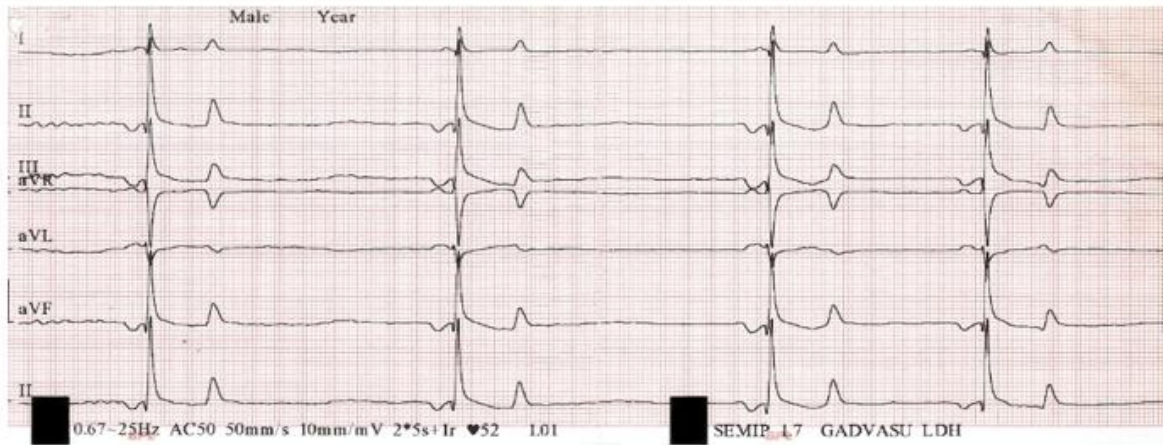


Figure 1 (a): Electrocardiogram of a 7 year-old female cocker spaniel dog with renal failure (creatinine 5.5 mg/dL, BUN 99.0 mg/dL), and hyperkalemia (8.6 mEq/L) showing bradycardia (heart rate 45 beatsper minute). (speed 50 mm/s, 1 cm = 1 mV)

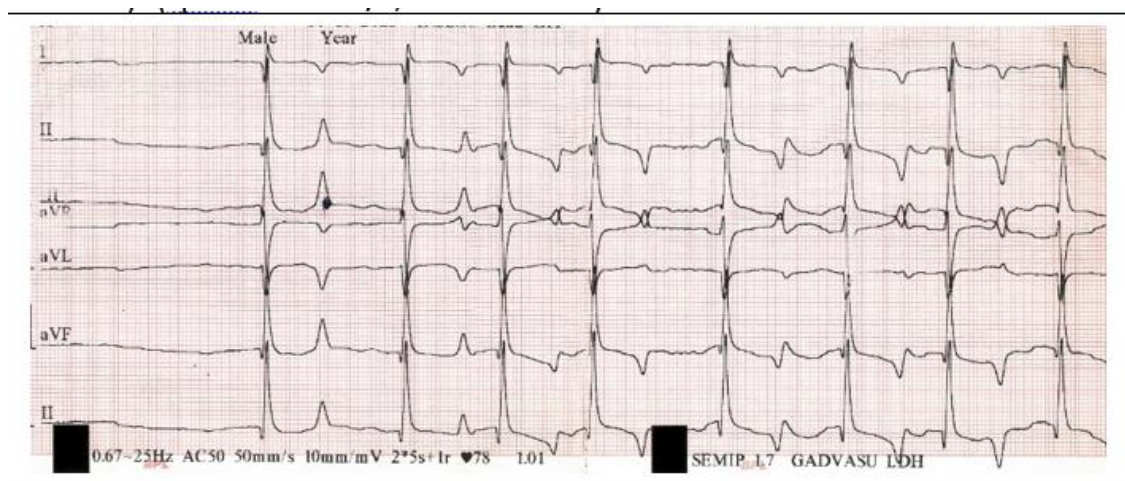


Figure 1(b): Electrocardiogram obtained from the dog in Figure (a) one hour after treatment of hyperkalemia with 10% calcium gluconate@1 ml/kg. Notice the normal sinus rhythm with heart rate of 100 bpm. (Paper speed = 50 mm/s, 1 cm = 1 mV)

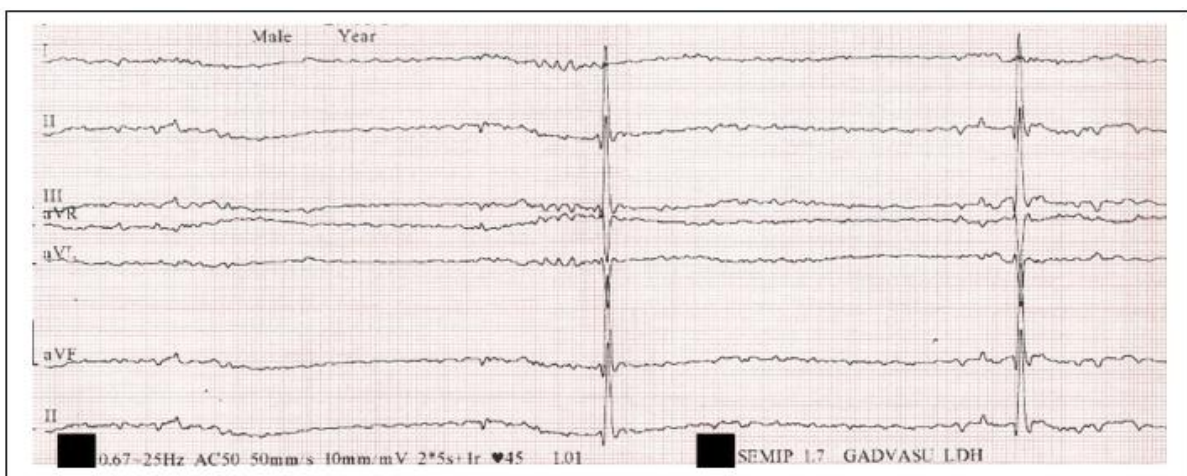


Figure 2(a): Electrocardiogram of a 8 month old male pomerian dog with hypothermia, showing bradycardia (heart rate 40bpm) (speed 50 mm/s, 1 cm = 1 mV)

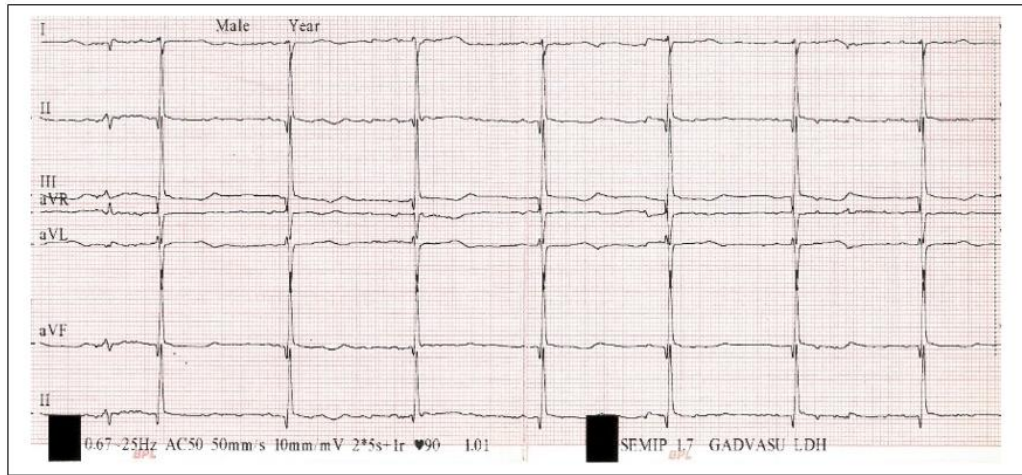


Figure 2(b): Electrocardiogram of a 8 month old male pomerian dog 6 h post therapy with warm fluids and insulation for hypothermia showing uniformity and regularity of the complexes with heart rate of 96bpm (speed 50 mm/s, 1 cm = 1 mV).

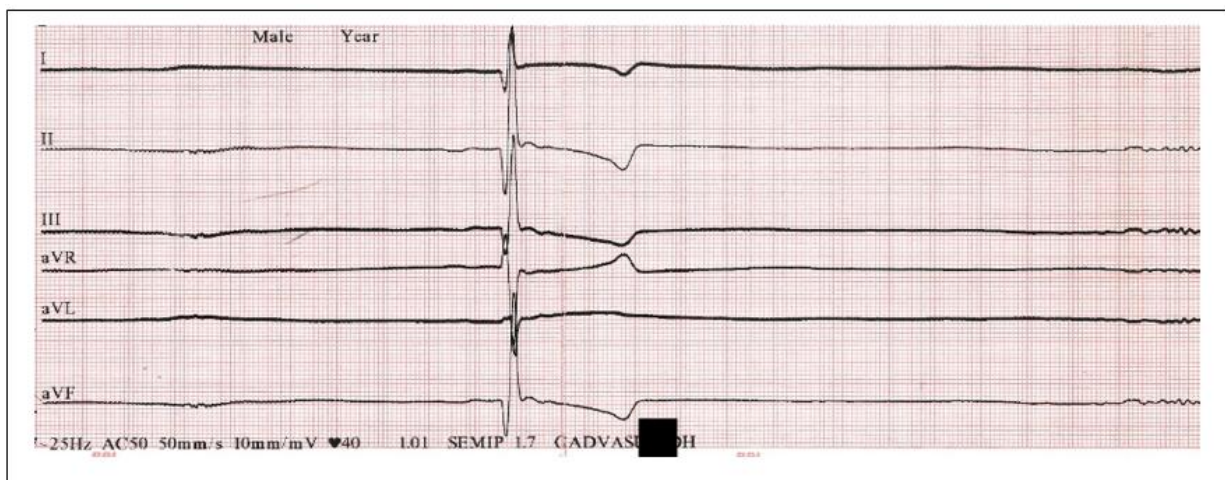


Figure 3 (a): Electrocardiogram of a 2.5 month old hypoglycemic dog (blood glucose 20 mg/dL) showing sinus bradycardia (heart rate 40 bpm sinus rhythm), and prolonged QT interval. (speed 50 mm/s, 1 cm = 1 mV)

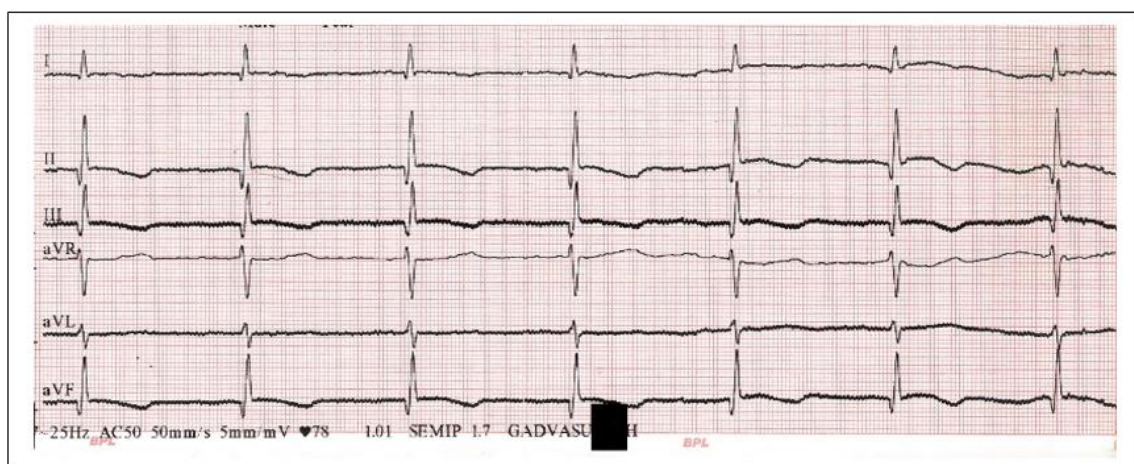


Figure 3(b): ECG recording approximately ten minutes after administration of an intravenous (IV) glucose bolus therapy indicating Sinus rhythm 100 bpm. Baseline irregularity is due to the dog shivering. (paper speed 50 mm/second, 1 cm = 1 mV).

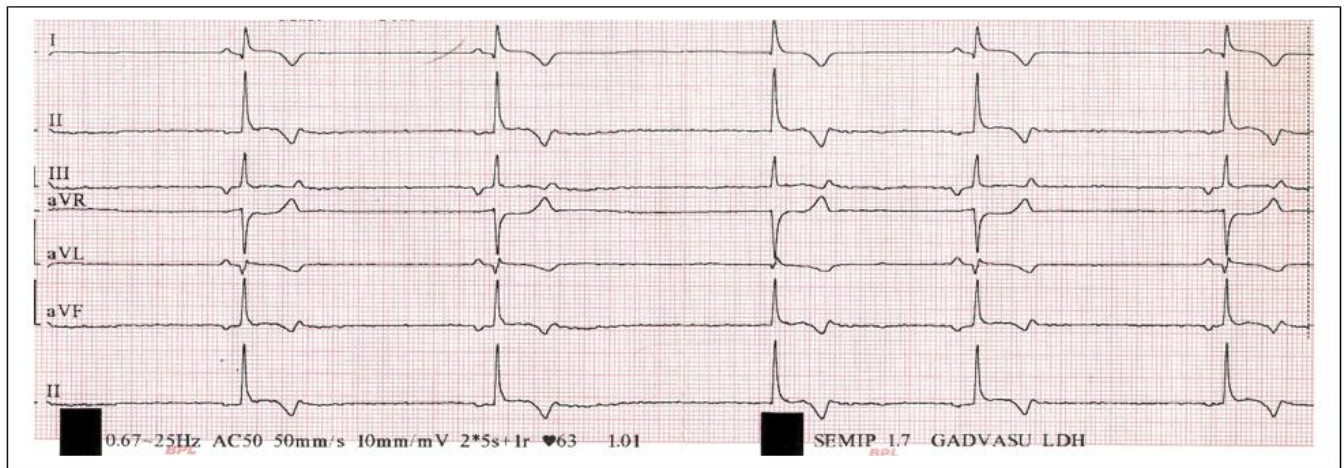


Figure 4(a): Hyperviscosity syndrome -Electrocardiogram of a 6.5 years old male German shepherd dog with seizures, hypersalivation and systemic hypertension (doppler blood pressure (250mmHg) . Notice heart rate 58bpm (speed 50 mm/s, 1 cm = 1 mV).

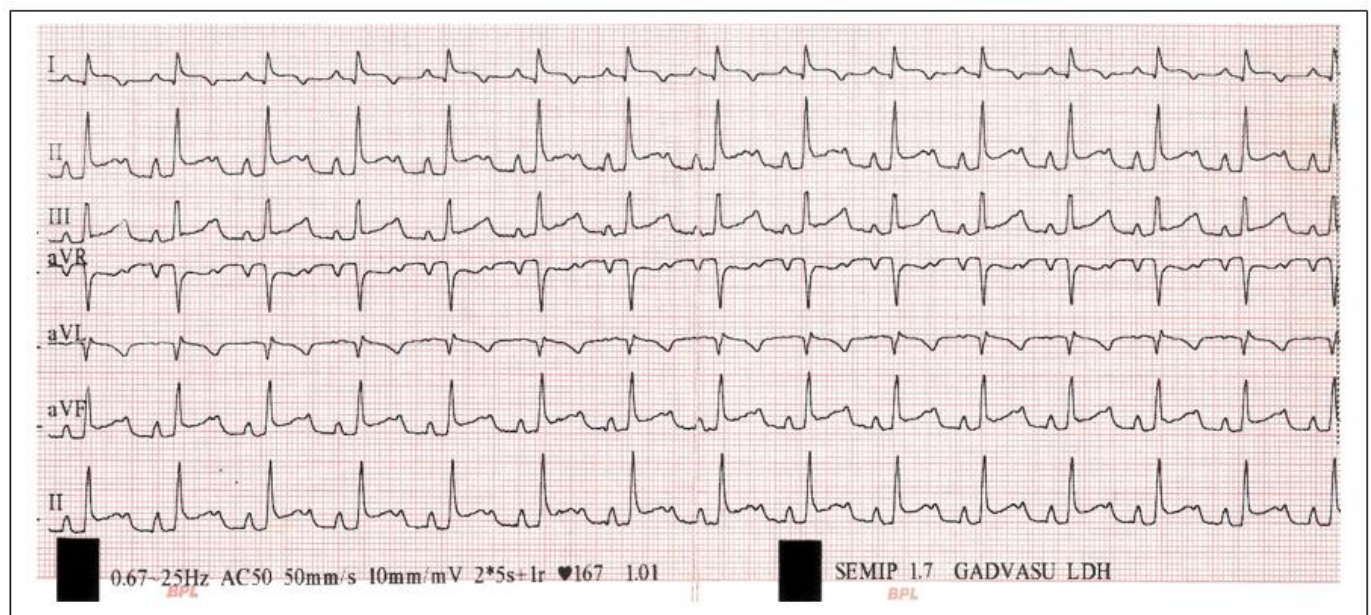


Figure 4(b): Electrocardiogram of a dog with heart rate-160 bpm obtained after 24 hours post therapy with amlodipine@0.5mg/kg. (doppler systolic blood pressure of 150 mm Hg). (speed 50 mm/s, 1 cm = 1 mV)

Contribution by Authors

All the authors contributed equally to writing the manuscript. The final manuscript was read by all authors and consented to publication.

Conflict of Interests

There is no conflict of interest.

Publisher Disclaimer

IJLR remains neutral concerning jurisdictional claims in published institutional affiliation.

References

1. Aslam, A. F., Aslam, A. K., Vasavada, B. C., & Khan, I. A. (2006). Hypothermia: evaluation,
2. Champion, T., Gava, F. N., de Brum, A. M., Pascon, J. P. E., João, C. F., Tinucci-Costa, M., & Camacho, A. A. (2009). Bradyarrhythmias in dogs with exocrine pancreatic insufficiency. *ArsVeterinaria*, 25(3), 125-128.
3. Devine, C. (2006). Bradyarrhythmias Part 1: Causes, clinical signs and diagnostic approach to bradyarrhythmias. *UK Vet Companion Animal*, 11(4), 42-49.
4. electrocardiographic manifestations, and management. *The American journal of medicine*, 119(4), 297-301.
5. Jeyaraja, K., Vairamuthu, S., Md, S., & Selvaraj, P. (2022). Electrocardiographic abnormalities in canine dilated cardiomyopathy and their management. *Indian Journal of Veterinary Sciences & Biotechnology*, 18(5), 63-67.
6. Jung, S., & Jandrey, K. E. (2012). Hyperkalemia secondary to renal hypoperfusion in a dog with third-degree atrioventricular block. *Journal of Veterinary Emergency and Critical Care*, 22(4), 483-487.
7. Little, C. J. L. (2005). Hypoglycaemic bradycardia and circulatory collapse in a dog and a cat. *Journal of small animal practice*, 46(9), 445-448.
8. Miller, C., & Flaherty, D. (2017). Anaesthetic-associated cardiac arrhythmias in dogs and cats: part 1. *Companion Animal*, 22(9), 504-509.
9. Moise, N. S. (2020, April). Bradyarrhythmias: when to worry. In *BSAVA Congress Proceedings 2020* (pp. 276-277). BSAVA Library.
10. Ohmori, T., Matsumura, Y., Yoshimura, A., Morita, S., Hasegawa, H., Hirao, D., & Fukushima, R. (2022). Efficacy of cilostazol in canine bradyarrhythmia. *Frontiers in Veterinary Science*, 9.
11. Rishniw, M., Tobias, A. H., & Slinker, B. K. (1996). Characterization of chronotropic and dysrhythmogenic effects of atropine in dogs with bradycardia. *American journal of veterinary research*, 57(3), 337-341.
12. Sodeck, G. H., Domanovits, H., Meron, G., Rauscha, F., Losert, H., Thalmann, M., ... & Laggner, A. N. (2007). Compromising bradycardia: management in the emergency department. *Resuscitation*, 73(1), 96-102.
13. Spalla, I., Spinelli, D., Lucatini, C., Memmi, S., Magnoni, R., Brambilla, P., ... & Locatelli, C. (2014). ECG of the Month. *Journal of the American Veterinary Medical Association*, 244(1), 45-47.
14. Thomason, J. D., Kraus, M. S., Surdyk, K. K., Fallaw, T., & Calvert, C. A. (2008). Bradycardia-associated syncope in 7 Boxers with ventricular tachycardia (2002–2005). *Journal of veterinary internal medicine*, 22(4), 931-936.
15. Trafny, D. J., Oyama, M. A., Wormser, C., Reynolds, C. A., Singletary, G. E., & Peddle, G. D. (2010). Cardiac troponin-I concentrations in dogs with bradyarrhythmias before and after artificial pacing. *Journal of Veterinary Cardiology*, 12(3), 183-190.
16. Ward, A. (1950). Atropine in the treatment of closed head injury. *Journal of neurosurgery*, 7(5), 398-402
17. Ward, J. L., DeFrancesco, T. C., Tou, S. P., Atkins, C. E., Griffith, E. H., & Keene, B. W. (2016). Outcome and survival in canine sick sinus syndrome and sinus node dysfunction: 93 cases (2002–2014). *Journal of Veterinary Cardiology*, 18(3), 199-212.
