



M-mode Echocardiographic Studies in Indigenous Dog Breeds of Tamil Nadu

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ABSTRACT

M-mode echocardiography is a non-invasive tool for the quantitative study of heart. Rajapalayam is a guard dog and Chippiparai is a sight hound breed which both originated from the southern districts of Tamil Nadu, India. Diagnosis of cardiac diseases in our indigenous breeds has been challenging due to less or no work done regarding cardiac anatomy and physiology in native breeds. Hence, this study was undertaken to establish basic reference data in these indigenous dog breeds which will help in diagnosing cardiac diseases. Various normal cardiac parameters were documented between young and adult age groups. The results indicated that a high significant difference ($P < 0.01$) was observed in LVDd and LVDs and only a significant difference ($P < 0.05$) in AO and RVD values between the age groups in Rajapalayam dogs, whereas, in Chippiparai dogs, a significant difference was observed in CO ($P < 0.05$) and in LVPWs, IVSd, IVSd ($P < 0.0$) between the young and adult age groups.

Keywords: M-mode echocardiography, Rajapalayam, Chippiparai, indigenous dog breeds

Echocardiography is a unique non-invasive application of ultrasound for imaging of live heart. It is based on detection of echoes produced by beams of ultrasound pulses transmitted into the heart. M-mode was the first ultrasound modality used in dogs, wherein, the ultrasound beams were aimed to give graphic recording of their anatomic positions and movements (Gugioo *et al.*, 2013).

The basic principles of M-mode echocardiography, including technical considerations were put forward by Bonagura and Pipers (1983). He observed that normal structures of heart can be scanned by changing the angle or location of transducer. If the transducer is maintained in a constant position during the cardiac cycle, the phasic motion of cardiac structures can be recorded. The resultant record is termed as motion or M-mode echocardiogram.

M-mode echocardiography can provide superior temporal resolution of recording cardiac walls and valves and

volumetric blood flow analysis. It is the effective and efficient way to record necessary multiple cardiac cycles (Feigenbaum, 2010).

Rajapalayam is the Indian guard dog that originated from the Rajapalayam town in the Virudhunagar district of Tamil Nadu. It is pristine white in colour with pink nose and ears and is known for companion of royalty and aristocracy. Of late, it is being used in Indian army. Chippiparai is the sight hound breed from Tirunelveli district of southern Tamil Nadu. It is known for its hunting abilities and was later kept as symbol of royalty and dignity (Karthikeyan *et al.*, 2015). Having such wonderful dogs gives us pride and also responsibilities to protect and conserve them. Hence, this study was aimed to know the basic cardiac anatomy of heart using M-Mode echocardiography, which would help us in early diagnosis of any cardiac abnormalities in these native dog breeds, if any.



MATERIALS AND METHODS

The study was carried out on 48 clinically healthy Rajapalayam and Chippiparai breeds of dogs (each n=24) brought to Madras Veterinary College teaching hospital with the consent of the owner. The dogs were grouped based on age as young (up to 6 months; n=12) and adult (above 6 months of age; n=12).

All the animals were subjected for screening to ascertain that they were clinically healthy by physical and clinical examination. Dogs with vital parameters within the established reference range were considered to be clinically healthy and subjected for cardiac evaluation.

Technique- M-mode echocardiography

Esoate MyLab 20 ultrasound machine with a cardiac probe of 6MHz was used for recording the echocardiographic studies. M-mode (motion-mode) echocardiographic images were recorded and stored for further evaluation.

Animals were allowed to relax in the room before examination. The area between costochondral junction and sternum in the right parasternal window was clipped. From the long axis view of the heart, the transducer was rotated in 90° in clockwise direction and ultrasound beam was oriented perpendicular to the long axis of the left ventricle *i.e.* right short axis view. Proper alignment was achieved in order to visualize the left ventricle and aortic root as round structures. The examination begun at the level of the apex of heart followed by planes through the papillary muscles, chordae tendinae, mitral valve and pulmonary artery (Boon, 1998).

Parameters

The following parameters were recorded to evaluate size of cardiac chambers: Left ventricular diameter at diastole (LVDd) and systole (LVDs), Left ventricular posterior wall thickness at diastole (LVPWd) and systole (LVPWs), Interventricular septal thickness at diastole (IVSd) and systole (IVSs), Right ventricular diameter at diastole (RVDd).

Calculations

Formulae by Teicholz *et al.* (1976) in human were used

to calculate the left ventricular volume at systole and diastole.

- End diastolic volume (EDV in ml) = $7 \times \text{LVDd}^3 / (2.4 + \text{LVDd})$
- End systolic volume (ESV in ml) = $7 \times \text{LVDs}^3 / (2.4 + \text{LVDs})$

Rest of the parameters was calculated using established formulae suggested by Kienle (1998) and Riedesel and Knight (2005).

- Stroke Volume (SV in ml) = $\text{EDV} - \text{ESV}$
- Ejection Fraction (EF in per cent) = $(\text{EDV} - \text{ESV}) \times 100 / \text{EDV}$
- Cardiac output (CO in l/min) = $\text{SV} \times \text{Heart rate}$
- Fractional Shortening (FS in per cent) = $[(\text{LVDd} - \text{LVDs}) / \text{LVDd}] \times 100$

SPSS® 20.0 for Windows was used for statistical analysis of data. The data obtained from various m-mode echocardiographic parameters were subjected to Mean \pm SE and independent sample test or t-test for equality of means.

RESULTS AND DISCUSSION

Rajapalayam dog breed

Mean \pm SE of various M-mode echocardiography parameters such as left ventricular diameter (LVD), left ventricular posterior wall thickness (LVPW), interventricular septal thickness (IVS), right ventricular diameter during diastole (RVDd), left ventricular volumes such as end diastolic volume (EDV), end systolic volume (ESV), stroke volume (SV) and cardiac output (CO) and left ventricular functional parameters like ejection fraction (EF) and fractional shortening (FS) for Rajapalayam dogs were given in Table 1. T-test for equality of means was performed to detect the significant difference between the age groups studied (young and adult).

Left ventricular dimensions

Left ventricular diameter (LVD) (cm)

Mean \pm SE for LVDd and LVDs for young dogs was in

Table 1: Mean \pm SE of M-mode echocardiographic parameters in Rajapalayam dogs

Parameters	Mean \pm SE		t value
	Young	Adult	
LVDd (cm)	2.54 \pm 0.01	2.69 \pm 0.15	1.01 ^{NS}
LVDs (cm)	1.59 \pm 0.03	1.77 \pm 0.09	1.81 ^{NS}
LVPWd (mm)	3.66 \pm 0.06	10.71 \pm 0.30	23.34**
LVPWs (mm)	8.03 \pm 0.22	13.63 \pm 0.71	7.57**
IVSd (mm)	2.02 \pm 0.02	5.20 \pm 0.90	3.52**
IVSs (mm)	2.04 \pm 0.01	8.44 \pm 0.75	8.48**
RVDd (mm)	4.86 \pm 0.04	9.32 \pm 0.77	5.76**
EDV (ml)	30.95 \pm 3.33	30.10 \pm 3.78	0.17 ^{NS}
ESV (ml)	7.07 \pm 0.40	5.95 \pm 1.0	1.04 ^{NS}
SV(ml)	23.88 \pm 3.41	24.15 \pm 2.87	0.06 ^{NS}
CO (l/min)	1.48 \pm 0.20	1.89 \pm 0.26	1.29 ^{NS}
EF (%)	75.64 \pm 3.17	81.10 \pm 2.15	1.43 ^{NS}
FS (%)	60.08 \pm 3.50	54.06 \pm 10.60	0.54 ^{NS}

^{NS} - No significant difference between young and adult age groups (P>0.05)

** - Significant difference between young and adult age groups (P<0.01)

accordance with the findings of Diez-Prieto *et al.* (2010) in 10 months old growing beagles, whereas, higher values were reported by Singh *et al.* (2012).

Similar observation for mean values of LVDd and LVDs was made by Diez-Prieto *et al.* (2010) in adult beagle dogs. However, no significant difference was observed between the age groups.

Left ventricular posterior wall thickness (LVPW) (mm)

Similar observations for LVPW mean values were made by Spasojevic-Kosic *et al.* (2017) in adult German Shepherd dogs. There was a high significant difference observed between the two age groups.

Interventricular septal thickness (IVS) (mm)

The mean values of IVS in young and adult dogs were lesser than the findings of Morrison *et al.* (1992) in Golden Retriever and Afghan Hound and Gugjoo (2011) in Labrador.

Right Ventricular Dimension

Right ventricular diameter during diastole (RVDd) (mm)

Mean \pm SE for RVDd was 4.86 \pm 0.04 and 9.32 \pm 0.77

in young and adult age groups respectively. Some similar values for adult age group were observed by Muzzi *et al.* (2006) and Torrad and Hassan (2014) in German Shepherd.

Left ventricular volume

Measurements of left ventricular volume included EDV, ESV and SV (ml).

In the present study, there was no significant difference between the young and adult age groups with regard to EDV, ESV and SV, though, there was significant difference observed in heart weight. This is in contrast to the findings of O'Grady *et al.* (1986), Saxena (2008), Yadav (2010) and Gugjoo (2011) in various breeds of dogs. They opined that with the increase in body weight, the cardiac size increases and with increase in cardiac size, left ventricular volume increases. However, other factors like excitement, fear and exercise may also increase the cardiac volume.

Cardiac output (CO) (l/min)

Mean cardiac output was in accordance with the findings of Muzzi *et al.* (2006), Saxena (2008) and Gugjoo (2011). There was no correlation observed between left ventricular volume and body weight.



Left ventricular function

In the present study, no significant difference was observed in EF and FS between the age groups. This is in accordance with the findings of Boon (1998) and Saxena (2008).

Variations, if occurred could be explained by the fact that left ventricular FS is influenced by other parameters such as preload, afterload and contractility. All these parameters may act independently or in combination to make changes in left ventricular function.

Chippiparai dog breed

Various M mode parameters of Chippiparai dog breed of young and adult age groups were given in Table 2.

Table 2: Mean \pm SE of various M-mode echocardiographic parameters in Chippiparai dogs

Parameters	Mean \pm SE		t value
	Young	Adult	
LVDd (cm)	2.11 \pm 0.08	2.17 \pm 0.07	0.54 ^{NS}
LVDs (cm)	1.30 \pm 0.07	1.27 \pm 0.06	0.30 ^{NS}
LVPWd (mm)	7.07 \pm 0.59	7.08 \pm 0.36	0.01 ^{NS}
LVPWs (mm)	7.73 \pm 0.39	10.43 \pm 0.29	5.56**
IVSd (mm)	3.64 \pm 0.38	7.02 \pm 0.39	6.21**
IVSs (mm)	3.16 \pm 0.35	4.96 \pm 0.40	3.40**
RVDd (mm)	5.21 \pm 0.31	3.60 \pm 0.71	2.09 ^{NS}
EDV (ml)	14.80 \pm 1.40	15.81 \pm 1.34	0.52 ^{NS}
ESV (ml)	4.27 \pm 0.53	4.02 \pm 0.48	0.36 ^{NS}
SV(ml)	10.53 \pm 1.22	11.80 \pm 1.31	0.71 ^{NS}
CO (l/min)	0.65 \pm 0.08	0.96 \pm 0.11	2.15*
EF (%)	71.03 \pm 2.96	74.14 \pm 3.07	0.73 ^{NS}
FS (%)	38.40 \pm 2.51	41.15 \pm 2.65	0.75 ^{NS}

^{NS} - No significant difference between young and adult age groups (P>0.05)

* - Significant difference between young and adult age groups (P<0.05)

** - Significant difference between young and adult age groups (P<0.01)

Left ventricular dimensions

Left ventricular diameter (LVD) (cm)

Mean \pm SE for LVDd and LVDs in young dogs was in accordance with the findings of Diez-Prieto *et al.* (2010)

in 4 months old growing beagles, whereas, higher values were reported by Singh *et al.* (2012).

Mean \pm SE for LVDd and LVDs was 2.17 \pm 0.07 and 1.27 \pm 0.06 for adult dogs. Similar observation was made by Diez-Prieto *et al.* (2010) in beagle dogs.

Left ventricular posterior wall thickness (LVPW) (mm)

A similar observation to values in adult age groups was made by Spasojevic-Kosic *et al.* (2017) for adult German Shepherd dogs, whereas, higher values were recorded in younger dogs.

There was a high significant difference observed between the two age groups in LVPWs but not in LVPWd.

Interventricular septal thickness (IVS) (mm)

Mean \pm SE of interventricular septal thickness during diastole and systole in young dogs were 3.64 \pm 0.38 and 3.16 \pm 0.35 respectively. Mean \pm SE of IVDd and IVSs for adult Chippiparai dogs were 7.02 \pm 0.39 and 4.96 \pm 0.40 respectively. The mean values of IVS in adult dogs was in accordance with the findings of Morrison *et al.* (1992) in Golden Retriever and Afghan Hound and Gugjoo (2011) in Labrador.

Right Ventricular Dimension

Right ventricular diameter during diastole (RVDd) (mm)

Mean \pm SE for RVDd was closer to the values in growing Spanish mastiffs (Bayon *et al.*, 1994). Lower values were observed by Muzzi *et al.* (2006) and Torrad and Hassan (2014) in German Shepherd.

Left ventricular volume

In the present study, there was no significant difference between the young and adult age groups with regard to EDV, ESV and SV, though, there was significant difference observed in heart weight. This is in contrast to the findings of O'Grady *et al.* (1986), Saxena (2008), Yadav (2010) and Gugjoo (2011) in various breeds of dogs.

Cardiac output (CO) (l/min)

Mean cardiac output in young and adult dogs was lesser than the findings of Hanton *et al.* (1998) in Beagles (2.27) and Muzzi *et al.* (2006) in German Shepherd (3.28).

Left ventricular function

In the present study, no significant difference was observed in EF and FS between the age groups. This is in accordance with the findings of Boon (1998) and Saxena (2008).

CONCLUSION

Rearing indigenous breeds of dogs has been blooming in recent years as they are strong, sturdy, tolerant and disease resistant and well adapted to survive in India's tropical climate. In Rajapalayam dog breed, a high significant difference ($P < 0.01$) was observed in case of both LVDD and LVDs between the age groups. AO and RVD also showed significant difference ($P < 0.05$) between young and adult groups, whereas, no significant difference was observed between the two age groups for rest of the parameters measured. In Chippiparai breed, a significant difference ($P < 0.05$) was observed in CO between the age groups. Also, significant difference ($P < 0.01$) in LVPWs, IVSd, IVSd between the age groups of the study was observed. Early diagnosis of cardiac diseases may be helpful to preserve these native breeds. As there is no literature available on M mode echocardiographic parameters in Rajapalayam and Chippiparai breeds of dogs, the results of this study will provide a basic reference data to understand the anatomy and physiology of heart.

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