

Clinical Evaluation of Various Cardiac Parameters with Emphasis on Doppler Echocardiography in Healthy Labrador Retriever Dogs

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ABSTRACT

Looking to the importance of emerging field of cardiac diseases in pet dogs, the present study was aimed to establish reference ranges for cardiac parameters and evaluate the impact of body weight in clinically healthy Labrador retrievers. During the study, 16 adult dogs (2-6 years) were divided into two groups based on body weight: Group I (<30 kg) and Group II (>30 kg). Diagnostic assessments including radiography and echocardiography were performed. Radiographic evaluations revealed vertebral heart scores (VHS) of 10.48 ± 0.21 and 10.18 ± 0.19 in Group I and II with no signs of cardiac enlargement. Echocardiography showed significant weight-related differences, with Group II exhibiting larger aortic and left atrial diameters, higher LA/Ao ratio and increased ventricular dimensions and wall thickness. Ejection fraction (EF) was higher in Group II ($73.70 \pm 1.81\%$) than Group I ($58.89 \pm 2.29\%$), while fractional shortening (FS) showed non-significant difference. End-diastolic (EDV) and end-systolic volumes (ESV) were significantly greater in Group II but remained within normal range. Doppler analysis showed non-significant differences in mitral, tricuspid, aortic, or pulmonic flow velocities. Based on results, it was concluded that body weight significantly influences cardiac parameters in Labrador retrievers underscoring the need for weight-adjusted reference ranges. The study highlights the utility of Doppler echocardiography and radiography for precise breed specific cardiac evaluation.

Key words: Doppler echocardiography, Healthy Labrador Retriever, Radiography

Ind J Vet Sci and Biotech (2025): 10.48165/ijvsbt.21.4.26

INTRODUCTION

The Labrador retriever is one of the most popular dog breeds worldwide, renowned for its friendly temperament, intelligence and versatility as a companion animal. Cardiovascular diseases are increasingly recognized as significant health concerns not only in humans but also in companion animals such as dogs. Labrador retrievers despite their affable nature and adaptability are predisposed to various cardiac conditions that can lead to severe complications if not diagnosed and managed promptly (American Kennel Club, 2021). Early detection of cardiac abnormalities is critical to improving treatment outcomes, slowing disease progression and enhancing the quality of life for affected dogs (Dove, 2001). To achieve this, veterinarians rely on a suite of diagnostic modalities, including thoracic radiography, echocardiography and cardiac biomarkers each with distinct advantages and limitations (Noszczyk-Nowak, 2011).

Thoracic radiography plays an essential role in evaluating cardiac anatomy and function. The Vertebral Heart Score (VHS) is a widely used radiographic metric that quantifies heart size relative to vertebral length offering a standardized approach for monitoring cardiac changes over time (Berry *et al.*, 2007). Echocardiography is a cornerstone in veterinary cardiology, providing real-time imaging of the heart to deliver detailed insights into cardiac size, chamber dimensions, wall thickness and blood flow dynamics. Various

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How to cite this article: Nanda, P. P., Parmar, S. M., Kunjadiya, R.J., Vala, J.A., Patel, M.D., & Mehta, S. A. (2025). Clinical Evaluation of Various Cardiac Parameters with Emphasis on Doppler Echocardiography in Healthy Labrador Retriever Dogs. *Ind J Vet Sci and Biotech*, 21(4), 138-142.

Source of support: Nil

Conflict of interest: None

Submitted 21/06/2025 **Accepted** 30/06/2025 **Published** 10/07/2025

echocardiographic techniques, such as M-mode, B-mode and Doppler echocardiography contribute complementary data. M-mode echocardiography is particularly effective for measuring chamber dimensions and wall thickness, while B-mode echocardiography offers two-dimensional anatomical imaging for comprehensive cardiac assessment. Doppler echocardiography evaluates blood flow patterns and detects haemodynamic abnormalities, such as valvular insufficiencies and intracardiac shunts, making it

indispensable for diagnosing complex cardiac conditions (Thomas *et al.*, 1993; Kunjadiya *et al.*, 2025). Research has demonstrated that cardiac parameters vary significantly among breeds, influenced by factors such as body weight, heart rate and breed-specific anatomical traits. Establishing breed-specific reference values is therefore essential for accurate interpretation of diagnostic findings and the development of effective treatment protocols (O'Leary *et al.*, 2003; Kunjadiya *et al.*, 2025). This study was planned to perform a comprehensive clinical evaluation of cardiac parameters in healthy Labrador Retrievers using thoracic radiography and advanced echocardiographic modalities, including M-mode, B-mode and Doppler imaging, with the goal of establishing baseline reference values and assessing the utility of these diagnostic tools in this breed.

MATERIALS AND METHODS

The study was conducted from January to September 2024 in the Department of Veterinary Medicine, Veterinary College, Kamdhenu University, Navsari (Gujarat, India) in collaboration with the Veterinary Clinical Complex (VCC) and the Department of Veterinary Surgery and Radiology following approval of IAEC of the College.

Animal Selection and Evaluation

Sixteen clinically healthy Labrador retrievers (2-6 years old) were selected for comprehensive clinical, haematological, biochemical, radiographic and electrocardiographic evaluations. Dogs with abnormalities were excluded.

Thoracic radiographs in right lateral and ventro-dorsal views were used to measure the Vertebral Heart Score (VHS; normal: 8.5-10.5) following the method described by Smith *et al.* (2015). Lung lobes and cardiac structures were examined to exclude abnormalities.

Echocardiographic evaluations of dogs were conducted using a color Doppler ultrasound machine (SonoSite M-Turbo, USA) according to protocols by Nyland and Mattoon (2002) and Boon (2011) following clipping the hair around the parasternal windows.

2D Echocardiography was performed in long-axis and short-axis views for assessing the left ventricular outflow, four chambers, papillary muscles, mitral valve, heart base and left atrium to aorta (LA/Ao) ratio as per Boon (2011).

Using M mode echocardiography, left and right ventricular internal diameters in systole and diastole (LVIDs & LVIDd, RVIDs & RVIDd), Interventricular septum in systole and diastole (IVSs & IVSd), Left ventricular posterior wall in systole and diastole (LVPWs & LVPWd), ejection fraction (EF) and fractional shortening (FS) were measured as per Nyland and Mattoon (2002) and Boon (2011).

Blood flow velocities across cardiac valves, mitral E/A ratios and color flow patterns were recorded using Doppler Echocardiography (Darke *et al.*, 1993).

Statistical Analysis

Descriptive statistics were presented as mean \pm SE. The student's t-test assessed differences, with significance set at $p \leq 0.05$. Data analysis was performed using IBM SPSS (v27.0), as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Radiography

The mean vertebral heart scores (VHS) for both Group I (<30 kg) and Group II (>30 kg) dogs of Labrador retrievers showed non-significant difference (10.48 ± 0.21 v 10.18 ± 0.19 v, $p = 0.31$). None of the dogs exhibited signs of cardiac enlargement or other abnormalities. These findings aligned with the results of Gugjoo *et al.* (2013) and Bodh *et al.* (2016), who reported non-significant effects of gender, body weight or radiographic positioning on VHS in healthy Labrador retrievers. Birks *et al.* (2017), Garbelini *et al.* (2020) and Kavitha *et al.* (2022) further support the minimal impact of these variables on VHS.

Two-Dimensional Echocardiography

In this study, 2D echocardiography was utilized to evaluate key cardiac parameters including the left atrium (LA), aorta (Ao) and the LA/Ao ratio (Table 1, Fig.1). The mean \pm SE values for Group II (>30 kg) were higher than in Group I (<30 kg) dogs with significant difference in LA and Ao. A significant correlation with body weight was observed, indicating larger dimensions in heavier dogs. These findings were consistent with previous studies. Boon *et al.* (1983) established correlations between body size and echocardiographic dimensions. Jeyaraja *et al.* (2019) documented similar values for Labrador retrievers, while Santos *et al.* (2018) reported reference values for Rottweilers. The results suggest that breed and body size significantly influence echocardiographic measurements, underscoring the importance of considering these factors in clinical evaluations.

Table 1: Mean \pm SE of 2 D-echo parameters in Labrador retriever dogs

Parameters	Group-I (n=8)	Group-II (n=8)	p values
LA (cm)	2.40 \pm 0.11	3.07 \pm 0.12	0.00**
Ao (cm)	2.24 \pm 0.12	2.72 \pm 0.19	0.04*
LA/Ao Ratio	1.09 \pm 0.07	1.15 \pm 0.06	0.54

*indicates significant at $p \leq 0.05$; **indicates highly significant at $p \leq 0.01$.

M-mode Echocardiography

The mean \pm SEs values of echocardiographic parameters in healthy Labrador retriever are presented in Table 2 and Figure 2.

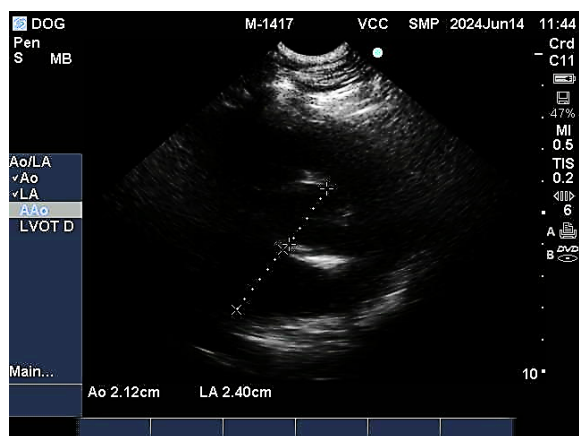


Fig. 1: Measurement of LA/Ao ratio under 2D echocardiography in healthy Labrador retriever dogs

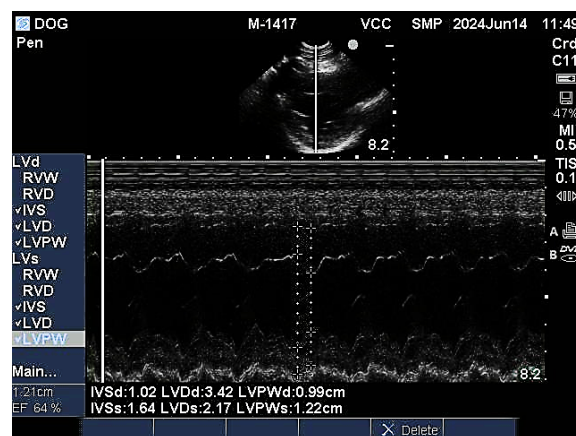


Fig. 2: Measurement of M-mode echo-cardiography parameters in healthy Labrador retriever dogs

Table 2: Mean ± SE of M-mode echocardiography parameters in Labrador retriever dogs

Parameters	Group-I (n=8)	Group-II (n=8)	P values
RVDd (cm)	0.43±0.03	0.56±0.05	0.04*
IVSd (cm)	0.96±0.07	1.29±0.06	0.00**
LVDd (cm)	3.73±0.06	4.10±0.04	0.00**
LVPWd (cm)	1.05±0.06	1.25±0.03	0.01**
RVDs (cm)	0.34±0.03	0.46±0.04	0.03*
IVSs (cm)	1.46±0.04	1.65±0.04	0.02*
LVDs (cm)	2.68±0.08	3.06±0.06	0.00**
LVPWs (cm)	1.32±0.10	1.64±0.08	0.02**
EF (%)	58.89±2.29	73.70±1.81	0.00**
FS (%)	28.22±1.57	25.44±1.21	0.18
EPSS (cm)	0.36±0.02	0.33±0.03	0.42
EDV (mL)	59.33± 2.31	74.19±1.82	0.00**
ESV (mL)	26.83±2.19	36.81±1.78	0.00**
SV (mL)	32.50±1.34	37.39±1.37	0.02*
CO (mL)	4280.9±313.9	4512.8±327.6	0.62

*indicates significant at p≤0.05; **indicates highly significant at p≤0.01.

The study showed that right ventricular diameters at end-diastole (RVDd) and end-systole (RVDs) were significantly larger in Group II dogs compared to Group I. These findings aligned with Saini *et al.* (2017) and Bhargavi *et al.* (2019), indicating a positive correlation between RVDd and body weight.

Left ventricular dimensions during diastole (LVDd) and systole (LVDs) were significantly larger in Group II, suggesting that body weight influences ventricular size. O’Leary *et al.* (2003), Muzzi *et al.* (2006) and Saini *et al.* (2017) reported similar trends, while Singh (2011) found no significant impact of weight.

The mean values for IVSd and IVSs of interventricular septum thickness were significantly greater in Group II, correlating with higher body weight. These measurements were within normal reference limits, supporting findings by Gugjoo *et al.* (2014).

Statistical analysis revealed significant differences in LVPWd and LVPWs values of left ventricular posterior wall between groups. These differences were within the standard reference range. Gugjoo *et al.* (2014) and Jeyaraja *et al.* (2019) reported similar variability, while Saini *et al.* (2017) found no significant influence of body weight.

Ejection fraction (EF) was significantly higher in Group II (73.70 ± 1.81%) compared to Group I (58.89 ± 2.29%). No significant difference was found in fractional shortening (FS) between groups. These findings align with Saini *et al.* (2017) and Boon *et al.* (1983), but differ from Gugjoo *et al.* (2014).

The mean ± SE value of E-point to septal separation (EPSS) was 0.36 ± 0.02 cm for Group I and 0.33 ± 0.03 cm for Group II, with no significant difference. Singh (2011) and Saini *et al.* (2017) reported similar results, indicating minimal impact of body weight on EPSS.

The mean ± SE values of end-diastolic volume (EDV) and end-systolic volume (ESV) for Group I were significantly lower than in Group II (Table 2), indicating significant difference based on body weight. Gugjoo *et al.* (2014) and Saini *et al.* (2017) similarly reported variability in EDV and ESV correlated with body weight. Jeyaraja *et al.* (2019) recorded similar finding in ESV for age difference, while Singh (2011) found no significant correlation of EDV with age. These findings suggest that body weight, rather than age, significantly impacts EDV in dogs, particularly in large breeds like Labradors.

The stroke volume (SV) was 32.50 ± 1.34 mL for Group I and 37.39 ± 1.37 mL for Group II, with a significant variation observed between weight categories (p<0.05). These results were in line with the findings of Gugjoo *et al.* (2014) and Jeyaraja *et al.* (2019), who reported significant variability in SV among different body weight groups.

The mean cardiac output for Groups I and II was 4280.9±313.9 mL and 4512.8±327.6 mL, respectively, with a non-significant difference (p>0.05). Bhargavi *et al.* (2019) also reported no significant correlation between body weight and cardiac output, suggesting that variations in body



weight may not substantially influence cardiac output or left ventricular volume in certain breeds.

These findings collectively underscore the importance of considering body weight when evaluating echocardiographic measurements in clinical settings, particularly for large breeds like Labrador retrievers.

Doppler Parameters

The mean ± SE of Doppler echocardiography parameters in healthy Labrador retriever dogs are given in Table 3 and Figure 3 & 4.

Normal haemodynamic flow patterns on colour flow Doppler echocardiography were observed in the left atrium, right atrium, aorta, pulmonary artery, mitral valve and tricuspid valve in both groups, with mitral and tricuspid regurgitation noted in less than 20% of the cases. These findings were consistent with Jeyaraja *et al.* (2016).

No significant differences ($p>0.05$) were observed in the mean peak velocity of the mitral E (Epeak) wave between Group I (75.23 ± 4.74 cm/s) and Group II (71.16 ± 6.42 cm/s). Similarly, the peak velocity of the mitral A (Apeak) wave showed non-significant differences ($p>0.05$) between the groups. Muzzi *et al.* (2006) reported similar findings in German Shepherds, while Saini *et al.* (2020) found body weight significantly affected the E/A ratio in Labrador retrievers.

The mean mitral E/A ratios for Group I and Group II were 1.48 ± 0.08 and 1.35 ± 0.05 , respectively, with no significant difference (Table 3). Muzzi *et al.* (2006) also found E/A ratio above 1.0 in German Shepherds. In contrast, Saini *et al.* (2020) reported body weight significantly influenced the E/A ratio.

The mean ± SE values of tricuspid peak E (Epeak) and peak A (Apeak) velocity were non-significantly higher in Group I than Group II dogs. These findings were consistent with Saini *et al.* (2020) and Bodh *et al.* (2022).

The mean ± SE of the tricuspid E/A ratio was 1.48 ± 0.05 in Group I and 1.51 ± 0.07 in Group II, showing no significant differences between groups. This aligned with Bodh *et al.* (2022), but Saini *et al.* (2020) found a significant influence of gender on the E/A ratio.

The average peak aortic blood flow velocities and peak pulmonic flow velocities (Fig. 3) for Group I and Group II were almost same ($p>0.05$). The findings on peak aortic blood flow velocities supported earlier observations of Yuill and O’Grady (1991) and Saini *et al.* (2020). However, the findings of peak pulmonic flow velocities contradicted Saini *et al.* (2020), who found significant negative correlations between pulmonic valve peak velocity and body weight.

Table 3: Mean ± SE of Doppler echocardiography parameters in Labrador retriever dogs

Particular	Doppler Parameters	Group-I (n=8)	Group-II(n=8)	p values
Mitral valve	Peak E Velocity (cm/s)	75.23± 4.74	71.16± 6.42	0.62
	Peak A Velocity (cm/s)	51.85± 4.09	52.18± 3.66	0.95
	E/A Ratio	1.48 ±0.08	1.35±0.05	0.20
Tricuspid valve	Peak E Velocity (cm/s)	59.68±2.66	53.76±2.44	0.12
	Peak A Velocity (cm/s)	40.74±2.69	35.96±2.27	0.19
	E/A Ratio	1.48±0.05	1.51±0.07	0.73
Aortic valve	Peak systolic Velocity(cm/s)	114.93± 5.14	115.58±3.59	0.92
Pulmonary valve	Peak systolic Velocity (cm/s)	83.08±3.34	88.22± 3.15	0.28

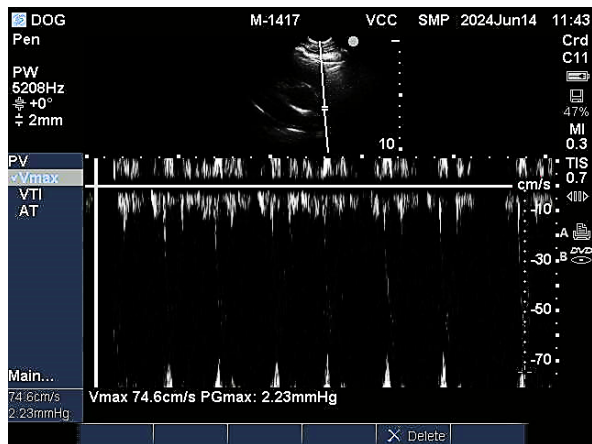


Fig. 3: Doppler evaluation of Pulmonic flow in healthy Labrador retriever dogs

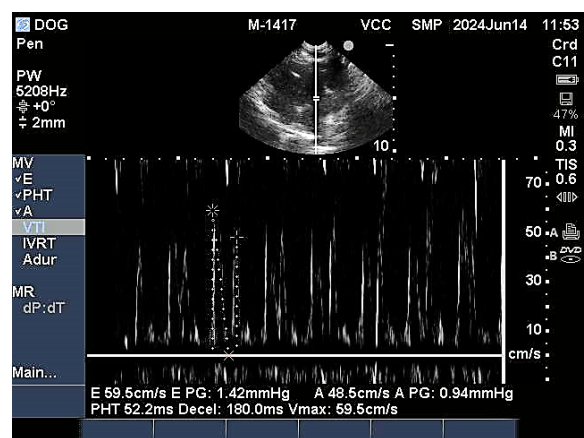


Fig. 4: Doppler measurement of E:A ratio in healthy Labrador retriever dogs

CONCLUSION

The study successfully established weight-related reference ranges for cardiac parameters in healthy Labrador retrievers, highlighting significant correlations between body weight and echocardiographic measurements. The findings underscore the necessity of considering body weight in clinical evaluations to ensure accurate diagnosis and management of cardiac conditions in this breed. Doppler echocardiography proved to be a reliable tool for assessing cardiac function and thoracic radiography providing valuable baseline data. These insights contribute to the refinement of diagnostic protocols and the development of breed-specific, weight-adjusted cardiac reference ranges.

ACKNOWLEDGEMENT

Authors are grateful to the authorities of Kamdhenu University and the Principal, College of Veterinary Science & Animal Husbandry, Kamdhenu University, Navsari for providing needful facilities.

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