

Studies on Echocardiographic Assessment of Healthy Non-Descript Dogs

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ABSTRACT

Considering echocardiography as the most widely accepted non-invasive diagnostic tool for assessing cardiac anatomy and function in small animals, present study was planned to assess echocardiographic parameters in dogs. Total 18 clinically healthy non-descript dogs were subjected to 2-D and M-mode echocardiographic examinations. Dogs were categorized by gender, age and body weight to assess their effects on various echocardiographic parameters. The mean LA, Ao, and LA/Ao ratio values were 1.70 ± 0.04 cm, 1.72 ± 0.05 cm, and 1.00 ± 0.03 , respectively, with non-significant group differences. However, the mean LA/Ao ratio was higher in dogs weighing >20 kg (1.04 ± 0.03) compared to those <20 kg (0.91 ± 0.04). M-mode echocardiographic parameters were within normal limits. Gender and body weight differences were non-significant, but age-related differences were observed. Dogs >3 years had significantly higher mean values of EF ($69.05 \pm 3.84\%$), FS ($38.34 \pm 3.31\%$), and CO (1991.34 ± 201.95 mL/min) compared to those <3 years ($51.92 \pm 6.11\%$, $25.97 \pm 3.65\%$, and 1330.71 ± 213.40 mL/min, respectively). Other M-mode parameters varied non-significantly across age groups. The study concludes that the variation in certain echocardiographic parameters should be taken into consideration while evaluation of cardiac diseases in non-descript dogs.

Keywords: 2-D and M-mode echocardiography, Non-descript dogs.

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INTRODUCTION

The Indian non-descript dog is renowned for its adaptability and low-maintenance nature, making it highly suited to the diverse climatic conditions of India. These dogs have naturally evolved to thrive in tropical environments, exhibiting excellent tolerance to high temperatures and remarkable resilience. When provided with appropriate care, attention, and training, they make excellent family companions. Their moderate size and minimal grooming requirements render them ideal for both urban and rural settings (Bhargavi *et al.*, 2018).

In recent years, cardiac diseases have become increasingly prevalent in dogs, often progressing to congestive heart failure - a major cause of morbidity and mortality in canines. Cardiac diseases in canines are an extensively studied phenomenon all over the world but less information has been reported in India (Hoque *et al.*, 2019). This highlights the need for improved veterinary awareness and intervention strategies (Sagar *et al.*, 2020). Cardiac performance in both healthy and diseased animals can be assessed by evaluating cardiac dimensions, functional parameters, and indices (Bodh *et al.*, 2019).

Echocardiography is now the most widely accepted non-invasive diagnostic tool for assessing cardiac anatomy and function in small animals. It is a safe procedure for patients, operators, and nearby personnel, requiring no specific safety precautions and enabling on-site evaluations. This technique is indispensable for diagnosing valvular lesions, cardiac shunts, masses, effusions, myocardial diseases, stenotic lesions, congenital anomalies, and vegetative lesions. Early research aimed at defining normal reference

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values for ECG and echocardiographic parameters in dogs and cats (Lombard, 1984; Jacobs and Knight, 1985). Subsequent studies highlighted the influence of factors such as body weight, surface area, and heart rate on specific echo measures in both dogs and cats. Breed specific variations in echocardiographic values underscore the importance of understanding typical values for each dog breed, as demonstrated in breed-specific research (Thomas *et al.*, 1993). Recognizing the significant impact of breed differences ensures that reference range of echocardiographic parameters are appropriately tailored, preventing misleading interpretations across diverse canine populations (Snyder *et al.*, 1995; O'Leary *et al.*, 2003). Considering the above facts, the

present work on echocardiographic assessment of healthy non-descript dogs was planned.

MATERIALS AND METHODS

The present study was carried out over a period from 1st February to 30th September, 2024 on 18 healthy non-descript dogs aged between 2 and 6 years of either sex. Non-descript dogs without any health ailments and followed proper preventive health care programs *i.e.* vaccination and deworming were included in the present study. A thorough clinical examination was performed and observations were recorded such as heart rate, pulse rate, rectal temperature, respiration rate, breathing pattern, capillary refill time *etc.* Auscultation of heart and lung was performed at specific area of the chest (Ettinger and Suter, 1970). The dogs found healthy based on history, clinical examination and haemato-biochemical profile were subjected to echocardiographic examination.

Echocardiographic examination was conducted using a high-end color Doppler ultrasound machine (SonoSite M turbo, USA). 2-Dimensional (2-D) and Motion mode (M-mode) echocardiography were performed as per standard protocols (Nyland and Mattoon, 2002; Boon, 2011). Short and long axes views such as Left ventricular outflow view, Four-chamber view, Right parasternal short-axis images, Left ventricle with papillary muscles and chordae tendinae, Mitral valve view and Heart base: aorta and left atrium view were focused. Two-dimensional measurements such as aorta (Ao), left atrium (LA) and their ratios were measured (Boon, 2011). The M-mode imaging represents depth through the heart on the Y-axis and time on the X-axis. The measurements listed in Table 4-6 were taken following the methods described by Nyland and Mattoon (2002) and Boon (2011). Dogs were categorized by gender, age and body weight to assess their effects on various echocardiographic parameters.

Descriptive statistical analysis was applied to various parameters, calculating the mean \pm standard error (SE). For comparisons involving healthy non-descript dogs, the Student's t-test was conducted using IBM SPSS software (version 27.0) following the methodology outlined by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Two-Dimensional Echocardiography

During the present study, important 2-D echocardiographic parameters such as left atrium (LA) and aorta (Ao) were measured and their ratio, *i.e.*, LA/Ao ratio was calculated for non-descript dogs in different groups. Gender, age and body weight wise values are given in Tables 1-3, respectively. The overall mean of LA, Ao and LA/Ao ratio were 1.70 ± 0.04 cm, 1.72 ± 0.05 cm and 1.00 ± 0.03 , respectively. The means of LA, Ao and LA/Ao ratio varied non-significantly among the groups, but, were within the normal range (De Madron *et al.*, 2015).

The finding of non-significant effect of gender and age is in agreement with previous reports on 2-D echocardiographic parameters of healthy dogs (Locatelli *et al.*, 2011; Gugjoo *et al.*, 2014; Jeyaraja *et al.*, 2019; Wiegel *et al.*, 2022).

On the contrary to the finding of non-significant effect of body weight, Boon *et al.* (1983) reported statistically significant correlations with body size of healthy dogs for the dimensions of the aorta and left atrium along with other M-mode parameters. Similarly, Singh (2011) also found significant effect of body weight on certain echocardiographic parameters such as LVIDd, LVIDs, LA and Ao in healthy Mongrel dogs. Gugjoo *et al.* (2014) and Saini *et al.* (2017) reported significant correlation of body weight obtained for some echocardiographic parameters including 2-D parameters such as LA and AO diameter in healthy Labrador dogs.

M-Mode Echocardiography

Various M-mode echocardiographic parameters measured for healthy non-descript dogs of different groups are given in Tables 4-6. All M-mode echocardiographic parameters of non-descript dogs were within the normal range. Similar to present non-significant difference in various M-mode parameters due to gender, Noviana *et al.* (2011) also reported non-significant difference between males and females of Indonesian Mongrel dogs. Later, Saini *et al.* (2017) also observed non-significant effect of gender on M-mode parameters, except for significant effect on RVIDd. In contrast to present findings, Muzzi *et al.* (2006) found statistically significant difference in the dimensions of the right and left ventricles and the posterior wall between genders while studying echocardiographic indices in healthy German shepherd dogs. Similarly, Singh (2017) also found significantly higher value of posterior wall thickness percentage (PW%) in male than female animals with non-significant difference in other parameters.

The non-significant differences found in various M-mode parameters due to body weight in our study were in contrast to Boon *et al.* (1983), who established the significant influence of body weight on echocardiographic parameters Singh (2011) also found significant effect of body weight on certain echocardiographic parameters such as LVIDd, LVIDs, LA and Ao. In another study, Singh (2017) reported that the values of RVDd of all animals, Ao of female animals, EF % and cardiac output of male animals were negatively correlated with body weight and body surface area of the animals, whereas, remaining M-mode parameters had positive correlations with body weight and body surface area. Saini *et al.* (2017) also observed significantly influence of body weight on the RVIDd, LVIDd, LVIDs, EPSS, EDV, EDVI, ESV, and ESVI.

During the study, the values of EF, FS and CO were found significantly higher in non-descript dogs aged >3 years than in <3 years with non-significant difference in remaining M-mode parameters in dogs of both age groups. Previously, Saini *et al.* (2017) also found statistically significant impact

of age on EF%, FS%, LVPWs, and IVSd in healthy Labrador Retriever dogs. Kosić *et al.* (2017) reported significant difference in the left ventricle wall thickness at end-diastole (LVWd) and end-systole (LVWs), and the relative wall thickness (RWT) between young and old German shepherd dogs. They reported that old dogs had different cardiac structure compared to the young dogs which could result in diastolic function change. Similarly, Bhargavi *et al.* (2019) found significant difference in values of LVPWd, LVPWs, IVSd, IVSs and RVDd between young and adult group with no significant difference for rest of the parameters measured for Rajapalayam breed. They also found significant difference in LVPWs, IVSd, IVSd and CO between the age groups of Chippiparai breed, whereas, Singh (2011) mentioned no effect of age on echocardiographic indices.

CONCLUSION

The overall mean of LA, Ao and LA/Ao ratio were 1.70±0.04 cm, 1.72±0.05 cm and 1.00±0.03, respectively. Their values varied non-significantly among the groups. The mean value of LA/Ao ratio of >20 kg weight was 1.04±0.03 and <20 kg weight 0.91±0.04, indicating that weight may influence the LA/Ao ratio. M-mode echocardiographic parameters were within the normal range with non-significant effect of gender and body weight. Means of EF, FS and CO were significantly higher in non-descript dogs aged >3 years than in <3 years. Therefore, the variation in certain echocardiographic parameters should be taken into consideration while evaluation of cardiac diseases in non-descript dogs.

Table 1: Mean ±SE of 2-D echocardiographic parameters in non-descript dogs of different gender

| Sr. No. | Parameters | Overall (n=18) | Gender | | p value | Ref. Range # |
|---------|------------|----------------|-------------|--------------|---------|--------------|
| | | | Male (n=11) | Female (n=7) | | |
| 1 | LA (cm) | 1.70±0.04 | 1.73±0.05 | 1.63±0.79 | 0.27 | 1.6-2.5 |
| 2 | AO (cm) | 1.72±0.05 | 1.76±0.05 | 1.64±0.08 | 0.24 | 1.6-2.4 |
| 3 | LA/AO | 1.00±0.03 | 0.99±0.03 | 1.01±0.07 | 0.77 | 0.8-1.5 |

#De Madron *et al.* (2016)

Table 2: Mean ±SE of 2-D echocardiographic parameters in non-descript dogs of different age group

| Sr. No. | Parameters | Overall (n=18) | Age group | | p value | Ref. Range # |
|---------|------------|----------------|---------------|----------------|---------|--------------|
| | | | <3 year (n=7) | >3 year (n=11) | | |
| 1 | LA (cm) | 1.70±0.04 | 1.70±0.06 | 1.69±0.06 | 0.92 | 1.6-2.5 |
| 2 | AO (cm) | 1.72±0.05 | 1.73±0.07 | 1.70±0.06 | 0.73 | 1.6-2.4 |
| 3 | LA/AO | 1.00±0.03 | 0.98±0.03 | 1.00±0.05 | 0.73 | 0.8-1.5 |

#De Madron *et al.* (2016)

Table 3: Mean ±SE of 2-D echocardiographic parameters in non-descript dogs of weight <20 kg and >20 kg

| Sr. No. | Parameters | Overall (n=18) | Body weight | | p value | Ref. Range # |
|---------|------------|----------------|--------------|---------------|---------|--------------|
| | | | <20 kg (n=6) | >20 kg (n=12) | | |
| 1 | LA (cm) | 1.70±0.04 | 1.68±0.10 | 1.70±0.04 | 0.86 | 1.6-2.5 |
| 2 | AO (cm) | 1.72±0.05 | 1.85±0.08 | 1.64±0.05 | 0.06 | 1.6-2.4 |
| 3 | LA/AO | 1.00±0.03 | 0.91±0.04 | 1.04±0.03 | 0.05 | 0.8-1.5 |

#De Madron *et al.* (2016)

Table 4: Mean ±SE of M-mode echocardiographic parameters in non-descript dogs of different gender

| Sr. No. | Parameters | Overall (n=18) | Gender | | P value | Ref. Range # |
|---------|------------|----------------|-------------|--------------|---------|--------------|
| | | | Male (n=11) | Female (n=7) | | |
| 1 | RVDd (cm) | 0.79±0.06 | 0.85±0.05 | 0.68±0.14 | 0.28 | 0.5-1.3 |
| 2 | IVSd (cm) | 0.90±0.06 | 0.85±0.03 | 0.98±0.13 | 0.34 | 0.6-1.3 |
| 3 | LVDd (cm) | 2.60±0.06 | 2.61±0.05 | 2.57±0.13 | 0.76 | 2.6-3.7 |
| 4 | LVPWd (cm) | 0.91±0.02 | 0.90±0.03 | 0.91±0.03 | 0.84 | 0.6-1.2 |
| 5 | RVDs (cm) | 0.96±0.05 | 0.94±0.07 | 0.99±0.08 | 0.65 | 0.5-2 |
| 6 | IVSs (cm) | 1.13±0.06 | 1.16±0.06 | 1.08±0.10 | 0.54 | 0.9-1.7 |
| 7 | LVDs (cm) | 1.71±0.07 | 1.62±0.08 | 1.85±0.09 | 0.08 | 1.6-3.0 |
| 8 | LVPWs (cm) | 1.19±0.07 | 1.14±0.08 | 1.24±0.14 | 0.51 | 0.9-1.7 |
| 9 | EF% | 62.39±3.82 | 67.61±4.57 | 54.18±5.75 | 0.08 | 44-75 |

| | | | | | | |
|----|-------------|----------------|----------------|----------------|------|----------|
| 10 | FS% | 33.53±2.81 | 37.46±3.67 | 27.34±3.45 | 0.08 | 25-45 |
| 11 | EDV (ml) | 24.89±1.41 | 25.08±1.38 | 24.59±3.07 | 0.87 | 10-45 |
| 12 | ESV (ml) | 8.97±0.85 | 7.80±1.01 | 10.80±1.30 | 0.08 | 10-30 |
| 13 | SV (ml) | 15.92±1.49 | 17.27±1.86 | 13.78±2.42 | 0.27 | 5-22 |
| 14 | CO (ml/min) | 1734.44±164.36 | 1901.15±209.41 | 1472.44±251.46 | 0.21 | 566-2200 |
| 15 | EPSS (mm) | 0.28±0.02 | 0.29±0.02 | 0.25±0.03 | 0.34 | 0.1-0.5 |

#Singh (2017)

Table 5: Mean ±SE of M-mode echocardiographic parameters in non-descript dogs of different age group

| Sr. No. | Parameters | Overall (n=18) | Age group | | P values | Ref. Range # |
|---------|-------------|----------------|----------------|----------------|----------|--------------|
| | | | <3 year (n=7) | >3 year (n=11) | | |
| 1 | RVDd (cm) | 0.79±0.06 | 0.77±0.06 | 0.79±0.09 | 0.91 | 0.5-1.3 |
| 2 | IVSd (cm) | 0.90±0.06 | 0.85±0.04 | 0.92±0.08 | 0.55 | 0.6-1.3 |
| 3 | LVDd (cm) | 2.60±0.06 | 2.52±0.09 | 2.64±0.07 | 0.35 | 2.6-3.7 |
| 4 | LVPWd (cm) | 0.91±0.02 | 0.89±0.02 | 0.91±0.03 | 0.64 | 0.6-1.2 |
| 5 | RVDs (cm) | 0.96±0.05 | 0.93±0.10 | 0.98±0.06 | 0.68 | 0.5-2 |
| 6 | IVSs (cm) | 1.13±0.06 | 1.02±0.08 | 1.20±0.07 | 0.14 | 0.9-1.7 |
| 7 | LVDs (cm) | 1.71±0.07 | 1.86±0.08 | 1.61±0.08 | 0.08 | 1.6-3.0 |
| 8 | LVPWs (cm) | 1.19±0.07 | 0.99±0.11 | 1.30±0.08 | 0.33 | 0.9-1.7 |
| 9 | EF% | 62.39±3.82 | 51.92±6.11 | 69.05±3.84 | 0.02* | 44-75 |
| 10 | FS% | 33.53±2.81 | 25.97±3.65 | 38.34±3.31 | 0.03* | 25-45 |
| 11 | EDV (ml) | 24.89±1.41 | 23.18±2.30 | 25.97±1.79 | 0.35 | 10-45 |
| 12 | ESV (ml) | 8.97±0.85 | 10.84±1.21 | 7.78±1.04 | 0.80 | 10-30 |
| 13 | SV (ml) | 15.92±1.49 | 12.34±2.14 | 18.19±1.75 | 0.06 | 5-22 |
| 14 | CO (ml/min) | 1734.44±164.36 | 1330.71±213.40 | 1991.34±201.95 | 0.05* | 566-2200 |
| 15 | EPSS (mm) | 0.28±0.02 | 0.28±0.03 | 0.27±0.02 | 0.81 | 0.1-0.5 |

#Singh (2017), *Indicates significance at p≤0.05

Table 6: Mean ±SE of M-mode echocardiographic parameters in non-descript dogs of weight <20 kg and >20 kg

| Sr. No. | Parameters | Overall (n=18) | Body weight | | P values | Ref. range # |
|---------|-------------|----------------|----------------|----------------|----------|--------------|
| | | | <20 kg (n=6) | >20 kg (n=12) | | |
| 1 | RVDd (cm) | 0.79±0.06 | 0.80±0.06 | 0.78±0.08 | 0.86 | 0.5-1.3 |
| 2 | IVSd (cm) | 0.90±0.06 | 0.83±0.03 | 0.93±0.08 | 0.42 | 0.6-1.3 |
| 3 | LVDd (cm) | 2.60±0.06 | 2.56±0.11 | 2.61±0.07 | 0.69 | 2.6-3.7 |
| 4 | LVPWd (cm) | 0.91±0.02 | 0.89±0.03 | 0.91±0.03 | 0.79 | 0.6-1.2 |
| 5 | RVDs (cm) | 0.96±0.05 | 1.07±0.09 | 0.91±0.06 | 0.16 | 0.5-2 |
| 6 | IVSs (cm) | 1.13±0.06 | 1.13±0.08 | 1.12±0.07 | 0.93 | 0.9-1.7 |
| 7 | LVDs (cm) | 1.71±0.07 | 1.83±0.06 | 1.65±0.09 | 0.21 | 1.6-3.0 |
| 8 | LVPWs (cm) | 1.19±0.07 | 1.25±0.16 | 1.15±0.07 | 0.55 | 0.9-1.7 |
| 9 | EF% | 62.39±3.82 | 55.64±4.37 | 65.76±5.13 | 0.22 | 44-75 |
| 10 | FS% | 33.53±2.81 | 27.93±2.79 | 36.33±3.80 | 0.16 | 25-45 |
| 11 | EDV (ml) | 24.89±1.41 | 24.08±2.52 | 25.29±1.77 | 0.70 | 10-45 |
| 12 | ESV (ml) | 8.97±0.85 | 10.29±0.86 | 8.31±1.18 | 0.28 | 10-30 |
| 13 | SV (ml) | 15.92±1.49 | 13.79±2.24 | 16.98±1.92 | 0.33 | 5-22 |
| 14 | CO (ml/min) | 1734.44±164.36 | 1475.80±228.46 | 1863.74±214.93 | 0.28 | 566-2200 |
| 15 | EPSS (mm) | 0.28±0.02 | 0.29±0.03 | 0.26±0.02 | 0.58 | 0.1-0.5 |

#Singh (2017)





Fig. 1: Auscultation in non-descript dogs



Fig. 2: Echocardiography of non-descript dog for right parasternal long axis view

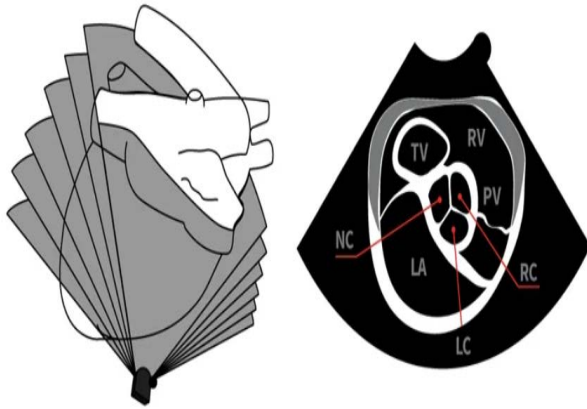


Fig. 3: Diagram showing probe positioning for Short axis level of LA & Aorta

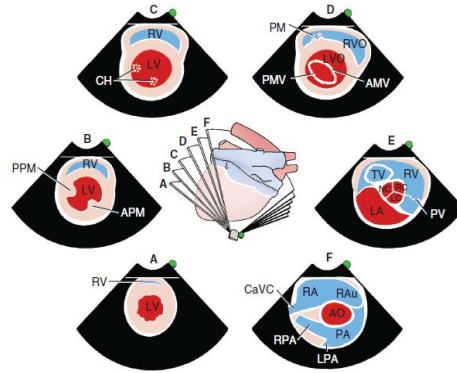


Fig. 4: Probe positioning for short axis images from RPLAX view

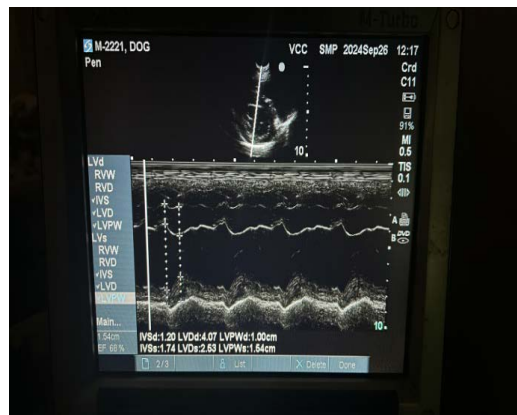


Fig. 5: Measuring of various parameters during M-mode echocardiography in non-descript dogs. RVDd- Right ventricular diameter in diastole (cm), IVSd- Inter ventricular septum in diastole (cm), LVDD- Left ventricular diameter in diastole (cm), RVDs- Right Ventricular diameter in diastole (cm), IVSs- Inter ventricular septum in systole (cm), LVDs- Left ventricular diameter in systole (cm), LVPWs- Left ventricular posterior wall in systole (cm), EF- Ejection fraction (%), FS- Fractional shortening (%), EPSS- E Point to Septal Separation (mm), EDV- End diastolic volume (mL), ESV- End systolic volume (mL), SV- Stroke volume (mL), and CO- Cardiac output (Lit/min).

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