

Echocardiography of Clinically Normal Dogs

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Abstract

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This study was to establish the normal reference echocardiographic values for three dog breeds, and to determine the effect of breed, gender and body weights on echocardiographic parameters.

VHS to evaluate the normal size of heart .ECG to detect the normal heart function.

M- mode, two-dimensional and Doppler echocardiography were performed on 42 clinically healthy dogs including [20 German shepherd, 12 Golden Retriever and 10 Rottweiler]. Echocardiographic measurements as, left ventricle internal diameter (LVD), as well as left atrial internal diameter (LAD) and aortic diameter (AOD) in early diastole, LAD: AOD ratio was calculated. Fraction shortening (FS) percentage and ejection fraction (EF) percentage, as well as, Mean range and standard deviation of measurements were calculated for the three dog breeds.

Key words: Echocardiography, dog, aortic diameter, Fraction shortening.

DEDICATION

TO THE SOUL OF MY FATHER
TO MY LOVELY MOTHER

TO MY HONEY SISTER
TO MY HANDSOME BROTHER

WITHLOVE

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Contents

Item	Pages
List of tables	I
List of figures	II - III
List of Abbreviations	IV – V
Introduction	1-4
Review of literature	5-59
Materials and Methods	60-74
Results	75-86
Discussion	87-93
Conclusion	96
Summary	97-99
References	98-115
الملخص العربي	۲ _ ۱

List of Tables

Table No	Title	Page No
1	Shows number of dog breeds used in this study	60
2	Shows numbers of dog breeds (Age& Bwt) (M±SD)	60
3	Number of dog breeds used for X-ray	61
4	Gender, Age and Bwt (M±SD)	62
5	VHS measurements in dog breeds in the study	75
6	HR measurements in dog breeds in the study	76
7	Effect of breeds on the echo measurements	84
8	Effect of gender on the echo measurements	85
9	Effect of weights on the echo measurements	86

List of Fingers

Fig No	Title	Page No
1	Heart wall layers	7
2(A&B)	Heart structure and chambers	8
3(A&B)	Heart valves	15
4(A&B)	Heart's electrical circuit	24
5	ECG diagram	25
6	Vertebral heart score	29
7(A&B)	VHS measurement R.L. Radiograph	29
8	VHS measurement DV or VD Radiograph	30
9	X-ray machine used in this study	62
10	VHS measurement, R.L. thoracic radiography	63
11(A)	ECG cables	64
11 (B)	ECG examination	64
12(A)	My Lab 3o Gold Vet' 'Cardiovascular	65
12(B)	Phased array probe (4-8MHz)	66
13	Echo Table	67
14	Echo Exam, left lateral recumbency	67
15	The right parasternal long axis 4-chamber view(Thomas ,1984)	69
16	The right parasternal long axis left ventricular outflow tract (Thomas ,1984)	69
17	The right parasternal short axis levels (Thomas ,1984)	71
18	Normal ECG waves	76
19	Right parasernal Long-axis (longitudinal) views	77

Fig No	Title	Page No
20	The 2D-right parasternal long axis view	78
21	right parasternal short axis view, the level of the PM	79
22	right parasternal short axis view, the level of the MV	80
23(A)	right parasternal short axis view the level of the Ao, (LA/AO) ratio	81
23(B)	right parasternal short axis view the level of the Ao	82
24(A&B)	Left parasternal views	82
25(A)	Color Doppler mode, right parasternal long axis view	83
25(B)	Color Doppler mode, left parasternal long axis four chamber view	84

Abbreviations

2D	Two dimensional mode
AMM	Anatomical M-mode
Ao	Aorta
AS	Atria Septum
AV	Aortic valve
B-mode	Bi-dimensional
CFM	Color-flow mapping
CHF	Congestive heart failure
CMM	Conventional M-mode
DCM	Dilatation cardiomyopathy
DV or VD	Dorso-ventral or Ventro-dorsal
Echo	Echocardiography
EDV	End-diastolic volume
EF	Ejection fraction
EPSS	E-point to septal separation
ESV	End-systolic volume
FS	Fractional shortening
GR	Golden Retriever
Gs	German shepherd
HR	Heart rate
IVS	Interventricular septum
IVSd	Interventricular septum end-diastolic

IVSs	Interventricular septum end-systolic
LA	Left atrium
LAD/AOD	Left atrium to Aortic root ratio
LV	Left ventricle
LVD	Left ventricular diameter
LVDd	Left ventricular end-diastolic dimension
LVDs	Left ventricular end-systolic dimension
LVFW	Left ventricular free wall
LVOT	Left ventricular outflow tract
LVWd	Left ventricular wall end-diastolic
LVWs	Left ventricular wall end-systolic
M-mode	Mono-dimensional mode, Motion-mode
MV	Mitral Valve
MVD	Mitral valve disease
PE	Pericardial effusion
PM	Papillary muscles
PV	Pulmonic valve
RA	Right atrium
RL	Right Lateral
RV	Right ventricle
RVOT	Right ventricular outflow tract
Rw	Rottweiler
SV	Stroke volume
TV	Tricuspid valve

INTRODUCTION

Echocardiography, cardiac ultrasound, is an important diagnostic tool in cardiology which has been introduced in the veterinary medicine as a non-invasive method for evaluating the anatomy and function of heart (Boon, 1998).

The earliest work carried on dogs was performed by unidimensional M mode echocardiography as a non- invasive tool for the quantitative study of heart (Mashiro *et al.*, 1976).

The first structure to be identified during the development of echocardiography was the mitral valve and detailed structures of mitral valves together with ventricular walls were studied (Yamamura *et al.*, 1977).

Later studies focused on these structures in normal (Dennis *et al.*, 1978) as well as abnormal dogs affected with left sided heart failure. For many problems, both ultrasound and X-rays are recommended for optimal evaluation (Pipers *et al.*, 1981).

As ultrasound images can discriminate between blood filled cardiac chambers and soft tissue structures of heart while radiographs can distinguish lungs from soft tissues and fluid density, echo images are complimentary to radiographic images for cardiac assessment (Gugjoo *et al.*, 2011).

Echocardiography is accepted as the most valuable diagnostic tool in the evaluation of cardiac anatomy and function, as well as in investigating cardiac diseases in small animal cardiology (Gugjoo *et al.*, 2014).

In addition to qualitative estimation, measurement of cardiac dimensions and calculation of cardiac functional parameters are inevitable to determine cardiac performance of healthy individuals and to diagnose pathological conditions (Foppa *et al.*, 2005).

An ultrasound examination of heart and large vessels represent a significant technological advance in veterinary medicine. Echocardiography allows an evaluation of the space relationship between structures, cardiac movement and blood flow features, the precise and non-invasive diagnosis of cardiac alterations, as well as follow-up therapy and to determine the prognosis through direct vision of cardiac chambers (Gugjoo *et al.*, 2013).

Defects which can be visualized including stenotic lesions, congenital and vegetative anomalies (Bonagura, 1983;Boon, 1998), valvular lesions and cardiac shunts (Kittleson, 1998), cardiac and thoracic masses, pleural and pericardial effusions (Gugjoo *et al.*, 2013), myocardial diseases (Gugjoo *et al.*, 2013).

Echocardiographic examination includes both qualitative as well as quantitative cardiac assessment. For quantitative examination, M-mode echocardiography is primarily being utilised for dimensional measurements and subsequently the functional activities of heart are being calculated. Reliable, normal echocardiographic values for chamber size, wall dimensions and myocardial function are needed for comparison and evaluation of dogs suspected for having heart diseases (O'Grady *et al.*, 1986).

However, it cannot be used to measure velocity, the direction or type of the blood flow but can be combined with contrast or colorcoded Doppler studies for accurate timing of flow events (Gugjoo et al., 2014).

Both M-mode and two-dimensional echocardiography (2DE) are widely used for cardiac measurements in the dog, and several authors have published reference values on normal values of canine populations which included various breeds (Boon *et al.*, 1983; Lombard, 1984; Gooding *et al.*, 1986; O'Grady *et al.*, 1986; Thomas *et al.*, 1993; Boon, 1998).

The influence of age, heart rate, and cardiac cycle length on cardiac parameters has also been reported (Jacobs and Mahjoob, 1988; Sisson and Schauffer, 1991).

Most echocardiographic values demonstrated linear correlations with body weight and body surface areas in normal dogs (Boon *et al.*, 1983; Lombard, 1984; Jacobs and Mahjoob, 1988; Kienle and Thomas, 1995; Kayar *et al.*, 2006).

Several published echocardiographic reference values were based on regression analysis and 95% confidence intervals related to body weight and body surface area using data of different breeds which were grouped together (Boon *et al.*, 1983; Lombard, 1984; Kienle and Thomas, 1995; Boon, 1998; Bonagura and Fuentes, 2000; Belanger, 2005).

However, previous studies suggested that reference ranges derived from pooled populations are wide, and result in great variability in standard measurements, partly due to the large variation in conformation and size of canine breeds (Morrison *et al.*, 1992; Della Torre *et al.*, 2000).

Breed has been demonstrated to be an important factor, influencing intracardiac parameters in addition to body weight in dogs (Gooding *et al.*, 1986; Crippa *et al.*, 1992; Morrison *et al.*, 1992;Page *et al.*, 1993; Snyder *et al.*, 1995; Della Torre *et al.*, 2000; Baade *et al.*, 2002 and Bavegems *et al.*, 2007).

Therefore, the need for normal breed-specific reference ranges has been emphasized for comparison of pathological changes caused by cardiac disorders. Recently published textbooks include (mainly M-mode) echocardiographic reference ranges of certain canine breeds (Bonagura and Fuentes, 2000; Kienle and Thomas, 2002; Belanger, 2005 and Ware, 2007).

The purpose of the present study

To determine clinically relevant normal M-mode, 2D and color Doppler values for three dog breeds (German shepherd, Golden retriever and Rottweiler).

Measurement data were related to body weight, and were compared to previously reported data of similar canine breeds. The potential effect of gender on echocardiographic parameters was also studied.

Review of literature

Anatomy and Physiology of Canine heart (Paul A. Iaizzo 2005 and Reece O. William, 2005)

The heart is a powerful muscle that pumps blood throughout the body by means of a coordinated contraction. The contraction is generated by an electrical activation, which is spread by a wave of bioelectricity that propagates in a coordinated manner throughout the heart.

• Position and Shape of the Heart:

The heart is located in the thoracic cavity in between the lungs, 60% of it lying to the left of the median plane. The heart's lateral projection extends from rib 3 to 6.

Most of the heart's surface is covered by the lungs and in juveniles it is bordered cranially by the thymus. Caudally the heart extends as far as the diaphragm. Orientation of the heart within the thoracic cavity is influenced by breed and the presence of pathology.

However, generally speaking, the long axis of the canine heart is typically positioned in a craniodorsal to caudoventral orientation that describes a 45 degree angle to a dorsal plane through the thorax. The apex of the heart is positioned to the left of midline, resting in a caudoventral and left lateral position. It is positioned within the mediastinum.