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ECHOCARDIOGRAPHIC VIEWS AND COLOR DOPPLER ULTRASOUND IN CLINICALLY NORMAL GERMAN SHEPHERD DOGS

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ABSTRACT

Aim of the study is to Evaluate the heart wall thickness, septal thickness and chambers size in clinically normal German Shepherd dogs with two dimension(B-mode), (M-mode) and color Doppler ultrasound modes, Measuring the mechanical functions of the heart (Fraction Shortening percentage and Ejection Fraction percentage.

Animals:

The current study was carried out on fifteen clinically normal German shepherd dogs (9 males and 6 females). The age of these dogs ranged from 24 months to 42 months and the body weight ranged from 25 to 40 kg.

Material and Methods:

The dogs in the study were examined by the ultrasound machine provided with a built in ECG software and ECG cables. The ultrasound transducer used in this study was the phased array (4-8 MHz), using Two-dimensional mode (B-mode), (M-mode), and (color and pulsed wave Doppler ultrasound modes). In (B- mode),(aortic root, left ventricular outflow tract, left ventricular chamber, mitral valve and left atrium) were examined from both right and left parasternal long and short axis views. In (M-mode) measurements, mechanical function of the heart is calculated (FS and EF percentage). In pulsed-wave and color Doppler ultrasound modes, mitral, aortic, tricuspid and pulmonary valves are evaluated.

RESULTS

All the measurements in the study similar to the normal echocardiographic parameters.

CONCLUSIONS

Echocardiography is an important non-invasive tool for evaluating the heart and valves in dogs.

Key words:

German shepherd, Dogs, Echocardiography, Color Doppler.

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 **(Henik, 1995).** The earliest work carried on dogs was carried out by **(Mashiro *et al,* 1976).** They performed uni-dimensional (M-mode) echocardiography as a non- invasive tool for the quantitative study of the heart. Later studies focused on these structures in normal **(Dennis *et al,* 1978)** as well as abnormal dogs affected with left sided heart failure. 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 determination and prognosis of heart diseases through direct visualization of cardiac chambers are accurately diagnosed by ultrasound **(Gugjoo *et al,* 2014)**. Ultrasound scanning allows assessment of cardiac chamber sizes, cardiac function and blood flow; it provides information on hemodynamic status and extent of disease process together with follow up therapy **(Boon, 1998)**. Defects which can be visualized including valvular lesions **(Bonagura and Schober, 2009),** cardiac shunts **(Kittleson, 1998),** cardiac and thoracic masses, pleural and pericardial effusions **(Gugjoo *et al,* 2014)**, myocardial diseases **(Gugjooet *et al,* 2014)**, stenosis lesions, congenital and vegetative anomalies are also diagnosed by ultrasound **(Bonagura, 1983 and Boon, 1998).** Echocardiographic examination includes both qualitative as well as quantitative cardiac assessment. For quantitative examination, (M-mode) is primarily being utilized for dimensional measurements and subsequently the functional activities of heart are also 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 color-coded Doppler studies for accurate timing of flow events. Variations in M-mode echocardiographic parameters with breed, age, sex and body weight occurs and need to be kept in mind while interpreting the findings. Because of the variations in echocardiographic values showed significant breed variations, it is important to know the normal echocardiographic value for each breed of dog

(Thomas *et al,* 1993 and O'Leary *et al,* 2003) considering the influence of body weight on the established echocardiographic values.

This study aimed to:

1-Evaluate the heart wall thickness, septal thickness and chambers size in clinically normal German Shepherd dogs with two dimension(B-mode) and(M-mode) ultrasound scanning in systole and diastole.

2-Measuring the mechanical functions of the heart by calculating Fraction Shortening percentage (FS %) and Ejection Fraction percentage (EF %)

3-Evaluation of the Mitral, tricuspid, aortic, pulmonic valves via color Doppler ultrasound

MATERIAL AND METHODS

Animals:

This study applied on fifteen adult mature German shepherd dogs (9males and 6 females). The average age was between 24 months to 42 months, with body weight ranging from 25 to 40kg.The dogs were examined physically and clinically through chest radiographic examination and ECG. These dogs were examined in (Police Academy in Cairo and Animal Reproduction Research Institute in Giza).

Ultrasound machine and ECG cables:

The ultrasound machine used in the study was "My Lab 30 Gold Vet Cardiovascular, (Esaote Pie Medical Co; Italy)".The ultrasound transducer was the phased array 4-8MHz. The ultrasound unit was also provided with a built in ECG software and ECG cables.

Scanning procedures:

Ultrasound gel and propyl alcohol were used as coupling media during cardiac scanning to ensure an intimate contact and eliminate air from the examination window. The animals were examined in right and left lateral recumbency using a manual restraint, without sedation **(Muzzi *et al.,* 2006)**.The examination table was provided with two triangular openings to facilitate the scanning. The transducer is put under the animal chest from the opened area of the table at the thoracic region, to obtain the different heart views according to **(Thomas *et al,* 1993).**

Ultrasound scan modes:

Echocardiographic examination included two-dimensional (2D) right and left parasternal

views, M-mode and color Doppler. Simultaneous electrocardiographic ECG was carried out through the scanning in each view to detect the stage of the cardiac cycle.

Two-dimensional mode (B-mode):

For the (B-mode) scanning the right and left parasternal positions, from the third to the fifth intercostal spaces and 1-5cm lateral to sternum. The ultrasound transducer was placed on the dependent side of the body at the point where strongest palpable apex beat was detected **(Thomas *et al,* 1993; Gugjio*et al.,* 2014).** In this mode (measurement of the left atrial to aortic root ratio (LA/AO),(AO-2D) along the commissure between the noncoronary and right cronoary aortic valve cusps,(LA-2D) a line extending from the commissure between the noncoronary and left coronary aortic valve cusps where a pulmonary vein was seen entering the left atrium at the caudolateral location**(Rishniw and Erb,2000)**,left ventricular outflow tract, left ventricular chamber and left atrium) were estimated from both left, right parasternal long and short axis views **(Thomas *et al,*1993).**

M-mode:

The measurements in M-Mode scanning were carried out in both systole and diastole to calculate EF and FS, using automated calculation software provided with the ultrasound machine. According to the established formulae **Lombard and Ackerman, (1984), Kittleson and Kienle, (1998a) and Reece, (2005)**

Left ventricle fractional shortening (LVFS in %) = (LVDd-LVDs) ×100/LVDd.

Color Doppler mode:

Color and pulsed wave Doppler modes were used to evaluate the mitral, tricuspid, aortic and pulmonary valves, to check whether any kind of regurgitation was present or not **(Singh P *et al,* 2014).**

Statistical analysis:

The student t test was used to compare the mean values between males and females and to set the significance level (percentage).

RESULTS

The animals subjected to ultrasound scanning after physical examination, chest X- ray and ECG were (60% males) and (40% females). The mean age was 2.8± 0.4 years in males and 2.5±0.2years in females. The mean body weight was 34.4±3.9 kg in males and 35±6.3 kg in females.

Two-dimensional mode (B-mode):

The average diameter of the left atrial cavity was 34.2±2.0 mm in males and 33.4±1.6 mm in females respectively Fig. (1). the diameter of the aorta at the level of the aortic valve annulus was 25.2 ± 1.6 mm. The left atrial to aortic root ratio was approximately 1.0.

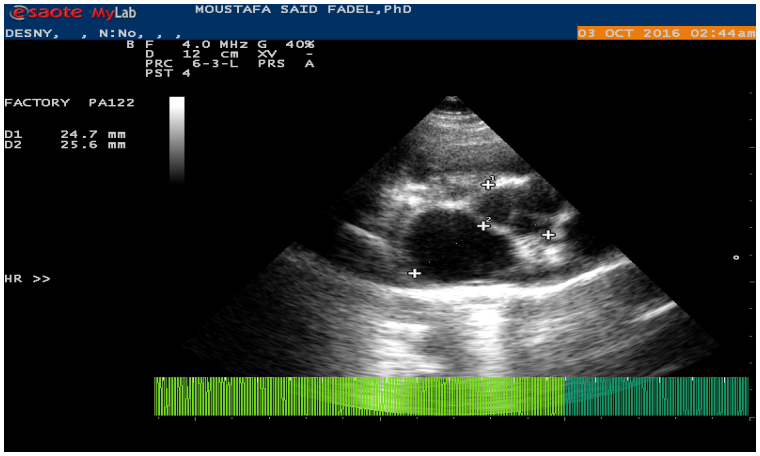

Fig. (1): Ultrasound image of the heart from the right parasternal view showing (LAD/AOD) ratio was (1.0), Left Atrium (LA), Right Ventricle (RV), Pulmonary Artery (PA).

Left parasternal apical view:

The left parasternal long axis caudal view (Fig2) showed the four heart chambers and the atrioventricular valves**.**

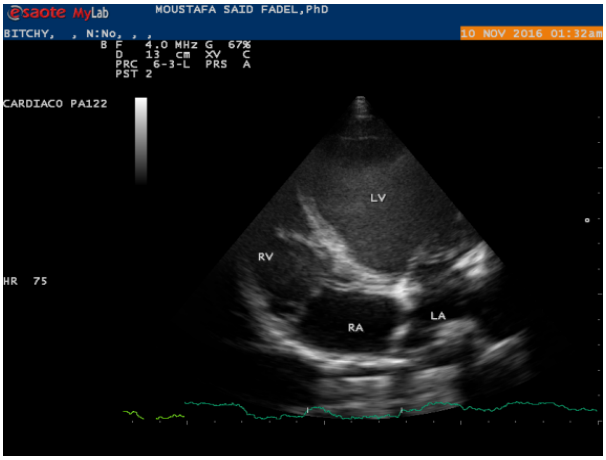

Fig.(2): Showing the ultrasound image of heart from left parasternal view showing the long axis four - chamber view, the left ventricle (LV) and right ventricle (RV) are at the upper part of the scan and the top of the scan and the left atrium (LA) and right atrium (RA) are at the bottom of the scan.

Right parasternal long axis view:

The right parasternal view showed the whole left ventricle, the right ventricle and the atrioventricular valves Fig.(3), The M mode line is located behind the mitral valve leaflets and crosses the right atrium cavity, the Interventricular septum, the left atrial cavity and the free heart wall. The obtained measurements from this view showed the systolic and diastolic functions of the heart (EF and FS).

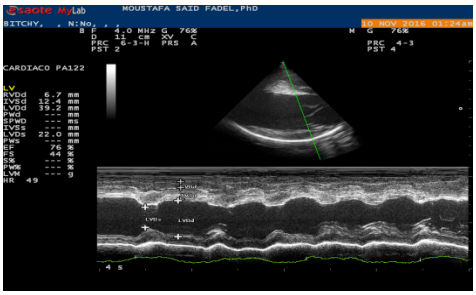

Fig. (3): Ultrasound image of the heart showing four chambers in the right parasternal long axis view.

M-mode:

The M-mode view at the level of the papillary muscles allowed us to evaluate the systolic and diastolic functions of the heart. The percentages of EF and FS are the most commonly used clinical measurement of the LV systolic function as it was considered to be an indicator of ventricular compliance and contractility. The result showed that [LVDd] was 46.2±2.4, [LVDs] 27.3±2.3 in males and [LVDd] was 36.0±2.3, [LVDs] 28.2±12.9 in females respectively. The percentages of FS and EF were 40.6±2.6, 71.2±3.2 in males and 36.1±5.7, 65.6±7.3 in females respectively Fig. (4).

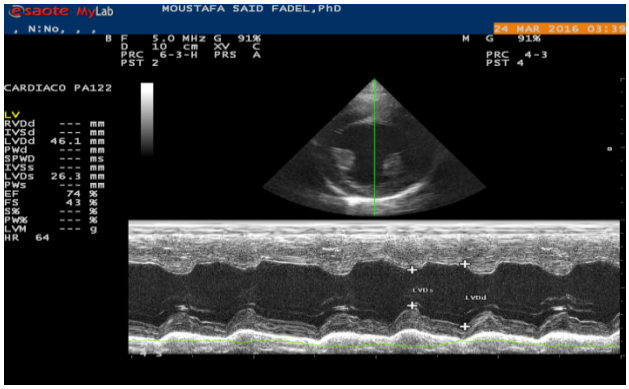

Fig. (4): Ultrasound image of the heart at the level of the two papillary muscles showing cross section in the heart wall, cavities and septum. The M mode showed the movement of the heart wall and septum during systole and diastole and also the left ventricular internal diameter changes in systole and diastole Both EF and FS percentages are calculated from the data of this view.

M-Mode-Mitral Valve Level:

The mitral valve view was obtained from the right parasternal short axis view in 2 D mode and M-mode ultrasound imaging. The E (end diastolic) and A (atrial kick) waves of the mitral valve leaflets in normal valve are depicted in(Fig 5). The E wave is higher than the A wave and the deceleration time was also normal.

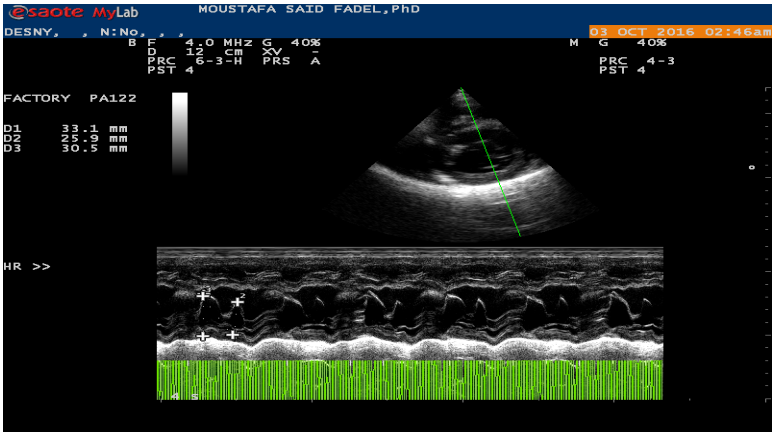

Fig. (5): Ultrasound image of the heart from the right parasternal short axis view at the level of the mitral valve and M mod scan for the mitral valve movements.The E wave is higher than the A wave (the curve inside the left ventricle the lower part of the image) and the time interval between the two waves (deceleration time) is normal.

Doppler mode (Color Doppler):

Mitral valve is also evaluated by color Doppler ultrasound to evaluate the blood flow direction. Fig. (6). the red color visible behind the valve indicates the on directional flow and the absence of regurgitation.

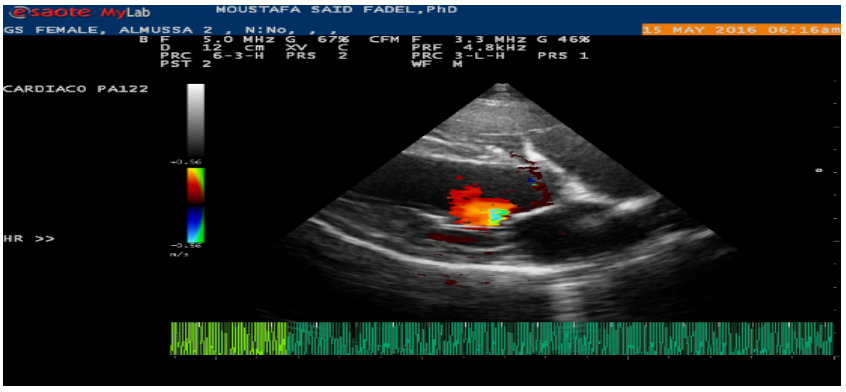

Fig. (6): Ultrasound image of the left atrium, left ventricle and mitral valve in right parasternal long axis view with color Doppler mode on the mitral valve. The absence of turbulence and presence of red colors only in the color box indicated that, the valve is normal.

DISCUSSION

Two dimensional (2D) echocardiography images were applied on fifteen adult mature German shepherd dogs of both sexes. Long axis and short axis views were consistently recorded. By the long axis images the four chambers, mitral and tricuspid were obtained. That was in agreement with **(Thomas *et al,* 1993**).A good image obtained for long axis from both right and left parasternal views. The same was mentioned by **(Thomas *et al,* 1993 and Muzzi *et al*., 2006**).The recorded diameter of left atrium was nearly similar to those described by **(O'Grady *et al,* 1986 and Muzzi *et al.,* 2006**). They mentioned that, the left atrium size was a good indicator to left ventricle size. Examination of aortic diameter at the level of aortic annulus showed better results. **(O'Leary *et al.,* and 2003**, **Muzzi *et al.,* 2006**) mentioned that this site was better than other sites, due to the greater ease in defining the region of the sinuses and it is reducibility. The LA/AO ratio was approximately 1.0 which is similar to what reported by **(Della *et al.,* 2000 and Muzzi *et al.,* 2006**). LA/AO ratio is important for detection of left atrium/left ventricle dilatation **(Godderd BJ 1995)**. The M-mode view at papillary muscles allowed estimating systolic and diastolic function of the heart. Estimation of LVDd and LVDs showed that there was gender difference in the left ventricle dimension. Nearly the same result was mentioned by **(Boon JA 1998, and Muzzi *et al.,* 2006**). They believed that these differences were the result of work hypertrophy and the higher body weight in males than females. The percentage of EF and FS are the most commonly used clinical measurements of LV systolic function. The percentage of FS (25-45 %) which lies within the range reported by (**Della *et al.,* 2000**, **O'Leary *et al.,* 2003 and Muzzi *et al.,* 2006**). The authors mentioned that FS% is considered to be an indicator for ventricular compliance and contractility. Moreover **(O'Leary *et al.,* 2003)** mentioned that FS% is an important parameter to distinguish between hypertrophy and dilated cardiomyopathy **(Bertarelli *et al.*, 2007)**.The mitral valve view was measured from right parasternal short axis view. The normal value of E and A waves was similar to that reported by **(Muzzi *et al.,* 2006 and Yuill *et al.,* 1991)**.The result showed that, the E wave was higher than A wave **(Paddy Mannion 2006).**Doppler mode was used to evaluate the blood flow direction in mitral valve and it was performed on left parasternal apical view. It was mentioned by **(Darke PGG *et al.,* 1993 and Muzzi *et al.,* 2006**).There was no regurgitation in the mitral valve, which was in agreement with **(Singh *et al.,* 2014**).

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